CONNECTICUT RIVER FLOOD CONTROL PROJECT

ENGINEERING DIVISION
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BUSHNELL PARK PUMPING STATION

CONNECTICUT RIVER
HARTFORD, CONN.

ANALYSIS OF DESIGN

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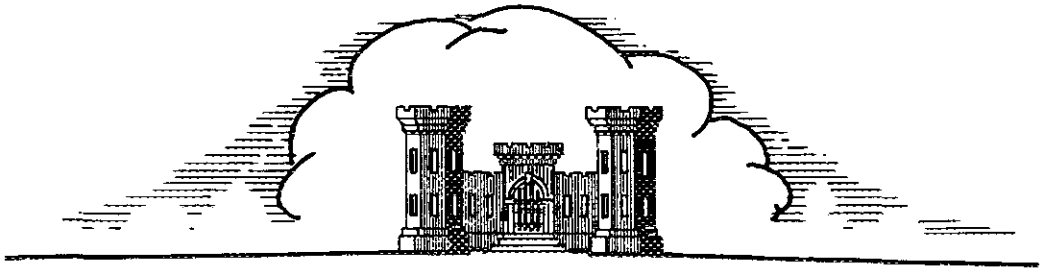

WAR DEPARTMENT CORPS OF ENGINEERS U. S. ARMY
U. S. ENGINEER OFFICE PROVIDENCE, R.I.

NOVEMBER 1944

REVISED JAN 1946

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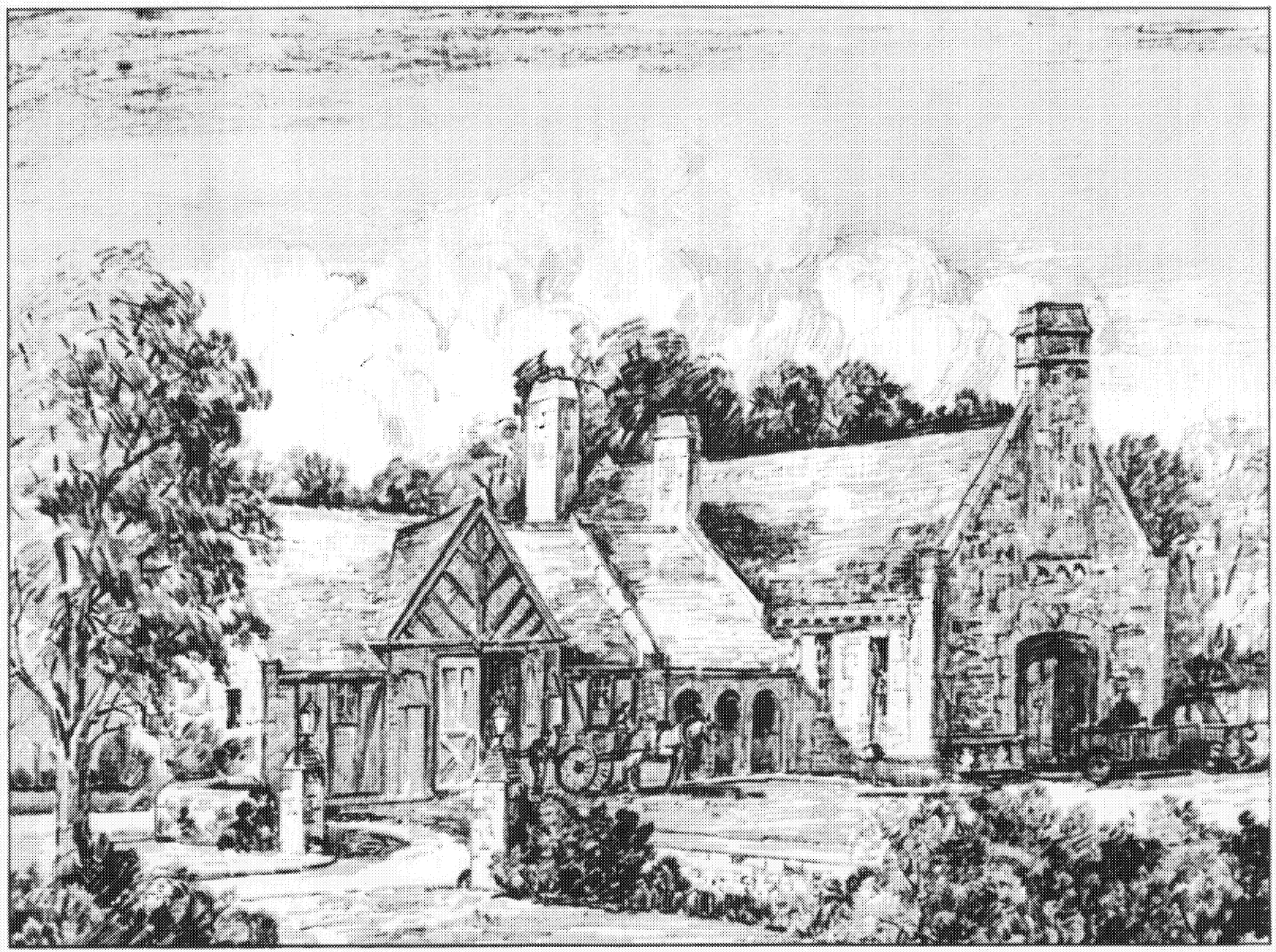

Bushnell Park Pumping Station

Hartford, Conn.

CONNECTICUT RIVER FLOOD CONTROL

ANALYSIS OF DESIGN

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

1944

(Revised November 1944)

CORPS OF ENGINEERS, U. S. ARMY

U. S. ENGINEER OFFICE PROVIDENCE, R. I.

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I. INTRODUCTION

ANALYSIS OF DESIGN

BUSHNELL PARK PUMPING STATION

I. INTRODUCTION

A. AUTHORIZATION AND PAST REPORTS. - The Bushnell Park Pumping Station is a part of the local flood protection works for the City of Hartford, as recommended by the District Engineer in the "Report of Survey and Comprehensive Plan for Flood Control on the Connecticut River Valley", dated March 20, 1937, approved by the Chief of Engineers, November 29, 1937, and published as House Document No. 455, 75th Congress, 2nd session. The project is authorized under the Flood Control Act approved June 28, 1938.

B. NECESSITY FOR THE NEW STATION. - The Park River Interceptor collects the sanitary sewage and storm run-off from an area of approximately 230 acres. During normal overflow the Park River Interceptor sewage leads to the sewage disposal plant by way of the Commerce Street Sewer near the Keeney Lane Pumping Station. During periods of heavy run-off, the Park River Interceptor will overflow into the Park River Storm Sewer which discharges into the Park River Conduit at Bushnell Park Pumping Station. During high stages of the Connecticut River and Park Rivers, this overflow sewage of the Park River Storm Sewer will be pumped into the Park River Conduit.

The war emergency precluded the construction of a permanent pumping station in the fall of 1943. A temporary pumping station was constructed to provide partial protection for the vital war industries located in the drainage area for the duration of the emergency. The temporary pumping station consists of a concrete substructure and a wooden superstructure, housing a volute pump borrowed from the North Meadows Pumping Station.

The temporary pumping station will be demolished under the contract for the construction of this station and the borrowed pumping unit returned to the North Meadows Pumping Station.

C. CONSULTATION WITH CITY OF HARTFORD. - During the design of the pumping station, consultations were held with officials representing the City of Hartford and the Flood Commission of Hartford. The proposed station layouts were studied by them, and in conference, the relative merits of the layouts and the equipment to be used were discussed in detail. The design of the pumping station as finally developed meets with the approval of the Flood Commission of the City of Hartford.

D. BRIEF DESCRIPTION OF THE STATION. - The building which will house the pumps and other equipment will consist of a reinforced concrete substructure and a single story superstructure of structural steel and brown stone. An ell will be constructed to the superstructure to provide rest rooms and storage facilities desired by the City of Hartford. The architectural treatment of this pumping station is consistent with the memorial structures in Bushnell Park and with nearby state buildings. The pumping station superstructure was designed in collaboration with this office by an architect retained by the City of Hartford. The City of Hartford will bear the difference in cost between this more expensive type of architecture together with the ell and other appurtenances not considered as essential to a more utilitarian pumping station as generally constructed by this District. The roof of the pumping station superstructure will be of slate.

The engine room on the ground floor will contain three gasoline engines and right angle gear units for the 30-inch pumps, the Diesel

engine and gear unit for the 16-inch pump, the standby unit, the overhead crane and other equipment. The substructure will be divided into a screening chamber, pump room, suction chamber, gravity flow and discharge conduits. The screening chamber will contain the mechanically-cleaned trash racks which were requested and will be provided at the expense of the City of Hartford. Gates will be installed in the screening chamber to keep it dry during periods when pumping will not be required. Three 30-inch volute pumps, one 16-inch volute pump, and a sump pump will be installed in the pump room. The discharge conduit will connect to the existing inlet at the Park River Conduit. The discharge conduit will be provided with a gate which will be closed during periods of gravity flow. The gravity flow conduit will be provided with a gate which will be closed during periods when pumping is required. On the intermediate floor of the screening chamber a room is provided for the operation of the mechanically-cleaned racks. The heating equipment for the pumping station and rest rooms will be located in a room under the ell.

II. SELECTION OF THE SITE

II. SELECTION OF THE SITE

The pumping station is located on the north side of and adjacent to the Park River Conduit at a point approximately 250 feet west of the intersection of Wells and Hudson Streets. This location was chosen for the following principal reasons: First, it is the lowest point in the drainage area; second, it is near the farthest downstream Park River interceptor overflow chamber; third, it is at the outlet of the Park River Storm Sewer which discharges into Park River Conduit; and fourth, it is the most economical site.

III. SOILS INVESTIGATIONS AND FOUNDATIONS

III. SOILS INVESTIGATIONS AND FOUNDATIONS

Foundation conditions were determined by one 2-1/2-inch bore hole, [illegible]-23, located as shown on Plate No. 11. Additional foundation information was obtained from three nearby 2-1/2-inch bore holes, also shown on Plate No. 11. Numbers in boring logs on profile shown on Plate No. 11 are those of the Providence Soil Classification described on the above noted plate and shown graphically on Plate No. 12. Soil at the time of exploration consisted of 0.5 ft. of topsoil resting over 11 feet of variable soil graded from gravel to fine silt and clay. Beneath this material is 3 feet of soft, red, varved clay, which, in turn, rests upon about 7 feet of reddish-brown cohesive glacial till. Beneath the till is shale and sandstone.

The bottom of pumping station base slab is founded upon firm shale or sandstone. No foundation difficulties are expected.

IV. HYDROLOGY

IV. HYDROLOGY

A. DRAINAGE AREA. - The Bushnell Park Pumping Station will serve a tributary drainage area of 257 acres which is shown on Plate No. 1.

1. Present conditions. - 85 percent of the area (219 acres) is fully developed by industrial and commercial interests, and the remaining 15 percent (38 acres) is park area.

2. Possible future conditions. - It is not expected that any future development in this area will either materially increase the drainage area contributing to the pumping station or the rate of run-off from the area.

B. SEWER FACILITIES.

1. Existing sewers. - The drainage area is served by a combined sewer system having the following interceptors as shown on Plate 3: the Gully Brook Interceptor, the Park River Interceptor, the Park River Storm Sewer and the Connecticut River Interceptor. When the Connecticut River is below El. 10 M.S.L., dry weather flow collected by the Park River Interceptor is diverted at Commerce Street into the Connecticut River Interceptor through which it flows to the South Meadows sewage treatment plant. When the Connecticut River reaches El. 10, a gate in the Park River Interceptor at Main Street is closed and dry weather flow above Main Street is diverted by means of overflows into the Park River conduit by way of the Park River Storm Sewer and other connections. As indicated on Plate 3 storm flow which reaches the Park River Interceptor is or will be controlled by the following:

(a) By-pass sewer and gates in siphon inlet chamber where Park River Interceptor passes under Park River Conduit.

(b) Diversion chamber at junction of Park River Interceptor, Gully Brook Interceptor and Park River Storm Sewer near Union Place.

(a) Overflow Chamber at Ann Street from Park River Interceptor to Park River Storm Sewer.

(b) Proposed Diversion Chamber at Main Street.

(c) Gate in Park River Interceptor at Main Street.

3. Existing pumping stations. - The existing Potter Street Pumping Station of the City of Hartford has two 16-inch pumps which handle sewage flow only, and three 54-inch pumps for storm water flow. These pumps are electrically driven. The temporary Bushnell Park and Sumner Lane pumping stations each have one 36" pump. The two 16" sewage pumps in the Potter Street station pump dry weather sewage flow from the East Side Interceptor, through a force main in Potter Street, into the Connecticut River Interceptor which conveys the sewage to the South Meadows treatment plant. When the Connecticut River reaches El. 16, combined flow in the East Side Interceptor and combined flow which reaches the Park River Interceptor from main sewers and laterals below the gate at Main Street are discharged by the 54" storm water pumps in the Potter Street station and the 36" pump in the temporary Sumner Lane station. Combined flow in the Park River Interceptor above Main Street is diverted into the Park River Conduit by way of bypass sewers, overflows, temporary diversion chambers and the Park River Storm Sewer. Combined flow which is conveyed by the Park River Storm Sewer to the temporary Bushnell Park Pumping Station is pumped when the Connecticut River reaches El. 17.

4. Future Development. - It is expected that any future changes to the existing sewer system will greatly increase the rate of runoff from the drainage area. The Bushnell Park Pumping Station will be located adjacent to and on the north side of the Park River

conduit near the intersection of Elm Street and Nelson Street. During flood stages it will pump the combined sanitary and storm drainage from the tributary area, shown on Plate 1, into the Rock River Conduit.

b. <u>Time of concentration</u>. - A study of the drainage system of the area shows that the probable time of concentration at the pumping station would be one hour.

c. <u>Storage</u>. - Natural surface storage is negligible and it is not feasible to create a basin for temporary storage of peak flows from the tributary area.

V. DETERMINATION OF DISCHARGE CAPACITY

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A. REQUIREMENTS FOR DISCHARGE CAPACITY. - The Bushnell Park Pumping Station will have sufficient capacity to meet the following requirements:

1. Discharge the storm run-off from the total tributary drainage area. Design criteria are as follows:

a. Run-off caused by a 1-hour storm (time of concentration of this area is approximately 1 hour) with a probable frequency of occurrence of once in 10 years, occurring in any month, when pumping against a head in the Park River Conduit with a probable frequency of occurrence of once in 10 years for that month.

b. Discharge 40 percent of the run-off from a 1-hour storm with a probable frequency of occurrence of once in 10 years, occurring in any month, when pumping against a head in the Park River Conduit with a probable frequency of occurrence of once in 1000 years, for that month.

2. Discharge the sanitary sewage from the area (computation indicates that this quantity is very small, and it would be inconsistent with the over-all accuracy of the problem to include it - hence, no further consideration is given to sanitary sewage flow).

3. Maintain the water-surface elevation in the sewers at the pumping station at or below elevation 17 feet above mean sea level, under conditions outlined in Paragraph 1 above.

B. RAINFALL. - Monthly rainfall intensity-frequency curves, Plate 7, were drawn for 1-hour storms from the 35 years of record of rainfall at Hartford. These records are complete for all months except the three

winter months of December, January, and February. Rainfall intensity-frequency values for these months were taken from the record of 1-hour storms at Providence, Rhode Island.

Month	1-hour Storm 10-year Frequency inches
January	0.55 *
February	0.44 *
March	0.43
April	0.53
May	0.63
June	1.20
July	1.50
August	1.45
September	1.10
October	0.76
November	0.52
December	0.52 *

* Rainfall intensity from Providence, R. I. records.

C. RUN-OFF COEFFICIENTS. - Coefficients of run-off were assigned to the drainage area according to the type of development and the season as shown in the following table, and a weighted run-off coefficient was obtained for each season to be applied to the drainage area as a whole.

Season	Run-off coefficient: Fully developed commercial and industrial 219 acres	Park 38 acres	Weighted run-off coefficient 257 acres
December through April	0.80	0.45	0.75
May and November	0.70	0.35	0.65
June through October	0.65	0.30	0.60

D. FREQUENCY OF RIVER STAGES. - Monthly stage-frequency curves, Plate 8, were drawn for the Connecticut River at Hartford from the 44 years of record. In order to obtain the 10-year monthly stage at the pumping station it was necessary to increase the Connecticut River stage by an amount corresponding to the 10-year monthly discharge of the Park River. Since discharge records of the Park River were available only for the period from October 1936 to June 1939, inclusive, it was impossible to determine, directly, reliable monthly discharge-frequency relations. Run-off-frequency studies, by months, of several streams tributary to the Connecticut River had previously been made by this office. Four of these streams, whose drainage areas are similar to the Park River drainage area, were chosen, and the 10-year values of one-day and two-day run-off by months were compared. A discharge-frequency curve for the Park River was drawn from the available record, and 10-year discharge values by months were obtained by comparison with the values obtained from the studies on similar streams. Using the discharge thus obtained,

and starting with the appropriate Connecticut River stage at the mouth of the Park River Conduit, backwater computations were made to the site of the proposed pumping station. In the case of the 1000-year river stages, the 1000-year Connecticut River stage was arbitrarily increased 0.5 foot to obtain the stage in the Park River opposite the pumping station.

E. REQUIRED DISCHARGE CAPACITY. - The amount of sanitary sewage from the area is a negligible quantity, therefore the required discharge capacity is based on surface run-off. The run-off from the area was determined by use of the formula:

$$Q = C\ I\ A$$

Q = discharge from the total drainage area, in c.f.s.;

C = the run-off coefficient

I = intensity of rainfall in inches per hour for the 1-hour storm

A = total drainage area tributary to the pumping station, in acres

The following table shows the relationship between the rate of run-off and the corresponding river stage.

(For table see following page)

Month	1-hr. 10-yr. intensity inches per hr.	Run-off coeff.	Run-off c.f.s.	Stage (m. s. l.) 10-year	Stage (m. s. l.) 1000-year	40% of 10-year run-off c.f.s.
January	0.55 *	0.75	106	14.0	23.8	42
February	0.44 *	0.75	85	16.0	28.3	34
March	0.43	0.75	83	23.7	40.7	33
April	0.53	0.75	102	24.0	29.4	41
May	0.63	0.65	105	18.7	22.7	42
June	1.20	0.60	185	14.0	22.0	74
July	1.50	0.60	232	10.0	21.8	93
August	1.45	0.60	224	8.5	20.8	90
September	1.10	0.60	170	10.0	35.4	68
October	0.76	0.60	117	12.0	33.8	47
November	0.52	0.65	87	14.0	31.3	35
December	0.52 *	0.75	100	16.0	25.9	40

* Rainfall intensity from Providence, R. I. records

The values given in the above table are plotted on Plate 9.

F. REQUIRED PUMP CAPACITY. - The required pump capacity is determined by means of the envelope curve, Plate 10. The required discharge capacity of the pumps, based on the design requirements used, is as follows:

River elevation m. s. l.	Discharge capacity c. f. s.
17	155
25	108
35	68

G. INSTALLED PUMP CAPACITY. - The size of pumps to be installed is dependent upon several factors. Naturally, the maximum estimated inflow is the first consideration. However, flexibility of operation, a factor of

safety to insure mechanical reliability, and available or developed pump sizes also influence the selection. The characteristics of the pumps to be installed for the case at hand are shown on Plate 17.

8. Operation. - During periods of low water (when Connecticut River stage is below elevation 17 m.s.l.) the dry weather flow is carried by the Park River Interceptor to the Commerce Street sewer and thence to the South Meadows Sewage Disposal Plant. If a storm occurs at the time part of the combined flow is diverted without treatment, through overflows into the Park River Storm Sewer and through the gravity conduit of the Bushnell Park Pumping Station into the Park River Conduit.

When the Connecticut River stage exceeds elevation 13 m.s.l., a gate on the Park River Interceptor at Main Street is closed, and sewage or combined flow from the Bushnell Park area discharges into the Park River Conduit by gravity at the Bushnell Park Pumping Station. When the Connecticut River stage increases so as to back the water level in the sewers at this point up to elevation 17 m.s.l., the pumping station will begin in operation.

The Gully Brook Conduit has been extended to and connected with the Park River Conduit. Provision has been made for diverting flow in the Gully Brook Interceptor into the Gully Brook Conduit at Walnut Street. Provision has been made also for diversion of flow from the Park River Interceptor to the Park River Conduit near the entrance of the conduit. Such diversion of flow makes it possible to reduce the area tributary to the Bushnell Park Pumping Station to that shown on Plates 1 and 2. A [redacted] diversion chamber [redacted] built by the City of Hartford will allow the flow in the Gully Brook Interceptor to be diverted through the Park River Storm Sewer and the Bushnell Park Pumping Station into the Park River Conduit. The Park River Storm Sewer will serve to carry all drainage to the pumping station.

VI. MECHANICAL DESIGN

VI. MECHANICAL DESIGN

A. GENERAL. - Prior to initiating the actual detail design of the pumping station, studies were made to determine the type of equipment to be installed. The studies recognized the fact that the area served is of an industrial and commercial nature and that the sewers have relatively flat grades with the result that material accumulates during low flows and washes out under storm flow. Predicated on these facts, the following type of equipment was selected as being satisfactory and most economical for the purpose.

Gasoline engine driven propeller pumps.

One small motor driven volute pump for dry weather sewage flow.

Hand-operated gate valves on all the pumps.

Swing check valves on all the pumps.

One 25 Kw. gasoline electric generator set.

One 5-ton overhead crane.

Motor operated sluice gates.

Cleaned bar screens.

Carbon Dioxide fire extinguisher system.

Two pipe steam heating system.

Necessary switchboard and control equipment.

Upon completion of the studies, a conference was held with representatives of the City of Hartford for the purpose of discussing all items of equipment. At that time the City representatives requested that volute pumps be used in lieu of propeller pumps, that the bar screens be mechanically cleaned, that the valves in the pump suction and discharge line be hydraulically operated and that a diesel engine be used to drive the sewage pump.

This office concurred with the request with the understanding that the City would reimburse the Government for the additional cost of the equipment that they desired over that which this office proposed to furnish. The equipment requested by the City will, in some respects, facilitate station operations. However, this office is of the opinion that the short period of annual operation does not entirely justify the additional expenditure by the Government.

B. PUMP DRIVE. - Three possible means of driving the pumps were considered; namely, electric motors, diesel engines and gasoline engines. Electric power is available in the immediate vicinity of the pumping station. However, past experience has shown that in order to be reasonably certain that the pumping station will be able to function under adverse conditions, at least two sources of power with independent transmission lines are necessary. In view of the additional cost of extending a second feeder to the station and the question of reliability of service, the proposal to employ electric power was discarded.

The possible use of diesel engines was then investigated. The conclusion reached was that the engines would be suitable, but that, except for driving the 16" sewage pump, their high first cost would not be offset by lower operating costs.

Gasoline engines of suitable characteristics can readily be obtained and at reasonable first cost. The failure of an engine, while possible, is unlikely, and the failure of two or more engines simultaneously is very remote. In the event that one engine fails, the danger of flooding while it is being repaired would be alleviated by the excess capacity of the remaining pumps over that which is required of them. Considering these factors, it was decided to use gasoline engines to drive the 36" pumps.

The gasoline engines will be of heavy duty industrial type capable of continuously driving the pumps at their rated speed under any head condition developed. The engines will not use over 85 percent of their developed horsepower at rated speed. They will be mounted on concrete bases and directly connected through disconnecting flexible couplings to the right angle gear units.

The diesel engine will be a high speed industrial type capable of continuously driving the pump at its rated speed under any head condition developed. The engine will not use over 75 percent of its developed horsepower. It will be mounted on a concrete base and directly connected through a disconnecting flexible coupling to the right angle gear unit.

C. PUMPS. - From the maximum required pumping capacity of 155 c.f.s. as determined in Section V, it was determined that provisions should be made to install three pumps. To install a larger number of pumps would materially increase the cost of the station without resulting in any great advantage and a smaller number would seriously limit the operating flexibility and reliability of the station.

No provisions were made in the capacity determined in Section V for possible mechanical failure of equipment. To provide for this contingency, it is considered necessary that any two pumps should be capable of delivering about 85 percent of the 155 c.f.s. A study of pump characteristics indicates that three 30" mixed flow volute pumps would be required; each pump to have a capacity of 66 c.f.s., or 30,000 g.p.m., with the river at Elevation 17. In addition, one 16" mixed flow volute pump having a capacity of 6,000 g.p.m. with the river at Elevation 35 will be provided to pump the sanitary sewage at such periods when the river is at flood stage.

D. RIGHT ANGLE GEAR UNITS. - The gear units will be of the self-contained type designed to transmit the power from the horizontal engine shaft through a pair of spiral bevel gears to the vertical pump shaft. The units will be inclosed in a cast iron and structural steel housing and will have a service factor of 1.25 at the maximum power required to drive the pumps under any condition of head.

E. STANDBY GENERATOR UNIT. - A gasoline engine-driven generator will be provided to furnish electric power at 120/208 volts, 3-phase, four wire, 60 cycle A.C. in the event of failure of commercial power. The unit will have a normal full-load capacity of 31 Kva., which will be sufficient to maintain in operation the electrical auxiliaries and the station lighting system.

F. CRANE. - A 5-ton overhead crane will be installed in the engine room to facilitate the repairing and installation of any items of equipment. The crane will be of standard construction, hand-operated throughout.

G. SLUICE GATES. - Two motor operated sluice gates will be located at the entrance to the pump suction chamber. These gates will normally be kept closed to prevent water from collecting in the suction chamber. They will be opened only at such periods as is necessary to operate the pumps. A third motor operated gate will be located at the end of the pump discharge conduit; this gate will be opened only when the pumps are being operated. A fourth gate will be located in the gravity discharge conduit to prevent back flow during periods when pumping is necessary. This gate will normally be kept open to permit water to flow by gravity to the Park River Conduit.

H. WATER SYSTEM. - The City water supply will be connected to the pumping station and will be used for cooling the gasoline engines and operating the hydraulic gate valves on the 30" pumps.

I. FUEL SYSTEMS. - Gasoline will be stored in a 3000 gallon tank, and diesel oil will be stored in a 1000 gallon tank. Both tanks will be buried in the ground adjacent to the building. Each engine will be supplied through an individual line running directly to its respective fuel tank. Drip pans will be provided on each gasoline engine carburetor and connected to a common header returning to the gasoline tank. All interior piping will be 3/4 inch inside diameter, copper tubing with flared joint fittings, exterior piping will be wrought iron. At points where the fuel lines are embedded in concrete or pass throughout beams or walls, they will be protected by wrought pipe sleeves.

J. SUMP PUMP. - A sump pump having a capacity of 100 g.p.m. will be located in the pump room. This sump pump will be used to keep the pump room dry and will also be used to unwater the suction chamber.

K. VALVES. - Gate valves on the 16" sewage pump will be hand operated. The gate valves for the 30" pumps will be hydraulically operated, using City water pressure. Swing check valves will be provided to prevent reverse rotation of the gear units and gasoline engines in the event that an engine stalls. In addition, their use will facilitate the starting of the units.

L. MECHANICALLY CLEANED BAR SCREENS. - Two six-foot wide, mechanically cleaned, bar screens will be installed directly behind the sluice gates at the entrance to the suction chamber.

M. FIRE EXTINGUISHER SYSTEM. - A carbon dioxide fire extinguishing system will be installed and so arranged that any gasoline engine can be blanketed with gas by tripping a valve just inside the main entrance to the building. Portable extinguishers will be provided to care for any other emergencies.

N. HEATING SYSTEM. - The heating system will be a two pipe gravity system consisting of an oil-fired boiler supplying steam to unit heaters and radiators. The oil burner will be of the automatic pressure atomizing type with constant electric ignition. The unit heaters will be of ample capacity to heat the engine room under the coldest weather conditions.

O. POWER SOURCE. - Power requirements for the station will be approximately 30 Kw. Power will be delivered to the station at 120/208 volts, three phase, 60 cycle over a four-wire grounded system directly from the Utility Company's underground power system. Power will be taken to the station through an underground feeder.

P. SWITCHBOARD AND CONTROL EQUIPMENT. - The switchboard will be of the dead front, steel enclosed, low-voltage type with all controls and meters flush mounted on the front. All air circuit breakers will be manually operated. Circuit breakers for the incoming feeder and standby generator feeder will be rated 600 volts, 60 cycles, A.C. provided with instantaneous and time-delay magnetic overcurrent trips and interlocked so that only one breaker can be in the closed position at any one time. All breakers operating three phase circuits will be rated 600 volts, 60 cycles, A.C. of suitable ampere rating.

Three distribution panelboards will be installed in the station to distribute power to the various light, receptacle, fan and heater circuits.

VII. STRUCTURAL DESIGN

VII. STRUCTURAL DESIGN

A. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - The structural design of the Bushnell Park Pumping Station has been executed in general in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5	pounds per cubic foot
Dry earth	100	do
Saturated earth	125	do
Concrete	150	do
Brick	120	do
Stone	160	do

3. Earth pressures. - For computing earth pressure caused by dry earth Rankine's formula was used. For saturated soils an equivalent liquid pressure of 80 pounds per square foot per foot of depth was assumed.

4. Structural steel. - The design of structural steel was carried out in accordance with the standard specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

5. Structural Timber. - The design of structural timber was carried out in accordance with the standards of construction and allowable stresses of the Manual of the Southern Pine Association.

a. Allowable working stresses.

Extreme fibre stress in bending - 1400 lbs. per sq. in.

Compression parallel to grain - 1000 do

Compression across the grain - 380 lbs. per sq. in.

Horizontal shear - 100 do

6. Structural aluminum. - The aluminum framing for the gate stands in the screening chamber was designed for a maximum stress in bending of 18,000 lbs. per sq. in.

7. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937.

a. Allowable working stress. - The allowable working stress in concrete used in the design was based on a compressive strength of 3,000 pounds per square inch in 28 days.

b. Flexure (fc). -	Lbs. per sq. in.
Extreme fibre stress in compression	800
Extreme fibre stress in compression adjacent to support of continuous or fixed beams or rigid frames.	900

c. Shear (v). -

Beams with no web reinforcement and without special anchorage	60
Beams with no web reinforcement but with special anchorage of longitudinal steel	90
Beams with properly designed web reinforcement but without special anchorage of longitudinal steel	180
Beams with properly designed web reinforcement and with special anchorage of longitudinal steel	270

	Lbs. per sq. in.
Footings where longitudinal bars have no special anchorage	60
Footings where longitudinal bars have special anchorage	90

d. Bond (u). -

In beams, slabs, and one way footings	100
Where special anchorage is provided	200

The above stresses are for deformed bars.

e. Bearing (fc). -

Where a concrete member has an area at least twice the area in bearing	500

f. Axial compression (fc).

Columns with lateral ties	675

g. Steel stresses.

Tension	20,000
Web reinforcement	16,000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Interior slabs	1
Interior beams and walls	2
Members poured directly against the ground . . .	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

B. BASIC ASSUMPTIONS FOR DESIGN. -

1. a. Roof framing. - The roof framing will consist of steel trusses and steel purlins over the pumping station, the stair hall and comfort station with tie rods where needed, and of timber trusses, wood rafters and wood purlins over the store room. An open grating cat-walk in the plane of the bottom chords of engine room roof trusses has been provided to permit servicing of the mufflers and exhaust fan located at this elevation. A cat-walk has also been provided in the plane of the bottom chords of the trusses over the stair hall to permit servicing the motor and exhaust fan, which ventilates the toilets.

b. Roof loading. - The roofs were designed for the following loads.

The estimated deal loads.

Live load of 10 lbs. per sq.ft. of roof area.

Wind load 20 lbs. per sq. ft. normal to surface of the roof.

2. Steel columns. - Structural steel columns take up all dead, live and wind loads. In addition, the columns in the side walls of the Pumping Station will carry crane brackets which support the crane runway. These columns are designed to carry full live and dead load from the roof; dead load, live load and impact effect from the traveling crane; bending due to eccentrically applied loads, and bending due to crane thrust and roof wind loads. It is assumed that the wind load on the walls of the pump room will be taken up by the wall masonry.

a. Allowable unit stress in columns was figured from the

formula $f = 17000-0.485\left(\frac{l}{r}\right)^2$ for dead loan plus live load. For combined dead load, live load, and wind load; the allowable stress was increased by 33%. Maximum l/r was limited not to exceed 120.

b. Because of clearance required for the travelling crane and the low eave line made necessary by architectural requirements it was not possible to brace the pumping station building transversely by means of knee braces from columns to trusses. Knee-braces were therefore omitted and all wind load on the roof and walls was assumed to be transferred into the columns by shear and from the columns into the foundations by means of properly designed column anchorage.

c. In the store room the two interior trusses are supported on 8" steel H columns which were designed to take in addition to the live and dead load, all wind load from the intermediate trusses and exposed wall surfaces. The trusses are connected to the tops of the columns with 2 - 5/8" bolts and the columns themselves securely anchored to the foundation. No such columns were deemed necessary for the two end trusses since these carry much less wind load and are located close to the faces of solid masonry walls which posses great transverse stiffness.

3. Engine room floor. - The engine room floor is designed to carry all engines, motors, etc., actually to be placed on the floor as well as a uniform live load.

The following assumptions were made for design purposes.

a. For flood slabs and removable steel floor plates above the pump room, the design loads are the dead load of the slab plus a uninform live load of 300 lbs. per sq. ft. except where concentrated machinery loads occur. Weight of 1-1/2 inch concrete fill plus tile was considered part of the live load. Deduction of the dead load of concrete fill plus tile will still leave a net live load capacity ample to take any likely loading condition.

b. For the floor beams, the design loads are the estimated dead loads, the actual machinery loads, a concrete base slab load under the gasoline and diesel engines, and a uniform live load on the unoccupied portion of the floor slabs which contribute loads to the beams under consideration. The uniform live load for beams over the pump room is 250# per sq. ft. including the weight of 1-1/2 inches of concrete fill plus tile. For the machinery loads, an impact factor of 100 percent has been added.

4. Screening chamber slabs and beams. - a. The screening chamber deck slab is designed for the estimated deadload plus a uniform live load of 250 lbs. per sq. ft. except for the short slabs between the large hatchway openings and the openings for the gates which were designed for a uniform live load of 825 lbs. per sq. ft. in order to take a possible gate load. The deck beams are designed for dead load plus a uniform live load of 250 lbs. per sq. ft. except beams adjacent to the gate openings which were designed for a live load equal to the weight of the gate.

b. The screening chamber floor slab was designed for dead load plus a uniform live load of 300 lbs. per sq. ft. which is considered ample to cover all likely loading conditions. The floor beams are designed for dead load plus a live load of 250 lbs. per sq. ft.

5. Comfort station and store room floors.

a. The comfort station floor slabs and beams were designed for estimated dead loads plus a uniform live load of 100 lbs. per sq. ft.

b. The storeroom floor slab was designed for dead load plus a uniform live load of 125 lbs. per sq. ft.

c. The beams under the toilet rooms, stairwell and porch frame into a division wall built on top of the outer edge of the Park River Conduit. In order to insure stability for this division wall, three longitudinal tie walls were placed below the store room floor. These longitudinal walls will hold the division wall securely in place and provide supports for the storeroom floor slab.

6. Floor at elevation + 16.50. - a. The floor at elevation + 16.50 is located between the Park River Conduit and the pump room and was designed as a framed floor carried by the pump room wall and by columns carried to rock. This was considered necessary in order to prevent floor settlement later where the floor slab is to be poured on fill.

The following assumptions were made in the design of the slabs and beams:

a. The slabs were designed for dead load plus a live load of 125 lbs. per sq. ft. The slab supporting the boiler was designed for the dead weight of the boiler, a live load on the remainder of the floor and dead load of the slab.

b. The floor beams were designed for dead load plus a live load of 125 lbs. per sq. ft.

7. Concrete columns and footings. - a. The columns supporting

the floor at elevation + 16.50 were designed as tied columns subjected to both direct load from the structure above and to bending caused by unequal lateral thrust on the sides. A value of 10 was the maximum permitted for l/d in the design. Spread footings provide a stable base for anchorage of the columns.

b. Tied concrete columns were also designed to support the framing of the screening chamber stairway, the main entrance slab and the storage tank for diesel oil. In each case the bottom of the column is supported on the roof of a conduit below. It was deemed advisable to use columns rather than to cantilever this framing from the pump room walls because of the large bending movements which would have been created in the walls.

8. Substructure. - The substructure is of reinforced concrete and consists of the pump room, screening chamber, suction conduit, gravity flow conduit, discharge conduit, gate chambers, boiler room, and main stairwell. The loading consists of the vertical loads, the horizontal thrusts against the walls from earth and water pressure, uplift on the base slab from hydrostatic head, and bursting pressure in the discharge conduit. As the base slabs of the structure are to be built on solid rock or on concrete fill extending to solid rock, it was assumed that all the vertical loads from the walls of the substructure would be transmitted to the rock directly at the base of the walls. This will give a maximum bearing pressure on the rock not exceeding 12000#/sq.ft. The base slab was therefore designed to withstand only uplift which was taken as full hydrostatic head from ground water level to the bottom of the slab. Finished ground elevation will be approximately at + 27.0 while the bottom of the pump room floor

is at elevation - 1.75. Ground water was assumed as reaching elevation + 17.0.

a. Pump room. - The side walls and base of the pumping station where no conduits occur were designed as one continuous monolithic section hinged at the engine room floor slab. Where the discharge and suction conduits occur they were designed monolithic with the walls and base slab of the pump room. The west wall of the pump room was designed as a vertical beam hinged at the top and fixed at the base. The east wall was designed monolithic with the gravity flow conduit fixed at the base and hinged at the engine room floor slab. The two gate chambers were designed as horizontal "U" Sections with the legs fixed at the pump room walls.

b. Screening chamber. - The portion of the screening chamber wall extending from the pump room wall to the top of the incline in base slab was designed monolithic with the gravity flow conduit, fixed at the base, supported at the screening chamber floor and hinged at the top. The remaining portion of the east and the west walls of the screening chamber was designed as a monolithic frame hinged at the top. Points of support were assumed at the dividing wall, and floor slab at elevation + 19.0. The north wall of the screening chamber was designed continuous with the roof, wall and base of the intake conduit. The section was figured hinged at the top and the base fixed at the gates. The reaction at this point of fixity was taken up in beam action in the base slab.

c. Gravity flow conduit. - The major portion of the gravity flow conduit has already been covered in the screening chamber and east wall of the pumping station designs. The portion of the gravity flow conduit extending from the screening chamber to the connection with the

existing sewer was designed as a "U" Section with both legs considered fixed. The vertical reactions at these points were taken up by beam action in the roof and base slab. Due to the excessive load on the roof slab, it was necessary to use a steel "WF" section to take up this action.

d. Park River Conduit connection. - It is expected that some damage will be caused to the copper water stop at the Park River Conduit connection when the temporary Bushnell Park Station is demolished. It is intended to repair this water stop as much as possible but to further insure against leakage from the high hydrostatic head in the conduit, a reinforced concrete collar was designed to cover the joining of the new conduit to the Park River Conduit connection.

e. Outside walls of boiler room and stairwell. - The outside walls of the boiler room and stairwell were designed as simply supported at top and bottom.

9. Waterproofing. - Three-ply membrane waterproofing is called for to be placed over the outer surface of the substructure walls of the pumping station and screening chamber. The floor slab at elevation + 16.5 is to be protected by 4-ply membrane waterproofing to insure against water coming through the 8-inch slab. Waterproofing will be omitted for the suction, gravity flow, and discharge conduits and the gate chamber walls as well as the walls of the screening chamber below elevation + 19.17.

10. Stairways and ladders. - A concrete stairway is provided for access to the screening chamber. A pressed steel stairway provides access to the boiler room and to an open grating stairway to the pump room floor. Steel ladders are provided in each gate well, from the screening chamber floor to the bottom of the intake room floor. Access to the catwalk

in the pump room and to the catwalk for the blower in the left above the comfort station are also provided by means of steel ladders.

11. Mechanically cleaned bar screens. - The screens are mechanically operated. Recesses were provided in the walls and base slab for the screens to be slid into place and grouted in.

12. Steady beams. - Steady beams are required to support the shafts from the right angle gear units to the pumps. Each beam is made of two 10 inch steel channels connected with batten plates and lattice bars to form a steel horizontal girder. The component parts of the steady beam are bolted together throughout.

13. Effect of loads on Park River Conduit roof. - Where the middle columns of the storeroom load the roof of the Park River Conduit spread footings 5'-6" were used to distribute the load into the roof. An analysis of all dead loads plus a live load of 125# per sq. ft. on the floor and apron that will load a 5'-6" wide strip under the outside wall of the storeroom gives an equivalent uniform load of 770 lbs. per sq. ft. The conduit at this location was designed to support a live load of 800# per sq. ft. over the full width of roof over both barrels and also for the condition of a live load of 800# per sq. ft. on the roof of one barrel and 400# per sq. ft. over the roof of the other barrel. The condition of loading which will exist when the new station is constructed will almost exactly approximate the second condition of loading.

14. Aluminum beams in screening chamber. - In the screening chamber at elevation 22.20 structural aluminum channels provide support for the gate stand and the checkered plate platform. Aluminum was used because of its lightness and ease in handling since these beams will have to be taken out if gate is removed. Aluminum was also used because of its corrosion resisting qualities.

C. ARCHITECTURE. - The building will contain a pumping station, men's and women's comfort stations and a storeroom for use by the Park Department of the City of Hartford. The exterior architecture of the building is commonly known as Queen Anne style and includes oak half timberwork, brick and brownstone face exterior walls. The City of Hartford has retained the services of a consulting architect for the building and has agreed to reimburse this office for all increased costs over a standard design. The building will be of satisfying appearance free of emphasis on decorative features.

The pumping station is 28'-6" by 61'-3" outside dimensions and will be of brick and brownstone exterior walls with gable ends, slate shingles on 2" gypsum plank and steel roof trusses supported on steel columns. The floor of the engine room will be quarry tile while the interior face of the walls will be glazed brick wainscote approximately 5'-0" high and painted common brick for the remaining heights of walls.

The gable roof will provide space for the mufflers and exhaust piping. Engine exhaust gases will be discharged through two chimneys. A ventilator will be installed in one end of the gable roof of the pumping station to remove air heated by the engine mufflers, and exhaust piping.

The engine room floor will be an 8-inch structural concrete slab. The hand-operated traveling crane of 5 tons lifting capacity will operate for the full length of the Engine Room and will be used for the installation and removal of pumps and heavy equipment. Access for the crane hoist to the pump room will be through openings in the Engine Room floor, covered with removable steel floor plates.

The Engine Room will be lighted by commercial projected, glazed steel sash. Wood casement sash with screens will be provided in the storeroom, and men's and women's toilets.

Three doors will give access to the Engine Room. Two of these doors will occur in the interior of the building and will be hollow metal construction consistent with the character of other structures in the vicinity. The main entrance to the engine room will be approximately 8'-8" wide and 11'-6" high, with oak doors, 1/4" wrought iron bound exterior for ornamentation and 24 gage sheet metal covering on the interior faces. The doors consist of two hinged leaves each 4'-4" wide. Access to the screening chamber room will be by stairway from Elevation 27.83 down to the screening chamber floor.

The men's and women's toilets will have ceramic tile floors, marble wainscote and plaster walls and ceilings. The toilet partitions will be marble.

The storeroom will have a brownstone faced fireplace, ornamental wood trusses, and paving brick floor on a sand bed over structural concrete slab.

The toilet rooms will be ventilated by a blower and duct system which will exhaust through a cupola in the roof. Access to the roof space and blower will be by means of a steel ladder and a catwalk carried on the bottom chords of steel trusses.

VIII. CONSTRUCTION PROCEDURE

VIII. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - The schedule of work will require the contractor to complete the pumping station and appurtenant works in 400 calendar days after receipt by the contractor of notice to proceed.

B. CONCRETE CONSTRUCTION.

1. Composition of concrete. - The concrete will be composed of cement, fine aggregate, coarse aggregate and water so proportioned and mixed as to produce a plastic, workable mixture. All concrete will be Class A except the pumping station base slab which will be Class B. Class A concrete will have an average compressive stress of not less than 3400 lbs. per square inch in accordance with a standard 28-day test. The average compressive stress for Class B concrete will be 3000 lbs. per square inch in accordance with a standard 28-day test. Concrete aggregates will be suitable quality and will be tested by the Central Concrete Testing Laboratory at Mt. Vernon, New York.

2. Laboratory Control. - A small concrete testing laboratory will be available in the Hartford Area to control the quality of the concrete during construction. The tests performed here will supplement those made at the Central Laboratory. Facilities will be available for testing the gradation of aggregates, designing concrete mixtures, mixing trial batches for the purpose of developing actual relations between the compressive strength and the water cement ratio, and the casting of concrete cylinders for compressive strength tests.

a. Cement. - Cement will be tested by a recognized testing laboratory and results of these tests shall be known before the cement is used. True Portland Cement of a well known and acceptable brand will be used throughout.

b. Fine aggregate. - Natural sand will be used as a fine aggregate. The aggregate will be subject to thorough analysis, including magnesium sulphate soundness tests, and tests made on motar specimens for compressive strength.

c. Coarse aggregate. - Washed gravel or crushed stone of required sizes will be used as coarse aggregate. It will consist of hard, tough and durable particles free from adherent coating and will be free from organic matter. Only a small amount of soft friable, thin or elongated particles will be allowed. The aggregate will be subject to accelerated freezing and thawing tests and to thorough analysis, including magnesium sulphate tests for soundness.

d. Water. - The amount of water used per bag of cement for each batch of concrete will be predetermined; in general, it will be the minimum amount necessary to produce a plastic mixture of the strength specified. Slump tests will be required in accordance with the specifications.

3. Field Control.

a. Storage. - The concrete components will be stored in a thoroughly dry, weather-tight and properly ventilated building. The fine and coarse aggregates will be stored in such manner that inclusion of foreign material will be avoided.

b. Mixing. - The exact proportions of all materials in the concrete will be predetermined. The mixing will be done in approved mechanical mixers of a rotating type and there will be adequate facilities for accurate measurements and control of each of the materials used in the concrete. Mixing will be done in batches of sizes as directed and samples will be taken for slump tests and for compressive strength tests. Inspectors will at all times supervise and inspect the mixing procedure.

c. Placing. - Concrete will be placed before the initial set has occurred. Forms will be clean, oiled, rigidly braced and of ample strength. Concrete poured directly against the ground will be placed on compacted, damp surfaces. Mechanical vibrators will be used and forking or hand spading will be applied adjacent to forms for exposed surfaces to insure smooth even surfaces. The location of vertical and horizontal construction joints, as well as expansion and contraction joints, and the location of copper water stops, are indicated on the drawings. The locations of construction joints are tentative and may be changed to suit conditions in the field. Before placing concrete, all reinforcing steel will be inspected and the pouring of the concrete will be supervised and directed by Government inspectors. Adequate precautions will be taken to protect the concrete from weather.

C. STRUCTURAL STEEL CONSTRUCTION. - Structural steel construction consists of the frame work for the superstructure, stairways and the miscellaneous frames, angles, checkered plates, crane rails, railings and ladders.

1. Superstructure framework. - The superstructure framework consists of steel trusses, beams and columns except in the storeroom where the roof framing consists of timber trusses, wood rafters and purlins. The steel trusses over the engine room will be bolted to the tops of the steel columns with turned bolts while the columns will be anchored to the concrete sub-structure with substantial anchor bolts. Steel trusses in other parts of the building will in general be carried on steel beams which in turn will frame into steel columns. The trusses will be braced with horizontal and vertical steel bracing to provide a rigid frame-work, this

bracing also serving as erection bracing for the trusses before the roof is on the building enclosed. A crane runway in the engine room will provide support for the 5-ton hand-operated travelling crane. The runway beams will be carried on steel cantilever brackets attached to the columns, with the runway rails clipped to the runway beams with bent hook bolts. Crane stops at each end of the runway will prevent the crane from running into the end walls.

2. Stairways. - The stairway in the pump room will have open grating steel treads supported on steel channels and provided with a pipe railing. The stairway to the boiler room floor level will be of pressed steel channels, concrete-filled treads and will have cast-in-place non-slip nosings. It will be provided with an ornamental railing and wood handrail.

3. Removable plates. - Access openings for the crane to the pump room will be covered with removable checkered floor plates. Angles welded to checkered plates will provide added strength and stiffness. Access to the pipe trench in the store room will be obtained by means of removable checkered plates. The gallery between the men's and women's toilets will have removable open gratings to permit servicing of plumbing. Removable checkered plates will be provided over the openings in the deck of the screening chamber. These screening chamber plates will be bolted to the frame and to each other with closely spaced bolts in order to obtain a water-tight connection. A poured-in-place mastic filler in the joints between plates will help to provide watertightness. The gate-wells will be provided with removable checkered plates to permit removal of the gates. In the discharge conduit gatewell a checkered cover plate will be provided at elevation 21.67 and will be securely bolted to the frame by means of bronze bolts and steel nuts closely spaced to provide water-tight

joints capable of withstanding a head to elevation 44.0. A gasket will be provided between the plates and angle frame.

4. Miscellaneous angles, frames, and catwalks. - Miscellaneous structural steel such as door frames, angles, grilles, etc., will be erected and placed as indicated on the drawings and at such time as required.

D. STRUCTURAL TIMBER CONSTRUCTION. - Structural timber construction consists of the wooden roof trusses, purlins, rafters and roof planking over the storeroom. Trusses will be securely anchored in place by means of strap anchors.

E. STRUCTURAL ALUMINUM. - Structural aluminum consists of channels, plates and bolts for the framing supporting gate stands in screening chamber.

F. CONSTRUCTION PERIOD. - A study of hydrographs of the Connecticut River plotted from data recorded by the United States Weather Bureau from 1917 to 1938, a total of 22 consecutive years, shows that the majority of the floods at Hartford occur in the spring months of March, April and May. Any rise in the stage of the Connecticut is reflected in a rise in the stage of Park River at the Bushnell Park Pumping Station site. The ground elevation at the site of the pumping station is about 23.0 M.S.L. With the exception of 1930, it will be noted that floods have reached elevation 18.0 M.S.L. or more, every spring. However, between May 15 and December 1 only twice has the peak of any flood reached elevation 20.0 M.S.L. as follows:

Date	Elevation of High Water
November 8, 1927	29.2
September 23, 1938	35.4

Consideration of this matter including a study of the flash floods which occur throughout the year on Park River leads to the conclusion that protection of the construction work to elevation 26.0 M.S.L. will probably be sufficient.

It is proposed to have the work carried out approximately in accordance with the following construction table:

Designation	Quantity	Time Limits Of Operation	No. of Working Days	Daily Rate of Construction	Remarks
Common Excavation	6400 c.y.	No date	20	320 c.y.	
Rock Excavation	680 c.y.	No date	20	34 c.y.	
Removal of wooden Superstructure & Masonry Substructure	Job	No date	40	-	
Concrete in Substructure	1350 c.y.	No date	40	34 c.y.	
Backfill	2500 c.y.	No date	10	250 c.y.	
Structural Steel Construction	Job	No date	25	-	
Superstructure	Job	No date	175	-	
Installation of Equipment	Job	No date	50	-	
Job Completed	-	No date	300	-	

G. INSTALLATION OF EQUIPMENT. - The installation of the electrical and mechanical equipment will be completed within the 300 days allowed for the construction of the station.

H. INSPECTION AND TESTS. - Field inspection of all portions of the construction work will be made. Progress reports including log of work accomplished and of the number of workers on the job will be made. Field and laboratory tests of concrete and other materials will be made in order to control the quality of the work.

IX. SUMMARY OF COST

IX. SUMMARY OF COST

The total construction cost of the Bushnell Park Pumping Station and mechanical equipment has been estimated to be $309,800 including 15 percent for engineering and 10 percent for contingencies.

This amount has been distributed as follows:

(1)	Pumping Station	
	a. Removal of temporary station	1,485
	b. Concrete features	76,000
	c. Superstructure	84,620
	d. Miscellaneous	10,985
(2)	Mechanical equipment	136,710
	Total	309,800

(1) a. The removal of the temporary station included under the pumping station Item (1) a. consists of the removal of the wooden superstructure and the concrete substructure.

(1) b. The concrete features included under the pumping station consist of the intake structure, screening room, building foundation to and including the operating floor slab and the gravity conduit.

(1) c. The superstructure consists of the complete building above the operating floor.

(1) d. Miscellaneous items are common excavation and backfill, miscellaneous iron and steel, and other items not included in (1) a. (1) b, and (1) c.

(2) The mechanical equipment consists of pumps, gasoline and diesel engines, electric motors, gear units, crane, check valves, valves and piping, gates and miscellaneous items.

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ANALYSIS OF DESIGN

BUSHNELL PARK PUMPING STATION

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5.	Hydrograph - Connecticut River #2
6.	Hydrograph - Park River
7.	Rainfall Intensity Frequency Curves
8.	Stage Frequency Curves
9.	Stage Duration Curve
10.	Required Pump Capacity Curve
11.	Subsurface Explorations
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13.	First Floor Plan - Architectural
14.	East Elevation
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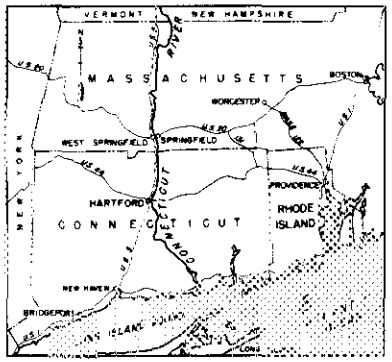
19.	General Arrangement of Equipment No. 3
20.	Output of Pumps
21.	Organization Chart

WAR DEPARTMENT

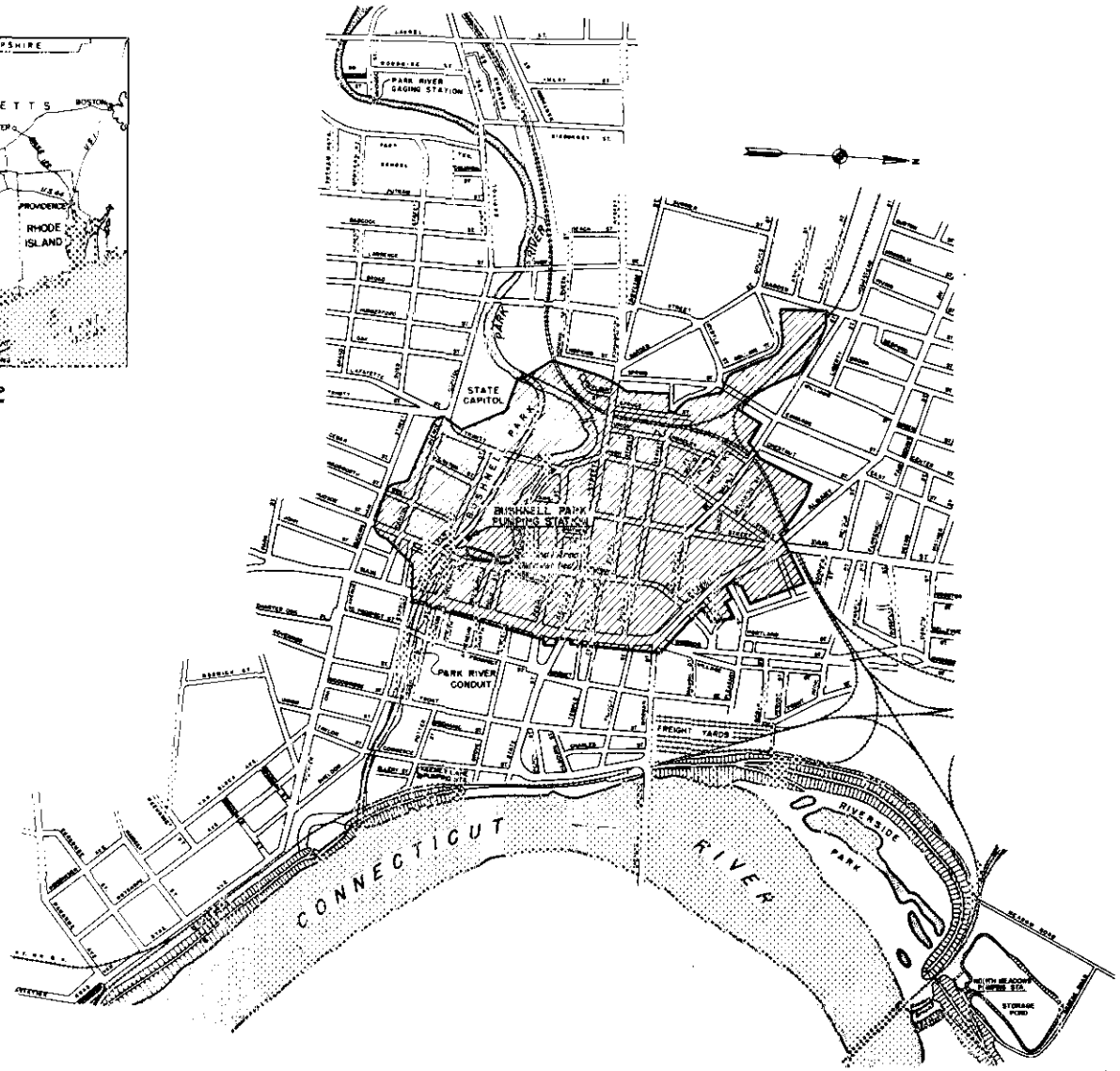
CORPS OF ENGINEERS, U. S. ARMY

A OF D Ht. 12



LOCATION MAP

SCALE OF MILES



LEGEND

Limits of Drainage Area for Bushnell Park Pumping Station

Spoil Area

KEY	DATE	REVISION (Indicated by △)	REVISN	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

PROJECT LOCATION AND INDEX

PARK RIVER CONNECTICUT

IN 72 SHEETS SCALE: 1 IN = 500 FT. SHEET NO. 1

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., NOV. 1944

SUBMITTED: PROJECT ENGINEER

APPROVAL RECOMMENDED: HEAD ENGINEER CHIEF, ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS DISTRICT ENGINEER

PREPARED: PROJECT MGR. NO. 3

DRAWN: H.S.B. TRACED: H.R.R., A.C.T. CHECKED: H.F.

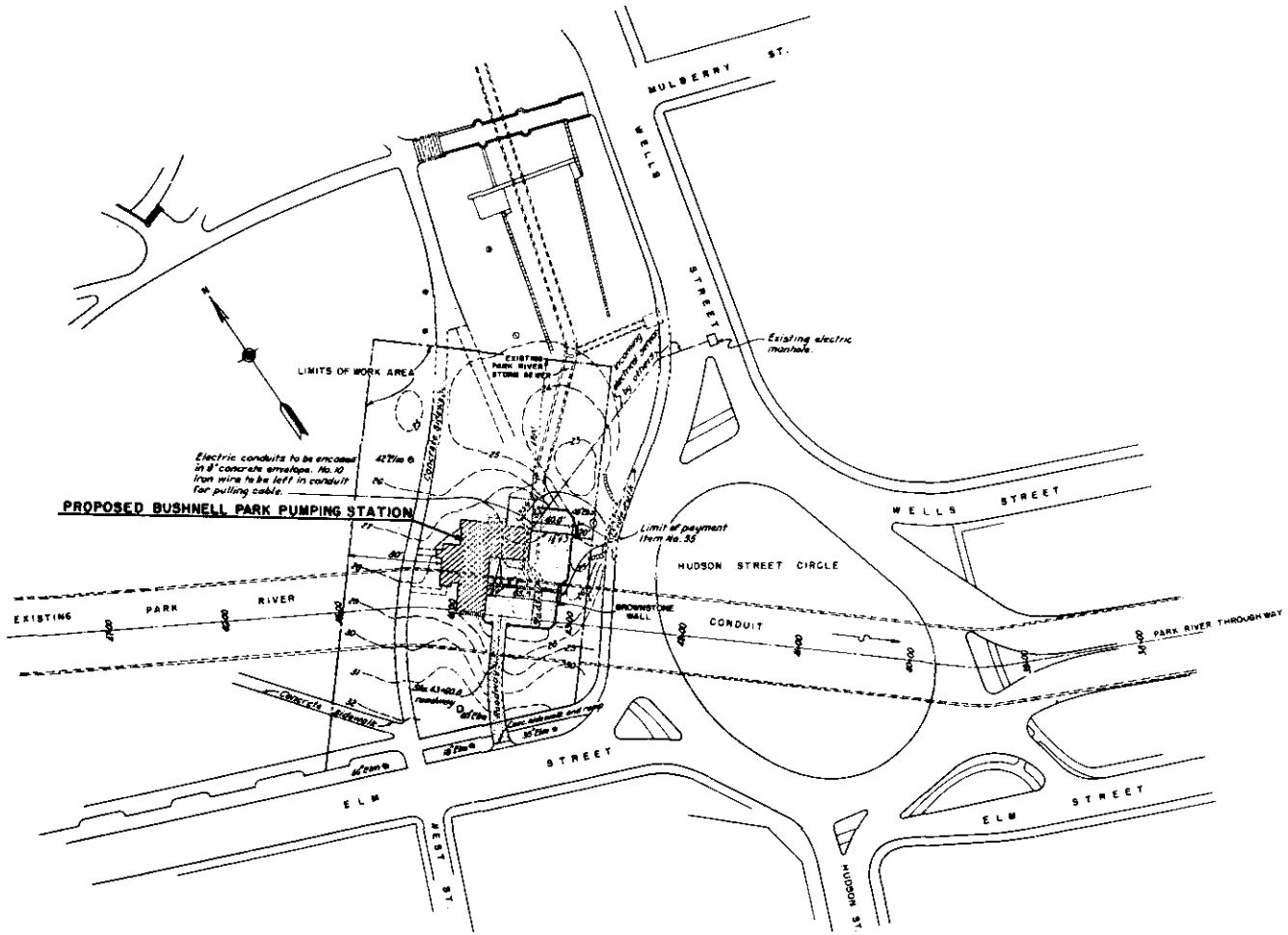
FILE NO. CT-4-3327

PLATE NO. 1

Ht. 12

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES

Electrical work on this sheet to be paid for under Item No. 35

Proposed grading shown - - - 30

For limits of grading under this contract see Sheet No. 7

KEY	DATE	REVISION (Indicated by △)	REVISED	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

GENERAL PLAN

PARK RIVER CONNECTICUT

IN 71 SHEETS SCALE: 1 IN. = 40 FT. SHEET NO. 6

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., NOV. 1944

SUBMITTED: P. C. Hanscomb, PROJECT ENGINEER

APPROVAL RECOMMENDED: HEAD ENGINEER, CIVIL ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED: PROJECT UNIT NO. 5

DRAWN: M.H.L. TRACED: A.C.T. CHECKED: W.H.

FILE NO. CT-4-3328

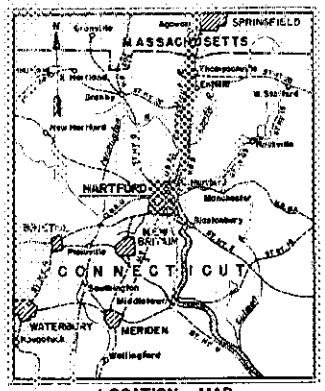
A. OF D. Ht. 12

PLATE NO. 2

Ht. 12

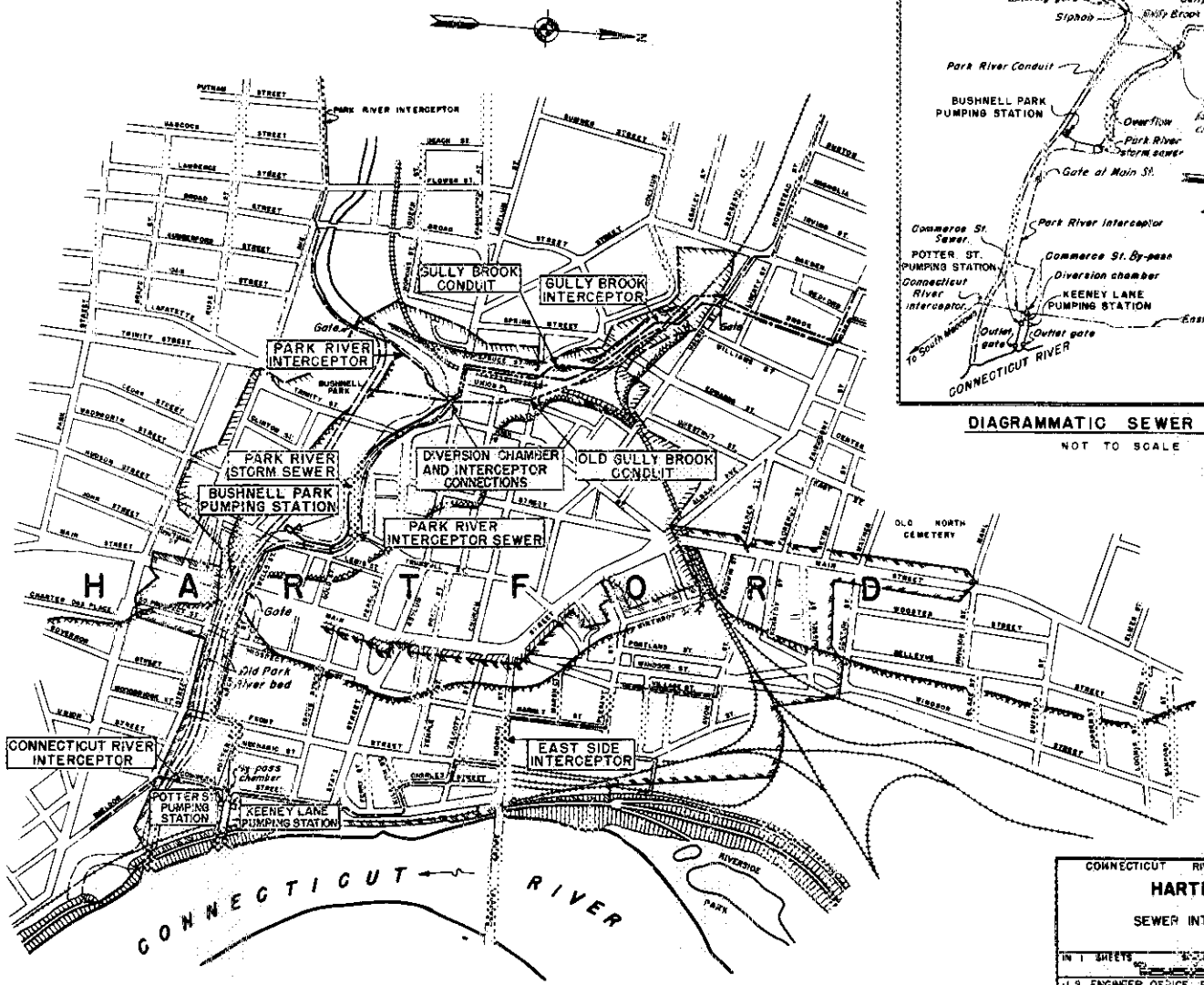
WAR DEPARTMENT

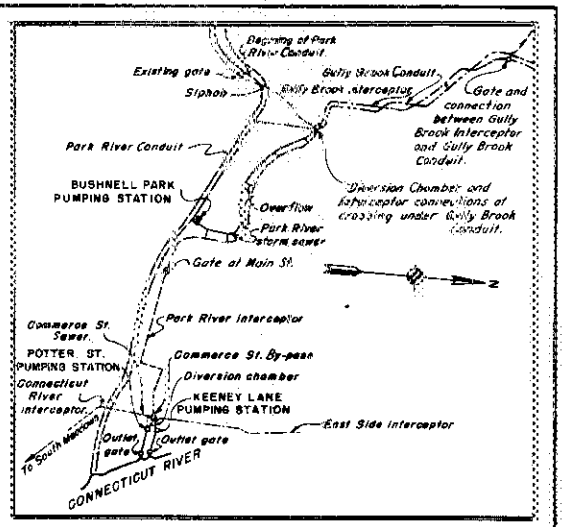
CORPS OF ENGINEERS, U. S. ARMY



LOCATION MAP

SCALE: 1 IN. = 8 Miles





DIAGRAMMATIC SEWER LAYOUT

NOT TO SCALE

LEGEND

- Area subject to flooding
- Limits of area served by Bushnell Park Pumping Station
- Limits of area served by Keeney Lane Pumping Station

CONNECTICUT RIVER FLOOD CONTROL

HARTFORD, CONN.

SEWER INTERCEPTOR PLAN

IN 1 SHEETS SHEET NO. 1

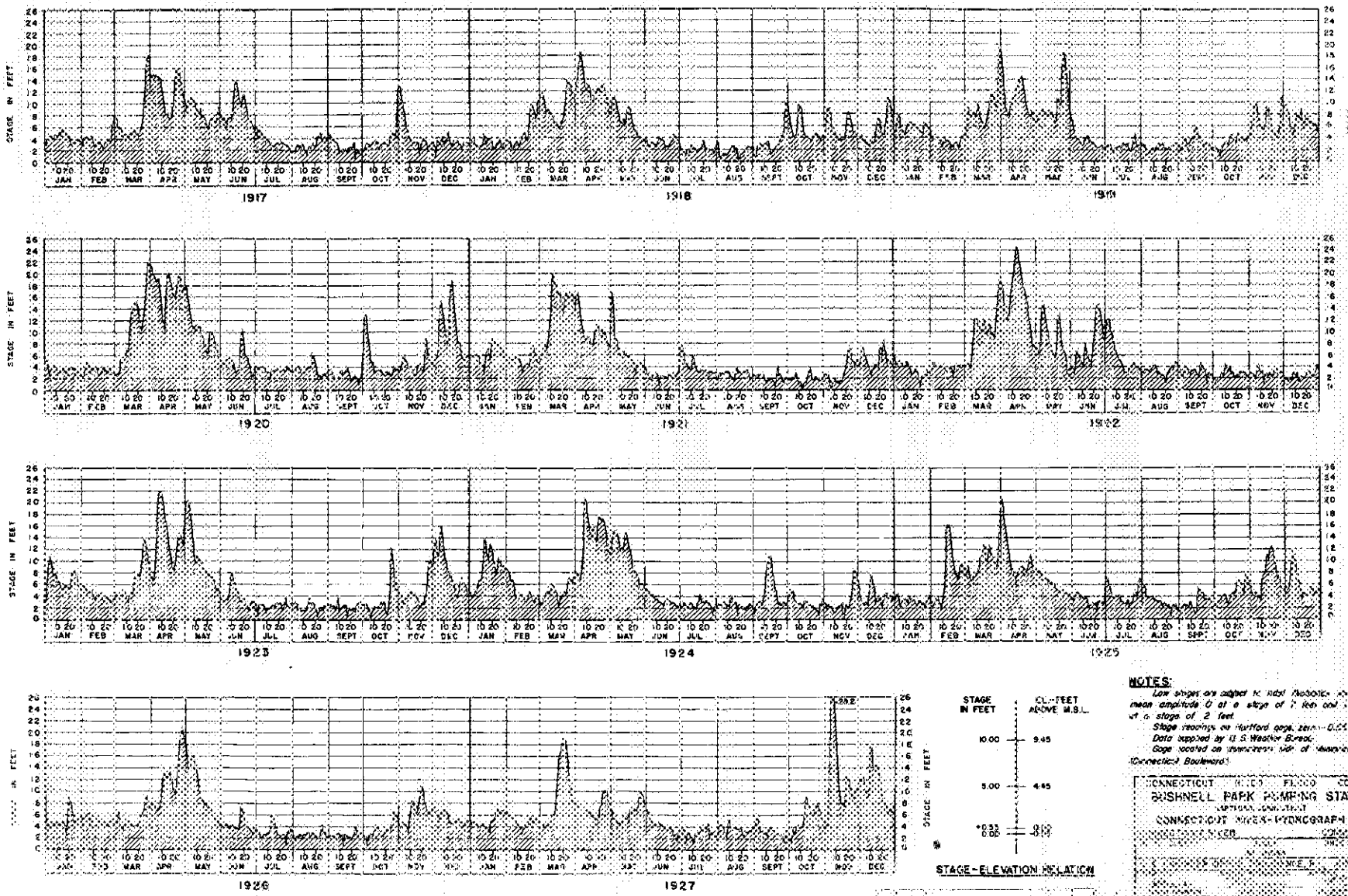
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. D. C. 1944

FILE NO. CT-4-3407

A. OF D. Ht. 12 PLATE NO. 3

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTES:

Low stages are subject to tidal fluctuation which has a mean amplitude 0 at a stage of 7 feet and 15 feet at a stage of 2 feet.

Stage readings on Hartford gage, zero = 0.05 M.S.L.

Data supplied by U. S. Weather Bureau.

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard).

CONNECTICUT RIVER FLOOD CONTROL

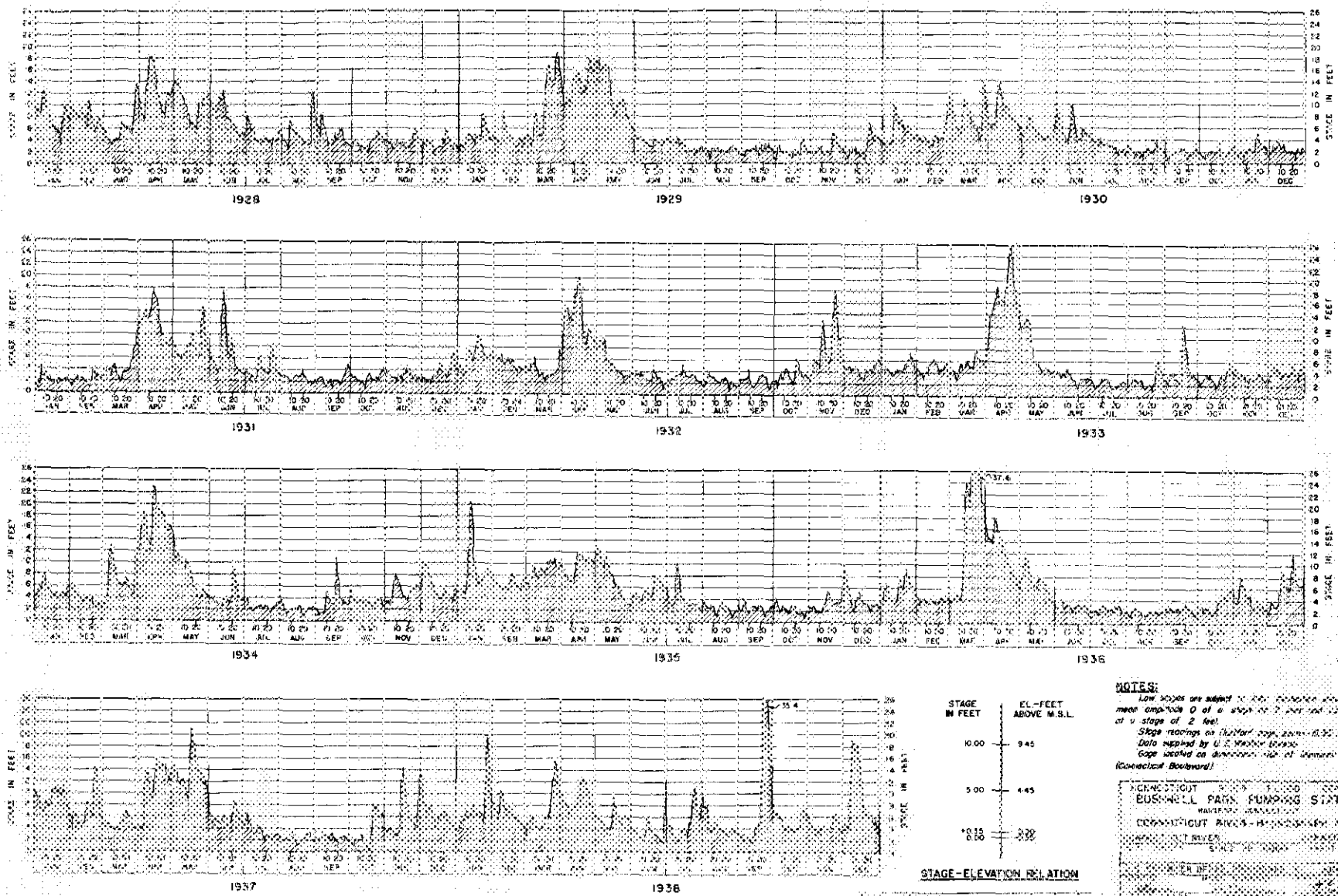
BUSHNELL PARK PUMPING STATION

CONNECTICUT RIVER-HYDROGRAPH NO. 1

A. OF D. Ht. 12 PLATE NO. 4

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



NOTES:

Low stages are subject to [illegible] mean amplitude 0 of a stage of 2 feet and [illegible] feet at a stage of 2 feet.

Stage readings on Hartford gage, [illegible]

Data supplied by U.S. Weather Bureau.

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard).

CONNECTICUT [illegible] FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

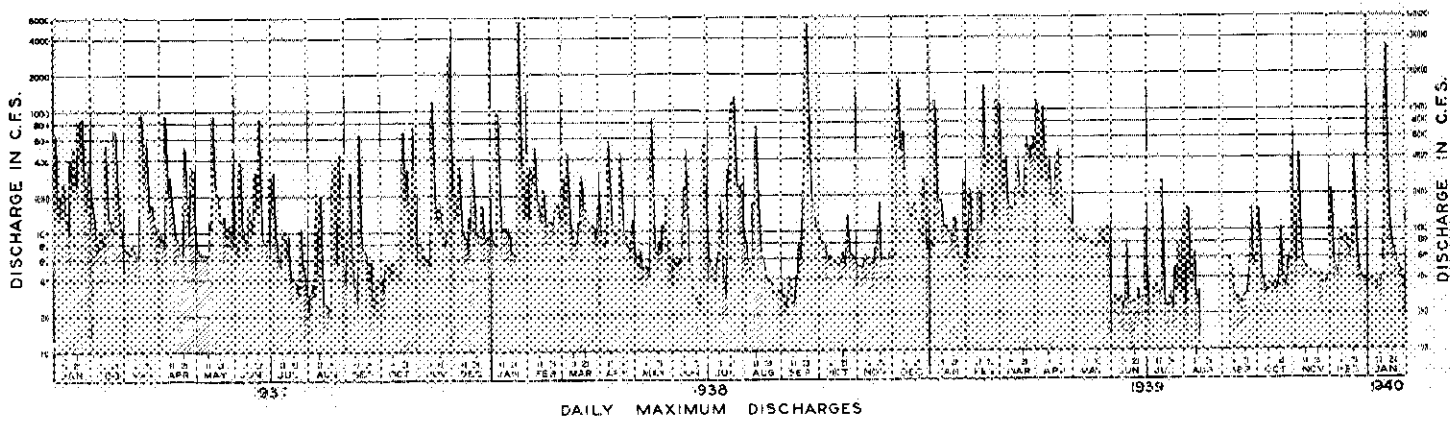
CONNECTICUT RIVER - [illegible] NO. 2

[illegible]

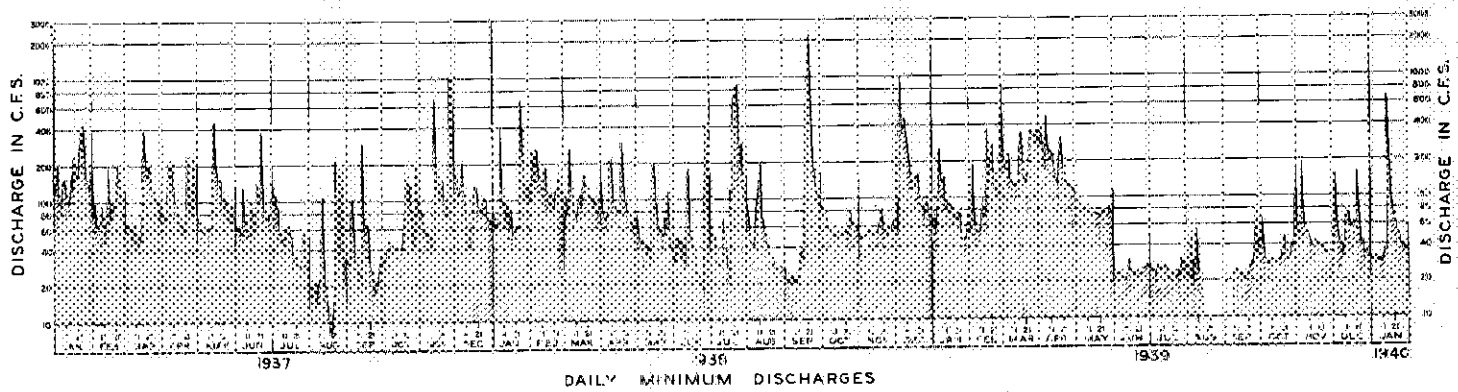
A. OF D. Ht. 12 PLATE NO. 5

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



DAILY MAXIMUM DISCHARGES



DAILY MINIMUM DISCHARGES

NOTES

Daily maximum and minimum discharges are computed from readings [illegible]

Data for this sheet [illegible] Department of Engineering of the City of Hartford, Conn.

Drainage areas:

At gaging station [illegible] Sq. Mi.

At [illegible] Sq. Mi.

At junction of Park River [illegible] River = [illegible]

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

PARK RIVER HYDROGRAPH NO. 1

[illegible] RIVER CONNECTICUT

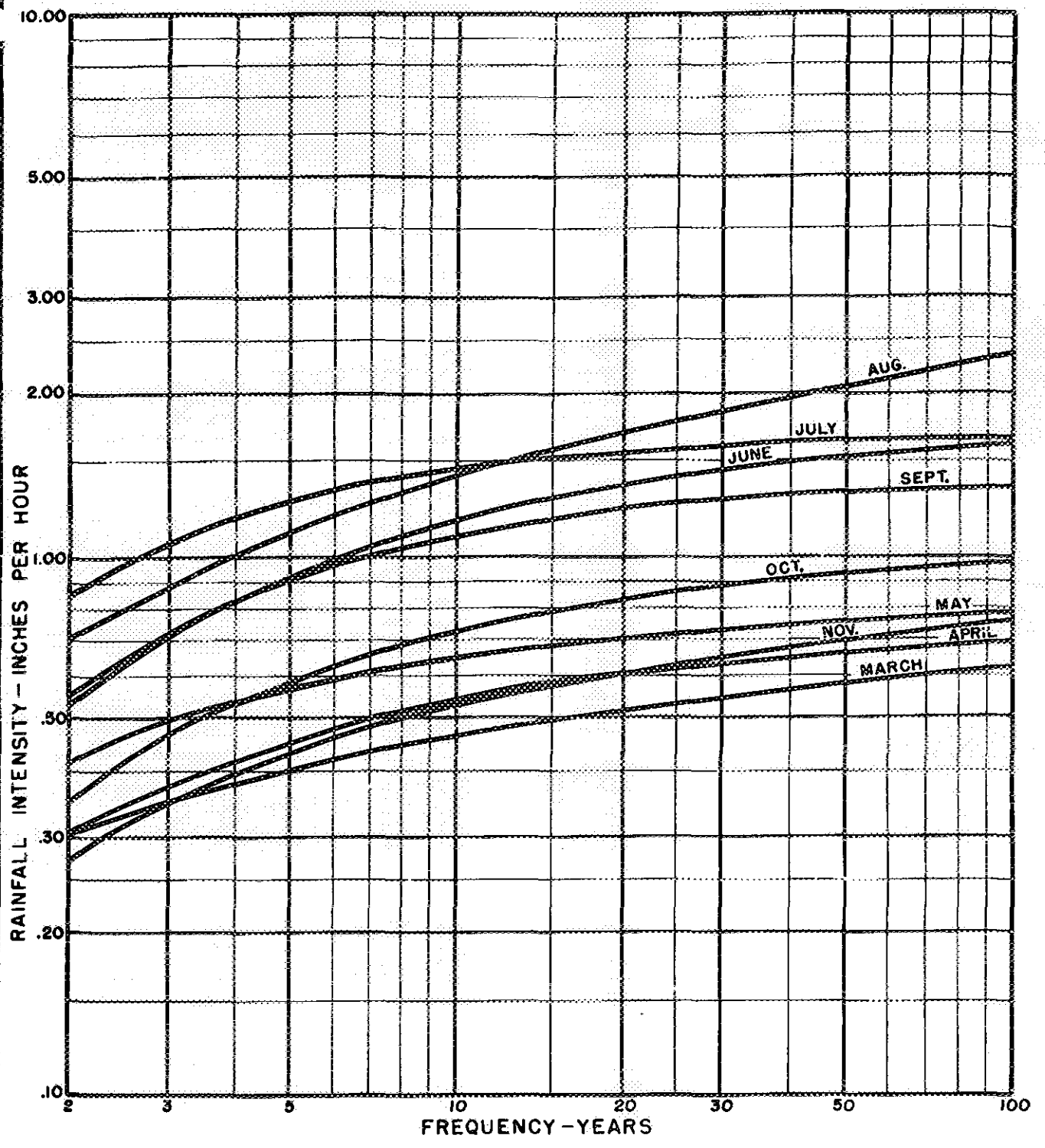
[illegible] SCALE AS SHOWN [illegible] NO. 4

[illegible] JUNE 1944

[illegible]

[illegible]

A. OF D. Ht. 12 PLATE NO. 6



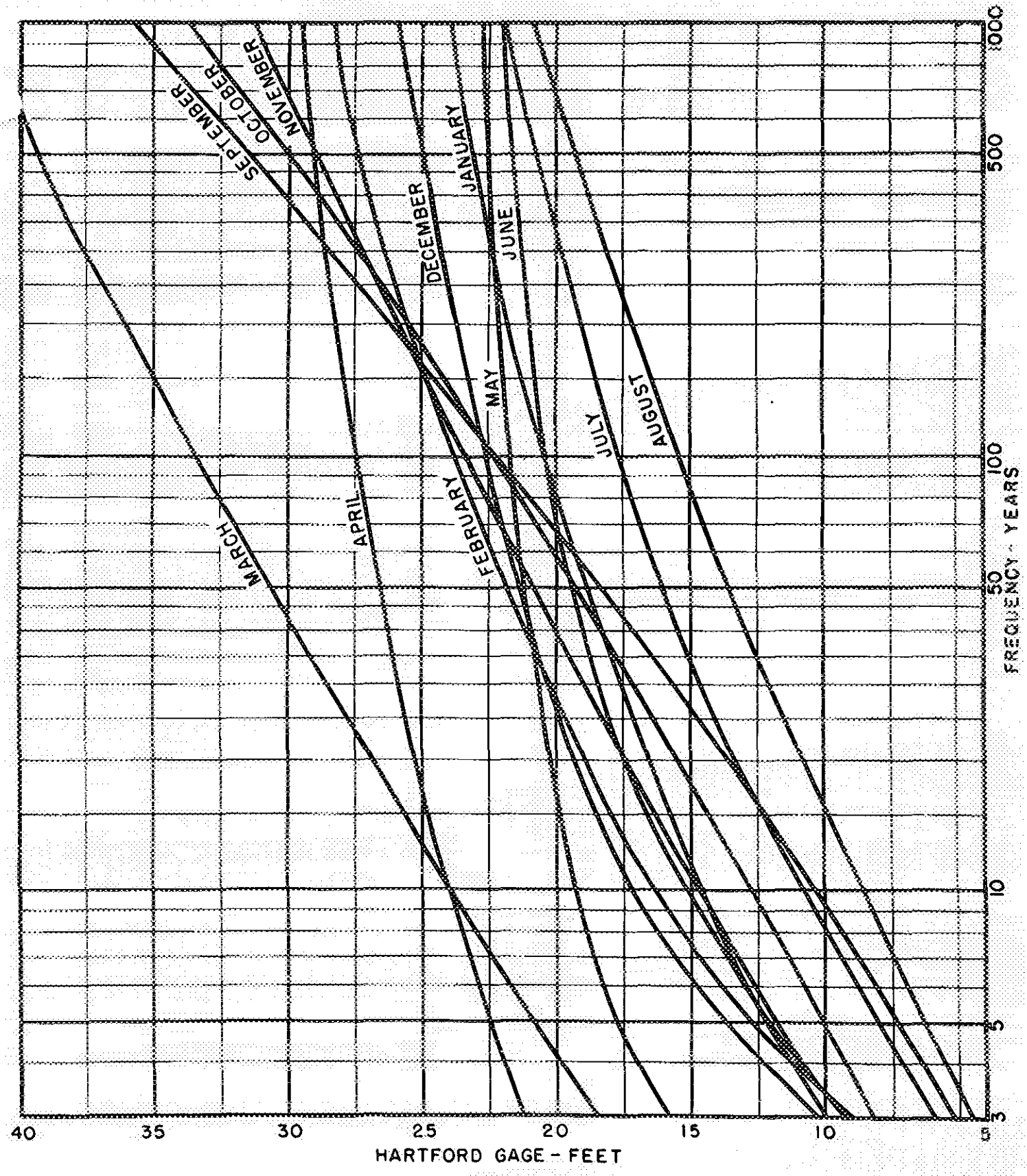
CONNECTICUT RIVER FLOOD CONTROL

RAINFALL INTENSITY – FREQUENCY CURVES

1-HOUR STORM

HARTFORD, CONNECTICUT

35 YEARS OF RECORD — 1905 TO 1939 INCL.



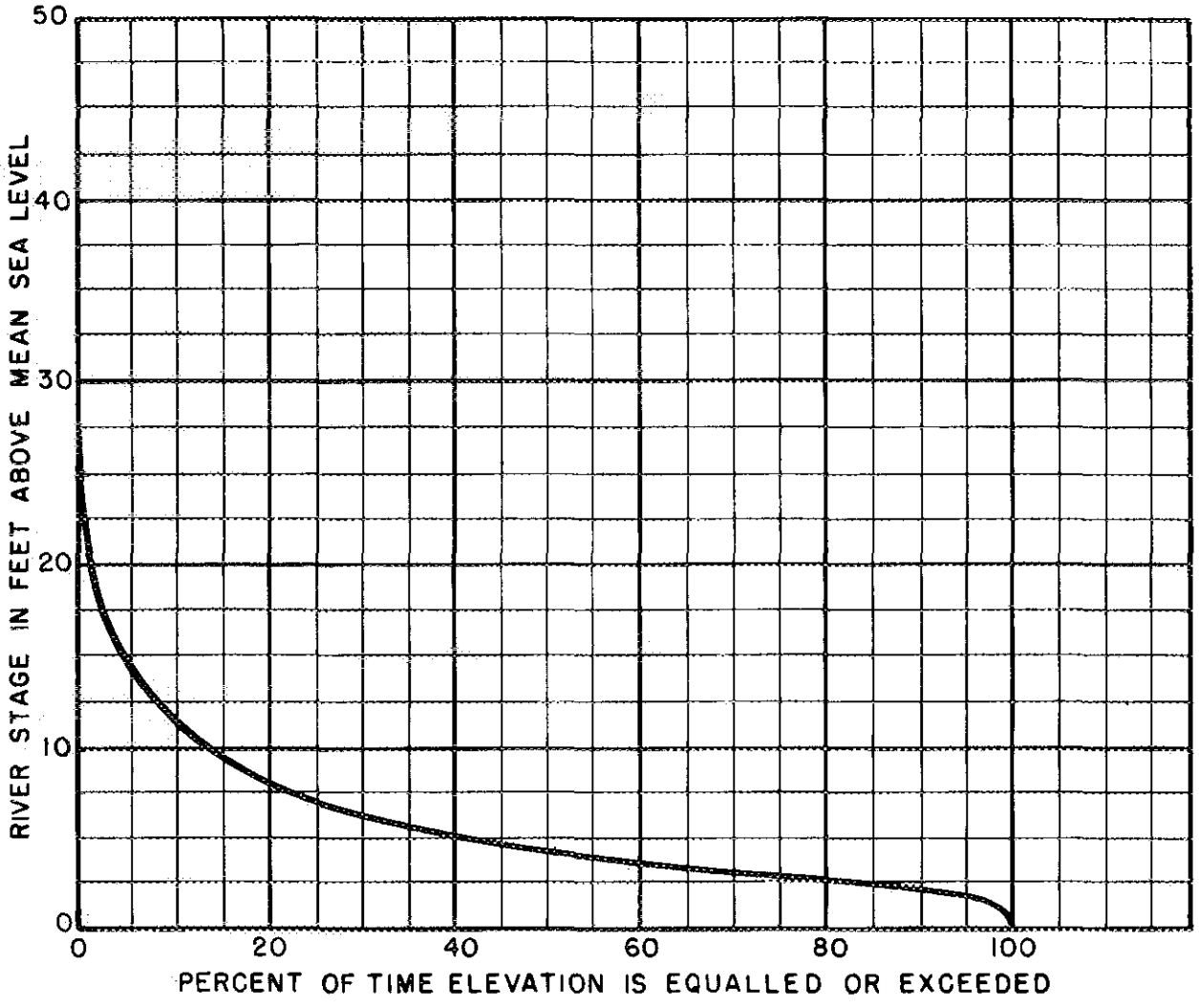
CONNECTICUT RIVER

STAGE - FREQUENCY CURVES

HARTFORD, CONNECTICUT

ZERO HARTFORD GAGE = MINUS 0.55 M.S.L.

A. OF D. Ht. 12 PLATE NO. 8

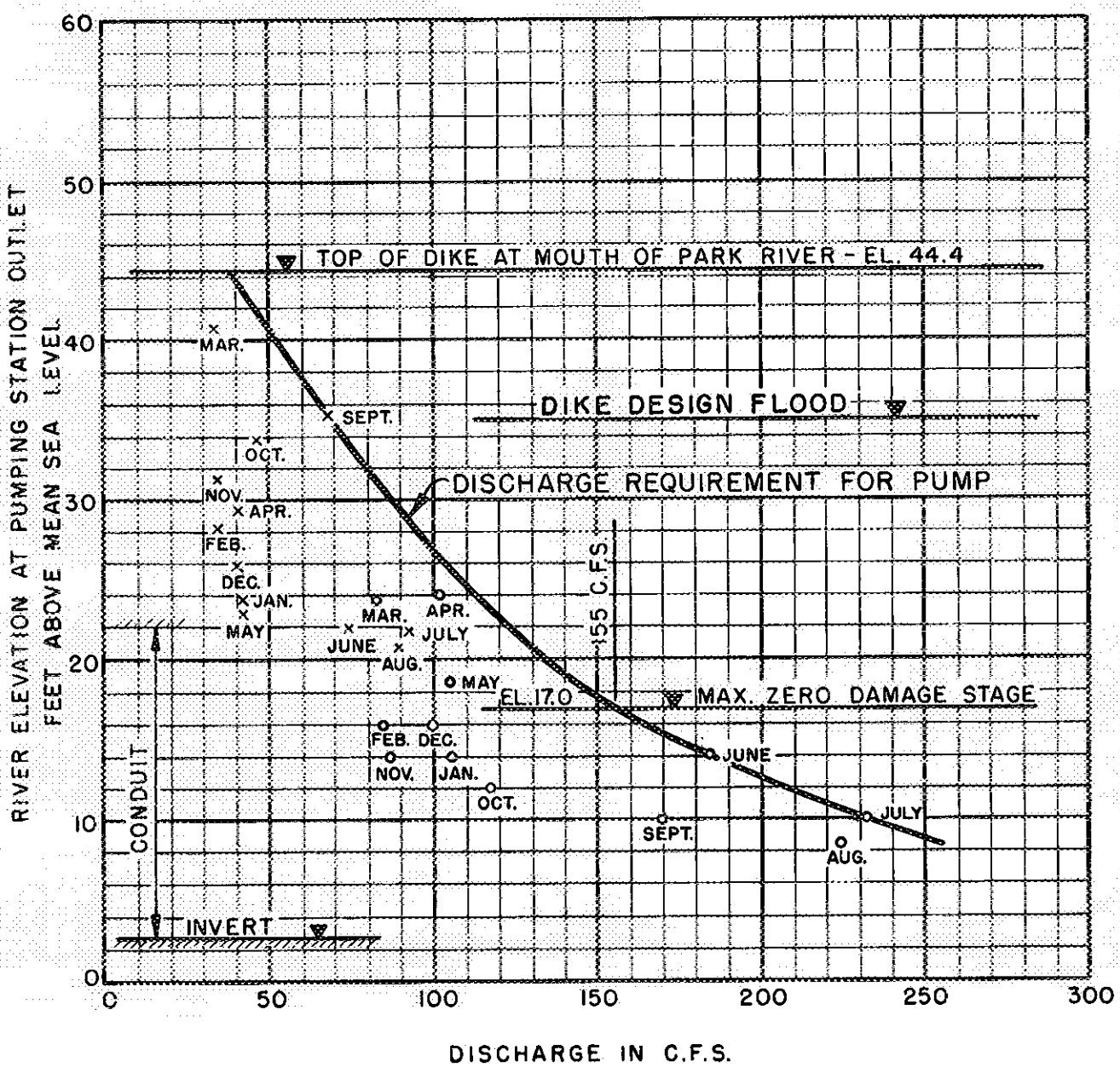


CONNECTICUT RIVER

STAGE — DURATION CURVE

AT

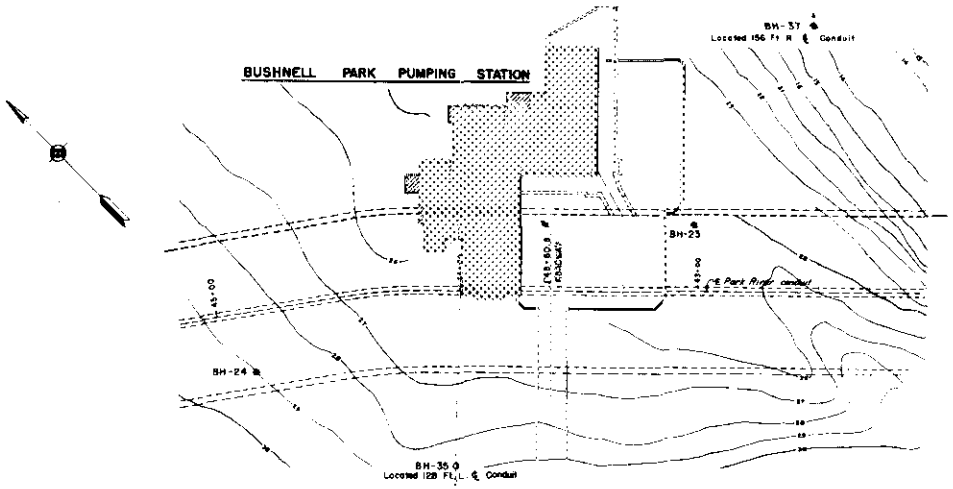
HARTFORD, CONN.



REQUIRED PUMP CAPACITY

BUSHNELL PARK PUMPING STATION

A. OF D. Ht. 12 PLATE NO. 10



PLAN

SCALE: 1" = 20'

DESCRIPTION OF SOIL CLASSES

1. Graded from Gravel to Coarse Sand - Contains little medium sand.
2. Coarse to Medium Sand - Contains little gravel and fine sand.
3. Graded from Gravel to Medium Sand - Contains little fine sand.
4. Medium to Fine Sand - Contains little coarse sand and coarse silt.
5. Graded from Gravel to Fine Sand - Contains little coarse silt.
6. Fine Sand to Coarse Silt - Contains little medium sand and medium silt.
7. Graded from Gravel to Coarse Silt - Contains little medium silt.
8. Coarse to Medium Silt - Contains little fine sand and fine silt.
9. Graded from Gravel to Medium Silt - Contains little fine silt.
10. Medium to Fine Silt - Contains little coarse silt and coarse clay. Possesses behavior characteristics of silt.
11. Medium Silt to Coarse Clay - Contains little coarse silt and medium clay. Possesses behavior characteristics of clay.
12. Graded from Gravel or Coarse Sand to Fine Silt - Contains little coarse clay.
13. Fine Silt to Clay - Contains little medium silt and fine clay (colloids). Possesses behavior characteristics of silt.
14. Clay - Contains little silt. Possesses behavior characteristics of clay.
15. Graded from Coarse Sand to Clay - Contains little fine clay (colloids). Possesses behavior characteristics of silt.
16. Clay - Graded from sand to fine clay (colloids). Possesses behavior characteristics of clay.

NOTES

Samples, logs, and test results may be inspected at U.S. Engineer Office, Providence, R.I.

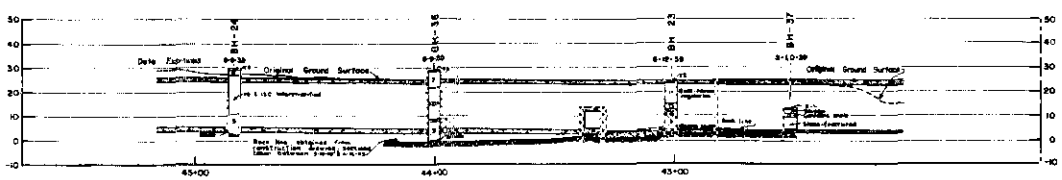
Soils having classifications of two soil classes, (1a 4-8) have coarser portion of soil in initial class (4) and finer portion in final class (2).

BH = Bore Hole

Contours shown are those taken at time of exploration and before construction operations.

LEGEND

- Water table at time of exploration.
- Numerical class (Providence District Soil Classification)
- Letter V indicates visual classification
- TS - Top soil



PROFILE

SECTION A-A

SCALE: 1" = 20'

KEY	DATE	REVISION (Indicated by △)	REVISION	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

PLAN AND PROFILE BORINGS

PARK RIVER CONNECTICUT

IN 71 SHEETS SCALE 1 IN = 20 FT SHEET NO. 5

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., NOV. 1944

SUBMITTED: R.L. Lane, ENGINEER, HEADQUARTERS LABORATORY

APPROVAL RECOMMENDED: J.W. Burns, HEAD ENGINEER, CHIEF, ENGINEERING DIV.

APPROVED: T.J. Tracy, COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED: R.A. Barrett, SOILS LABORATORY

DRAWN: R.D.L. TRACED: R.D.A. CHECKED: E.A.B.

FILE NO. CT-2-1404

Ht. 12

A. OF D. Ht. 12 PLATE NO. 11

PROVIDENCE DISTRICT SOIL CLASSIFICATION

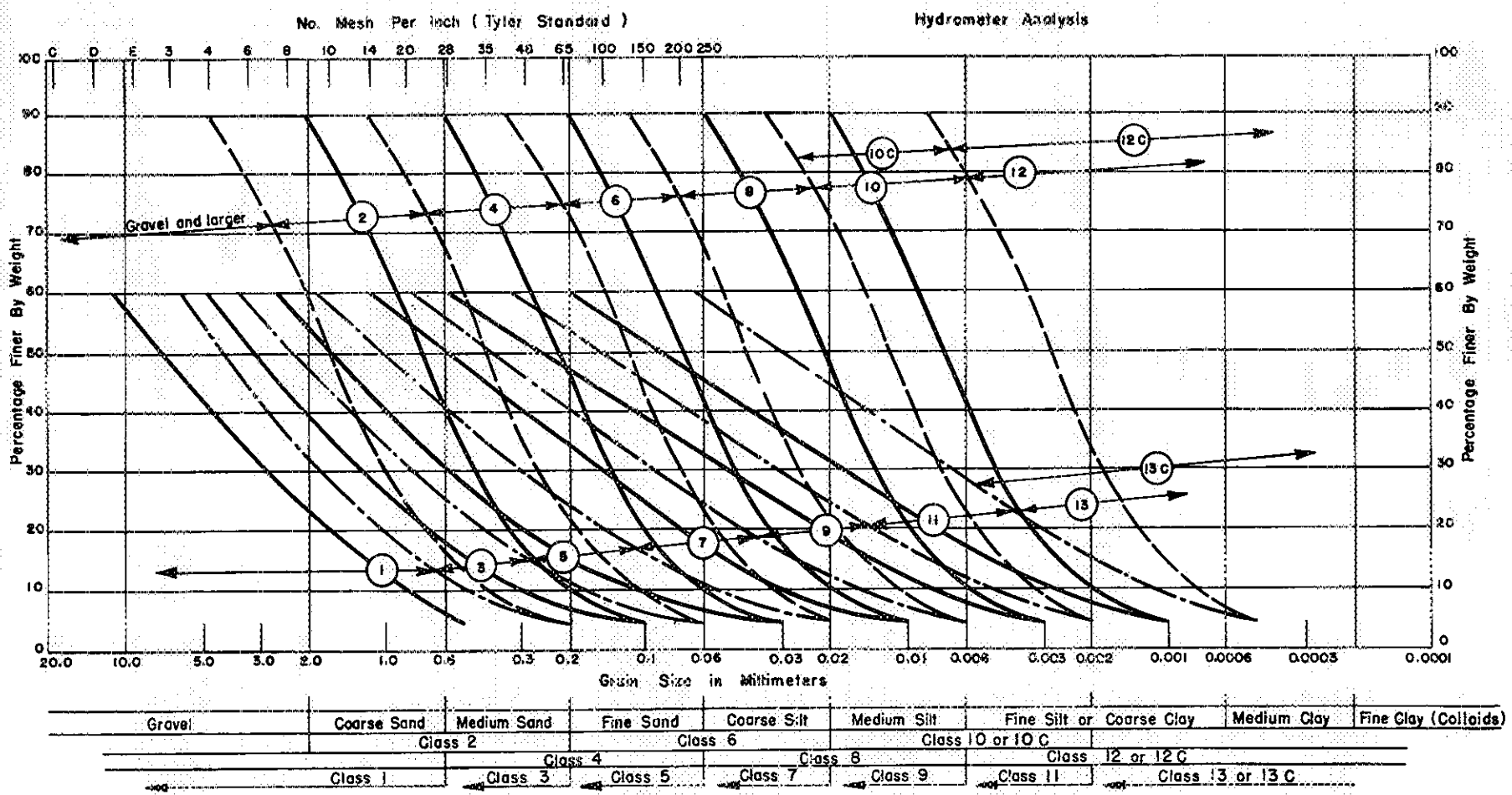
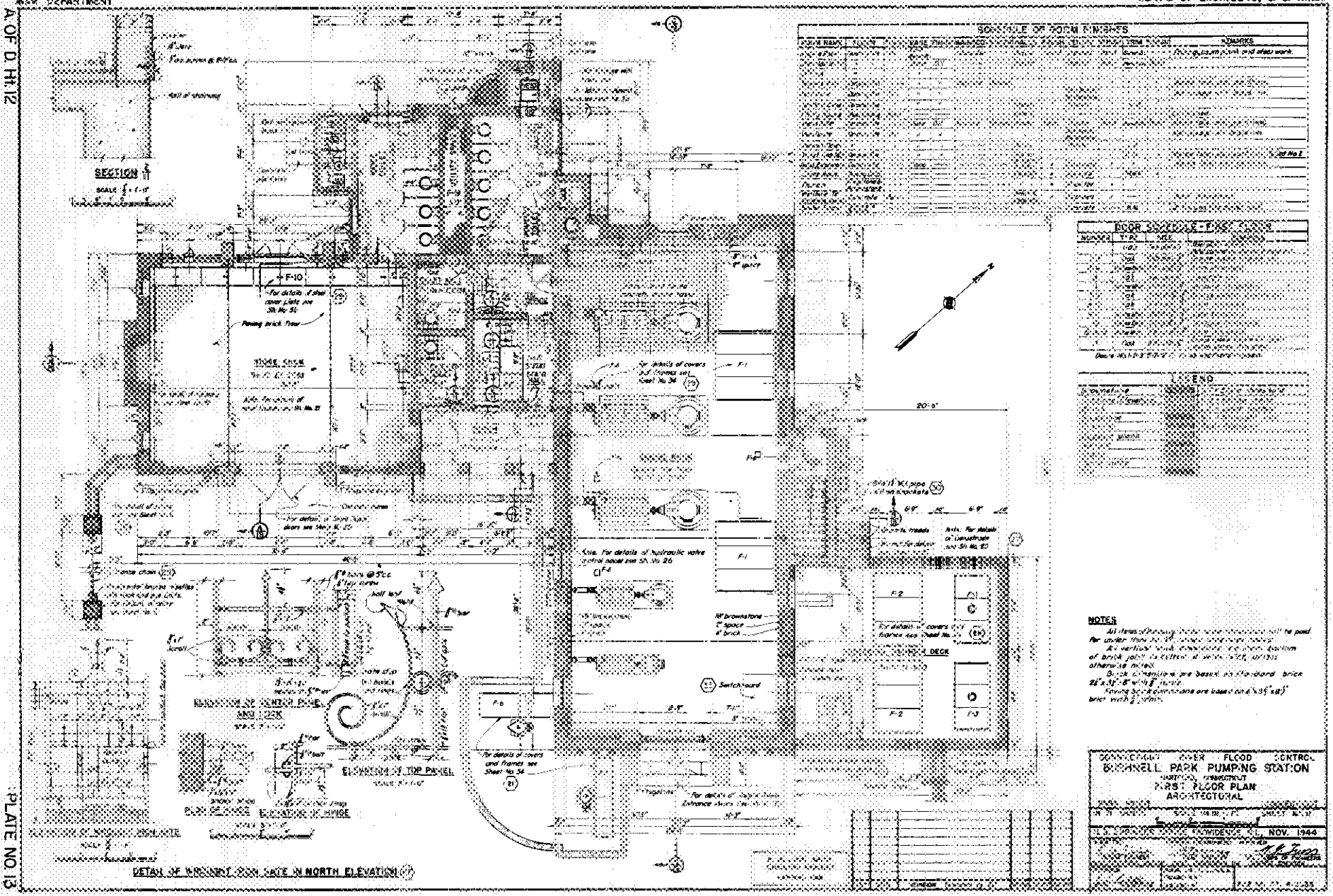
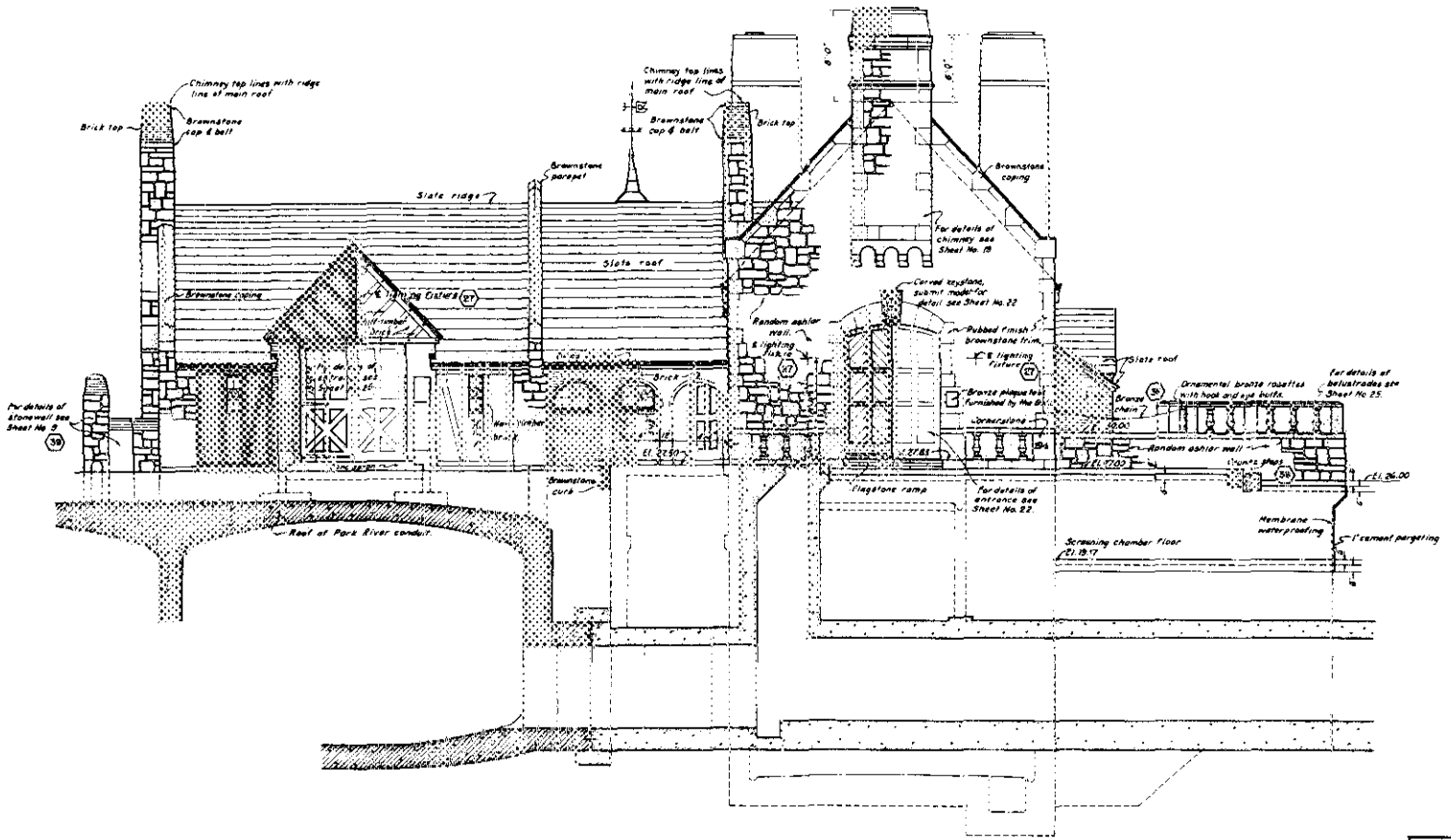


DIAGRAM SHOWING LIMITS OF SOIL CLASSES


SCHEDULE OF ROOM FINISHES
FLOOR SCHEDULE
LEGEND
SECTION
PUMPING BRICK FLOOR
WHEEL CHUCK
ELEVATION OF TOP PANEL
PLAN OF HINGE
ELEVATION OF HINGE
DETAIL OF WROUGHT IRON GATE IN NORTH ELEVATION
Switchboard
1ST FLOOR DECK
NOTES
SOUTHEASTERN NEW ENGLAND FLOOD CONTROL
BURNSIDE PARK PUMPING STATION
HARTFORD, CONNECTICUT
FIRST FLOOR PLAN
ARCHITECTURAL
U.S. EXPERIMENT STATION, WARDWICKS, N.J. NOV. 1944

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



EAST ELEVATION

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

EAST ELEVATION

PARK RIVER CONNECTICUT

IN 71 SHEETS SCALE: 1/4 IN. = 1 FT. SHEET NO. 13

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., NOV. 1944

SUBMITTED: SENIOR ENGINEER, HEAD, SECTIONAL DIVISION

APPROVAL RECOMMENDED: HEAD, ENGINEER, CHIEF, ENGINEERING DIV.

APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED: ARCH. SUBDIVISION

DRAWN: F. V. B. Jr.
TRACED: A. C. T.
CHECKED: A.

FILE NO. CT-4-3335

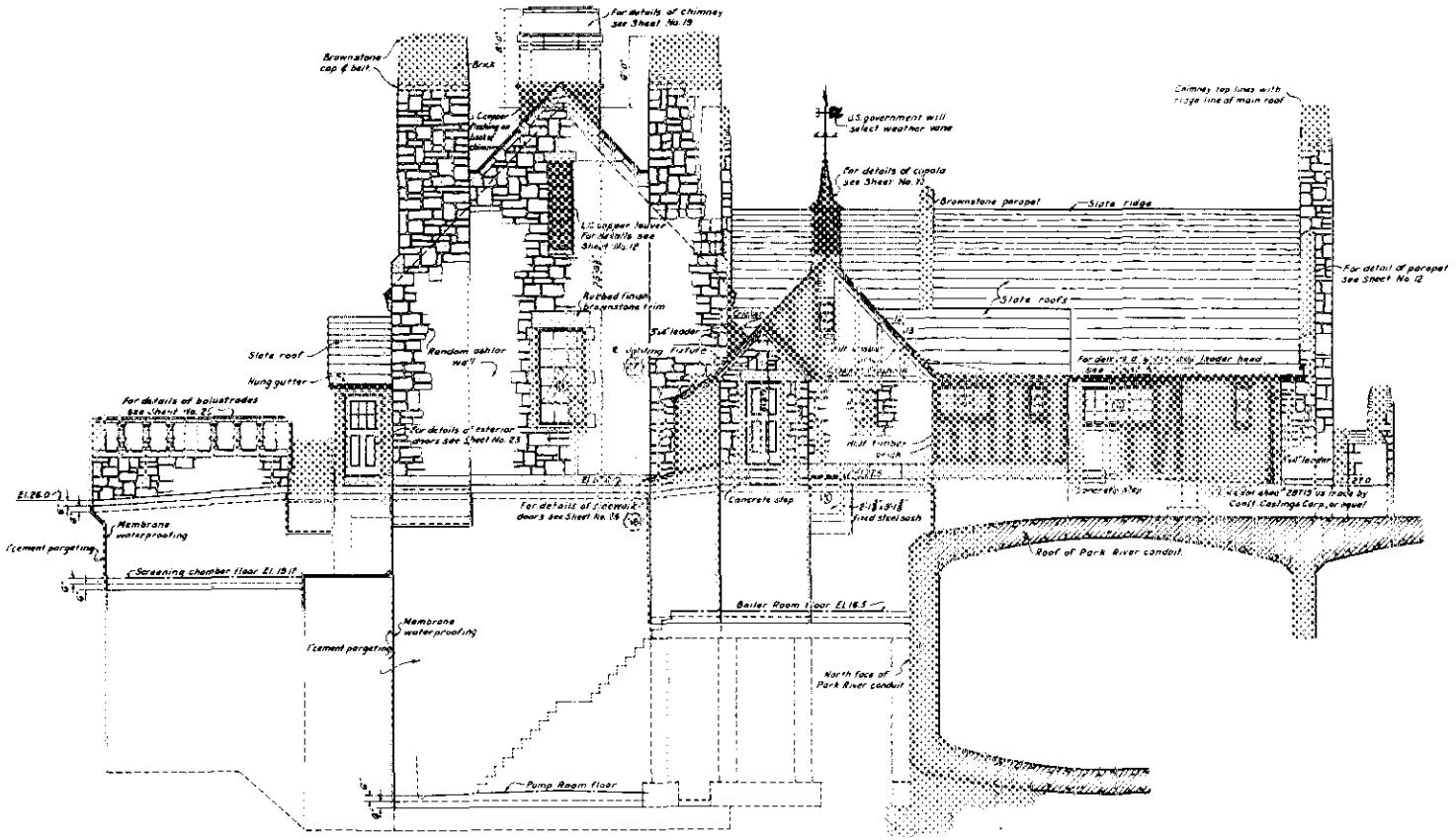
H. HILLYARD SMITH
CONSULTING ARCHITECT
HARTFORD, CONN.

A. OF D. Ht. 12 PLATE NO. 14

Ht. 12

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



WEST ELEVATION

SCALE 1/4" = 1'-0"

H. HILLIARD SMITH
CONSULTING ARCHITECT
HARTFORD, CONN.

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

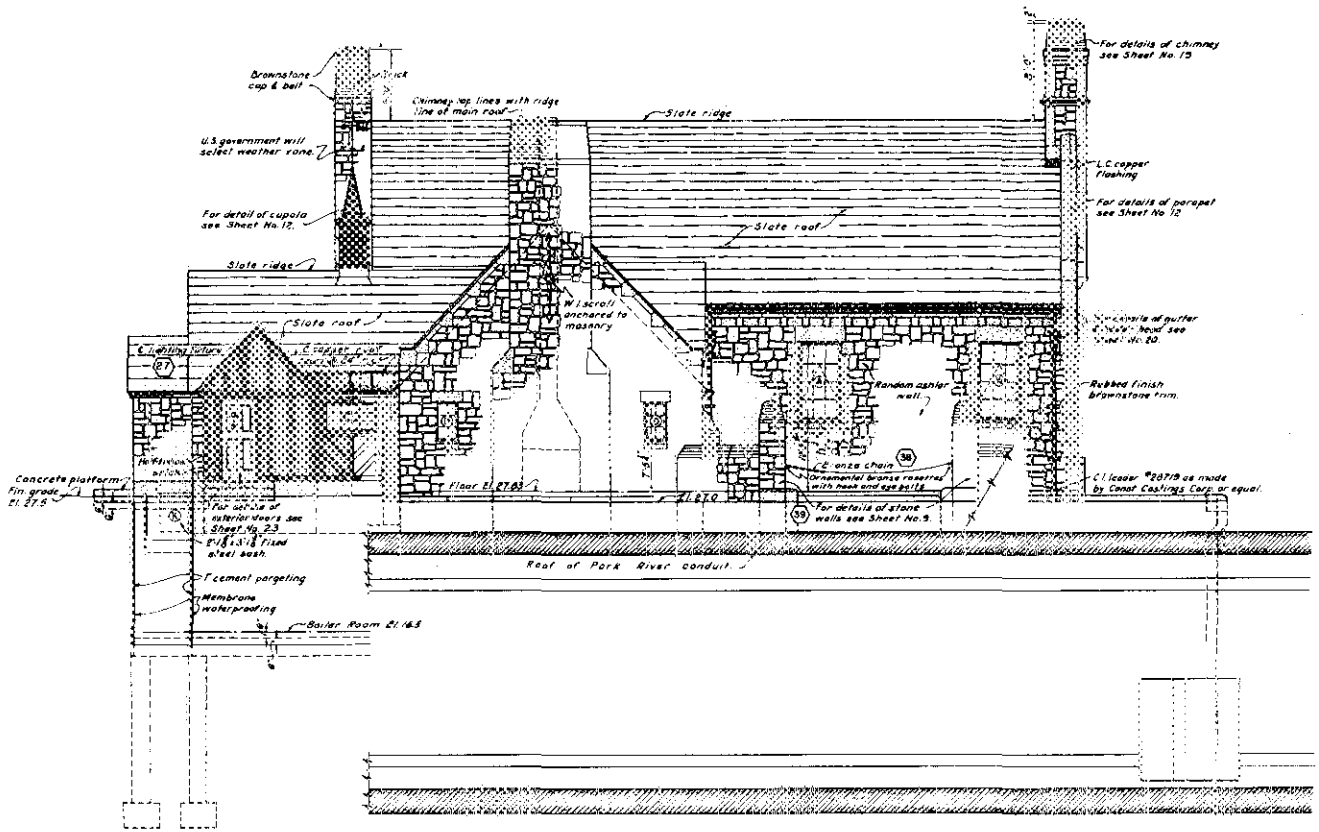
CONNECTICUT RIVER FLOOD CONTROL
BUSHNELL PARK PUMPING STATION
HARTFORD, CONNECTICUT
WEST ELEVATION
PARK RIVER CONNECTICUT
IN 71 SHEETS SCALE: 1/4 IN. = 1 FT. SHEET NO. 15
U.S. ENGINEER OFFICE, PROVIDENCE, R.I. NOV. 1944
FILE NO. DT-4-3337

Ht. 12

A. OF D. Ht. 12 PLATE NO. 15

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



SOUTH ELEVATION

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONNECTICUT

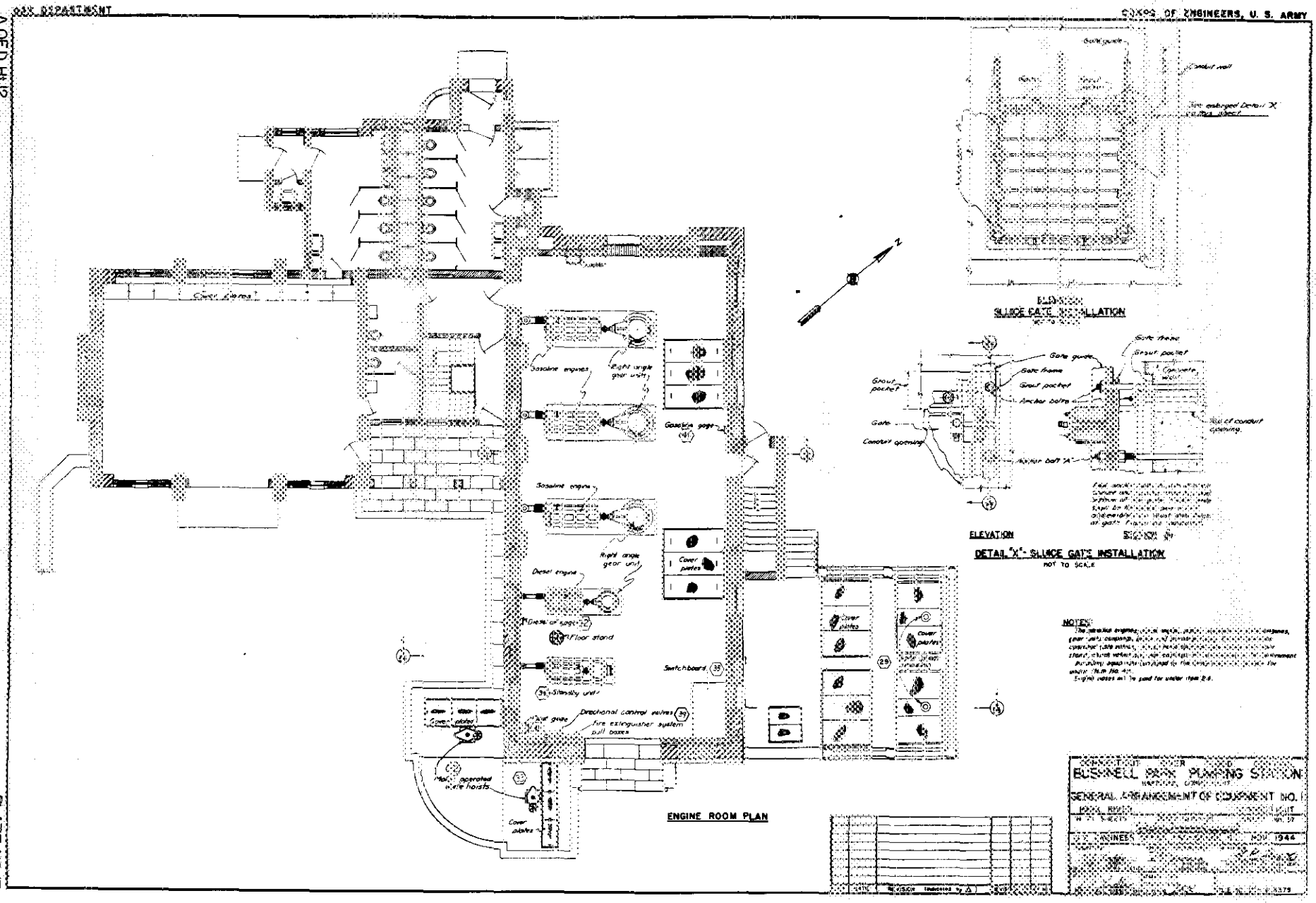
SOUTH ELEVATION

PARK RIVER CONNECTICUT

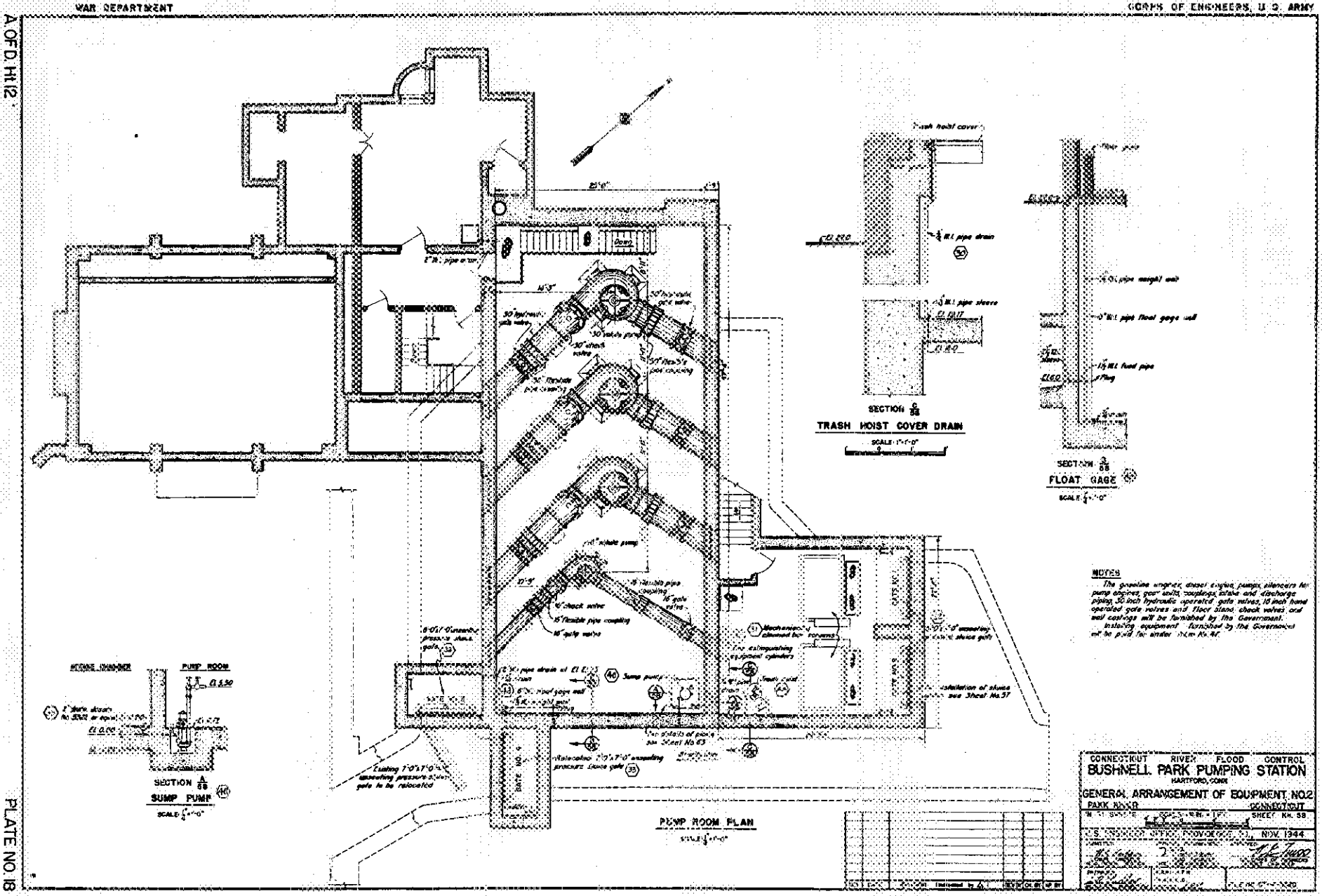
IN 71 SHEETS SCALE 1/4 IN. = 1 FT. SHEET NO. 16

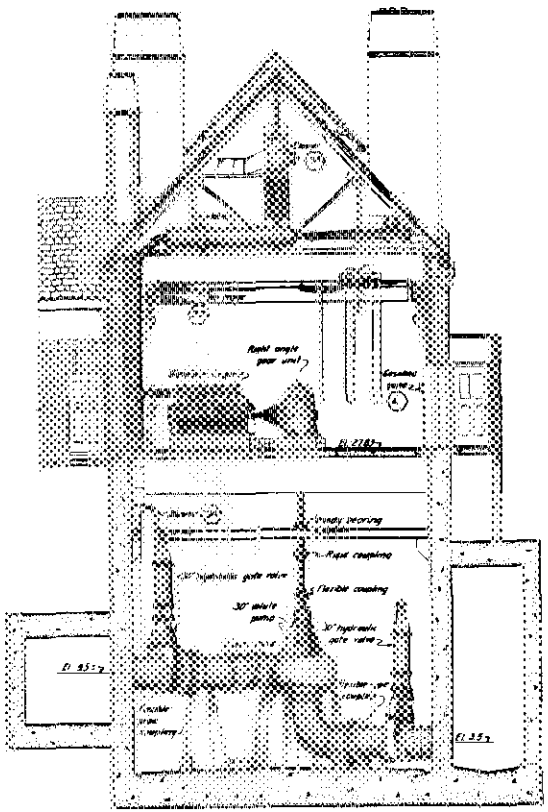
U.S. ENGINEER OFFICE, PROVIDENCE, R.I., NOV. 1944

A. OF D. Ht. 12 PLATE NO. 16

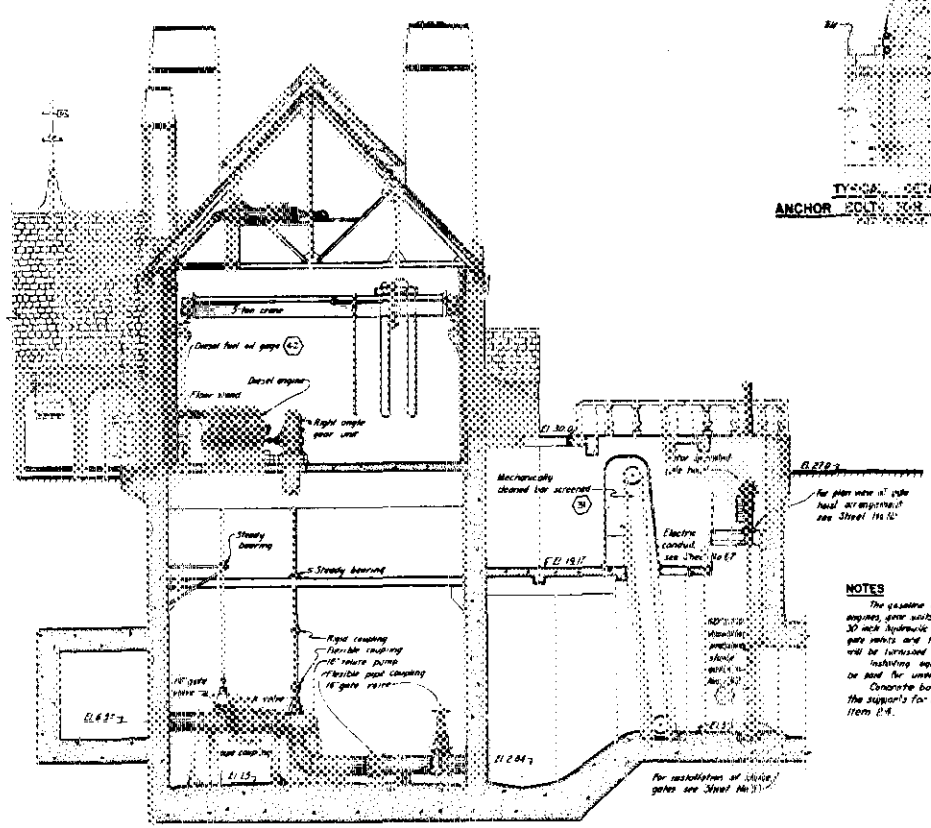


CORPS OF ENGINEERS, U. S. ARMY
Gate guide
Conduit wall
Gate
Grout pocket
Gate
Conduit opening
Gate frame
Grout pocket
Anchor bolts
Gate guide
Gate frame
Grout pocket
Concrete wall
Gate
Conduit opening
Anchor bolt "A"
ELEVATION
DETAIL "X" - SLUICE GATE INSTALLATION
NOT TO SCALE
Cover plates
Gasoline engines
Right angle gear unit
Gasoline gage
Gasoline engine
Right angle gear unit
Diesel engine
Diesel oil gage
Floor stand
Standby unit
Switchboard
Cover plates
Directional control valves
Fire extinguisher system pull boxes
Motor operated gate hoists
Cover plates
Cover plates
Cover plates
ENGINE ROOM PLAN
NOTES:
BUSHNELL PARK PUMPING STATION
GENERAL ARRANGEMENT OF EQUIPMENT NO. 1
NOV. 1944

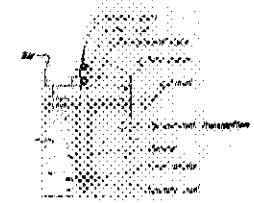

PUMP ROOM PLAN
SCALE 1/4"=1'-0"
SECTION A/58
TRASH HOIST COVER DRAIN
SCALE 1"=1'-0"
SECTION 3/58
FLOAT GAGE
SCALE 1/4"=1'-0"
SECTION A/58
SUMP PUMP
SCALE 1/4"=1'-0"
MOTOR CHAMBER
PUMP ROOM
NOTES
The gasoline engines, diesel engines, pumps, silencers for pump engines, gear units, couplings, intake and discharge piping, 30 inch hydraulic operated gate valves, 18 inch hand operated gate valves and floor stand, check valves and wall castings will be furnished by the Government.
Installing equipment furnished by the Government will be paid for under Item No. 47.
CONNECTICUT RIVER FLOOD CONTROL
BUSHNELL PARK PUMPING STATION
HARTFORD, CONN.
GENERAL ARRANGEMENT OF EQUIPMENT NO. 2
PARK NO. 2
CONNECTICUT
SHEET NO. 58
NOV. 1944



SECTION A/67



SECTION B/67



TYPICAL DETAIL
ANCHOR BOLTS FOR EQUIPMENT

NOTES

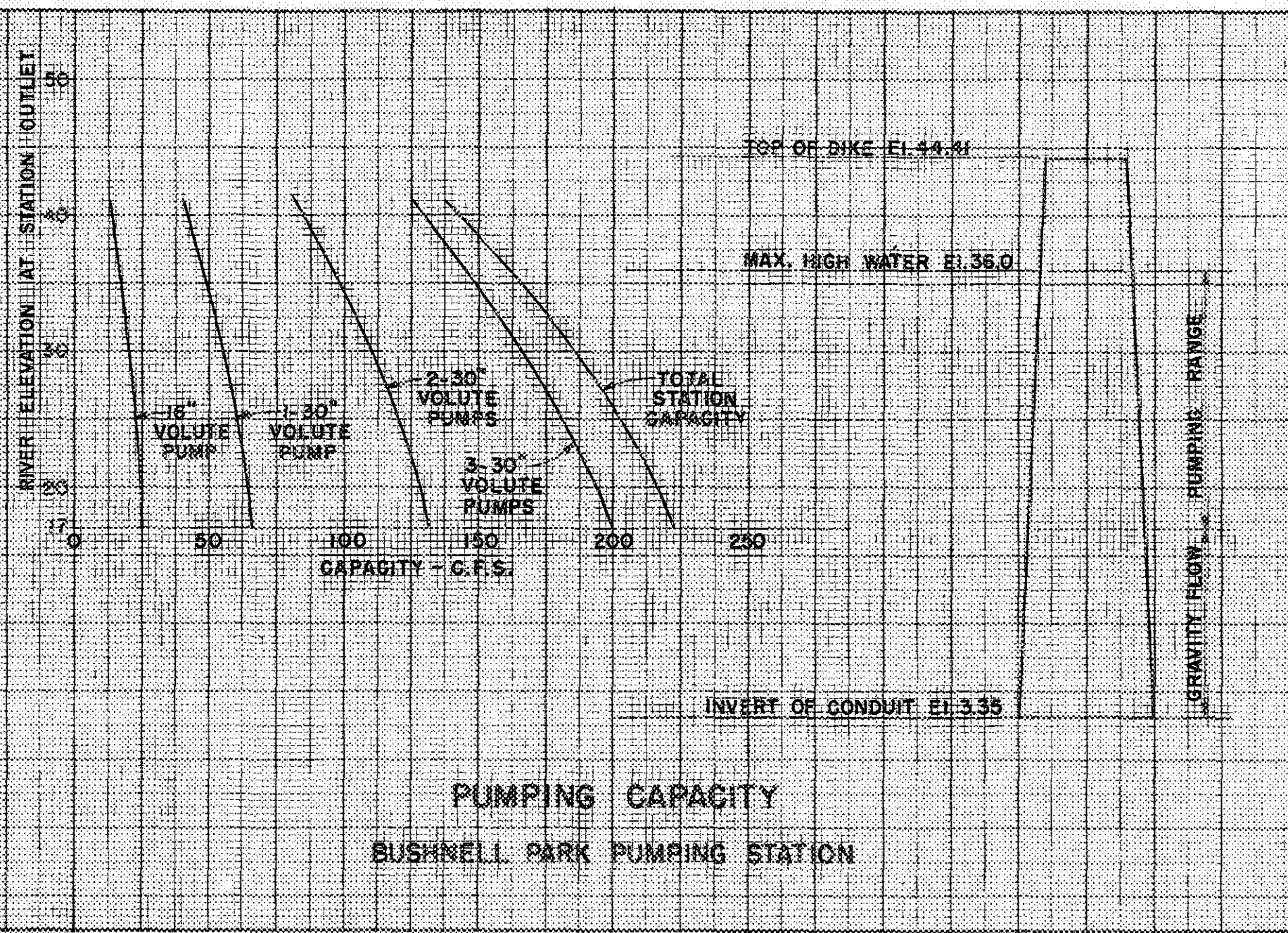
The gasoline engines, diesel engine, [illegible] for pump engines, gear units, coupling, [illegible] 30 inch hydraulic operated gate valves, [illegible] gate valves and floor stand, [illegible] and rail castings will be furnished by the Government.

Installing equipment furnished by the Government will be paid for under Item No. 4.5.

Concrete bases for pumps, gears and engines and the supports for valves and pipes will be paid for under Item 2.4.

KEY	DATE	REVISION (Indicated by △)	REVISED	CK. BY	AP. BY

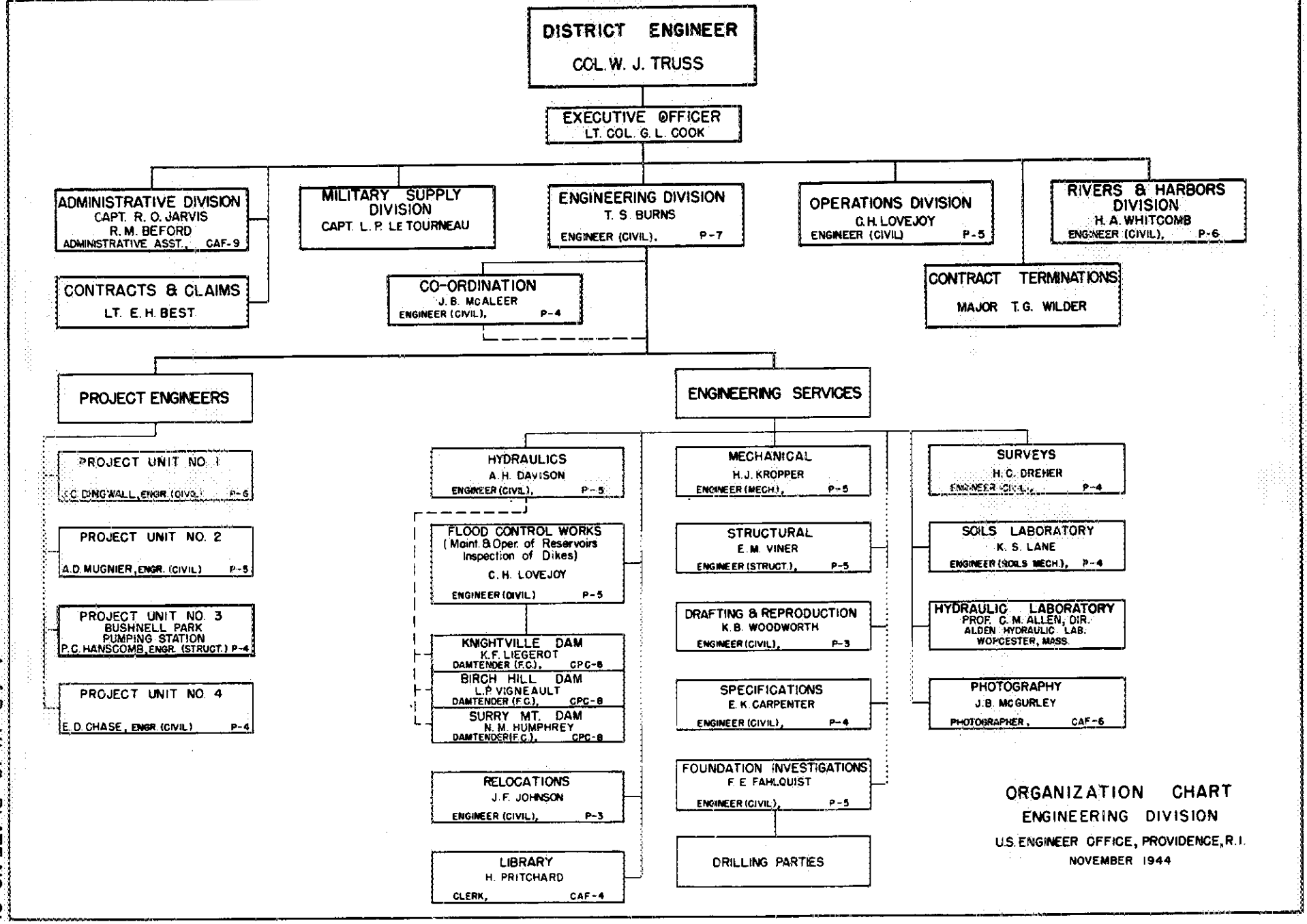
CONNECTICUT RIVER FLOOD CONTROL
BUSHNELL PARK PUMPING STATION
HARTFORD, CONN.
GENERAL ARRANGEMENT OF EQUIPMENT NO. 3
PARK PARK CONNECTICUT
U. S. ENGINEER OFFICE, PROVIDENCE, R.I. 1944
FILE NO. CT-4-3381



PUMPING CAPACITY

BUSHNELL PARK PUMPING STATION

A OF D HI. 12 PLATE NO. 20



ORGANIZATION CHART
ENGINEERING DIVISION
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.
NOVEMBER 1944

APPENDIX I

ANALYSIS OF DETAILED STRUCTURAL COMPUTATIONS

BUSHNELL PARK PUMPING STATION

APPENDIX "A" COMPUTATIONS

	Page
Estimated Weight of Mechanical Equipment	1
Engine Room Floor Slab	2-11
Engine Room Floor Beams	12-29
Screening Chamber Roof Slab and Beams	30-38
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BUSHNELL PARK PUMPING STATION
Estimated Weight of Mechanical Equipment

Gasoline engine for 30" pump	6000#
Gear Reduction unit for 30" pump	5000#
Concrete Base under engine and gear unit for 30" pump 12'x4'x1'6"	10,800#
Diesel engine for 16" pump	4000#
Gear Reduction unit for 16" pump	2000#
Concrete Base under diesel engine and gear unit for 16" pump 10'x3'6"x1'3"	6200#
Standby Unit	4000#
Concrete Base under Standby Unit	4200#
Switchboard	4000#
Floorstand for 6'x7' sluice gate including gate load	29,000#
16" pump (full of water)	4000#
Suction pipe and valves for 16" pump (full of water)	4300#
Discharge pipe and valves for 16" pump (full of water)	4300#
30" pump (full of water)	13,000#
Suction pipe and valves for 30" pump (full of water)	22,000#
Discharge pipe and valves for 30" pump (full of water)	23,000#
Thrust on 16" pump	3500#
Thrust on 30" pump	13,000#
Boiler	3000#
Mechanical trash rack	8000#
6'x7' Sluice Gate	7500#
5 Ton Crane Maximum wheel load	6600#

C-C Truck Wheels 8'-0"
Use 25# ASCE rail

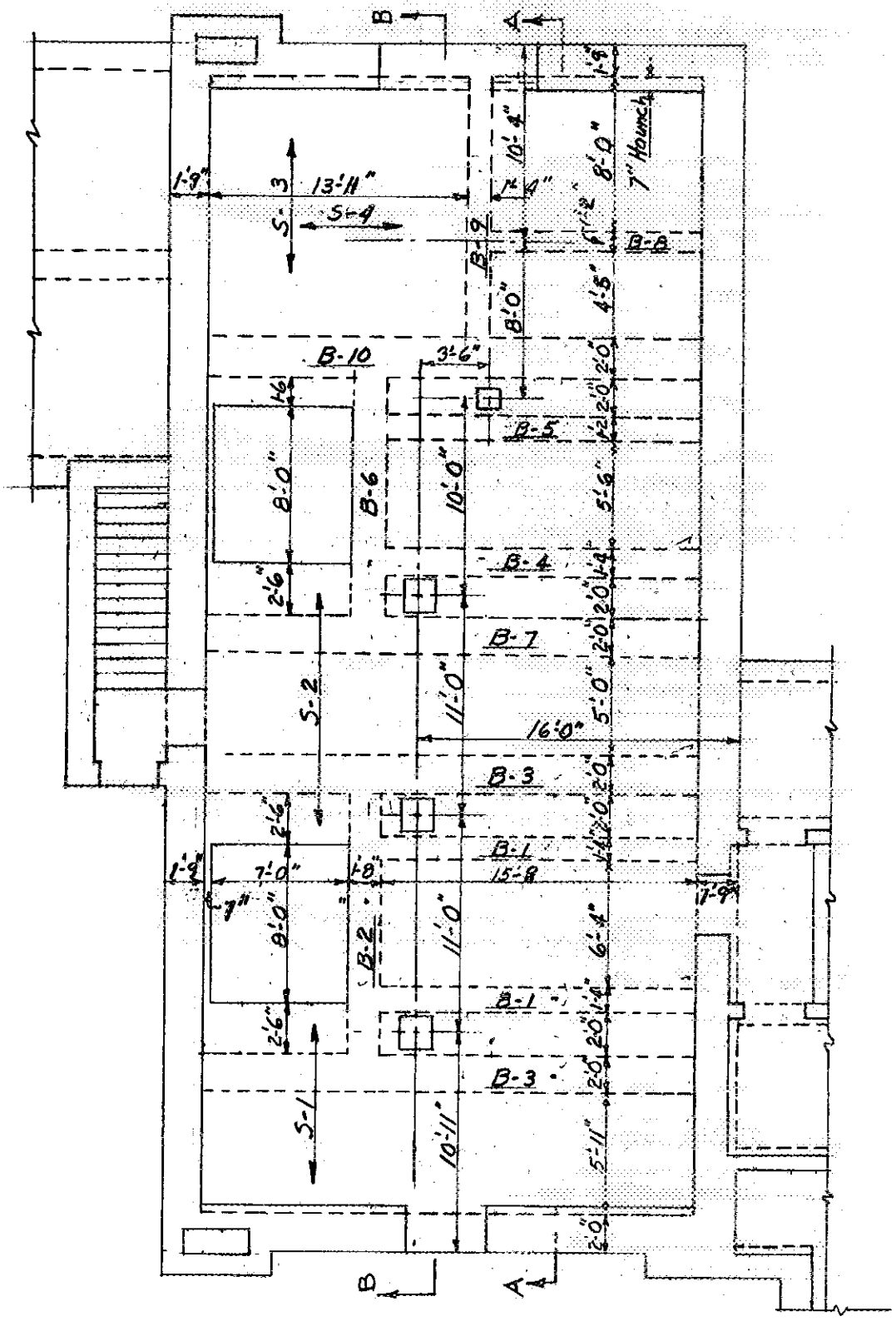
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Engine Room Floor Slab

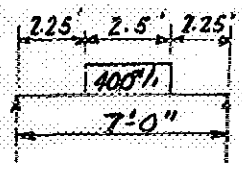
Computed by H. E. W. **Checked by** **Date** 14 Feb. 44



Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Slab
Computed by: H. E. W. Checked by: A.L.K. Date: 14 - Feb - 44

Determination of Uniform L.L. for Floor Design

Span = 5'-0" Engine Wt. = $\frac{6000}{6 \times 2.5}$ = 400 #/□'



$M = 500 \times 3.5 - 400 \times \frac{1.25^2}{2} = 1338'^{\#}$

$1338 = \frac{1}{8} w\, 49 \qquad w = 222\ \#/□'$

Weight of $1\frac{1}{2}$" conc fill + tile = 30 #/□'
252 #/□'

Floor slabs will be designed for a uniform live load of 300 #/□' except where concentrated machinery loads occur. Weight of 1½ inch conc. fill plus tile will be considered part of live load

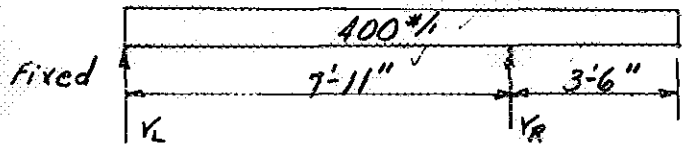
Design Constants

$f_c' = 3000$ #/□' $\quad f_s = 20{,}000$ #/□" $\quad n = 12$

When $f_c = 800$ #/□" at center $\quad k = .325;\ j = 0.89;\ K = 116$

When $f_c = 900$ #/□" at support $\quad k = .351;\ j = 0.88 \quad K = 139$

Slab S-1



	+2.09	-2.09	+2.450
	0	-10.36	0
	+0.18	0	0
	0	0	0
- Mom.	+1.91	-2450	+2450
End Shear	1510	1650	1400
Vert.	1510	30	50
x_0 =	3.78		

Assume 8" slab

D. L. =	100 #/□'
L. L. =	300
	400 #/□'

Moments

$\frac{1}{12}\, 400 \times 7.92^2 = 2090'^{\#}$

$3.5 \times 400 \times 1.75 = 2450'^{\#}$

Max $+M = 1510 \times 3.78 - 1910$
$- 400 \times \frac{3.78^2}{2} = 940'^{\#}$

$- A_s = \frac{2450 \times 12}{20000 \times .88 \times 6.75} = .25$ □" $\frac{1}{2}$"φ @ 9" cc

$- A_s = \frac{1910 \times 12}{20{,}000 \times .88 \times 6.75} = .19$ □" $\frac{1}{2}$"φ @ 12" cc

$+A_s$ Use $\frac{1}{2}$"φ @ 12" cc

req'd $d = \sqrt{\frac{2480}{139}} = 4.2$" 8" slab OK

$v = \frac{1650}{12 \times .88 \times 6.75} = 23$ #/□" OK

$u_0 = \frac{1650}{2.1 \times .88 \times 6.75} = 132$ #/□" OK

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Computation Engine Room Floor Slab
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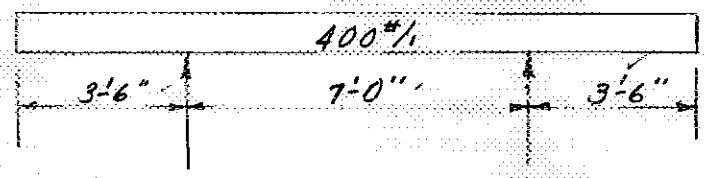
Slab S-2

D.L + L.L = 400 #/□'



$V_L = V_R = 7 \times 400 = 2800^{\#}$

$-M = 3.5 \times 400 \times 1.75 = 2450'^{\#}$

$+M = \frac{1}{8} \times 400 \times 49 - 2450 = 0'^{\#}$

$-A_s = \frac{2450 \times 12}{20{,}000 \times .88 \times 6.75} = .25''^{\square}$ Use $\frac{1}{2}''\phi$ @ 9" cc

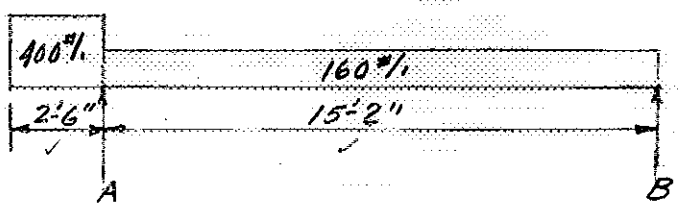
$+A_s =$ Use $\frac{1}{2}''\phi$ @ 12" cc

Floor Slabs S-3 and S-4 will be designed as a two way slab

Slab Loading
D.L. 8" Slab = 100 #/□'
L.L = 300 #/□'
400 #/□'

Slab S-4 can be considered fixed at both ends while slab S-3 will be simply supported at one end and partially fixed at the other It will be assumed that slab S-3 will be loaded with 40% of 400# or 160 #/□'. Slab S-4 will be loaded with 60% 400# or 240 #/□'

Slab S-3



Moment due to cantilever
$2.5 \times 400 \times 1.25 = 1250'^{\#}$

Shear at $A_L = 400 \times 2.5 = 1000^{\#}$
Shear at $A_R = 160 \times 15.17 \times .5 + \frac{1250}{15.17} = 1300^{\#}$

Shear at $B = 160 \times 15.17 \times .5 - \frac{1250}{15.17} = 1130^{\#}$

$x_0 = \frac{1130}{160} = 7.06'$ from B

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Slab - S-3 cont.

$+M = 1130 \times 7.06 - 160 \times \frac{7.06^2}{2} = 3990^{\#}$ ✓

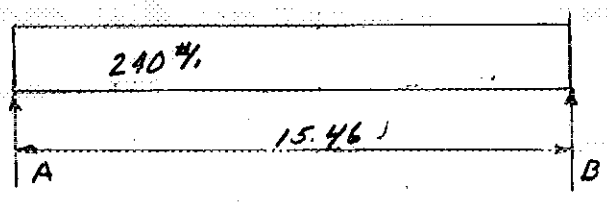
$-A_s = \frac{1,250 \times 12}{20,000 \times .88 \times 6.75} = .13^{\square''}$ Use 5/8"ϕ @ 1'-0" c.c.

$+A_s = \frac{3,990 \times 12}{20,000 \times .89 \times 6.25} = .43^{\square''}$ Use 5/8"ϕ @ 8½" c.c.

$u_0 = \frac{1300}{2.6 \times .88 \times 6.25} = 91^{\#/\square''}$

$v = \frac{1300}{12 \times .88 \times 6.25} = 20^{\#/\square''}$

Slab S-4



$-M = \frac{1}{12} \times 240 \times 15.46^2 = 4780^{\#}$ ✓

End shear $= 240 \times 15.46 \times .5 = 1855$

$+M = 2390^{\#}$ ✓

req'd $d = \sqrt{\frac{4780}{139}} = 5.85$ OK

d for top steel = 6.06" ✓

d for bot steel = 5.56" ✓

$v = \frac{1855}{12 \times .88 \times 6.01} = 29^{\#/\square''}$

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Slab S-4

$-A_s = \frac{4780 \times 12}{20{,}000 \times .88 \times 6.06} = .54^{\square''}$ Use 5/8"ϕ @ 7"cc

$+A_s = \frac{2390 \times 12}{20{,}000 \times .89 \times 5.56} = .29^{\square''}$ Use 5/8"ϕ @ 8"cc as $\frac{1}{24} w l^2$ is extreme 8" spacing will be the same as S-3

$u_0 = \frac{1855}{3.4 \times .88 \times 6.06} = 102^{\#}/\square''$

The remainder of the engine room floor slab will be designed as a continuous slab. Two sections will be investigated. Section A-A will pass thru that portion of the slab loaded with the engine proper while Section B-B will pass thru the gear units

Load under Gasolene Engine

Engine = 6000#
Impact = 6000#
Base 4×1.5×8×150 = 7200#
19200#

$\frac{19200}{4 \times 8} = 600^{\#}/\square'$

Load under Gear Unit

Unit = 5000#
Impact = 5000
Base $4^2 \times 1.25 \times 150$ = 3000#
13000#

$\frac{13000}{16 - 2.8} = 985^{\#}/\square'$

Load under Diesel Engine

Unit = 4000#
Impact 4000#
Base 5×3.5×1.25×150 = 3280
11280#

$\frac{11280}{3.5 \times 5} = 645^{\#}/\square'$

Subject: Bushnell Park Pumping Station
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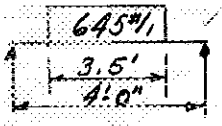
Computed by: H. E. W. Checked by: [illegible] Date: 15 Feb. 48

Load under Diesel Engine (cont.)
Equiv. uniform load over 4'-0" span



$R_L = 645 \times 1.75 = 1129^{\#}$

$M = 1129 \times 2 - 1129 \times \frac{1.75}{2} = 1270^{'\#}$

$1270 = \frac{1}{8} w \times 4^2 \quad w = 635^{\#}/'$

Load under Diesel Engine Gear Unit

Unit	=	2000#	
Impact	=	2000#	$\frac{5838}{3.5^2 \times 1.25^2} = 545^{\#}/\square'$
Base: $3.5^2 \times 1 \times 150$	=	1838	
		5838#	

Equiv. uniform load over 4'-0" span = $535^{\#}/\square'$

Load under Standby Unit
Load will be assumed uniformly distributed over base area

Unit	=	4000#	
Impact	=	4000#	$\frac{12200}{3 \times 9} = 450^{\#}/\square'$
Base	=	4200#	
		12200#	

Fixed End Moments Section A-A

$M = \frac{1}{12} 400 \times 7.92^2 = 2090^{'\#}$

$M = \frac{1}{12} 700 \times 3.67^2 = 785^{'\#}$

$M = \frac{1}{12} 400 \times 7.67^2 = 1960^{'\#}$

$M = \frac{1}{12} 400 \times 7.0^2 = 1633^{'\#}$

$M = \frac{1}{12} 400 \times 6.75^2 = 1520^{'\#}$

$M = \frac{1}{12} 745 \times 3.58^2 = 795^{'\#}$

$M = \frac{1}{12} \times 400 \times 6^2 + \frac{.25(6 \cdot 2 + 3 \times .0625)}{12} \times 225 \times 6 = 1320^{'\#}$

$M = \frac{1}{12} \times 400 \times 6^2 + \frac{.0625(4 \cdot 75)}{12} \times 225 \times 6 = 1220^{'\#}$

$M = \frac{1}{12} \times 400 \times 9.17^2 + \frac{.164(6 - 8 \times .164 + 3 \times .027)}{12} \times 225 \times 9.17 = 3010^{'\#}$

$M = \frac{1}{12} \times 400 \times 9.17^2 + \frac{.027(4 \cdot 49)}{12} \times 225 \times 9.17 = 2970^{'\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

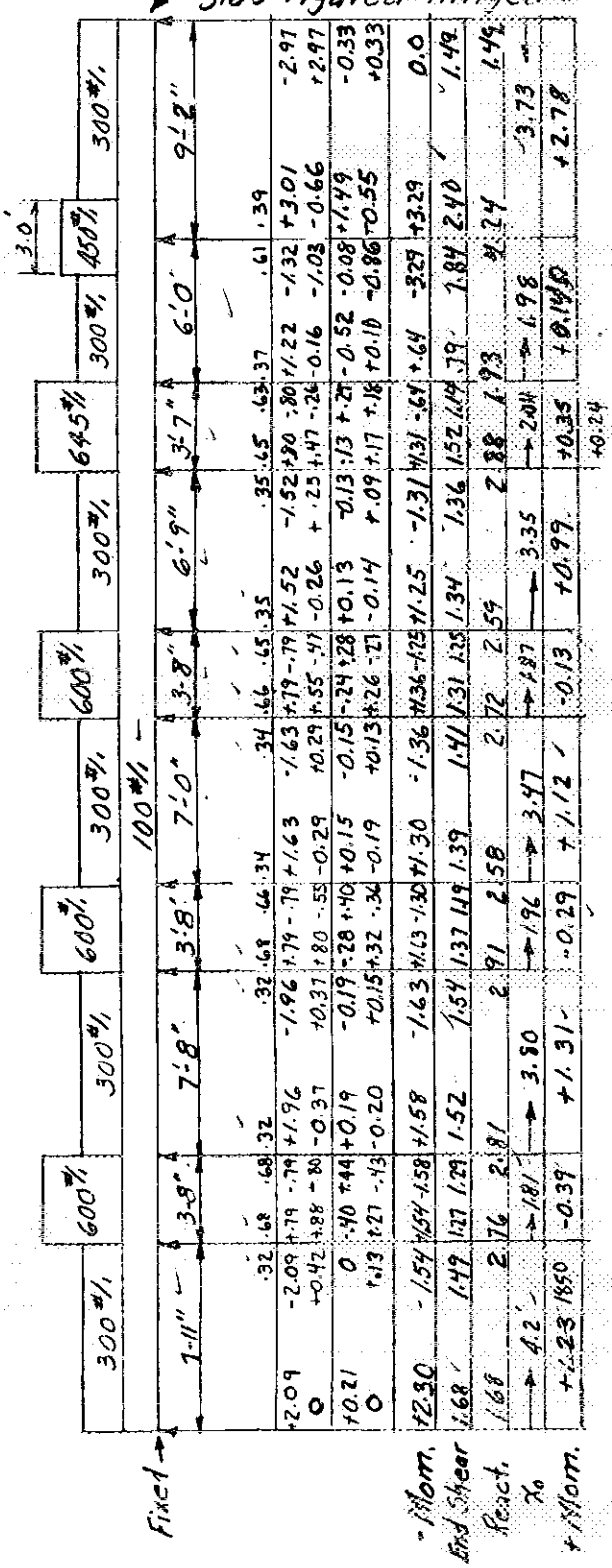
Subject Bushnell Park Pumping Station

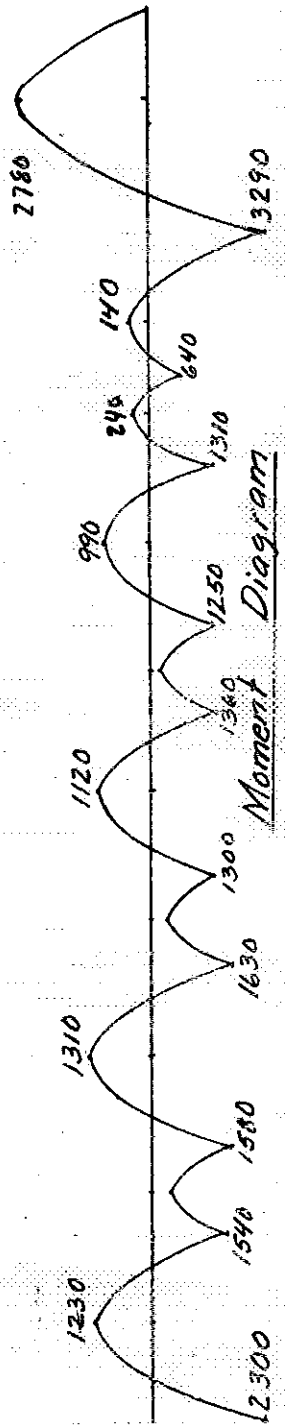
Computation Engine Room Floor Slab

Computed by H.E.W. **Checked by** A.L.K. **Date** 15 Feb. 44

Section A-A

slab figured hinged at this end





reqd $d = \sqrt{\frac{2780}{116}} = 4.90$

8" slab OK

for $+A_s$ $d = 6.25'$

for $-A_s$ $d = 6.75'$

$-A_s = \frac{3290 \times 12}{20{,}000 \times .88 \times 6.75} = .33 \square''$

$\frac{1}{2}''\phi$ @ 6" cc

$-A_s = \frac{2300 \times 12}{20{,}000 \times .88 \times 6.75} = .23 \square''$

$\frac{1}{2}''\phi$ @ 8" cc

$-A_s = \frac{1630 \times 12}{20{,}000 \times .88 \times 6.75} = .17 \square''$

$\frac{1}{2}''\phi$ @ 1'-0" cc

$+A_s = \frac{2780 \times 12}{20{,}000 \times .89 \times 6.25} = .30 \square''$

$\frac{1}{2}''\phi$ @ 6" cc

$v = \frac{2400}{12 \times .88 \times 6.75} = 34\ \#/\square''$

$u_0 = \frac{2400}{3.1 \times .88 \times 6.75} = 130\ \#/\square''$

$u_0 = \frac{1570}{1.6 \times .88 \times 6.75} = 165\ \#/\square''$

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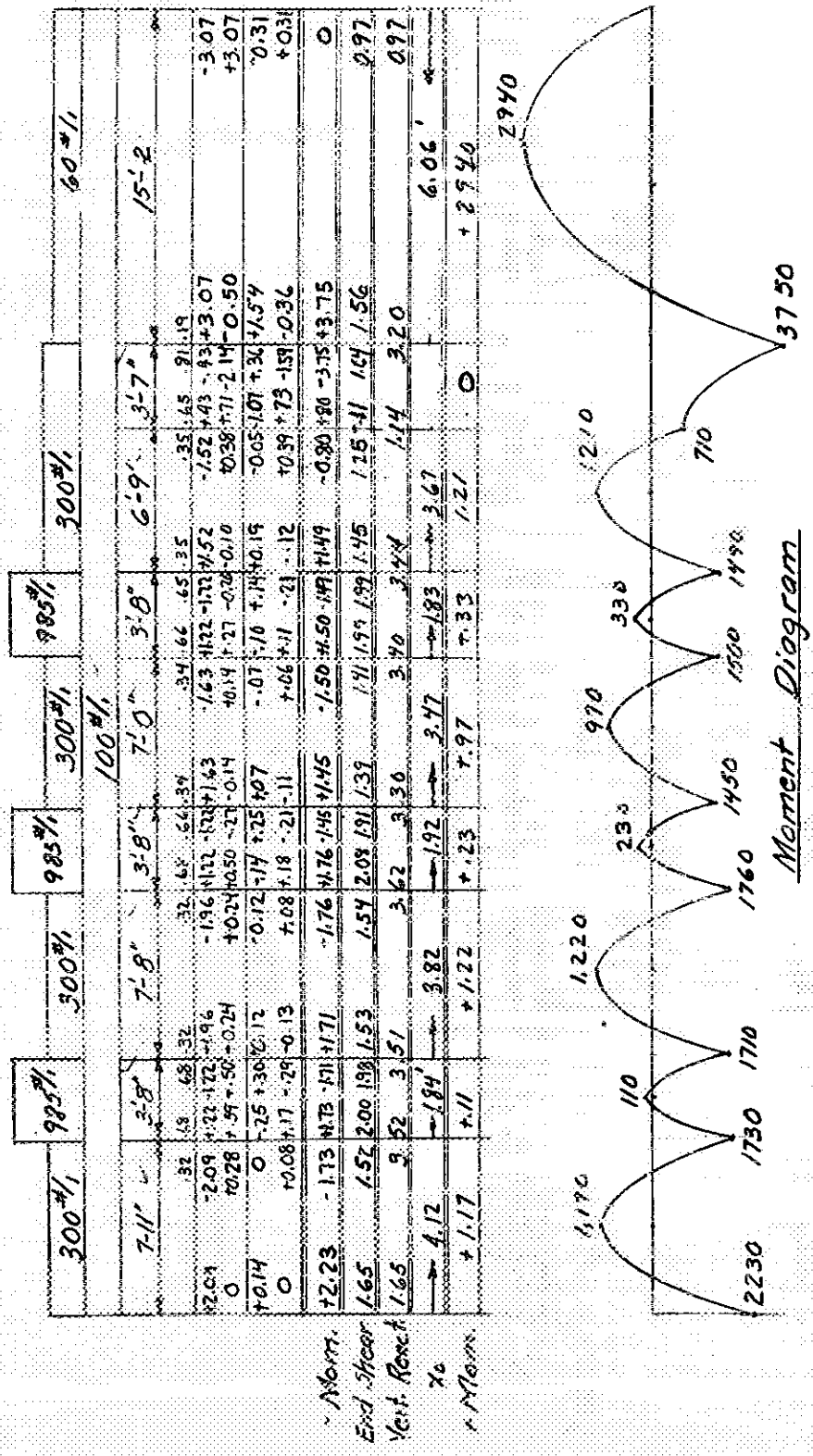
Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor Slab

Computed by: H.E.W. Checked by: A.L.K. Date: 16-Feb.-44

Section B-B (Applies to area 1'6" ± to the front and rear of gear unit openings)



Fixed End Moments

$\frac{1}{12} \times 1085 \times 3.67^2 = 1220^{\#}$

$\frac{1}{12} \times 400 \times 3.58^2 = 427^{\#}$

$\frac{1}{12} \times 160 \times 15.17^2 = 3070^{\#}$

$-A_s = \frac{3750 \times 12}{20{,}000 \times .88 \times 6.75} = .38^{\square''}$

5/8"ϕ @ 10" c.c.

$-A_s = \frac{1760 \times 12}{20{,}000 \times .88 \times 6.75} = .18^{\square''}$

1/2"ϕ @ 1'-0" c.c.

$-A_s = \frac{2230 \times 12}{20{,}000 \times .88 \times 6.75} = .23^{\square''}$

1/2"ϕ @ 10" c.c.

$+A_s = \frac{2940 \times 12}{20{,}000 \times .89 \times 6.25} = .32^{\square''}$

5/8"ϕ @ 1'-0" c.c.

$v = \frac{2080}{12 \times .89 \times 6.75} = 29^{\#/\square''}$

$u_0 = \frac{2080}{1.6 \times .88 \times 6.75} = 219^{\#/\square''}$ NG

Try 1/2"ϕ @ 10" c.c.

$u_0 = \frac{2080}{2.4 \times .88 \times 6.75} = 185^{\#/\square''}$

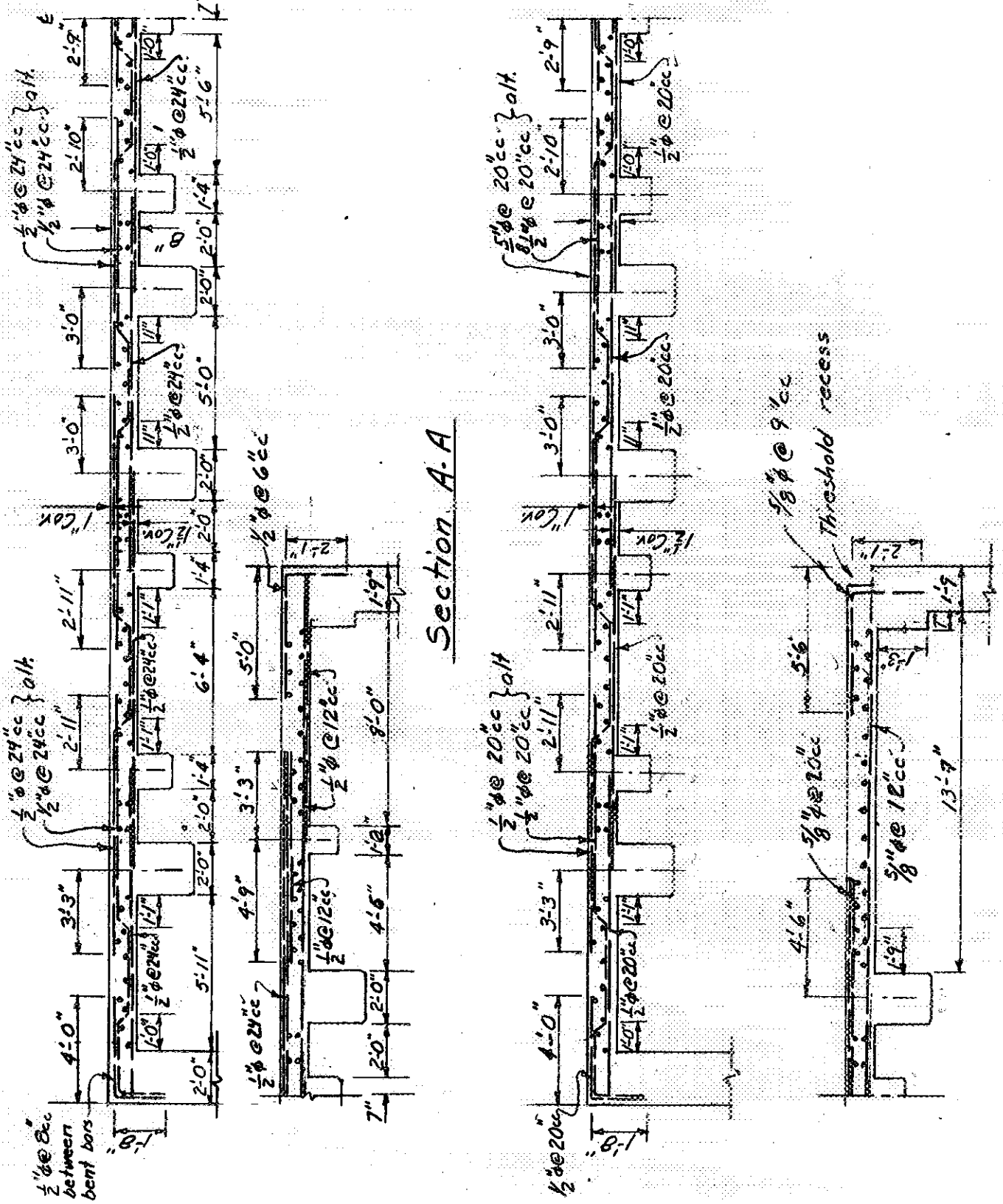
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnel Park Pumping Station

Computation Engine Room Floor Slab

Computed by H.E.W. **Checked by** **Date** 17 Feb. 44



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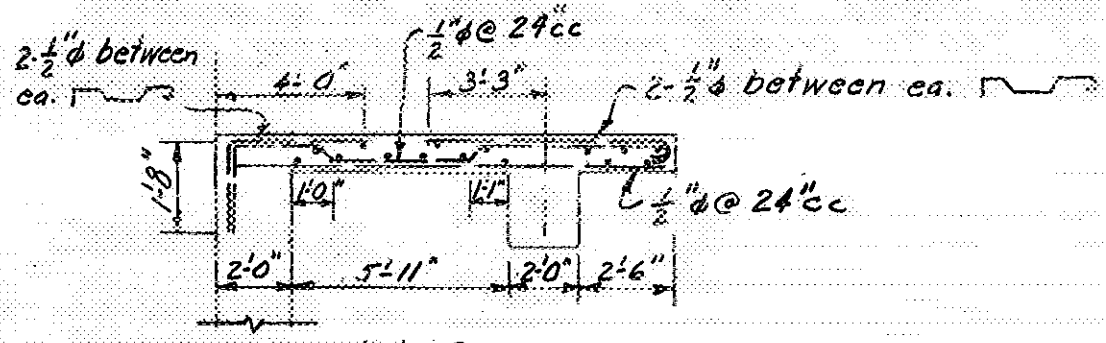
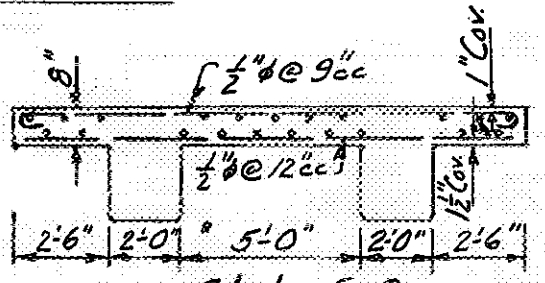
Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor Slab

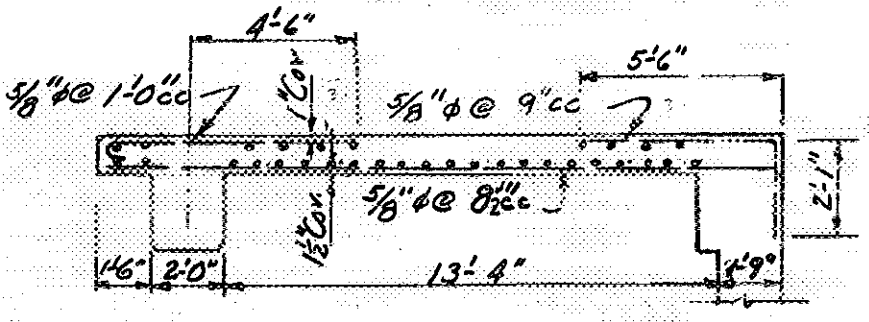
Computed by: H. E. W. Checked by: Date: 17 Feb. 49



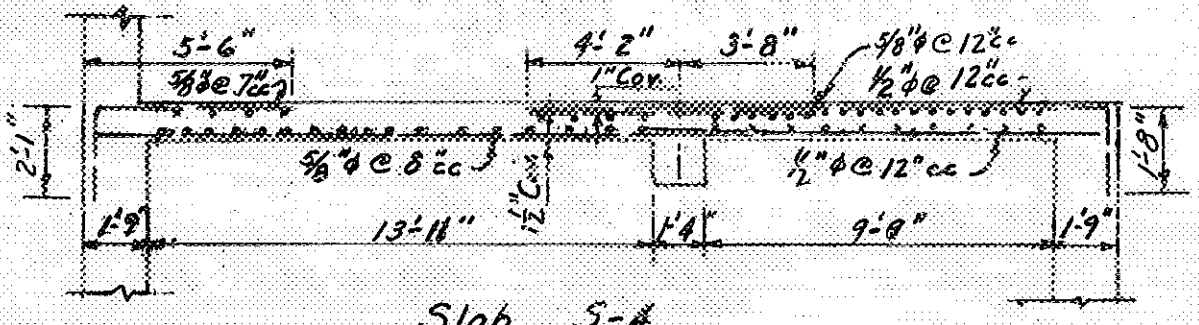
Slab S-1



Slab S-2



Slab S-3

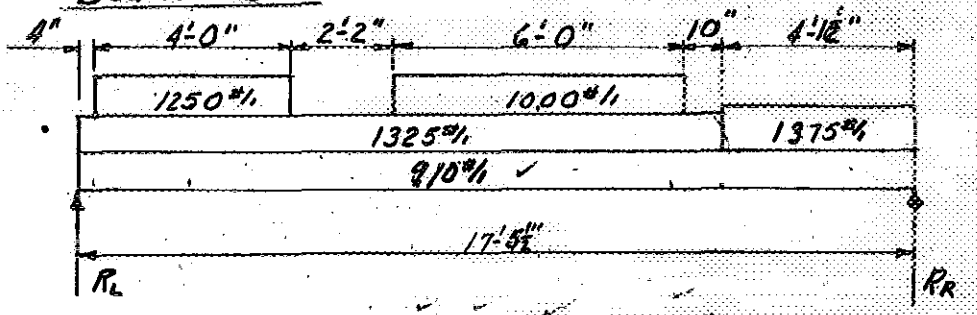


Slab S-4

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: D.L.K. Date: 18-Feb-44

Engine Room beams will be designed for a uniform live load of 250#/□' except where concentrated machinery loads occur. Beams will be considered simply supported

Beam B-1



Try beam 16"x30"

D.L. 8" Slab = 100 x 5.5 = 550#
D.L. 16" x 30 = 1.33 x 150 = 360#
D.L. Slab + Beam = 910#/'

D.L. Conc. Base = 2 x 1.5 x 150 = 450#/'
L.L. on Floor = 250 x 3.5 = 875#/'
" " " = 250 x 5.5 = 1375#/'
} 1325#/'

Wt. Engine = 6000#
Impact = 6000#
} = 1000#/'

Wt. Gear Unit = 5000
Impact = 5000
} = 1250#/'

R_L =
910 x 17.46 x .5 = 7947#
1325 x 13.33 x .618 = 10925
1375 x 4.12 x .118 = 668
1000 x 6 x .455 = 2730
1250 x 4 x .866 = 4330
26589#

R_R =
910 x 17.46 x .5 = 7947#
1325 x 13.33 x .382 = 6758
1375 x 4.12 x .882 = 4993
1000 x 6 x .545 = 3280
1250 x 4 x .134 = 670
23628#

x_0 = 8.7' from R_L

Max M = 26,587 x 8.7 − 2235 x $\frac{8.7^2}{2}$ − 4 x 1,250 x 6.37 = 112,450

req'd d = $\sqrt{\frac{112,950 \times 12}{116 \times 16}}$ = 27.0" ≈ 27.5"

Try Beam 16" x 28"

Beam will act as a Tee Beam

b = 35" $\frac{t}{d}$ = .313 K = 118

req'd d = $\sqrt{\frac{112,950 \times 12}{116 \times 35}}$ = 18.2" < 27.5" OK

v = $\frac{26,587}{16 \times .89 \times 27.5}$ = 70.7#/□" OK

Use 16" x 28" Beam
d = 27.5"

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.F.W. Checked by: A.L.F. Date: 18 Feb. 41

Beam B-1 cont.

$A_s = \frac{112,750 \times 12}{20,000 \times .89 \times 25.5} = 2.98$ □" Use 4-1"ϕ bars

$u_0 = \frac{26587}{12.57 \times .89 \times 25.5} = 93$ #/□"

Bending Pt. for steel
Assume 2 bars to be bent up

$M = \frac{1.57 \times 20,000 \times .89 \times 25.5}{12} = 69000$ #

Bending pt at left

$26387x - 2235\frac{x^2}{2} - 1250\left(\frac{x-.33}{2}\right)^2 = 69,000$ #

$x = 3.13'$

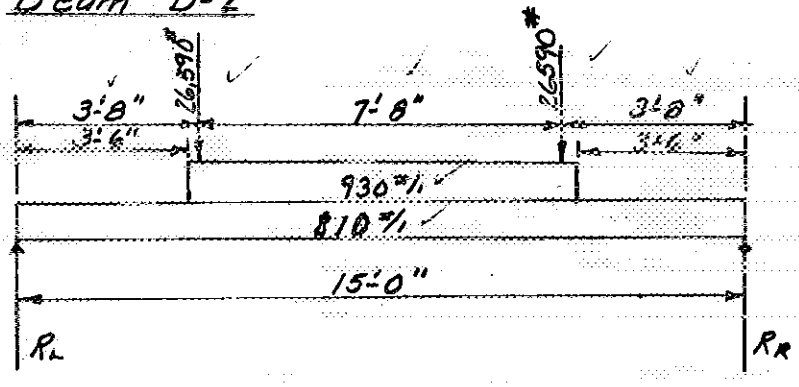
Bending pt at right

$23688x - 2285\frac{x^2}{2} = 69000$ #

$x = 3.52$

Carry bars straight thru as angle of inclination is too steep

Beam B-2



Try Beam 20"x38"

D.L. Beam = 1.67x2.03x150 = 520
100x.82 = 82
L.L. on Bm = 250x.83 = 208
810#

D.L. Cover plate = 15x3.5 = 53#
L.L. " " = 250x3.5 = 875
928#

$R_L = R_R =$ 26590#
810x15.0x.50 = 6080
930x8.0x.50 = 3720
36390#

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 19 Feb. 44

Beam B-2 cont.

$$\text{Max } M = 36{,}390 \times 7.5 - 810 \times \frac{7.5^2}{2} - 930 \times \frac{4^2}{2} - 26{,}390 \times 3.83 = 141{,}630''^{\#}$$

$$\text{req'd } d = \sqrt{\frac{141{,}630 \times 12}{20 \times 116}} = 27.0'' < 30.5''$$

$$v = \frac{36{,}390}{20 \times .89 \times 30.5} = 67\ \#/\square'' \quad \text{OK} \qquad \underline{\text{Use } 20'' \times 33'' \text{ beam}}$$

$$A_s = \frac{141{,}630 \times 12}{20{,}000 \times .89 \times 30.5} = 3.13\ \square'' \qquad \text{Use } 4\text{-}1''\phi \text{ bars}$$

Bending Pt for steel

Assume 2 bars to be bent up

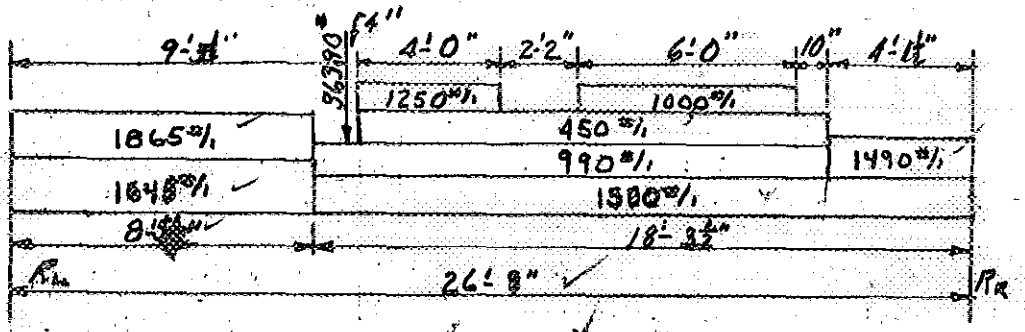
$$M = \frac{1.57 \times 20{,}000 \times .89 \times 30.5}{12} = 71{,}030''^{\#}$$

$$36390x - 810\frac{x^2}{2} = 71030 \qquad x = 2.1'$$

Carry bars straight thru

$$u_0 = \frac{36390}{12.57 \times .89 \times 30.5} = 106\ \#/\square'' \quad \text{OK}$$

Beam B-3



Try 24" × 44" Beam

D.L. Slab = 100 × 5.96 = 596#
" " = 100 × 7.46 = 748#
} 1496#/' say 1500#/'
D.L. Beam = 3.08 × 2 × 150 = 900# } 1685#/'
L.L. = 250 × 7.46 = 1865#/'
L.L = 250 × 3.96 = 990#/'
L.L = 250 × 5.96 = 1490#/'

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 19 - Feb. 44

Beam B-3 cont.

R_L =			R_R =		
3510 × 8.46 × .842 =		25,030#	3510 × 8.46 × .158 =		4590
1500 × 18.29 × .342 =		9380	1500 × 18.29 × .658 =		18030
990 × 14.17 × .418 =		5880	990 × 14.17 × .582 =		8150
1490 × 4.12 × .073 =		470	1490 × 4.12 × .927 =		5670
450 × 13 × .397 =		2320	450 × 13 × .603 =		3530
1250 × 4 × .566 =		2830	1250 × 4 × .434 =		2170
1000 × 6 × .297 =		1780	1000 × 6 × .703 =		4220
36390 × .653		23,760	36390 × .347		12,630
		71,450#			59,430#

x_0 = 10.2 from R_L

Max M = 71,450 × 10.2 − 3510 × 8.46 × 5.97 − 2490 × 1.74 × 0.87 − 36,390 × .72 − 1700 × 0.58 × 0.29 = 514,340 '#

req'd d = $\sqrt{\frac{514340 \times 12}{116 \times 24}}$ = 46.8" > 41.5" No Tee Beam Action

Beam will act as a Tee Beam

b = 50.5" $\frac{t}{d} = \frac{8}{40} = .2$ K = 101

req'd d = $\sqrt{\frac{514340 \times 12}{101 \times 50.5}}$ = 34.8" < 41.5 OK

Use 24" × 44" beam with 2 layers of steel d = 40" at center
d = 41.5 at ends

$v = \frac{71450}{24 \times .89 \times 41.5}$ = 80 #/□" Stirrups are req.

$A_s = \frac{514340 \times 12}{20{,}000 \times .89 \times 40}$ = 8.6 □" Use 9-1"□ bars
5-1"□ bot. layer - 4-1"□ top layer

$u_0 = \frac{71450}{20 \times .89 \times 40}$ = 100 #/□" OK

Bending Pts for top layer of steel
left side

$M = 5 \times 20{,}000 \times .89 \times \frac{41.5}{12}$ = 308,000 '#

$71450x - 3510\frac{x^2}{2} = 308{,}000$

x = 50

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H. E. W. Checked by: A. L. Date: 23 Feb. 44

Beam B-3 (cont.)
Bending Pt. for steel
Right side

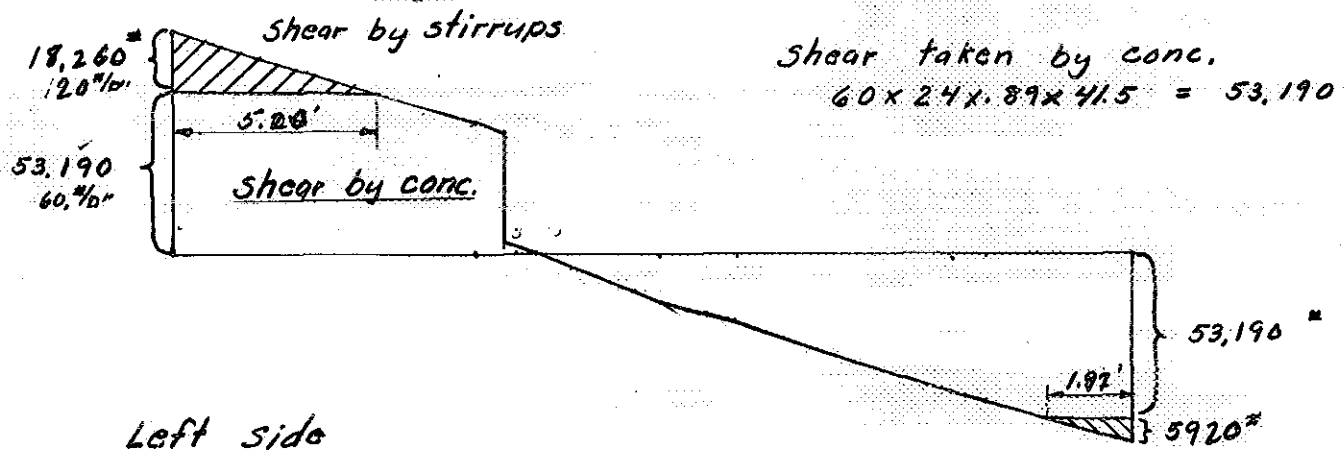
$$59{,}110(x+4.12) - 2990\times 4.12(x+2.06) - 2940\frac{x^2}{2} - 1000\frac{(x-.83)^2}{2} = 308{,}000$$

$$1470x^2 - 243530 - 59110x + 12320x + 25380 + 500x^2 - 830x + 344 + 308{,}000 = 0$$

$$1970x^2 - 47620x + 90{,}190 = 0$$

$$x^2 - 24.2x + 45.8; \quad x = 3.65 \quad x_3 = 6\text{-}2'' \text{ from } R_R \ ?$$

Shear Diagram



Shear taken by conc.
$60\times 24\times .89\times 41.5 = 53{,}190$

Left side

Try ½"φ stirrups

No stirrups $= \dfrac{18260\times 5.20\times .5\times 12}{.39\times 16000\times .89\times 41.5} = 3$ stirrups

Spacing =

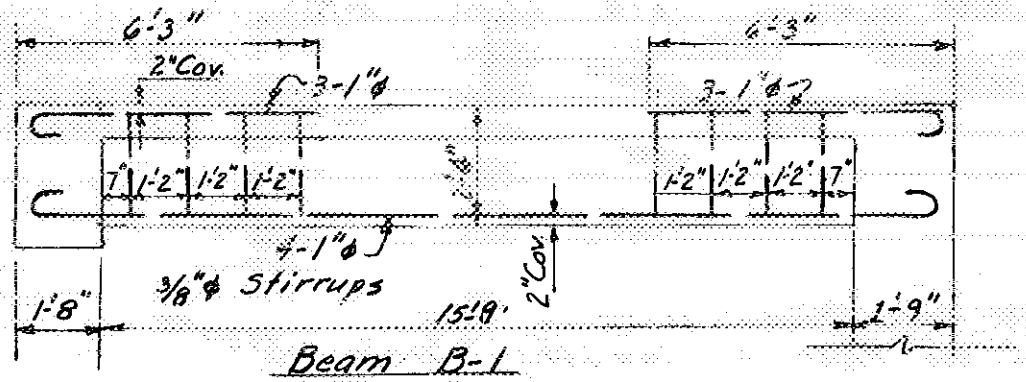
$.39\times 16000 = 120\times 24\times S_1 \qquad S_1 = 13''$

$.39\times 16000 = 158\times 24\times S_2 \qquad S_2 = 16''$

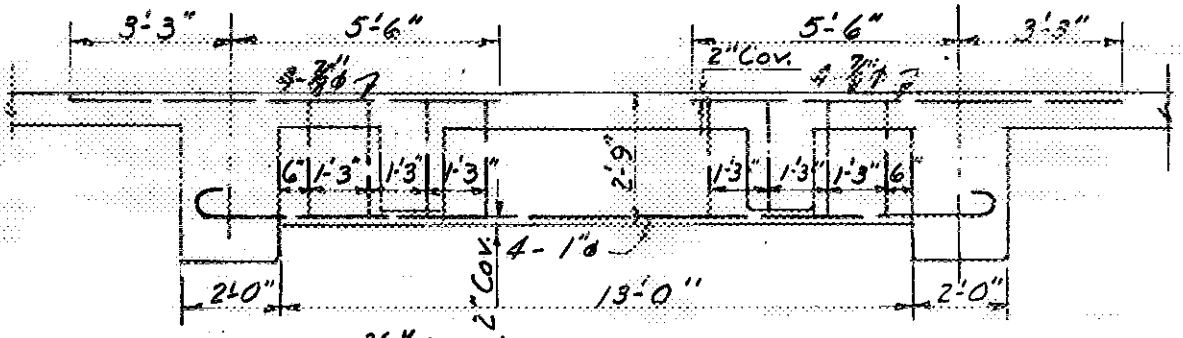
$.39\times 16000 = 104\times 24\times S_3 \qquad S_3 = 25''$

Make spacing 6", 15", 20", 20" at both ends

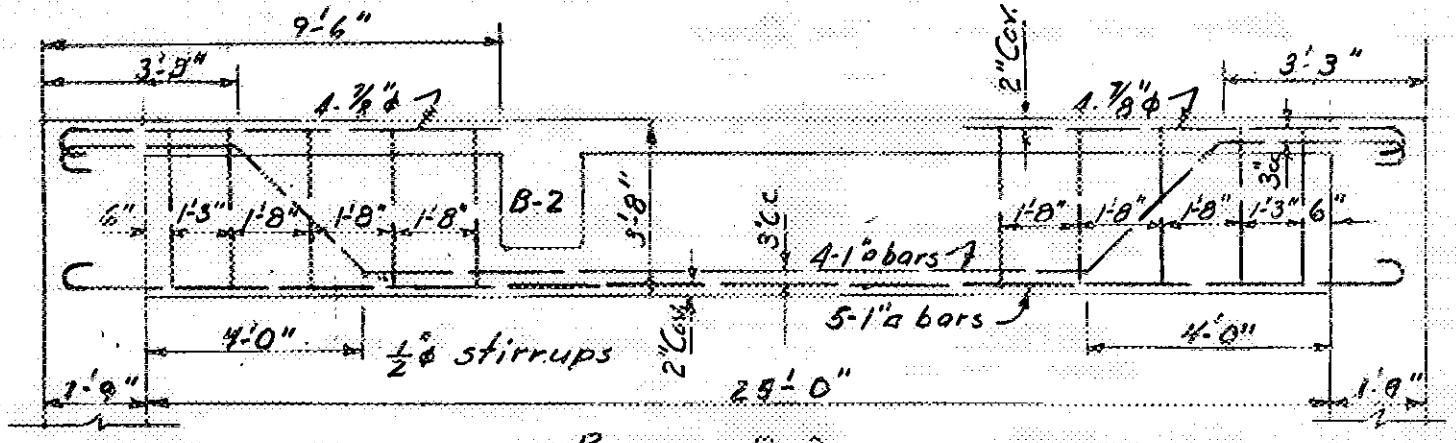
Subject Bushnell Park Pumping Station
Computation Engine Room Floor Beams
Computed by H.E.W. **Checked by** R.L.F. **Date** 19 Feb 48



Beam B-1
16" x 28"



Beam B-2
20" x 33"

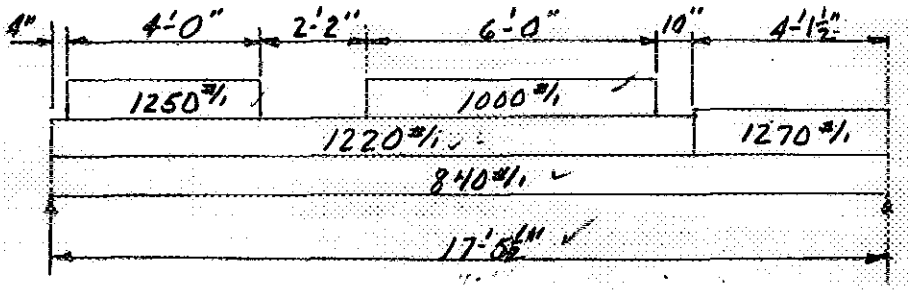


Beam B-3
24" x 44"

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 23-Feb-44

Beam B-4

TRY 16" x 28"



D.L. 8" slab = 100 x 5.08 = 508 #/'
D.L. 16" x 28" bm = 1.33 x 1.67 x 150 = 333
D.L. Slab + Bm. = 841 #/'

D.L. conc. base = 2 x 1.5 x 150 = 450 #/'
L.L. on Floor = 250 x 3.08 = 770 #/'
} 1220 #/'
L.L. on floor = 250 x 5.08 = 1270 #/'
Gear unit + engine loads are the same as for B-1

R_L =	840 x 17.46 x .5 =	7330	R_R =	840 x 17.46 x .5 =	7330
	1220 x 13.33 x .618 =	10,050		1220 x 13.33 x .382 =	6210
	1270 x 4.12 x .118 =	620		1270 x 4.12 x .882 =	4620
	1000 x 6 x .455 =	2730		1000 x 6 x .545 =	3270
	1250 x 4 x .866 =	4330		1250 x 4 x .134 =	670
		25060#			22,090#

x_0 = 8.68' from R_L

$$\text{Max } M = 25060 \times 8.68 - 2060 \times \frac{8.68^2}{2} - 4 \times 1250 \times 6.35 - 1000 \times \frac{2.18^2}{2} = 105,790$$

$$\text{req'd } d = \sqrt{\frac{105,790 \times 12}{116 \times 16}} = 26.4'' > 25.5''$$

Beam will act as a Tee Beam

$b = 35''$, $\frac{t}{d} = .313$ $K = 115$

$$\text{req'd } d = \sqrt{\frac{105,790 \times 12}{115 \times 35}} = 17.7'' < 25.5''$$

$$V = \frac{25,060}{16 \times .89 \times 25.5} = 69 \text{ \#/□''}$$ Use 16" x 28" beam d = 25.5"

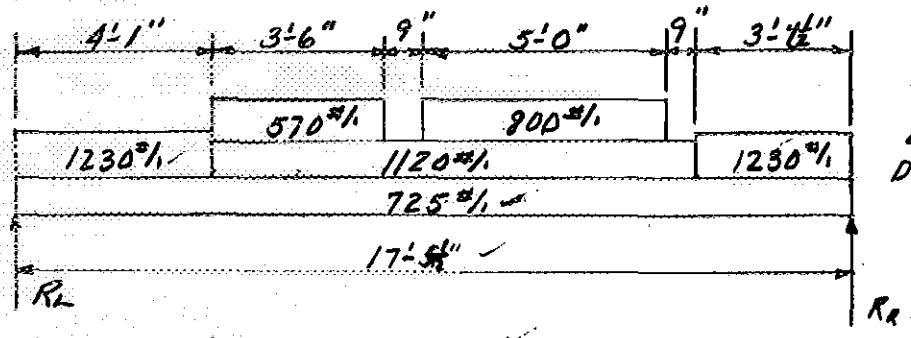
$$A_s = \frac{105,790 \times 12}{20,000 \times .89 \times 25.5} = 2.79 \text{ □''}$$ Use 4 - 1" ø bars

$$u_0 = \frac{25,060}{12.57 \times .89 \times 25.5} = 88 \text{ \#/□''}$$

Make Beam B-4 same as B-1

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 24 Feb. 44

Beam B-5



Try 14" x 24" Beam.
D.L. Slab = 100 x 4.92 = 492 #/'
D.L. Bm = 1.17 x 1.33 x 150 = 233
D.L. slab + beam = 725 #/'

Live Load = 250 x 4.92 = 1230 #/'
" " 250 x 3.17 = 790 #/'
D.L conc. base = 1.75 x 1.25 x 150 = 330 #/' } 1120 #/'
Wt. Engine = 4000#
Impact = 4000# } = $\frac{8000}{2 \times 5}$ = 800 #/'
Gear Unit = 2000
Impact = 2000 } = $\frac{4000}{2 \times 3.5}$ = 570 #/'

R_L =	725 x 17.46 x .5	= 6330#	R_R =	725 x 17.46 x .5	= 6330#
	1230 x 4.08 x .888	4430		1230 x 4.08 x .118	= 590
	1120 x 10 x .480	5380		1120 x 10 x .520	= 5820
	1230 x 3.87 x .097	400		1230 x 3.87 x .903	= 3940
	570 x 3.5 x .666	1330		570 x 3.5 x .334	= 660
	800 x 5 x .379	1520		800 x 5 x .621	= 2480
		19390			19,620#

x_0 8.93 from R_L

Max M = 19390 x 8.93 - 1230 x 4.08 x 6.88 - 1120 x 4.85 x 2.43 - 570 x 3.5 x 3.16 - 800 x $\frac{.60^2}{2}$ = 725 x $\frac{8.93^2}{2}$ = 90140 ′#

req'd d = $\sqrt{\frac{90140 \times 12}{116 \times 14}}$ = 25.8" (No Tee Beam Action)

Beam will act as a Tee Beam.
b = 35" $\frac{t}{d}$ = .372 K = 114

req'd d = $\sqrt{\frac{90140 \times 12}{114 \times 35}}$ = 16.5" < 21.5" M

v = $\frac{19620}{14 \times .89 \times 21.5}$ = 73 #/□" OK Make beam 14" x 24" d = 21.5"

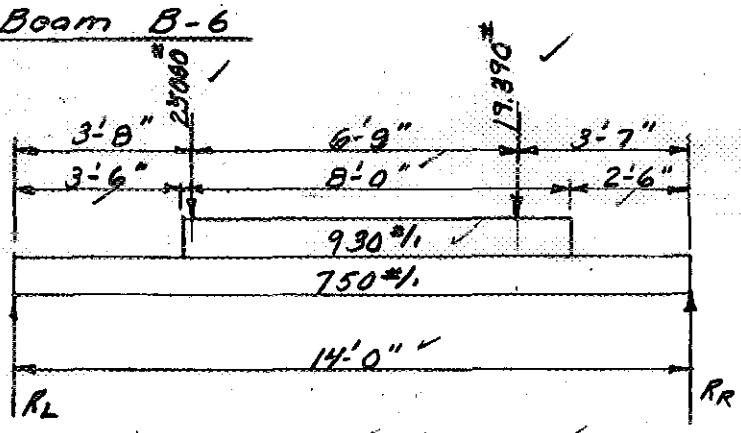
Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 24 Feb. 44

Beam B-5 (cont.)

$A_s = \frac{90,140 \times 12}{20,000 \times .89 \times 21.5} = 2.82^{\square''}$ Use 4 - 1" ⌀ bars

$u_o = \frac{19870}{12.57 \times .89 \times 21.5} = 82^{\#}/_{\square''}$ OK

Beam B-6



Try Beam 20" x 30"

D.L. Beam = 1.67 x 1.83 x 150 = 458#/'
100 x .83 = 83
L.L on Beam = 250 x .83 = 208
749#/'

D.L cover plate = 15 x 3.5 = 53#/'
L.L on " " = 250 x 3.5 = 875
928#/'

R_L = 750 x 14 x .5 = 5250
930 x 8 x .464 = 3450
25060 x .738 = 18390
19390 x .256 = 4960
32,150

R_R = 750 x 14 x .5 = 5250
930 x 8 x .536 = 3990
25060 x .262 = 6570
19390 x .744 = 14430
30240

x_o = 6.16' from R_L

Max M = 32050 x 6.16 - 750 x $\frac{6.16^2}{2}$ - 25,060 x 2.53 - 930 x $\frac{2.66^2}{2}$ = 117,120 '#

req'd d = $\sqrt{\frac{117,120 \times 12}{20 \times 116}}$ = 24.8" < 27.5" OK

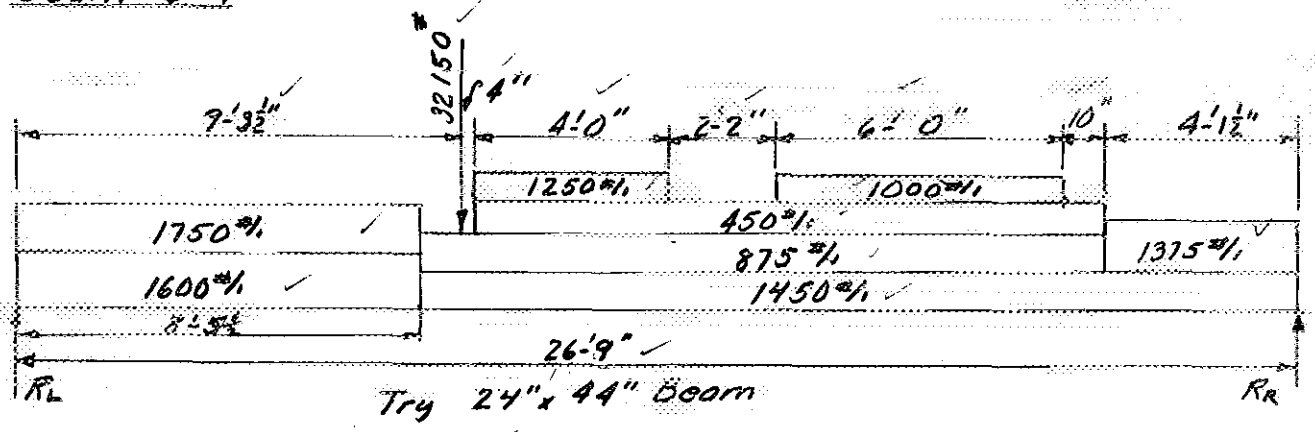
$v = \frac{32150}{20 \times .89 \times 27.5} = 66^{\#}/_{\square''}$ OK Make beam 20" x 30"

$A_s = \frac{117,080 \times 12}{20,000 \times .89 \times 27.5} = 2.87^{\square''}$ Use 4 - 1" ⌀ bars

$u_o = \frac{32050}{12.57 \times .89 \times 27.5} = 104^{\#}/_{\square''}$ OK

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H. E. W. Checked by: A.L.C. Date: 25 Feb. 44

Beam B-7



Try 24" x 44" Beam

D.L. slab	= 100 x 5.5	= 550#	1450#/'
" "	= 100 x 7.0	= 700#	
D.L. Beam	= .3 x 2 x 150	= 900	1600#/'
Live Load	= 250 x 7.00	= 1750#/'	
" "	= 250 x 3.5	= 875#/'	
" "	= 250 x 5.5	= 1375#/'	

R_L =		R_R =	
3350 x 8.46 x .842	= 23,860	3350 x 8.46 x .158	4480
1450 x 18.29 x .342	= 9070	1450 x 18.29 x .658	= 17450
875 x 14.17 x .419	= 5200	875 x 14.17 x .581	= 7200
1375 x 4.12 x .077	= 440	1375 x 4.12 x .923	= 5230
450 x 13 x .399	= 2320	450 x 13 x .603	= 3530
1250 x 4 x .566	= 2830	1250 x 4 x .434	= 2170
1000 x 6 x .297	= 1780	1000 x 6 x .703	= 4220
32150 x .653	20990	32150 x .347	11160
	66,490#		55440#

x_0 = 10.43' from R_L

$$\text{Max } M = 66490 \times 10.43 - 3350 \times 8.46 \times 6.2 - 2375 \times 1.97 \times .985 - 32150 \times 1.14 - 1700 \times \frac{.8^2}{2}$$

$$M = 476060 \text{ '#}$$

$$\text{req'd } d = \sqrt{\frac{476060 \times 12}{116 \times 24}} = 45.3" > 40" \quad \text{(No Tee Beam Action)}$$

Beam will act as a Tee Beam

$b = 50.5"$ $\frac{t}{d} = .20$ $K = 101$

$$\text{req'd } d = \sqrt{\frac{476060 \times 12}{101 \times 50.5}} = 33.5"$$

$$v = \frac{66,490}{24 \times .89 \times 41.5} = 75 \text{ \#/□"}$$

Make Beam 24"x44"
(2 layers of steel)
d = 40.0" at center
d = 41.5 " ends

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H. E. W. Checked by: A. L. R. Date: 25- Feb. 44

Beam B-7 (cont.)

$A_s = \frac{476,060 \times 12}{20,000 \times .89 \times 40} = 8.02 \square''$ Use 8-1"□ bars 2 layers

$u_o = \frac{66,490}{16 \times .89 \times 41.5} = 113\ \#/\square''$ OK

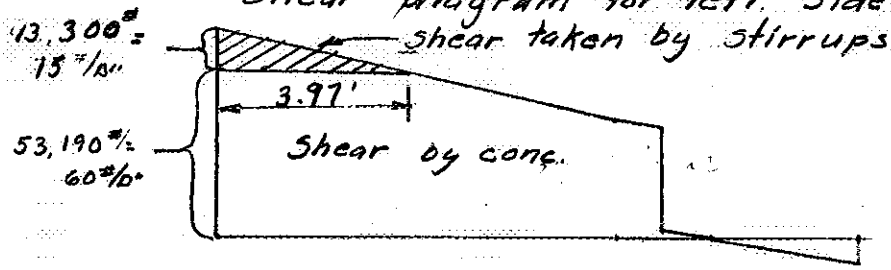
Pts. to bend bars up
Left side will be critical (Will be similar to B-3)

$M = 4 \times 20,000 \times .89 \times \frac{41.5}{12} = 238\ 030^{\#}$

$66,490x - 3350\frac{x^2}{2} = 238,030$ $x = 4.0$ ft.

Left side will require stirrups

Shear diagram for left side



Use $\frac{1}{2}$"ϕ stirrups

No. stirrups $= \frac{13300 \times 3.97 \times .5 \times 12}{.39 \times 16000 \times .89 \times 41.5} = 2$ stirrups

Spacing
$.39 \times 16000 = 15 \times 24 \times S_1$ $S_1 = 17''$
$.39 \times 16000 = 11.7 \times 24 \times S_2$ $S_2 = 27''$

Make spacing 6", 15", 20", 20", 20" at both ends

WAR DEPARTMENT

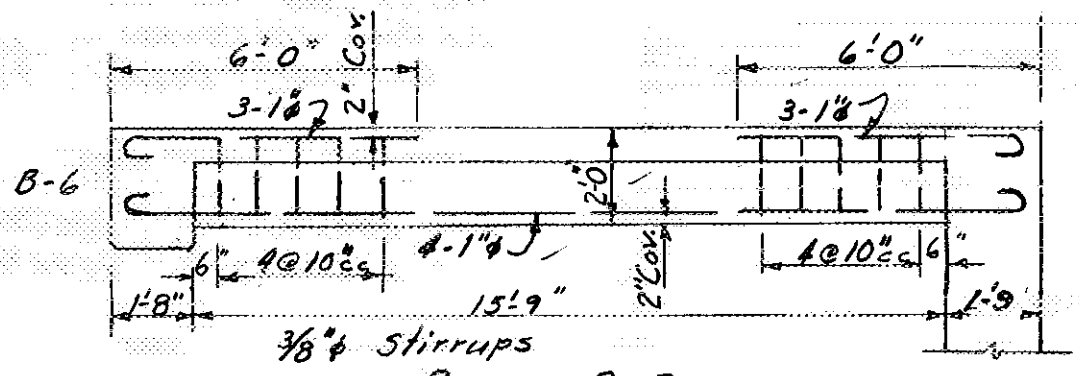
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

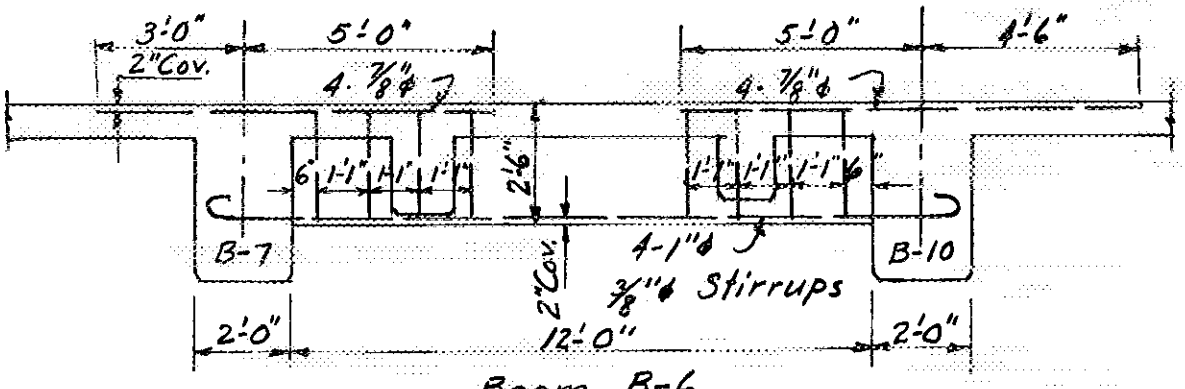
Computation Engine Room Floor Beams

Computed by H.E.W. **Checked by** A.L.K. **Date** 26-Feb-44

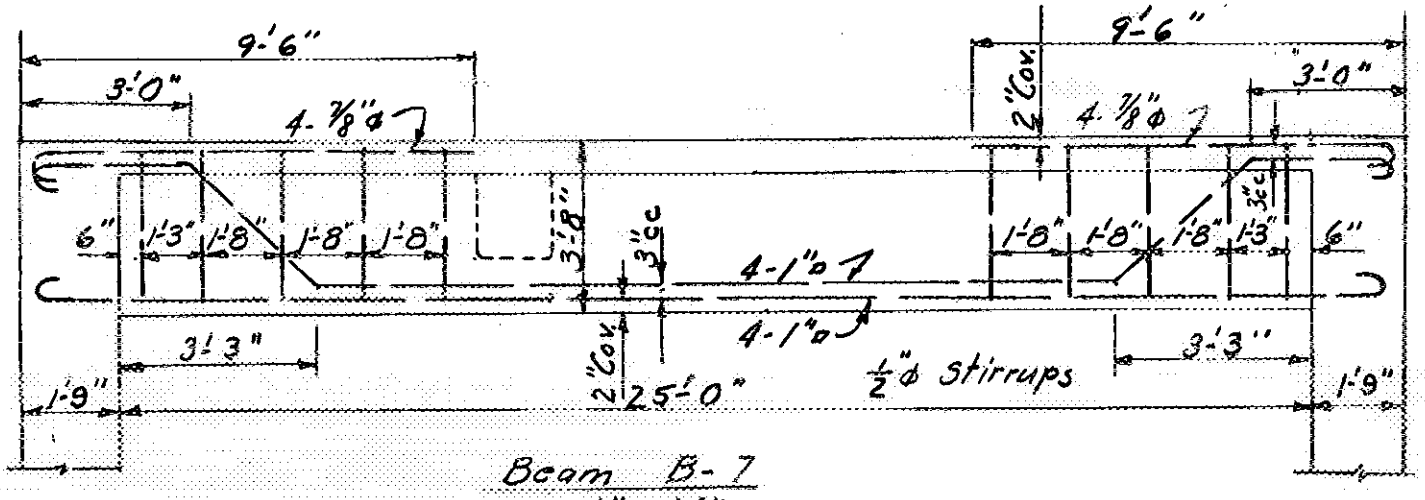
Beam B-4 Details the same as B-1



Beam B-5
14"x 24"



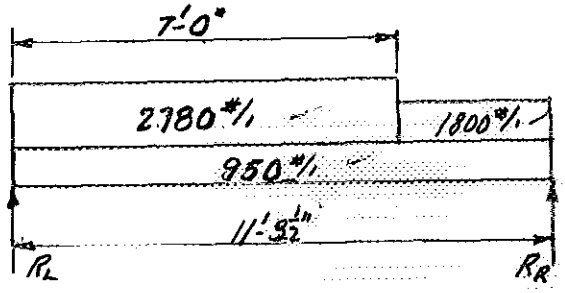
Beam B-6
20"x 30"



Beam B-7
24"x 44"

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K Date: 26 - Feb. 44

Beam B-8



Try 14" x 24" Beam.

D.L. Fl. slab = 100 x 7.17 = 717 #/'
D.L. Beam = 1.17 x 1.33 x 150 = 233
D.L. Floor + Beam = 950 #/'

Standby unit + base = 12,200 / 7 = 1740 #/'

L.L = 250 x 7.17 = 1800 #/'
L.L = 250 x 4.17 = 1040 #/'

R_L = 950 x 11.29 x .5 = 5360
2780 x 7 x .690 = 13,430
1800 x 4.29 x .190 = 1470
20,260 #

R_R = 950 x 11.29 x .5 = 5360
2780 x 7 x .310 = 6030
1800 x 4.29 x .810 = 6250
17640 #

x_0 = 5.43' from R_L

Max M = 20,260 x 5.43 - 3730 x $\frac{5.43^2}{2}$ = 55,020 '#

req'd d = $\sqrt{\frac{55,020 \times 12}{116 \times 14}}$ = 20.2" < 21.5" = 20

V = $\frac{20,260}{14 \times .89 \times 21.5}$ = 76 #/□" OK Make beam 14" x 24"

A_s = $\frac{55020 \times 12}{20,000 \times .89 \times 21.5}$ = 1.73 □" Use 3 - 7/8" ϕ bars

u_0 = $\frac{20,260}{8.25 \times .89 \times 21.5}$ = 128 #/□"

Space stirrups @ 6", 10", 10", 10"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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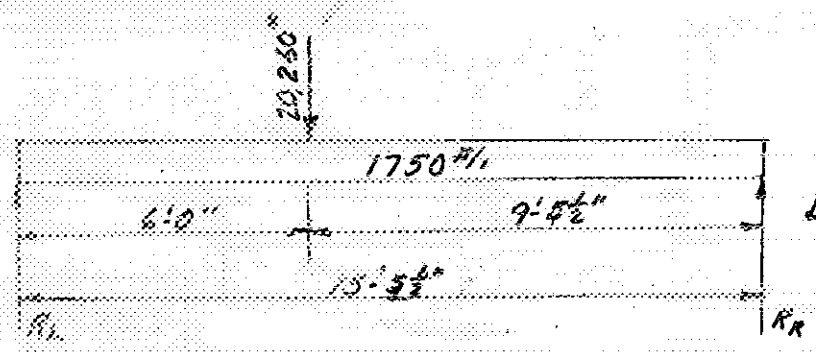
Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor Slab

Computed by: H.E.W. Checked by: A.L.K. Date: 26 Feb - 49

Beam B-3



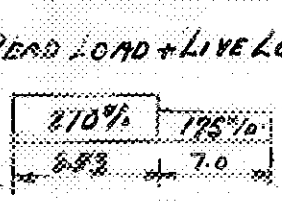
Try Beam 16"x30"

D.L. Beam = 1.33x1.83x150 = 365 #/'

DEAD LOAD + LIVE LOAD Slab

" .50x350 = 175#/'

" .60x350 = 210#/'



React. Loading beam = 175x7x.77 + 210x8.33x.27 = 1410 #/'
17.25 #/'

R_L = 1775x15.46x.5 + 20,260 x 9.46/15.46 = 26100#

R_R = 1775x15.46x.5 + 20,260x 6/15.46 = 21,590#

Max M = 26100x6 - 1775x6x3 = 124,500 '#

req'd d = $\sqrt{\frac{124,500 \times 12}{116 \times 16}}$ = 28.4" > 27.5 OK as beam will have Tee Beam action

v = 26,100 / 16x.89x27.5 = 67 #/□" OK use 16"x30" Beam d = 27.5"

As = 124,500x12 / 20,000x.89x27.5 = 3.08 □" Use 4-1"φ bars

u = 26,100 / 12.57x.89x27.5 = 84 #/□" OK

Bending Pts for 2 bars

M = 1.57x20,000x.89x 27.5/12 = 64,040 '#

Left side

64,040 = 25930x - 1750 x^2/2 x = 2.3 ft.

Right side

64,040 = 21,390 - 1750 x^2/2 x = 3.45 ft.

} Run bars straight thru

WAR DEPARTMENT

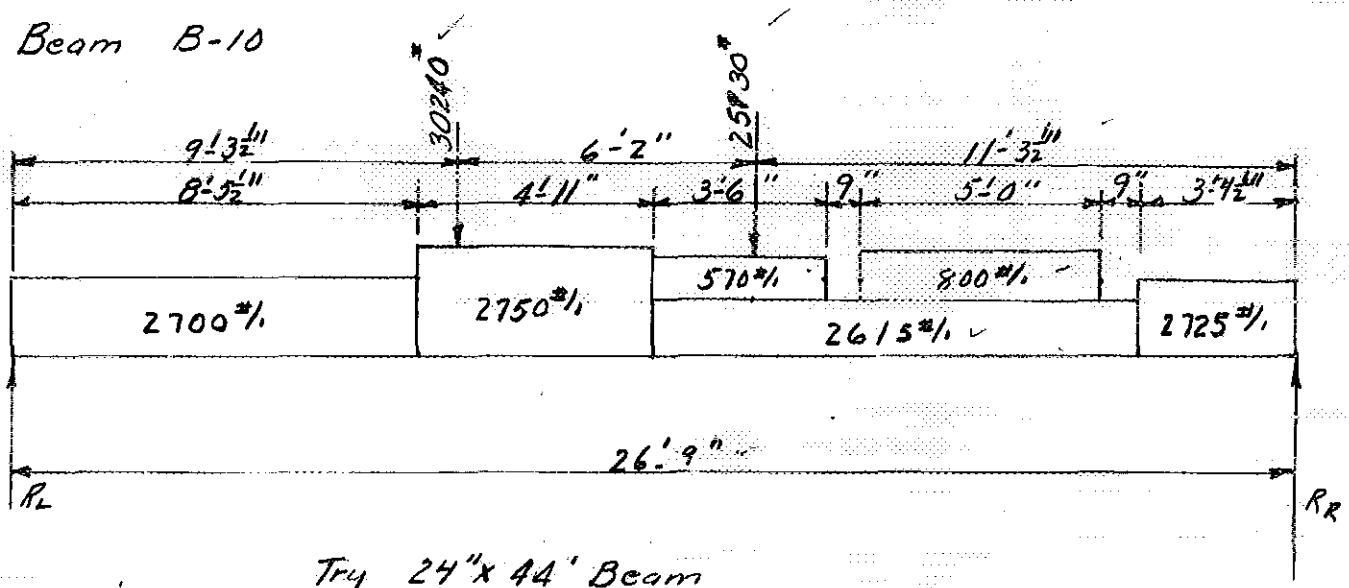
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Engine Room Floor Beams

Computed by H. E. W. **Checked by** A. L. K. **Date** 26. Feb. -44

Beam B-10



Try 24"x 44' Beam

D.L. Beam = 2×3.00×150 = 900#
D.L Slab = 2.5× 100' = 250
" " 6.58 × 40 = 263
L.L = 250× 2.5 = 625
L.L = 6.58 × 100 = 658
2696#/'
Say 2700

D.L. Beam = 900#/'
D.L. Slab = 2×100 = 200
" " = 6.58×50 = 329
L.L = = 250 × 2 = 500
L.L = 125×6.58 = 823
2752
Say 2750

D.L. Beam = 900
D.L. Slab = 100 × 5.21 = 521
L.L = 250 × 5.21 = 1303
2724
Say 2725

D.L. Beam = 900
D.L. Slab = 521
L.L. = 3.46×250 = 865
Eng. Base = 1.75×1.25×150 = 330
2616
Say 2615

D.L. Beam = 900
D.L. Slab 2 × 100 = 200
" " 6.58×50 = 329
L.L = 125 × 6.83 = 854
Eng. Base 1.75×1.25×150 = 330
2613 Say 2615

wt. Eng = 4000
Impact = 4000 } = $\frac{8000}{2\times5}$ = 800#/'

Gear Unit = 2000
Impact = 2000 } = $\frac{4000}{2\times3.5}$ = 570#/'

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 26 Feb. 44

Beam B-10 (cont.)

R_L =	2700 × 8.46 × .842	= 19230	R_R =	2700 × 8.46 × .158	= 3610
	2750 × 4.92 × .592	= 8010		2750 × 4.92 × .408	= 5520
	26.15 × 10 × .313	= 8180		26.15 × 10 × .687	= 17970
	570 × 3.5 × .434	= 870		570 × 3.5 × .566	= 1130
	800 × 5 × .247	= 990		800 × 5 × .753	= 3010
	2725 × 3.37 × .063	= 580		2725 × 3.37 .937	= 8600
	30240 × .653	= 19750		30240 × .347	= 10490
26,100	26100 × .422	= 10940		26100 × .578	= 14990
		68550#			65,320

x_0 = 14' from R_L

Max M = 68550 × 14.0 − 2700 × 8.46 × 9.77 − 2750 × 4.92 × 3.08 − 30240 × 4.71 − 317.5 × $\frac{.62^2}{2}$ = 551,820 '#

req'd d = $\sqrt{\frac{551,820 \times 12}{116 \times 24}}$ = 48.7 > 40

Beam will act as a Tee Beam
b = 50.5 $\frac{t}{d} = \frac{8}{40} = .2$ K = 101

req'd d = $\sqrt{\frac{551,820 \times 12}{101 \times 50.5}}$ = 36.1 < 40

Use beam 24" × 44"
d = 40.0 at center
d = 41.5 at ends
2-layers of steel

$v = \frac{68,550}{24 \times .89 \times 41.5}$ = 77.3 #/□" (left side)

$v = \frac{65320}{24 \times .89 \times 41.5}$ = 73.7 #/□" right side

$A_s = \frac{551320 \times 12}{20,000 \times .89 \times 40}$ = 9.30 □" Use 10-1"□ bars
5 bars each layer

$u_0 = \frac{68550}{20 \times .89 \times 41.5}$ = 93 #/□" OK

Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H.E.W. Checked by: A.L.E. Date: 28 Feb 44

Bending Pts for top layer of steel

$$M = 5 \times 20{,}000 \times .89 \times \frac{41.5}{12} = 308{,}000'^{\#}$$

Left side

$$68{,}550x - 2700\frac{x^2}{2} = 308{,}000$$

$$x = 5.0'$$

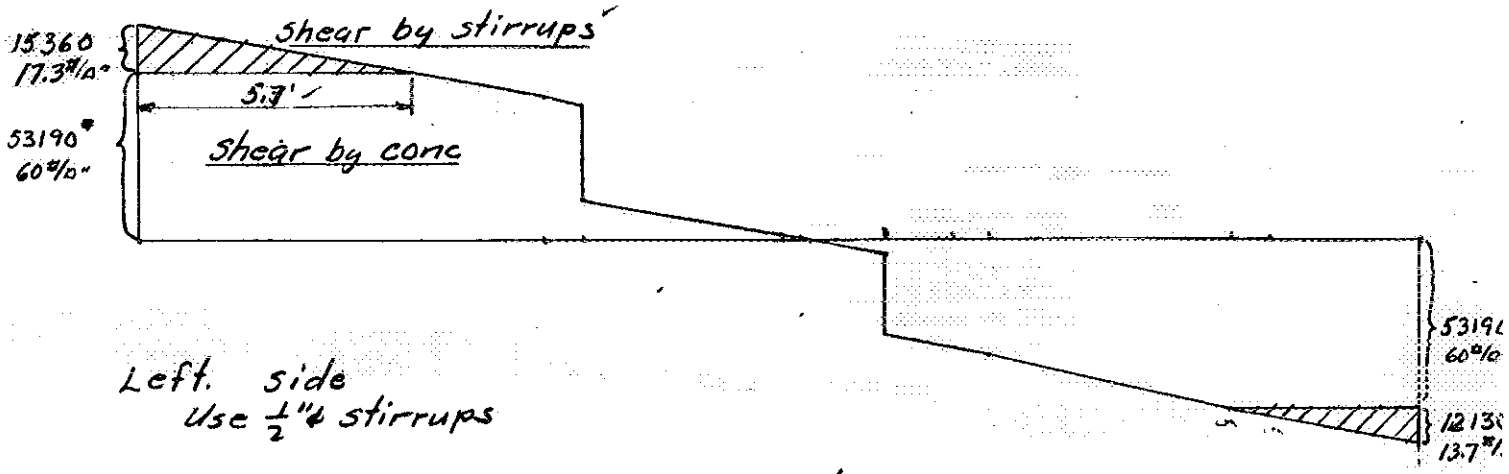
Right side

$$68320\,x - 2725 \times 3.37(x - 1.68) - 2615\left(\frac{x-3.37}{2}\right)^2 - 800\left(\frac{x-4.12}{2}\right)^2 = 308{,}000$$

$$1407x^2 - 68245x + 300631 = 0$$

$$x = 4.3'' \quad 5.1$$

Shear Diagram



Left side
Use $\frac{1}{2}$"ϕ stirrups

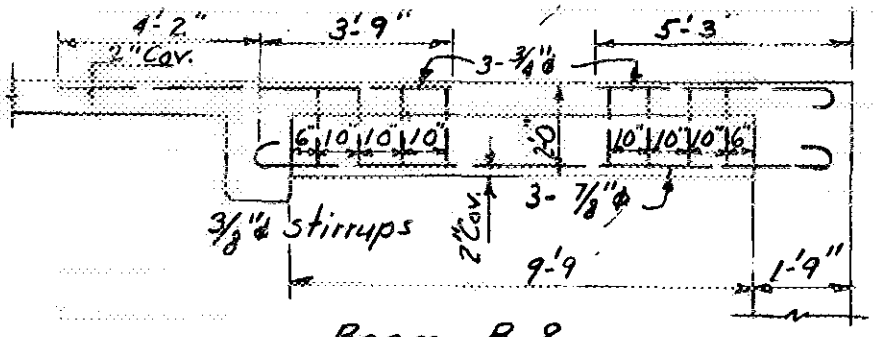
$$No = \frac{15360 \times 5.7 \times .5 \times 12}{.39 \times 16000 \times .89 \times 41.5} = 3 \text{ stirrups}$$

Spacing

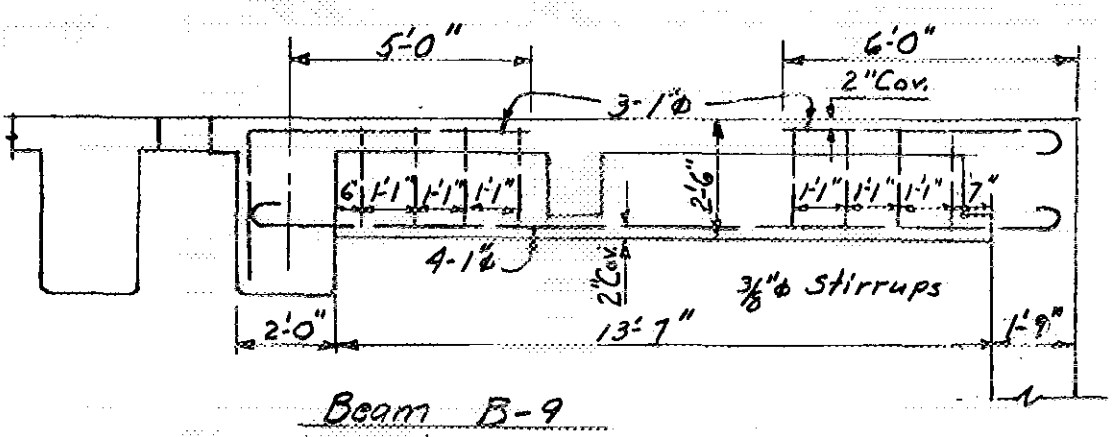
$$.39 \times 16000 = 17.3 \times 24 \times S_1 \qquad S_1 = 15''$$
$$.39 \times 16000 = 13.5 \times 24 \times S_2 \qquad S_2 = 19''$$
$$.39 \times 16000 = 8.7 \times 24 \times S_3 \qquad S_3 = 30''$$

Spacing 6" 15" 20" 20" 20" both sides

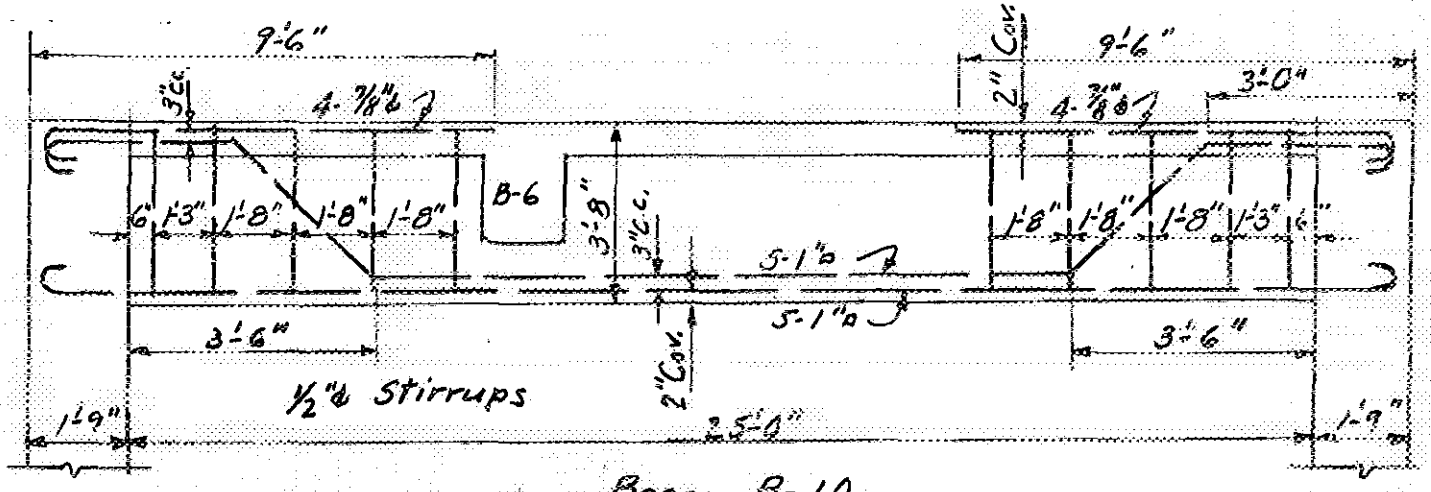
Subject: Bushnell Park Pumping Station
Computation: Engine Room Floor Beams
Computed by: H. E. W. Checked by: [illegible] Date: 28-Feb-41



Beam B-8
14" x 24"



Beam B-9
16" x 30"



Beam B-10
24" x 44"

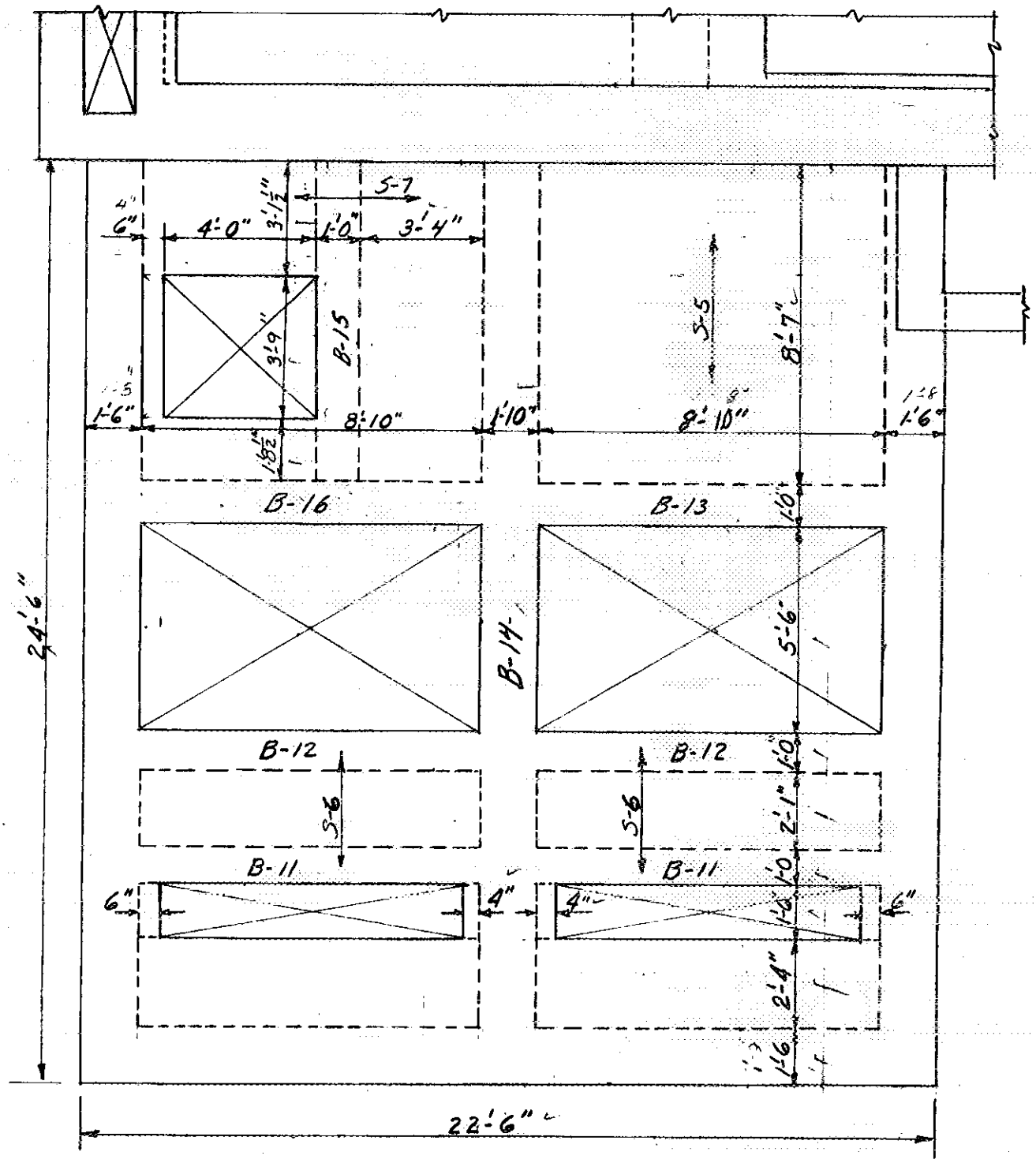
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Screening Chamber Roof Slab & Beams

Computed by H.E.W. **Checked by** A.L.R. **Date** 29-Feb-44

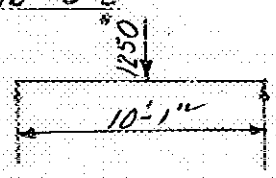


Subject Bushnell Park Pumping Station
Computation Screening Chamber Roof Slab & Beams
Computed by H. E. W. **Checked by** [illegible] **Date** 27 Feb - 44

Determination of Design Loading

Gate weights 7500# equals 1250#/ft length of gate

Slab S-5



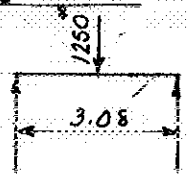
$M = 625 \times 5.04 = 3150'^{\#}$

Equiv. uniform load

$3150 = \frac{1}{8} \times w \times 10.08^2 \qquad w = 250\ \#/'$

Design S-5 for 250#/□' live load. Assume slab fixed at wall and simply supported at B-13

Slab S-6



$M = 625 \times 1.54 = 963'^{\#}$

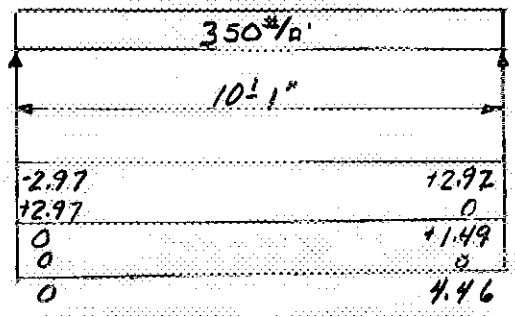
Equiv. uniform load

$963 = \frac{1}{8} \times w \times 3.08^2 \qquad w = 812\ \#/'$

Design S-6 for 825#/□' live load and assume slab simply supported at ends

Beams B-12, B-13, + B-16 will be designed for a uniform live load of 250#/□'. B-11 will be designed for gate load

Slab S-5



Assume 8" slab - D.L + L.L = 100 + 250 = 350#/□'

Fixed end Moments

$M = \frac{1}{12} \times 350 \times 10.08^2 = 2970'^{\#}$

$R_L = 350 \times 10.08 \times .5 - \frac{4460}{10.08} = 1320^{\#}$

$R_R = 350 \times 10.08 \times .5 + \frac{4460}{10.08} = 2210^{\#}$

$x_0 = 3.77'$ from R_L

$+M = 1320 \times 3.78 - 350 \times \frac{3.78^2}{2} = 2490'^{\#}$

req'd $d = \sqrt{\frac{4460}{139}} = 5.66'' < 5.75$ OK

$v = \frac{2210}{12 \times .9 \times 5.75} = 36\ \#/\square'$ OK

Subject Bushnell Park Pumping Station
Computation Screening Chamber Roof Slab & Beams
Computed by H.E.W. **Checked by** A.L.K. **Date** 29-Feb-44

Slab S-5 (cont.)

$-A_s = \frac{4460 \times 12}{20{,}000 \times .89 \times 5.75} = .52^{\square''}$ Use 5/8"ϕ @ 6" cc

$+A_s = \frac{2490 \times 12}{20{,}000 \times .89 \times 5.75} = .29^{\square''}$ Use 5/8"ϕ @ 1'-0" cc

$u_o = \frac{2210}{3.93 \times .89 \times 5.75} = 110^{\#/\square''}$ OK

Slab S-6

M = 963 '# Max shear = 1250 #

$A_s = \frac{963 \times 12}{20{,}000 \times .89 \times 5.75} = .09^{\square''}$ Use 5/8"ϕ @ 1'-0" cc Top & Bot.

$u_o = \frac{1250}{1.96 \times .89 \times 5.75} = 125^{\#/\square''}$ OK

Design of Haunch
Floor stand & Gate load = 29000 #
Assume load distributed over 3' width = 9700 #/'

M = 9700 × 1.8 = 17450 '# assume d = 2'-0"

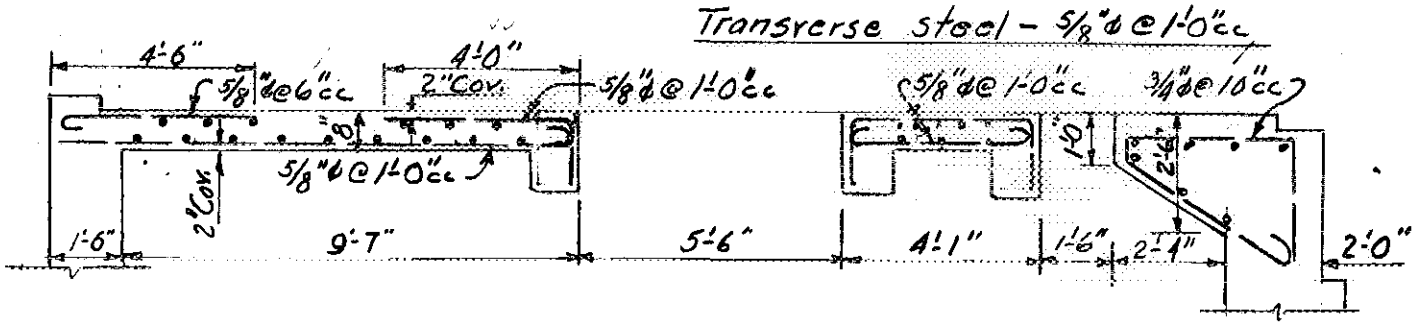
$A_s = \frac{17450 \times 12}{20{,}000 \times .89 \times 24} = .49^{\square''}$ Try 3/4"ϕ @ 10" cc

Shear at face = 9700 + 2.33 × 1.75 × 150 = 10300 #

$v = \frac{10{,}300}{12 \times .89 \times 24} = 40^{\#/\square''}$ OK

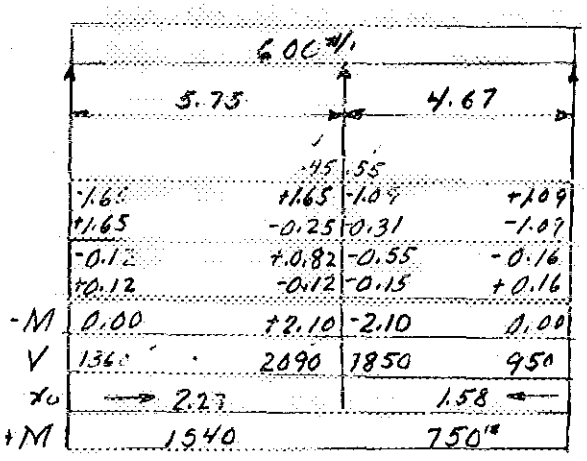
$u_o = \frac{10{,}300}{2.8 \times .89 \times 24} = 172^{\#/\square''}$ OK

Transverse steel – 5/8"ϕ @ 1'-0" cc



Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Roof Slab & Beams
Computed by: H. E. W. Checked by: A. L. K. Date: 29-Mar 44

Slab S-7



Equiv. Uniform load from gate = 500#/'
D.L + L.L = 600#/'

Fixed End Moments

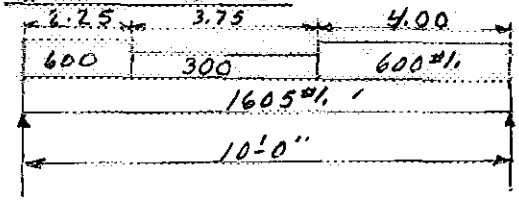
$M = \frac{1}{12} \times 600 \times 5.75^2 = 1.65^{'K}$

$M = \frac{1}{12} \times 600 \times 4.67^2 = 1.09^{'K}$

$-A_s = \frac{2100 \times 12}{20{,}000 \times .88 \times 5.75} = .25^{\square''}$ use 5/8"φ Top & Bot. 1'-0" c.c.

$u_0 = \frac{2090}{1.96 \times .88 \times 5.75} = 210^{\#/\square''}$ OK as shear at face will be 1600#

Beam B-15



Design Beam for L.L = 250#/□'
L.L = 250 × 5.92 = 1480#/'
D.L. slab = 100 × 5.92 = 600
D.L slab + cover = 2.67 × 100 + 2 × 15 = 300#/'
Assume 12" × 18" beam = 125#/'

$V_L = 1605 \times 10 \times .5 + 600 \times 2.25 \times .89 + 300 \times 3.75 \times .58 + 600 \times 4 \times .2 = 10{,}360^{\#}$

$V_R = 1605 \times 10 \times .5 + 600 \times 2.25 \times .11 + 300 \times 3.75 \times .42 + 600 \times 4 \times .8 = 10{,}570^{\#}$

$x_0 = 5.08$ from V_L

$M = 10360 \times 5.08 - 2205 \times 3.96 \times 2.25 - 1905 \times \frac{2.83^2}{2} = 25{,}180^{'\#}$

req'd $d = \sqrt{\frac{25180}{116}} = 14.7 < 15.5''$ OK

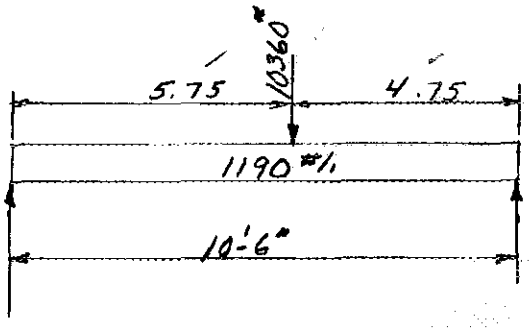
$v = \frac{10570}{12 \times .89 \times 15.5} = 64^{\#/\square''}$

$-A_s = \frac{25180 \times 12}{20{,}000 \times .89 \times 15.5} = 1.09^{\square''}$ Use 3-3/4"φ Top & Bot. 12" × 18" Beam

$u_0 = \frac{10570}{7.07 \times .89 \times 15.5} = 108^{\#/\square''}$

Subject Bushnell Park Pumping Station
Computation Screening Chamber Roof Slab & Beams
Computed by H. E. W. **Checked by** A. L. K. **Date** 29 Mar. 44

Beam B-16



D.L. cover plate = 15 x 2.75 = 41
D.L 12"x21" beam = 1 x 1.08 x 150 = 162
D.L. 8" slab = 100 x .5 = 50
L.L = 3.75 x 250 = 937
1190#/'

$V_L = 1190 \times 10.5 \times .5 + 10360 \times \frac{4.75}{10.5} = 10940^{\#}$

$V_R = 1190 \times 10.5 \times .5 + 10360 \times \frac{5.75}{10.5} = 11920^{\#}$

$M = 10940 \times 5.75 - 1190 \times \frac{5.75^2}{2} = 43{,}230$ '#

req'd $d = \sqrt{\frac{43230}{116}} = 19.3'$ make beam 12"x22" d = 19.5

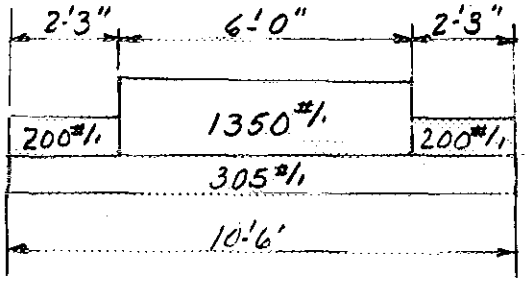
$v = \frac{11920}{12 \times .89 \times \cancel{15.5}\ 18.5} = \cancel{72}\ 61\ \#/\square''$

$A_s = \frac{43{,}230 \times 12}{20{,}000 \times .89 \times 19.5} = 1.50\ \square''$ 3- 7/8" ϕ bars

$u_o = \frac{11920}{8.25 \times .89 \times \cancel{15.5}\ 18.5} = \cancel{104}\ 87\ \#/\square''$ OK

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Roof Slab & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 23 Feb. 44

Beam B-11



Assume area 1'-0" x 6'-0" loaded with gate and remaining area loaded with a live load equal to 100#/□'

Gate load = 1250#/'
L.L. = 1.04 x 100 = 100#/'
1350#/'

L.L = 2.04 x 100 = 200#/'

D.L. slab = 2.04 x 100 = 204#/'
D.L. 12"x16" = 1 x .67 x 150 = 101
305#/'

$R_L = R_R = 305 \times 10.5 \times .5 = 1600$
$200 \times 2.25 = 450$
$1350 \times 6 \times .5 = 4050$
$6100^{\#}$

Max $M = 6100 \times 5.25 - 505 \times 2.25 \times 4.12 - 1655 \times 3 \times 1.5 = 19{,}900'^{\#}$

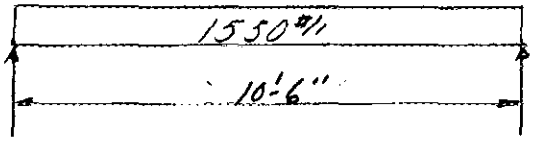
reqd $d = \sqrt{\frac{19900}{116}} = 13.1'' < 13.5''$

$V = \frac{6100}{12 \times .89 \times \cancel{9.5}\ 13.5} = \cancel{60}\ 42\ \#/\square''$ OK

$A_s = \frac{19{,}900 \times 12}{20{,}000 \times .89 \times 13.5} = 1.0\ \square''$ Use 3-3/4"ϕ bars.

$u_o = \frac{6100}{7.07 \times .89 \times \cancel{9.5}\ 13.5} = \cancel{102}\ 72\ \#/\square''$ OK

Beam B-12



D.L. cover plate = 15 x 2.75 = 41
D.L. 12"x16" Bm = 1 x .67 x 150 = 100
D.L. 8" slab = 100 x 2.04 = 204
L.L. = 250 x 4.79 = 1198
1543#/'

Say 1550#/'

$R_L = R_R = 1550 \times 5.25 = 8140^{\#}$

$M = \frac{1}{8} \times 1550 \times 10.5^2 = 21{,}360'^{\#}$

reqd $d = \sqrt{\frac{21360}{116}} = 13.5''$ OK

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Roof Slab + Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 29-Feb.-44

Beam B-12 (cont.)

$v = \frac{8140}{12 \times .89 \times \cancel{9.5}\ 12.5} = \cancel{80}\ 61\ \#/\square''$ OK

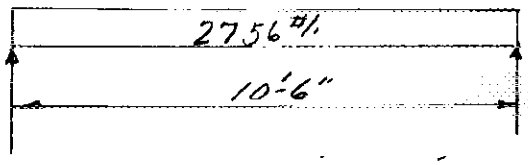
$A_s = \frac{21360 \times 12}{20{,}000 \times .89 \times 13.5} = 1.07\ \square''$ Use 3-3/4"ϕ bars

$u_o = \frac{8140}{7.07 \times .89 \times \cancel{9.5}\ 12.5} = \cancel{136}\ 104\ \#/\square''$

Make Beam details same as B-11

Beam B-13

D.L. cover plate = 15 × 2.75 = 41
D.L. 12"×22" Bm = 1×117×150 = 176
D.L. 8" slab = 100 × 5.29 = 529
L.L = 8.04 × 250 = 2010
2756



$R_L = R_R = 2756 \times 5.25 = 14{,}470^{\#}$

$\text{Max } M = \frac{1}{8} \times 2756 \times 10.5^2 = 37980^{'\#}$

req'd $d = \sqrt{\frac{37980}{116}} = 18.1 < 19.5''$

$v = \frac{14470}{12 \times .89 \times \cancel{15.5}\ 18.5} = \cancel{87}\ 73\ \#/\square''$ Use Stirrups

$A_s = \frac{37980 \times 12}{20{,}000 \times .89 \times 18.5} = 1.38\ \square''$ Use 3-7/8"ϕ bars Top & Bot.

$u_o = \frac{14470}{8.25 \times .89 \times \cancel{15.5}\ 18.5} = \cancel{127}\ 106\ \#/\square''$ OK

WAR DEPARTMENT

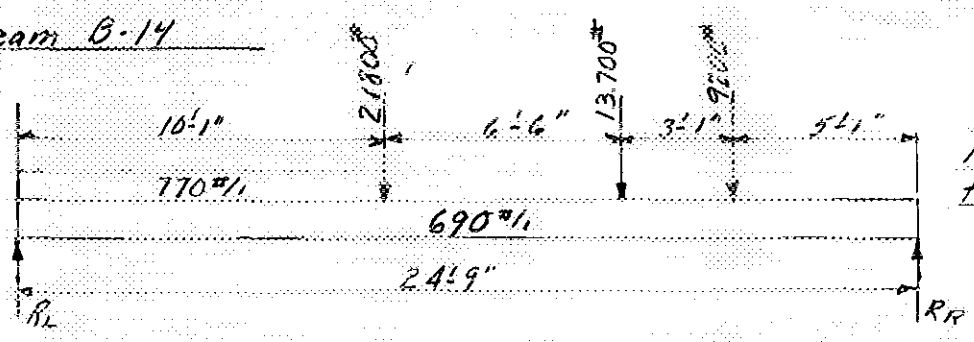
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Screening Chamber - Roof Slab & Beams

Computed by H.E.W. **Checked by** [illegible] **Date** 7 Mar 44

Beam B-14



For Beam - B-14 live load will be reduced to 200#/□'

Try 22" x 38" Beam

D.L = 1.83 x 2.5 x 150 = 690#/'

D.L. slab = 2.58 x 100 = 258

L.L = 2.58 x 200 = 516

774

Load concentration at B-13 & B-14

B-13 L.L = 8.04 x 200 = 1610

D.L = 41 + 162 + 529 = 732#

2342

Total load = 10.5 x 2340 = 12300#

B-16 200 x 5.92 x 4.29 = 5080

100 x 5.92 x 4.29 = 2540

125 x 4.29 = 540

8200 x 5.75/10.5 = 4500#

3.75 x 2.00 x 5.25 = 3940

1.17 x 1 x 150 x 5.25 = 920

15 x 2.75 x 5.25 = 220

5080 + 5080

9580#

Load concentration at B-12

L.L = 200 x 4.79 = 960

D.L = 41 + 100 + 204 = 345

1305

Total load = 10.5 x 1305 = 13,700#

Load concentration at B-11

L.L = 2.79 x 200 = 560

D.L = 204 + 101 + 10 = 315

875

Total load = 10.5 x 8.75 = 9200#

R_L = 690 x 24.75 x .5 = 8540

21800 x .593 = 12930

13,700 x .33 = 4520

9,200 x .205 = 1890

770 x 10.08 x .796 = 6180

34060#

R_R = 690 x 24.75 x .5 = 8540

21800 x .407 = 8870

13700 x .67 = 9180

9200 x .795 = 7310

770 x 10.08 x .204 = 1580

35480#

x_0 = 10.08 from R_L

Max M = 34060 x 10.08 - 1460 x $\frac{10.08^2}{2}$ = 269,150'#

req'd d = $\sqrt{\frac{269,150 \times 12}{116 \times 22}}$ = 35.5" = 35.5" OK

v = $\frac{35480}{22 \times .89 \times 35.5}$ = 51#/□" OK Use 22" x 38" beam

No stirrups req'd d = 35.5"

As = $\frac{269,150 \times 12}{20,000 \times .89 \times 35.5}$ = 5.10□" Use 5-1"□ bars

Try bending 2 bars

u_0 = $\frac{35,480}{12 \times .89 \times 35.5}$ = 94#/□"

Bending Pts

Mom taken by 3-1"□ = 3 x 20000 x .89 x 35.5 = 162,500'#

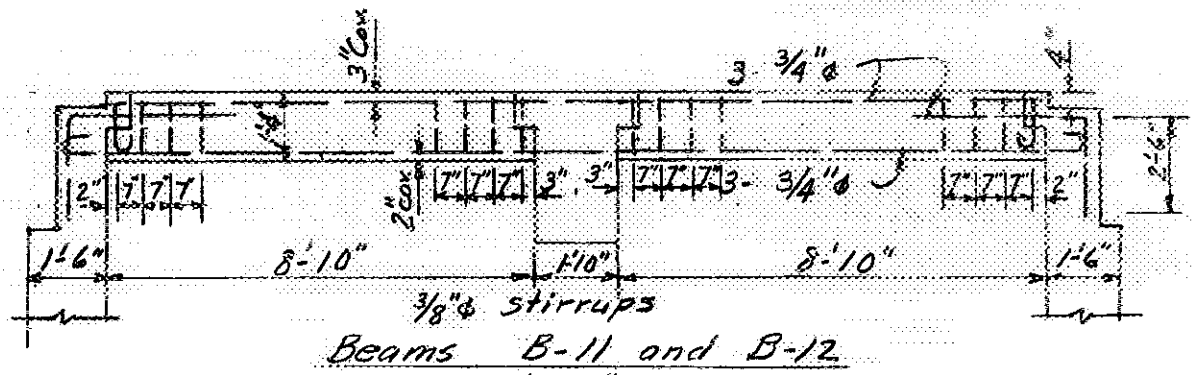
Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Roof Slab & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 1-Mar-44

Beam B-14 (cont.)
Bending Pts
Left side

$$34060x - 1460\frac{x^2}{2} = 162,500 \qquad x = 5.4'$$

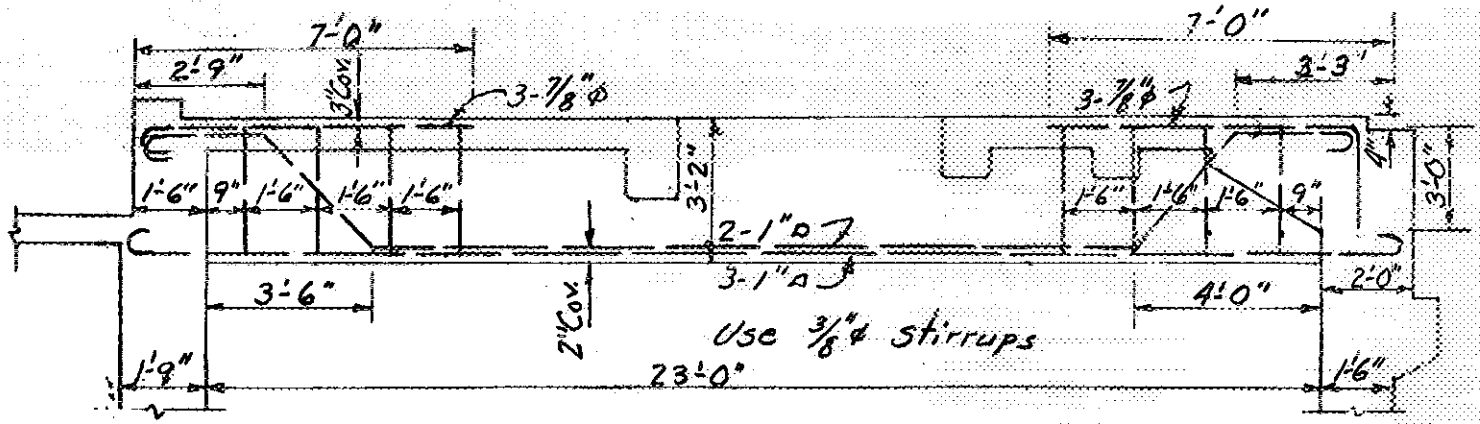
Right side

$$35480x - 690\frac{x^2}{2} = 162,500 \qquad x = 4.8'$$



Beams B-11 and B-12
12" x 16"

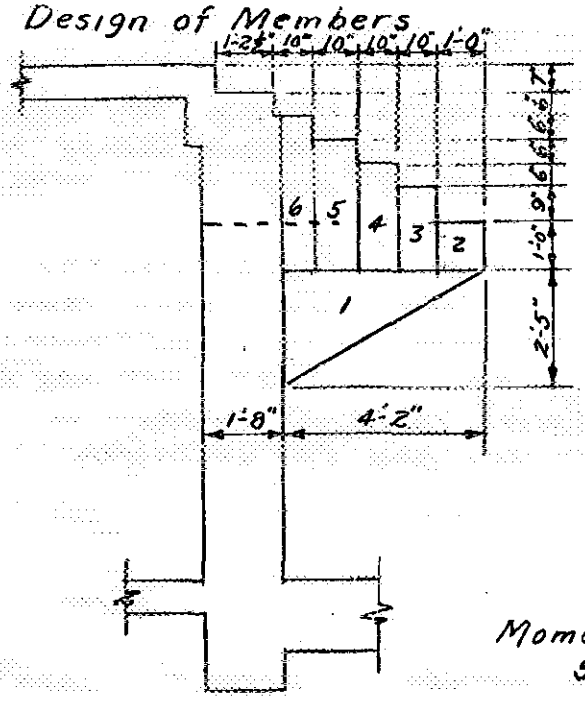
Beam B13-B16- 12" x 22" Same details as B-11 & B-12 except for depth and use 3-7/8"φ in top & bot



Beam B-14
22" x 38"

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Access Stairs to Roof Slab
Computed by: J.O.S. Checked by: H.E.H. Date: 5-31-44

Design of Members



Area

$A_1 = 2.42 \times 4.17 \times .5 = 5.05$

$A_2 = 1.0 \times 1.08 = 1.08$

$A_3 = .83 \times 1.83 = 1.53$

$A_4 = .83 \times 2.33 = 1.94$

$A_5 = .83 \times 2.83 = 2.35$

$A_6 = .67 \times 3.33 = 2.77$

$A_7 = 4.17 \times .5 = 2.08$

Moment

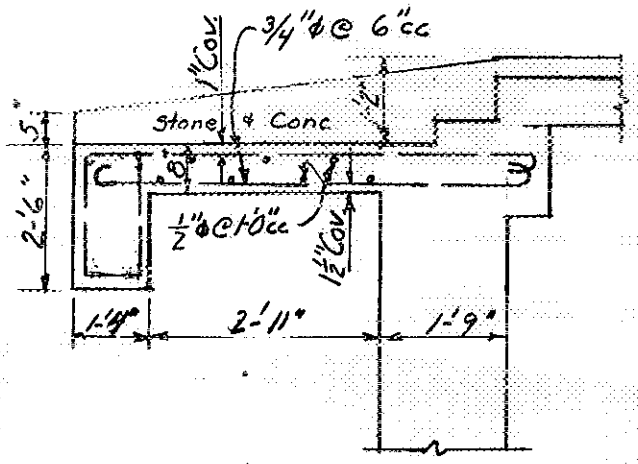
$5.05 \times 1.39 \times 150 =$	1053
$1.08 \times 3.67 \times 150 =$	595
$1.53 \times 2.75 \times 150 =$	632
$1.94 \times 1.92 \times 150 =$	560
$2.35 \times 1.08 \times 150 =$	381
$2.77 \times .33 \times 150 =$	138
$2.08 \times 2.08 \times 160 =$	692
$4.17 \times .75 \times 2.08 =$	650
	4701'#

$$A_s = \frac{4701 \times 12}{20{,}000 \times .88 \times 64.0} = .05 \square''$$

Use $\frac{5}{8}''\phi$ @ 1'-0" c.c.

Subject Bushnell Park Pumping Station
Computation Apron at Main Entrance Door
Computed by H. E. W. **Checked by** A. L. K. **Date** May 4, 1944

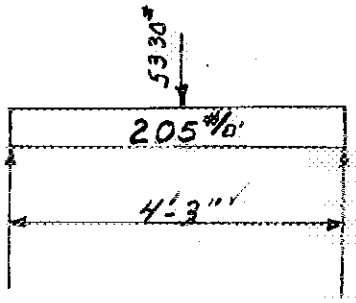
Slab Supporting Flagstone Apron



For design assume thickness of stone and conc. above slab will be 8" and wt = 155#/cu. ft.

Slab will also be loaded with one H20 wheel load. The load will be assumed spread out over 3 ft and thus equal to 5330# concentration on any one ft. of width

D.L. Slab = 8" slab 100#/
D.L. Fill = .67 x 155 = 105
205#/



$V_L = 205 \times 4.25 \times .5 + 5330 \times .5 = 3100^{\#}$

$M = \frac{1}{12} \times 205 \times 4.25^2 + \frac{1}{8} \times 5330 \times 4.25 = 3140^{'\#}$

req'd $d = \sqrt{\frac{3140}{116}} = 5.2" < 6.25$ ok

Max. Shear = $5330 + 2.92 \times 205 = 5660^{\#}$

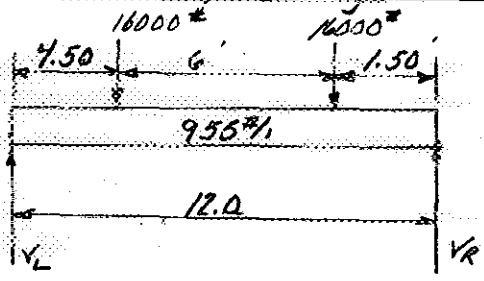
$v = \frac{5660}{12 \times .89 \times 6.75} = 78$ #/o" OK

$A_s = \frac{3140 \times 12}{20{,}000 \times 89 \times 6.25} = .34$ □" Try 1/2"φ @ 6"cc Top & Bot

$u_o = \frac{5660}{3.14 \times .89 \times 6.75} > 300$ #/o" Use 3/4"φ @ 6"cc Then $u_o = 200$ #/o"

Subject: Bushnell Park Pumping Station
Computation: Apron at Main Entrance Door
Computed by: H. E. W. Checked by: A.L.K. Date: May 4, 1944

Beam spanning from Column to Gate Well Wall



D.L from slab = 205 x 2.82 = 590 #/'
D.L. Beam 16"x30" = 1.33x1.83x150 = 365
955 #/'

Max Shear possible
$955 \times 6 + 16000 + \frac{6}{12} \times 16000 = 29730^{\#}$

$V_L = \frac{955 \times 12 \times 4.5 + 16000(1.50 + 7.50)}{12} = 17,730$

$M = 17730 \times 4.50 - 955 \times \frac{4.5^2}{2} = 70,110^{'\#}$

reqd $d = \sqrt{\frac{70,110 \times 12}{116 \times 16}} = 21.3'' < 26.5''$ OK

$v = \frac{29,730}{16 \times .89 \times 26.5} = 80\ \#/\square''$

$A_s = \frac{70,110 \times 12}{20,000 \times .89 \times 26.5} = 1.80\ \square''$ Use 3 - 7/8" ϕ bars Bot +
" 3 - 3/4" ϕ bars Top

$u_o = \frac{29,730}{8.25 \times .89 \times 26.5} = 153\ \#/\square''$ OK

Supporting Column

Bot. El. of Beam = 24.17
Top El. of Conduit = 14.00

$l = 122$ Use 16"x12" column
$\frac{l}{d} = \frac{122}{12} = 10.2$

Use 4 - 3/4" ϕ bars

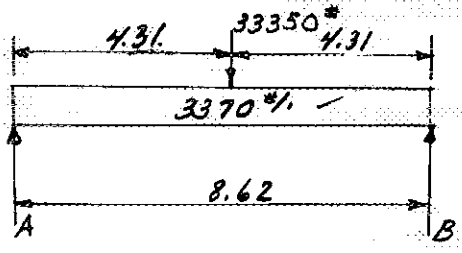
$p = \frac{1.77}{12 \times 16} = .0092$ $P = .18 f'_c (A_g - A_s) + .8 A_s f_s$

Max Allowable load $= .18 \times 3000 (192 - 1.77) + .8 \times 1.77 \times 16000 = 125,400^{\#}$

Actual load

Beam react =		29730
End apron =	1x2.5x4.25x150 =	1590
Column	1x1.33x10.17x150 =	2030
		33,350# OK

Subject Bushnell Park Pumping Station
Computation Apron at Main Entrance Door
Computed by H. E. W. **Checked by** A. L. K. **Date** May 5, 1944



Assume load spread over 2' width and both ends fixed (Assume conc. ld. in center of spa

Moment at Ends

$\frac{1}{12} \times 3370 \times 8.62^2 + \frac{1}{8} \times 33350 \times 8.62 = 56,800$ '#

$V = 3370 \times 8.62 \times .5 + 33350 \times .5 = 31,200$ #

Addition of Joint def. M from Sect. D gives - $M = 56,800 + 2(8960) = 74,620$ '#

Addition of Joint def V from Sect. D gives $V = 31,200 + 2(2170) = 35,540$ #

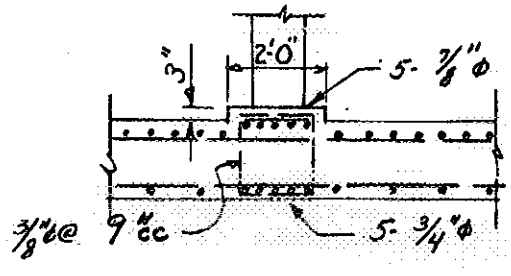
$$\text{req'd } d = \sqrt{\frac{74620 \times 12}{24 \times 139}} = 16.4''$$ Make beam 21" deep d = 17.5

$$A_s = \frac{74,620 \times 12}{20,000 \times .88 \times 17.5} = 2.90 \text{ □''}$$ use 5 - 7/8" ϕ Top

use 5 - 3/4" ϕ Bot.

$$u_0 = \frac{35,540}{13.75 \times .88 \times 17.5} = 168 \text{ \#/□''}$$

$$v = \frac{35540}{24 \times .88 \times 17.5} = 96 \text{ \#/□''}$$ OK as Loading condition is extreme



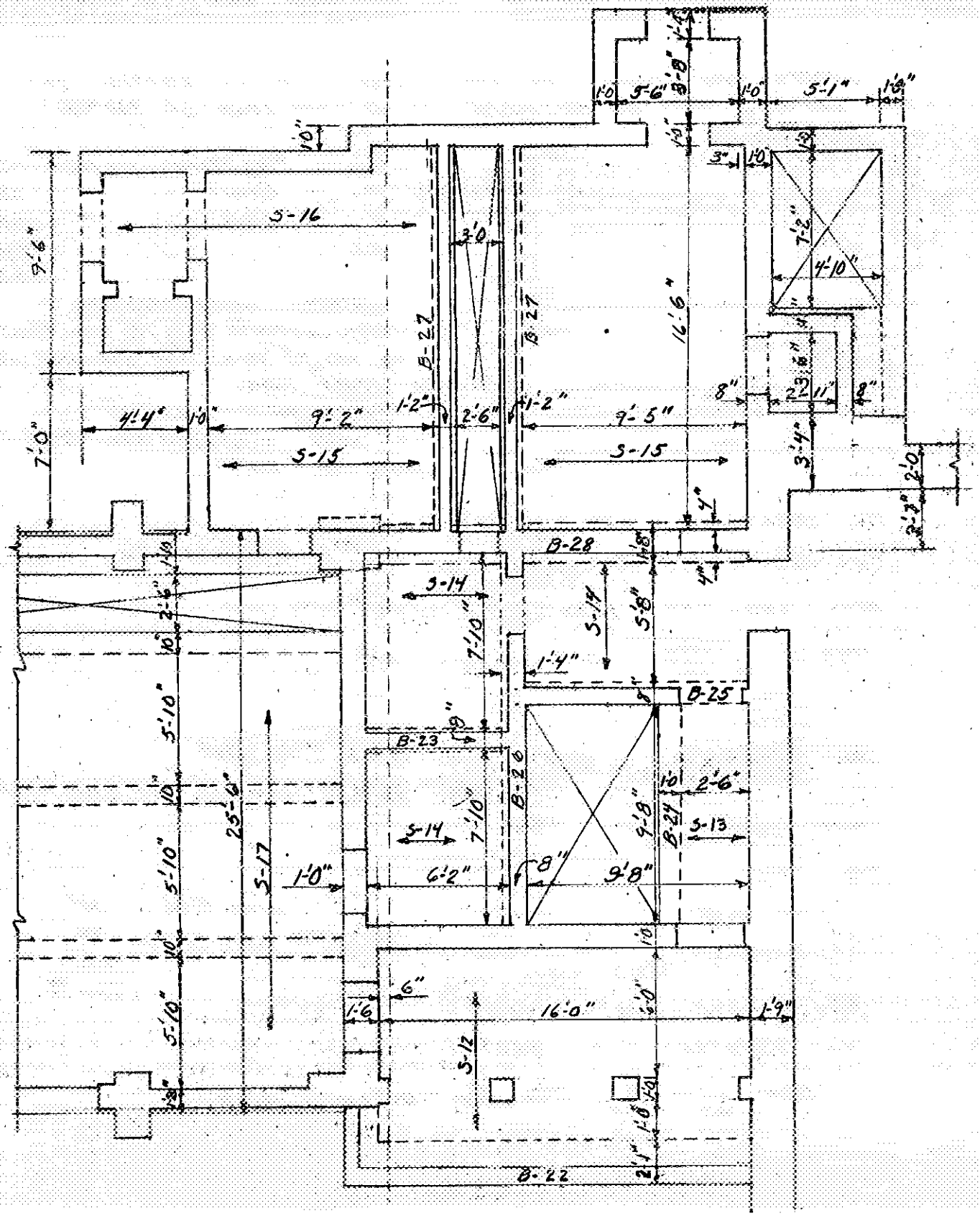
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

Computation: Comfort Station and Store Room Floors-Slabs & Beams

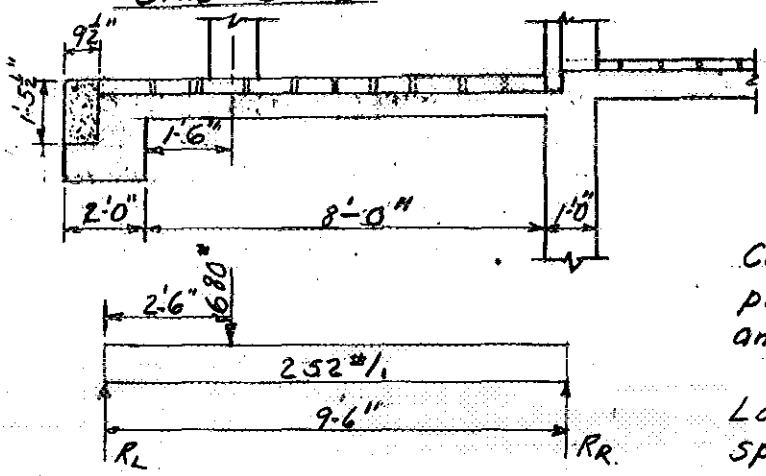
Computed by: H. E. W. Checked by: A. L. K. Date: 8-May-44



Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors-Slabs & Beams
Computed by: H. E. W. Checked by: A. L. K. Date: 12- May- 44

Floors and Beams in the comfort station portion of the building will be designed for a live load of 100#/□'

Slab S-12



D.L	3" Flag stone = .25 x 160 =	40#
"	1 Grout	12#
"	8" Slab	100#
L.L =		100#
		252#/'

Column Concentration

Column supports only its own load plus wt. of arch and does not carry any roof load

Approx wt = 2300#

Load will be spread over .3 ft of span = 680#/'

$R_L = 252 \times 9.5 \times .5 + 680 \times \frac{7}{9.5} = 1700^{\#}$

$R_R = 252 \times 9.5 \times .5 + 680 \times \frac{2.5}{9.5} = 1380$ $\quad x_o = 5.50$ from R_R

$M = 1380 \times 5.50 - 252 \times \frac{5.5^2}{2} = 3780'^{\#}$

req'd $d = \sqrt{\frac{3780}{116}} = 5.71 < 5.75$ OK

$v = \frac{1700}{12 \times .89 \times 5.71} = 28\#/\square''$

$A_s = \frac{3780 \times 12}{20{,}000 \times .89 \times 5.75} = .45\square''$ Use 5/8"φ @ 8"cc Bot

Use 5/8"φ @ 1'-0"cc Top for neg. mom.

$u_o = \frac{1700}{2.9 \times .89 \times 5.75} = 115\#/\square''$

Slab S-13

Span = 4.04'

D.L =	1½" fill plus tile =	30#
"	7" Slab =	90
L.L		100
		220#/'

$M = \frac{1}{8} \times 220 \times 4.04^2 = 450'^{\#}$

$V = 4.04 \times 220 \times .5 = 440^{\#}$

Use ½"φ @ 1'-0"cc Top + Bot in 7" slab

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 7-May-44

Slab S-14

Span = 6'-8" Load = 220 #/□'

For neg M at supports $-M = \frac{1}{12} \times 220 \times 6.67^2 = 816'^{\#}$

For max. possible pos. $M = \frac{1}{8} \times 220 \times 6.67^2 = 1220'^{\#}$

$V = 220 \times 6.67 \times .5 = 730^{\#}$

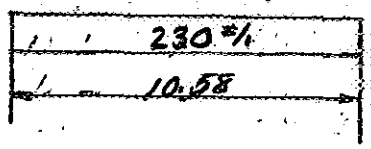
req'd $d = \sqrt{\frac{1220}{116}} = 3.26" < 5.25"$ OK use 7" slab

$v = \frac{730}{12 \times .89 \times 5.25} = 18$ #/□"

$A_s = \frac{1220 \times 12}{20{,}000 \times .89 \times 5.25} = .12^{\square"}$ Use $\frac{1}{2}$"φ @ 1'-0" cc Top & Bot.

$u_o = \frac{730}{1.57 \times .89 \times 5.25} = 100$ #/□" OK

Slab S-15



Load on slab = 230 #/□'

$V_L = V_R = 230 \times 10.58 \times .5 = 1220^{\#}$

Max. possible pos. $M = \frac{1}{8} \times 230 \times 10.58^2 = 3220'^{\#}$

" neg $M = \frac{1}{12} \times 230 \times 10.58^2 = 2150'^{\#}$

req'd $d = \sqrt{\frac{3220}{116}} = 5.25$

$v = \frac{1220}{12 \times .89 \times 5.25} = 22$ #/□" OK Use 7" slab d = 5.25 pos. M, d = 5.75 neg. M

$+A_s = \frac{3220 \times 12}{20{,}000 \times .89 \times 5.25} = .40^{\square"}$ Use 5/8"φ @ 9" cc Bot.

$-A_s = \frac{2150 \times 12}{20{,}000 \times .88 \times 5.75} = .26^{\square"}$ Use 5/8"φ @ 1'-0" cc Top

$u_o = \frac{1220}{1.96 \times .88 \times 5.75} = 128$ #/□" OK

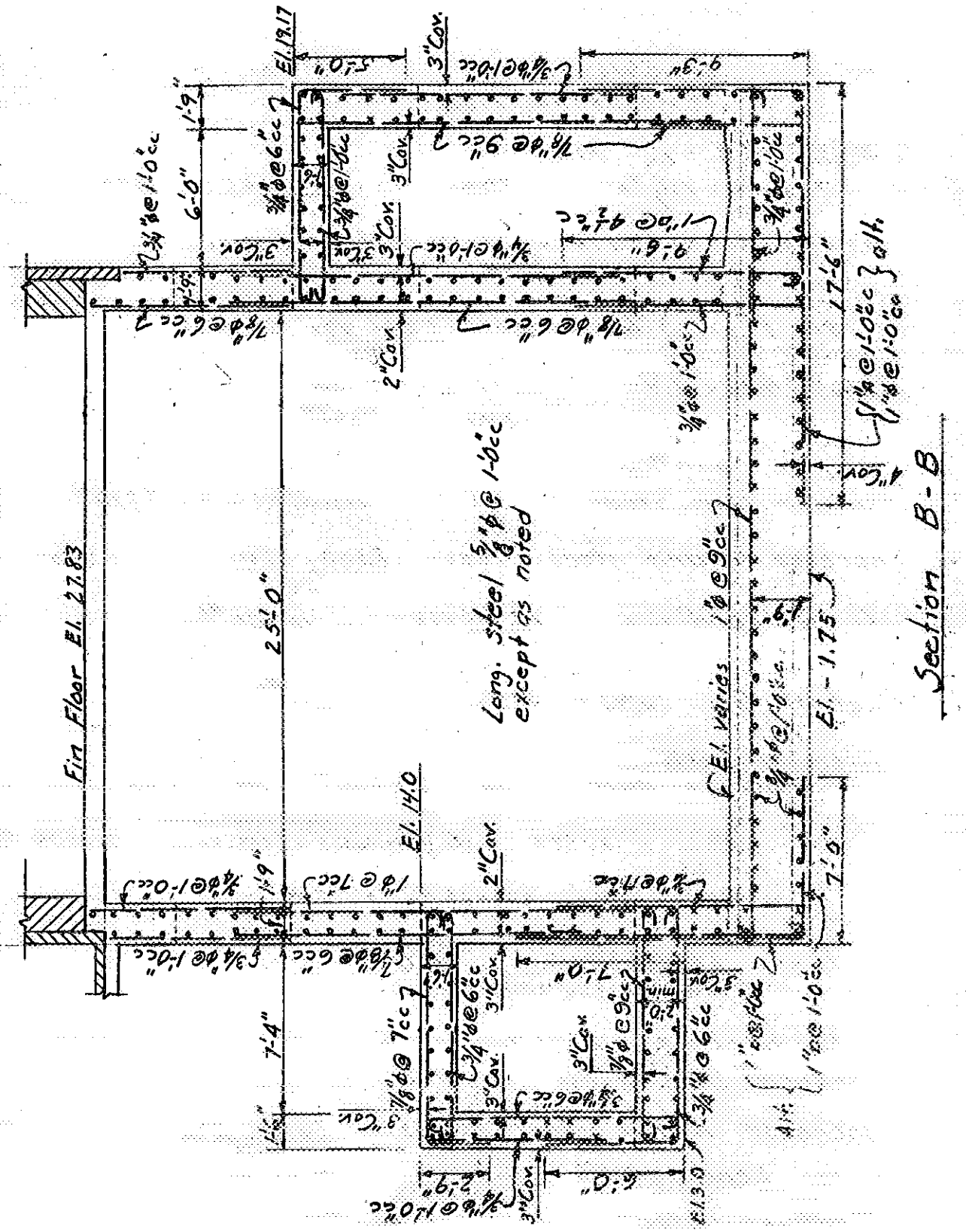
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

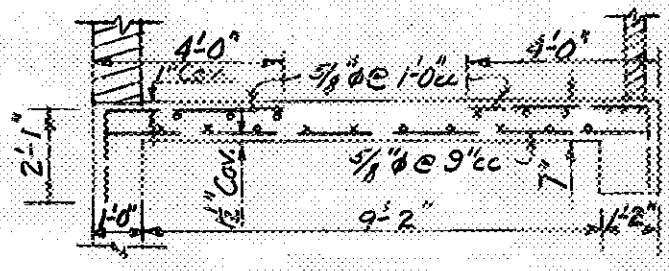
Computation: Transverse Section B-B

Computed by: H.E.W. Checked by: Date: 27-Mar. '44



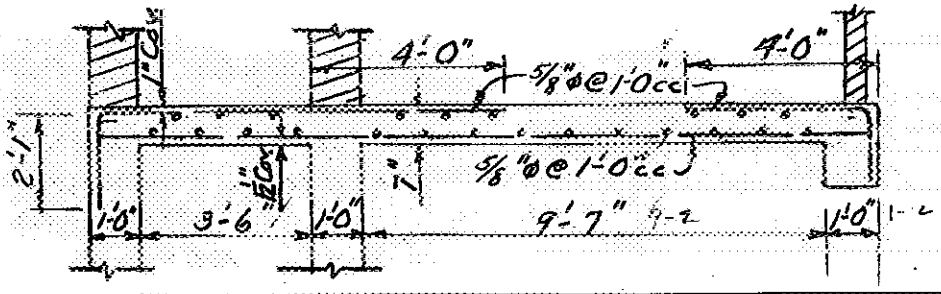
Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slab & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 11, May 44

Slab S-15



Temp. steel $\frac{1}{2}$" ϕ @ 1'-0" cc

Slab S-16



Store Room Floor — Store Room Floor will be designed for a live load of 125#

4" Paving Brick	40#
2" sand	17#
6" slab	75#
L.L.	125
	257#/□'

Say 260#/□'

260#/□'					
6.75		6.67		6.67	
+0.99	-0.99	0.96	-0.96	0.96	-0.96
-0.99	+0.02	+0.01	0	0	+0.96
+0.01	-0.50	0	0	+0.48	0
-0.01	+0.25	+0.25	-0.24	-0.24	0
+0.12	0	-0.12	+0.12	0	-0.12
-0.12	+0.06	+0.06	-0.06	-0.06	+0.12
0	-1.16	+1.16	-1.14	+1.14	0
780#	1050#	870#	870#	1040	700#
→ 2.73		→ 3.33 ←		2.70 ←	

-M
V
x_0
M

F.E.M = $\frac{1}{12} \times 260 \times 6.75^2 = .99'^K$

$\frac{1}{12} \times 260 \times 6.67^2 = .96'^K$

$+M = 710 \times 2.73 - 260 \times \frac{2.73^2}{2} = 970'^{\#}$

$+M = \frac{1}{8} \times 260 \times 6.67^2 = 1160 = 1290'^{\#}$

$+M = 700 \times 2.7 - 260 \times \frac{2.7^2}{2} = 1040'^{\#}$

req'd $d = \sqrt{\frac{1040}{116}} = 3"$

Use 6" slab

$-A_s = \frac{1160 \times 12}{20{,}000 \times .88 \times 4.75} = .17 \square''$

Use $\frac{1}{2}$" ϕ @ 1'-0" cc Top & Bot.

$u_0 = \frac{1050}{1.57 \times .88 \times 4.75} = 160$#/□"

$v = \frac{1050}{12 \times .88 \times 4.75} = 21$#/□"

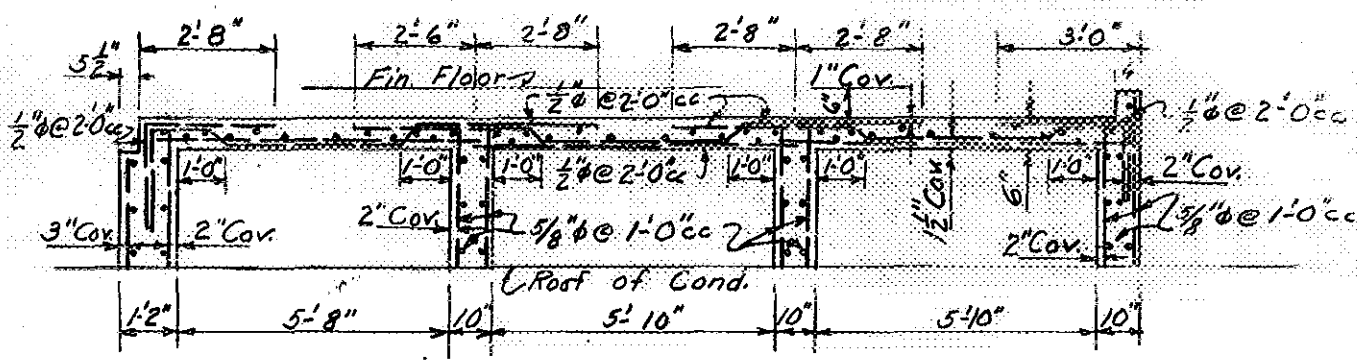
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

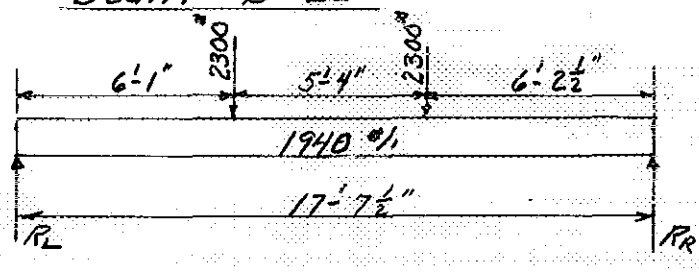
Computation Comfort Station and Store Room Floor - Slabs & Beams

Computed by H.E.W. **Checked by** A.L.K. **Date** 13 - May



Slab S-17

Beam B-22



D.L. Flgstone fl =	52 × 5.21	=	271
D.L. Slab =	100 × 4.21	=	421
D.L. Curb =	.79 × 1.46 × 160	=	185
D.L. Beam =	2.0 × 1.21 × 150	=	363
	.79 × .87 × 150	=	102
L.L. =	100 × 6.0	=	600
			1943

$R_L = 1940 \times 17.62 \times .5 + 2300\left(\frac{6.21 + 11.54}{17.62}\right) = 19{,}410$ #/' Say 1940 #/'

$R_R = 1940 \times 17.62 \times .5 + 2300\left(\frac{6.08 + 11.42}{17.62}\right) = 19380$ #

$x_0 = 8.82'$ from R_L

$M = 19410 \times 8.82 - 1940 \times \frac{8.82^2}{2} - 2300 \times 2.74 = 89{,}440$ '#

req'd $d = \sqrt{\frac{89440 \times 12}{116 \times 14.5}} = 25.2'' > 21.5$ No Tee Beam Action

Beam will act as Tee Beam

$b = 32''$ $\frac{t}{d} = .372$ $K = 110$

req'd $d = \sqrt{\frac{89{,}440 \times 12}{110 \times 32}} = 17.5'' < 21.5''$ OK

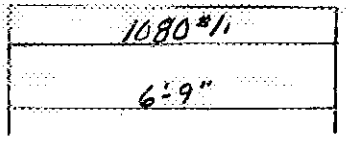
$v = \frac{19{,}410}{14.5 \times .89 \times 21.5} = 70$ #/□''

$A_s = \frac{89{,}440 \times 12}{20{,}000 \times .89 \times 21.5} = 2.8$ □'' Use 3 - 1"□ in bot.

$u_0 = \frac{19{,}410}{12 \times .89 \times 21.5} = 85$ #/□'' OK

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs + Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 4-May-44

Beam B-23



Beam supports 8" brick partition 8'-6" high

D.L. Part. 8.5 x .67 x 120 = 680 #/'
D.L. 12"x12" bm = 1 x 1 x 150 = 150
" Plaster 3'-6" high 3.5 x 20 = 70
" 1" Marble 5 x .17 x 160 = 140
L.L. = .33 x 100 = 33
1073

Max. $M = \frac{1}{8} \times 1080 \times 6.75^2 = 6150$ '#

$V = 1080 \times 6.75 \times .5 = 3650$ #

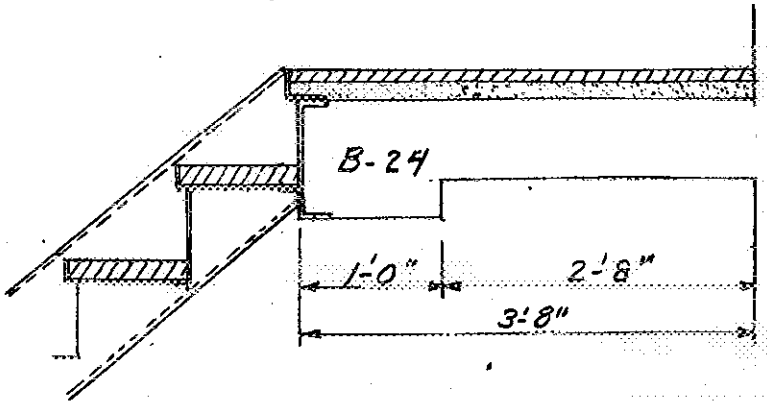
reqd $d = \sqrt{\frac{6150}{116}} = 7.28" < 9.5"$ OK

$v = \frac{3650}{12 \times .89 \times 9.5} = 36$ #/□"

$A_s = \frac{6150 \times 12}{20{,}000 \times .89 \times 9.5} = .44$ □" Use 2 - 3/4"φ

$u_0 = \frac{3650}{4.71 \times .89 \times 9.5} = 92$ #/□"

Stairway Details



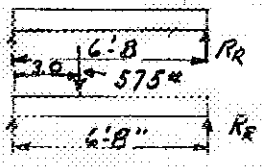
Stairway weight for design purpose will be assumed at 40 # per sq. ft
Live Load = 75 # " " "
Total 115 #/ " " "

Load on B-24 from Stairway

Outside Face

6.00 x 1.50 x 115 x .5 = 520 #

Inside Face



$R_R = 1.50 \times 115 \times 6.67 \times .5 = 575$ #

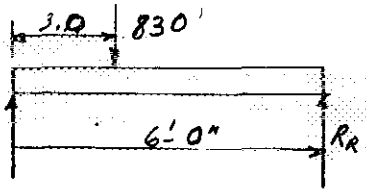
$R_R = 1.50 \times 115 \times 6.67 \times .5 + 575 \times \frac{3}{6.67} = 830$ #

Subject: Bushnell Park Pumping Station

Computation: Comfort Station and Store Room Floors - Slabs & Beams

Computed by: H. E.W. Checked by: A.L.K. Date: 15- May - 44

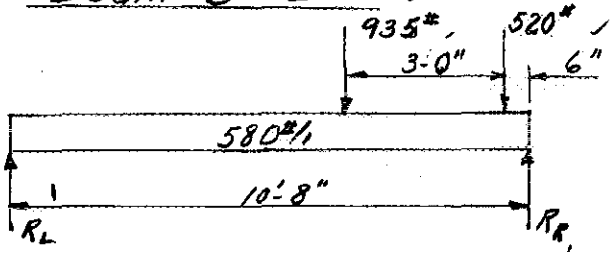
Load on B-24 from Stairway



$R_R = 1.65 \times 6.00 \times 115 \times .5 + 830 \times \frac{3.0}{6.0} = 935^{\#}$

$R_L = 1.65 \times 600 \times 115 \times .5 + 830 \times \frac{3.0}{6.0} = 935^{\#}$

Beam B-24



D.L. $1\frac{1}{2}$" fill plus tile = 30×2.33 = 70

" 7" slab = 90×2.33 = 210

" 12"x12" beam = $.42 \times 1 \times 150$ = 63

L.L = 100×2.33 = 233

576#

say 580#/'

$R_L = 580 \times 10.67 \times .5 + 520 \times \frac{.5}{10.67} + 935 \times \frac{3.50}{10.67} = 3430^{\#}$

$R_R = 580 \times 10.67 \times .5 + 520 \times \frac{10.17}{10.67} + 935 \times \frac{7.17}{10.67} = 4220^{\#}$

$x_0 = 6.0'$ from R_L

$M = 3430 \times 6.0 - 580 \times \frac{6.0^2}{2} = 10{,}140'^{\#}$

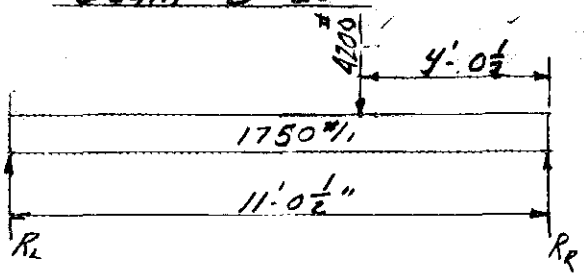
req'd $d = \sqrt{\frac{10140}{116}} = 9.4 < 9.6"$

$v = \frac{4220}{12 \times .89 \times 9.6} = 41\ ^{\#}/\square''$

$A_s = \frac{10140 \times 12}{20{,}000 \times .89 \times 9.6} = .71\ \square''$ Use 2 - 3/4"ø Bars

$u_0 = \frac{4220}{4.71 \times .89 \times 9.6} = 105\ ^{\#}/\square''$ OK

Beam B-25



D.L $1\frac{1}{2}$" fill plus tile = 30×3.33 = 100

" 7" slab = 90×3.33 = 300

" 12"x 21" beam = $1 \times 1.17 \times 150$ = 175

D.L Brick part. = $8.5 \times .67 \times 120$ = 680

Plaster = 8.5×20 = 170

L.L = 3.17×100 = 317

1742#/'

Say 1750#/'

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 16-May-1944

Beam B-25 (cont.)

$R_L = 1750 \times 11.04 \times .5 + 4220 \times \frac{4.04}{11.04} = 11200^{\#}$

$R_R = 1750 \times 11.04 \times .5 + 4220 \times \frac{7.00}{11.04} = 12340^{\#}$

$x_0 = 6.4'$ from R_L

$M = 11200 \times 6.4 - 1750 \times \frac{6.4^2}{2} = 35840'^{\#}$

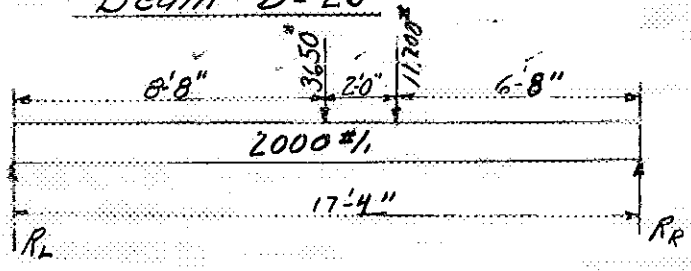
reqd $d = \sqrt{\frac{35840}{116}} = 17.5 > 18.5$

$v = \frac{12340}{12 \times .89 \times 18.5} = 62\ \#/\square''$

$A_s = \frac{35840 \times 12}{20{,}000 \times .89 \times 18.5} = 1.31\ \square''$ Use 3-3/4"ϕ bars

$u_0 = \frac{12340}{7.07 \times .89 \times 18.5} = 106\ \#/\square''$

Beam B-26



D.L. 1½" fill plus tile = 30 × 3.42 = 103
" 7" Slab = 90 × 3.42 = 308
" 16"×30" beam = 1.33 × 1.92 × 150 = 384
" Brick Part = 8.5 × .67 × 120 = 680
" Plaster = 12 × 10 = 120
" 1" Marble = 5 × .08 × 160 = 64
L.L. = 3.42 × 100 = 342
2001

Say 2000 #/'

$R_L = 2000 \times 17.33 \times .5 + 3650 \times \frac{8.66}{17.33} + 11{,}200 \times \frac{6.67}{17.33} = 23470^{\#}$

$R_R = 2000 \times 17.33 \times .5 + 3650 \times \frac{8.66}{17.33} + 11{,}200 \times \frac{10.67}{17.33} = 26050^{\#}$

$x_0 = 9.91'$ from R_L

$M = 23470 \times 9.91' - 2000 \times \frac{9.91^2}{2} - 3650 \times 1.24 = 129850'^{\#}$

reqd $d = \sqrt{\frac{129{,}850 \times 12}{16 \times 116}} = 29.0 > 27.5''$ (No Tee Beam Action)

Beam will act as a Tee Beam
$b = 33''$ $\frac{T}{d} = .254$ $K = 123$

reqd $d = \sqrt{\frac{129850 \times 12}{33 \times 123}} = 19.6'' < 27.5''$

$v = \frac{26050}{16 \times .89 \times 27.5} = 66\ \#/\square''$ OK Use 16"×30" beam

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs & Beams
Computed by: H. E. W. Checked by: A. L. K. Date: 16-May-1944

Beam B-26 (cont.)

$$A_s = \frac{129,850 \times 12}{20,000 \times .89 \times 27.5} = 3.17^{\square''} \text{ use } 4\text{-}1''\phi \text{ bars}$$

Bending Pts
Try 2 bars bent up

$$M = 20,000 \times .89 \times \frac{27.5}{12} \times 1.58 = 64,500^{\prime\#}$$

Left Side

$$23,470x - 2000\frac{x^2}{2} = 64,500$$

$$x = 3.2'$$

Right side

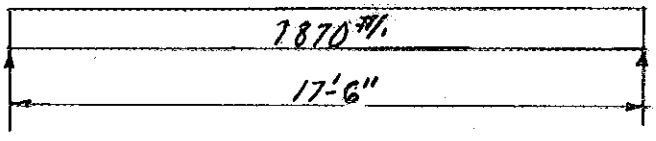
$$26050 - 2000\frac{x^2}{2} = 64500$$

$$x = 2.7'$$

Run bars straight thru

$$u_o = \frac{26050}{12.57 \times .89 \times 27.5} = 85^{\#}/\square'' \quad OK$$

Beam B-27



D.L. $1\frac{1}{2}''$ Fill + Tile	$30 \times 5.88 =$	176
D.L 7" Slab	$90 \times 5.88 =$	529
" 14" x 24" Beam	$1.17 \times 1.42 \times 150 =$	250
Tile Partition	$16 \times 6.75 =$	108
1" Marble	$5 \times .08 \times 160 =$	64
Plaster	$3.5 \times 10 =$	35
L.L	$6.54 \times 100 =$	654
Metal covers	15×1.25	19
concurs	$.5 \times 1 \times 150 =$	75
		1910#/'

$$R_L = R_R = 1910 \times 17.5 \times .5 = 16700^{\#}$$

$$M = \frac{1}{8} \times 1910 \times 17.5^2 = 73,800^{\prime\#}$$

$$\text{req'd } \sqrt{\frac{73000 \times 12}{14 \times 116}} = 23.2 > 21.5''$$

Beam will act as a Tee Beam

$$b = 31'' \quad \frac{t}{d} = .326 \quad K = 116$$

$$\text{req'd } d = \sqrt{\frac{73000 \times 12}{31 \times .89 \times 116}} = 16.6 < 21.5'' \text{ OK}$$

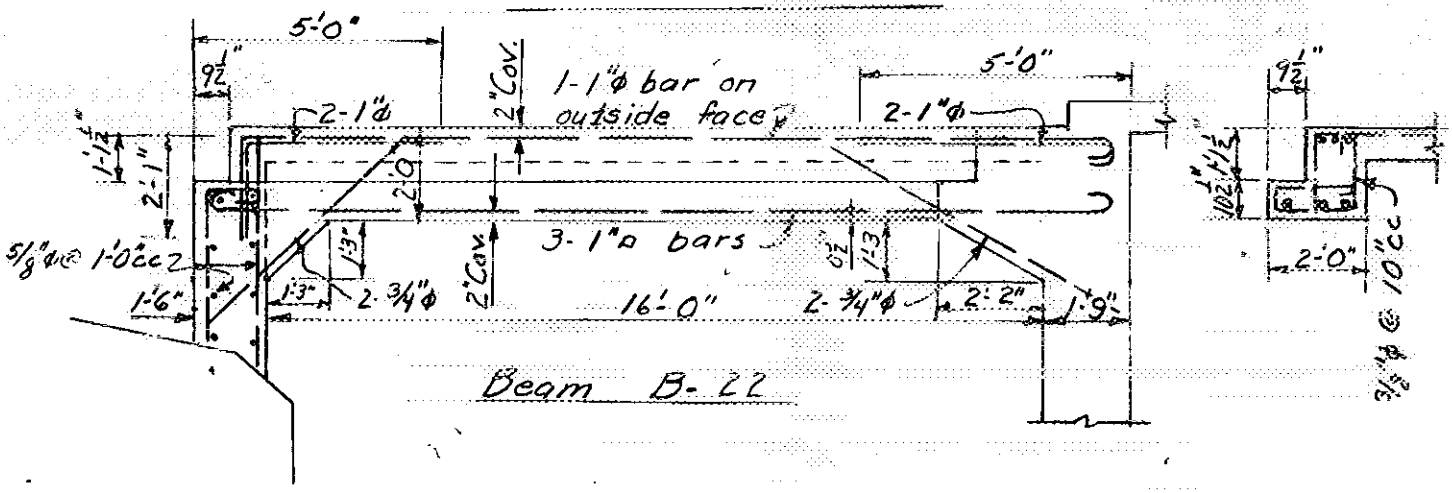
$$v = \frac{16700}{14 \times .89 \times 21.5} = 62^{\#}/\square'' \quad OK$$

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs & Beams
Computed by: Checked by: A.L.K. Date:

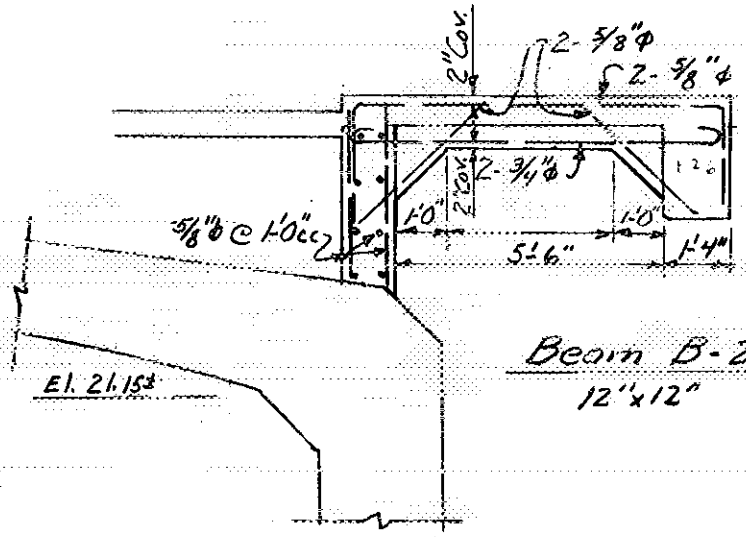
Beam B-28

$$A_s = \frac{73,000 \times 12}{20,000 \times .89 \times 21.5} = 2.30^{\square''} \quad \text{Use } 3\text{-}1''\phi$$

$$u_o = \frac{16200}{9.42 \times .89 \times 21.5} = 94\ \#/\square'' \quad \text{OK}$$



Beam B-22



Beam B-23
12"x12"

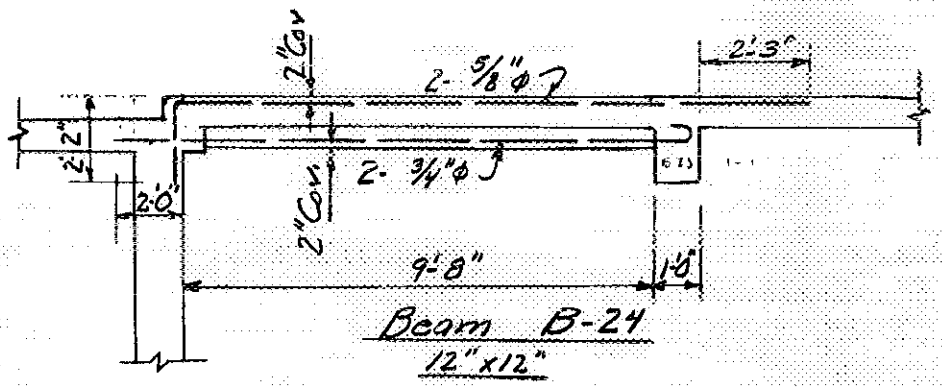
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

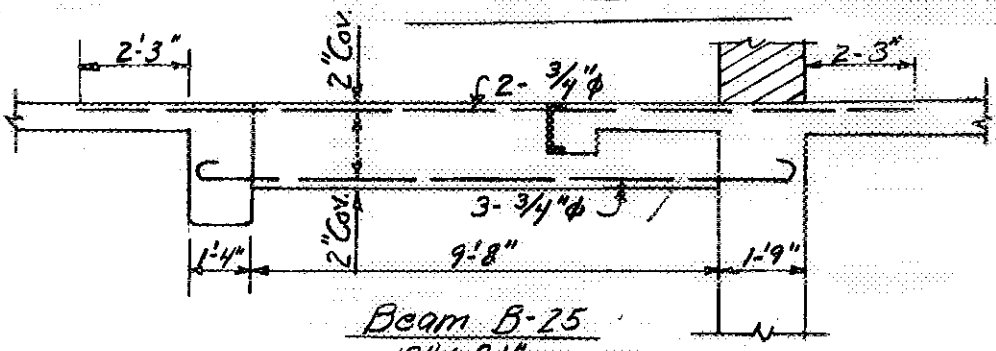
Subject Bushnell Park Pumping Station

Computation Comfort Station and Store Room Floors - Slabs + Beams

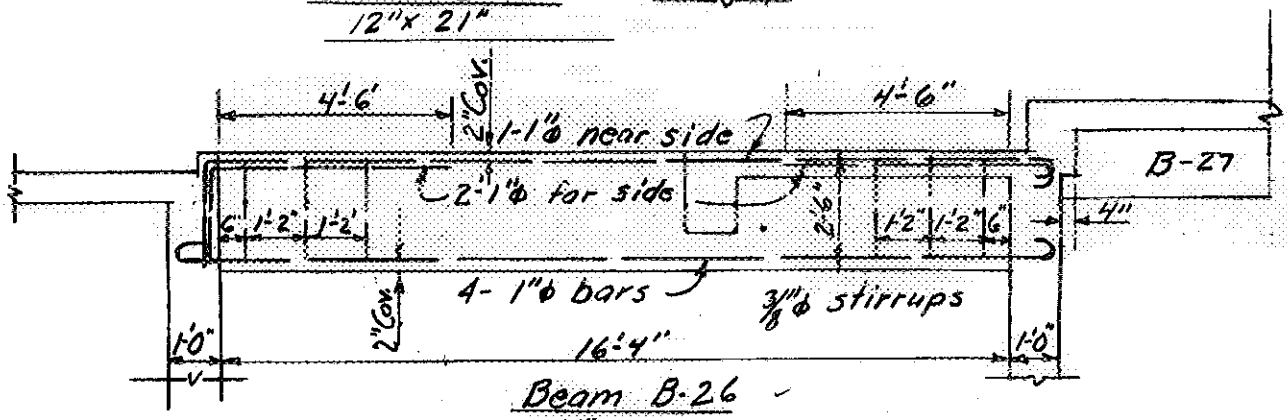
Computed by H.E.W. **Checked by** A.L.K. **Date** 18 May 1944



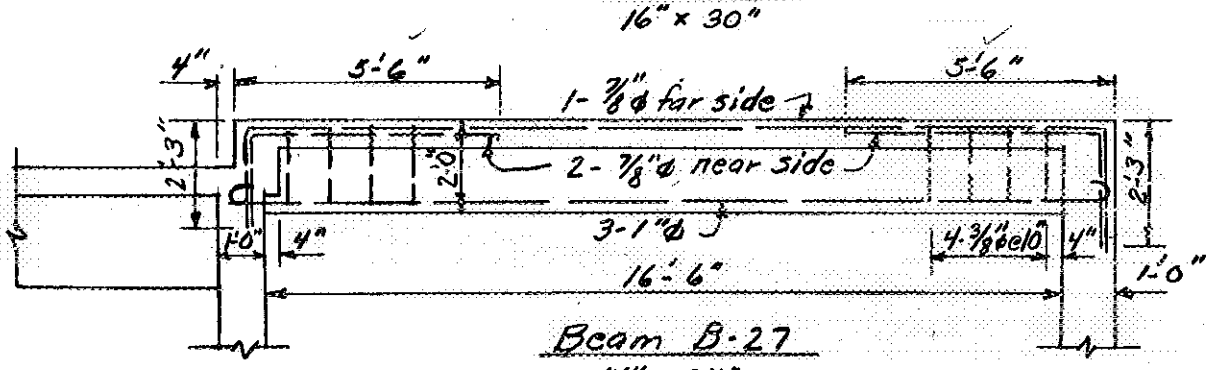
Beam B-24
12" x 12"



Beam B-25
12" x 21"



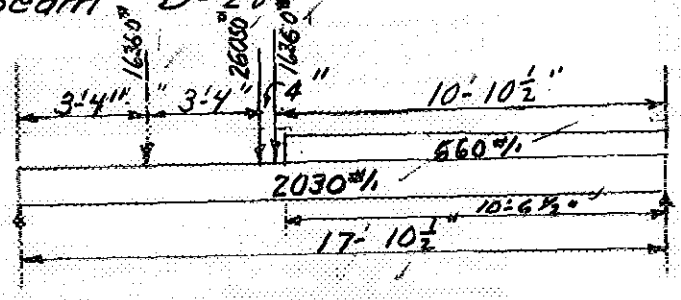
Beam B-26
16" x 30"



Beam B-27
14" x 24"

Subject: Bushnell Park Pumping Station
Computation: Comfort Station and Store Room Floors - Slabs + Beams
Computed by: H.E.W. Checked by: A.L.K Date: 29-May-44

Beam B-28



D.L 20"x44" Beam = 1.67 x 3.67 x 150 = 917#/'
D.L Curb 1x1x150 = 150
D.L/12" Br. Wall 1x8x120 = 960
2027#/'

D.L. slab + fill = 2.83 x 120 = 340
L.L 3.17 x 100 = 317
657#/'

$$R_L = 2030 \times 17.87 \times .5 + 16{,}360 \times \frac{14.54}{17.87} + 26050 \times \frac{11.2}{17.87} + 16{,}360 \times \frac{10.87}{17.87} + 660 \times 10.54 \times \frac{5.27}{17.87}$$

$$= 59{,}780^{\#}$$

$$R_R = 2030 \times 17.87 \times .5 + 16{,}360 \times \frac{3.33}{17.87} + 26050 \times \frac{6.67}{17.87} + 16{,}360 \times \frac{7.}{17.87} + 660 \times 10.54 \times \frac{12.60}{17.87}$$

$$= 42{,}230^{\#}$$

$x_0 = 10.87$ from R_R

$$M = 42{,}230 \times 10.87 - 2030 \times \frac{10.87^2}{2} - 660 \times 10.54 \times 5.60 = 300{,}160^{'\#}$$

$$\text{req'd } d = \sqrt{\frac{300{,}160 \times 12}{20 \times 116}} = 39.4" < 41.5"$$

$$v = \frac{59{,}780}{20 \times .89 \times 41.5} = 80^{\#}/\square"$$

$$A_s = \frac{300{,}160 \times 12}{20{,}000 \times .89 \times 41.5} = 4.88^{\square"} \text{ Use } 5 - 1"\square \text{ bars}$$

Try: Bending up two bars

$$M = 3 \times 20000 \times .89 \times \frac{41.5}{12} = 184{,}680^{'\#}$$

Bending Pt. Left side

$$59{,}780x - 2030\frac{x^2}{2} - 16360(x - 3.33) = 184{,}680 \qquad x = 3.33'$$

Bending Pt. Right side

$$42{,}230x - 2690\frac{x^2}{2} = 184{,}680 \qquad x = 5.3'$$

run bars straight thru.

$$u_0 = \frac{59{,}780}{20 \times .89 \times 41.5} = 80^{\#}/\square"$$

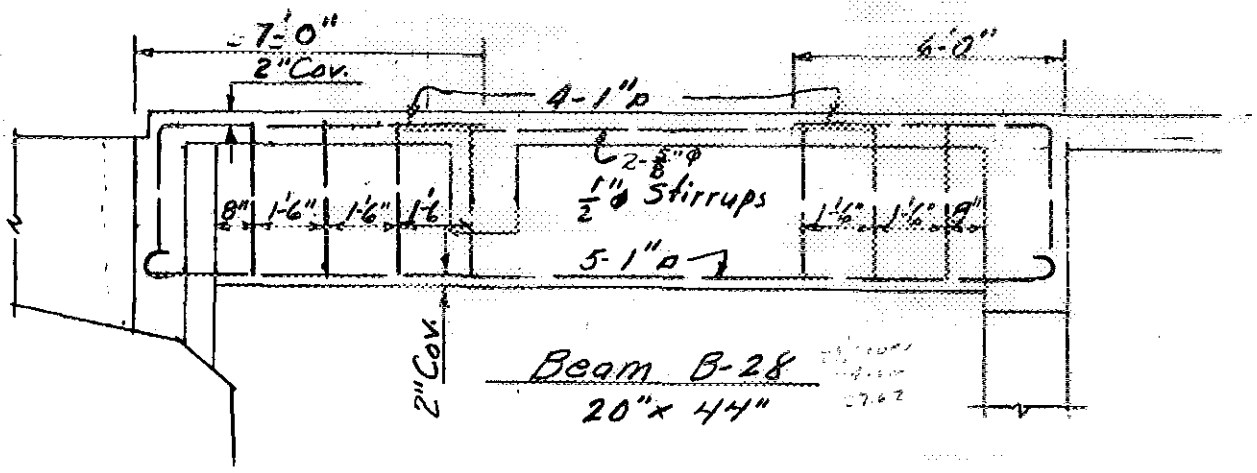
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

Computation: Comfort Station and Store Room Floors - Slabs & Beams

Computed by: H.E.W. Checked by: A.J.K. Date: 29-May-44



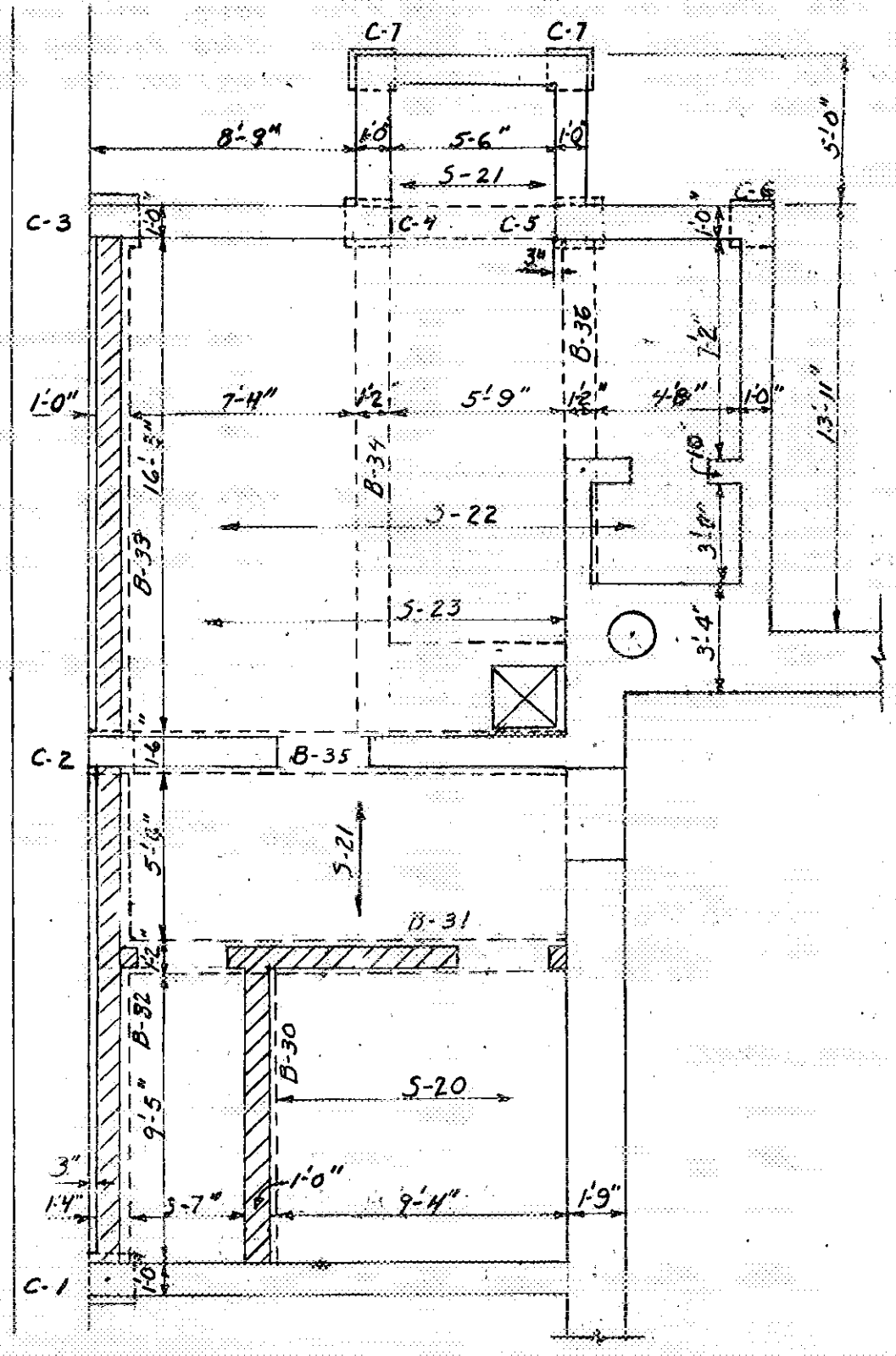
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

Computation: Boiler Room Floor Level – Slabs and Beams

Computed by: H. E. W. Checked by: [illegible] Date: 19-May-44



Subject Bushnell Park Pumping Station
Computation Boiler Room Floor Level - Slabs and Beams
Computed by H.E.W. **Checked by** A.L.K. **Date** 23-May-44

The slabs at boiler room floor level will be designed for a live load of 125#/□'. The slab holding the boiler will be designed for the dead weight of the boiler plus the live load and dead load of slab.

Slab S-20

	225#/□'				
	4'-9"		10'-8½"		
	.69		.31		
	+.42	-.42	+2.15	-2.15	
	-.42	-1.19	-0.54	+2.15	
	-0.59	-0.24	+1.08	-0.27	
	+0.59	-0.60	-0.27	+0.27	
	-0.36	+0.30	+0.14	-0.14	
	+0.36	-0.30	-0.14	+0.14	
-M	0	-2.42	+2.42	0	-M
V	25	10.45	1430#	-980#	V
x_0	→ 0.11		-4.36'	←	x_0
+M	20'#		-2130'#		+M

D.L 8" slab 100#/□'
L.L 125
225#/□'

Fixed End Moments

$M = \frac{1}{12} \times 225 \times 4.75^2 = 0.42'^k$

$M = \frac{1}{12} \times 225 \times 10.71^2 = 2.15'^k$

$+M = 980 \times 4.36 - 225 \times \frac{4.36^2}{2} = 2130'^\#$

$M = 90 \times .4 - 225 \times \frac{.4^2}{2} = 18'^k$

req'd $d = \sqrt{\frac{2130}{116}} = 4.27 < 5.25''$ OK Use 8" slab

$v = \frac{1430}{12 \times .88 \times 6.75} = 20\#/\square''$

$+A_s = \frac{2130 \times 12}{20{,}000 \times .89 \times 6.25} = .23\square''$

$-A_s = \frac{2420 \times 12}{20{,}000 \times .89 \times 6.75} = .24\square''$

Use ½"φ @ 10" cc Top & Bot

$u_0 = \frac{1430}{1.9 \times .88 \times 6.75} = 126\#/\square''$

Slab S-21

Span = 6'-10" load = 225 #/□'

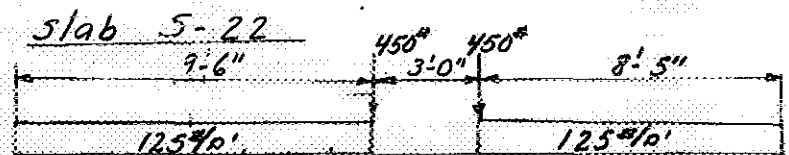
$M = \frac{1}{10} \times 225 \times 6.83^2 = 1050'^\#$

$V = 225 \times 6.83 \times .5 = 770\#$

Use ½"φ @ 1'-0" cc Top & Bot.

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H.E.W. Checked by: H.L.K. Date: 20, May - 44

Slab S-22



	.45	.55	.45	.55		
+1.36	-1.36	+1.24	-1.20	+0.62	-0.62	
-1.36	+0.05	+0.07	+0.26	+0.32	+0.62	
+0.03	-0.68	+0.13	+0.04	+0.31	+0.16	
-0.03	+0.25	+0.30	-0.16	-0.19	-0.16	
0	-1.79	+1.74	-1.06	+1.06	0	-M
750#	1160#	1230	870	830	460	V
→ 3.33'		3.0' ←		2.04 ←		x_0
+1,250'#		535 ~~1600~~'#		470'#		M

L.L. = 125
D.L 8" slab = 100#/□'
Assume boiler with water weights 6400#
Load per ft on eq. side = $\frac{6400}{14.5}$ = 450#/'

Fixed End Moments

$$M^F_{AB} = \frac{1}{12} \times 225 \times 8.5^2 = 1.36'^K$$

$$M^F_{CD} = \frac{1}{12} \times 225 \times 5.75^2 = 0.62'^K$$

$$M^F_{BC} = \frac{1}{12} \times 100 \times 49 + \frac{450 \times 36 \times 1}{49} + \frac{450 \times 9 \times 4}{49} + \frac{.428^2(4-3\times.428)}{12} 375 \times 7$$

$$+ \frac{.143(6-8\times.143+3\times.143^2)}{12} \times 125 \times 7 = 1.24'^K$$

$$M^F_{CB} = \frac{1}{12} \times 100 \times 49 + \frac{450 \times 6 \times 1}{49} + \frac{450 \times 3 \times 16}{49} + .428\left(\frac{6-8\times.428+3\times.428^2}{12}\right) \times 375 \times 7$$

$$+ \frac{.143^2(4-3\times.143)}{12} \times 125 \times 7 = 1.20$$

$$\text{reqd } d = \sqrt{\frac{1600}{116}} = 3.71'' < 6.25'' \text{ OK} \quad \text{Use 8" slab}$$

$$V = \frac{1230}{12 \times .88 \times 6.75} = 17\ \#/\square''$$

$$-A_s = \frac{1750 \times 12}{20{,}000 \times .88 \times 6.75} = .18\ \square'' \quad \text{Use } \tfrac{1}{2}''\phi \text{ @ } 12''\text{cc}$$

$+A_s$ Use $\frac{1}{2}''\phi$ @ 12" cc

$$u_0 = \frac{1230}{1.57 \times .88 \times 6.75} = 131\ \#/\square''$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
Page 60

Subject Bushnell Park Pumping Station
Computation Boiler Room Floor Level - Slabs and Beams
Computed by H. E. W. **Checked by** A. L. H. **Date** 22 May - 44

Slab S-23

225 #/□'				
8'-5"		6'-11"		
	.45	.55		
+1.33	-1.33	+0.90	-0.90	
+1.33	+0.19	+0.24	+0.90	
+0.10	-0.67	+0.45	+0.12	
0.10	+0.10	+0.12	-0.12	
0	-1.71	+1.71	0	-M
740#	1150#	1030	530	V
→ 3.29		2.55 ←		x°
1220'#		630'#		+M

Fixed End Moments

$\frac{1}{12} \times 225 \times 8.42^2 = 1.33$ 'K

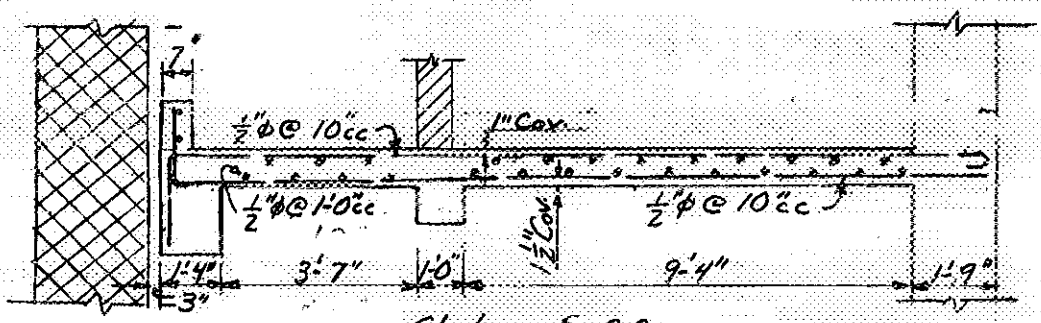
$\frac{1}{12} \times 225 \times 6.92^2 = 0.90$ 'K

reqd d = $\sqrt{\frac{1710}{139}} = 3.5"$ OK

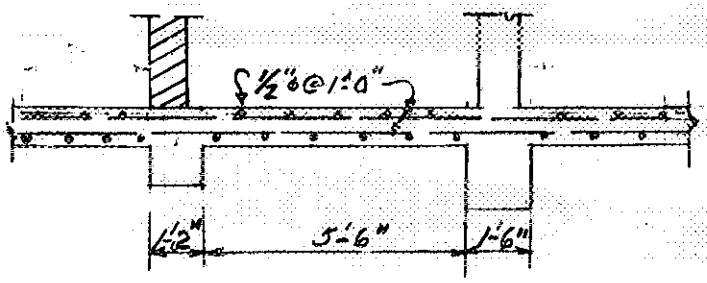
$v = \frac{1150}{12 \times .88 \times 6.75} = 15$ #/□"

$A_s = \frac{1710 \times 12}{20{,}000 \times .88 \times 6.75} = .17$ □" Use $\frac{1}{2}$"φ @ 1'-0"cc Top & Bot.

$u_o = \frac{1150}{1.57 \times .88 \times 6.75} = 123$ #/□" OK

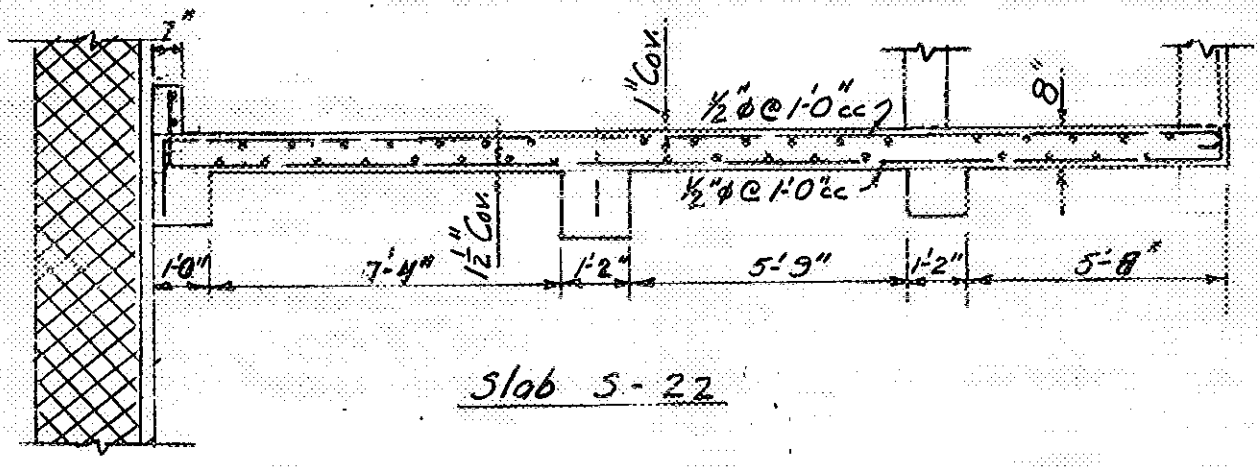


Slab S-20

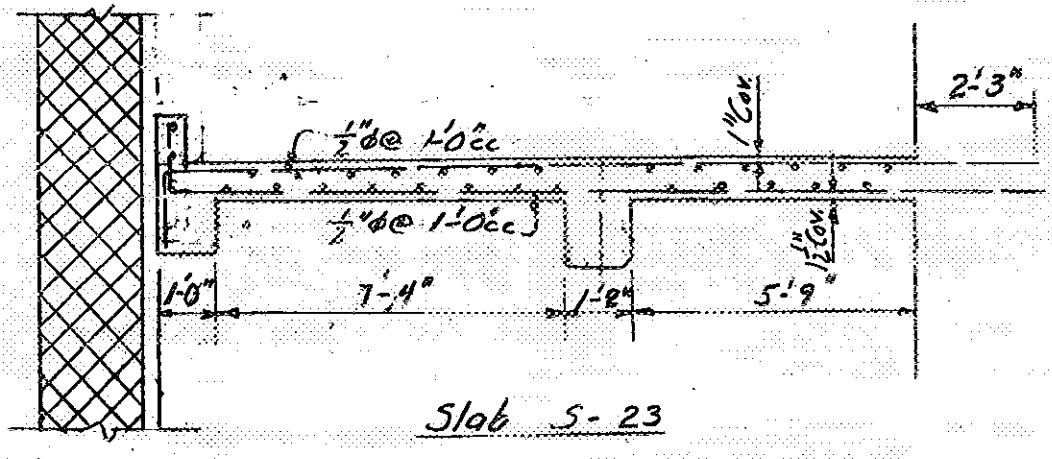


Slab S-21

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H.E.W. Checked by: Date: 23, May 44



Slab S-22

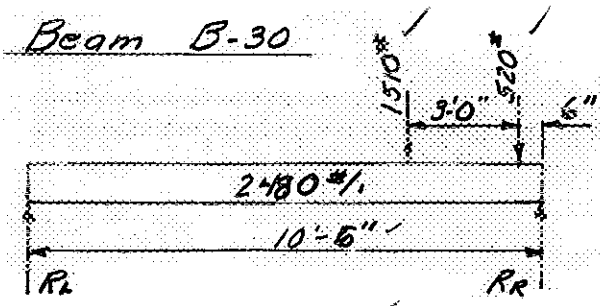


Slab S-23

Subject Bushnell Park Pumping Station
Computation Boiler Room Floor Level - Slabs and Beams
Computed by H.E.W. **Checked by** A.L.K. **Date** 23-May-44

The beams at the boiler room floor level will be designed for dead load plus a live load of 125 #/□'

Beam B-30



DL. 8" brick Wall =	80 × 8.62 =	690#
D.L 8" Slab =	100 × 7.67 =	767
D.L 12"×20" beam:	1 × 1 × 150 =	150
L.L	125 × 7.0 =	875
		2482

Stairway Concentration (See B-24)

$R_L = 2480 \times 10.5 \times .5 + \frac{.5}{10.5} \times 520 + 1510 \times \frac{3.5}{10.5} = 13{,}550^{\#}$

$R_R = 2480 \times 10.5 \times .5 + \frac{10}{10.5} \times 520 + 1510 \times \frac{7}{10.5} = 14520^{\#}$

$x_0 = 5.47$ from R_L

$M = 13550 \times 5.47 - 2480 \times \frac{5.47^2}{2} = 37020'^{\#}$

reqd $d = \sqrt{\frac{37020}{116}} = 17.9'' > 17.5''$ (No Tee Beam Action)

- Beam will act as a Tee Beam

$b = 31''$ $\frac{T}{d} = .456$ $K = 104$

reqd $d = \sqrt{\frac{37020 \times 12}{31 \times 104}} = \frac{13.8}{11.7} < 17.5''$ OK

$V = \frac{14520}{12 \times .89 \times 17.5} = 78^{\#}/\square''$ OK Use Stirrups

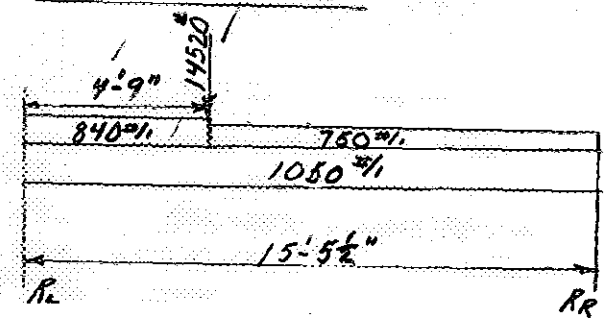
$A_s = \frac{37{,}020 \times 12}{20{,}000 \times .88 \times 17.5} = \cancel{1.20}\ 1.44\ \square''$ Use 3-~~3/4~~ 3/8"ϕ bars

$u_0 = \frac{14520}{7.07 \times .88 \times 17.5} = 133^{\#}/\square''$

Space 3/8"ϕ Stirrups @ 4", 8" 8" 8"

Project: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level Slabs & Beams
Computed by: H.E.W. Checked by: A.L.E. Date: 24-May-44

Beam B-31



D.L 8" Slab = 100 × 3.96 = 396
D.L 14" × 27" beam = 1.17 × 1.58 × 150 = 277
L.L 125 × 3.04 = 380
1053#/'

D.L 8" Brick wall = 80 × 10.54 = 840#/'
" 8" " " = 80 × 9.37 = 750#/'

$$R_L = 1050 \times 15.47 \times .5 + 750 \times 10.71 \times \frac{5.35}{15.47} + 14520 \times \frac{10.71}{15.47} + 840 \times 4.75 \times \frac{13.09}{15.47}$$
$$= \cancel{24{,}020}\ 24540\ \#$$

$$R_R = 1050 \times 15.47 \times .5 + 750 \times 10.71 \times \frac{10.12}{15.47} + 14520 \times \frac{4.75}{15.47} + 840 \times 4.75 \times \frac{2.38}{15.79}$$
$$= 18450\ \#$$

$$x_0 = \frac{18450}{1800} = 10.25' \text{ from } R_R$$

$$M = 18450 \times 10.25 - 1800 \times \frac{10.25^2}{2} = 94560'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{94560 \times 12}{14 \times 116}} = 26.5 > 23.5 \text{ (No Tee Beam Action)}$$

Beam will act as a Tee Beam
$b = 47''$ $\frac{t}{d} = .327$ $K = 116$

$$\text{req'd } d = \sqrt{\frac{94560 \times 12}{47 \times 116}} = 14.5'' < 23.5''$$

$$v = \frac{\cancel{24020}\ 24540}{14 \times .89 \times 23.5} = \cancel{82}\ 84\ \#/\square'' \quad \text{Use Stirrups Make Beam } 14'' \times 27''$$

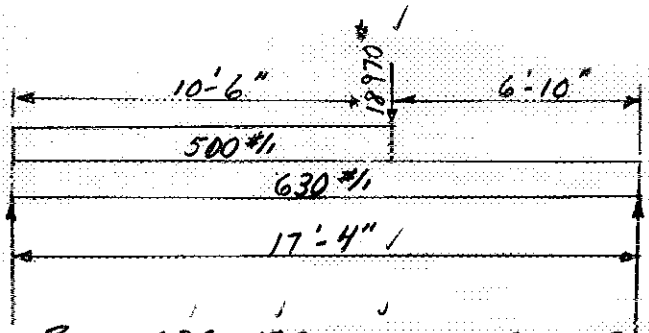
$$A_s = \frac{94560 \times 12}{20{,}000 \times .89 \times 23.5} = 2.70\ \square'' \quad \text{Use } 3\text{-}1''\square \text{ bars}$$

$$u_0 \quad \frac{\cancel{24020}\ 24540}{12 \times .89 \times 23.5} = \cancel{96}\ 97.5\ \#/\square''$$

Space $\frac{3}{8}''\phi$ stirrups @ 5" 12" 12" 12" both ends

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs & Beams
Computed by: H.E.W. Checked by: A.L.L. Date: 24 May-44

Beam B-32



D.L 6" H.T. Wall $30 \times 10.54 = 315$
D.L 16"x27" $1.33 \times 1.58 \times 150 = 315$
630#/'

D.L. 8" Slab $= 192 \times 100 = 192$
L.L $= 125 \times 2.5 = 310$
500#/'

$R_L = 630 \times 17.33 \times .5 + 500 \times 10.5 \times \frac{12.08}{17.33} + 18970 \times \frac{6.83}{17.33} = 16,580^{\#}$

$R_R = 630 \times 17.33 \times .5 + 500 \times 10.5 \times \frac{5.25}{17.33} + 18970 \times \frac{10.5}{17.33} = 18,540^{\#}$

$M = 18,540 \times 6.83 - 630 \times \frac{6.83^2}{2} = 111,930''^{\#}$

reqd $d = \sqrt{\frac{111,930 \times 12}{16 \times 116}} = 26.9'' > 24.5''$ (No Tee Beam Action)

Beam will act as a Tee Beam

$b = 33''$ $\frac{t}{d} = .327$ $K = 116$

reqd $d = \sqrt{\frac{111,930 \times 12}{33 \times 116}} = 18.8'' < 24.5''$ OK

$v = \frac{18540}{16 \times .88 \times 24.5} = 54^{\#}/\square''$ OK use 16"x27" beam

$A_s = \frac{111,930 \times 12}{20,000 \times .89 \times 24.5} = 3.08\ \square''$ Use 4-1"φ bars

$u_o = \frac{18540}{12.57 \times .89 \times 24.5} = 68^{\#}/\square''$

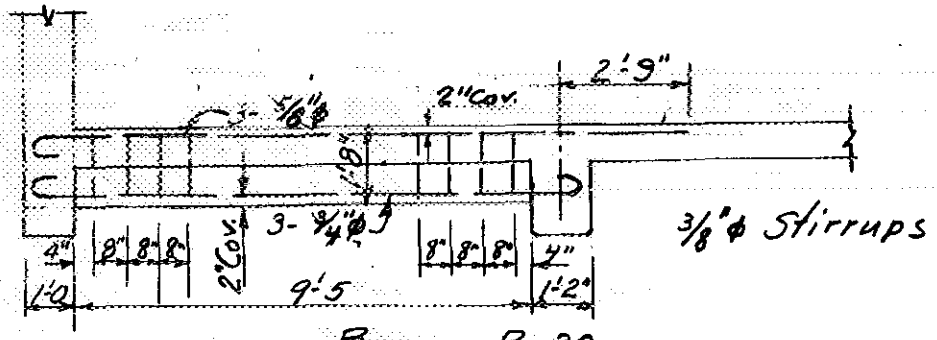
Bending Points
Bend up two bars

$M = 1.57 \times 20000 \times .89 \times \frac{24.5}{12} = 57,060''^{\#}$

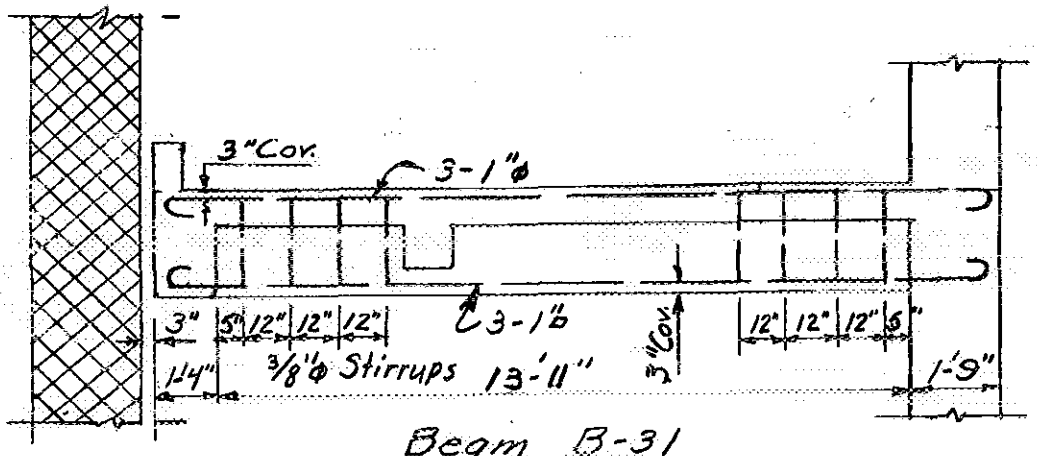
Left side
$57060 = 16580x - 1130\frac{x^2}{2}$ $x = 4.1'$

Right side
$57060 = 18540x - 630\frac{x^2}{2}$ $x = 3.1'$ (Run bars straight thru)

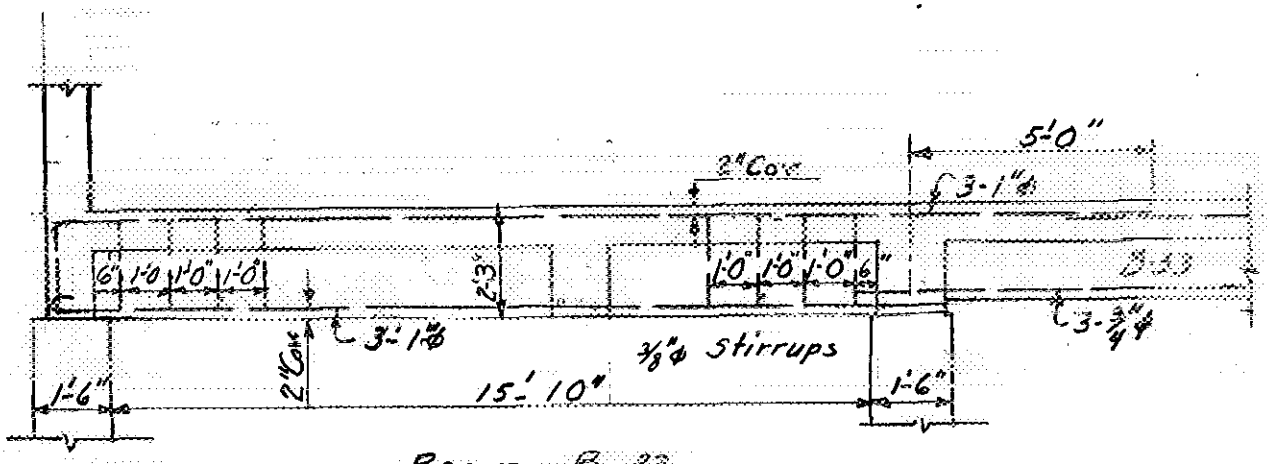
Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level Slabs and Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 25-May-44



Beam B-30
12" x 20"



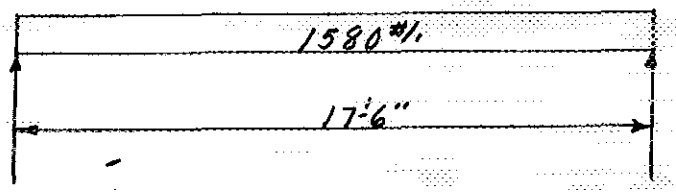
Beam B-31
14" x 27"



Beam B-32
16" x 27"

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level Slabs & Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 29-May 44

Beam B-33



D.L 6" H.T. Wall = 30 x 10.5' = 315 #/'
D.L 12" Curb = 1 x .58 x 150 = 87
D.L. 8" Slab = 3.67 x 100 = 367
D.L. 12" x 24" bm = 150 x 1.0 x 2.0 = 300
L.L = 125 x 4.08 = 510
1579 #/'

$R_L = R_R = 1580 \times 17.5 \times .5 = 13{,}830^{\#}$

$M = \frac{1}{8} \times 1580 \times 17.5^2 = 60{,}490^{\#'}$

reqd d: $\sqrt{\frac{60{,}490}{116}} = 22.8'' > 21.5''$ (No Tee Beam Action

Beam will act as a Tee Beam

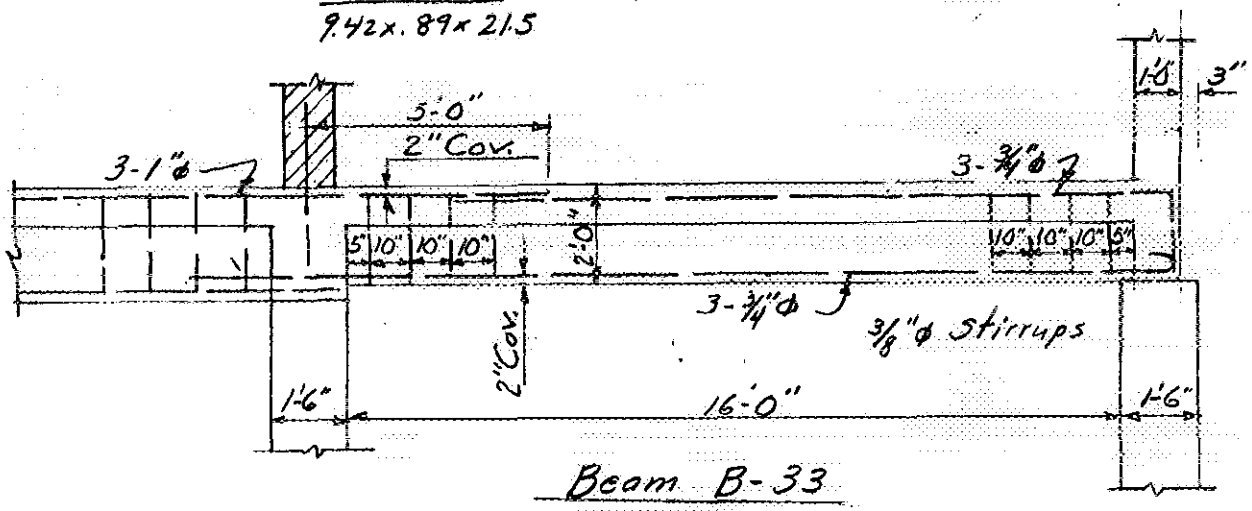
$b = 29''$ $\frac{t}{d} = .372$ $K = 114$

reqd d: $\sqrt{\frac{60{,}490 \times 12}{29 \times .114}} = 14.8'' < 21.5''$ OK

$v = \frac{13830}{12 \times .89 \times 21.5} = 60\ \#/\square''$ OK Use 12" x 24" beam

$A_s = \frac{60{,}490 \times 12}{20{,}000 \times .89 \times 21.5} = 1.90\ \square''$ Use 3-1" ϕ bars

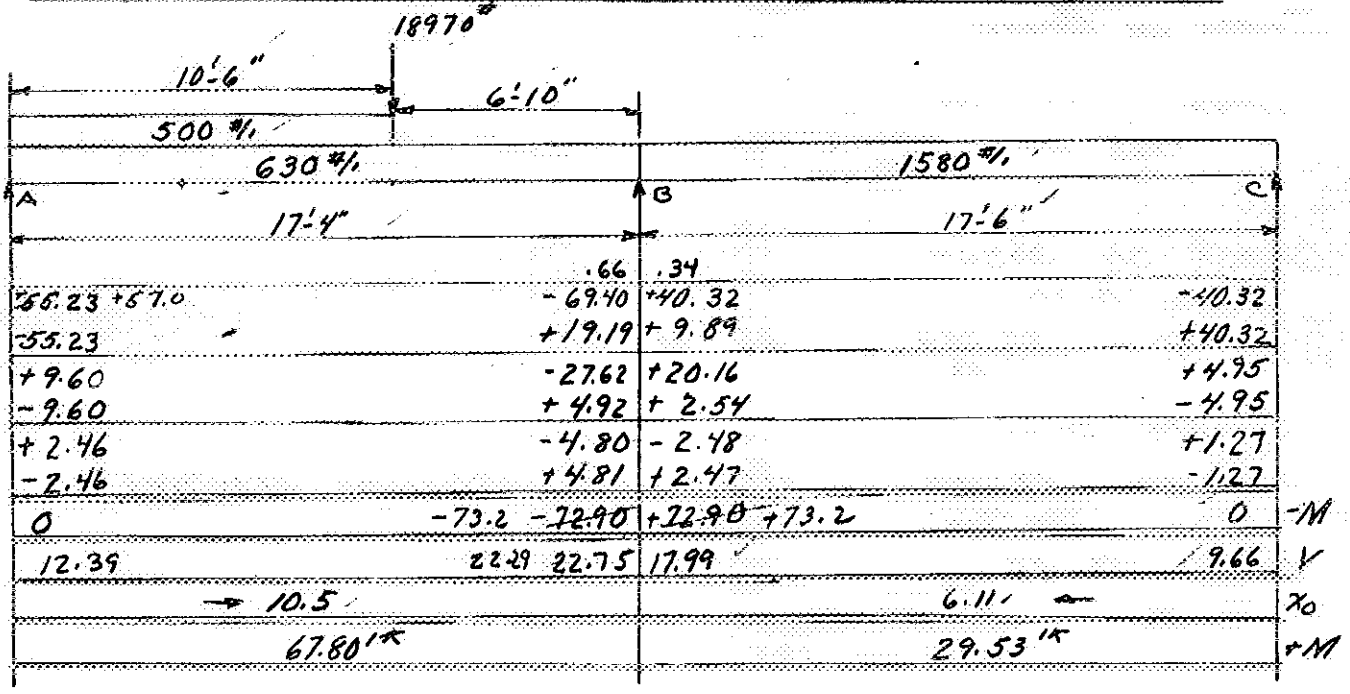
$u_o = \frac{13830}{9.42 \times .89 \times 21.5} = 77\ \#/\square''$



Beam B-33
12" x 24"

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H. E. W. Checked by: M. L. K. Date: 17 June - 44

Check on Beams 32 & 33 for a Continuous Beam Design



Stiffness

$$\frac{I}{L} = \frac{16\times 27^3}{12\times 208} = 126.2 \qquad \frac{I}{L} = \frac{12\times 24^3}{12\times 210} = 65.8$$

Fixed End Moments

Member AB

$$M^F_{AB} = \frac{1}{12}\times 630\times 17.33^2 + \frac{18970\times 6.83^2\times 10.5}{17.33^2} + \frac{.605(6-8\times .605+3\times .605^2)}{12}\times 500\times 10.5\times 17.33$$

$$= \cancel{55.23}\ 57.0\ ^{'K}$$

$$M^F_{BA} = \frac{1}{12}\times 630\times 17.33^2 + \frac{18970\times 6.83\times 10.5^2}{17.33^2} + .605^2\left(4-\frac{3\times .605}{12}\right)\times 500\times 10.5\times 17.33$$

$$= 69.40\ ^{'K}$$

Member BC

$$M^F = \frac{1}{12}\times 1580\times 17.5^2 = 40.32\ ^{'K}$$

Check on req'd d

Beam B-32 - req'd $d = \sqrt{\frac{\cancel{72,900}\ 73,200\times 12}{16\times 139}} = 19.8" < 24.5"$ OK

Beam B-33 req'd $d = \sqrt{\frac{\cancel{72,900}\ 73,200\times 12}{12\times 139}} = 22.9" > 21.5$

reduced M at face of col.

$$\cancel{72,900}\ 73,200 - \frac{3}{3}\times(17,990 - 1580\times .375)\times 1.5 = 64,200\ ^{'K}$$

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H.E.W. Checked by: A.L.K. Date: 17 June - 44

Check on Beams B32 + B33

Beam B-33 cont.

$$\text{req'd } d = \sqrt{\frac{64{,}500}{139}} = 21.5'' = 21.5'' \text{ OK}$$

Check on shear. ✓

Beam B-32

$$v = \frac{22{,}750}{16 \times .89 \times 24.5} = 66\ \#/\square'' \text{ OK}$$

Beam B-33

$$v = \frac{17{,}990}{12 \times .89 \times 21.5} = 78\ \#/\square'' \text{ OK Stirrups provided}$$

Beam B-32

$$-A_s = \frac{\cancel{72{,}900}\ 73{,}200 \times 12}{20{,}000 \times .88 \times 24.5} = 2.0\ \square'' \quad 3\text{-}1''\phi \text{ OK}$$

$$+A_s = \frac{67{,}800 \times 12}{20{,}000 \times .89 \times 24.5} = 1.87\ \square'' \quad \underline{\text{Change steel to } 3\text{-}1''\phi}$$

$$u_o = \frac{22750}{9.42 \times .89 \times 24.5} = 111\ \#/\square'' \text{ OK}$$

Beam B-33

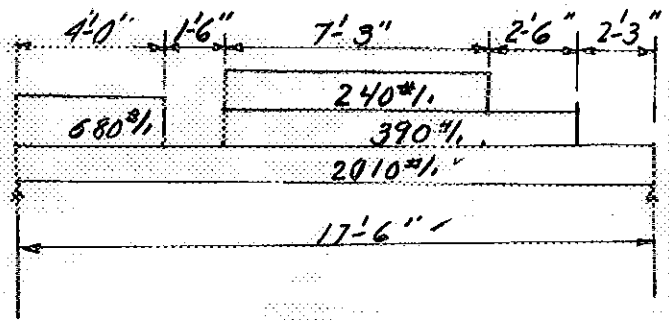
$$-A_s = \frac{\cancel{72{,}900}\ 73{,}200 \times 12}{20{,}000 \times .88 \times 21.5} = 2.31\ \square'' \quad 3\text{-}1''\phi \text{ OK}$$

$$+A_s = \frac{29{,}530 \times 12}{20{,}000 \times .89 \times 21.5} = 0.92\ \square'' \quad \underline{\text{Change steel to } 3\text{-}\tfrac{3}{4}''\phi}$$

$$u_o = \frac{17{,}990}{9.42 \times .89 \times 21.5} = 100\ \#/\square'' \text{ OK}$$

Project: Bushnell Park Pumping
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H.E.W. Checked by: [illegible] Date: 30 - May - 44

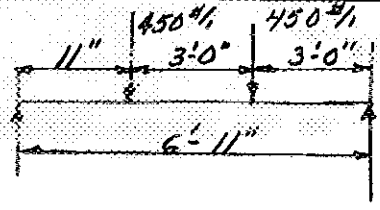
Beam B-34



D.L. 8" slab = 100 x 7.71 = 771#/'
L.L 125 x 7.71 = 964
D.L 14"x27" bm = 1.17 x 1.58 x 150 = 277
2012#/'

D.L slab = 100 x 7.71 = 771
150 x 1.58 x 2.87 = 680
L.L 125 x 7.71 = 964
D.L 14"x27" bm = 277
2692#/'

Load of Boiler on Beam



$R_L = \frac{450(3+6)}{6.92} = 585$#/'

$R_R =$ 315#/'

D.L. Slab 7.71
D.L 14"x27" bm 2.77
D.L Boiler 585
L.L. 125 x 5.75 = 719
2352#/'
D.L. Boiler Mat
$4 \times 1 \times 150 \times \frac{4.5}{6.92} = 390$#/'

$R_L = 2010 \times 17.5 \times .5 + 390 \times 9.75 \times \frac{7.13}{17.5} + 240 \times 7.25 \times \frac{8.38}{17.5} + 580 \times 4 \times \frac{15.5}{17.5} = 22000^{\#}$

$R_R = 2010 \times 17.5 \times .5 + 390 \times 9.75 \times \frac{10.37}{17.5} + 240 \times 7.25 \times \frac{9.12}{17.5} + 580 \times 4 \times \frac{2}{17.5} = 21000^{\#}$

$x_0 = 8.78$ from R_L

$M = 22000 \times 8.78 - 2110 \times \frac{8.78^2}{2} - 580 \times 4 \times 6.78 - 630 \times \frac{3.28^2}{2} = 92{,}450$ '#

req'd $d = \sqrt{\frac{92{,}450 \times 12}{14 \times 116}} = 26.1'' > 24.5''$

Beam will act as a Tee Beam
$b = 53''$ $\frac{t}{d} = .326$ $K = .116$

req'd $d = \sqrt{\frac{92{,}450 \times 12}{53 \times 116}} = 18.9'' < 24.5''$ OK

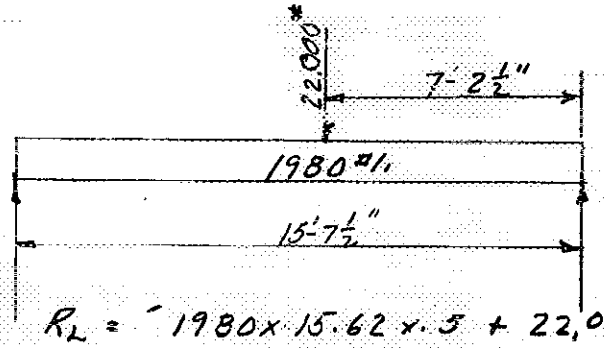
$V = \frac{22000}{14 \times .89 \times 24.5} = 65.5$#/□" OK use 14"x27" Beam

$A_s = \frac{92{,}450 \times 12}{20{,}000 \times .89 \times 24.5} = 2.59$ □" Use 3-1"□ bars

$u_0 = \frac{22000}{12 \times .89 \times 24.5} = 80.5$#/□"

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor Level - Slabs and Beams
Computed by: H.E.W. Checked by: A.L.F. Date: 31-May-44

Beam B-35



D.L. 8" slab 100 × 3.50 = 350
L.L 125 × 3.0 = 375
D.L Brick Wall = 120 × 7.45 = 894
D.L. 18"×27" pm = 1.58 × 1.50 × 150 = 356
1975#/'

$R_L = 1980 \times 15.62 \times .5 + 22{,}000 \times \frac{7.21}{15.62} = \cancel{26\,030}^{\#}$ 25,700

$R_R = 1980 \times 15.62 \times .5 + 22{,}000 \times \frac{8.42}{15.62} = 27\,250^{\#}$

$M = 27{,}250 \times 7.21 - 1980 \times \frac{7.21^2}{2} = 143{,}500'^{\#}$

reqd $d = \sqrt{\frac{143{,}500 \times 12}{18 \times 116}} = 28.7'' > 23.5''$ (No Tee Beam Action)

Beam will act as Tee Beam
$b = 34''$ $\frac{t}{d} = .326$, $K = 116$

reqd $d = \sqrt{\frac{143{,}500 \times 12}{34 \times 116}} = 20.9'' < 23.5''$

$v = \frac{27{,}250}{18 \times .89 \times 23.5} = 73^{\#}/\square''$

$A_s = \frac{143{,}500 \times 12}{20{,}000 \times .89 \times 23.5} = 4.20\square''$ Use 2-1"□ + 2-1⅛"□ bars

Try Bending 2-1"□ bars

$M = 20{,}000 \times 2.53 \times .89 \times \frac{23.5}{12} = 88{,}000'^{\#}$

Bending Pt Left Side

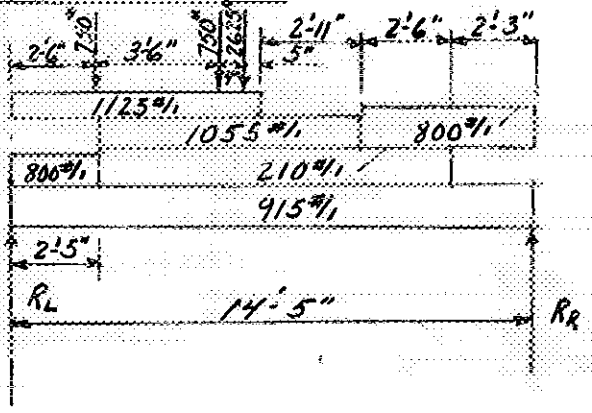
$25{,}700x - 1980\frac{x^2}{2} = 88{,}000$ $x = 3.9'$

Bending Pt right side

$27{,}250x - 1980\frac{x^2}{2} = 88{,}000$ $x = 3.7'$

Subject: Bushnell Park Pumping Station
Computation: Boiler Room Floor level - Slabs and Beams
Computed by: H. E. W. Checked by: A.L.K. Date: 1 June - 44

Beam B-36



D.L. 8" slab = 100 x 6.37 = 637
D.L. 14" x 27" Bm = 150 x 1.17 x 1.58 = 277
914 #/'

D.L. Boiler Mat = 4 x 1 x 150 x 2.42 / 6.92 = 210 #/'

L.L. = 125 x 6.37 = 796 #/'

D.L. Boiler = 315 #/'
L.L. 125 x 5.92 = 740 #/'
1055 #/'

D.L 10" conc. wall 125 x 9 = 1125 #/'
" " " " 125 x 9 x 2.33 = 2625 #/'

R_L =		R_R =	
915 x 14.42 x .5 =	6597#	915 x 14.42 x .5 =	6597#
800 x 2.42 x .916 =	1773	800 x 2.42 x .084 =	163
210 x 9.75 x .494 =	1011	210 x 9.75 x .506 =	1036
1055 x 7.25 x .581 =	4444	1055 x 7.25 x .419 =	3205
800 x 4.75 x .164 =	623	800 x 4.75 x .836 =	3177
1125 x 6.75 x .768 =	5832	1125 x 6.75 x .232 =	1762
750 x .827 =	620	750 x .173 =	130
750 x .584 =	438	750 x .416 =	312
2625 x .561 =	1473	2625 x .439 =	1152
	22811		17534#

x_0 = 8'-1" from R_R

$$M = 17534 \times 8.08 - 915 \times \frac{8.08^2}{2} - 210 \times \frac{5.83^2}{2} - 800 \times 4.75 \times 5.71 - 1055 \times \cancel{2.92 \times 1.88}\ 3.33 \times 1.66$$

$$- 1125 \times \frac{4.12^2}{2} = 80,650'^{\#}$$

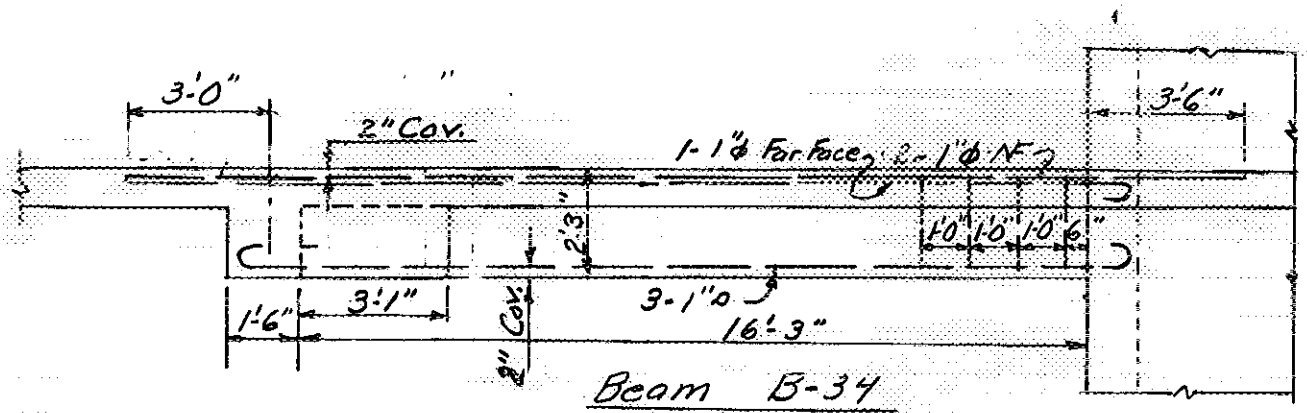
$$\text{req'd } d = \sqrt{\frac{80650 \times 12}{14 \times 116}} = 24.4'' < 24.5'' \text{ OK}$$

$$v = \frac{22811}{17 \times .89 \times 24.5} = 75\ ^{\#}/_{\square''} \text{ OK} \quad \text{Use } 14'' \times 27'' \text{ beam.}$$

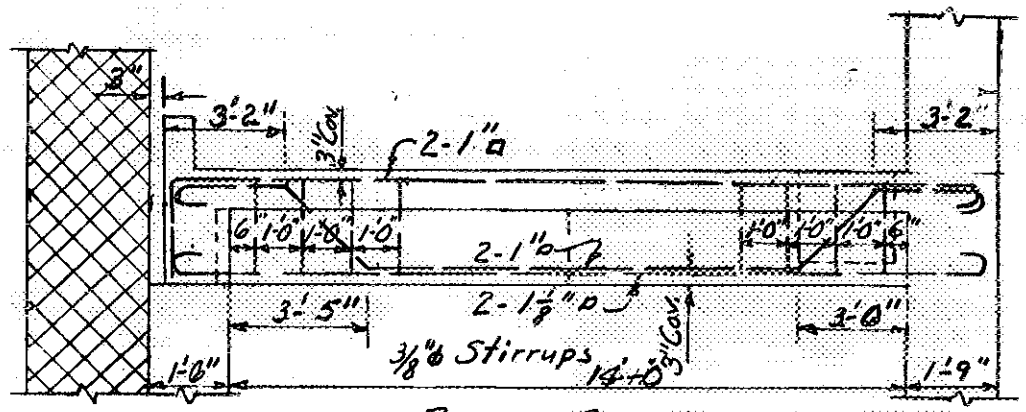
$$A_s = \frac{80,650 \times 12}{20,000 \times .89 \times 24.5} = 2.22\ ^{\square''} \quad \text{Use } 3\text{-}1''\phi$$

$$u_0 = \frac{22811}{9.42 \times .89 \times 24.5} = 111\ ^{\#}/_{\square''}$$

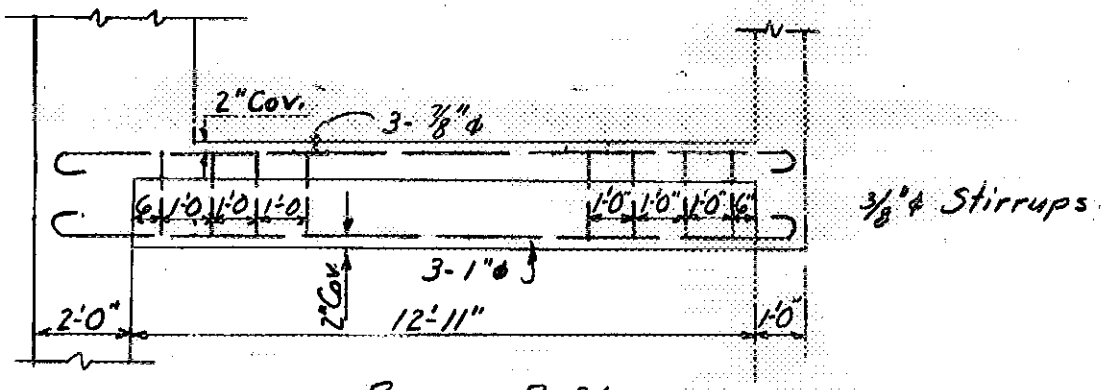
Subject Bushnell Park Pumping Station
Computation Boiler Room Floor Level - Slabs and Beams
Computed by H.E.W. **Checked by** A.L.R. **Date** 31 May 44



Beam B-34
14"x 27"



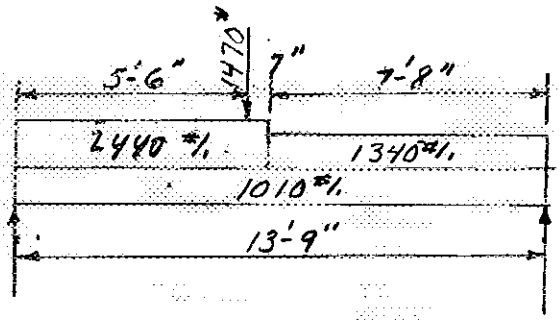
Beam B-35
18"x 27"



Beam B-36
14"x 27"

Subject: Bushnell Park Pumping Station
Computation: North Wall at Boiler Room
Computed by: H. E. W. Checked by: A. L. Date: 31 May - 44

Beam at Top of Wall



D.L 8" Brick Wall = 7 x 80 = 560#
D.L 1'-0" x 3'-0" bm = 3 x 150 = 450
1010 #/'

D.L 7" slab + surf = 120 x 4.71 = 565
D.L. steel cov. = 15 x 2.67 = 40
L.L. = 7.38 x 100 = 738
1343 #/'

D.L 7" slab + surf = 120 x 4.71 = 565
D.L 2'-0½" slab + surf = 336 x 2.42 = 813
D.L 8" wall = 80 x 5.5 x 2.41/5.83 = 200
L.L = 7.38 x 100 = 738
Load from roof = .70 x 50 x 3.58 = 125
2440 #/'

D.L conc. from Br wall
100 x 7 x 2.92 x 4.2/5.83 = 1470#

$R_L = 1010 \times 13.75 \times .5 + 1340 \times 7.67 \times \frac{3.84}{13.75} + 2440 \times 6.08 \times \frac{10.71}{13.75} + 1470 \times \frac{8.25}{13.75} = 22300^{\#}$

$R_R = 1010 \times 13.75 \times .5 + 1340 \times 7.67 \times \frac{9.91}{13.75} + 2440 \times 6.08 \times \frac{3.04}{13.75} + 1470 \times \frac{5.5}{13.75} = 18200^{\#}$

$x_0 = 7.75$ from R_R

$M = 18200 \times 7.75 - 2350 \times \frac{7.75^2}{2} = 70{,}400$ '#

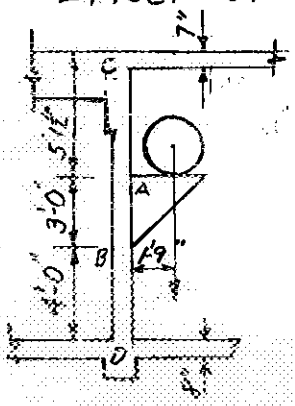
req'd $d = \sqrt{\frac{70400 \times 12}{12 \times 116}} = 24.6'' < 33.5$

$v = \frac{22300}{12 \times .89 \times 33.5} = 62$ #/□"

$A_s = \frac{70400 \times 12}{20{,}000 \times .89 \times 33.5} = 1.42$ □" Use 3 - 7/8" ϕ bars bot.

$u_0 = \frac{22300}{8.25 \times .89 \times 33.5} = 91$ #/□' OK Use 3 3/4" ϕ bars top

Effect of Hot Water Storage Tank



Weight 150 gal hot water tank = 1500#

$H_A = H_B = \frac{1500}{2} \times \frac{1.75}{3} = 440^{\#}$

$H_D = -4.83 \times \frac{440}{12.08} + 440 \times \frac{7.83}{12.08} = 110^{\#}$

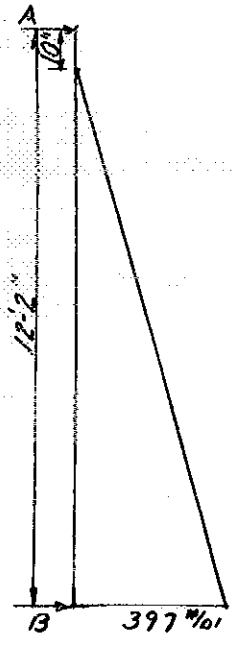
$M = 110 \times 4 = 440$ '#

$A_s = \frac{440 \times 12}{20{,}000 \times .89 \times 7.6} = .04$ □" Use ½" ϕ @ 12" cc.

Subject Bushnell Park Pumping Station

Computation Outside Walls for Boiler Room and Stair well

Computed by H.E.W. **Checked by** A.L.K. **Date** 2 June - 44



Walls will be designed as simply supported at top and bottom.

$$H_A = 397 \times 11.33 \times .5 \times \frac{3.78}{12.17} = 700^{\#}$$

$$H_B = 397 \times 11.33 \times .5 \times \frac{8.39}{12.17} = 1550^{\#}$$

$x_0 = 7.15'$ from A

$$M = 700 \times 7.15 - 221 \times \frac{6.32^2}{2 \times 3} = 3530'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{3530}{116}} = 5.5'' < 9.5'' \text{ OK}$$

$$V = \frac{1550}{12 \times .89 \times 9.5} = 15^{\#}/\square'' \text{ OK}$$

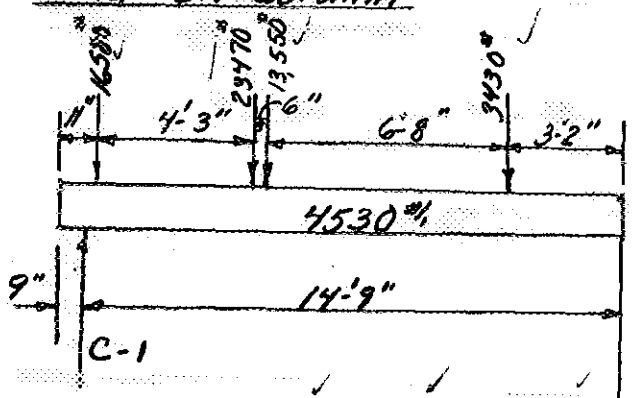
$$A_s = \frac{3530 \times 12}{20{,}000 \times .89 \times 9.5} = .25^{\square''} \text{ Use } \tfrac{5}{8}'' @ 1'\text{-}0''$$

$$u_0 = \frac{1550}{1.96 \times .89 \times 9.5} = 94^{\#}/\square'' \text{ OK}$$

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab Level
Computed by: H.E.W. Checked by: A.L.K. Date: 5 June - 44

Column C-1

Load on column



Concrete wall = 150 × 13.37 = 2010#/'
Brick wall = 120 × 9.5 = 1140#/'
Slab S-12 1380#/'
4530#/'

$C\text{-}1 = 4530 \times 8.12 + 3430 \times \frac{3.17}{14.75} + 13,550 \times \frac{9.83}{14.75} + 23,470 \times \frac{10.33}{14.75} + 16580 \times \frac{14.58}{14.75}$

$= 79380^{\#}$

$x_o = 5'\text{-}8''$ from C-1

$M = 79380 \times \cancel{5.67}\ 4.92 - 4530 \times \frac{5.67^2}{2} - 16580 \times 4.75 - 23470 \times .5 = \cancel{286,760}\ 225,900^{\#}$

$A_s = \frac{\cancel{286\,760}\ 225900 \times 12}{20,000 \times .89 \times 156} = \cancel{1.24}\ .98\ \square''$ Use 3 - 3/4"φ bars in bottom

$u_o = \frac{79380}{7.07 \times .89 \times 156} = 81\ \#/\square''$

Design of column.

Approx ht. of col from rock to bot of beams

El. of bot. of beams = 14.25

Aprox El. of rock = - 1.00

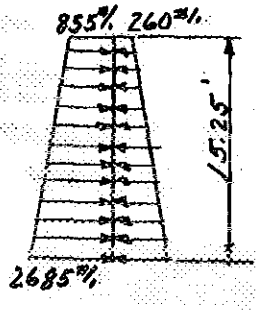
D = 15.25'

Assume 18" square column

$\frac{l}{d} = \frac{15.25 \times 12}{18} = 10.17$

4 - 7/8"φ $p_g = .0034$

Horiz. Load on column



$H = (35 \times 70 + 2.75 \times 80)1.5 = 853\ \#/'$

$H = 855 + 15.25 \times 80 \times 1.5 = 2685\ \#/'$

$H = (2.75 \times 62.5) \times 1.5 = 260\ \#/'$

$H = 260 + 15.25 \times 80 \times 1.5 = 2090\ \#/'$

$M = \frac{1}{8} \times 595 \times 15.25^2 = 17350'^{\#}$

Vertical Load

$79,380 + 150 \times 15.25 \times 1.5^2 = 84530^{\#}$

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab
Computed by: H.E.W. Checked by: H.L.K. Date: 6 June - 47

Column C-1 (cont.)

$$\text{Max } f_c = \frac{P\left(1 + \frac{ec}{R^2}\right)}{A_g\left[1 + (n-1)p_g\right]}$$ (Theory & Practice of Reinf. Conc. by Dunham Pg. 165)

$$e = \frac{17350 \times 12}{84530} = 2.5'' \qquad R = 5.20 \qquad c = 9$$

$$f_c = \frac{84530\left(1 + \frac{2.5 \times 9}{5.2^2}\right)}{18^2\left[1 + 11 \times .0074\right]} = 445\ \#/\square''$$

$$\text{Allowable } f_c = \frac{.18 f_c' + .8 f_s p_g}{1 + (n-1)p_g}\left[\frac{1 + \frac{ec}{R^2}}{1 + .8\frac{ec}{R^2}}\right]$$ Based on 1940 Joint Code. See Dunham page 166

$$f_c = \frac{.18 \times 3000 + .8 \times 16000 \times .0074}{1 + 11 \times .0074}\left[\frac{1 + \frac{2.5 \times 9}{5.2^2}}{1 + \frac{.8 \times 2.5 \times 9}{5.2^2}}\right] = 650\ \#/\square''$$

Use 18"x18" col. with 4-7/8" ϕ bars
Use 1/4" ϕ Lat. ties 12" cc

Column C-2

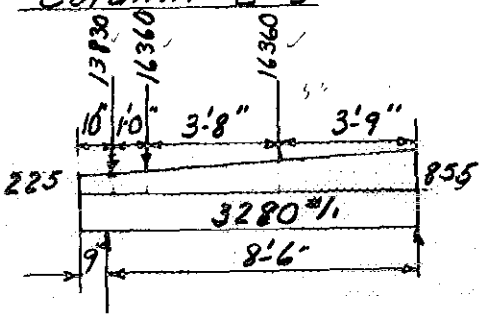
Load on column

Reaction from B-32	=	18540
" " B-33	=	13830
" " B-35	=	25290
Wt. col. = 150 x 15.25 x 1.5²	=	5150
		63220#

Column not subjected to bending

Make column same as C-1

Column C-3



Concrete wall	= 150 x 14.37	=	2160#/'
Stone wall	= 160 x 7	=	1120#/'
			3280#/'
Brick wall	= 90 x 2.5	=	225#/'
	90 x 9.5	=	855

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab
Computed by: H.E.W. Checked by: A.L.K. Date: 7- June- 44

Column C-3 (cont.)

$R_L = 3505 \times 9.25 \times \frac{4.63}{8.5} = 17,660^{\#}$

$630 \times 9.25 \times .5 \times \frac{3.08}{8.5} = 1060^{\#}$

$13,830 \times \frac{8.42}{8.50} = 13700$

$16360 \times \frac{7.42}{8.5} = 14280$

$16360 \times \frac{3.75}{8.5} = 7220$

$53920^{\#}$

$R_R = 3505 \times 9.25 \times \frac{3.87}{8.5} = 14,760$

$630 \times 9.25 \times .5 \times \frac{5.42}{8.5} = 1860$

$13830 \times \frac{0.08}{8.50} = 130$

$16360 \times \frac{1.08}{8.50} = 2080$

$16360 \times \frac{4.75}{8.5} = 9140$

$27970^{\#}$

$x_0 = 3.75'$ from R_R

$M = 27970 \times 3.75 - 3505 \times \frac{3.75^2}{2} - 256 \times \frac{3.75^2}{3} = 79,040^{'\#}$

$A_s = \frac{79040 \times 12}{20,000 \times .89 \times 16.8} = .32$ 2 - $\frac{5}{8}$"ϕ OK

Bending Moment on col = 17350'# (same as C-1)
Total Vertical load on 18"x18" col = 53920 + 5150 = 59,070#

$\frac{l}{d} = 10.17$; Use 4-$\frac{7}{8}$"ϕ bars then $p = .0074$ R = 5.20 c = 9

$e = \frac{17350 \times 12}{59,070} = 3.52$

$\text{Max } f_c = \frac{59070\left(1 + \frac{3.52 \times 9}{5.2^2}\right)}{18^2\left[1 + 11 \times .0074\right]} = 370$ #/□" OK

Column C-4

Load on column

Wall load	=	27970
Beam B-34		2100
Conc Wall at entry 150 x 13.37 x 2	=	4010
S-21 2 x 225 x 2	=	900
Beam bet. C-4 + C-5: 1 x 2.25 x 150 x 3.25	=	1100
Beam over opening 3.12 x 1 x 150 x 3.25	=	1520
Entry slab 220 x 2 x 2.75	=	1210
Stone wall 1 x 7 x 160 x 2	=	2240
Brick wall 13 x 3.75 x 80	=	3900
Roof Load 50 x 6 x 2	=	600
Wt. col		5150
		48600#

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab
Computed by: H.E.W. Checked by: A.L.K. Date: 7-June-44

Column C-4 cont.

Make col same as C-1

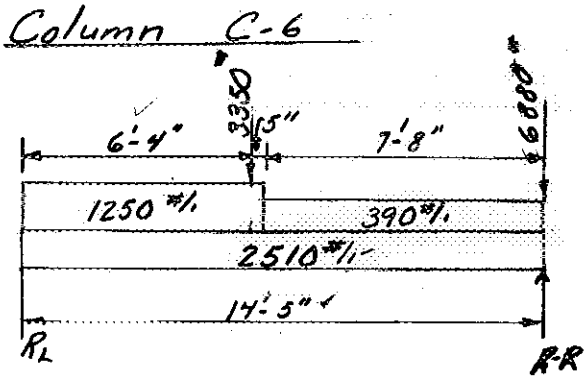
Column C-5

Load on Column

Beam B-36			17530
Service Pit wall =	150×14.37×3.2	=	6900
Beams between col =	150×1×2.25×2.75		930
Conc. Wall at entry =	150×13.37×2	=	4010
S-21	2×225×2		900
Entry slab	220×2×2.75	=	1210
Stone wall	1×7×160×3	=	3360
Brick wall	9×80×2.75	=	1980
Roof Load	50×6×2	=	600
Reaction from wall		=	18200
Column load	(approx.)	=	9600
Wt. conc. col		=	5150
			70370#

Make col same as C-1

Column C-6



Concrete wall 13.25×1×150 = 1990#/'
Concr. base slab 225×2.33 = 520
2510#/'

10" Conc. wall 10.1×2.33×125×. = 2940#
12" Conc. wall 1×150×3.33×2.75 = 6880#

Assume 2'-0½" roof slab plus 100# L.L.
400 × 2.33 = 940#/'
8" br. wall 6×80×3.08/5.83 = 260#/'
roof load 30×50×3.58 = 50#
1250#/'

D.L. Steel cover plus 100# L.L
115×3.33 = 390#/'
8" br. wall 6.5×80×2.58×1.8/5.83 = 410#/'

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab
Computed by: H.E.W. Checked by: A.L.K. Date: 7 - June - 44

Column C-6 cont.

$$R_L = 2510 \times 14.42 \times .5 + 1250 \times 6.75 \times \frac{11.05}{14.42} + 390 \times 7.67 \times \frac{3.84}{14.42} + 3350 \times \frac{8.08}{14.42}$$

$$R_L = 27,250^{\#}$$

$$R_R = 2510 \times 14.42 \times .5 + 1250 \times 6.75 \times \frac{3.38}{14.42} + 390 \times 7.67 \times \frac{10.58}{14.42} + 3350 \times \frac{6.33}{14.42}$$

$$R_R = 23,770^{\#}$$

$$M = 27,250 \times 6.33 - 3760 \times \frac{6.33^2}{2} = 97,160^{'\#}$$

$$A_s = \frac{97,160 \times 12}{20,000 \times .89 \times 156} = .42^{\square''}$$ Use 3-7/8"ϕ bars

Column Load

R_R	=	23,770#
		6800#
wt. col	=	5150
		35720#

Column will be subjected to a bending moment of 17,350'# on each of two sides

Design col for bending and direct load

$$e = \frac{17350 \times 12}{35,720} = 5.82^{\#}$$ Outside middle third therefore there will be tension in one end

Solve for f_c by approx. method as outlined by Dunham on pages 190 & 191

$$f_c = f_1 + f_2 \times 2 \qquad f_1 = \frac{2P}{A_g + (n-1)A_{sg}} \qquad f_2 = \frac{P(e - r_k)kd}{I_c}$$

$$I_c' = \frac{bd^3}{12} + (n-1)I_s = \frac{18^4}{12} + 11(\cancel{2} \times .60 \times \cancel{7.9^2}) = \cancel{9571} + 114 = 9145$$

$$r_k = \frac{I_c'}{0.5D[A_g + (n-1)A_{sg}} = \frac{\cancel{9571}\ 9145}{9(324 + 11 \times 2.41)} = \cancel{3.034}\ 2.86 \text{ in}$$

find kd by mom. about neutral axis

$$kd = -\frac{nA_{sg}}{D} + \sqrt{\frac{(nA_{sg})^2}{D^2} + nA_{sg}}$$

$$kd = \cancel{4.00}\ 3.8^{\#}$$

Subject: Bushnell Park Pumping Station
Computation: Concrete Columns below Boiler Room Slab
Computed by: H. E. W. Checked by: A.L.K. Date: 7- June - 44

Col. C-6 cont.

$$I_c = \frac{18.0 \times \cancel{4.0}^{3.8\,3}}{3} + 11(2.41 \times 5.54^2) + 11 \times 2.41\,(9 - \cancel{4.0}^{3.8})^2 = 1860''^4$$

$$f_1 = \frac{2 \times 35720}{324 + 11 \times 2.41} = 202\ \#/\square''$$

$$f_2 = \frac{2 \times 35720\,(5.88 - \cancel{3.03}^{2.86})(\cancel{4.00}^{3.8})}{1860} = 430$$

$$f_c = 630\ \#/\square''\ \text{OK}$$

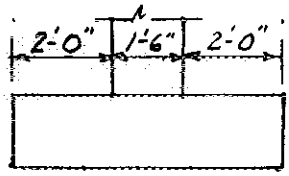
Column C-7

Load on Column

D.L. 1'-0" wall	=	5.75 x 150 x 13.62	=	11750
D.L+L.L. Boiler Room Fl	=	2.75 x 2 x 225	=	1220
D.L+L.L. Entry Fl		2.75 x 2 x 220	=	1210
D.L. 16" st. wall	=	9.5 x 3.75 x 214	=	7620
D.L. 1'-0" st. wall		7.5 x 2 x 160	=	2400
Roof Load	=	50 x 6 x 3	=	900
Wt. col	=			5150
				30250 #

Col will be subjected to a bending moment equal to that of C-6. As the direct load is only slightly less than C-6 the details for column C-7 will be made the same as C-6

Design of Col. Footings
Footings for C-1, C-2, C-3



$$\text{Uniform load on base} = \frac{84530}{1.5 \times 5.5} = 10{,}200\ \#/\square'$$

$$\text{Mom. at face of col.} = 10{,}200 \times 1.5 \times 2 \times 1 = 30{,}600''^{\#}$$

$$V = 10{,}200 \times 1.5 \times (2.00 - 1.12) = 13{,}500^{\#}$$

$$\text{req'd } d = \sqrt{\frac{30{,}600 \times 12}{18 \times 139}} = 12.1'' < 16.5''\ \text{OK}$$ Make footings 1'-9" min

$$v' = \frac{13{,}500}{18 \times .88 \times 16.5} = 52\ \#/\square''$$

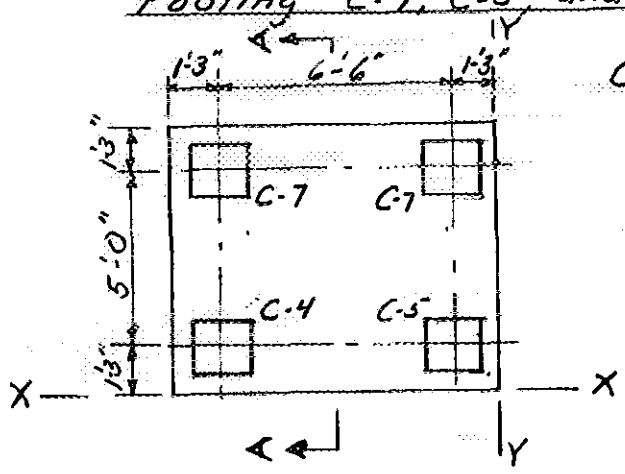
Subject: Bushnell Park Pumping Station
Computation: Column Footings
Computed by: H.E.W. Checked by: A.L.K. Date: 16 - June - 44

Footing C-1, C-2, C-3 (cont.)

$A_s = \frac{30,600 \times 12}{20,000 \times .88 \times 16.5} = 1.27^{\square''}$ Try 4-7/8"φ

$u_o = \frac{30,600}{11.0 \times .88 \times 16.5} = 191$ #/□" OK

Footing C-4, C-5, and C-7



Colum C-4 Load = 69,600#
" C-5 " = 70,370#
" C-7 " = 30,250#

Moments about Axis X-X

Force	Amount	Arm	Moment
C-4	69,600	1.25	87,000
C-5	70,370	1.25	87,650
C-7	30,250	6.25	189,060
C-7	30,250	6.25	189,060
	200,470#		552,770

$R = \frac{552770}{200470} = 2.79'$ e = 0.96'

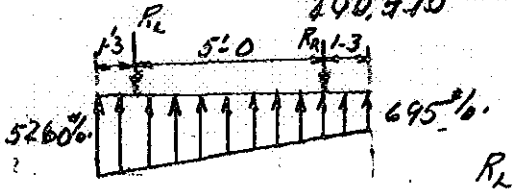
Moments about Axis Y-Y

Force	Amount	Arm	Moment
C-4	69,600	7.75	540,000
C-5	70,370	1.25	87,650
C-7	30,250	7.75	234,440
C-7	30,250	1.25	37,810
	200,470		899,800'#

$R = \frac{899800}{200470} = 4.86$

e = 0.04

ecc. abt. Y-Y to be neg.



Bearing $= \frac{200470}{9 \times 7.5}\left(1 \pm \frac{6 \times .96}{7.5}\right) = 5260$ #/□', 695 #/□'

$R_L = 695 \times 7.5 \times .5 + 4565 \times 7.5 \times .5 \times \frac{3.75}{5.00} = 15,400$#

$R_R = 695 \times 7.5 \times .5 + 4565 \times 7.5 \times .5 \times \frac{1.25}{5.0} = 6,880$#

$x_o = \cancel{3.46}$ 3.26 from R_R

$M = 6880 \times 3.26 - 695 \times \frac{4.51^2}{2} - 2750 \times \frac{4.51^2}{6} = 5950$'#

reqd $d = \sqrt{\frac{5370}{116}} = 7.1'' < 16.5''$ OK

$V = \frac{15050 - 2 \times 4550}{12 \times .88 \times 16.5} = 34$ #/□"

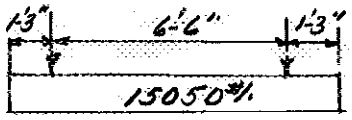
Subject: Bushnell Park Pumping Station
Computation: Column Footings
Computed by: H.E.W. Checked by: A.L.K. Date: 16 June 44

Footing C-4, C-5, C-7

$A_s = \frac{5950 \times 12}{20{,}000 \times .88 \times 16.5} = .25^{\square''}$ use $\frac{7}{8}''\phi$ @ 1'-0" cc

$u_o = \frac{5990}{2.75 \times .88 \times 16.5} = 150^{\#/\square''}$ OK

Beam Between Col. C-4 & C-5



$R_L = R_R = 15400 \times 4.5 = 69{,}500^{\#}$

Shear at Col. face $= 69500 - 2 \times 15400$
$= 38{,}700^{\#}$

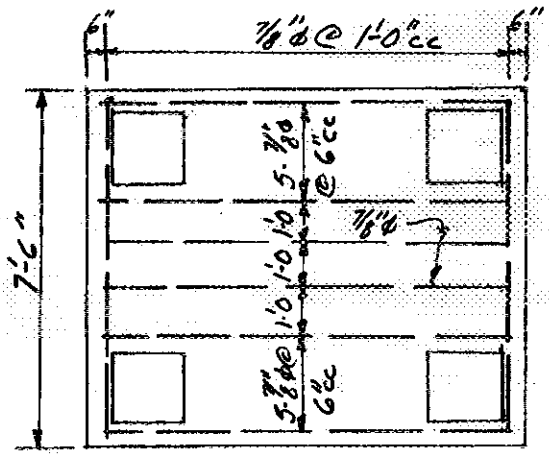
$M = 69{,}500 \times 3.25 - 15400 \times \frac{4.5^2}{2} = 70{,}000^{'\#}$

req'd $d = \sqrt{\frac{70{,}000 \times 12}{30 \times 116}} = 15.5'' < 16.5''$ OK

$v = \frac{38700}{30 \times .88 \times 16.5} = 89^{\#/\square''}$ OK

$A_s = \frac{70{,}000 \times 12}{20{,}000 \times .88 \times 16.5} = 2.9^{\square''}$ Try 5-$\frac{7}{8}''\phi$ bars

$u_o = \frac{38700}{13.75 \times .88 \times 16.5} = 194^{\#/\square''}$ hook all bars



Steel same top & bot
all bars hooked

Footing C-6

Make footing under column 2'-6" square
4-$\frac{7}{8}''\phi$ dowels from col to footing

Subject: Bushnell Park Pumping Station
Computation: Investigation of Loading on Roof of Pack River Conduit
Computed by: H.E.W. Checked by: A.L.K. Date: 10-June-44

Roof Truss Load

2" Plank	5.2x11x19.5x2	=	2230#
Slate Roof	27x11x19.5x2	=	11583
6"x6" Ridge Pole	8.4x11	=	92
3"x12" "	8.4x11	=	92
3"x6" Rafters	17x2x4x4.1	=	623
6"x8" Purlins	4x11x11.5	=	506
8"x10" Top Chord	2x16x19.8	=	634
8"x10" Bot. Chord	24x19.8	=	475
6"x8" Strut	11x11.5	=	127
6"x8" "	2x6.5x11.5	=	150
Live Load on roof	10x11x19.5x2	=	4290
	Total roof load	=	20,800#
Load on each Pilaster		=	10,400#
Brick Pilaster	3x1.33x7.5x120		3600
Conc. "	3x1.33x2x150		1200
Total Pilaster Load		=	15,200#

Concrete Curtin Wall Load

Floor slab + Live Load	2.92x257	=	750#
Wt. 9" brick wall	90x7.5	=	675
Wt. 12" wall	1.17x150x3.58	=	630
			2055#

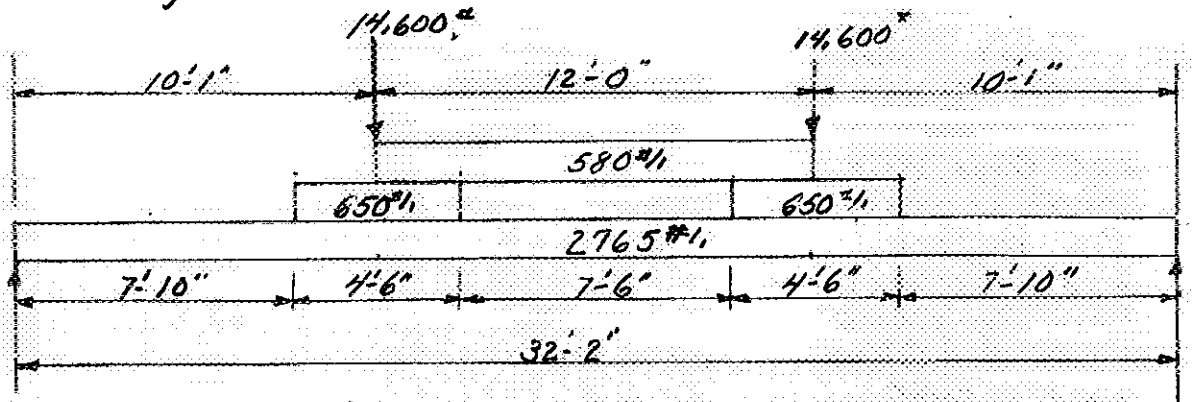
Wt. Earth Fill on outside of wall
2.58x2.75x100 = 710#

Wt. conc. Pilaster Footing
1.75x1.0x150 = 260#/'
150x1.0x2.58 = 390
650#/'

Wt. 8" Conc. Apron with 125# L.L
225x2.58 = 580#/'

Subject: Bushnell Park Pumping Station
Computation: Investigation of Loading on Roof of Park River Conduit
Computed by: Checked by: A.L.K. Date:

Loading Dist. on 5'-6" wide strip of Roof.



$R_L = R_R = 2765 \times 32.17 \times .5 + 650 \times 4.5 + 580 \times 12 \times .5 + 15{,}200^{\#} = 66{,}080^{\#}$

$M = 65{,}480 \times 16.08 - 2765 \times \frac{16.08^2}{2} - 650 \times 4.5 \times 6 - 15{,}200 \times 6$

$- 580 \times \frac{12^2}{2} = 552{,}400^{'\#}$

Equiv Uniform Load: $\frac{1}{8} w \times 32.17^2 = 552{,}400 \quad w = 4300^{\#}/'$

Equiv. Unif. Ld per ft. of width $= \frac{4300}{5.5} = 780^{\#}/\square'$

Park River Conduit Roof is designed for a uniform live load of 800#/□' at this point. Therefore the max. mom. produced by loading the conduit roof with the building loads will not exceed the max mom. produced by the designed live load of 800#/□'

Total load on conduit roof: $2 \times 66{,}080 = 132{,}160^{\#}$

Load per sq. ft. on roof $= \frac{132{,}160}{32.17 \times 5.5} = 750^{\#}/\square' < 800^{\#}/\square'$ OK

Design of Footing Steel

Net pressure on base of footing $= \frac{15{,}200}{4.5 \times 5.5} = 615^{\#}/\square'$

$M = 615 \times \frac{1.58^2}{2} = 765^{'\#}$ at face of pilaster

$V = 615 \times 1.58 = 910^{\#}$ " " " "

Use ½"⌀ @ 1'-0" cc both ways with footing 12" deep

$v = \frac{910}{12 \times .88 \times 8.75} = 10^{\#}/\square''$

$u_0 = \frac{910}{1.57 \times .88 \times 8.75} = 77^{\#}/\square''$ OK

Subject: Bushnell Park Pumping Station
Computation: Criteria for Substructure Analysis
Computed by: H.E.W. Checked by: A.L.K. Date: 2 Mar - 44

The substructure of Bushnell Park Pumping Station will rest on rock and will be from 6'-8" to 15'-6" from the Park River Conduit. The comfort station portion of the structure will bear directly upon the roof of the Park River Conduit. and will frame accross the space between the Conduit and the West wall of the Pump Room.

It will be assumed that the building loads will be carried down the walls and directly into the rock at the base of the walls. The base slab will be considered loaded with the uplift from static head due to ground water as the rock foundation is fissured. The walls will be designed for horizontal loading for dry earth above ground water and saturated earth below ground water. Roof slabs of the intake and discharge conduits will be loaded with the weight of dry earth to ground water elevation and saturated earth below ground water elevation.

The Park River Conduit Roof will be investigated to determine the effect of loads from the Comfort Station.

Design Data
Ground water assumed at El. 17.00
Bot. of base slab -1.50.
Ground El. assumed at 27.83'

Note. It was found necessary in order to provide proper floor drainage to lower the bottom of base slab to El -1.75 after computations were completed. The computations will not be revised because the effect on the structure will be negligible.

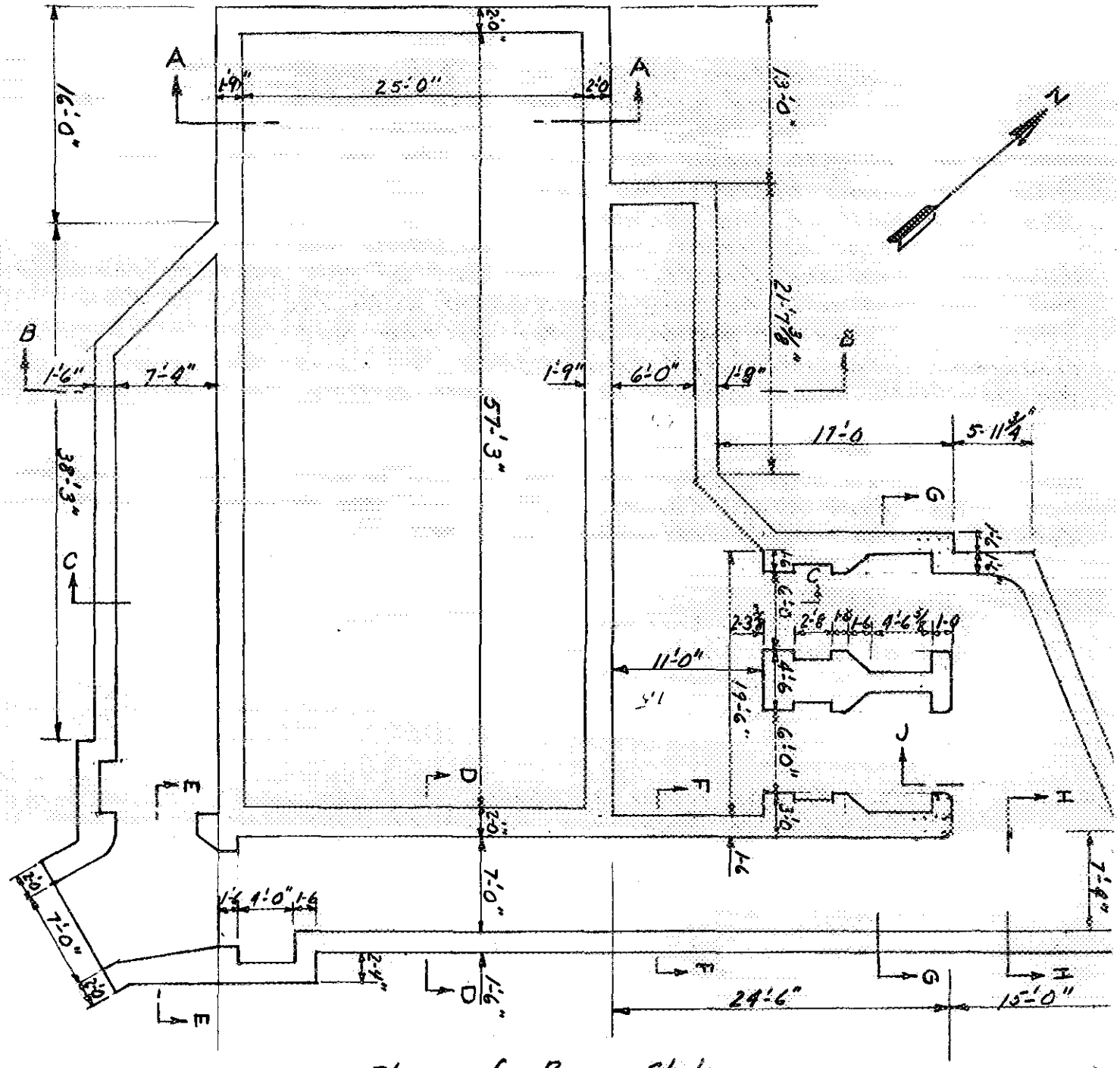
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Key Plan for Design Sections in Substructure Investigation

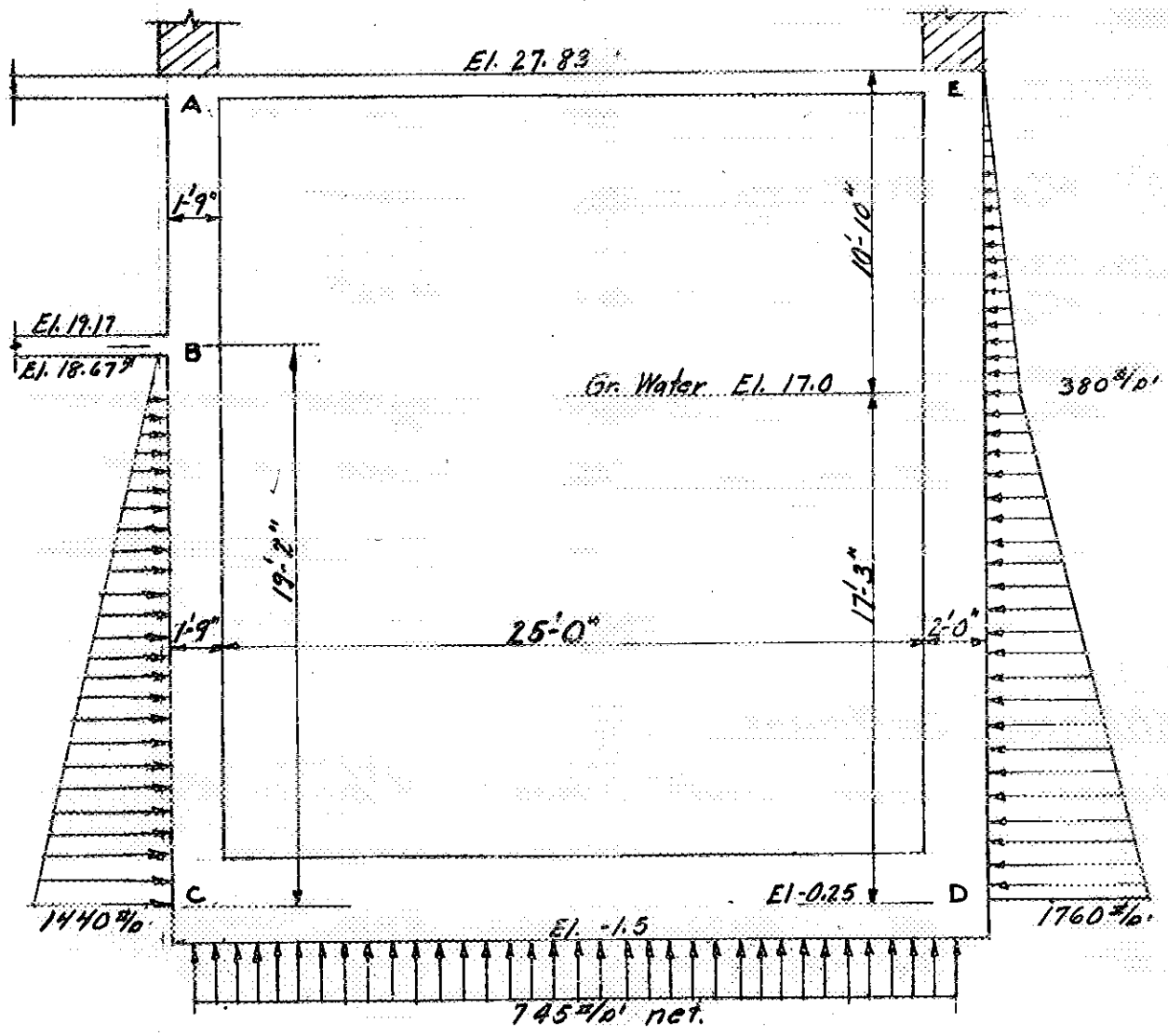
Computed by H.E.W. **Checked by** A.L.K. **Date** 2-Mar. 44



Plan of Base Slab

Scale 3/32" = 1'-0"

Subject: Bushnell Park Pumping Station
Computation: Transverse Section A-A
Computed by: H.E.W. Checked by: [illegible] Date: 7 Mar. 44



Section A-A

Soil Pressures on Walls

10.83 x 35 = 380#
17.25 x 80 = 1380
1760 #/□'

1.67 x 35 = 60
17.25 x 80 = 1380
1440 #/□'

Base Pressure

Static Pressure = 18.5 x 62.5 = 1156 #/□'
Weight of Base = 2.75 x 150 = 413
743 say 745 #/□' net

Subject: Bushnell Park Pumping Station
Computation: Transverse Section A-A
Computed by: H.E.W. Checked by: A.L.K. Date: 2 Mar. 41

Fixed End Moments

Member AC

$$M^F_{AC} = \frac{.684^2(5-3\times.684)}{30} \times \frac{1440\times19.17\times28.08}{2} = 17.82$$

$$M^F_{CA} = \frac{.684(10-10\times.684+3\times.684^2)}{30} \times \frac{1440\times19.17\times28.08}{2} = 39.45$$

Member CD

$$M^F_{CD} = M^F_{DC} = \frac{1}{12}\times745\times26.88^2 = 44.86^{'K}$$

Member DE

$$M^F_{DE} = \frac{.386^2(5-4\times.386)}{10}\times\frac{380\times10.83\times28.08}{2} + \frac{.614(6-8\times.614+3\times.614^2)}{12}\times380\times17.25\times28.08$$

$$+ \frac{.614(10-10\times.614+3\times.614^2)}{30}\times\frac{1380\times17.25\times28.08}{2} = 58.00$$

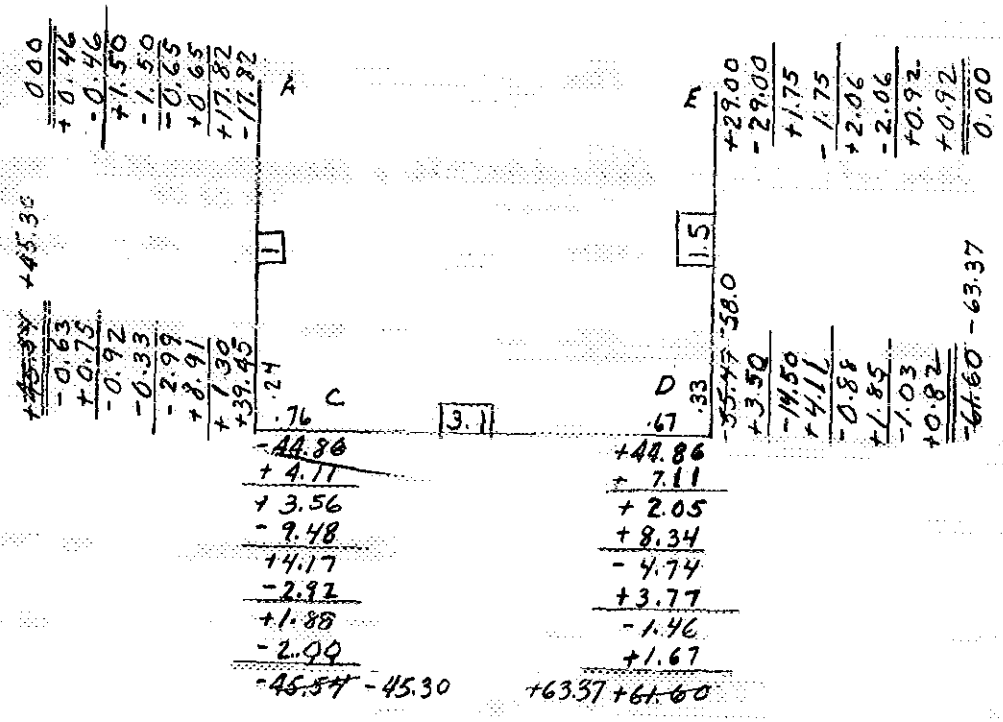
$$M^F_{ED} = \frac{.386(10-15\times.386+6\times.386^2)}{15}\times\frac{380\times10.83\times28.08}{2} + \frac{.614^2(4-3\times.614)}{12}\times380\times17.25\times28.08$$

$$+ \frac{.614^2(5-3\times.614)}{30}\times\frac{1380\times17.25\times28.08}{2} = 29.00$$

Stiffness Coefficient

Member	depth	depth³	length	d³/l	K
AC	21"	9261	337	27.48	1
CD	30"	27000	322.5	83.72	3.1
DE	24"	13824	337	41.02	1.5

Subject Bushnell Park Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** [illegible] **Date** 3-Mar-44



End Shears & Pos. Mom.

Member AC

$$H_C = \frac{1440 \times 19.17 \times 21.63}{2 \times 28.08} + \frac{45{,}540}{28.08} = 12250^{\#}$$

$$H_A = \frac{1440 \times 19.17 \times 6.45}{2 \times 28.08} - \frac{45540}{28.08} = 1550^{\#}$$

x_0 $\quad 1550 = 75\frac{x^2}{2} \quad x = 6.42 \quad x_0 = 15.33$ from A

$$M = 1550 \times 15.33 - \frac{75 \times 6.42 \times 6.42 \times 6.42}{2 \times 3} = 20{,}450^{\prime\#}$$

Member CD

$$V_C = 745 \times 13.44 - \frac{18{,}070}{26.88} = 9{,}340^{\#}$$

$$V_D = 745 \times 13.44 + \frac{18{,}070}{26.88} = 10{,}684^{\#}$$

$$x_0 = \frac{9340}{745} = 12.5 \text{ from C}$$

$$+M = 9340 \times 12.5 - 745 \times \frac{12.5^2}{2} - 45{,}300 = 13250^{\prime\#}$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section A-A
Computed by: H.E.W. Checked by: F.L.K. Date: 3 Mar. 44

End Shears & Pos. Mom. (cont.)

Member DE.

$$H_E = \frac{380\times10.83\times20.86}{2\times28.08} + \frac{17.25\times380\times8.62}{28.08} + \frac{1380\times17.25\times5.75}{2\times28.08} - \frac{63,370}{28.08} = 3860^{\#}$$

$$H_D = \frac{380\times10.83\times7.22}{2\times28.08} + \frac{17.25\times380\times19.46}{28.08} + \frac{1380\times17.25\times22.33}{2\times28.08} + \frac{63,370}{28.08} = 16,650^{\#}$$

$$x_0 \quad 3860 - 2060 - 380x - \frac{80x^2}{2} = 0 \qquad x_0 = 14.3' \text{ from } E$$

$$+M = 3860\times14.3 - \frac{380\times10.83\times7.06}{2} - 380\times4.45\times1.7 - \frac{4.45\times80\times4.45^2}{2\times3} = 36,600^{'\#}$$

Design of Members

Member AC

$$-M \text{ at top of slab} = 45,300 - \left(\frac{12250\times10,500}{2}\right)\times\frac{2.5}{3} = 35,840^{'\#}$$

$$\text{Shear at top of slab} = 12250 - \left(1440 - \frac{75\times1.25}{2}\right)\times1.25 = 10,500^{\#}$$

$$\text{req'd } d = \sqrt{\frac{35840}{139}} = 16.1'' < 17.5'' \text{ OK}$$

$$v = \frac{10,500}{12\times.88\times17.5} = 56^{\#}/\square'' \text{ OK}$$

$$-A_s = \frac{35840\times12}{20,000\times.88\times17.5} = 1.40^{\square''} \quad \text{Try } 1''\phi \text{ @ } 6''cc$$

$$u_0 = \frac{10,500}{6.28\times.88\times17.5} = 107^{\#}/\square'' \text{ OK}$$

$$+A_s = \frac{20,450\times12}{20,000\times.89\times18.5} = .75^{\square''} \quad \text{Use } 3/4''\phi \text{ @ } 6''cc$$

$$M_0 = 45300 - 12,250x + (1440 - 75x)\frac{x^2}{2} + \frac{75x^3}{3} \qquad x = 5.1'$$

Member CD

left. side
- M at face of wall $= 45300 - \frac{9340+8690}{2}\times\frac{1.75}{3} = 40,040^{\#}$
- Shear at face of wall $= 9340 - \frac{1.75}{2}\times745 = 8690^{\#}$

$$\text{req'd } d = \sqrt{\frac{56510}{139}} = 20.1'' \quad \text{OK use } 20.5'' \text{ for } d$$

$$v = \frac{8690}{12\times.89\times20.5} = 40^{\#}/\square''$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section A-A
Computed by: H.E.W. Checked by: [illegible] Date: 3-Mar-44

Member CD (cont.)

$-A_s = \frac{40,040 \times 12}{20,000 \times .88 \times 20.5} = 1.33$ □" 1"φ @ 6"cc OK

$+A_s = \frac{13250 \times 12}{20,000 \times .89 \times 20.5} = .44$ □" Use $\frac{3}{4}$"φ @ 12"cc

M_o left side $45,300 - 9340x + 745\frac{x^2}{2}$ $x = 6.5$ ft.

right side { M at face of wall $= 63370 - \frac{(10680 + 9840)}{2}\frac{(2.0)}{3} = 56510$ '#
Shear at face of wall $= 10,680 - 745 \times \frac{2.0}{2} = 9840$ #

$-A_s = \frac{56,510 \times 12}{20,000 \times .88 \times 20.5} = 1.88$ □" 1"φ @ 12"cc } alt.
1"□ @ 12"cc }

$u_o = \frac{9840}{8.0 \times .88 \times 20.5} = 68$ #/□"

M_o right side $63370 - 10,684x + 745\frac{x^2}{2}$ $x = 8.4$ ft.

Member DE

$-M$ at top of slab $= 63,370 - \frac{(16650 + 14500)}{2}\frac{2.5}{3} = 50,420$ '#

shear at top of slab $= 16650 - \left(1760 - 80 \times \frac{1.25}{2}\right)(1.25) = 14500$ #

reqd $d = \sqrt{\frac{48550}{139}} = 19.0" < 20.5"$ OK

$v = \frac{14,500}{12 \times .89 \times 20.5} = 66$ #/□" OK

$-A_s = \frac{50,420 \times 12}{20,000 \times .88 \times 20.5} = 1.68$ □" 1"□ @ 12"cc OK

$u_o = \frac{14500}{8.0 \times .88 \times 20.5} = 100$ #/□" OK

$+A_s = \frac{36,600 \times 12}{20,000 \times .89 \times 21.5} = 1.16$ □" Use $\frac{7}{8}$"φ @ 6"cc

$M_o = 63370 - 16650x + (1760 - 80x)\frac{x^2}{2} + 80\frac{x^3}{3}$ $x = 4.9'$

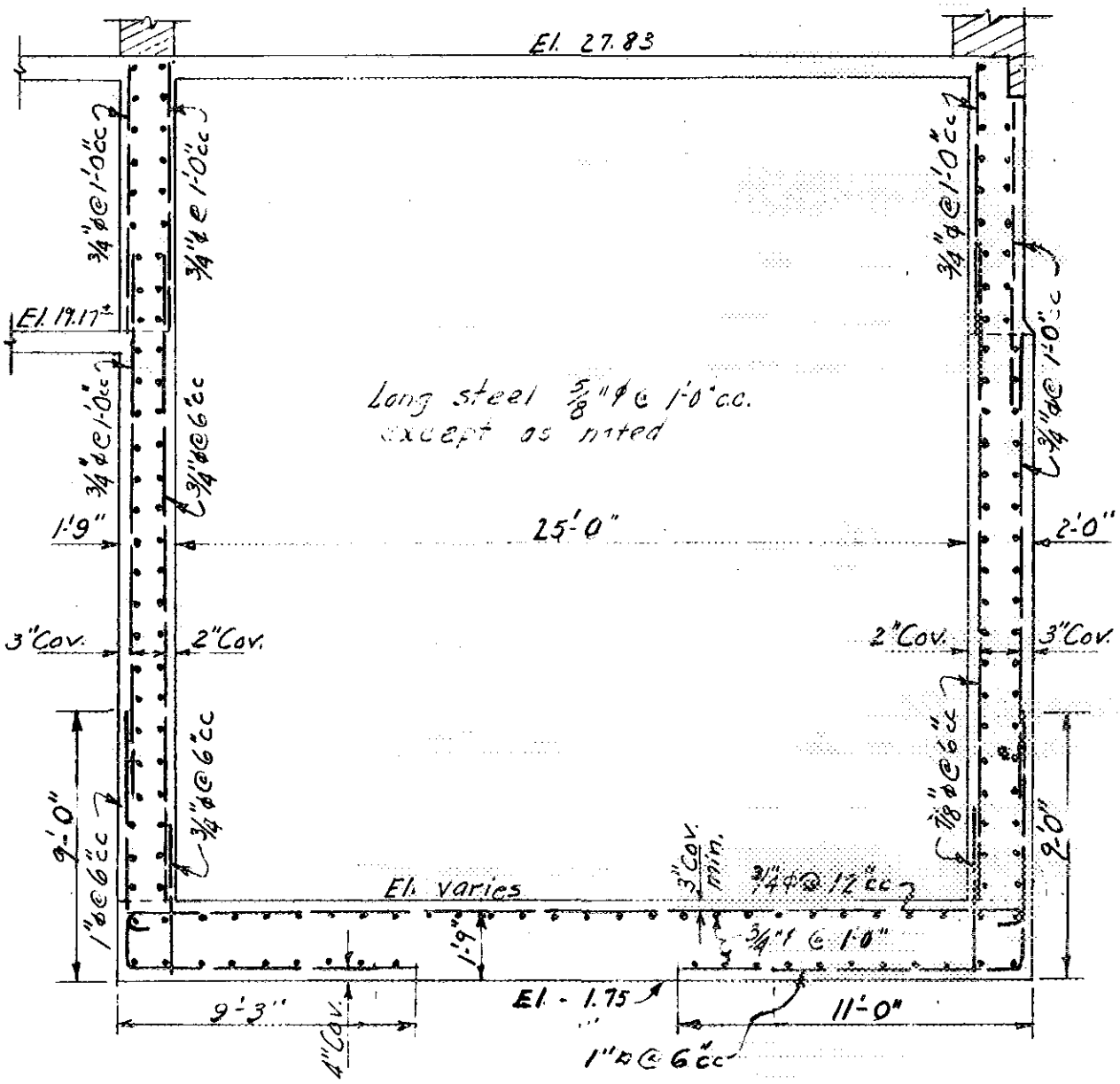
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Transverse Section - A-A

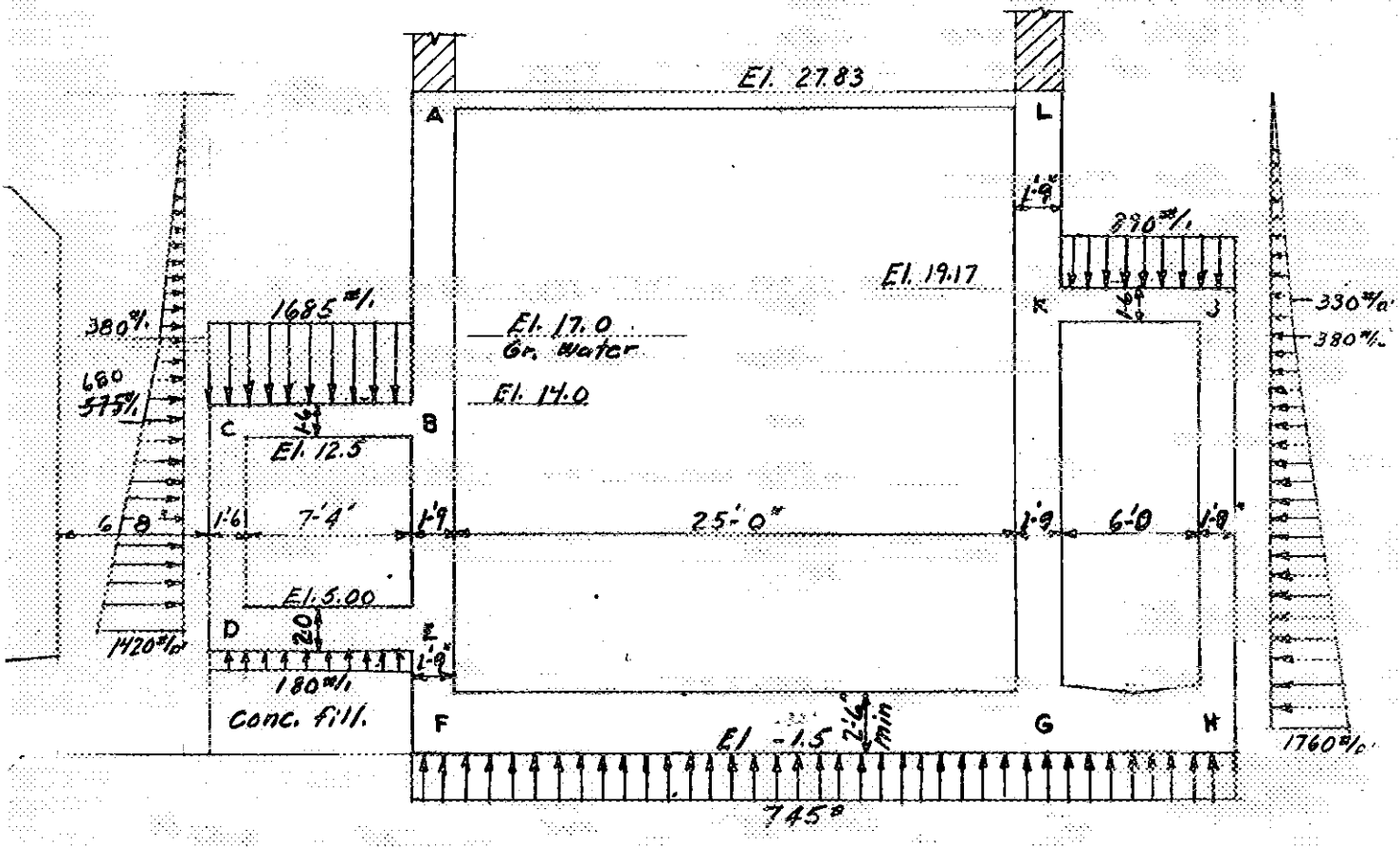
Computed by H.E.W. **Checked by** A.L.K. **Date** 3-Mar-44



Section A-A

Scale 3/16" = 1'-0"

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H. E. W. Checked by: [illegible] Date: 4-Mar-44



Section B-B
Scale 1/8" = 1'-0"

Case I Section will be investigated as a continuous frame with both conduits empty and ground water at El. 17.00. The base slab will be designed for full static pressure. The walls will be considered simply supported at top.

Loading Assumptions

Center of intake roof slab 9.41 x 35 = 330#/'
Ground water elev. 10.83 x 35 = 380#/'
Center of base slab 17.25 x 80 + 380 = 1760#/'
Center of discharge roof slab ~~2.42~~ 3.72 x 80 + 380 = ~~575~~ 680#/'
center of discharge base slab 13 x 80 + 380 = 1420#/'
Wt. earth on intake roof slab 8.66 x 100 + 1.5 x 150 = 890#/'
Wt. earth on discharge roof slab 13.83 x 100 + 3 x 25 + 1.5 x 150 = 1685#/'
Static pressure on pump room base = 745#/' net (see Sect. A-A)

Subject Bushnell Park Pumping Station
Computation Transverse Section - B-B
Computed by H. E. W. **Checked by** [illegible] **Date** 6 - Mar. 41

Load Assumptions (cont.)

Base Pres. on discharge conduit

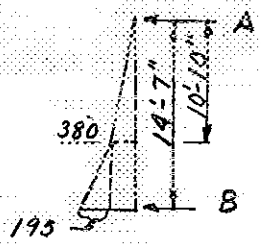
Static Pressure = $18.5 \times 62.5 = 1156$ #/□'

Wt. of base = $6.5 \times 150 = 975$

181 Say 180 #/□'

Fixed End Moments

Member AB



$$M^F_{AB} = \frac{.743(10 - 15 \times .743 + 6 \times .743^2)}{15} \times 380 \times \frac{10.83 \times 14.58}{2} + \frac{.257^2(4 - 3 \times .257)}{12} \times 380 \times \frac{3.75 \times 14.58}{2} + \frac{.257^2(5 - 3 \times .257)}{30} \times 195 \times \frac{3.75 \times 14.58}{2}$$

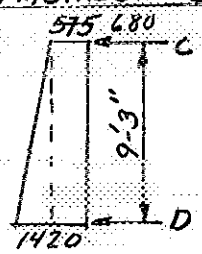
$$= 3.64^{'K}$$

$$M^F_{BA} = \frac{.743^2(5 - 4 \times .743)}{10} \times \frac{380 \times 10.83 \times 14.58}{2} + \frac{.257(6 - 8 \times .257 + 3 \times .257^2)}{12} \times 380 \times \frac{3.75 \times 14.58}{2} + \frac{.257(10 - 10 \times .257 + 3 \times .257^2)}{30} \times \frac{195 \times 3.75 \times 14.58}{2} = 5.55^{'K}$$

Member BC

$$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1685 \times 8.95^2 = 11.25^{'K}$$

Member CD



$$M^F_{CD} = \frac{1}{12} \times \overset{680}{\cancel{575}} \times 9.25^2 + \frac{1}{15} \times \overset{740}{\cancel{845}} \times \frac{9.25 \times 9.25}{2} = \cancel{6.51}\ 6.97^{'K}$$

$$M^F_{DC} = \frac{1}{12} \times \overset{680}{\cancel{575}} \times 9.25^2 + \frac{1}{10} \times \overset{740}{\cancel{845}} \times \frac{9.25^2}{2} = \cancel{7.72}\ 8.00^{'K}$$

Note. Error is not appreciable and will be neglected

Member DE

$$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 180 \times 8.95^2 = 1.20^{'K}$$

Member FG

$$M^F_{FG} = M^F_{GF} = \frac{1}{12} \times 745 \times 26.75^2 = 44.42$$

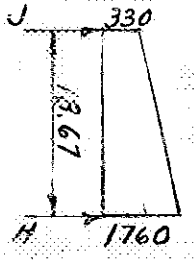
Member GH

$$M^F_{GH} = M^F_{HG} = \frac{1}{12} \times 745 \times 7.75^2 = 3.73^{'K}$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section H-H
Computed by: H.E.W. Checked by: Date: 6 Mar 44

Fixed End Moments (cont.)

Member HJ



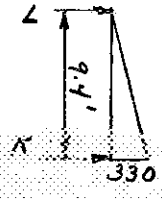
$$M^F_{HJ} = \frac{1}{12} \times 330 \times 18.67^2 + \frac{1}{10} \times 1430 \times \frac{18.67^2}{2} = 34.51^{'K}$$

$$M^F_{JH} = \frac{1}{12} \times 330 \times 18.67^2 + \frac{1}{15} \times 1430 \times \frac{18.67^2}{2} = 26.21^{'K}$$

Member KJ

$$M^F_{KJ} = M^F_{JK} = \frac{1}{12} \times 890 \times 7.75^2 = 4.45$$

Member LK



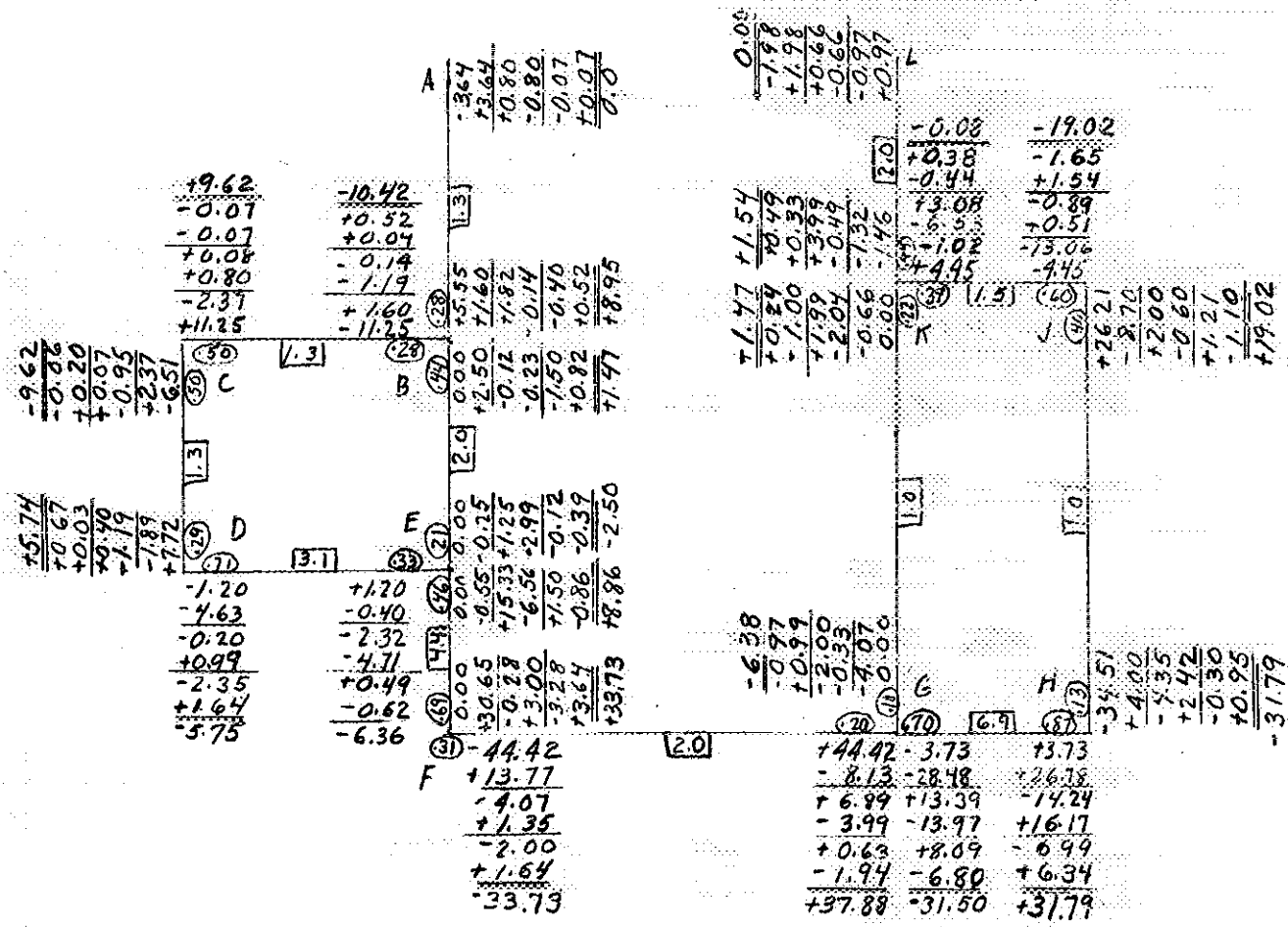
$$M^F_{LK} = \frac{1}{15} \times \frac{330 \times 9.4^2}{2} = 0.97^{'K}$$

$$M^F_{KL} = \frac{1}{10} \times \frac{330 \times 9.4^2}{2} = 1.46^{'K}$$

Stiffness Factors

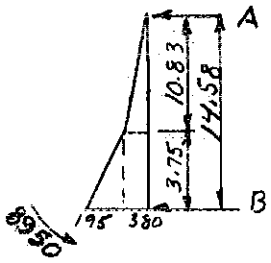
Member	d	d^3	L	d^3/L	K
AB	21"	9261	175	52.92	1.3
BC	18"	5832	107.5	54.25	1.3
CD	18"	5832	111	52.54	1.3
DE	24"	13824	107.5	128.60	3.1
EB	21"	9261	111	83.43	2.0
EF	21"	9261	51	181.59	4.4
FG	30"	27000	321	84.11	2.0
GH	30"	27000	93	290.32	6.9
HJ	21"	9261	224	41.34	1.0
JK	18"	5832	93	62.71	1.5
KG	21"	9261	224	41.34	1.0
KL	21	9261	113	81.95	2.0

Subject Bushnell Park Pumping Station
Computation Transverse Section D-D
Computed by H.E.W. **Checked by** [illegible] **Date** 7- Mar 41



End Reactions and Positive Moments

Member AB

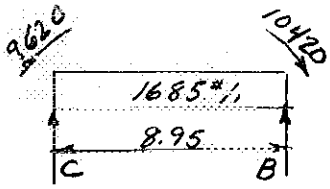


$$H_A = 380 \times 10.83 \times .5 \times .505 + 380 \times 3.75 \times .129 + 195 \times 3.75 \times .5 \times .086 - \frac{8950}{14.58} = 650^{\#}$$

$$H_B = 380 \times 10.83 \times .5 \times .495 + 380 \times 3.75 \times .871 + 195 \times 3.75 \times .5 \times .914 + \frac{8950}{14.58} = 3200^{\#}$$

$x_0 = 6.1$ from A

$$+M = 650 \times 6.1 - 6.1 \times 35 \times \frac{6.1^2}{3} \times .5 = 2640^{'\#}$$



$$V_C = 1685 \times 8.95 \times .5 - \frac{800}{8.95} = 7430^{\#}$$

$$V_B = 1685 \times 8.95 \times .5 + \frac{800}{8.95} = 7650^{\#}$$

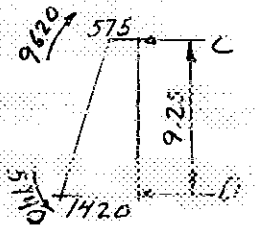
$x_0 = 4.42$ from C

$$+M = 7440 \times 4.42 - 9620 - 1685 \times \frac{4.42^2}{2} = 6810^{'\#}$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-E
Computed by: H. E. W. Checked by: [illegible] Date: 7 Mar 41

End Reactions and Pos. Moments (cont.)

Member CD



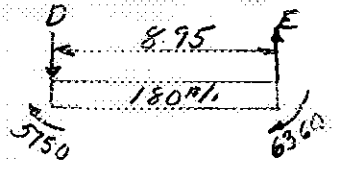
$H_C = 575 \times 9.25 \times .5 + 845 \times 9.25 \times .5 \times .33 + \frac{3880}{9.25} = 4380$

$H_D = 575 \times 9.25 \times .5 + 845 \times 9.25 \times .5 \times .67 - \frac{3880}{9.25} = 4840^{\#}$

$x_0 = 4380 - 575x - 80\frac{x^2}{2} = 0 \qquad x_0 = 5.51$ from C

$+M = 4370 \times 5.51 - 9620 - 575 \times \frac{5.51^2}{2} - 5.51 \times 80 \times \frac{5.51^2}{2 \times 3} = 3500'^{\#}$

Member DE

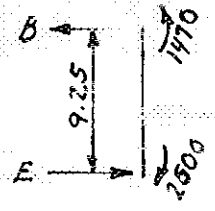


$V_D = 180 \times 8.95 \times .5 + \frac{12110}{8.95} = 2160$

$V_E = 180 \times 8.95 \times .5 - \frac{12110}{8.95} = -550$

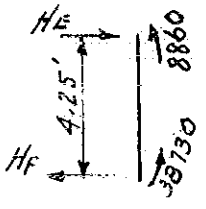
Max +M at E

Member BE



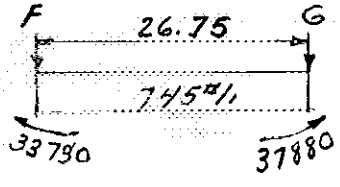
$H_B = H_E = \frac{2500 - 1470}{9.25} = 110^{\#}$

Member EF



$H_E = H_F = \frac{33730 + 8860}{4.25} = 10{,}020^{\#}$

Member FG



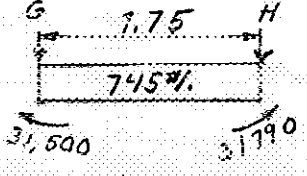
$V_F = 745 \times 26.75 \times .5 - \frac{4150}{26.75} = 9810^{\#}$

$V_G = 745 \times 26.75 \times .5 + \frac{4150}{26.75} = 10120^{\#}$

$x_0 = 13.17$ from F

$+M = 9810 \times 13.17 - 33730 - 745 \times \frac{13.17^2}{2} = 30{,}850'^{\#}$

Member GH



$V_G = 745 \times 7.75 \times .5 - \frac{290}{7.75} = 2850^{\#}$

$V_H = 745 \times 7.75 \times .5 + \frac{290}{7.75} = 2920^{\#}$

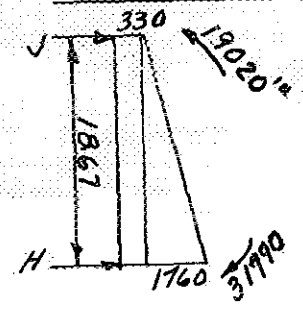
$x_0 = 3.83$ from G

$+M = 2850 \times 3.83 - 31{,}500 - 745 \times \frac{3.83^2}{2} = -26{,}050'^{\#}$ No pos. M.

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L. Date: 7 Mar. 44

End Reactions & Pos. M (cont.)

Member JH



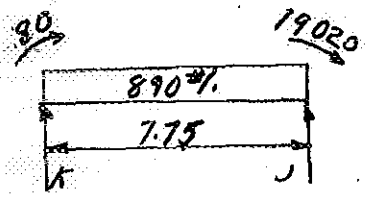
$H_J = 330 \times 18.67 \times .5 + 1430 \times 18.67 \times .33 \times .5 - \frac{12770}{18.67} = 6780^{\#}$

$H_H = 330 \times 18.67 \times .5 + 1430 \times 18.67 \times .67 \times .5 + \frac{12770}{18.67} = 12730^{\#}$

$x_0 = 9.7$ from J

$+M = 6780 \times 9.7 - 19{,}020 - 330 \times \frac{9.7^2}{2} - 750 \times \frac{9.7^2}{6} = 19170^{\#}$

Member KJ



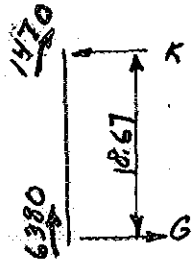
$V_K = 890 \times \frac{7.75}{2} - \frac{19100}{7.75} = 980^{\#}$

$V_J = 890 \times \frac{7.75}{2} + \frac{19100}{7.75} = 5920^{\#}$

$x_0 = 1.10'$ from K

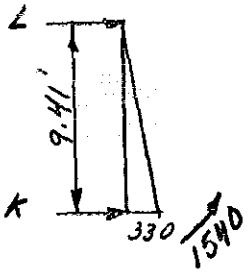
$+M = 980 \times 1.10 + 80 - 890 \times \frac{1.1^2}{2} = 660$ '#

Member KG



$H_K = \frac{7850}{18.67} = 420^{\#} = V_G$

Member KL



$H_L = 330 \times 9.41 \times .5 \times .33 + \frac{1540}{9.41} = 680^{\#}$

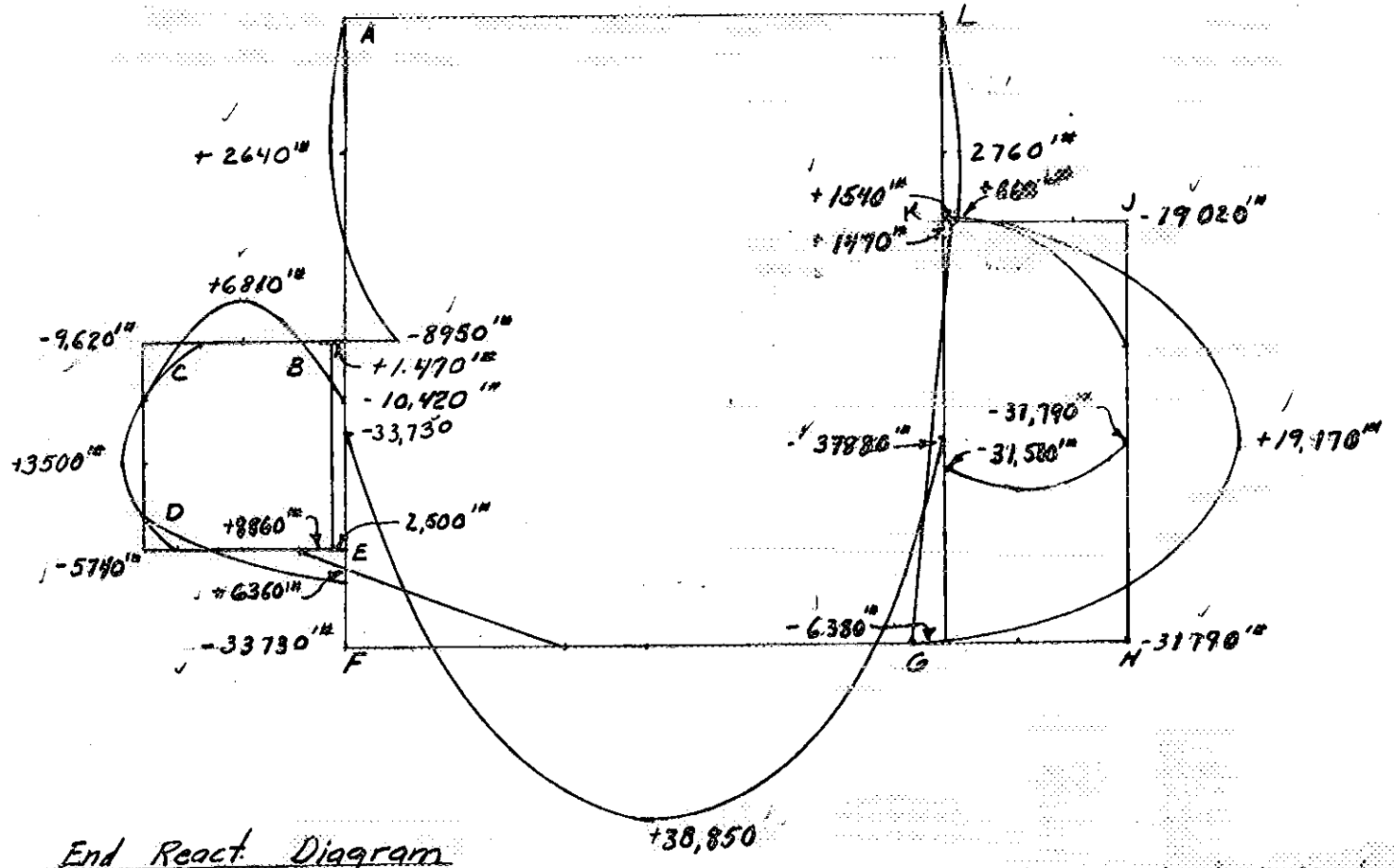
$H_K = 330 \times 9.41 \times .5 \times .67 - \frac{1540}{9.41} = 870$

$x_0 = 6.2'$ from L

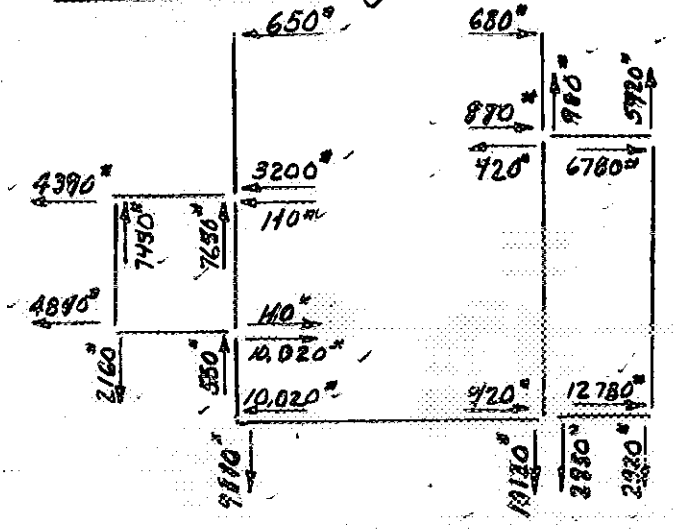
$+M = 870 \times 6.2 - 217 \times \frac{6.2^2}{6} = 2760$ '#

Subject: Bushnell Park Pumping Station
Computation: Transverse Section "B-B"
Computed by: H.E.W. Checked by: M.K. Date: 7 Mar-44

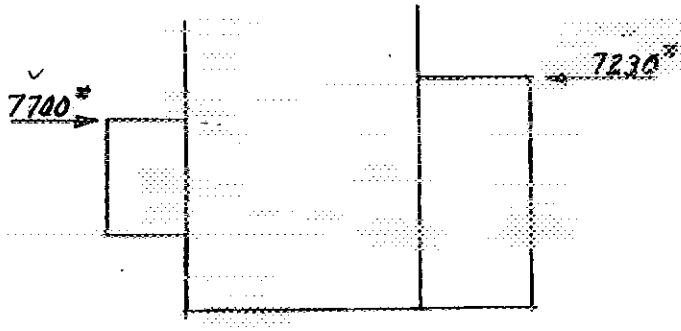
Moment Diagram Case I - No Joint Deflection



End React. Diagram



Forces Producing Joint Deflection



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Transverse Section B-B

Computed by H. E. W. **Checked by** L. K. **Date** 7- Mar. 44

Deflection of Joint C & B

Assume joints C & B will deflect to the right .01 inch. Joints D & E will not deflect inward due to the large force at E pushing the joints outward. It is assumed no deflection outward will take place as any such tendancy will be resisted by the soil.

Member AB

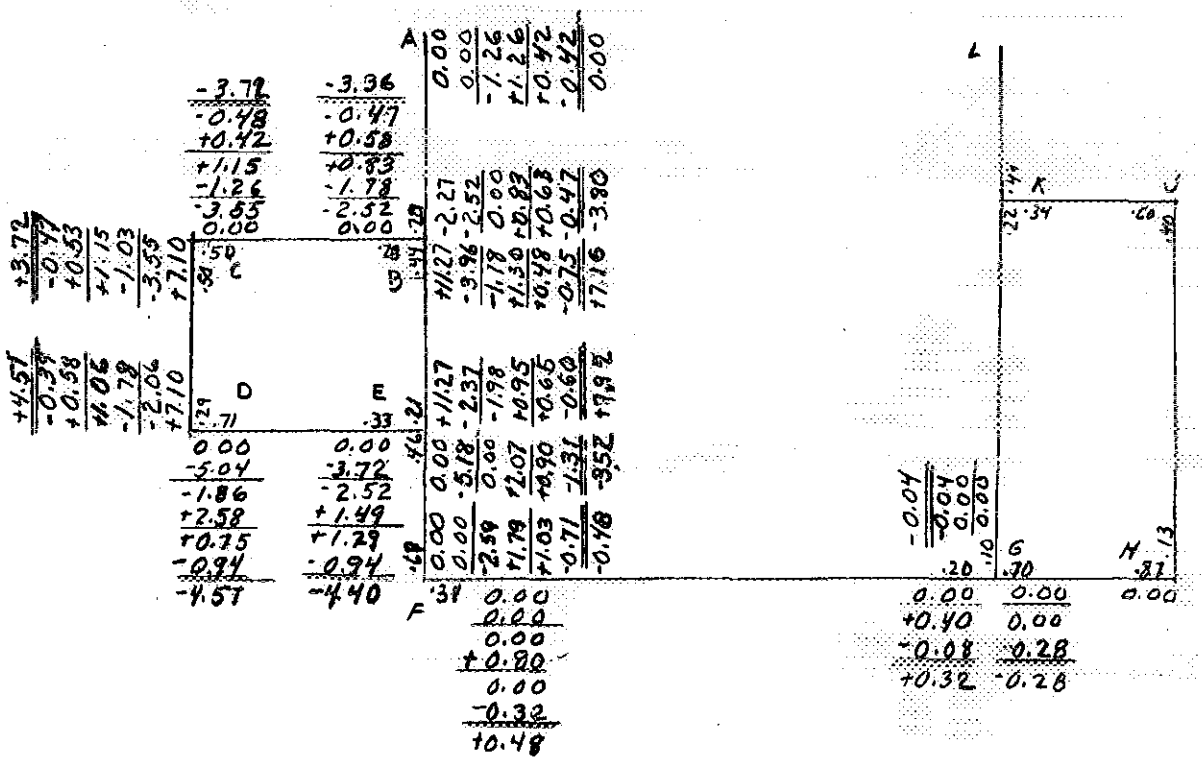
$$M = \frac{3 \times 3{,}000{,}000 \times 9261 \times .01}{175 \times 175 \times 12 \times 1000} = 2.27^{'K}.$$

Member CD

$$M = \frac{6 \times 3{,}000{,}000 \times 5832 \times .01}{111 \times 111 \times 12 \times 1000} = 7.10^{'K}$$

Member BE

$$M = \frac{6 \times 3{,}000{,}000 \times 9261 \times .01}{111 \times 111 \times 12 \times 1000} = 11.27^{'K}$$



Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H. E. W. Checked by: A.F. Date: 8-Mar-44

Deflection of Joints C & B (cont.)

Member AB – $H_B = \frac{3800}{14.58} = 261^{\#} \rightarrow$

Member BE $H_B = \frac{15080}{9.25} = 1630^{\#} \rightarrow$

Member CD $H_C = \frac{8230}{9.25} = \frac{890^{\#}}{2781^{\#}} \rightarrow$

Moment Multiplier $= \frac{7700}{2781} = 2.77$

Member	Trial Mom	Mult.	Moment.
AB @ A	0.00	2.77	0.00
@ B	-3.80	"	-10 530
BC @ B	-3.36	"	-9 310
@ C	-3.72	"	-10,300
CD @ C	+3.72	"	+10 300
@ D	+4.51	"	+12,490
DE @ D	-4.51	"	-12490
@ E	-4.40	"	-12190
BE @ B	+7.16	"	+19,830
@ E	+7.92	"	+21940
EF @ E	-3.52	"	-9750
@ F	-0.48	"	-1 330
FG @ F	+0.48	"	+1 330
@ G	+0.32	"	+ 890
GH @ G	-0.28	"	- 780
@ H	0.00	"	0
HJ @ H	0.00	"	0
@ J	0.00	"	0
JK @ J	0.00	"	0
@ K	0.00	"	0
KG @ K	0.00	"	0
@ G	-0.04	"	-110
KL @ K	0.00	"	0
@ L	0.00	"	0

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: Bushnelt Park Pumping Station

Computation: Transverse Section B-B

Computed by: H.E.W. Checked by: A.L.K. Date: 8-Mar. 49

Deflection of Joints K & J

Assume .01 inch deflection of K & J inward and solve for the moment it produces

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: Bushnelt Park Pumping Station

Computation: Transverse Section B-B

Member LK

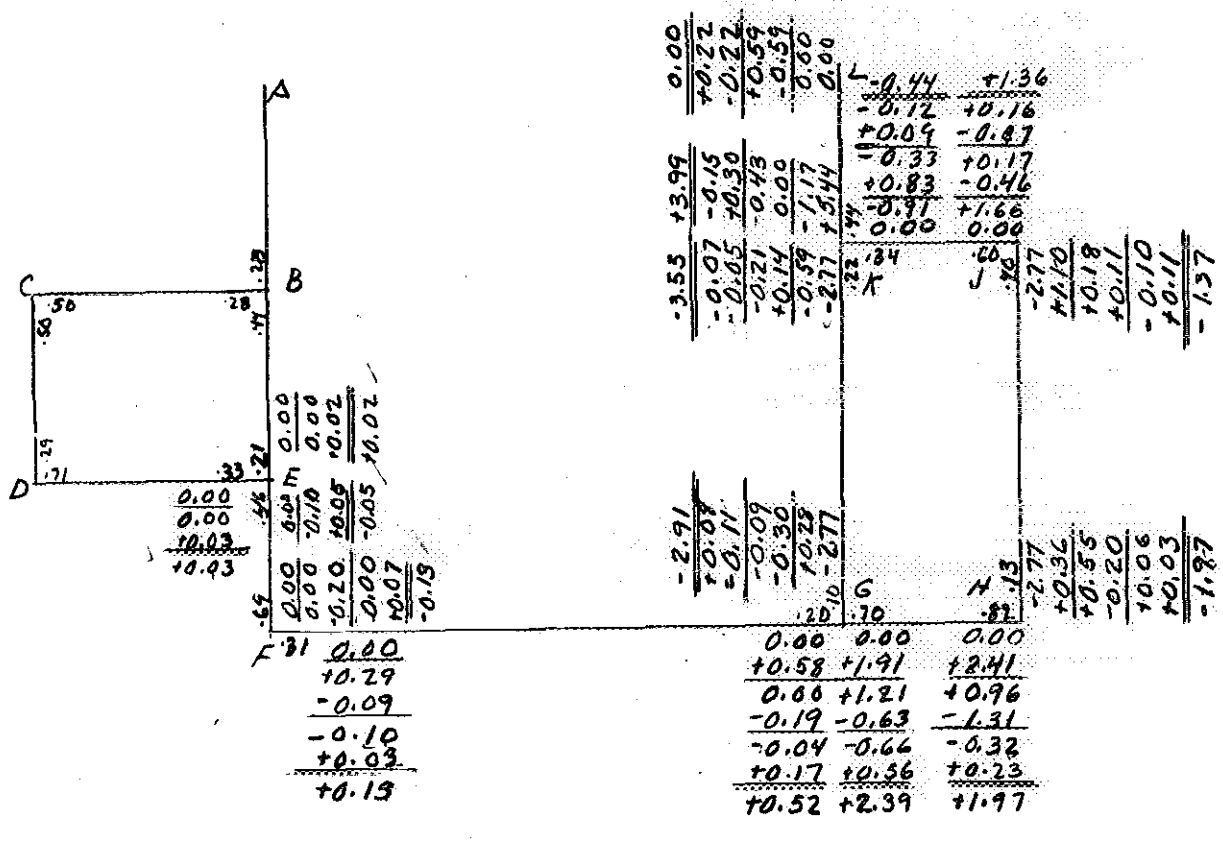
$$M = \frac{3 \times 3{,}000{,}000 \times 9261 \times .01}{113 \times 113 \times 12 \times 1000} = 5.44^{'K}$$

Member KG

$$M = \frac{6 \times 3{,}000{,}000 \times 9261 \times .01}{224 \times 224 \times 12 \times 1000} = 2.77^{'K}$$

Member JH

$$M = \frac{6 \times 3{,}000{,}000 \times 9261 \times .01}{224 \times 224 \times 12 \times .1000} = 2.77^{'K}$$



Subject: Bushnell Park Pumping Station
Computation: Transverse Section D-D
Computed by: H.E.W. Checked by: A.L.K. Date: 5 Mar. 44

Deflection of Joints C + B (cont.)

Member KL $H_K = \frac{2990}{7.41} = 424$

Member KG $H_K = \frac{6460}{18.67} = 346$

Member JH $H_J = \frac{3340}{18.67} = \frac{179}{949}$ *

Moment Multiplier $= \frac{7230}{949} = 7.62$

Member	Trial Mom.	Mult.	Mom.
AB @ A	0.00	7.62	0
@ B	0.00	"	0
BC @ B	0.00	"	0
@ C	0.00	"	0
CD @ C	0.00	"	0
@ D	0.00	"	0
DE @ D	0.00	"	0
@ E	+0.03	"	+230 '#
BE @ B	0.00	"	0
@ E	+0.02	"	+150 '#
EF @ E	-0.05	"	-380 '#
@ F	-0.13	"	-990 '#
FG @ F	+0.13	"	+990 '#
@ G	+0.52	"	+3960 '#
GH @ G	+2.39	"	+18,210 '#
@ H	+1.97	"	+15010 '#
HJ @ H	-1.97	"	-15010 '#
J	-1.37	"	-10440 '#
JK @ J	+1.36	"	+10440 '#
@ K	-0.44	"	-3350 '#
KG @ K	-3.55	"	-27,050 '#
@ G	-2.91	"	-22,170 '#
KL @ K	+3.99	"	+30,400 '#
@ L	0.00	"	0

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.K. Date: 9-Mar-44

Joint Deflection (cont.)

Member	Mom from →	Mom from ←	Combined M
AB @ A	0	0	0
@ B	-10530	0	-10530
BC @ B	-9310	0	-9310
@ C	-10300	0	-10,300
CD @ C	+10300	0	+10,300
@ D	+12490	0	+12490
DE @ D	-12490	0	-12490
@ E	-12190	+230	-11960
BE @ B	+19830	0	+19830
@ E	+21940	+150	+22090
EF @ E	-9750	-380	-10130
@ F	-1,330	-990	-2320
FG @ F	+1330	+990	+2320
@ G	+890	+3960	+4850
GH @ G	-780	+18210	+17,430
@ H	0	+15010	+15010
HJ @ H	0	-15010	-15,010
@ J	0	-10440	-10,440
JK @ J	0	+10440	+10,440
@ K	0	-3350	-3350
KG @ K	0	-27,050	-27,050
@ G	-110	-22170	-22,280
KL @ K	0	+30,400	+30,400
@ L	0	0	0

Reactions

Member AB — $H_A = \frac{10530}{14.58} = 720^{\#} \leftarrow$ $H_B = 720^{\#} \rightarrow$

Member BC $V_B = \frac{19610}{8.95} = 2190^{\#} \uparrow$ $V_C = 2190^{\#} \downarrow$

Member CD $H_C = \frac{22790}{9.25}$ $H_C = 2460^{\#} \rightarrow$ $H_D = 2460^{\#} \leftarrow$

Member DE $V_D = \frac{24450}{8.95} = 2730^{\#} \downarrow$ $V_E = 2730^{\#} \uparrow$

Member BE $H_B = \frac{41920}{9.25} = 4530^{\#} \rightarrow$ $H_E = 4530^{\#} \leftarrow$

Member EF $H_E = \frac{12450}{4.25} = 2940^{\#} \leftarrow$ $H_F = 2940^{\#} \rightarrow$

Member FG V_F $\frac{7170}{26.75} = 270^{\#} \uparrow$ $V_G = 270^{\#} \downarrow$

Subject Bushnell Park Pumping Station
Computation Transverse Section B-B
Computed by H. E. W **Checked by** A. L. K. **Date** 9 Mar - 44

Joint Deflection (cont.)

Member GH $V_G = \frac{32440}{7.75} = 4190^{\#} \uparrow$ $V_H = 4190^{\#} \downarrow$

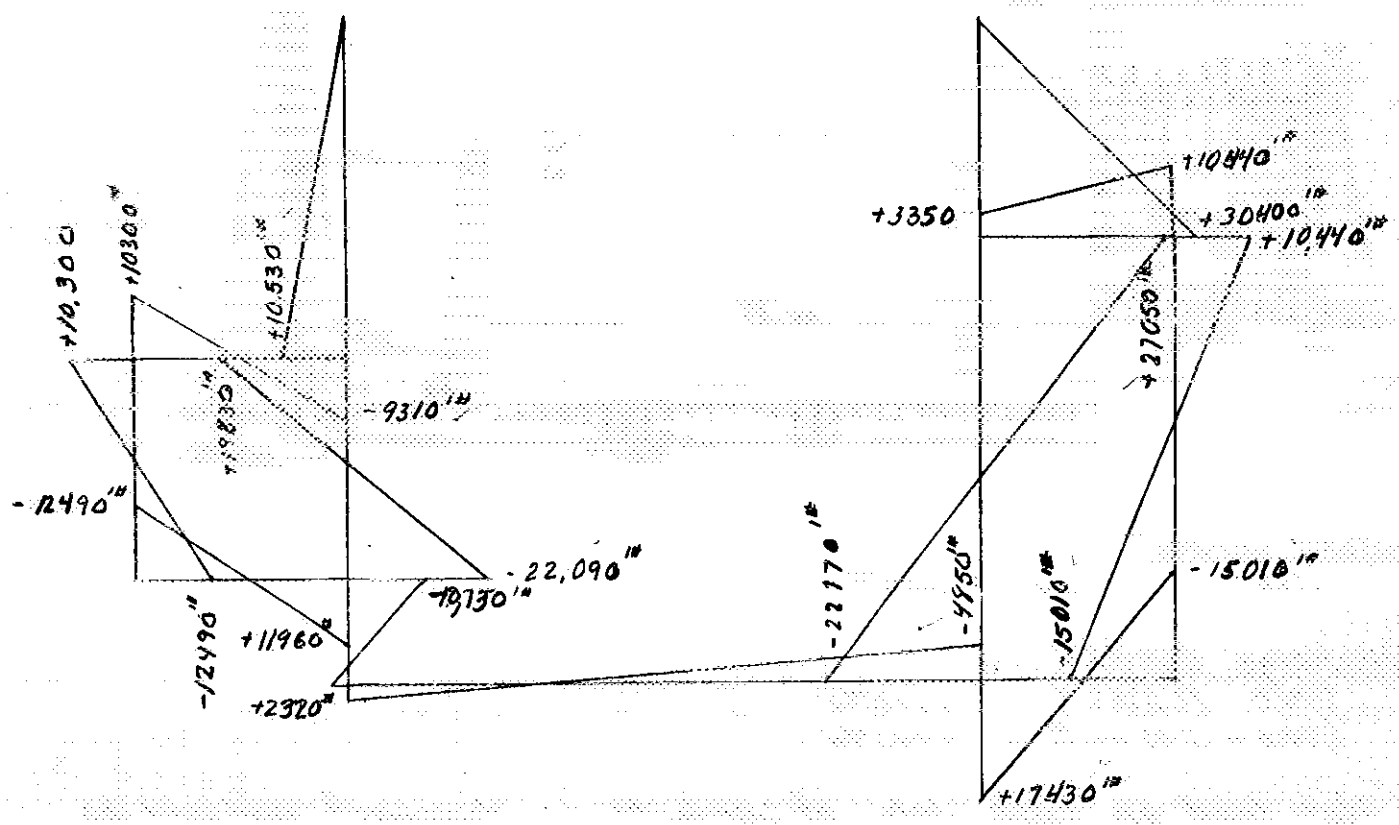
Member HJ $H_H = \frac{25450}{18.67} = 1360^{\#} \rightarrow$ $H_J = 1360^{\#} \leftarrow$

Member JK $V_J = \frac{7090}{7.75} = 910^{\#} \downarrow$ $V_K = 910^{\#} \uparrow$

Member KG $H_K = \frac{49330}{18.67} = 2640^{\#} \leftarrow$ $H_G = 2640^{\#} \rightarrow$

Member KL $H_K = \frac{30400}{9.41} = 3230^{\#} \leftarrow$ $H_L = 3230^{\#} \rightarrow$

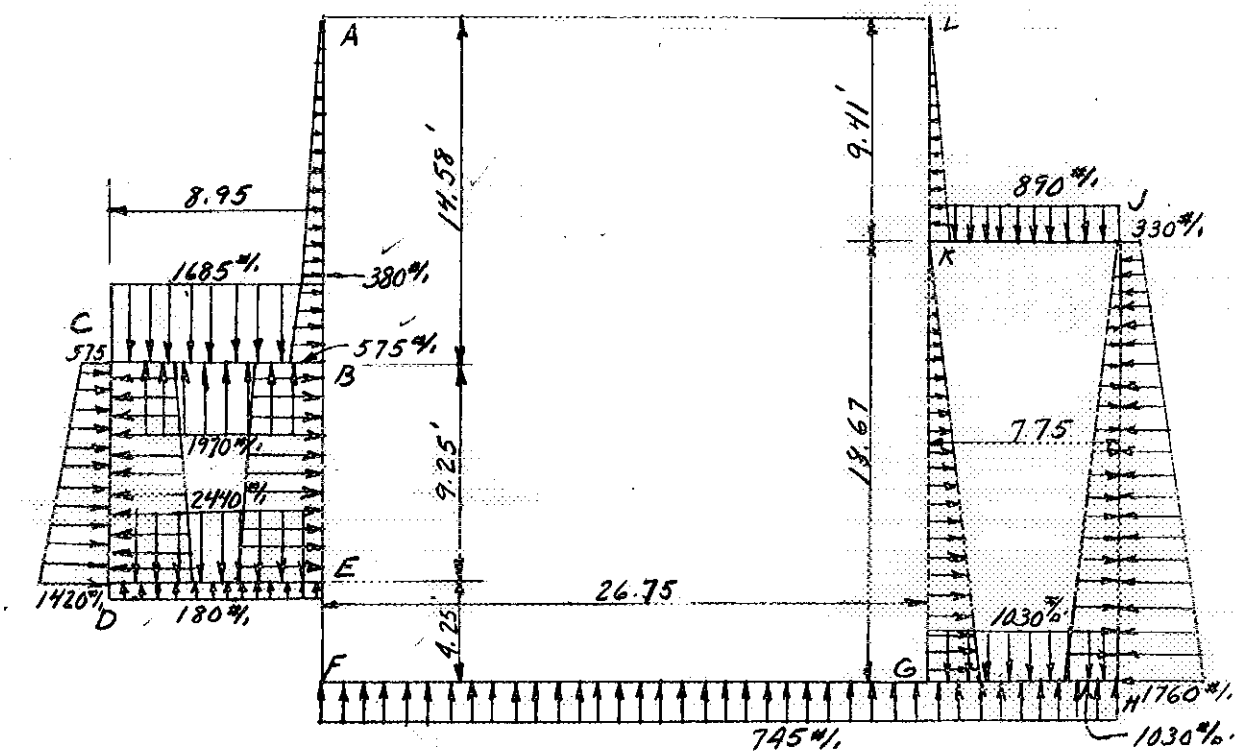
Bending Moment Diagram due to Joint Deflection



Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.K. Date: 4 Mar-44

Section B-B Case II

Section B-B will be reinvestigated with the same external loading as Case I and with the Intake Conduit full of water and the Discharge Conduit subjected to bursting pressure when the Park River Conduit has full head to El. 44.0 ft.



Intake conduit
$(17.67 - 1.25)\,62.5 = 1030\#/'$

Discharge Conduit
$(44.0 - 12.5)\,62.5 = 1970\#/'$
$(44.0 - 5.0)\,62.5 = 2440\#/'$

Net load on base slabs of conduits is downward and will be transferred directly into rock foundation

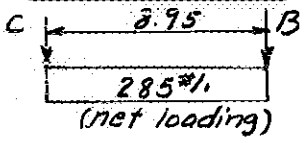
Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.K. Date: 11 Mar 49

Fixed End Moments (Case II cont.)

Member AB

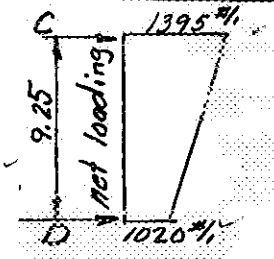
$M^F_{AB} = 3.64^{'K}$ $M^F_{BA} = 5.55^{'K}$ (See Case I)

Member BC



$M^F_{BC} = M^F_{CD} = \frac{1}{12} \times 285 \times 8.95^2 = 1.90^{'K}$

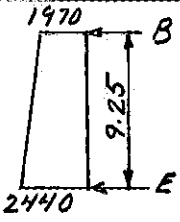
Member CD



$M^F_{DC} = \frac{1}{12} \times 1020 \times 9.25^2 + \frac{1}{18} \times 375 \times \frac{9.25^2}{2} = 8.34^{'K}$

$M^F_{CD} = \frac{1}{12} \times 1020 \times 9.25^2 + \frac{1}{10} \times 375 \times \frac{9.25^2}{2} = 8.87^{'K}$

Member BE



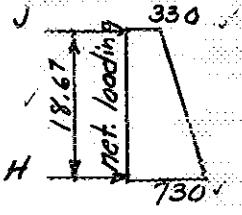
$M^F_{BE} = \frac{1}{12} \times 1970 \times 9.25^2 + \frac{1}{15} \times 470 \times \frac{9.25^2}{2} = 15.39^{'K}$

$M^F_{EB} = \frac{1}{12} \times 1970 \times 9.25^2 + \frac{1}{10} \times 470 \times \frac{9.25^2}{2} = 16.06^{'K}$

Member FG

$M^F_{FG} = M^F_{GF} = 44.42^{'K}$ (see Case I)

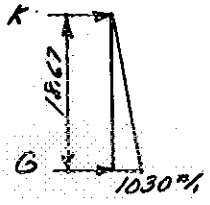
Member HJ



$M^F_{HJ} = \frac{1}{12} \times 330 \times 18.67^2 + \frac{1}{10} \times 400 \times \frac{18.67^2}{2} = 16.55^{'K}$

$M^F_{JH} = \frac{1}{12} \times 330 \times 18.67^2 + \frac{1}{15} \times 400 \times \frac{18.67}{2} = 14.23^{'K}$

Member KG



$M^F_{GK} = \frac{1}{10} \times 1030 \times \frac{18.67^2}{2} = 17.95^{'K}$

$M^F_{KG} = \frac{1}{15} \times 1030 \times \frac{18.67^2}{2} = 11.97^{'K}$.

Subject Bushnell Park Pumping Station

Computation Transverse Section B-B

Computed by H.E.W. **Checked by** A.L.K. **Date** 11-Mar-44

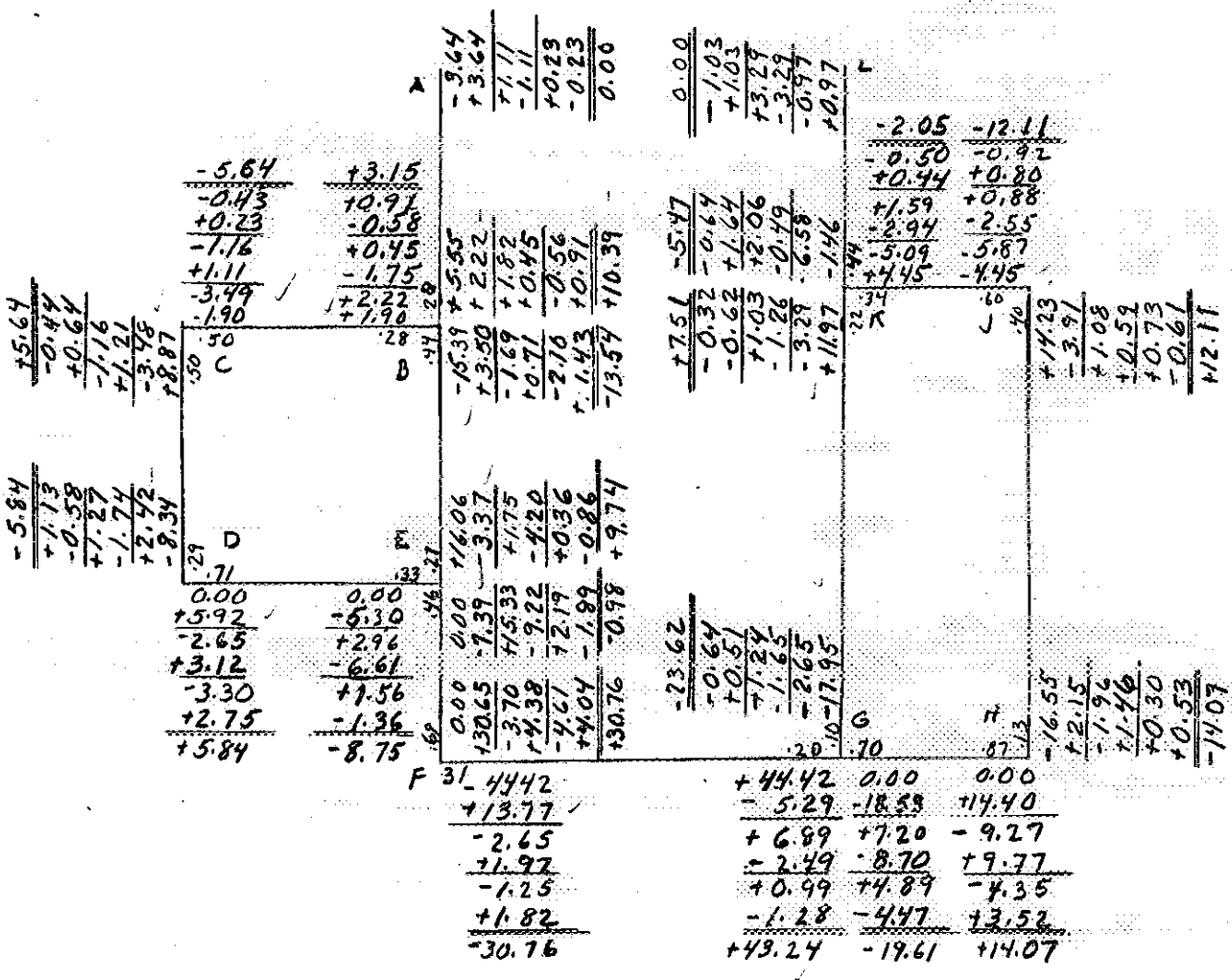
Fixed End Moments (cont.) Case II

Member KJ

$M^F_{KJ} = M^F_{JK} = 4.45^{'K}$ (see Case I)

Member KL

$M^F_{KL} = 1.46$ $M^F_{LK} = 0.97^{'K}$ (see Case I)

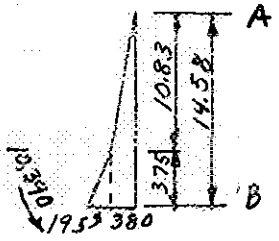


Subject: Bushnell Park Pumping Station
Computation: Transvers Section B-B
Computed by: H. E. W. Checked by: H. L. K. Date: 13-Mar-44

Case II (cont.)

End Reactions - Pos. moments at mid span

Member AB



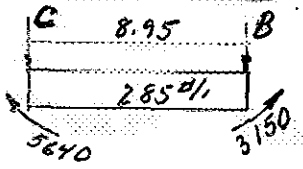
$H_A = 380 \times 10.83 \times .5 \times .505 + 380 \times 3.75 \times .129 + 195 \times 3.75 \times .5 \times .086 - \frac{10,210}{14.58} = 540$

$H_B = 380 \times 10.83 \times .5 \times .495 + 380 \times 3.75 \times .871 + 195 \times 3.75 \times .5 \times .914 + \frac{10,210}{14.58} = 3300$

$x_0 = 5.6'$

$+M = 550 \times 5.6 - 196 \times \frac{5.6^2}{6} = 2060^{\#}$

Member BC



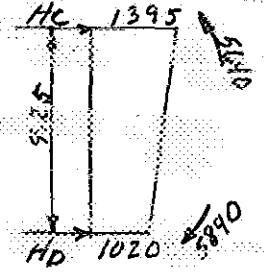
$V_B = 285 \times 8.95 \times .5 - \frac{1490}{8.95} = 1110^{\#}$

$V_C \quad 285 \times 8.95 \times .5 + \frac{1490}{8.95} = 1440^{\#}$

$x_0 = 5.05'$ from C

$+M = 1440 \times 5.05 - 5640 - 285 \times \frac{5.05^2}{2} = -2000$ No +M

Member CD



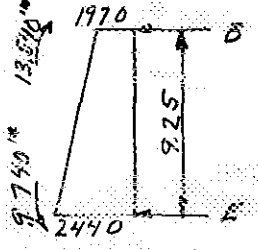
$H_C = 1020 \times 9.25 \times .5 + 375 \times 9.25 \times .5 \times .67 - \frac{200}{9.25} = 5860^{\#}$

$H_D = 1020 \times 9.25 \times .5 + 375 \times 9.25 \times .5 \times .33 + \frac{200}{9.25} = \cancel{5270}^{\#}$ 5320#

$x_0 = 4.8'$ from D

$+M = \cancel{5270}\ 5310 \times 4.8 - 5840 - 1020 \times \frac{4.8^2}{2} - 195 \times \frac{4.8^2}{6} = 6670^{\#}$ 7180

Member BE



$H_B = 1970 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .33 + \frac{3800}{9.25} = 10240^{\#}$

$H_E = 1970 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .67 - \frac{3800}{9.25} = 10,160^{\#}$

$x_0 = \cancel{5.6}\ 4.9'$ from B

$M = 10,240 \times \cancel{5.6}\ 4.9 - 13,540 - 1970 \times \frac{\cancel{5.6}\ 4.9^2}{2} - 285 \times \frac{\cancel{5.6}\ 4.9^2}{6} = 11,430^{\#}$ 11,250

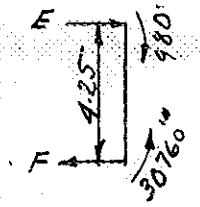
Subject Bushnell Park Pumping Station
Computation Transverse Section B-B
Computed by H. E. W. **Checked by** A.L.K. **Date** 15 Mar. 41

End Reactions & Moments (cont.) Case II

Member DE

$V_D = \frac{2910}{8.95} = 330^{\#} \downarrow \qquad V_E = 330^{\#} \uparrow$

Member EF



$H_E = \frac{29780}{4.25} = 7000^{\#}$

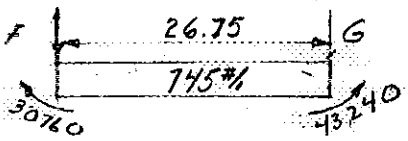
$V_F = 745 \times 26.75 \times .5 - \frac{12480}{26.75} = 9480^{\#}$

$V_G = 745 \times 26.75 \times .5 + \frac{12480}{26.75} = 10{,}430^{\#}$

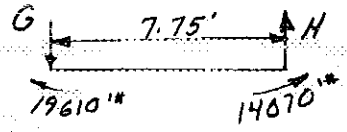
$x = \frac{9480}{745} = 12.7'$

$M = 9480 \times 12.7 - 30{,}760 - 745 \times \frac{12.7^2}{2} = 29{,}560'^{\#}$

Member FG

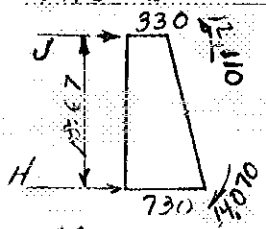


Member GH



$V_G = V_H = \frac{5540}{7.75'} = 710^{\#}$

Member HJ



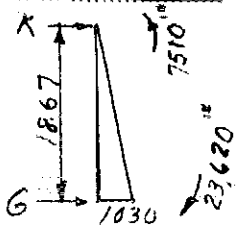
$H_H = 330 \times 18.67 \times .5 + 400 \times 18.67 \times .5 \times .67 + \frac{1960}{18.67} = 5700^{\#}$

$H_J = 330 \times 18.67 \times .5 + 400 \times 18.67 \times .5 \times .33 - \frac{1960}{18.67} = 4200^{\#}$

$x_0 = 9.6'$ from J

$M = 4200 \times 9.6 - 12{,}110 - 330 \times \frac{9.6^2}{2} - 206 \times \frac{9.6^2}{6} = 9840'^{\#}$

Member KG



$H_G = 1030 \times 18.67 \times .5 \times .67 + \frac{16110}{18.67} = 7300^{\#}$

$H_K = 1030 \times 18.67 \times .5 \times .33 - \frac{16110}{18.67} = 2310^{\#}$

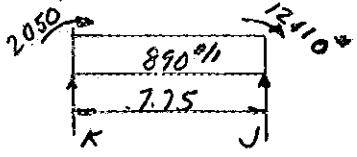
$x_0 = \cancel{9.2}\ 9.6'$ from K

$M = 2310 \times \cancel{9.2}\ 9.6 - 7510 - 506 \times \frac{\cancel{9.2}\ 9.6^2}{6} = \cancel{6600}\ 6910'^{\#}$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.K. Date: 13 Mar. 44

End Reactions & Moments (cont.) Case II

Member JK



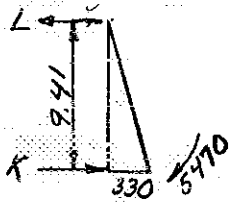
$V_J = 890 \times 7.75 \times .5 + \frac{14,150}{7.75} = 5280^{\#}$

$V_K = 890 \times 7.75 \times .5 - \frac{14,150}{7.75} = 1620^{\#}$

$x_0 = \cancel{2.1}\ 1.82'$ from K

$M = 1620 \times \cancel{2.1}\ 1.82 + 2050 - 890 \times \frac{\cancel{2.1}\ 1.82^2}{2} = \cancel{3490}\ 3525'^{\#}$

Member KL

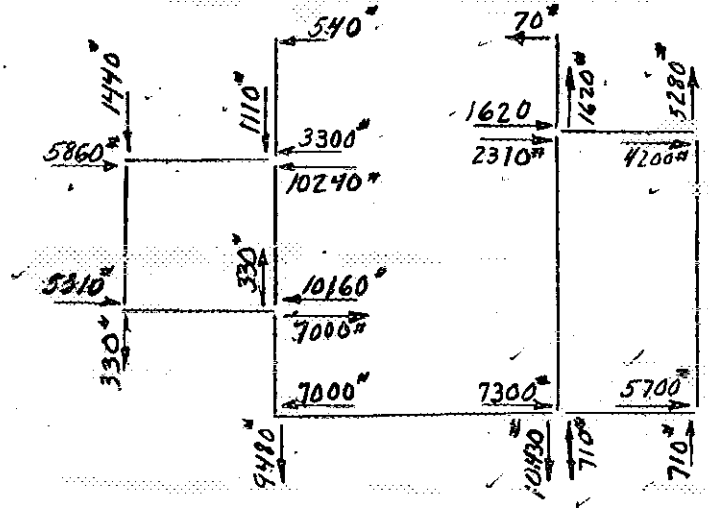


$H_K = .5 \times 330 \times 9.41 \times .67 + \frac{5470}{9.41} = 1620^{\#}$

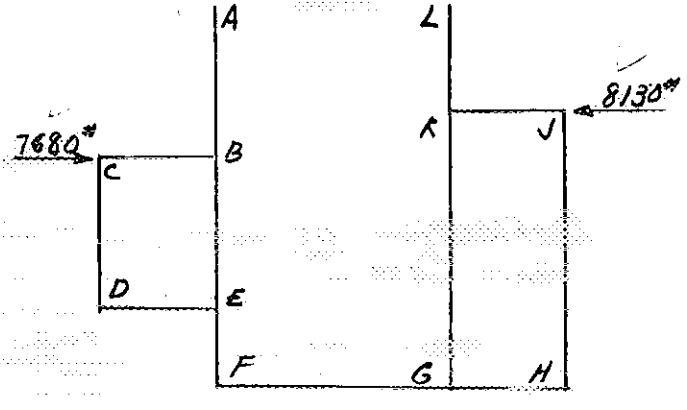
$H_L = .5 \times 330 \times 9.41 \times .33 - \frac{5470}{9.41} = 70^{\#} \leftarrow$

No pos. M.

End Reaction Diagram

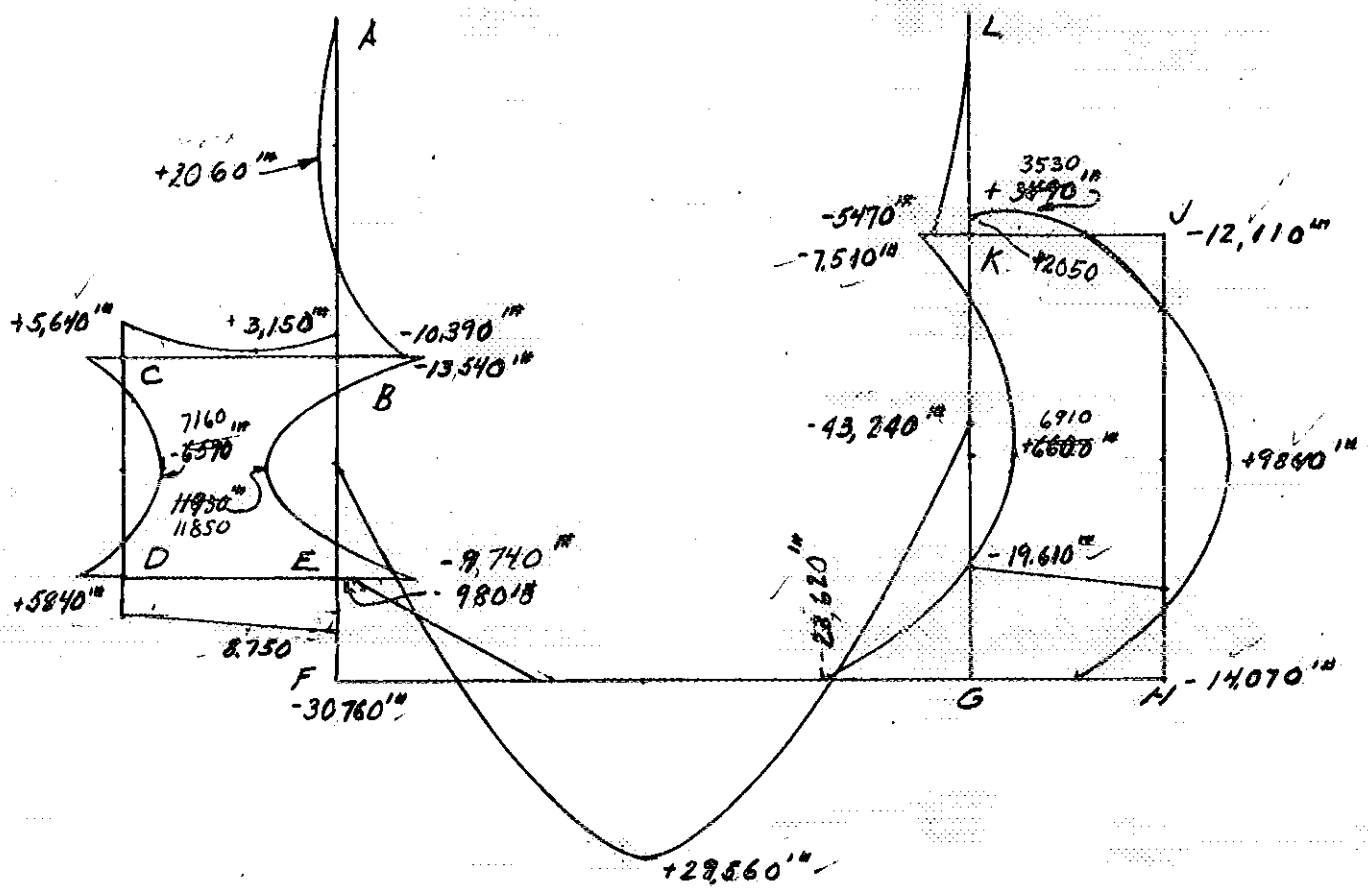


Forces Producing Joint Deflection



Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.K. Date: 15 Mar 44

Bending Moment Diagram - Case II - (Joint Def. not incl.)



Deflection of Joints C + B inward (use same trial moments as in Case I)

$$\text{Mom. Mult.} = \frac{7680}{2781} = 2.76$$

Deflection of Joints J + K inward (use same trial moments as in Case I)

$$\text{Mom. Mult.} = \frac{8130}{949} = 8.57$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section
Computed by: H. E. W. Checked by: Date: 16 - Mar. 44

Joint Deflection Moments - Case II

Member	Force → Trial M	Mult.	Mom	Force ← Trial M	Mult.	Mom.	Combined Moment
AB @ A	0.00	2.76	0.00	0.00	8.57	0	0
@ B	-3.80	"	-10,490	0.00	"	0	-10490
BC @ B	-3.36	"	-9 270	0.00	"	0	-9,270
@ C	-3.72	"	-10 270	0.00	"	0	-10,270
CD @ C	+3.72	"	+10 270	0.00	"	0	+10,270
@ D	+4.51	"	+12450	0.00	"	0	+12450
DE @ D	-4.51	"	-12450	0.00	"	0	-12450
@ E	-4.40	"	-12140	+0.03	"	+260	-11880
BE @ B	+7.16	"	+19760	0.00	"	0	+19760
@ E	+7.92	"	+21,860	+0.02	"	+170	+22030
EF @ E	-3.52	"	-9,720	-0.05	"	-430	-10150
@ F	-0.48	"	-1,320	-0.13	"	-1,110	-2430
FG @ F	+0.48	"	+1320	+0.13	"	+1110	+2430
@ G	+0.32	"	+880	+0.52	"	+4460	+5340
GH @ G	-0.28	"	-770	+2.39	"	+20,480	+19,710
@ H	0.00	"	0	+1.97	"	+16,880	+16880
HJ @ H	0.00	"	0	-1.97	"	-16,880	-16880
@ J	0.00	"	0	-1.37	"	-11,740	-11740
JK @ J	0.00	"	0	+1.36	"	+11 740	+11740
@ K	0.00	"	0	-0.44	"	-3,770	-3770
KG @ K	0.00	"	0	-3.55	"	-30,420	-30420
@ G	-0.04	"	-100	-2.91	"	-24940	-25040
KL @ K	0.00	"	0	+3.99	"	+34,190	+34190
@ L	0.00	"	0	0.00	"	0	0

Reactions

Member AB - $H_A = \frac{10490}{14.58} = 720^{\#} \leftarrow$ $H_B = 720^{\#} \rightarrow$

Member BC $V_B = \frac{19540}{8.95} = 2180^{\#} \uparrow$ $V_C = 2180^{\#} \downarrow$

Member CD $H_C = \frac{22720}{9.25} = 2460^{\#} \rightarrow$ $H_D = 2460^{\#} \leftarrow$

Member DE $V_D = \frac{24330}{8.95} = 2720^{\#} \downarrow$ $V_E = 2720^{\#} \uparrow$

Member BE $H_B = \frac{41,190}{9.25} = 4520^{\#} \rightarrow$ $H_E = 4520^{\#} \leftarrow$

Member EF $H_E = \frac{12600}{4.25} = 2960^{\#} \leftarrow$ $H_F = 2960^{\#} \rightarrow$

Member FG $V_F = \frac{7790}{26.75} = 290^{\#} \uparrow$ $V_G = 290^{\#} \downarrow$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H. E. W. Checked by: A.L.K. Date: 10 - Mar. 43

Joint Deflections (cont.)

Member GH $V_G = \frac{36600}{7.75} = 4720^{\#} \downarrow$ $V_H = 4740^{\#} \downarrow$

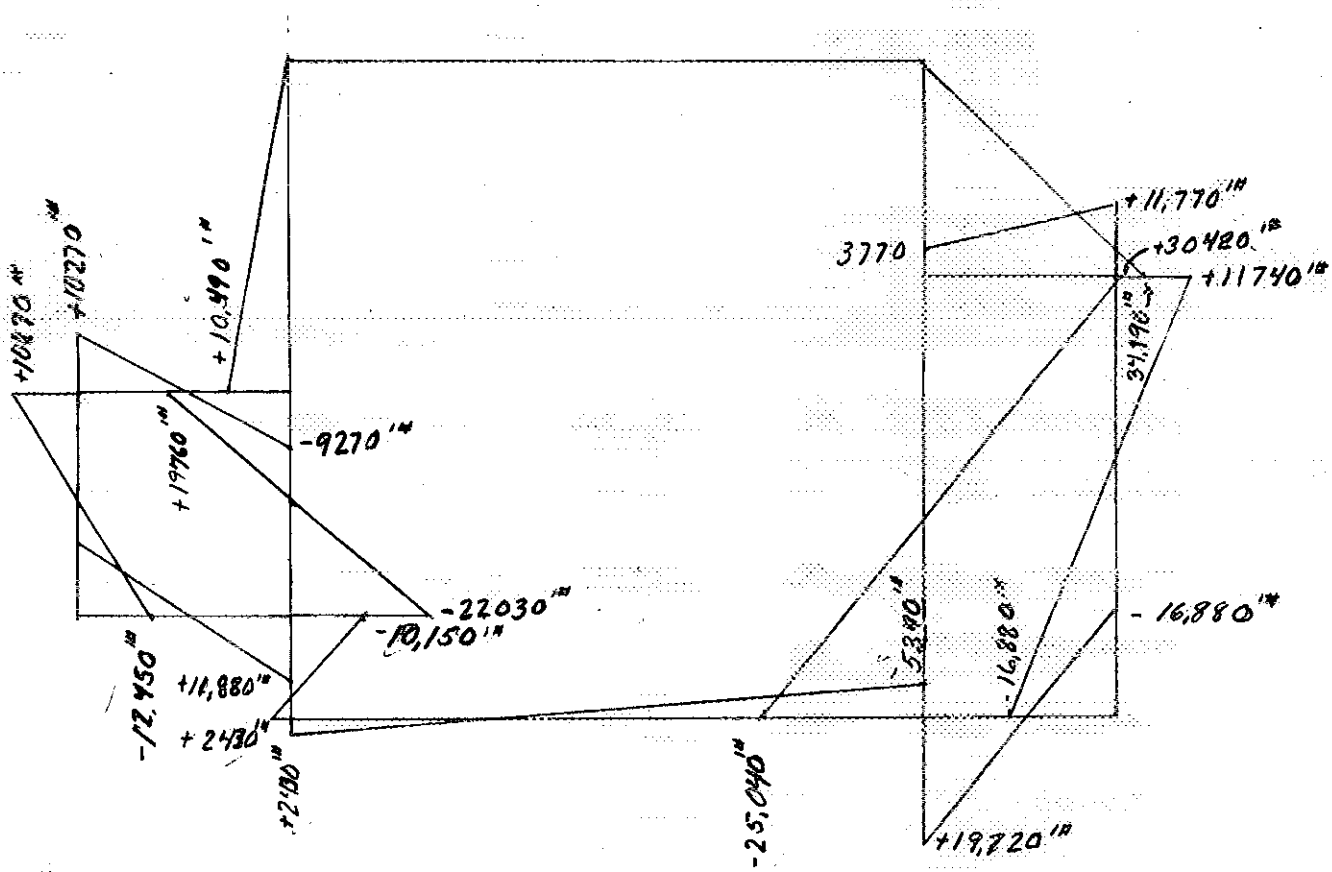
Member HJ $H_H = \frac{28620}{18.67} = 1530^{\#} \rightarrow$ $H_J = 1530^{\#} \leftarrow$

Member JK $V_J = \frac{7970}{7.75} = 1030^{\#} \downarrow$ $V_K = 1030^{\#} \uparrow$

Member KG $H_K = \frac{55460}{18.67} = 2970^{\#} \leftarrow$ $H_G = 2970^{\#} \rightarrow$

Member KL $H_K = \frac{34190}{9.41} = 3630^{\#} \leftarrow$ $H_L = 3630^{\#} \rightarrow$

Bending Moment Diagram due to Joint Deflection

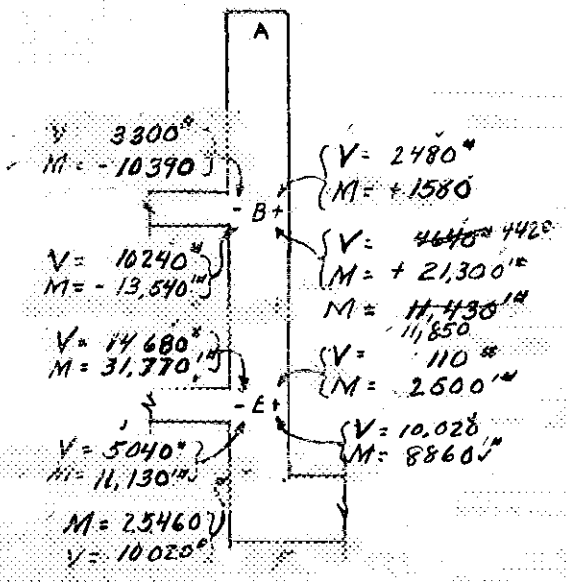


Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H. E. K. Checked by: A. C. Date: Mar. 44

Design of Members

Section B-B will be designed for maximum combination of moments and shear from either Case I or Case II whichever is the larger. Moments and shears as found under joint deflection investigation will only be used where they tend to increase the values or cause a reversal in the values

Member A, B, E, F



- Mat top of base slab

$33730 - 10020 \times 2.5 \times .33 = 25460'^{\#}$

req'd $d = \sqrt{\frac{31770}{139}} = 15.0'' < 18.5''$ OK
use 21" wall

$v = \frac{14680}{12 \times .88 \times 17.5} = 78\ \#/\square''$ OK

$+As = \frac{21,300 \times 12}{20,000 \times .88 \times 18.5} = .78\ \square''$

c.c dist. between discharge pipe = 11'-0"
net distance after taking out opening equals = 6'-9" ±
req'd steel area per ft between pipes
$\frac{11.0}{6.75} \times .78 = 1.27\ \square''$ Use 1"ϕ@7"cc

$V = \frac{11.0}{6.75} \times 4640 = 7560\#$

$u_0 = \frac{7560}{5.4 \times .89 \times 18.5} = 85\ \#/\square''$ OK

+ Mom below cond. base slab

$+As = \frac{8860 \times 12}{20,000 \times .88 \times 18.5} \times \frac{11.0}{6.75} = .53\ \square''$ Use $\frac{3}{4}''$ϕ@7"cc $u_0 = \frac{10,020 \times 11}{5.4 \times .88 \times 18.5 \times 6.75} = 187\ \#/\square''$

$-As = \frac{25460 \times 12}{20,000 \times .88 \times 17.5} \times \frac{11}{6.75} = 1.60\ \square''$
$-As = \frac{31770 \times 12}{20,000 \times .88 \times 17.5} \times \frac{11}{6.75} = 1.98\ \square''$
Use 1"ϕ@6"cc

$u_0 = \frac{14680}{8.0 \times .88 \times 17.5} \times \frac{11}{6.75} = 191\ \#/\square''$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.E. Date: 16 Mar 44

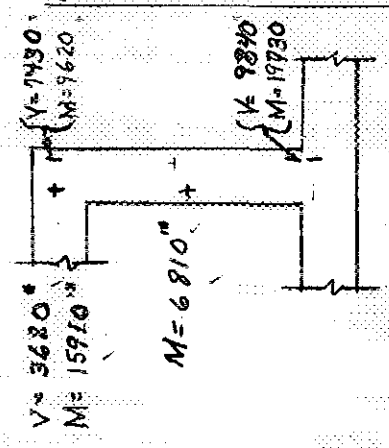
Design of Members (cont.)

Member ABEF (cont.)

$$-A_s = \frac{13,540 \times 12}{20,000 \times .88 \times 17.5} \times \frac{11}{6.75} = .85^{\square''}$$ Try $\frac{3}{4}''\phi$ @ 6"cc

$$u_o = \frac{10240 \times 11}{4.7 \times .88 \times 17.5 \times 6.75} = 228^{\#/\square''}$$ Use $\frac{7}{8}''\phi$ @ 6"cc then $u_o = 195^{\#/\square''}$

Member BC



req'd $d = \sqrt{\frac{19730}{139}} = 11.9''$ Make slab 18" d = 14.5"

$$V = \frac{9840}{12 \times .88 \times 14.5} = 64^{\#/\square''}$$

$$-A_s = \frac{19730 \times 12}{20,000 \times .88 \times 14.5} = .93^{\square''}$$ Use $\frac{7}{8}''\phi$ @ 7"cc

$$u_o = \frac{9840}{4.7 \times .88 \times 14.5} = 164^{\#/\square''}$$

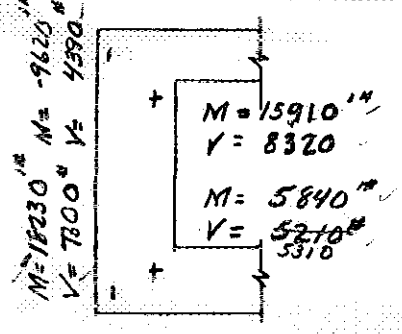
$$-A_s = \frac{9620 \times 12}{20,000 \times .88 \times 14.5} = .45^{\square''}$$ Try $\frac{3}{4}''\phi$ @ 12"cc

$$u_o = \frac{7430}{2.4 \times .88 \times 14.5} = 242^{\#/\square''}$$ NG. Bend $\frac{7}{8}''\phi$ @ 7"cc down into side wall

$$+A_s = \frac{15910 \times 12}{20,000 \times .88 \times 14.5} = .75^{\square''}$$ Use $\frac{3}{4}''\phi$ @ 6"cc

$$u_o = \frac{3620}{4.7 \times .88 \times 14.5} = 60^{\#/\square''}$$ OK

Member CD



req'd $d = \sqrt{\frac{18230}{139}} = 11.5''$ use 18" wall d = 14.5

$$V = \frac{8270}{12 \times .88 \times 14.5} = 54^{\#/\square''}$$

$$-A_s = \frac{9620 \times 12}{20,000 \times .88 \times 14.5} = .45^{\square''}$$ Use $\frac{3}{4}''\phi$ @ 12"cc

$$u_o = \frac{4390}{2.4 \times .88 \times 14.5} = 144^{\#/\square''}$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: A.L.D. Date: 16 Mar. 44

Design of Members (cont.)

Member CD

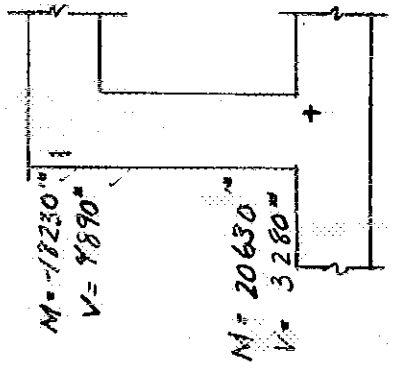
$-A_s = \frac{18,230 \times 12}{20,000 \times .88 \times 14.5} = .86^{\square''}$ Use $\frac{3}{4}''\phi$ @ 6" cc

$u_o = \frac{7300}{4.7 \times .88 \times 14.5} = 121\ \#/\square''$

$+A_s = \frac{15910 \times 12}{20,000 \times .88 \times 14.5} = .75^{\square''}$ Use $\frac{3}{4}''\phi$ @ 6" cc

$u_o = \frac{8320}{4.7 \times .88 \times 14.5} = 140\ \#/\square''$ OK

Member DE



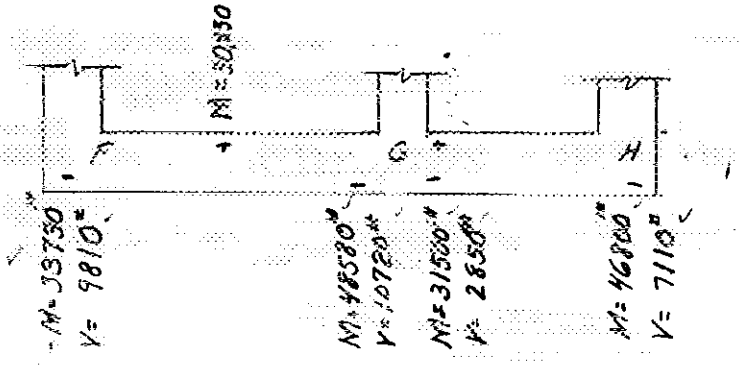
req'd $d = \sqrt{\frac{20410}{139}} = 12.1'' < 20.5$

$v = \frac{4890}{12 \times .88 \times 20.5} = 23\ \#/\square''$

$-A_s = \frac{18230 \times 12}{20,000 \times .88 \times 20.5} = .61^{\square''}$ $\frac{3}{4}''\phi$ @ 6" cc

$+A_s = \frac{20,630 \times 12}{20,000 \times .88 \times 20.5} = .68^{\square''}$ Use $\frac{7}{8}''\phi$ @ 9" cc

Member FGH



req'd $d = \sqrt{\frac{48580}{139}} = 18.7'' < 19.5''$ OK

$v = \frac{10720}{12 \times .88 \times 19.5} = 52\ \#/\square''$

Reduction in M & V at face of wall at Pt. F

$V = 9810 - 745 \times \frac{1.75}{2} = 9160\#$

$M = 33730 - \left(\frac{9810 + 9160}{2}\right) \times .33 \times 1.75 = 28250'\#$

Subject Bushnell Park Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** A.L.K. **Date** 24 Mar. 44

Design of Members (cont.)

Member FGH cont.

Reduction in M and V at face of wall at pt. G (left side)

$$V = 10720 - 745 \times \frac{1.75}{2} = 10{,}070^{\#}$$

$$M = 48580 - \left(\frac{10720 + 10{,}070}{2}\right) \times 1.75 \times .33 = 42580^{'\#}$$

$$-A_s = \frac{28250 \times 12}{20{,}000 \times .88 \times 20.5} = .99^{\square''} \quad \text{Try } 1''\square \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_o = \frac{9160}{4.0 \times .88 \times 20.5} = 134^{\#}/\square''$$

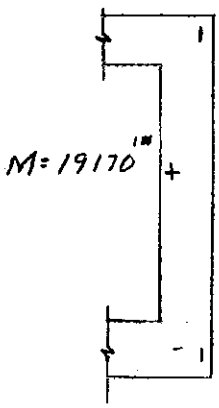
$$-A_s = \frac{42580 \times 12}{20{,}000 \times .88 \times 20.5} = 1.49^{\square''} \quad \text{Use } \left.\begin{matrix} 1''\square \text{ @ } 1'\text{-}0'' \\ 1''\phi \text{ @ } 1'\text{-}0''\text{cc} \end{matrix}\right\} \text{alt.}$$

$$u_o = \frac{10{,}070}{7.1 \times .88 \times 20.5} = 83^{\#}/\square''$$

$$-A_s = \frac{46800 \times 12}{20{,}000 \times .88 \times 20.5} = 1.63^{\square''} \quad \text{Use } \left.\begin{matrix} 1''\square \text{ @ } 1'\text{-}0''\text{cc} \\ 1''\phi \text{ @ } 1'\text{-}0''\text{cc} \end{matrix}\right\} \text{alt.}$$

$$+A_s = \frac{30{,}850 \times 12}{20{,}000 \times .89 \times 20.5} = 1.01^{\square''} \quad \text{Use } 1''\phi \text{ @ } 9''\text{cc}$$

Member JH



Reduction in M + V at top of base slab

$$V = 14090 - \frac{1760 + 1660}{2} \times 1.25 \quad \cancel{12380}\ 11950$$

$$M = 46800 - \left(\frac{14090 + \cancel{12380}\ 11950}{2}\right) \times 2.5 \times .33 = \cancel{35880}\ 36900^{'\#}$$

$$\text{req'd } d = \sqrt{\frac{\cancel{35880}\ 36{,}900}{139}} = 16.3'' < 17.5''$$

$$V = \frac{\cancel{12380}\ 11{,}950}{12 \times .88 \times 17.5} = \cancel{67}\ 65^{\#}/\square''$$

$$-A_s = \frac{\cancel{35880}\ 36900 \times 12}{20{,}000 \times .88 \times 17.5} = \cancel{1.46}\ 1.44^{\square''} \quad \text{Use } \left.\begin{matrix} 1''\square \text{ @ } 1'\text{-}0'' \\ 1''\phi \text{ @ } 1'\text{-}0 \end{matrix}\right\} \text{alt.}$$

$$u_o = \frac{\cancel{12380}\ 11{,}950}{7.1 \times .88 \times 17.5} = \cancel{113}\ 110^{\#}/\square''$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H. E. W. Checked by: [illegible] Date: 24 Mar 44

Design of Members

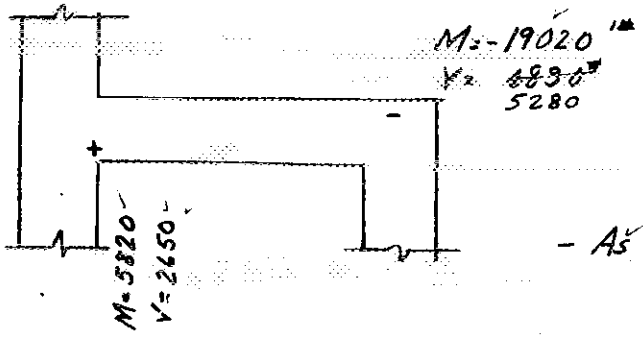
Member JH (cont.)

$$A_s = \frac{19020 \times 12}{20{,}000 \times .88 \times 17.5} = .74^{\square''} \quad \text{Use } \tfrac{3}{4}''\phi \text{ @ } 6''\text{cc}$$

$$u_o = \frac{6780}{4.7 \times .88 \times 17.5} = 94\ ^{\#}/_{\square''}$$

$$+A_s = \frac{19{,}170 \times 12}{20{,}000 \times .89 \times 17.5} = .74^{\square''} \quad \text{Use } \tfrac{7}{8}''\phi \text{ @ } 9''\text{cc}$$

Member JK



$$\text{reqd } d = \sqrt{\frac{19020}{137}} = 11.7'' < 14.5''$$

$$v = \frac{\cancel{6830}\ 5280}{12 \times .88 \times 14.5} = \cancel{45}\ 35\ ^{\#}/_{\square''}$$

$$-A_s = \frac{19020 \times 12}{20{,}000 \times .88 \times 14.5} = .88^{\square''} \quad \text{Use } \tfrac{3}{4}''\phi \text{ @ } 6''\text{cc}$$

$$u_o = \frac{6830}{4.7 \times .88 \times 14.5} = 114\ ^{\#}/_{\square''}$$

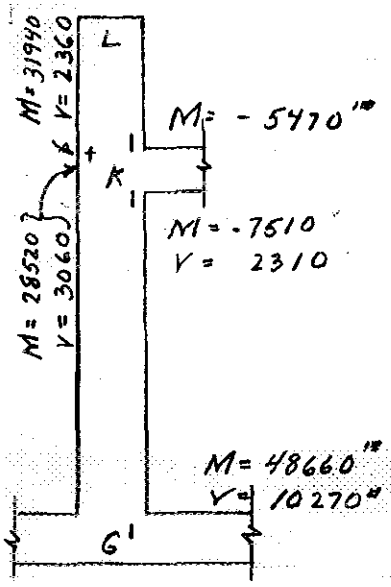
$$+A_s = \frac{5820 \times 12}{20{,}000 \times .88 \times 14.5} = .27^{\square''} \quad \text{Use } \tfrac{3}{4}''\phi \text{ @ } 12''\text{cc}$$

$$u_o = \frac{2650}{2.4 \times .88 \times 14.5} = 86\ ^{\#}/_{\square''}$$

Subject Bushnell Park Pumping Station
Computation Transverse Section "B-B"
Computed by H. E. W. **Checked by** [illegible] **Date** 25 Mar. 44

Design of Members (cont.)

Member L K G



Reduction in M & V at top of base slab

$V = 10270 - \left(\frac{1030 + 960}{2}\right) \times 1.25 = 9270^{\#}$ (9020#)

$M = 48660 - \frac{10270 + 9270}{2} \times 2.5 \times .33 = 40610^{\#}$ (9020)

req'd $d = \sqrt{\frac{40610}{139}} = 17.1'' < 17.5''$ OK

$v = \frac{9270}{12 \times .88 \times 17.5} = 50\ \#/\square''$

$-A_s = \frac{40610 \times 12 \times 11}{20000 \times .88 \times 17.5 \times 6.75} = 2.58\ \square''$ use 1"□ @ 4½" cc

$u_o = \frac{10270 \times 11}{10.7 \times .88 \times 17.5 \times 6.75} = 93\ \#/\square''$

$-A_s = \frac{7510 \times 12}{20{,}000 \times .88 \times 17.5} = .29\ \square''$ use ¾"φ @ 1'-0" cc

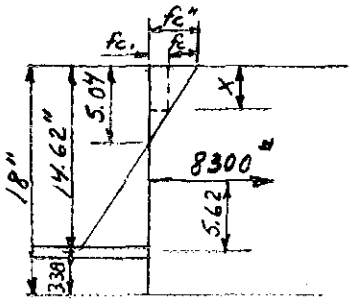
$u_o = \frac{2310}{2.4 \times .88 \times 17.5} = 63\ \#/\square''$

$+A_s = \frac{31940 \times 12}{20{,}000 \times .88 \times 18.5} = 1.18\ \square''$ use ⅞"φ @ 6" cc

Effect of Direct Tension

Member CB

Direct Tension = 8300# M = 15910'# As = .88 □" (¾"φ @ 6" cc)



$p = \frac{A_s}{bd} = \frac{.88}{12 \times 14.62} = .005$

$k = \sqrt{2np + (np)^2} - np$

$= \sqrt{24 \times .005 + (.005 \times 12)^2} - 12 \times .005 = .345$

$j = 1 - \frac{k}{3} = .885$

$kd = .345 \times 14.62 = 5.04''$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section A-B
Computed by: H. E. W. Checked by: A. L. K. Date: 25 Mar. 44

Direct Tension (cont.)

$$f_c'' = \frac{2 \times 15910 \times 12}{12 \times .343 \times 14.62^2 \times .883} = 488 \ \#/\square''$$

Find NA by trial

Try $f_c' = 100 \ \#/\square''$ then $x = \frac{5.04 \times 388}{488} = 4.00$

$$12 \times 100 \times 4 \times 12.62 + \frac{1}{2} \times 100 \times 1.04 \times 12 \times 10.27 = 8300 \times 5.62$$
$$66984 > 46650 \quad NG$$

try $f_c' = 67 \ \#/\square''$ $x = \frac{5.04 \times 421}{488} = 4.36''$

$$12 \times 67 \times 4.36 \times 12.44 + \frac{1}{2} \times 67 \times 12 \times .67 \times 10.0 = 46{,}650$$
$$46340 < 46650 \quad OK$$

$f_c = 421 \ \#/\square''$

Reduced conc. stress $= \frac{1}{2}(5.04 + 4.36)(67)(12 = 3780^{\#}$

Increase in unit steel stress $= \frac{8300 - 3780}{.88} = 5150 \ \#/\square''$

f_s for bending $= \frac{15{,}910 \times 12}{.88 \times .88 \times 14.62} = 16{,}900 \ \#/\square''$

Actual $f_s = 16{,}900 + 5150 = 22{,}050 \ \#/\square''$ OK

Member DE

Tension $= 7680^{\#}$ $M = 20{,}630^{\#\prime}$ $A_s = \frac{7}{8}''\phi @ 9''cc = .80$

$p = \frac{.80}{12 \times 20.5} = .00325$ $k = \sqrt{24 \times .00325 + (.00325 \times 12)^2} - 12 \times .00325 = 0.279$

$j = 0.907$ $kd = .279 \times 19.56 = 5.46''$

$$f_c'' = \frac{2 \times 20{,}630 \times 12}{12 \times .279 \times 19.56^2 \times .907} = 426 \ \#/\square''$$

By trial $f_c' = 56 \ \#/\square''$ $f_c = 370$ $x = 4.75$

Reduced conc. stress $= \frac{1}{2}(5.46 + 4.75)(56)(12) = 3430^{\#}$

Increase in unit steel stress $= \frac{7680 - 3430}{.80} = 5300 \ \#/\square''$

f_s for bending only $= \frac{20630 \times 12}{.80 \times .91 \times 19.56} = 17{,}400 \ \#/\square''$

Total $f_s = 17{,}400 + 5300 = 22{,}700 \ \#/\square''$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: Date: 27-Mar-44
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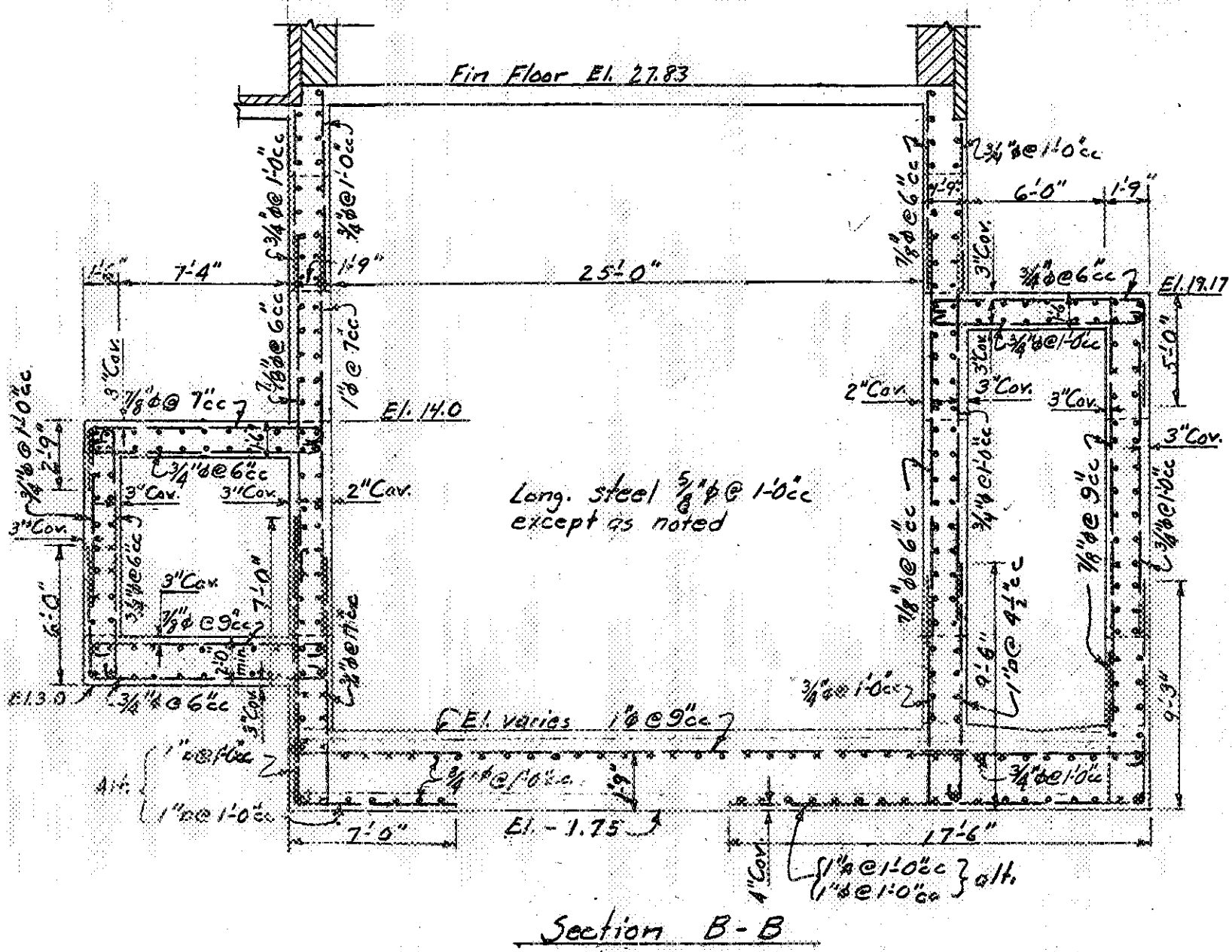
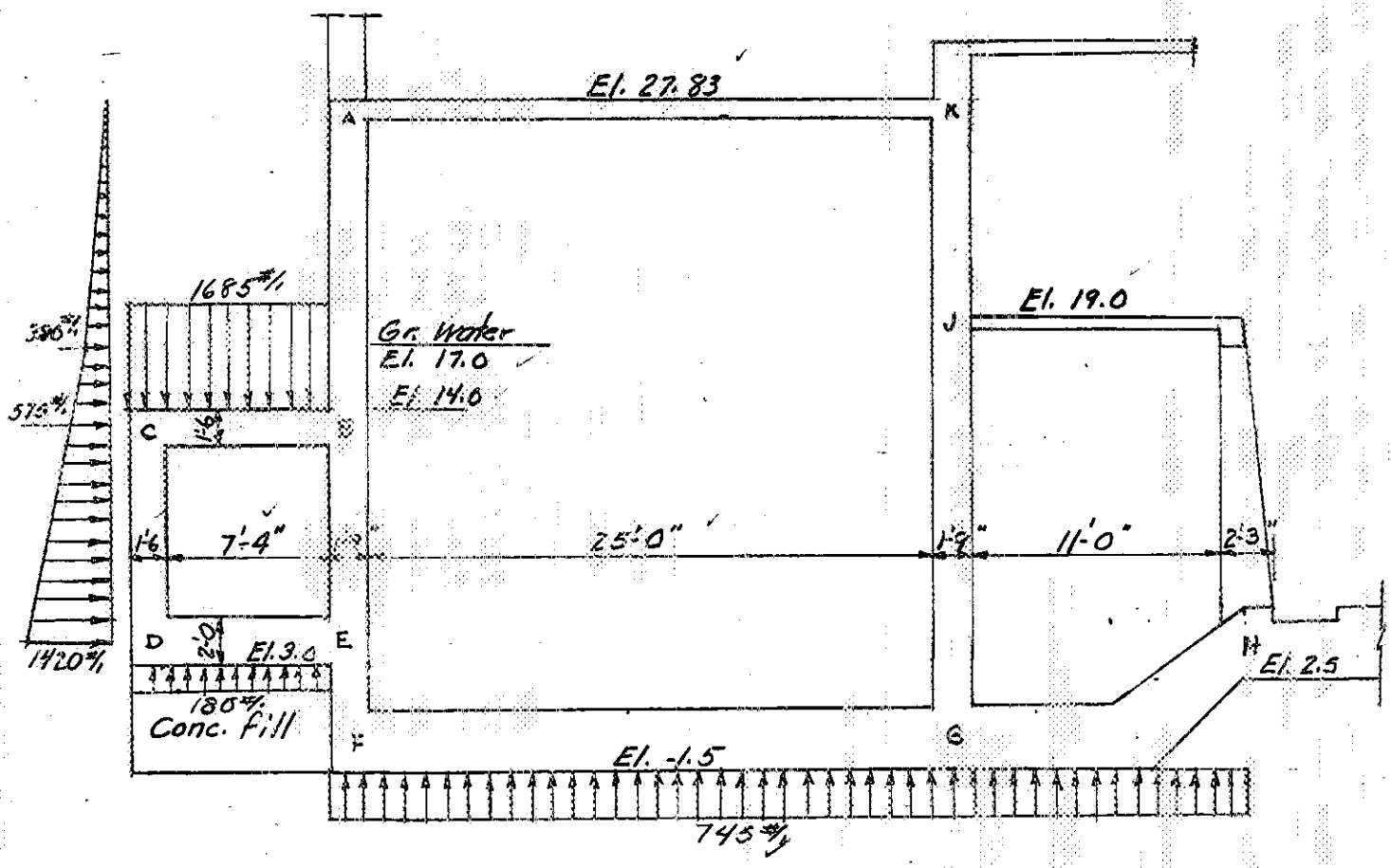


WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station
Computation: Transverse Section
Computed by: H.E.K. Checked by: Date: 28 Mar 40



Section C-C

Case I

Subject: Bushnell Park Pumping Station
Computation: Transverse Section C-C
Computed by: H. E. W. Checked by: A.L.K. Date: 29- Mar. 44

Design Assumptions

Section C-C will be analyzed similar to Section B-B. The walls will be considered simply supported at A & K. A point of support will be assumed at J. The base slab will be considered fixed at H. and the reaction taken by beam action.

Case I - Both conduits empty and ground water at El. 17.0

Fixed End Moments

Member GH

$M^F_{GH} = M^F_{HG} = \frac{1}{12} \times 745 \times 13^2 = 10.49^{'K}$

For fixed end moments of remaining members see Section B-B

Stiffness Factors

Member	d	d^3	L	d^3/L	K
AB	21	9261	175	52.92	1.3
BC	18	5832	107.5	54.25	1.3
CD	18	5832	111	52.54	1.3
DE	24	13824	107.5	128.60	3.1
EB	21	9261	111	83.43	2.0
EF	21	9261	51	181.59	4.4
FG	30	27000	321	84.11	2.1
GH	30	27000	170	158.82	3.9
GJ	21	9261	227	40.80	1.0
JK	21	9261	110	84.19	2.06

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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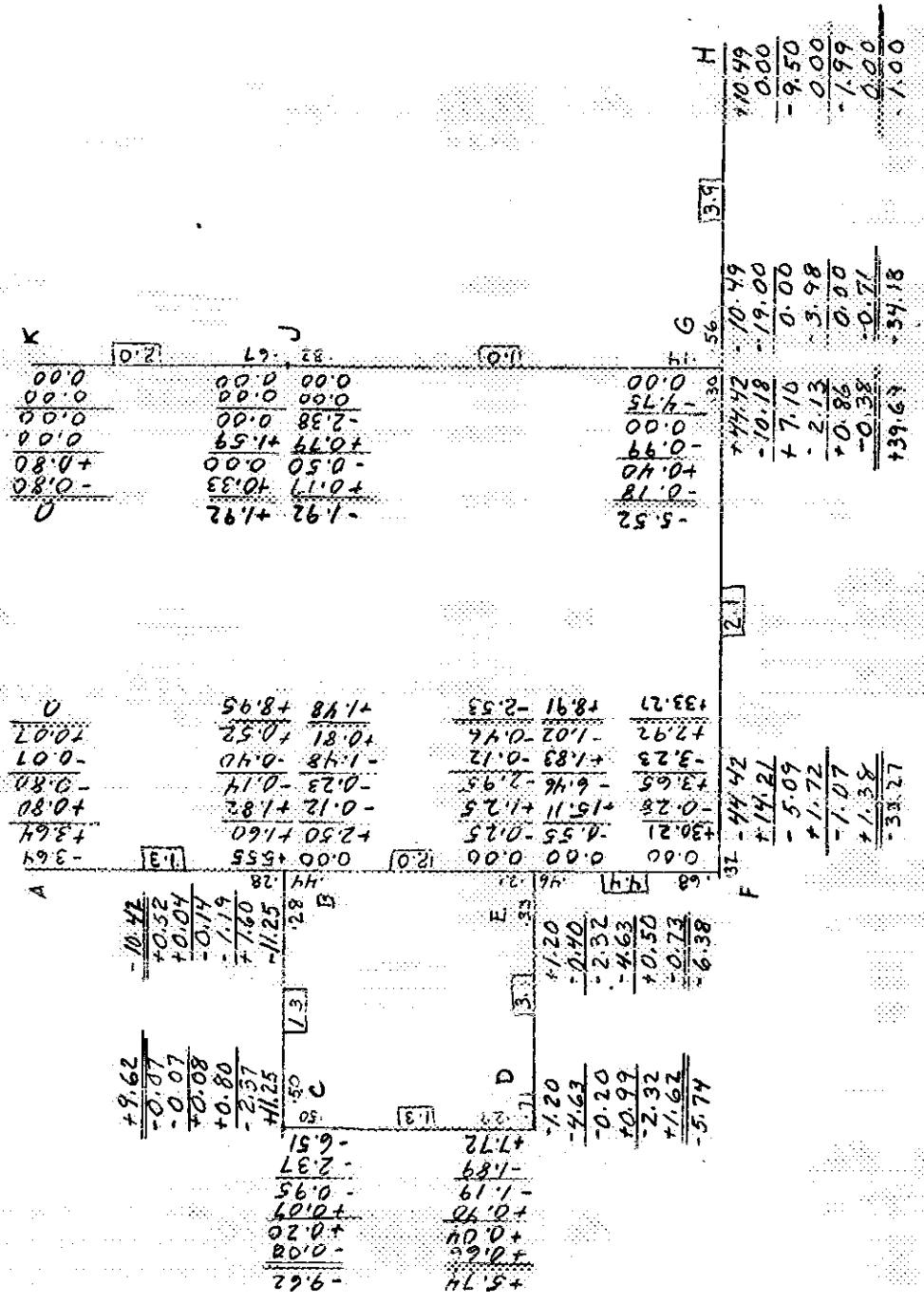
Subject Bushnell Park Pumping Station

Computation Transverse Section - C-C

Computed by H.E.W. **Checked by** [illegible] **Date** 30 - Mar. 44

Case I

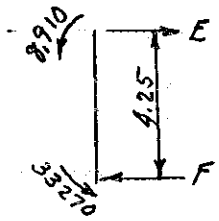


Subject: Bushnell Park Pumping Station
Computation: Transverse Section C.C.
Computed by: H.E.W. Checked by: A. Date: 30. Mar. 44

End Reactions and Pos. Moments Case I

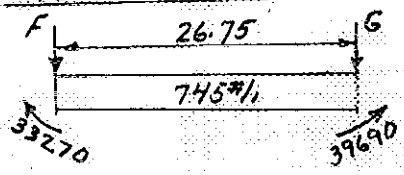
Members AB, BC, CD, DE and BE will be the same as in Case I of Section BB

Member EF



$$H_E = H_F = \frac{42,180}{4.25} = 9920^{\#}$$

Member FG



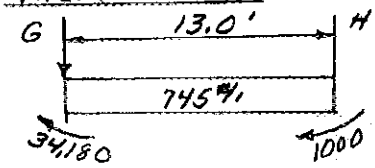
$$V_F = 745 \times 26.75 \times .5 - \frac{6420}{26.75} = 9720^{\#}$$

$$V_G = 745 \times 26.75 \times .5 + \frac{6420}{26.75} = 10,200^{\#}$$

$$x_0 = 13.05 \text{ from } F$$

$$+M = 9720 \times 13.05 - 33270 - \frac{745 \times 13.05^2}{2} = 30,140^{'\#}$$

Member GH



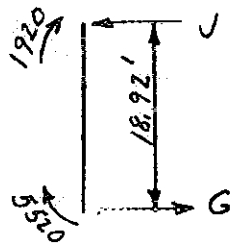
$$V_G = 745 \times 13 \times .5 + \frac{35180}{13} = 7550^{\#}$$

$$V_H = 745 \times 13 \times .5 - \frac{35180}{13} = 2130^{\#}$$

$$x_0 = 10.13' \text{ from } G$$

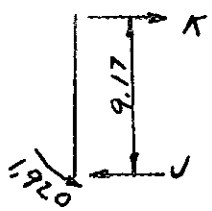
$$+M = 7550 \times 10.13 - 34180 - \frac{745 \times 10.13^2}{2} = 4080^{'\#}$$

Member GJ



$$H_G = H_J = \frac{7440}{18.92} = 390^{\#}$$

Member KL

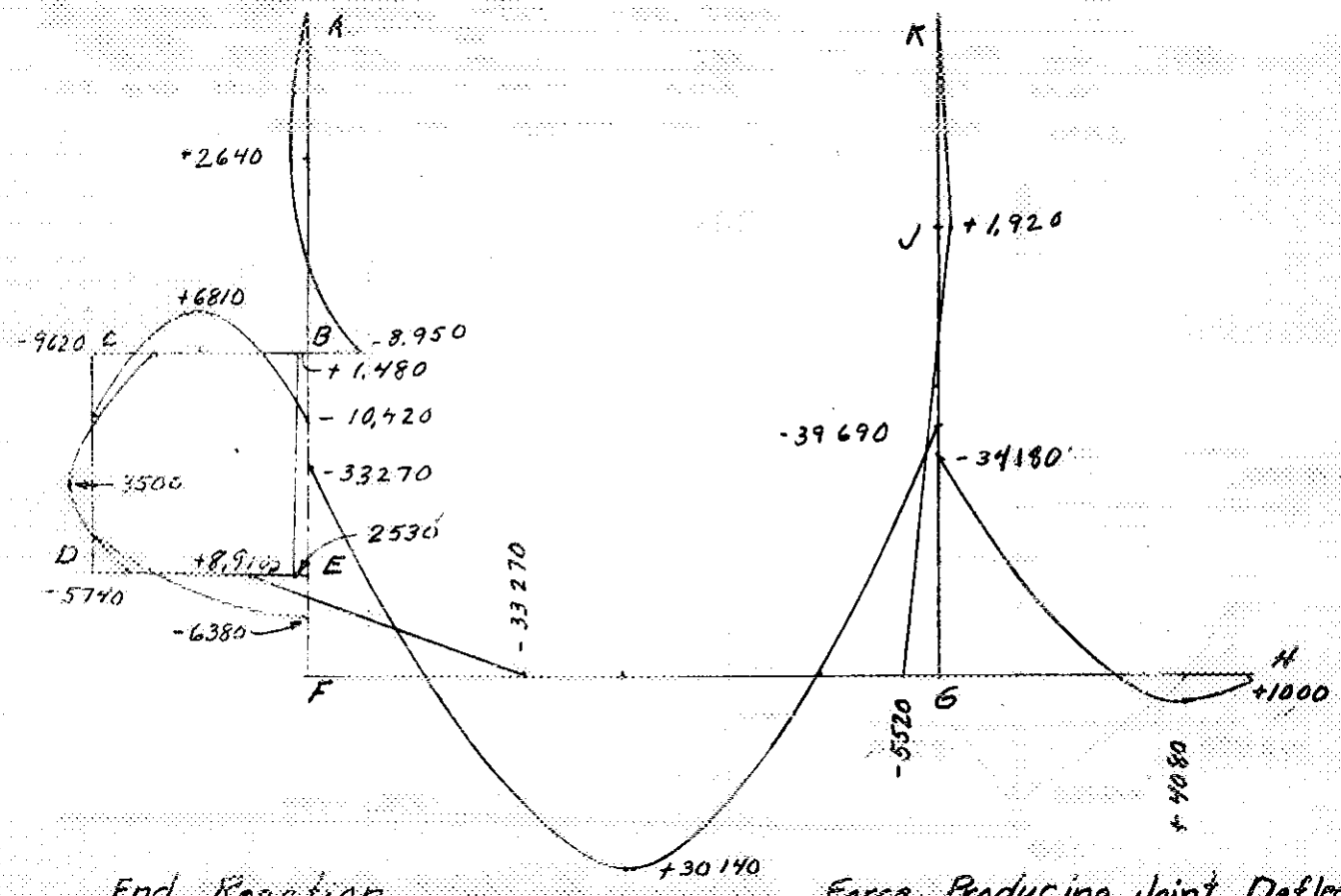


$$H_J = H_K = \frac{1920}{9.17} = 210^{\#}$$

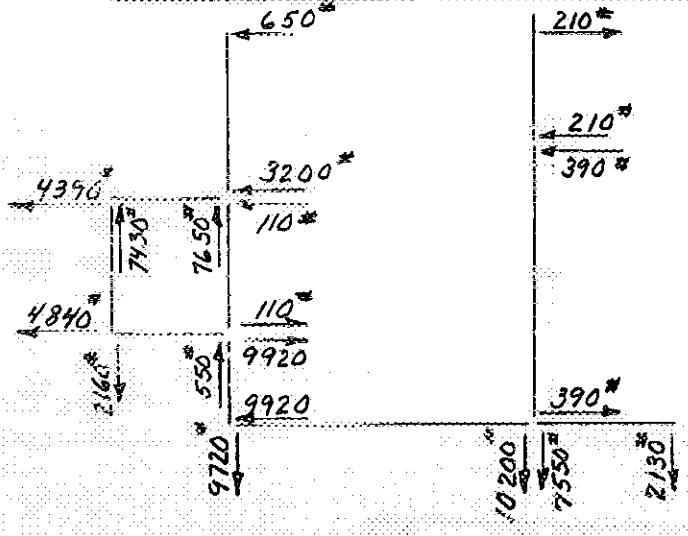
Subject: Bushnell Park Pumping Station
Computation: Transverse Section C.C.
Computed by: H.E.W. Checked by: A.L.K. Date: 30 Mar. 44

Case I

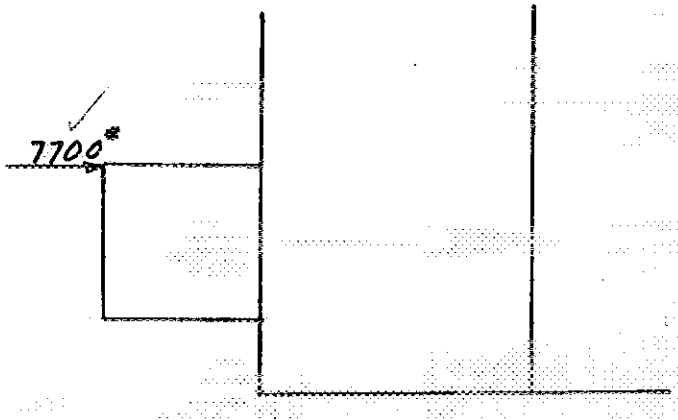
Moment Diagram - No Joint Deflection Included



End Reaction



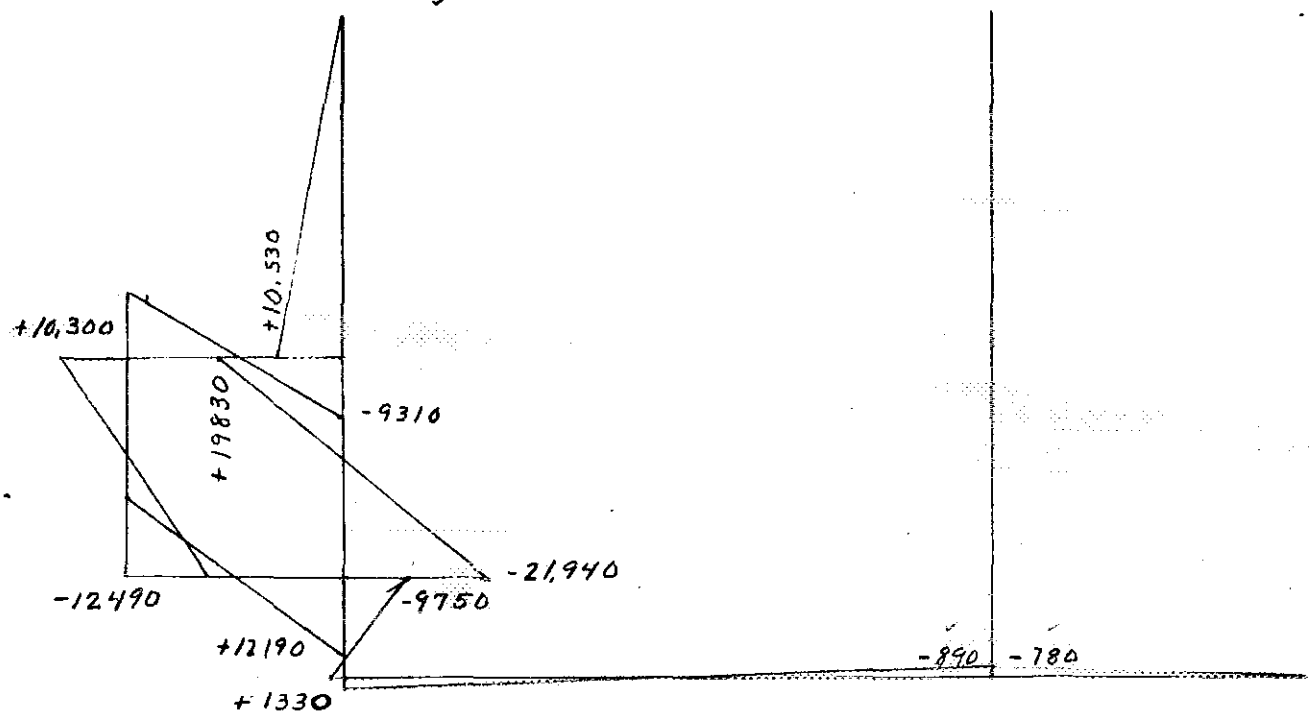
Force Producing Joint Deflection



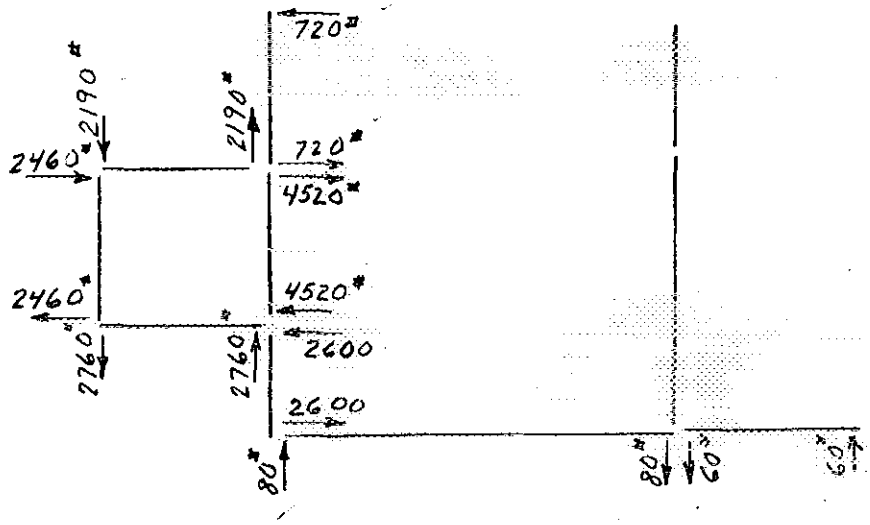
Subject: Bushnell Park Pumping Station
Computation: Transverse Section C-C
Computed by: H. E. W. Checked by: A.L.N. Date: 30 - Mar. 41

Joint Deflection Case I

The effect of joint deflection along the line CB will be the same as Case I Section B-B
Note: This is not true at joint G but values are so small they will be considered the same



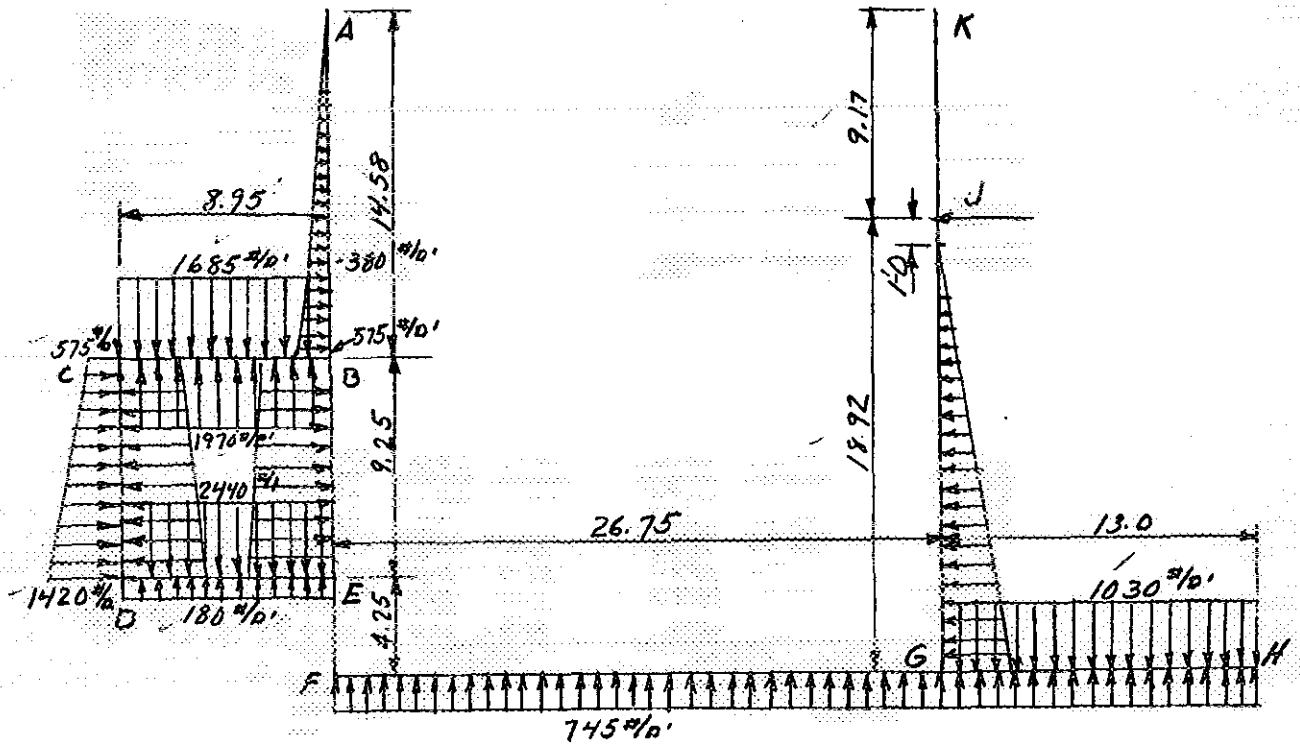
Moment Diagram for Joint Deflection



Subject: Bushnell Park Pumping Station
Computation: Transverse Section C-C
Computed by: H.E.W. Checked by: A.L.K. Date: 30 Mar. 44

Case II - Section C-C will be reinvestigated with the same external loading as Case I and with the Screening Chamber with water to El. 17.67 and the Discharge Conduit subjected to bursting pressure when the Park River Conduit has full head to El. 44.0

Loading Diagram



For loading values see Section B-B

Fixed End Moments
Member JG

$$M^F_{GJ} = \frac{.947(10-10\times.947+3\times.947^2)}{30}\times\frac{1030\times17.92}{2}\times18.92 = 17.75^{1K}$$

$$M^F_{JG} = \frac{.947^2(5-3\times.947)}{30}\times\frac{1030\times17.92\times18.92}{2} = 11.32^{1K}$$

For fixed end moments of remaining members see Case II Section B-B

WAR DEPARTMENT

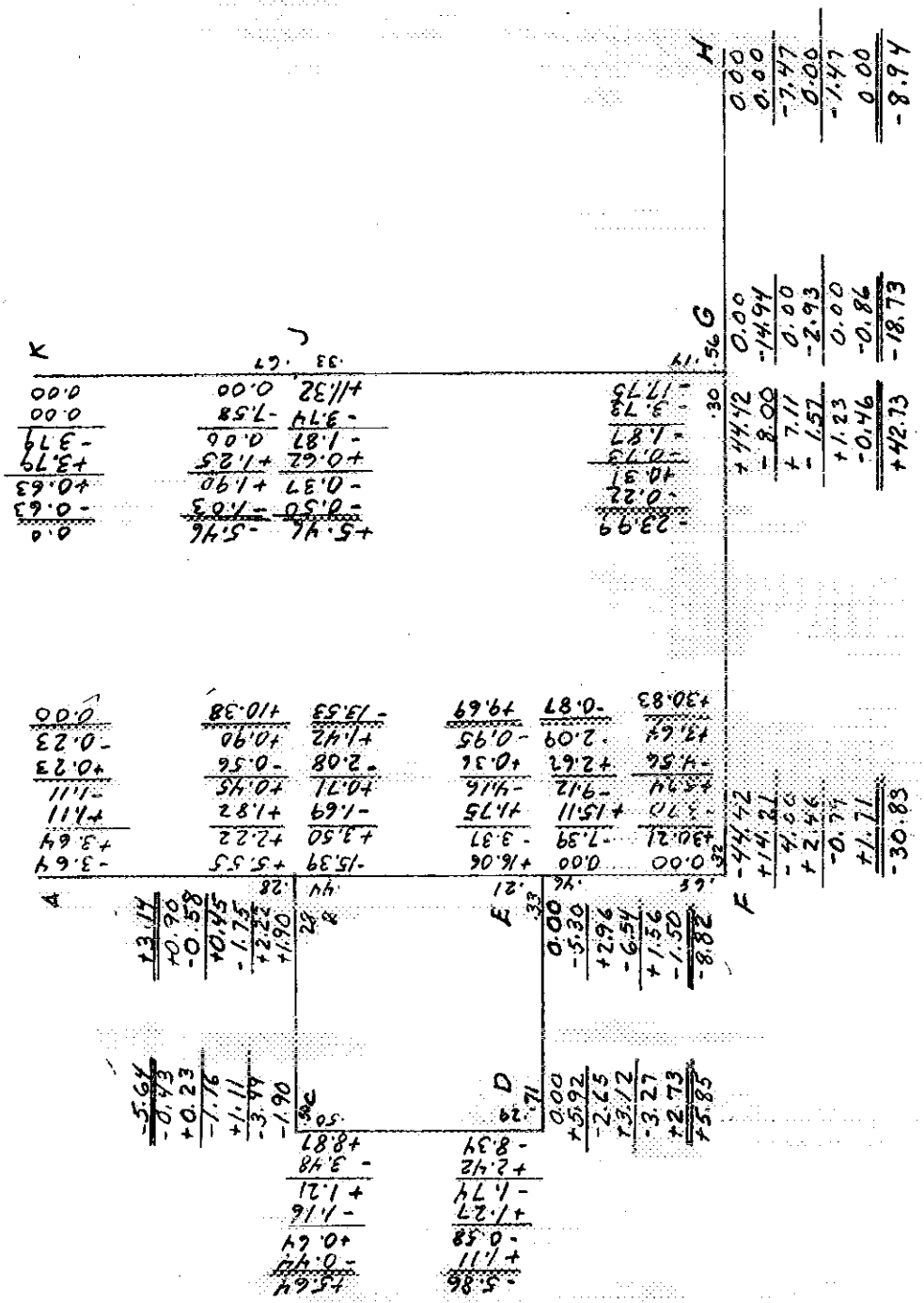
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Transverse Section "C-C"

Computed by H.E.W. **Checked by** A.H.K. **Date** 30 Mar 44

Case II

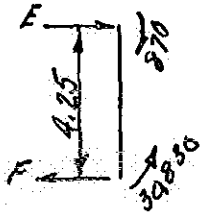


Subject: Bushnell Park Pumping Station
Computation: Transverse Section C-C
Computed by: H. E. W. Checked by: Date: 31 Mar 44

End Reactions and Pos. Moments (Case II)

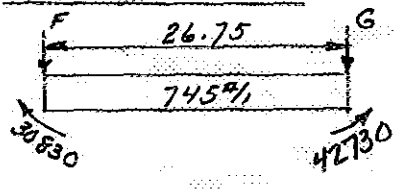
Members AB, BC, CD, DE and BE will be the same as in Case II of Section B-B

Member EF



$$H_E = H_F = \frac{29960}{4.25} \quad 7050^{\#}$$

Member FG



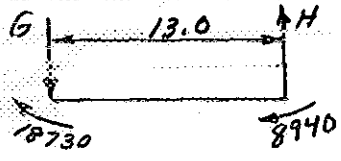
$$V_F = 745 \times 26.75 \times .5 - \frac{11900}{26.75} = 9520^{\#}$$

$$V_G = 745 \times 26.75 \times .5 + \frac{11900}{26.75} = 10,410^{\#}$$

$x_0 = 12.78'$ from F

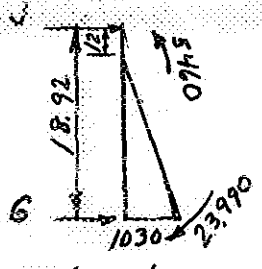
$$M = 9520 \times 12.78 - 30830 - 745 \times \frac{12.78^2}{2} = 30,000'^{\#}$$

Member GH



$$V_G = V_H = \frac{27670}{13.0} = 2130^{\#}$$

Member GJ



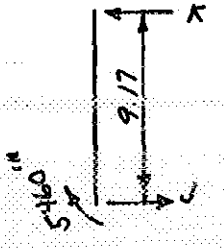
$$H_G = 1030 \times 17.92 \times .5 \times \frac{12.95}{18.92} + \frac{18530}{18.92} = 7300^{\#}$$

$$H_J = 1030 \times 17.92 \times .5 \times \frac{5.97}{18.92} - \frac{18530}{18.92} = 1933^{\#}$$

$x_0 = 9.3'$ from J

$$M = 1933 \times 9.3 - 5460 - 56.5 \times 8.3 \times \frac{8.3}{2} \times \frac{8.3}{3} = 7130'^{\#}$$

Member JK

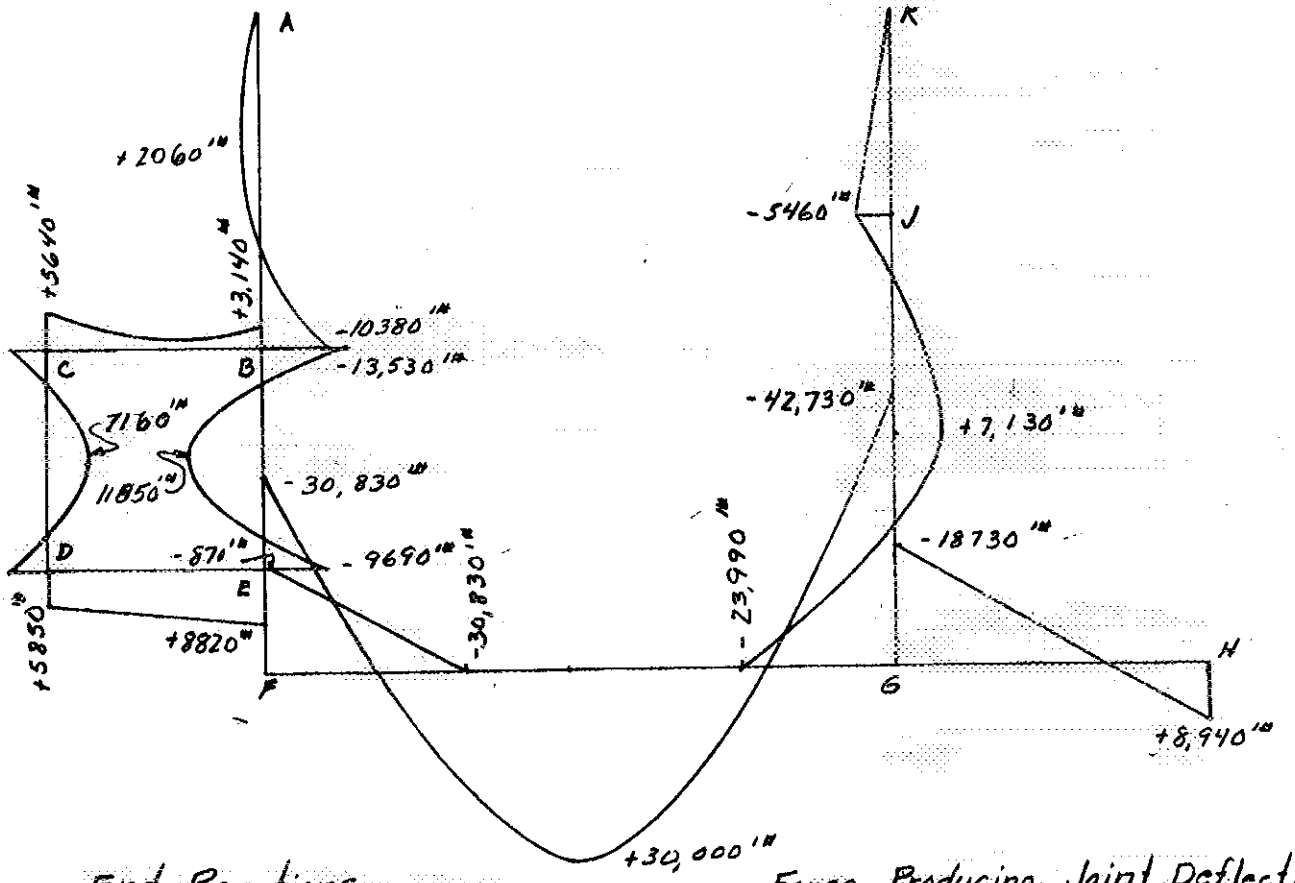


$$H_J = H_K = \frac{5460}{9.17} = 600^{\#}$$

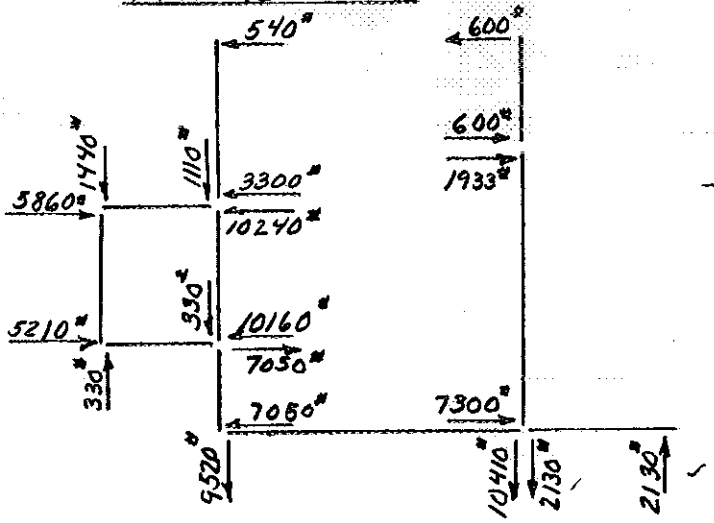
Subject: Bushnell Park Pumping Station
Computation: Transverse Section CC
Computed by: H. E. W. Checked by: A.L.K. Date: 31 Mar. 44

Case II

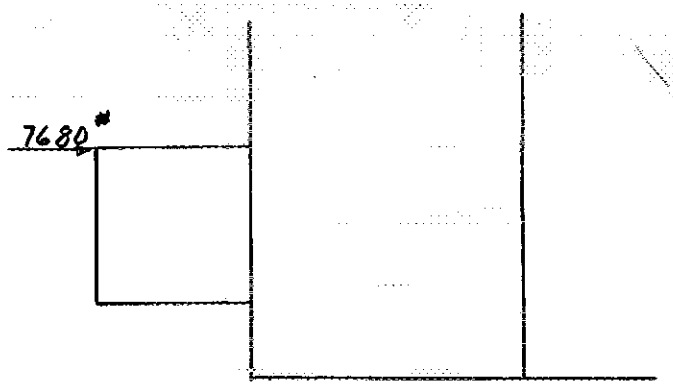
Moment Diagram - No Joint Deflection Included



End Reactions



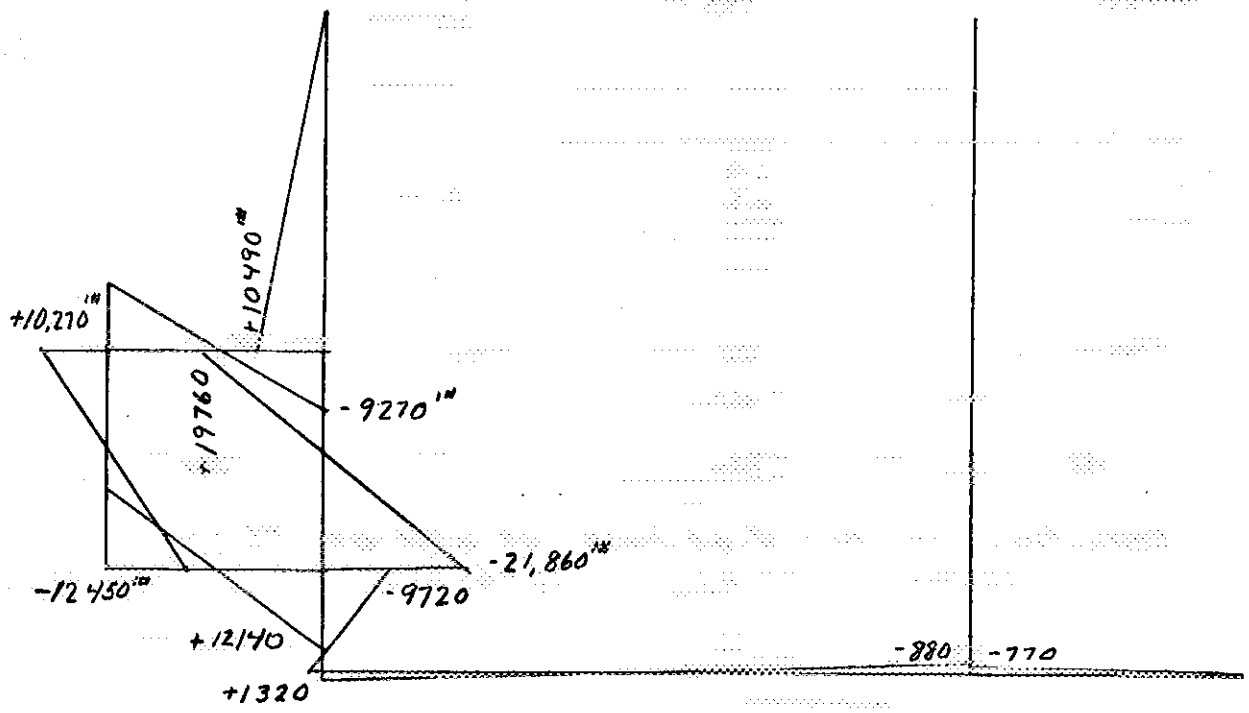
Force Producing Joint Deflection



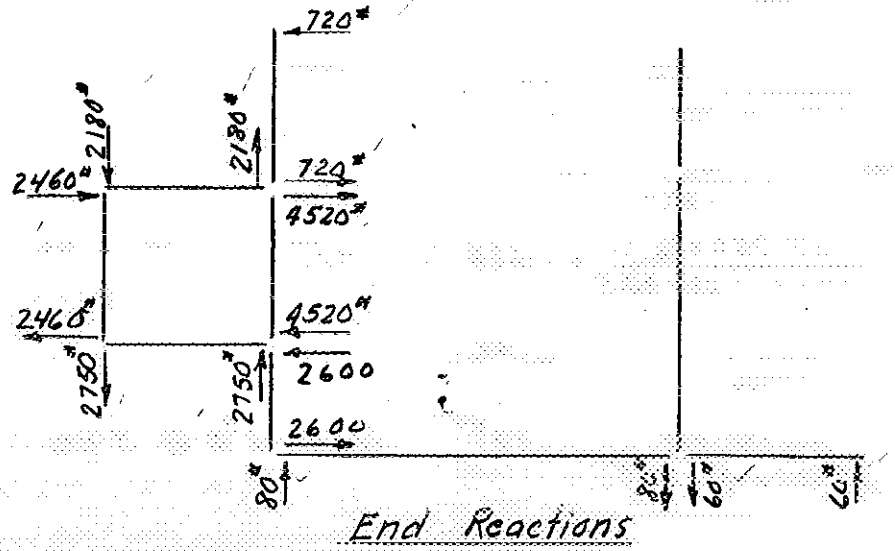
Subject Bushnell Park Pumping Station
Computation Transverse Section C-C
Computed by H.E.W. **Checked by** A.L.K. **Date** 31, Mar. 44

Joint Deflection Case II

The effect of joint deflection along the line CB will be the same as Case II Section B-B.



Moment Diagram for Joint Deflection



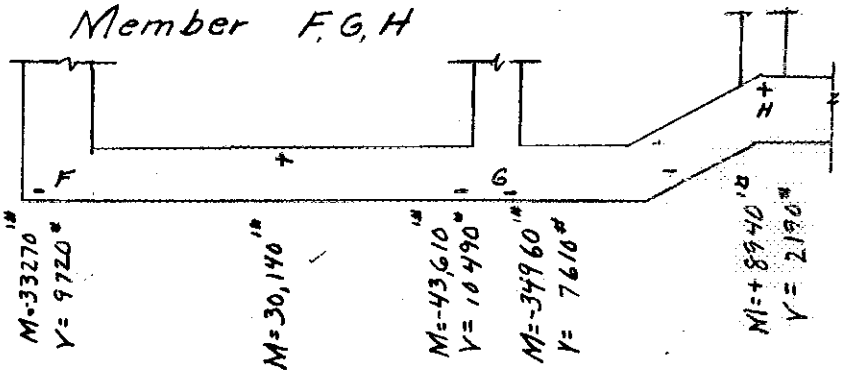
End Reactions

Subject: Bushnell Park Pumping Station
Computation: Transverse Section C.C
Computed by: H. E. W. Checked by: L. L. K. Date: 31 Mar 44

Design of Members

The steel for members AB, BC, CD, DE, BE, and EF will be the same as in Section B.B

Member F, G, H



Reduction in M + V at face of wall at Pt. F

$V = 9720 - 745 \times \frac{1.75}{2} = 9070^{\#}$

$M = 33,270 - \frac{9720 + 9070}{2} \times 1.75 \times .33 = 27,850'^{\#}$

Reduction in M + V at face of wall at Pt. G

$V = 10490 - 745 \times \frac{1.75}{2} = 9840$

$M = 43,610 - \frac{10490 + 9840}{2} \times 1.75 \times .33 = 37,750'^{\#}$

reqd $d = \sqrt{\frac{37750}{139}} = 16.5'' < 20.5''$ OK

$v = \frac{9840}{12 \times .88 \times 20.5} = 46^{\#}/\square''$ OK

$-A_s = \frac{27850 \times 12}{20,000 \times .88 \times 20.5} = .95^{\square''}$ 1"□ @ 1'-0" cc OK

$u_o = \frac{9070}{4 \times .88 \times 20.5} = 127^{\#}/\square''$

$-A_s = \frac{37,750 \times 12}{20,000 \times .88 \times 20.5} = 1.28^{\square''}$ Use 1" ϕ @ 6" cc

$u_o = \frac{9840}{6.3 \times .88 \times 20.5} = 87^{\#}/\square''$

$+A_s = \frac{30,140 \times 12}{20,000 \times .89 \times 20.5} = .99^{\square''}$ Use 1" ϕ @ 9" cc.

Subject: Bushnell Park Pumping Station
Computation: Transverse Section C. C.
Computed by: H.E.W. Checked by: [illegible] Date: 31 Mar-44

Design of Members (cont.)

Member F,G,H (cont.)

$$+A_s = \frac{8940 \times 12}{20{,}000 \times .88 \times 20.5} = .30''^2 \quad \text{use } 3/4''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

Moment Inflection Pts

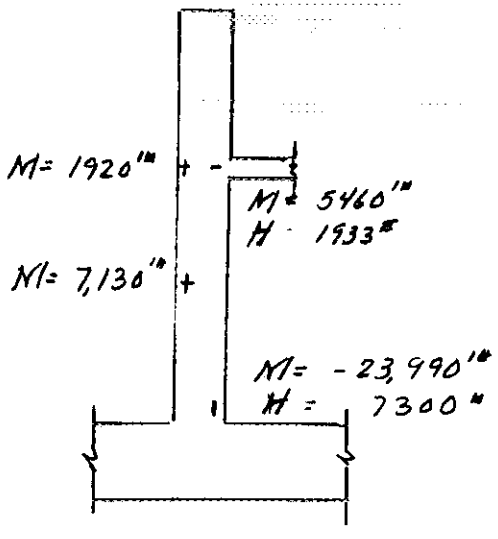
$$9720x - 33270 - 745\frac{x^2}{2} \qquad x_0 = 4.1 \text{ from } F$$

$$10490x - 43610 - 745\frac{x^2}{2} \qquad x_0 = 5.1 \text{ from } G$$

$$7610x - 34960 - 745\frac{x^2}{2} \qquad x_0 = 7.1 \text{ from } G \text{ (Case I)}$$

$$x_0 = 8.5 \text{ " " (Case II)}$$

Member K J G



$$\text{req'd } d = \sqrt{\frac{23{,}990}{139}} = 13.1'' < 17.5'' \text{ OK}$$

$$v = \frac{7300}{12 \times .88 \times 17.5} = 40\#/\square''$$

$$-A_s = \frac{23{,}990 \times 12}{20{,}000 \times .89 \times 17.5} = .93''^2 \quad \text{use } 1''\phi \text{ @ } 12''\text{cc}$$

add 2 more bars eq. side of pipes

$$u_0 = \frac{7300}{4 \times .89 \times 17.5} = 117\#/\square''$$

$$-A_s = \frac{5460 \times 12}{20{,}000 \times .88 \times 17.5} = .21''^2 \quad \text{use } 3/4''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

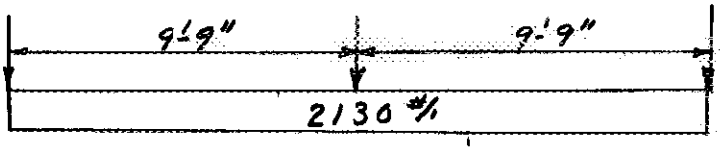
$$+A_s = \frac{7130 \times 12}{20{,}000 \times .89 \times 18.5} = .26''^2 \quad \text{use } 3/4''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

Moment Inflection Pt.

$$7300x - 23990 - (1030 - 57.5x)\frac{x^2}{2} - 57.5\frac{x^3}{3} \qquad x = 4.5' \text{ from } G$$

Subject: Bushnell Park Pumping Station
Computation: Transverse Section C-C
Computed by: H.E.W. Checked by: A.L.K. Date: 1-April-44

Beam Action at Pt. H.



Fixed End M = $\frac{1}{12} \times 2130 \times 9.75^2 = 16.87$ 'K

	-16.87	+16.87	-16.87	+16.87
	+16.87	0	0	-16.87
	0	+8.43	-8.43	0
	0	0	0	0
-M	0	25.30	25.30	0
V	7.79	12.98	12.98	7.79
x_0	→ 3.66			3.66 ←

$+M = 7790 \times 3.66 - 2130 \times \frac{3.66^2}{2}$

$M = 14250$ '#

reqd $d = \sqrt{\frac{25,130}{139}} = 13.4''$ OK

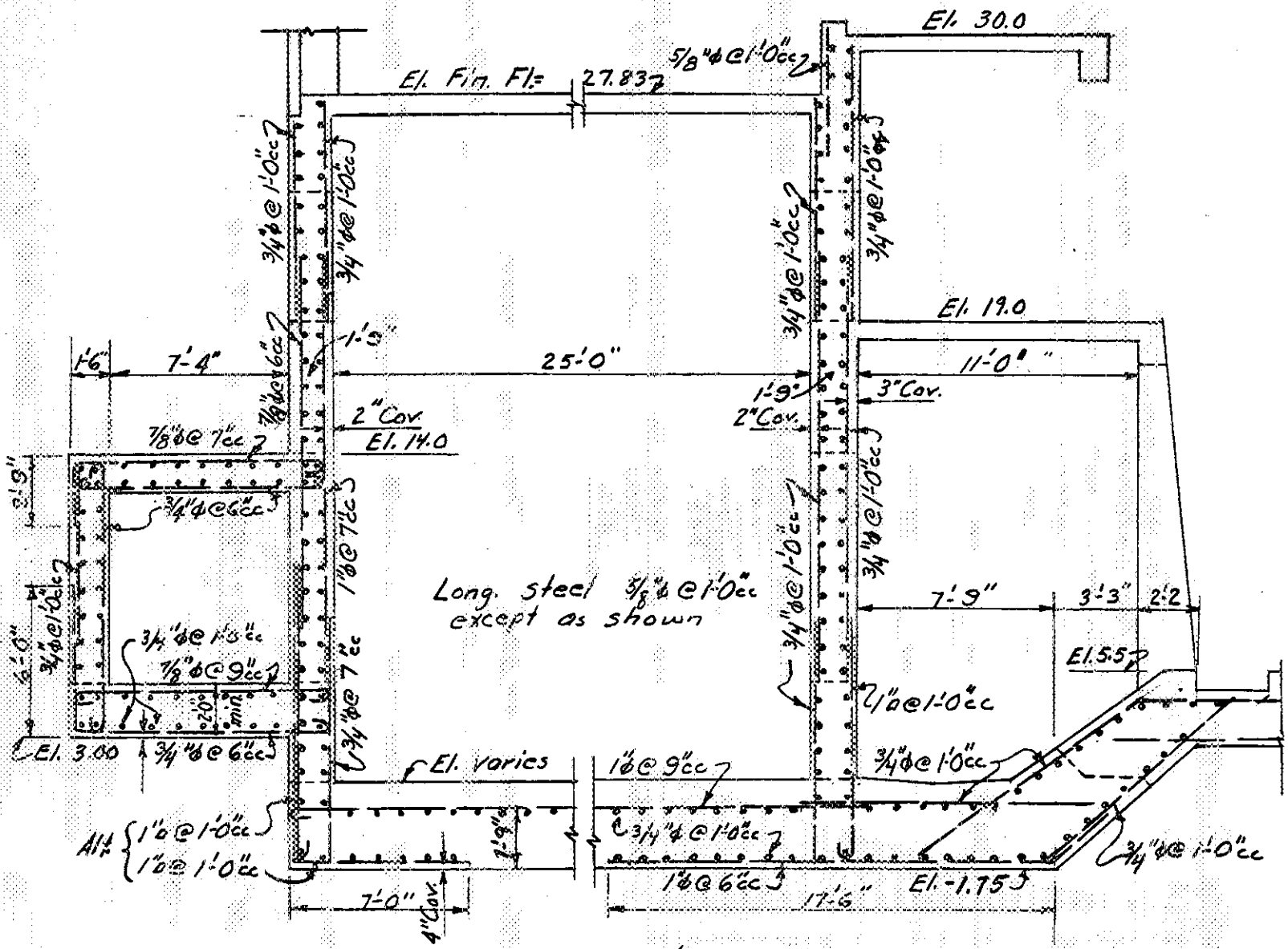
$v = \frac{12980}{26 \times .88 \times 24} = 24$ #/□"

$-A_s = \frac{25,360 \times 12}{20,000 \times .88 \times 24} = .72$ □" 3-3/4"φ furnished OK

$u_0 = \frac{12980}{7.1 \times .88 \times 24} = 87$ #/□" OK

WAR DEPARTMENT
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.

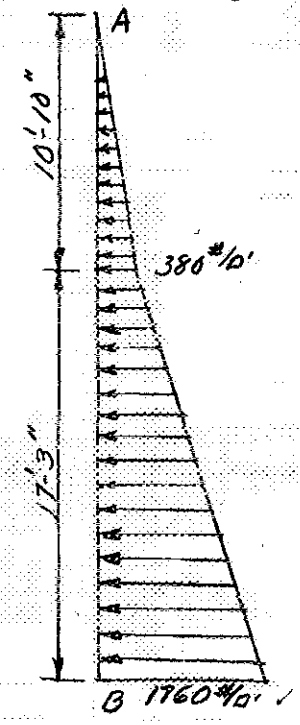
Subject Bushnell Park Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. Checked by Date 1-April-44



Section C-C

Subject: Bushnell Park Pumping Station
Computation: End Wall (West Side)
Computed by: H.E.W. Checked by: A.L.K. Date: 28 Mar 44

Loading Diagram



Design Assumptions
For determining neg. mom at base the wall will be considered fully fixed.
For determining pos. mom. wall will be considered 75% fixed.

$M^F_{AB} = 29.00$
$M^F_{BA} = 58.00$ } See Section A-A

Neg M at B = 58.00 + 14.50 = 72.50'K

$$H_A = \frac{380\times10.83\times20.86}{2\times28.08} + \frac{380\times17.25\times8.62}{28.08} + \frac{1380\times17.25\times5.75}{2\times28.08} - \frac{\cancel{69,970}\ 72500}{28.08} = 3400$$

$$H_B = \frac{380\times10.83\times7.22}{2\times28.08} + \frac{380\times17.25\times19.46}{28.08} + \frac{1380\times17.25\times22.33}{2\times28.08} + \frac{\cancel{69970}\ 72500}{28.08} = 17120^{\#}$$

$75\times72,500 = 54380'^{\#}$ Then $H_A = 4050^{\#}$

$x_0 = 4050 - 2060 - 380x - \frac{80x^2}{2}$ $x = 3.75$ $x_0 = 14.58$ from A

$+M = 4050\times14.58 - 2060\times7.36 - 380\times\frac{3.75^2}{2} - \frac{300\times3.75^3}{6} = 40,610'^{\#}$

Reduction in M & V at top of base slab

$V = 17020 - (1760 - \frac{80\times1.25}{2})(1.25) = 14980^{\#}$

$M = 72,500 - (\frac{17020+14980}{2})\times\frac{2.5}{3} = 59,130'^{\#}$

req'd $d = \sqrt{\frac{59130}{139}} = 20.6"$ OK

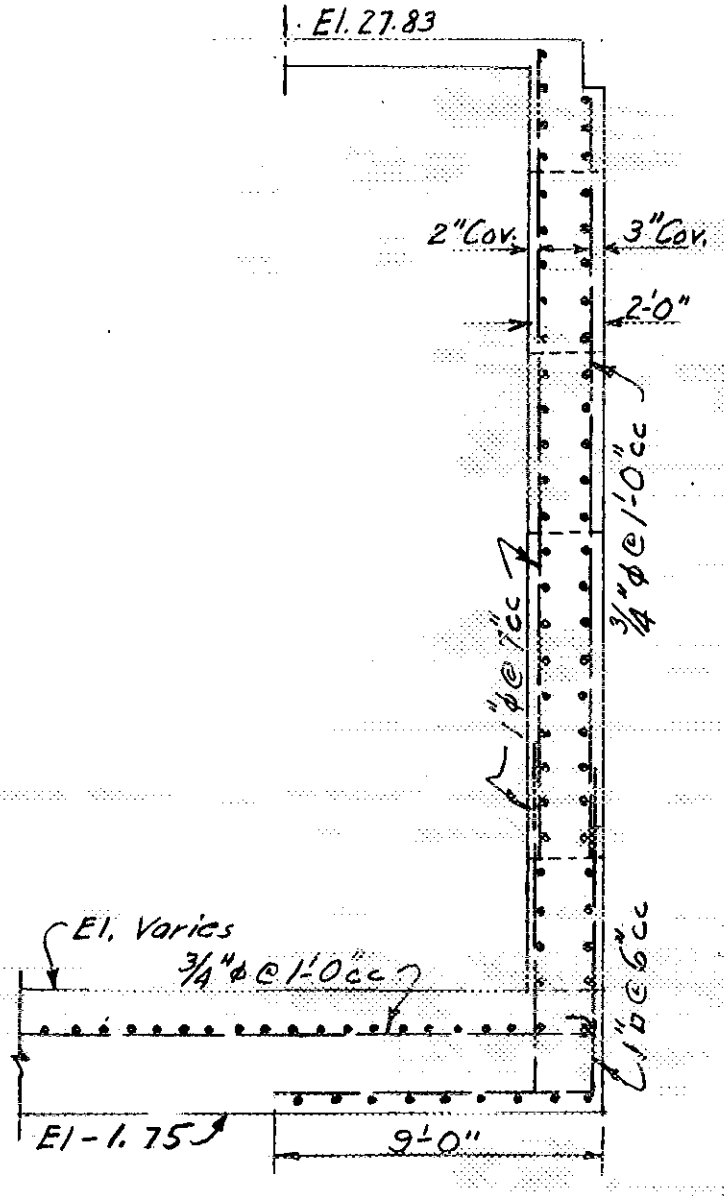
$v = \frac{14980}{12\times.88\times20.5} = 69\#/□"$ OK

$-A_s = \frac{59130\times12}{20,000\times.88\times20.5} = 1.97□"$ Use 1"□ @ 6" cc

Subject Bushnell Park Pumping Station
Computation End Wall (West Side)
Computed by H. E. W. **Checked by** **Date** 28 Mar 1944

$$u_o = \frac{14980}{8 \times .88 \times 20.5} = 103\ \#/\square''$$

$$+A_s = \frac{40{,}610 \times 12}{20{,}000 \times .88 \times 21.5} = 1.28\ \square''/' \qquad 1''\phi\ @\ 7''cc$$



West Wall

Subject Bushnell Park Pumping Station
Computation End wall in intake Conduit
Computed by S. W. M Checked by N.E.W. Date 6-12-44

Note.
Design of end wall member from El. 1.50 to El. ~~17.67~~ 9.69

Case I
Analysis for maxium moment at lower end of member, Considered as Simply Supported @ ends.

dry Earth Pressure
9.33 x 35# = 327 #/□'
Saturated earth pressure
16.2 x 80# = 1296 #/□'
1623 #/□'

Say 1,625#/□' horizontally

$M = \frac{1}{8}\ 1625 \times \cancel{7.875}^{7.75^2} = \cancel{12,578}\ 12,200$ ft lbs

$+A_s = \frac{\cancel{150,936}\ 146,400 \text{ in lbs}}{20,000 \times .88 \times 17.5} = 0.\cancel{49}\ .47\ \square''$ Use 3/4 @ 9" c.c.

$V = \frac{1,625 \times \cancel{7.875}\ 6}{2} = \cancel{6,397}\ 4875\ \#$

bond $U_o = \frac{\cancel{6,397}\ 4875}{\cancel{2.36}\ 3.1 \times .88 \times 17.5} = \cancel{176}\ 102\ \#/\square''$

Shearing Unit Stress

$v = \frac{4,875}{12 \times .88 \times 17.5} = \cancel{345}\ 26\ \#/\square''$

Case II
Analysis for maxium moment at lower end of end wall member, Considered fixed ends

$M = \frac{1}{12}\ 1625 \times 6^2 = 4,869$ ft. lbs.

Dry earth pressure = 327 #/□'
Saturated " " = 1,296 #/□'
1,623 #/□'

$A_s = \frac{58,428''\#}{20,000 \times .88 \times 17.5} = 0.189\ \square'' = 1/2''\phi$ @ 1'-0"

Use 5/8"φ @ 1'-0" c.c.

$V = 1625 \times \frac{6}{2} = 4,875\#$

Bond $U_o = \frac{4,875}{\cancel{1.57}\ 2.0 \times .88 \times 17.5} = \cancel{26}\ 157\ \#/\square''$

Shearing Unit Stress $v = \frac{4,875}{12 \times .88 \times 17.5} = 26\ \#/\square''$

Subject: Bushnell Park Pumping Station
Computation: End Wall in Intake Conduit
Computed by: JWM. Checked by: [illegible] Date: 6-12-44

Note
Design of End Wall member moment at center @ El. 9.60
Case I
Analysis for member simply supported @ ends.

Dry Earth Pressure (9.33' x 35#) = 327 #/□'
Saturated Earth Pressure (8.1 x 80#) = 648 #/□'
975 #/□'

975 #/□' horizontally

$M = \frac{1}{8}\ 975 \times \overset{7.75}{\cancel{7.875}}^2 = \overset{7,330}{\cancel{7,557}}$ ft. lbs.

$A_s = \frac{\overset{88,000}{\cancel{90,684}}\ "\#}{20,000 \times .88 \times 17.5} = 0.29\ \square''$ Use 5/8"ϕ @ 1'-0" c.c.

$V = 975 \times \frac{\overset{6}{\cancel{7.875}}}{2} = \overset{2925}{\cancel{3,838}}\ \#$

Bond $U_o = \frac{\overset{2925}{\cancel{3,840}}}{1.95\ .88 \times 17.5} = \overset{97}{\cancel{128}}\ \#/\square''$

Shearing, Unit-stress

$v = \frac{\overset{2925}{\cancel{3,840}}}{12 \times .88 \times 17.5} = \overset{16}{\cancel{21}}\ \#/\square''$

Case II Analysis for moments at center @ El. 9.60 member Considered fixed at ends

$M = \frac{1}{12}\ 975 \times 6^2 = 2,925$ ft. lbs

$A_s\ \frac{35,100\ "\#}{20,000 \times 88 \times 17.5} = 0.114\ \square'' = 3/8"\phi$ Use 5/8"ϕ @ 1'-0" c.c.

$V = 975 \times \frac{6}{2} = 2,925\ \#$

Bond $U_o = \frac{2,925}{\overset{1.95}{\cancel{1.17}} \times .88 \times 17.5}\ \overset{97.5}{\cancel{162}}\ \#/\square''$

Shearing Unit-stress $v = \frac{2925}{12 \times .88 \times 17.5}\ 15.8\ \#/\square''$

WAR DEPARTMENT

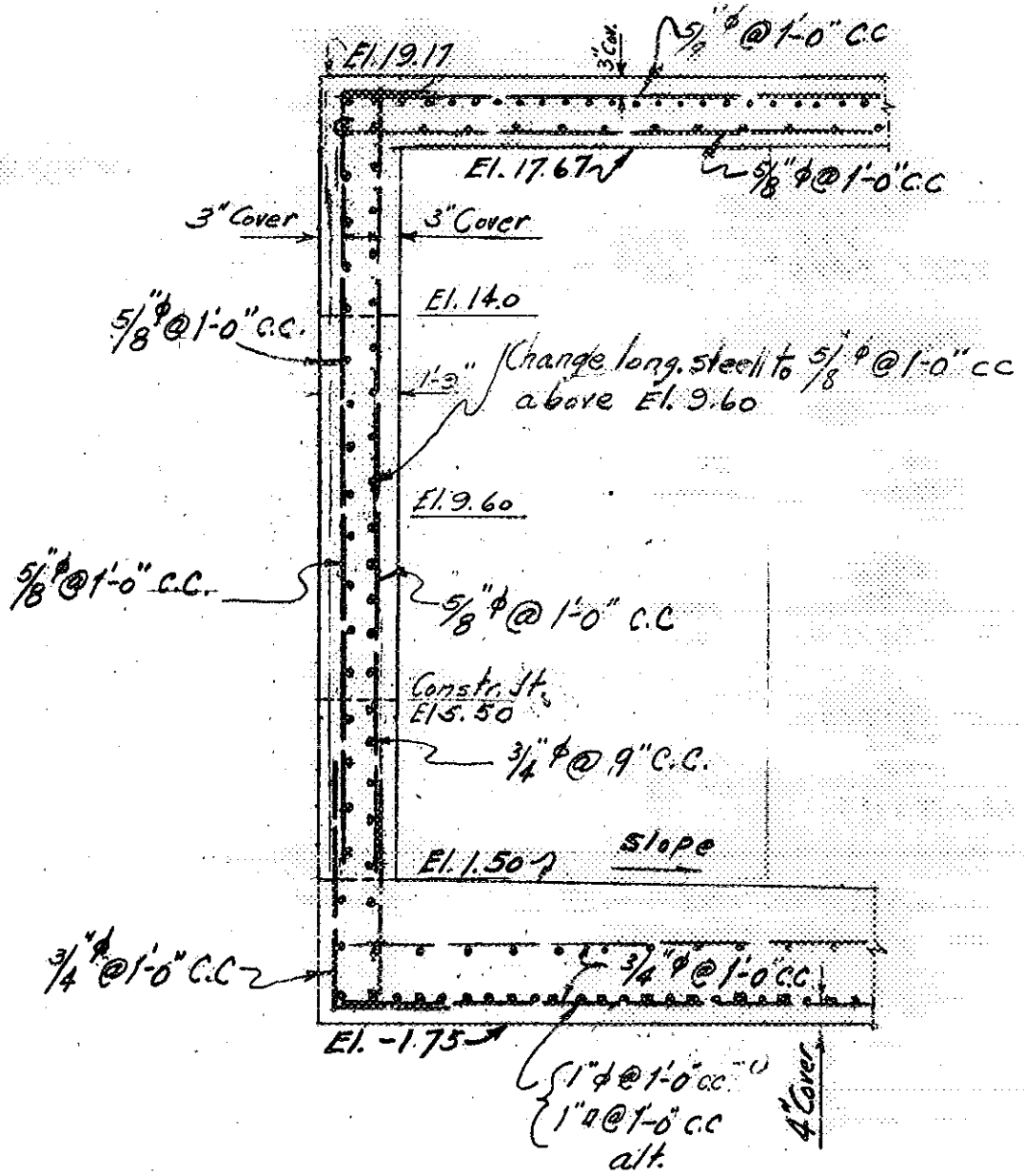
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page 142

Subject Busnell Park Pumping Station

Computation End wall in Intake Conduit from El. 1.50 to El. 17.67

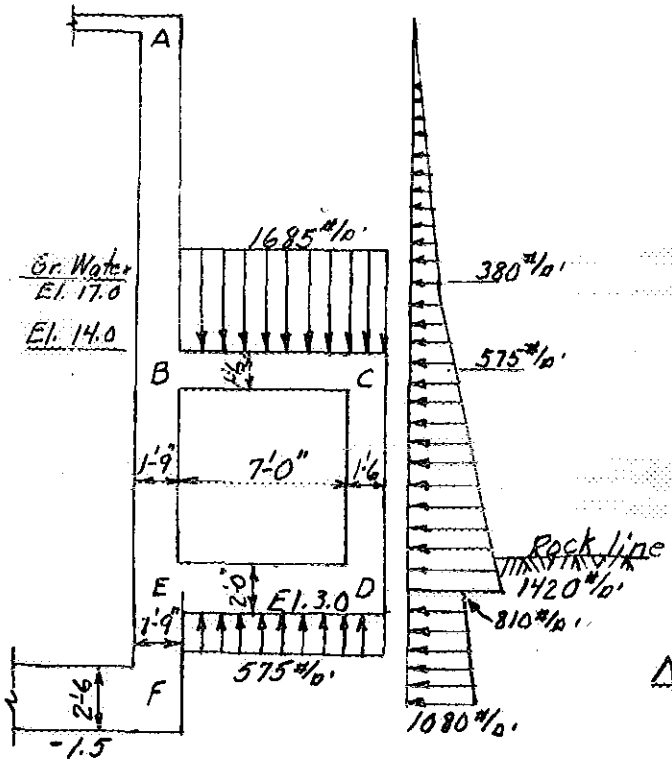
Computed by S.W.M. Checked by H.E.W. Date 6-12-44



SECTION

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H. E. [illegible] Checked by: [illegible] Date: 1 April 44

Case I Cond. empty



Section D-D

Loading -
For loading against AB, BC+CD see Section B-B

Base slab CD
Static head = 14 x 62.5 = 875
Wt. of slab = 2 x 150 = 300#
net uplift = 575#

Wall EF -
Center cond. slab = 13 x 62.5 = 810#/□'
" base slab = 17.25 x 62.5 = 1080#/□'

Fixed End Moments
For AB + CD, see Section B-B

Member BC
$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1685 \times 8.62^2 = 10.43^{'k}$

Member DE
$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 575 \times 8.62^2 = 3.56^{'k}$

Member EF
$M^F_{EF} = \frac{1}{12} \times 810 \times 4.25^2 + \frac{1}{15} \times 270 \times \frac{4.25^2}{2} = 1.38^{'k}$

$M^F_{FE} = \frac{1}{12} \times 810 \times 4.25^2 + \frac{1}{10} \times 270 \times \frac{4.25^2}{2} = 1.46^{'k}$

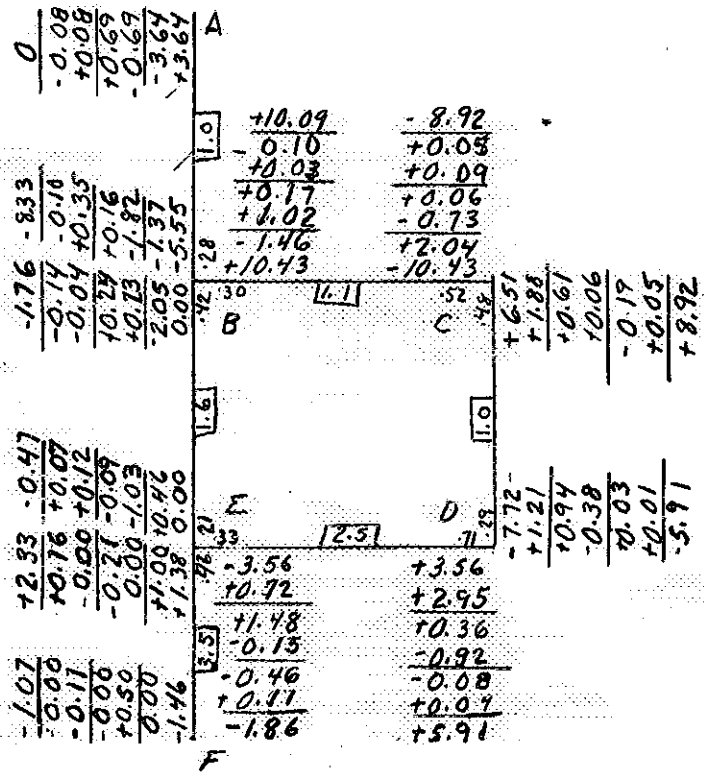
Stiffness Factors

Member	d	d^3	L	d^3/L	K
AB	21"	9261	175	52.92	1.0
BC	18"	5832	103.4	56.40	1.1
CD	18"	5832	111	52.54	1.0
DE	24"	13824	103.4	133.69	2.5
BE	21"	9261	111	83.43	1.6
EF	21	9261	51	181.59	3.5

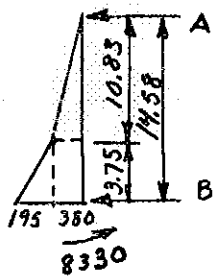
Consider frame freely supported at A and fixed at F

Subject Bushnell Park Pumping Station
Computation End Section D-D
Computed by H.E.W. **Checked by** A.L.K. **Date** 3-April-44

Case I - cont.



Member AB



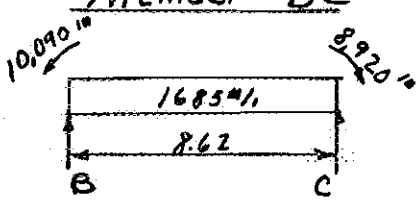
$$H_A = 380 \times 10.83 \times .5 \times .505 + 380 \times 3.75 \times .129 + 195 \times 3.75 \times .5 \times .086 - \frac{8330}{14.58} = 680^{\#}$$

$$H_B = 380 \times 10.83 \times .5 \times .495 + 380 \times 3.75 \times .871 + 195 \times 3.75 \times .5 \times .914 + \frac{8330}{14.58} = 3170^{\#}$$

$x_0 = 6.24$ from A

$$+M = 680 \times 6.24 - 6.24 \times 35 \times \frac{6.24^2}{3} \times .5 = 2830^{'\#}$$

Member BC



$$V_B = 1685 \times 8.62 \times .5 + \frac{1170}{8.62} = 7400^{\#}$$

$$V_C = 1685 \times 8.62 \times .5 - \frac{1170}{8.62} = 7130^{\#}$$

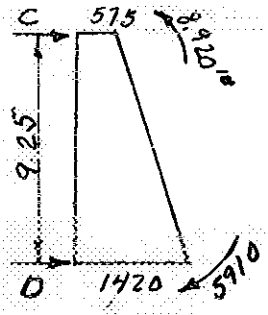
$$x_0 = \frac{7130}{1685} = 4.23' \text{ from C}$$

$$+M = 7130 \times 4.23 - 8920 - 1685 \times \frac{4.23^2}{2} = 6170^{'\#}$$

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H. E. W. Checked by: A.L.K. Date: 4 April - 44

Case I (cont.)

Member CD



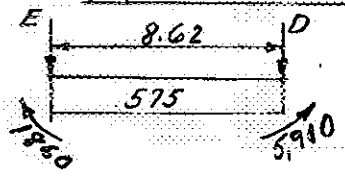
$H_C = 575 \times 9.25 \times .5 + 845 \times 9.25 \times .5 \times .33 + \frac{3010}{9.25} = 4280^{\#}$

$H_D = 575 \times 9.25 \times .5 + 845 \times 9.25 \times .5 \times .67 - \frac{3010}{9.25} = 4950^{\#}$

$4280 - 575x - 80\frac{x^2}{2} = 0 \quad x_0 = 5.4$

$+M = 4280 \times 5.4 - 8920 - 575 \times \frac{5.4^2}{2} - 432 \times \frac{5.4^2}{6} = 3710^{\#}$

Member DE



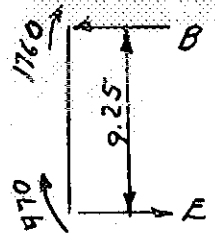
$V_E = 575 \times 8.62 \times .5 - \frac{4050}{8.62} = 2010^{\#}$

$V_D = 575 \times 8.62 \times .5 + \frac{4050}{8.62} = 2950^{\#}$

$x_0 = \frac{2010}{575} = 3.5$ from E

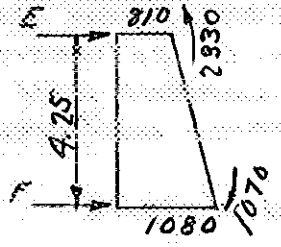
$+M = 2010 \times 3.5 - 1860 - 575 \times \frac{3.5^2}{2} = 1650^{\#}$

Member BE



$H_B = H_E = \frac{2230}{9.25} = 240^{\#}$

Member EF



$H_E = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .33 + \frac{\cancel{1540}\ 1260}{4.25} = \cancel{2270}\ 2208^{\#}$

$H_F = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .67 - \frac{\cancel{1540}\ 1260}{4.25} = \cancel{1740}\ 1805^{\#}$

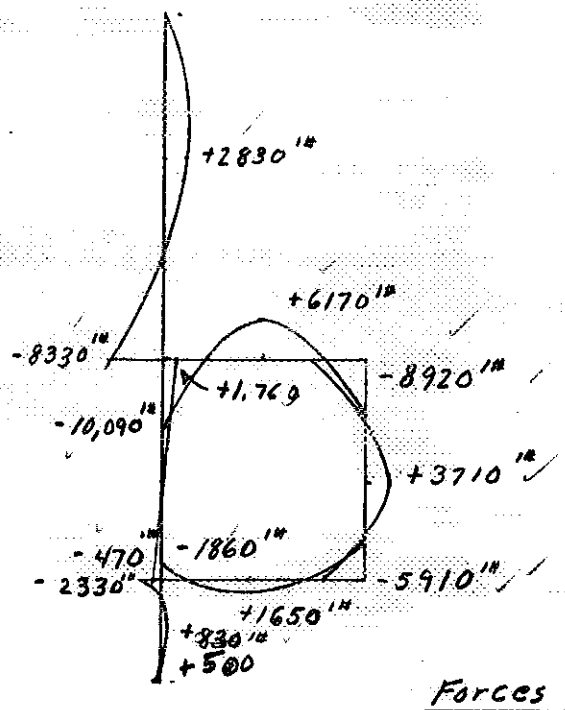
$x_0 = \cancel{2270}\ 2208 - 810x - 62.5\frac{x^2}{2} \quad x = 2.5'$ from E

$+M = \cancel{2270}\ 2208 \times 2.5 - 2330 - 810 \times \frac{2.5^2}{2} - 172 \times \frac{2.5^2}{6} = \cancel{648}\ 500^{\#}$

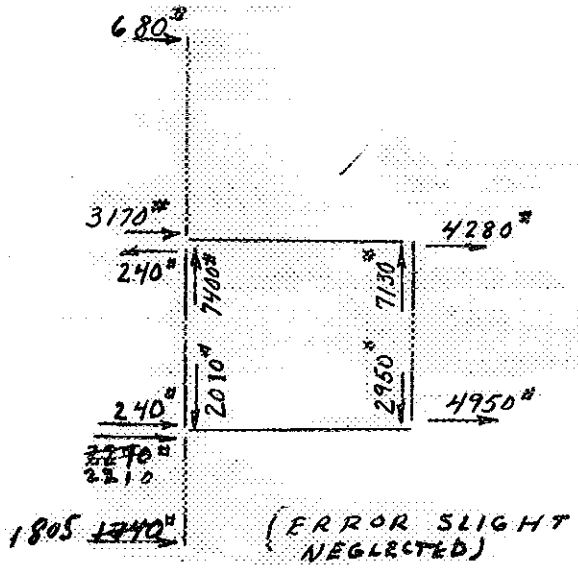
Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H.E.W. Checked by: A.L.K. Date: 3-April-44

Case I cont.

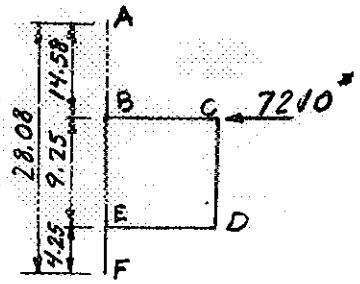
Moment Curve



End Reactions



Forces Producing Joint Deflection



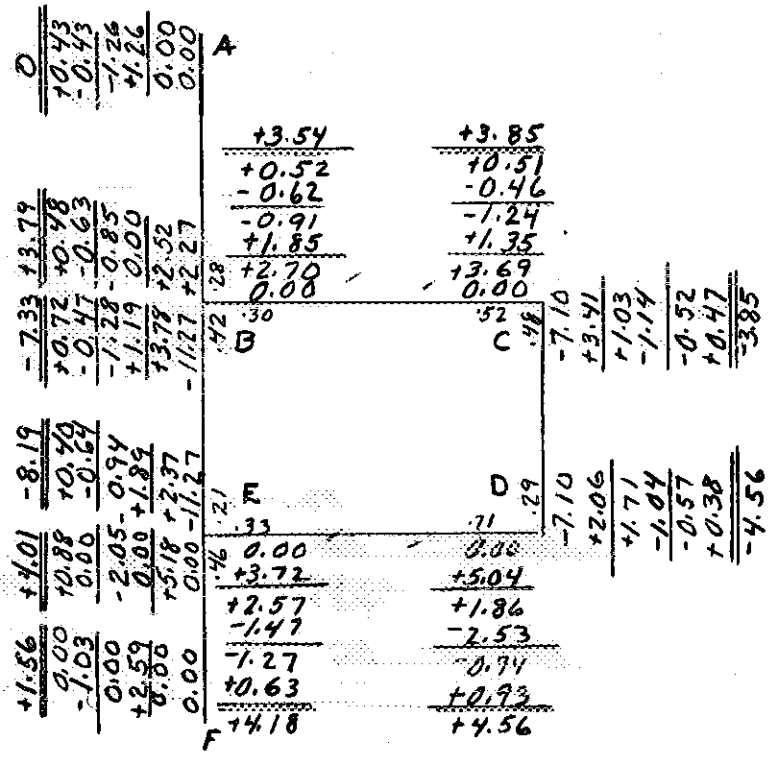
The Force inward along ED will not be considered as producing any joint deflection as the distance between pt. E + F is small. Also the base slab of the conduit will be poured against an uneven rock surface which will prevent any movement of ED inward.

Assume joints B + C will deflect inward and solve the same as Section B-B

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H.E.W. Checked by: A.L.K. Date: 6 April

Case I cont.

Fixed End Moments will be the same as in Section B-B



Member AB

$$H_B = \frac{3790}{14.58} = 260$$

Member BE

$$H_B = \frac{15.520}{9.25} = 1678$$

Member CD

$$H_C = \frac{8.410}{9.25} = 909$$

2847

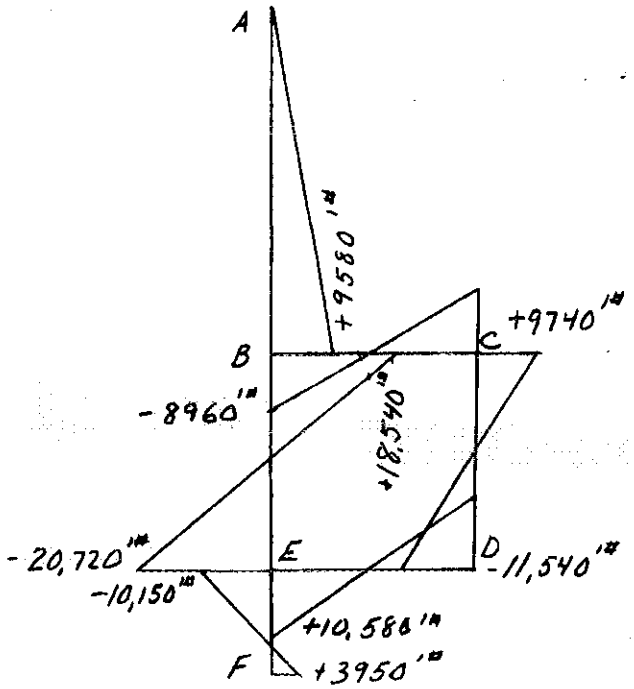
$$\text{Moment Mult.} = \frac{7210}{2847} = 2.53$$

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H.E.W. Checked by: L.-K. Date: 6-April-44

Joint Deflection (cont.) Case I

Member	Trial M	Mult.	Moment
AB @ A	0.00	2.53	0.00
@ B	+3.79	"	+9.580'#
BC @ B	+3.54	"	+8.960'#
@ C	+3.85	"	+9.740'#
CD @ C	-3.85	"	-9.740'#
@ D	-4.56	"	-11,540'#
DE @ D	+4.56	"	+11,540'#
@ E	+4.18	"	+10,580'#
BE @ B	-7.33	"	-18,540'#
@ E	-8.19	"	-20,720'#
EF @ E	+4.01	"	+10,150'#
@ F	+1.56	"	+3,950'#

Moment Curve



Reactions

Member AB

$H_A = \frac{9580}{14.58} = 660^{\#} \rightarrow \quad H_B = 660^{\#} \leftarrow$

Member BC

$V_B = \frac{18700}{8.62} = 2170^{\#} \uparrow \quad V_C = 2170^{\#} \downarrow$

Member CD

$H_C = \frac{21280}{9.25} = 2300^{\#} \leftarrow \quad H_D = 2300^{\#} \rightarrow$

Member ED

$V_E = \frac{22,120}{8.62} = 2570^{\#} \uparrow \quad V_D = 2570^{\#} \downarrow$

Member BE

$H_B = \frac{39,260}{9.25} = 4240^{\#} \leftarrow \quad H_E = 4240^{\#} \rightarrow$

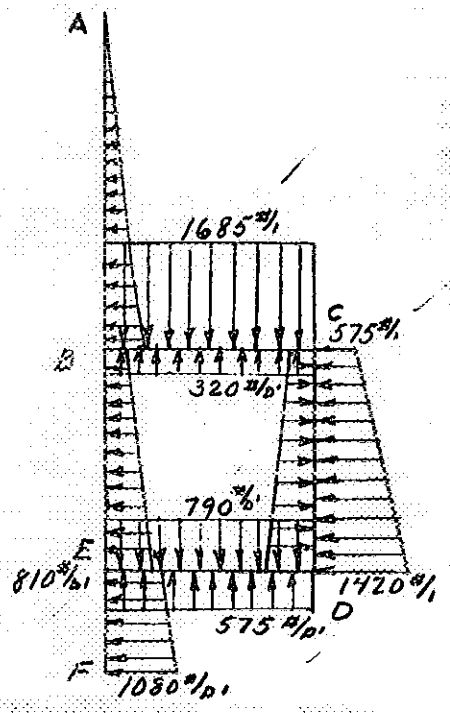
Member EF

$H_E = \frac{14100}{4.25} = 3320^{\#} \rightarrow \quad H_F = 3320^{\#} \leftarrow$

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H. E. W. Checked by: A. L. K. Date: 6 April - 44

Case II

Case II - Cond. full of water



Water Pressure in Conduit

$(17.67 - 12.5)\,62.5 = 320\ \#/\square'$

$(17.67 - 5.0)\,62.5 = 790\ \#/\square'$

Fixed End Moments

Member AB & EF will be the same as in Case I

Member BC

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1365 \times 8.62^2 = 8.45^{'K}$

Member DE

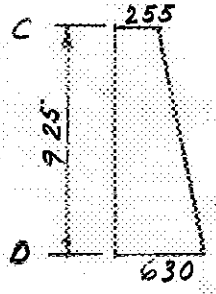
There will be no fixed end moments as net pressure is down.

Member BE

$M^F_{BE} = \frac{1}{12} \times 320 \times 9.25^2 + \frac{1}{15} \times 470 \times \frac{9.25^2}{2} = 3.62^{'K}$

$M^F_{EB} = \frac{1}{12} \times 320 \times 9.25^2 + \frac{1}{10} \times 470 \times \frac{9.25^2}{2} = 4.29^{'K}$

Member CD

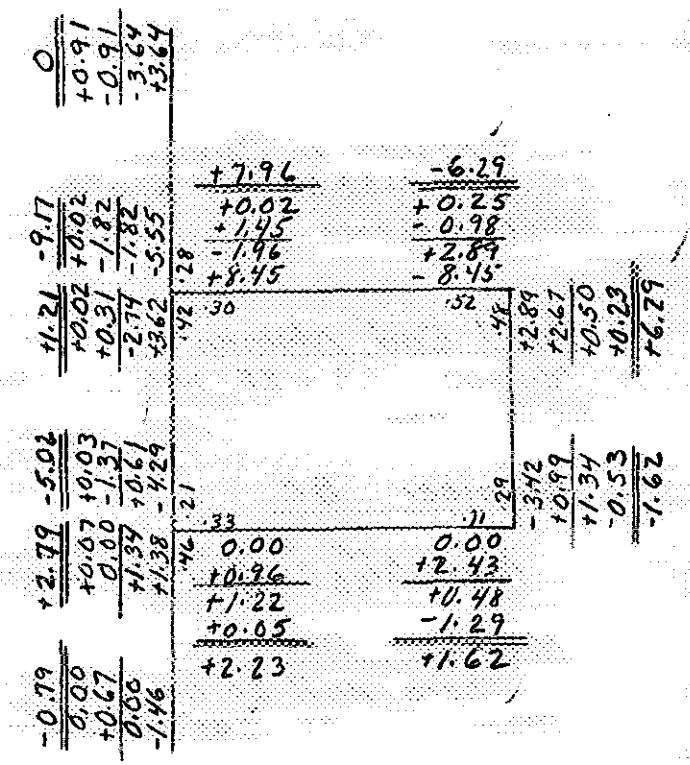


$M^F_{CD} = \frac{1}{12} \times 255 \times 9.25^2 + \frac{1}{15} \times 375 \times \frac{9.25^2}{2} = 2.89^{'K}$

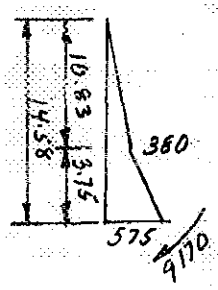
$M^F_{DC} = \frac{1}{12} \times 255 \times 9.25^2 + \frac{1}{10} \times 375 \times \frac{9.25^2}{2} = 3.42^{'K}$

Subject: Bushnell Park Pumping Station
Computation: End Section B-D
Computed by: H.E.W. Checked by: A.L.K. Date: 1- April- 44

Case II (cont.)



Member AB



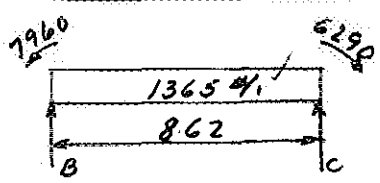
$$H_A = 380 \times 10.83 \times .5 \times .505 + 380 \times 3.75 \times .129 + 195 \times 3.75 \times .5 \times .086 - \frac{9170}{14.58} = 670^{\#}$$ 626

$$H_B = 380 \times 10.83 \times .5 \times .495 + 380 \times 3.75 \times .871 + 195 \times 3.75 \times .5 \times .914 + \frac{9170}{14.58} = 3180^{\#}$$ 3230

$$x_0 = \cancel{6.2}\ 6$$

$$+M = 670 \times \frac{6.2}{6} - \frac{\cancel{6.2}\ 6 \times 3.5 \times \cancel{6.2}\ 6^2 \times .5}{3} = 2760^{'\#}$$

Member BC



$$V_B = 1365 \times 8.62 \times .5 + \frac{1670}{8.62} = 6080^{\#}$$

$$V_C = 1365 \times 8.62 \times .5 - \frac{1670}{8.62} = 5690^{\#}$$

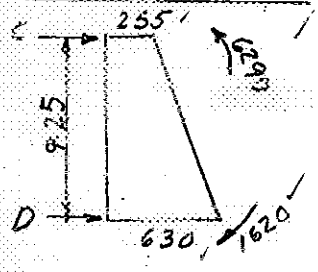
$$x_0 = \frac{5690}{1365} = 4.17 \text{ from } C$$

$$+M = 5690 \times 4.17 - 6290 - 1365 \times \frac{4.17^2}{2} = 5570^{'\#}$$

Subject: Bushnell Park Pumping Station
Computation: Section D-D
Computed by: H.E.W. Checked by: A.L.K. Date: 1 April '44

Case II (cont.)

Member CD



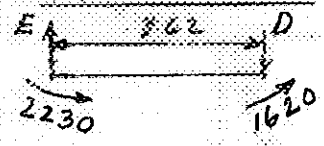
$H_C = 255 \times 9.25 \times .5 + 375 \times 9.25 \times .5 \times .33 + \frac{4670}{9.25} = 2260^{\#}$

$H_D = 255 \times 9.25 \times .5 + 375 \times 9.25 \times .5 \times .67 - \frac{4670}{9.25} = 1840^{\#}$

$2260 - 255x - 40.6\frac{x^2}{2}$ $x = 6.0$ from C

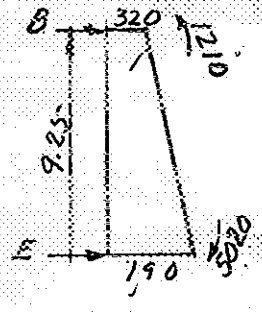
$+M = 2260 \times 6 - 6290 - 255 \times \frac{36}{2} - 244 \times \frac{6^2}{6} = 1220^{\prime\prime\#}$

Member DE



$V_D = V_E = \frac{3850}{8.62} = 450^{\#}$

Member BE



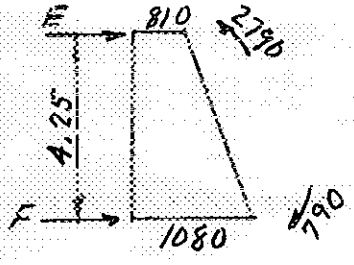
$H_B = 320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .33 - \frac{3810}{9.25} = 1790^{\#}$

H_E $320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .67 + \frac{3810}{9.25} = 3350^{\#}$

$x_0 = 1790 - 320x - 51\frac{x^2}{2}$ $x = 4.2$

$+M = 1790 \times 4.2 - 320 \times \frac{4.2^2}{2} - 213 \times \frac{4.2^2}{6} - 1210 = 2860^{\prime\prime\#}$

Member EF



$H_E = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .33 + \frac{2000}{4.25} = 2380^{\#}$

$H_F = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .67 - \frac{2000}{4.25} = 1640^{\#}$

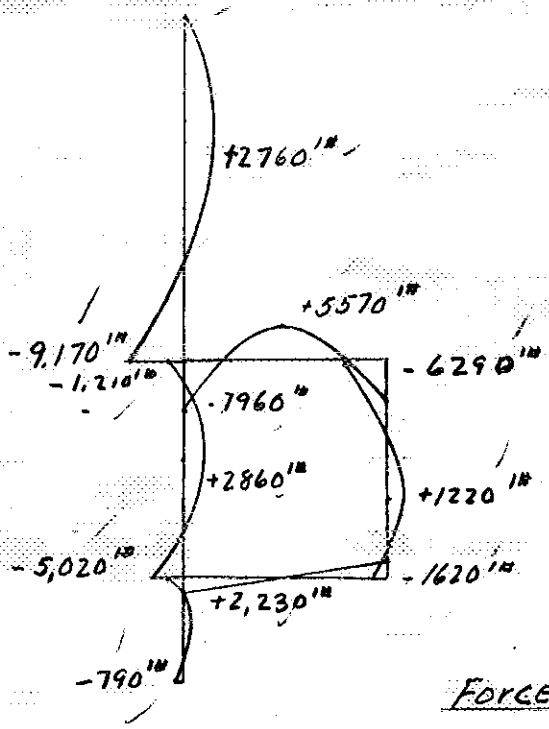
$x_0 = 2380 - 810x - 62.5\frac{x^2}{2}$ $x = 2.65$ from E

$M = 2240 \times 2.65 - 2790 - 810 \times \frac{2.65^2}{2} - 166 \times \frac{2.65^2}{6} = 170^{\prime\prime\#}$

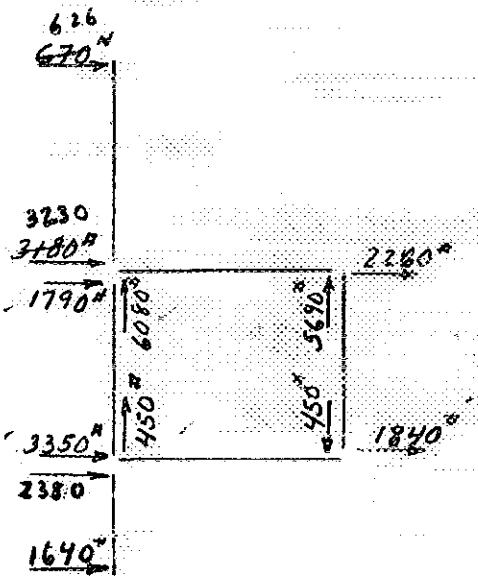
Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H.E.W. Checked by: H.L.K. Date: 7-April-44

Case II (cont.)

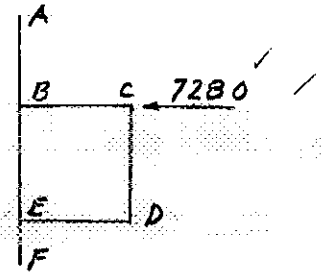
Moment Curve



End Reactions



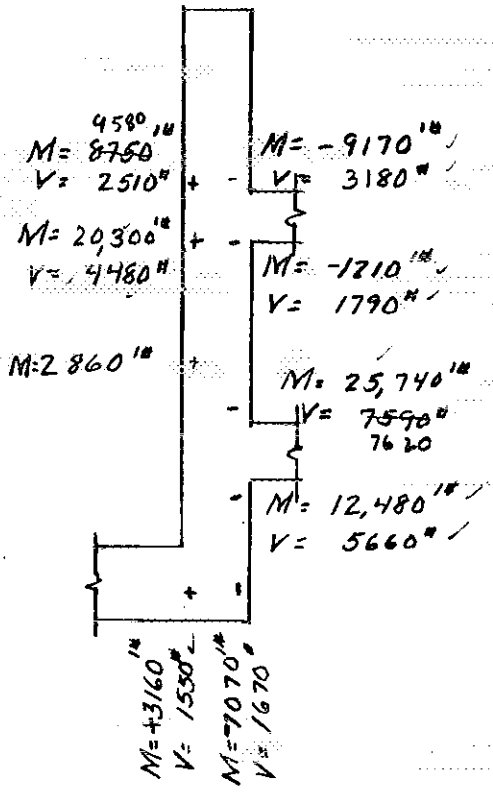
Force Producing Joint Deflection



Moment and shear values for joint deflection will be the same as in Case I

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H.E.W. Checked by: A.L.K. Date: 7-April-44

Design of Members



$$\text{req'd } d = \sqrt{\frac{25,740}{139}} = 13.6 < 17.5''$$

$$v = \frac{7590\ (7620)}{12 \times .89 \times 17.5} = 41\ \#/\square''$$

$$- A_s = \frac{25,740 \times 12}{20,000 \times .89 \times 17.5} = .99\ \square'' \quad \text{Use } 1''\phi @ 1'\text{-}0''cc$$

$$u_o = \frac{7620}{4.2 \times .89 \times 17.5} = 117\ \#/\square''$$

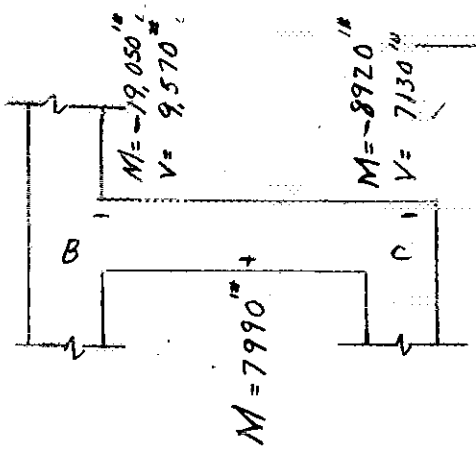
$$- A_s = \frac{9170 \times 12}{20,000 \times .89 \times 17.5} = .35\ \square'' \quad \text{Use } 3/4''\phi @ 1'\text{-}0''cc$$

$$u_o = \frac{3180}{2.4 \times .89 \times 17.5} = 85\ \#/\square''$$

$$+ A_s = \frac{20,300 \times 12}{20,000 \times .89 \times 18.5} = .74\ \square'' \quad \text{Use } 1''\phi @ 12''cc$$

$$u_o = \frac{4480}{3.1 \times .89 \times 18.5} = 88\ \#/\square''$$

$$+ A_s = \frac{8750\ (9580) \times 12}{20,000 \times .89 \times 18.5} = .32\ (.35)\ \square''$$



Max Pos. M-

$V_c = 3520 \quad M_c = +3450'^{\#}$

$$x_o = \frac{3520}{1365} = 2.58' \text{ from C}$$

$$+M = 3520 \times 2.58 + 3450 - 1365 \times \frac{2.58^2}{2} = 7990'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{19,050}{139}} = 11.7'' < 14.5'' \text{ OK}$$

$$v = \frac{9570}{12 \times .89 \times 14.5} = 62\ \#/\square'' \text{ OK}$$

$$- A_s = \frac{19,050 \times 12}{20,000 \times .89 \times 14.5} = .88\ \square'' \quad \text{Use } 3/4''\phi @ 6''cc$$

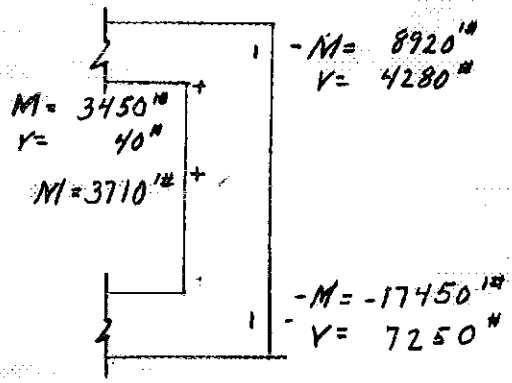
$$u_o = \frac{9570}{4.7 \times .89 \times 14.5} = 157\ \#/\square'' \text{ OK}$$

$$+ A_s = \frac{7990 \times 12}{20,000 \times .88 \times 14.5} = .37\ \square'' \quad \text{Use } 3/4''\phi @ 12''cc.$$

Subject: Bushnell Park Pumping Station
Computation: End Section D-D
Computed by: H. E. W. Checked by: A. L. K. Date: 7- April- 44

Design of Members (cont.)

Wall CD



$$\text{req'd } d = \sqrt{\frac{17450}{139}} = 11.2'' < 14.5''$$

$$V = \frac{7250}{12 \times .89 \times 14.5} = 47\ \#/\square''$$

$$-A_s = \frac{17450 \times 12}{20{,}000 \times .89 \times 14.5} = .81\ \square'' \quad \underline{3/4''\phi @ 6''cc}$$

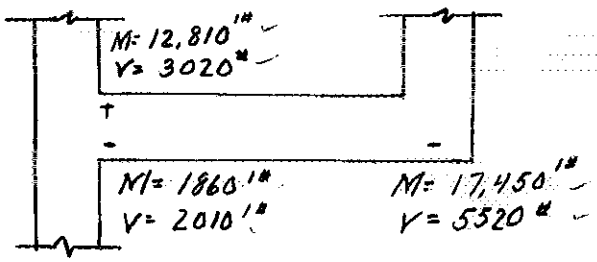
$$u_o = \frac{7250}{4.7 \times .89 \times 14.5} = 119\ \#/\square'' \text{ OK}$$

$$-A_s = \frac{8920 \times 12}{20{,}000 \times .89 \times 14.5} = .42\ \square'' \quad \underline{\text{Use } 3/4''\phi @ 12''cc}$$

$$u_o = \frac{4280}{2.4 \times .89 \times 14.5} = 138\ \#/\square''$$

$+A_s =$ Use 3/4"φ @ 12"cc

Base DE



$$V = \frac{5520}{12 \times .89 \times 19.5} = 27\ \#/\square''$$

$$-A_s = \frac{17450 \times 12}{20{,}000 \times .89 \times 19.5} = .60\ \square''$$

Use 3/4"φ @ 6"cc

$$+A_s = \frac{12810 \times 12}{20{,}000 \times .89 \times 20.5} = .42\ \square''$$

Use 3/4"φ @ 12"cc

$$u_o = \frac{3020}{2.4 \times .89 \times 20.5} = 70\ \#/\square''$$

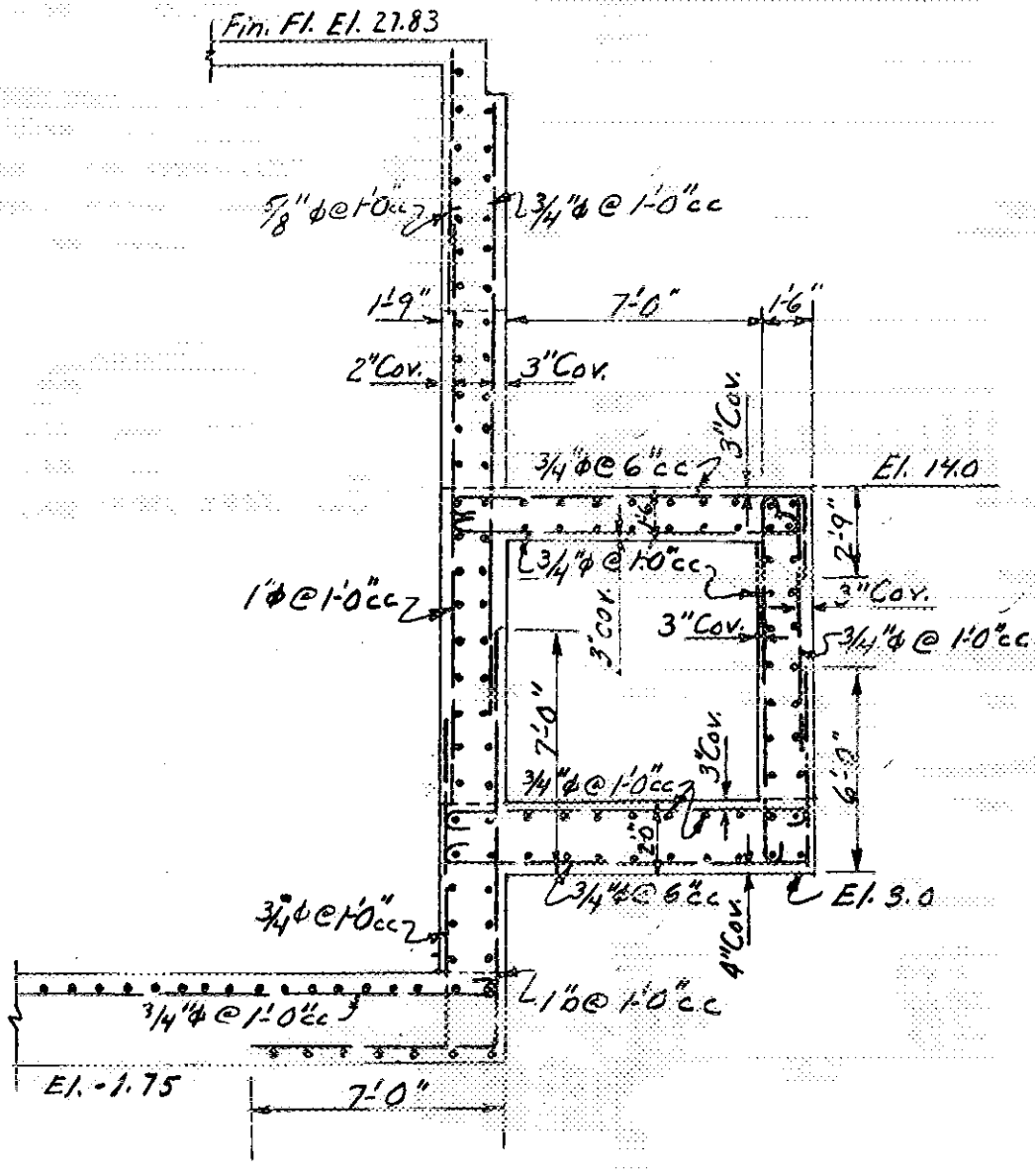
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

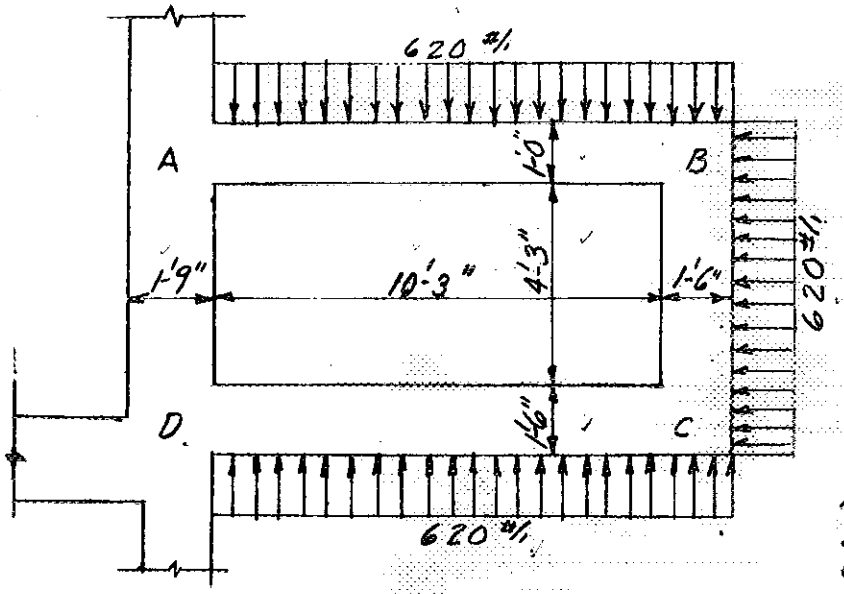
Computation End Section D-D

Computed by H.E.W. **Checked by** A.L.R. **Date** 7-April-44



Section D-D

Subject Bushnell Park Pumping Station
Computation Gravity Flow Gate Chamber
Computed by H. E. K. **Checked by** A. L. K. **Date** 8 April 44



Eq. Pressure at El. 14.
$10.83 \times 35 + 3 \times 80 = 620$ #/'

Design Assumptions
Section will be designed as a continuous frame with fixed points at A and D

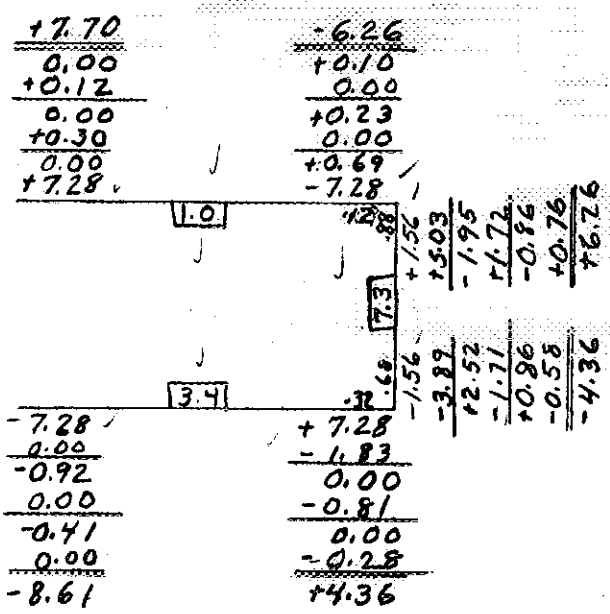
Stiffness

	d^3	L	d^3/L	K
AB	1728	142.5	12.1	1.0
BC	5832	66	88.4	7.3
CD	5832	142.5	40.9	3.4

Fixed End Moments

Member AB & DC
$M^F = \frac{1}{12} \times 620 \times 11.87^2 = 7.28$ 'K

Member BC
$M^F = \frac{1}{12} \times 620 \times 5.5^2 = 1.56$ 'K



Subject: Bushnell Park Pumping Station
Computation: Gravity Flow Gate Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 8-April-44

Pos. Moments and End Reactions

Member AB

$H_A = 620 \times 11.87 \times .5 + \frac{1440}{11.87} = 3800^{\#}$

$H_B = 620 \times 11.87 \times .5 - \frac{1440}{11.87} = 3560^{\#}$

$x_0 = \frac{3800}{620} = 6.13'$ from A

$+M = 3800 \times 6.13 - 7,700 - 620 \times \frac{6.13^2}{2} = 3,950^{'\#}$

Member BC

$H_B = 620 \times 5.5 \times .5 + \frac{1900}{5.5} = 2050^{\#}$

$H_C = 620 \times 5.5 \times .5 - \frac{1900}{5.5} = 1360^{\#}$

$x_0 = \frac{2050}{620} = 3.30'$ from B

$+M = 2050 \times 3.30 - 6,260 - 620 \times \frac{3.30^2}{2} = -2870$ - No + M

Member CD

$H_C = 620 \times 11.87 \times .5 - \frac{4250}{11.87} = 3320^{\#}$

$H_D = 620 \times 11.87 \times .5 + \frac{4250}{11.87} = 4040^{\#}$

$x_0 = \frac{3320}{620} = 5.35'$ from C

$+M = 3320 \times 5.35 - 4360 - 620 \times \frac{5.35^2}{2} = 4530^{'\#}$

Design of Members

Member AB

req'd d: $\sqrt{\frac{3700}{139}} = 7.45'' < 8.0''$ OK

$v = \frac{3800}{12 \times .88 \times 8.0} = 45^{\#}/\square''$

$-A_s = \frac{3700 \times 12}{20,000 \times .88 \times 8.0} = .66^{\square''}$ use $\frac{7}{8}''\phi$ @ 1'-0" c.c.

$u_0 = \frac{3800}{2.8 \times .88 \times 8.0} = 193^{\#}/\square''$

Subject: Bushnell Park Pumping Station
Computation: Gravity Flow Gate Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 8-April-44

Design of Members (cont.)

7/8"φ may be changed to 3/4"φ @ El. 19.00

$+A_s = \frac{3950 \times 12}{20{,}000 \times .89 \times 8} = .33 \square''$ Use 5/8"φ @ 1'-0" cc

Member DC

reqd $d = \sqrt{\frac{8610}{139}} = 7.9'' < 14''$ OK.

$V = \frac{4040}{12 \times .88 \times 14} = 27\ \#/\square''$

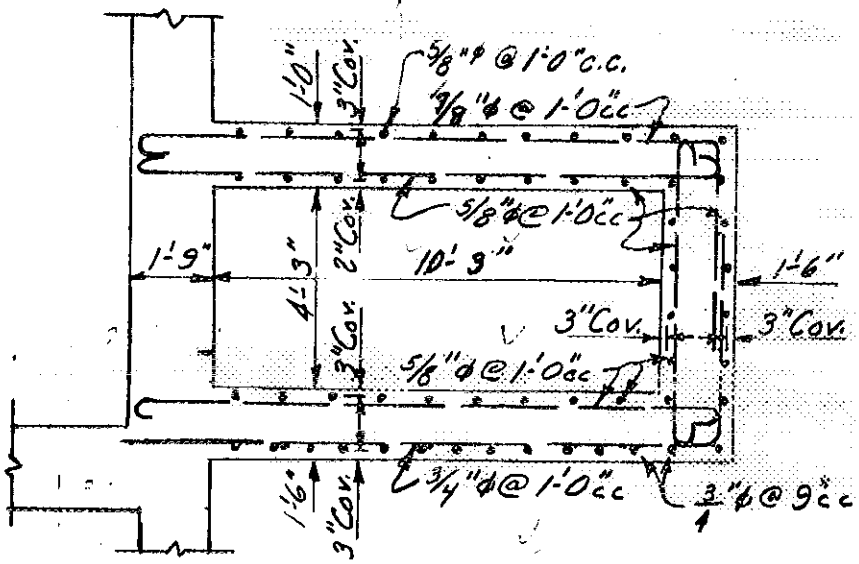
$-A_s = \frac{8610 \times 12}{20{,}000 \times .88 \times 14} = .42 \square''$ Use 3/4"φ @ 1'-0" cc

$u_0 = \frac{4040}{2.4 \times .88 \times 14.0} = 137\ \#/\square''$

$+A_s \frac{4530 \times 12}{20{,}000 \times .89 \times 14} = .22 \square''$ Use 5/8"φ @ 12" cc

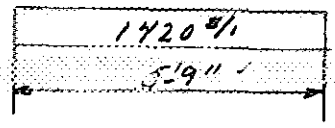
Member BC

+As - Use 5/8"φ @ 12" cc



Subject: Bushnell Park Pumping Station
Computation: Gravity Flow Gate Chamber
Computed by: H. E. W. Checked by: A. L. K. Date: 10 - April - 47

The portion of the gate chamber below El. 12.5 will be designed as a horiz. beam with a span of 5.5 ft.



$M = \frac{1}{10} \times 1420 \times 5.75^2 = 4690^{'\#}$

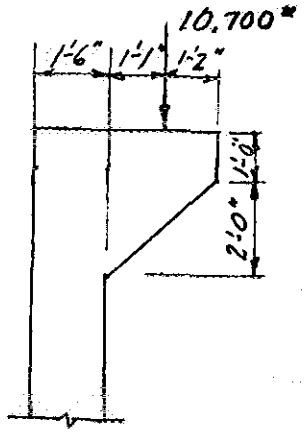
$V = 1420 \times 5.75 \times .5 = 4080^{\#}$

$v = \frac{4080}{12 \times .88 \times 14} = 28^{\#/\square''}$

$A = \frac{4690 \times 12}{20{,}000 \times .88 \times 14} = .23^{\square''}$ Use 5/8"ϕ both faces @ 1'-0" cc

$u_0 = \frac{4080}{1.96 \times .88 \times 14} = 169^{\#/\square''}$ O.K.

Gate Stand Haunch



Assume 32000# load is spread out over 3 ft. of width = 10700 #/'

$V = 10{,}700 + 1 \times 2.25 \times 150 + 2 \times 2.25 \times .5 \times 150$
$= 11{,}380^{\#}$

$M = 10{,}700 \times 1.08 + 338 \times \frac{2.25}{3} + 338 \times \frac{2.25}{3} = 12{,}200^{'\#}$

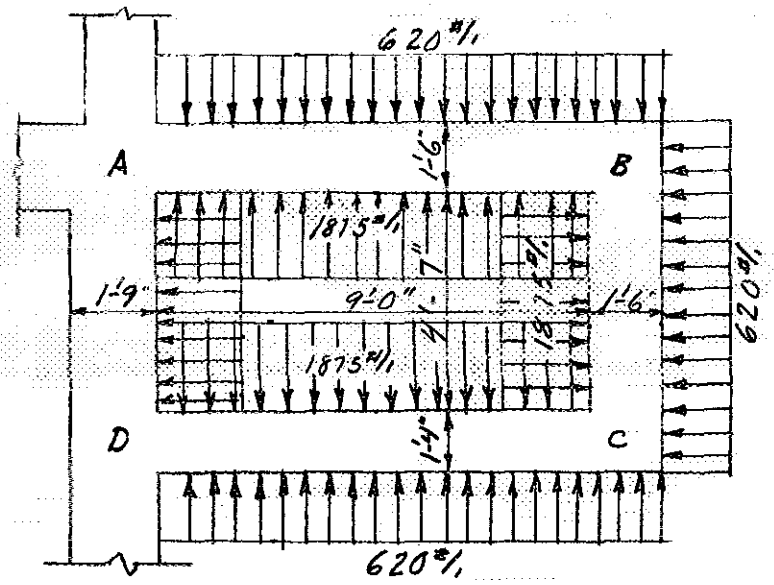
d req'd by shear $= \frac{11380}{60 \times .88 \times 12} = 18'' < 32''$ OK

Moment will be critical at base of haunch

req'd $d = \sqrt{\frac{12{,}200}{139}} = 9.4'' < 14.6''$ OK

$A_s = \frac{12{,}200 \times 12}{20{,}000 \times .88 \times 14.6} = .58^{\square''}$ Use 3/4"ϕ @ 9" cc

Subject Roosevelt Park Pumping Station
Computation Discharge Conduit Gate Chamber
Computed by H.E.W. **Checked by** A.L.K. **Date** 10, April 44



External Loading

Ea. pressure at El. 140 = 620#/□'

Internal Loading

Water pressure
(44 - 14) x 62.5 = 1875#/□'

Stiffness

	d^3	L	d^3/L	K
AB	5832	127.5	45.74	2.1
BC	5832	72	81.00	3.8
CD	2744	127.5	21.52	1.0

Case I - No internal pressure

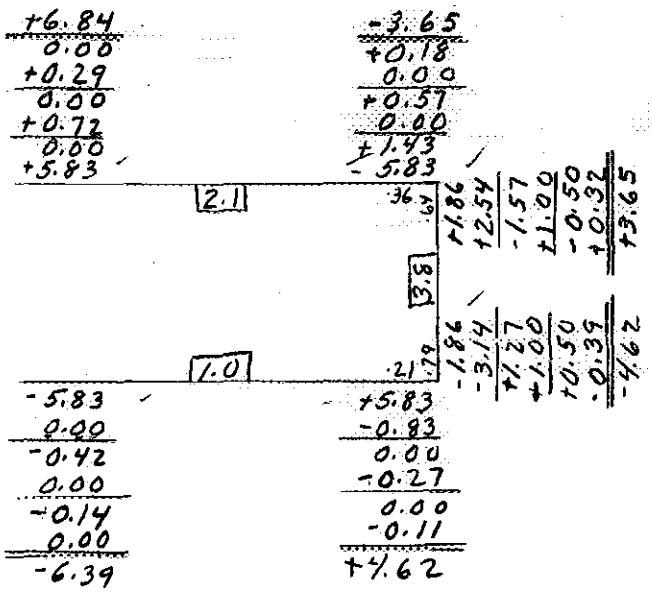
Fixed End Moments

Member AB + CD

$M^F = \frac{1}{12} \times 620 \times 10.62^2 = 5.83$ 'K

Member BC

$M^F = \frac{1}{12} \times 620 \times 6^2 = 1.86$ 'K



Subject: Bushnell Park Pumping Station
Computation: Discharge Conduit Gate Chamber
Computed by: H.E.W. Checked by: [illegible] Date: 10 - April [illegible]

Case I (cont)

Pos. Moments and End Reactions

Member AB

$H_A = 620 \times 10.62 \times .5 + \frac{3190}{10.62} = 3590^{\#}$

$H_B = 620 \times 10.62 \times .5 - \frac{3190}{10.62} = 2990^{\#}$

$x_0 = \frac{3590}{620} = 5.8'$ from A

$+M = 3590 \times 5.8 - 6610 - 620 \times \frac{5.8^2}{2} = 3790'^{\#}$

Member BC

$H_B = 620 \times 6 \times .5 - \frac{970}{6} = 1700^{\#}$

$H_C \quad 620 \times 6 \times .5 + \frac{970}{6} = 2020^{\#}$

$x_0 = \frac{1700}{620} = 2.74$ from B

$+M = 1700 \times 2.74 - 3650 - 620 \times \frac{2.74^2}{2} = -1320$ No pos. M.

Member CD

$H_C = 620 \times 10.62 \times .5 - \frac{1770}{10.62} = 3130^{\#}$

$H_D = 620 \times 10.62 \times .5 + \frac{1770}{10.62} = 3460^{\#}$

$x_0 = \frac{3130}{620} = 5'$ from C

$+M = 3130 \times 5 - 4620 - 620 \times \frac{25}{2} = 3280'^{\#}$

Case II - Internal & External Loading

Fixed End Moments

Member AB & CD

$M^F = \frac{1}{12} \times 1255 \times 10.62^2 = 11.80'^{K}$

Member BC

$M^F = \frac{1}{12} \times 1255 \times 6^2 = 3.77'^{K}$

Subject: Bushnell Park Pumping Station
Computation: Discharge Conduit Gate Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 10-April-44

Case II (cont.)

A	B	C	D
-13.82	+7.41		
0.00	-0.36		
-0.57	0.00		
0.00	-1.14		
-1.45	0.00		
0.00	-2.89		
-11.80	+11.80		
	.36 / .64		
	-3.77		
	-5.14		
	+3.17		
	-2.03		
	+1.01		
	-0.65		
	-7.41		
		.79 / .21	
		+3.77	
		+6.34	
		-2.57	
		+2.03	
		-1.01	
		+0.81	
		+9.37	
+11.80		-11.80	
0.00		+1.69	
+0.85		0.00	
0.00		+0.54	
+0.27		0.00	
0.00		+0.21	
+12.92		-9.36	

Pos. Moments & End Reactions

Member AB

$$H_A = 1255 \times 10.62 \times .5 + \frac{6410}{10.62} = 7270^{\#}$$

$$H_B = 1255 \times 10.62 \times .5 - \frac{6410}{10.62} = 6060^{\#}$$

$$x_0 = \frac{7270}{1255} = 5.8' \text{ from } A$$

$$+M = 7270 \times 5.8 - 13{,}820 - 1255 \times \frac{5.8^2}{2} = 7240'^{\#}$$

Member BC

$$H_B = 1255 \times 6 \times .5 - \frac{1960}{6} = 3440^{\#}$$

$$H_C = 1255 \times 6 \times .5 + \frac{1960}{6} = 4090^{\#}$$

$$x_0 = \frac{3440}{1255} = 2.74 \text{ from } B$$

$$M = 3440 \times 2.74 - 7410 - 1255 \times \frac{2.74^2}{2} = -2695 \text{ '}^{\#} + M$$

Subject: Bushnell Park Pumping Station
Computation: Discharge Cond. Gate Chamber
Computed by: H. E. W. Checked by: H. L. K. Date: 10 April 44

Case II cont.

Member CD

$H_C = 1255 \times 10.62 \times .5 - \frac{3560}{10.62} = 6330^{\#}$

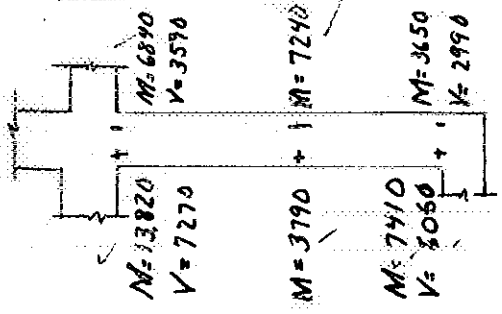
$H_D = 1255 \times 10.62 \times .5 + \frac{3560}{10.62} = 7000^{\#}$

$x_0 = \frac{6330}{1255} = 5'$ from C

$+M = 6330 \times 5 - 9360 - 1255 \times \frac{25}{2} = 6600^{\#}$

Design of Members

Member AB



req'd $d = \sqrt{\frac{13820}{139}} = 10'' < 14$ OK

$v = \frac{7270}{12 \times .88 \times 14} = 49^{\#}/\square''$

$-A_s = \frac{7240 \times 12}{20{,}000 \times .89 \times 14} = .35^{\square''}$ $\frac{3}{4}''\phi$ @ 1'-0" cc

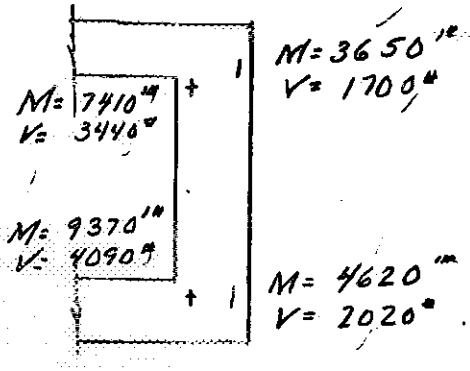
$u = \frac{3590}{2.4 \times .88 \times 14} = 121^{\#}/\square''$

$+A_s = \frac{13820 \times 12}{20{,}000 \times .88 \times 14} = .67^{\square''}$ Try $\frac{3}{4}''\phi$ @ 6" cc

$u_0 = \frac{7270}{4.7 \times .88 \times 14} = 126^{\#}/\square''$

Effect of direct tension will not produce an f_s exceeding $20{,}000^{\#}/\square''$

Member BC



$-A_s$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

$+A_s = \frac{9370 \times 12}{20{,}000 \times .88 \times 14} = .46^{\square''}$ Use $\frac{3}{4}''\phi$ @ 9" cc

$u_0 = \frac{4090 \times 12}{3.1 \times .88 \times 14} = 130^{\#}/\square''$

Direct Tension $= 6330^{\#}$ $A_s = .59$

$p = \frac{.59}{12 \times 13.9} = .0035$ $k = .251$ $j = .916$

$kd = .251 \times 13.9 = 3.5''$

Subject: Bushnell Park Pumping Station
Computation: Discharge Cond. Gate Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 10 - April - 44

Member BC

$$f_c'' = \frac{2 \times 9370 \times 12}{12 \times .251 \times .916 \times 13.9^2} = 422 \text{ \#/□"}$$

$f_c = 67$ #/□" by trial

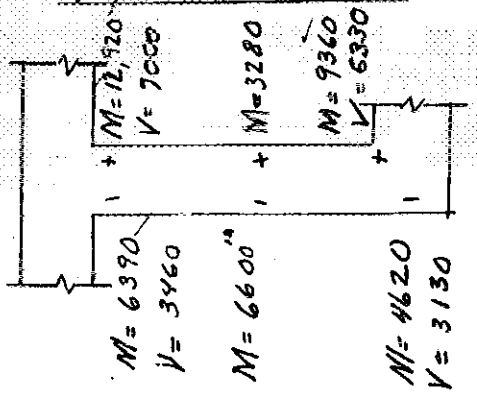
Reduced conc. stress $= \frac{1}{2}(2.94+3.50)(67)(12) = 2590$#

Increase in unit $f_s = \frac{6330 - 2590}{.59} = 6340$ #/□"

f_s for bending $= \frac{9370 \times 12}{.59 \times .88 \times 13.9} = 15,600$ #/□"

Total $f_s = 21,940$ #/□" OK

Member CD



req'd $d = \sqrt{\frac{12,920}{139}} = 9.65" < 12"$ OK

$V = \frac{7000}{12 \times .88 \times 12} = 55$ #/□"

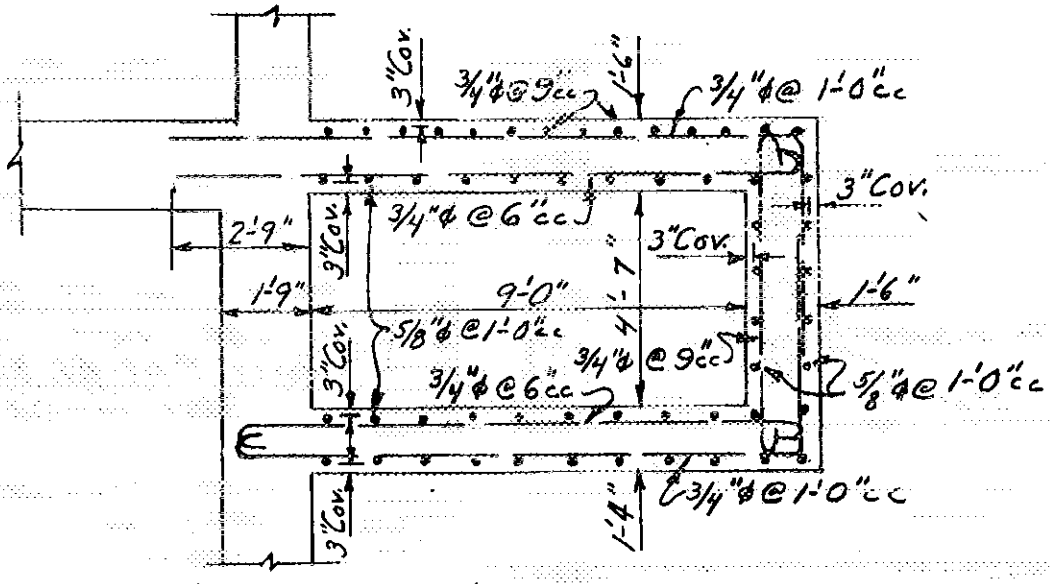
$-A_s = \frac{6600 \times 12}{20,000 \times .89 \times 12} = .37$ □" use $\frac{3}{4}$"ϕ @ 1'-0" cc

$u_0 = \frac{3460}{2.4 \times .89 \times 12} = 135$ #/□"

$+A_s = \frac{12,920 \times 12}{20,000 \times .89 \times 12} = .73$ □" use $\frac{3}{4}$"ϕ @ 6" cc

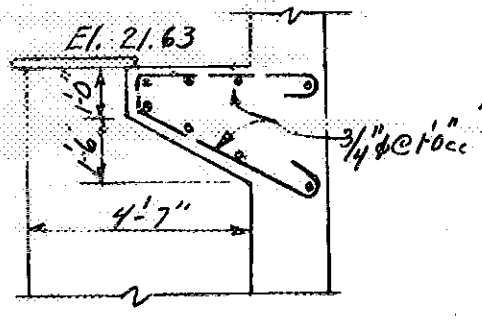
The effect of direct tension will not cause f_s to exceed 21000 #/□"

Subject: Bushnell Park Pumping Station
Computation: Discharge Conduit Gate Chamber
Computed by: H.E.W. Checked by: A.L.W. Date: 11 April 47



Section from El. 14.0 to 21.63

Stuffing Box Haunch



Water pressure against bottom of haunch
$(44-21) \times 62.5 = 1440$ #/□'

M at face of haunch $= 3.58 \times 1440 \times 1.79 = 9230$ '#

V " " " $3.58 \times 1440 = 5160$ #

$$v = \frac{5160}{12 \times .88 \times 24} = 20 \text{ \#/□"}$$

$$A_s = \frac{9230 \times 12}{20{,}000 \times .88 \times 24} = .26 \text{ □"} \quad \text{use } 3/4\text{"}\phi \text{ @ } 1'\text{-}0\text{" cc}$$

$$u_0 = \frac{5160}{2.4 \times .88 \times 24} = 102 \text{ \#/□"} \quad \text{OK}$$

Cover Plate

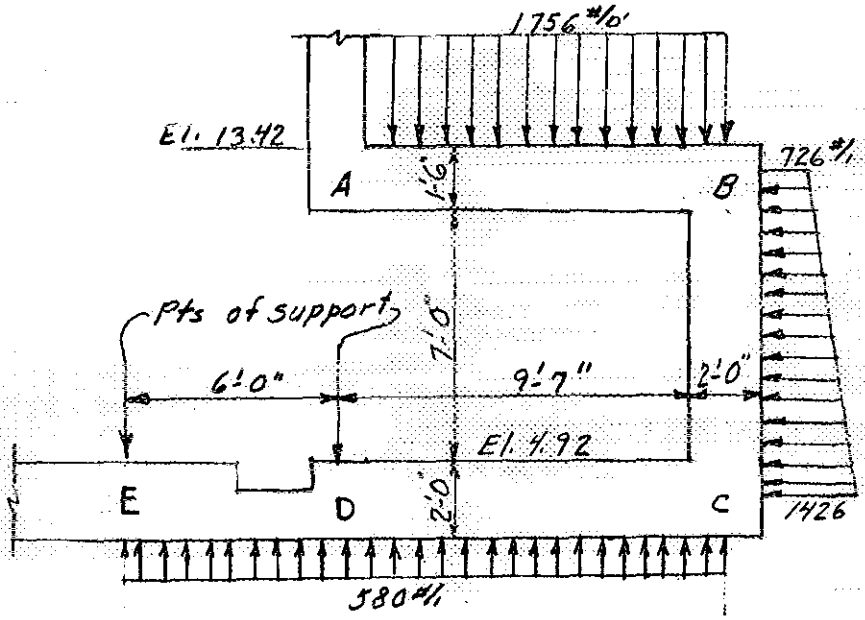
$$M = \frac{1}{8} \times 1440 \times 4 = 720 \text{ '#}$$

$$\text{req'd } S = \frac{720 \times 12}{20000} = .43 \text{ "}^3$$

$$\frac{7}{16}\text{" plate} \quad S = \frac{12 \times .4375^2}{6} = .38 \text{ "}^3$$

$$f_s = \frac{.43}{.38} \times 20{,}000 = 22{,}600 \text{ \#/□"} \quad \text{OK}$$

Subject Bushnell Park Pumping Station
Computation Section E-E Thru Discharge Conduit
Computed by H.E.W. **Checked by** H.L.K. **Date** 11- April- 44



Roof Pressure

14.41 × 100	=	1441
3.58 × 25	=	90
1.5 × 150		225
		1756 #/

Horiz P at El. 12.67
$3.80 + 80 \times 4.33 = 726$ #/□'
Horiz P at El. 3.92
$3.80 + 80 \times 13.08 = 1426$ #/□'

Base Pressure

14.08 × 62.5	=	880 #/□'
1.50 × 2	=	300
net pressure	=	580 #/□'

Design Assumption - Frame will be designed as continuous with fixed supports at A & E. The reactions produced at A, D & E will be take by beam action at these points

Case I - Conduit empty and external loading only

Fixed End Moments

Member AB

$$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 1756 \times 10.58^2 = 16.38^{'K}$$

Member BC

$$M^F_{BC} = \frac{1}{12} \times 726 \times 8.75^2 + \frac{1}{15} \times 700 \times \frac{8.75^2}{2} = 6.42^{'K}$$

$$M^F_{CB} = \frac{1}{12} \times 726 \times 8.75^2 + \frac{1}{10} \times 700 \times \frac{8.75^2}{2} = 7.31^{'K}$$

Member CD

$$M^F_{CD} = M^F_{DC} = \frac{1}{12} \times 580 \times 10.58^2 = 5.41^{'K}$$

Member DE

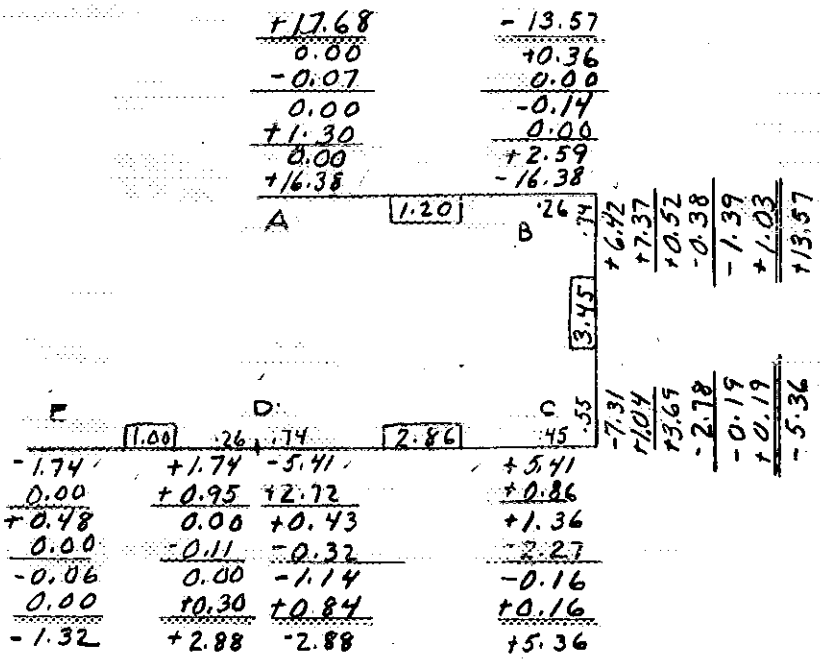
$$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 580 \times 6^2 = 1.74^{'K}$$

Subject Bushnell Park Pumping Station
Computation Section E-E Thru Discharge Conduit
Computed by H.E.W. **Checked by** A.L.K. **Date** 11-April-44

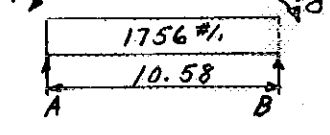
Case I (cont.)

Stiffness

Member	d	d^3	L	d^3/L	K
AB	18	5832	127	45.92	1.20
BC	24	13824	105	131.66	3.45
CD	24	13824	127	108.85	2.86
DE	14"	2744	72	38.11	1.00



Member AB



$$V_A = 1756 \times 10.58 \times .5 + \frac{4110}{10.58} = 9680^{\#}$$

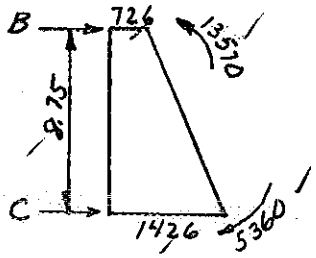
$$V_B = 1756 \times 10.58 \times .5 - \frac{4110}{10.58} = 8900^{\#}$$

$$x_0 = \frac{9680}{1756} = 5.51' \text{ from } A$$

$$+M = 9680 \times 5.51 - 17{,}680 - 1756 \times \frac{5.51^2}{2} = 9000^{'\#}$$

Subject: Bushnell Park Pumping Station
Computation: Section E-E thru Discharge Conduit
Computed by: H.E.W. Checked by: A.L.K. Date: 11-April-44

Member BC



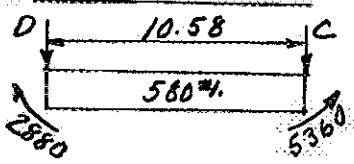
$$H_B = 726 \times 8.75 \times .5 + 700 \times 8.75 \times .5 \times .33 + \frac{8210}{8.75} = 5120^{\#}$$

$$H_C = 726 \times 8.75 \times .5 + 700 \times 8.75 \times .5 \times .67 - \frac{8210}{8.75} = 4290^{\#}$$

$$x_0 \quad 5120 - 726x - 80\frac{x^2}{2} \qquad x_0 = 5.4' \text{ from } B$$

$$+M = 5120 \times 5.4 - 13570 - 726 \times \frac{5.4^2}{2} - \frac{432 \times 5.4^3}{6} = 1400^{'\#}$$

Member CD



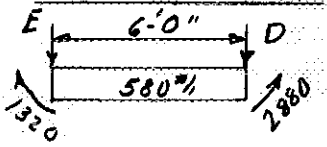
$$V_C = 580 \times 10.58 \times .5 + \frac{2480}{10.58} = 3300^{\#}$$

$$V_D = 580 \times 10.58 \times .5 - \frac{2480}{10.58} = 2830^{\#}$$

$$x_0 = \frac{3300}{580} = 5.7' \text{ from } C$$

$$+M = 3300 \times 5.7 - 5360 - 580 \times \frac{5.7^2}{2} = 4030^{\#}$$

Member DE

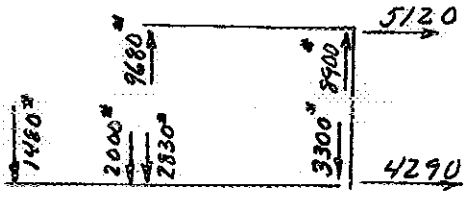


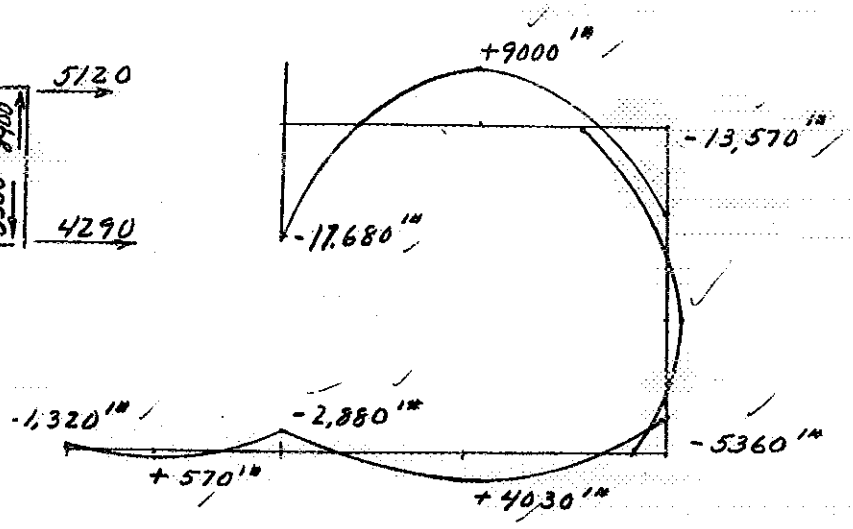
$$V_D = 580 \times 6 \times .5 + \frac{1560}{6} = 2000^{\#}$$

$$V_E = 580 \times 6 \times .5 - \frac{1560}{6} = 1480^{\#}$$

$$x_0 = \frac{2000}{580} = 3.45 \text{ from } D$$

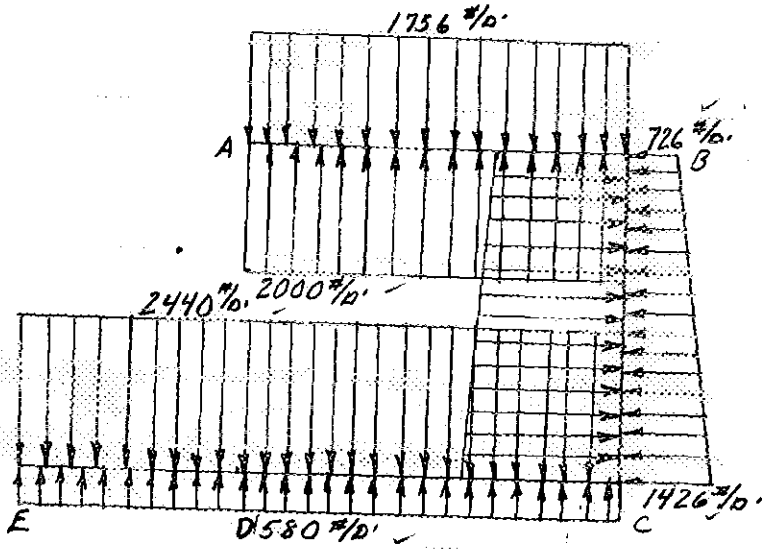
$$+M = 2000 \times 3.45 - 2880 - 580 \times \frac{3.45^2}{2} = 570^{'\#}$$





Bending Moment Diagram

Case II - External and internal pressure



Water pres. at El. 11.93
$32.07 \times 62.5 = 2000$ #/□'

Water pres at El. 4.93
$39.07 \times 62.5 = 2440$ #/□'

Net pressure against base slab is downward and will be taken by the rock

Fixed End Moments

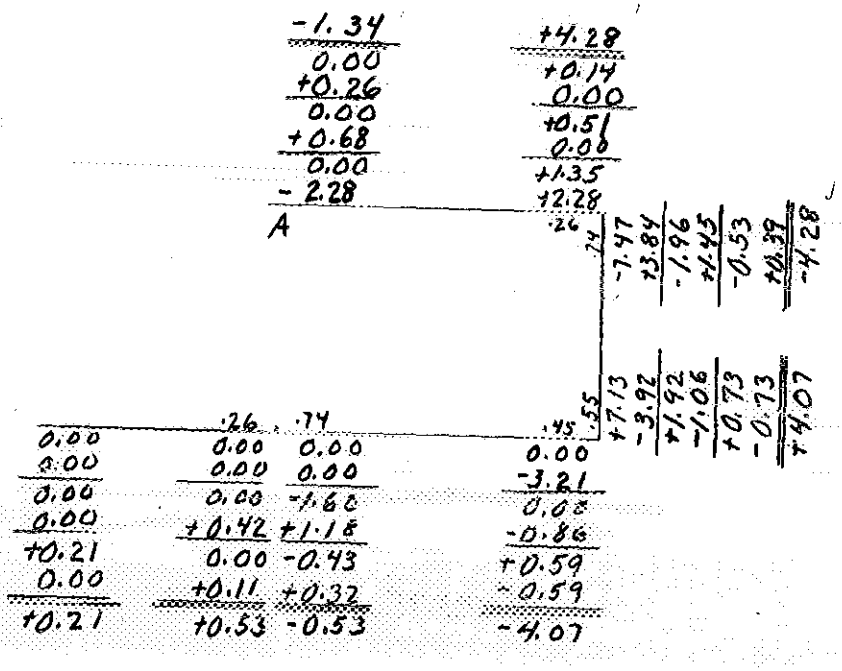
Member AB

$M^F \quad \frac{1}{12} \times 244 \times 10.58^2 = 2.28$ 'K

Member BC

$M^F_{BC} \quad \frac{1}{12} \times 1014 \times 8.75^2 + \frac{1}{10} \times 260 \times \frac{8.75^2}{2} = 7.47$ 'K

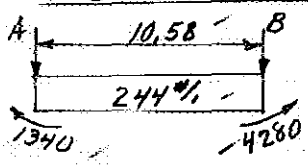
$M^F_{CB} = \frac{1}{12} \times 1014 \times 8.75^2 + \frac{1}{15} \times 260 \times \frac{8.75^2}{2} = 7.13$ 'K



Subject: Bushnell Park Pumping Station
Computation: Station E-E Thru Discharge Conduit
Computed by: H. E. W. Checked by: A. L. K. Date: 12-April-44

Case II (cont.)

Member AB



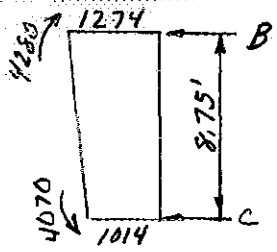
$V_A = 244 \times 10.58 \times .5 - \frac{2940}{10.58} = 1010^{\#}$

$V_B = 244 \times 10.58 \times .5 + \frac{2940}{10.58} = 1570^{\#}$

$x_0 = \frac{1010}{244} = 4.14$

$+M = 1010 \times 4.14 - 1340 - 244 \times \frac{4.14^2}{2} = 750^{'\#}$

Member BC



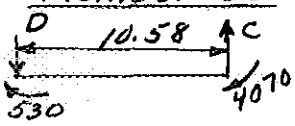
$H_B = 1014 \times 8.75 \times .5 + 260 \times 8.75 \times .5 \times .67 + \frac{210}{8.75} = 5220^{\#}$

$H_C = 1014 \times 8.75 \times .5 + 260 \times 8.75 \times .5 \times .33 - \frac{210}{8.75} = 4790^{\#}$

$x_0 = 4790 - 1014x - 30\frac{x^2}{2} = \quad x = 4.45'$ from C

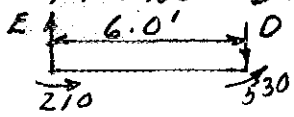
$+M = 4790 \times 4.45 - 4070 - 1014 \times \frac{4.45^2}{2} - 132 \times \frac{4.45^2}{6} = 6770^{'\#}$

Member CD

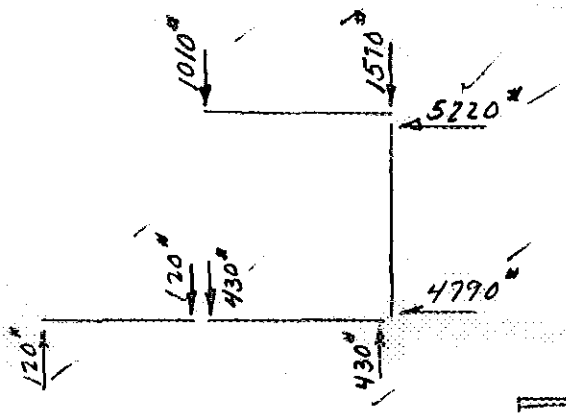


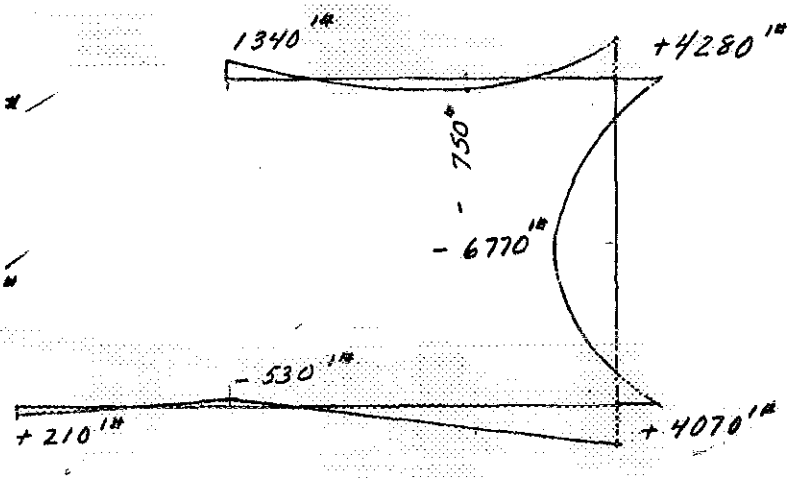
$V_C = V_D = \frac{4600}{10.58} = 430^{\#}$

Member DE



$V_D = V_E = \frac{740}{6} = 120^{\#}$



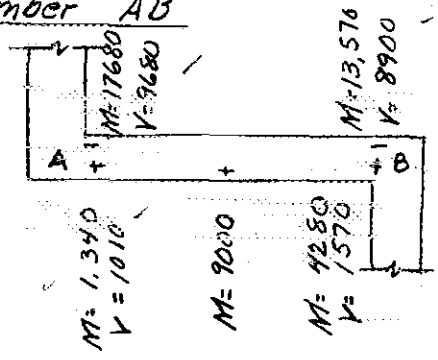


Moment Diagram

Subject: Bushnell Park Pumping Station
Computation: Section E-E thru Discharge Conduit
Computed by: H.E.W Checked by: A.L.K. Date: 12-April-44

Design of Members

Member AB



$$\text{req'd } d = \sqrt{\frac{17680}{139}} = 11.3'' < 14.5'' \text{ OK}$$

$$v = \frac{9680}{12 \times .88 \times 14.5} = 63\#/\square'' \text{ OK}$$

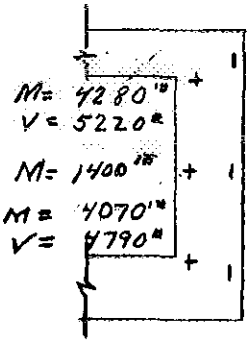
$$-A_s = \frac{17680 \times 12}{20{,}000 \times .88 \times 14.5} = .83\square'' \text{ Try } 3/4''\phi @ 6''cc$$

$$u_o = \frac{9680}{4.7 \times .88 \times 14.6} = 160\#/\square''$$

$$+A_s = \frac{9000 \times 12}{20{,}000 \times .88 \times 14.6} = .42\square'' \quad \text{Use } 3/4''\phi @ 1'\text{-}0''cc$$

When the direct tension is applied the max. moment is only 4280 causing an f_s = 9000 #/□"

Member BC



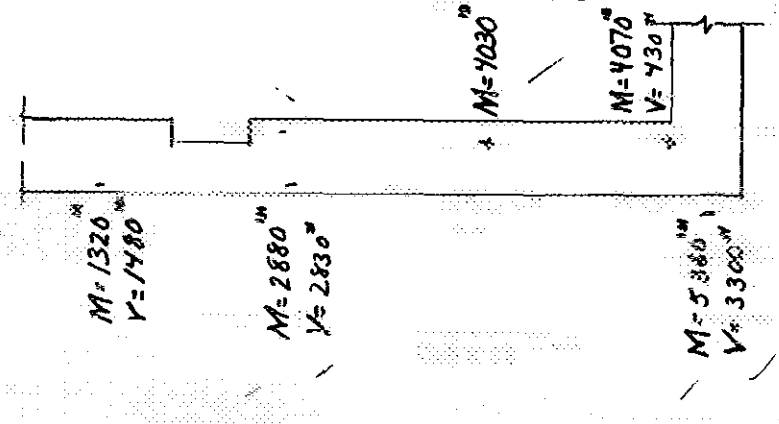
$$\text{req'd } d = \sqrt{\frac{13{,}570}{139}} = 9.86'' < 20.5''$$

$$v = \frac{5220}{12 \times .88 \times 20.5} = 24\#/\square''$$

$$-A_s = \frac{13{,}570 \times 12}{20{,}000 \times .88 \times 20.5} = .45\square'' \quad 3/4''\phi @ 1'\text{-}0''cc$$

$$u = \frac{5120}{2.4 \times .88 \times 20.5} = 118\#/\square''$$

$$+A_s = \frac{4280 \times 12}{20{,}000 \times .88 \times 20.5} = .14\square'' \quad \text{use } 3/4''\phi @ 1'\text{-}0''cc$$



$$v = \frac{3300}{12 \times .88 \times 19} = 16\#/\square''$$

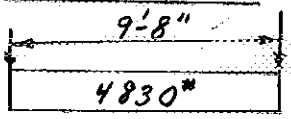
$$-A_s = \frac{5360 \times 12}{20{,}000 \times .88 \times 19} = .19\square'' \text{ use } 3/4''\phi @ 1'\text{-}0''cc \text{ both faces}$$

$$u_o = \frac{3300}{2.4 \times .88 \times 19} = 82\#/\square''$$

Subject: Bushnell Park Pumping Station
Computation: Section E-E Thru Discharge Conduit
Computed by: H. E. W. Checked by: A. L. R. Date: 18-April-77

Design of Beams at E & D

Beam at D



$M = \frac{1}{10} \times 4830 \times 9.67^2 = 45{,}170^{'\#}$

$V = 4830 \times 4.84 = 23{,}380^{\#}$

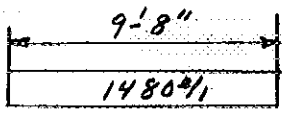
req'd $d = \sqrt{\frac{45{,}170 \times 12}{116 \times 18}} = 16.1'' < 19.5''$ OK

$v = \frac{23{,}380}{18 \times .88 \times 19.5} = 75^{\#}/\square''$ OK

$A_s = \frac{45170 \times 12}{20{,}000 \times .88 \times 19.5} = 1.58^{\square''}$ use 3-7/8"ϕ

$u_o = \frac{23{,}380}{8.25 \times .88 \times 19.5} = 165^{\#}/\square''$ OK

Beam at E



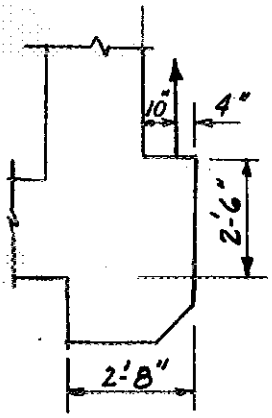
$M = \frac{1}{10} \times 1480 \times 9.67^2 = 13{,}840^{'\#}$

$V = 1480 \times 4.84 = 7160^{\#}$

$A_s = \frac{13840 \times 12}{20{,}000 \times .88 \times 19.5} = .48^{\square''}$ Use 2-3/4"ϕ @ 12" c c

$u_o = \frac{7160}{4.7 \times .88 \times 19.5} = 89^{\#}/\square''$ OK

Gate Pull on Haunch



Gate Pressure
$(44.0 - 8.43)(62.5) = 2220^{\#}/\square'$

Total $P = 2220 \times 49 = 108{,}930^{\#}$

Load on ea. bolt $= \frac{108{,}930}{12} = 9080^{\#}$

Moment $= 9080 \times 10 = 90800^{''\#}$

$A_s = \frac{90800}{20{,}000 \times .88 \times 26} = .20^{\square''}$

req'd d for shear $= \frac{9080}{17 \times .88 \times 60} = 10''$ OK

WAR DEPARTMENT

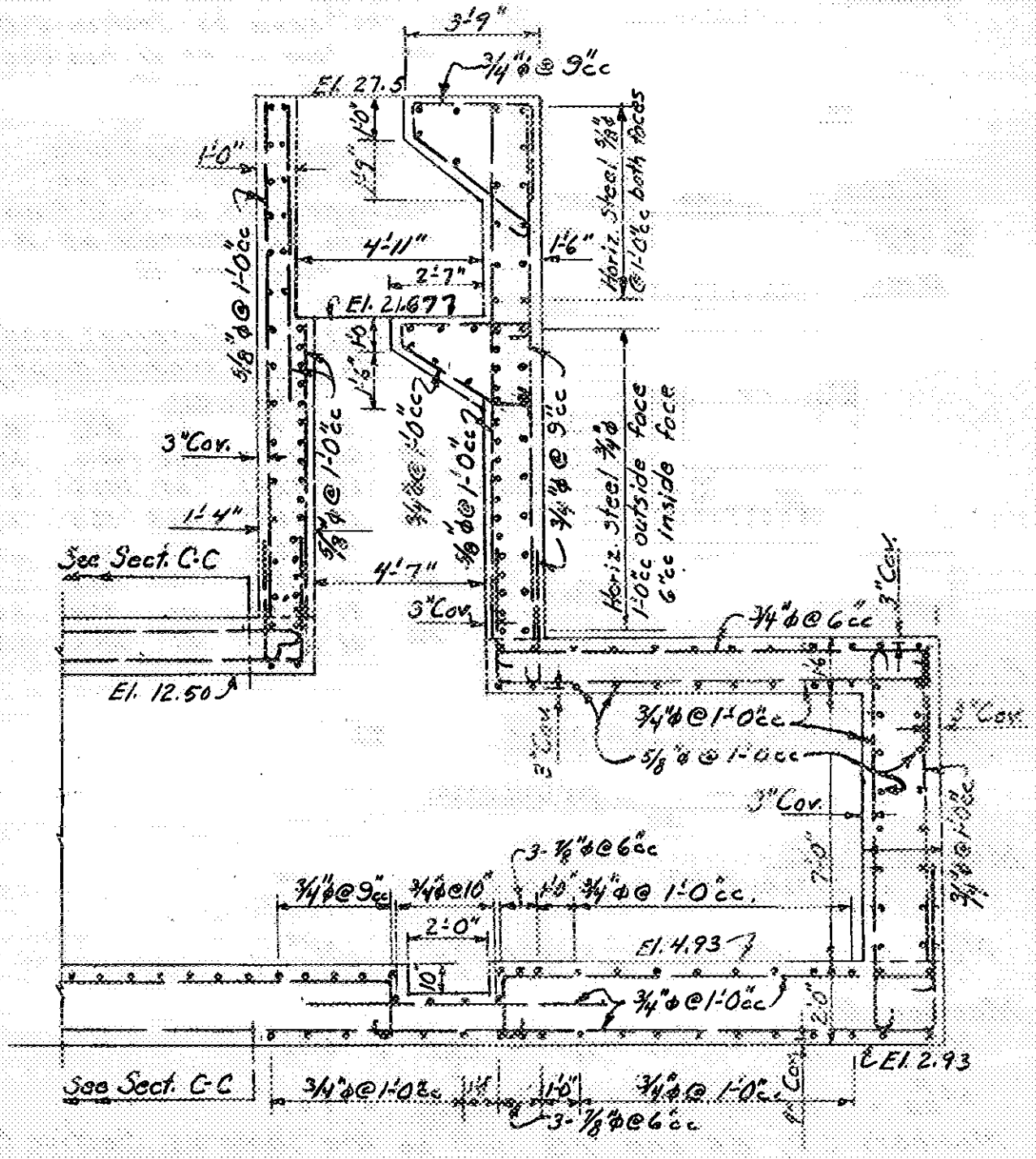
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

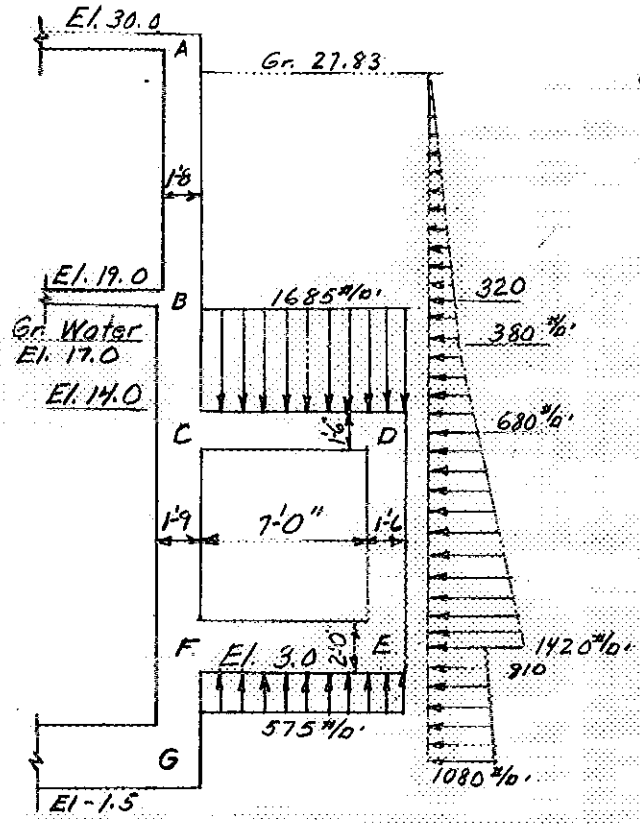
Computation: Section E-E Thru Discharge Conduit

Computed by: M.E.W. Checked by: A.L.K. Date: 13-Apr.-44

Section E-E



Subject Bushnell Park Pumping Station
Computation Section F.F Thru Screening Chamber
Computed by H. E.W. **Checked by** A.L.K. **Date** 14-April-44



Loading for Section F.F will be the same as Section D-D. Horiz. load at pt. D has been corrected to 680 #/lo'.

Design Assumptions

The section will be designed as a rigid frame simply supported at A and fixed at G.

Case I - External loading only with conduit empty

Stiffness

	d	d^3	L	d^3/L	K
AB	20	8000	132	60.6	1.2
BC	21	9261	65	142.5	2.7
CD	18	5832	103.5	56.3	1.1
DE	18	5832	111	52.5	1.0
EF	24	13824	103.5	133.6	2.5
CF	21	9261	111	83.4	1.6
FG	21	9261	51	181.6	3.5

Fixed End Moments

Member AB

$$M^F_{AB} = \frac{.833^2(5-3\times.833)}{30}\times\frac{9.16\times320\times11}{2} = .93^{'K}$$

$$M^F_{BA} = \frac{.833(10-10\times.833+3\times.833^2)\times9.16\times320\times11}{30} = 1.68^{'K}$$

Member BC

$$M^F_{BC} = \frac{1}{12}\times320\times5.42^2 + \frac{1}{15}\times360\times\frac{5.42^2}{2} = 1.14^{'K}$$

$$M^F_{CB} = \frac{1}{12}\times320\times5.42^2 + \frac{1}{10}\times360\times\frac{5.42^2}{2} = 1.31^{'K}$$

Member DE

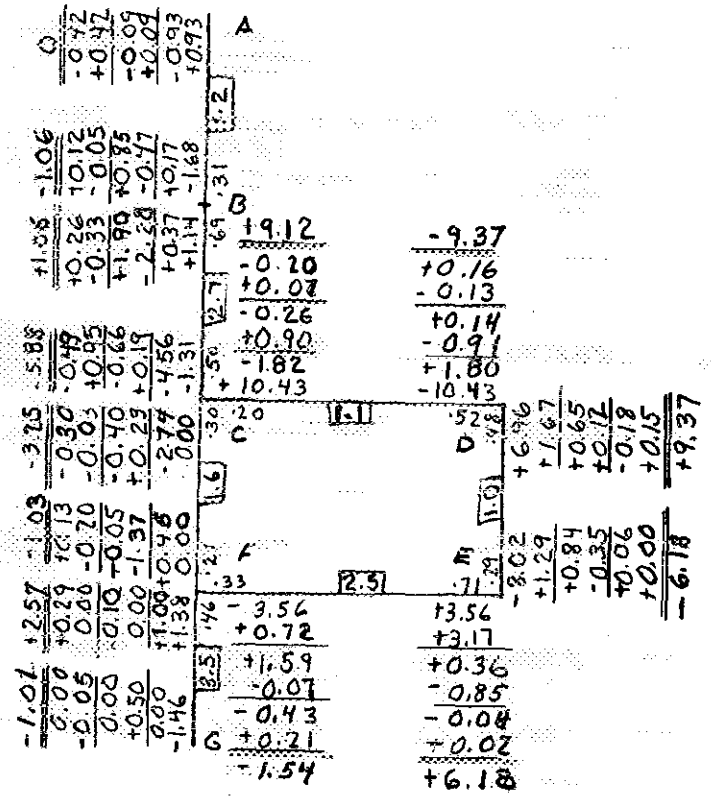
$$M^F_{DE} = \frac{1}{12}\times680\times9.25^2 + \frac{1}{15}\times740\times\frac{9.25^2}{2} = 6.96^{'K}$$

$$M^F_{ED} = \frac{1}{12}\times680\times9.25^2 + \frac{1}{10}\times740\times\frac{9.25^2}{2} = 8.02^{'K}$$

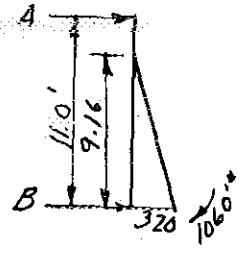
Members CD, EF and FG will be the same as Section E-E

Subject: Bushnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.L. Date: 14-April-44

Case I (cont.)



Member AB



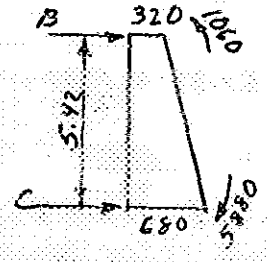
$H_A = 320 \times 9.16 \times .5 \times \frac{3.05}{11} - \frac{1060}{11} = 310^{\#}$

$H_B = 3.20 \times 9.16 \times .5 \times \frac{7.95}{11} + \frac{1060}{11} = 1160^{\#}$

$x_0 = 6.04'$ from A

$M = 310 \times 6.04 - 147 \times \frac{4.2^2}{6} = 1440'^{\#}$

Member BC



$H_B = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .33 - \frac{4820}{5.42} = 300^{\#}$

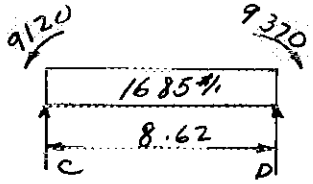
$H_B = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .67 + \frac{4820}{5.42} = 3410^{\#}$

No Pos. Mom.

Subject: Bushnell Park Pumping Station
Computation: Section F-F Tank Screening Chamber
Computed by: H.E.W. Checked by: R.L.K. Date: 15 April - 74

Case I (cont.)

Member CD



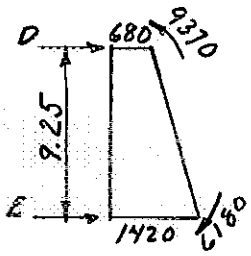
$V_C = 1685 \times 8.62 \times .5 - \frac{250}{8.62} = 7230^{\#}$

$V_D = 1685 \times 8.62 \times .5 + \frac{250}{8.62} = 7290^{\#}$

$x_0 = \frac{7230}{1685} = 4.3$ from C

$+M = 7230 \times 4.3 - 9120 - 1685 \times \frac{4.3^2}{2} = 6390^{'\#}$

Member DE



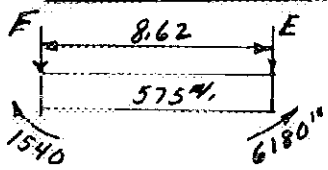
$H_D = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .33 + \frac{3190}{9.25} = 4620$

$H_E = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .67 - \frac{3190}{9.25} = 5090^{\#}$

$x_0 \quad 4620 - 680x - 80\frac{x^2}{2} \quad 5.2$ from D

$M = 4620 \times 5.2 - 9370 - 680\frac{5.2^2}{2} - 416\frac{5.2^2}{6} = 3590^{\#}$

Member FE



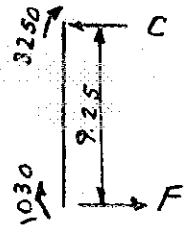
$V_F \quad 575 \times 8.62 \times .5 - \frac{4640}{8.62} = 1940^{\#}$

$V_E = 575 \times 8.62 \times .5 + \frac{4640}{8.62} = 3020^{\#}$

$x_0 = \frac{1940}{575} = 3.38'$ from F

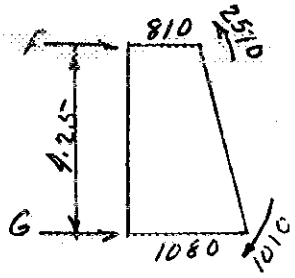
$M = 1940 \times 3.38 - 1540 - 575 \times \frac{3.38^2}{2} = 1730^{'\#}$

Member CF



$H_C = H_F = \frac{4280}{9.25} = 460^{\#}$

Member FG



$H_F = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .33 + \frac{1560}{4.25} = 2280^{\#}$

$H_G = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .67 - \frac{1560}{4.25} = 1740^{\#}$

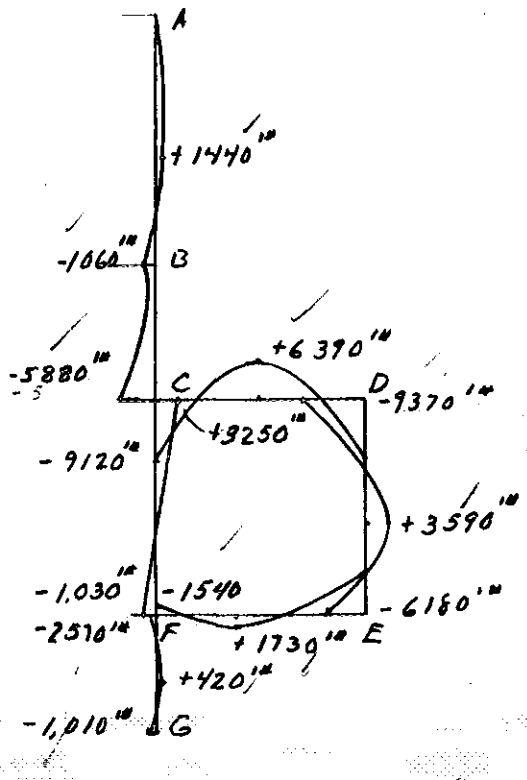
$x_0 = 2280 - 810x - 62.5\frac{x^2}{2} \quad x = 2.5$ from E

$M = 2280 \times 2.5 - 2510 - 810\frac{2.5^2}{2} - 172\frac{2.5^2}{6} = 420^{'\#}$

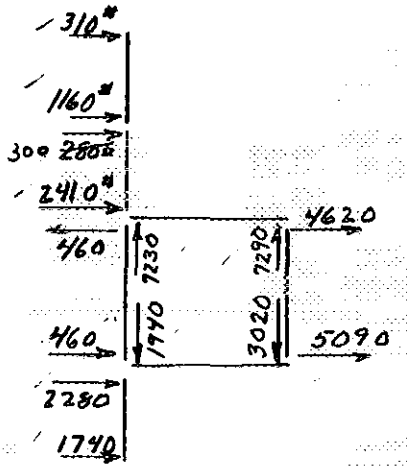
Subject: Bushnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 15-April-44

Case I (cont.)

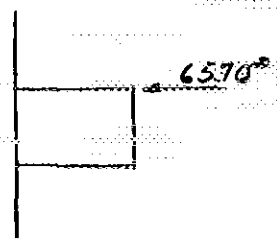
Moment Curve



End Reactions



Force Producing Joint Def.



It is assumed that there will be no deflection inward at G due to the proximity to the base slab and to the fact FE is poured on uneven rock. There will also be no deflection inward at pt B

End Moments

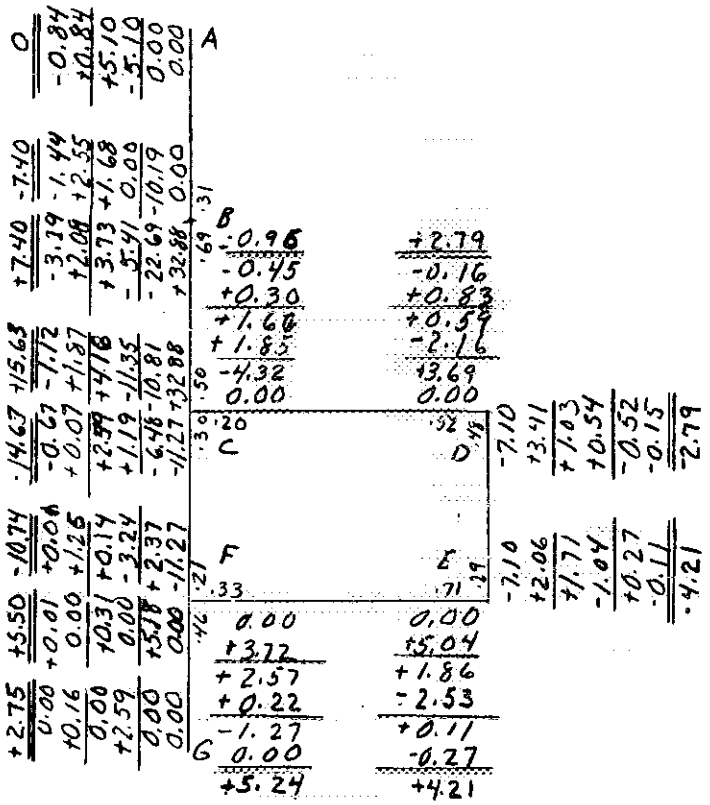
Member BC

$$M = \frac{6 \times 3000000 \times 9261 \times .01}{65 \times 65 \times 12 \times 1000} = 32.88'^{K}$$

For Member CF & DE see Section B-B

Subject Bushnell Park Pumping Station
Computation Section FF Thru Screening Chamber
Computed by H.E.W. **Checked by** A.L.K. **Date** 15- April- 44

Joint Deflection Case I (cont.)



Member BC
$H_C = \frac{23,030}{5.42} = 4249$

Member CF
$H_C \frac{25410}{9.25} = 2747$

Member DE
$H_D = \frac{7000}{9.25} = 757$

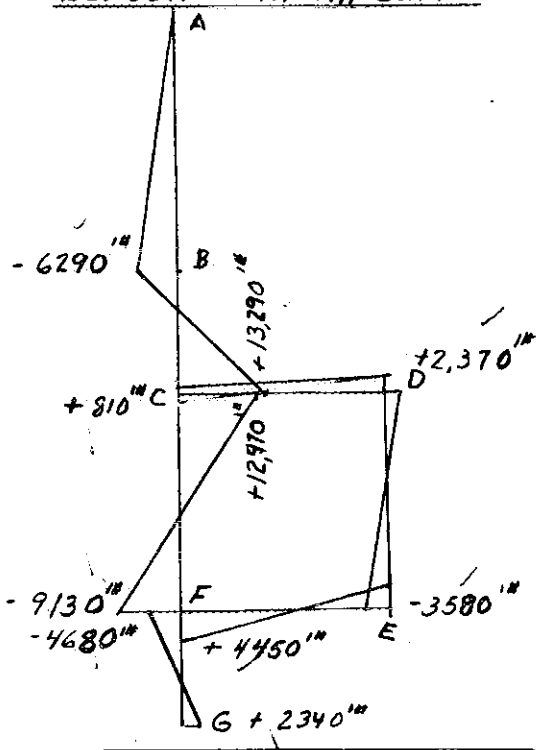
Moment Mult. $= \frac{6530}{7750} = .84$

Member	Trial M	Mult.	Moment
AB @ A	0	.85	0
@ B	-7,400		-6290 '#
BC @ B	+7,400		+6290 '#
@ C	+15,630		+13,290 '#
CD @ C	-960		-810 '#
@ D	+2,790		+2370 '#
DE @ D	-2,790		-2,370 '#
@ E	-4210		+3,580 '#
EF @ E	+4,210		+3580 '#
@ F	+5240		+4450 '#
CF @ C	-14670		-12470 '#
@ F	-10740		-9130 '#
FG @ F	+5500		+4680 '#
@ G	+2750		+2340 '#

Subject: Bushnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 15-April-44

Joint Deflection - Case I (cont.)

Deflection Mom. Curve



Reactions

Member AB
$H_A = \frac{6280}{11.0} = 570^{\#} \leftarrow \quad H_B = 570^{\#} \rightarrow$

Member BC
$H_B = \frac{19580}{5.42} = 3610^{\#} \rightarrow \quad H_C = 3610^{\#} \leftarrow$

Member CD
$V_C = \frac{1560\ \cancel{3190}}{8.62} = \frac{\cancel{370}^{\#}}{180} \uparrow \quad V_D = \frac{\cancel{370}^{\#}}{180} \downarrow$

Member DE
$H_D = \frac{5950}{9.25} = 640^{\#} \leftarrow \quad H_E = 640^{\#} \rightarrow$

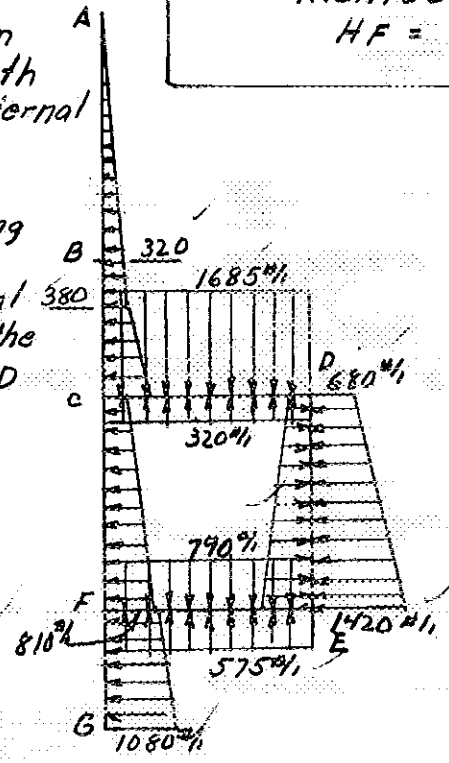
Member EF
$V_E = \frac{8030}{8.62} = 930^{\#} \downarrow \quad V_F = 930^{\#} \uparrow$

Member CF
$H_C = \frac{21,600}{9.25} = 2340^{\#} \leftarrow \quad H_F = 2340^{\#} \rightarrow$

Member FG
$H_F = \frac{7020}{4.25} = 1650^{\#} \rightarrow \quad H_G = 1650^{\#} \leftarrow$

Case II - Section loaded with both internal and external loading

External loading is the same as Case I - Internal loading will be the same as Sect. DD



Fixed End Moments

Members AB, BC and FG are the same as in Case I
Members CD CF & FE are the same as for Section - D-D

Member DE

$M^F_{DE} = \frac{1}{12} \times 360 \times 9.25^2 + \frac{1}{15} \times 270 \times \frac{9.25^2}{2}$

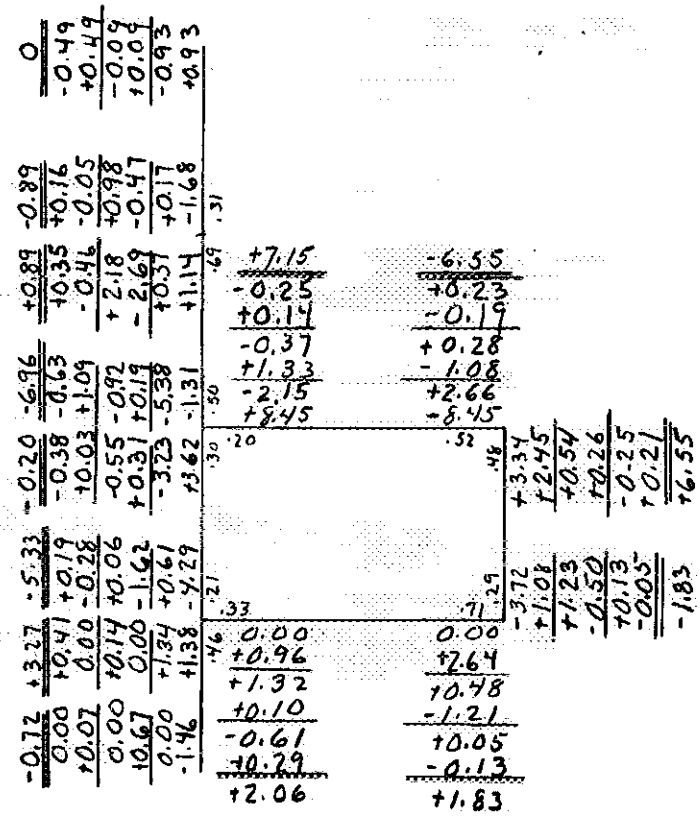
$= 3.34'^K$

$M^F_{ED} = \frac{1}{12} \times 360 \times 9.25^2 + \frac{1}{10} \times 270 \times \frac{9.25^2}{2}$

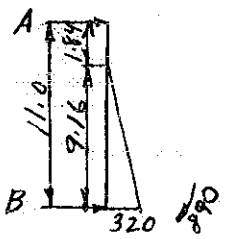
$= 3.72'^K$

Subject Bushnell Park Pumping Station
Computation Section F-F Thru Screening Chamber
Computed by H.E.W. **Checked by** A.L.K. **Date** 15 April – 44

Case II cont.



Member AB



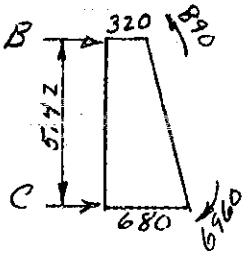
$$H_A = 320 \times 9.16 \times .5 \times \frac{3.05}{11} - \frac{890}{11} = 330^{\#}$$

$$H_B = 320 \times 9.16 \times .5 \times \frac{7.95}{11} + \frac{890}{11} = 1140^{\#}$$

$$x_0 = 6.18 \text{ from } A$$

$$M = 330 \times 6.18 - 152 \times \frac{4.34^2}{6} = 1560^{'\#}$$

Member BC



$$H_B = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times 33 - \frac{6070}{5.42} = 70^{\#}$$

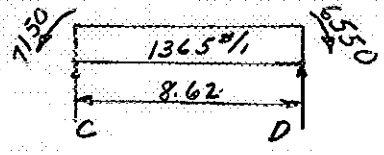
$$H_C = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .67 + \frac{6070}{5.42} = 2640^{\#}$$

No pos. Moment

Subject: Busnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 17 April - 44

Case II (cont.)

Member CD



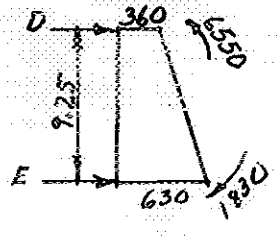
$V_C = 1365 \times 8.62 \times .5 + \frac{600}{8.62} = 5950$

$V_D = 1365 \times 8.62 \times .5 - \frac{600}{8.62} = 5810^{\#}$

$x_0 = \frac{5950}{1365} = 4.36$ from C

$+M = 5950 \times 4.36 - 7150 - 1365 \times \frac{4.36^2}{2} = 5820^{'\#}$

Member DE



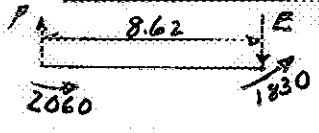
$H_D = 360 \times 9.25 \times .5 + 270 \times 9.25 \times .5 \times .33 + \frac{4720}{9.25} = 2590^{\#}$

$H_E = 360 \times 9.25 \times .5 + 270 \times 9.25 \times .5 \times .67 - \frac{4720}{9.25} = 1990^{\#}$

$x_0 = 2590 - 360x - 29\frac{x^2}{2}$ $x = 5.8'$ from D

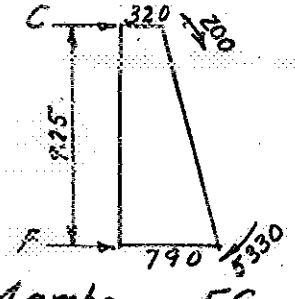
$+M = 2590 \times 5.8 - 6550 - 360 \times \frac{5.8^2}{2} - 168 \times \frac{5.8^2}{6} = 1470^{'\#}$

Member EF



$V_F = V_E = \frac{3890}{8.62} = 450^{\#}$

Member CF



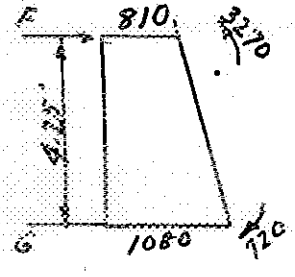
$H_C = 320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .33 - \frac{5530}{9.25} = 1600^{\#}$

$H_F = 320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .67 + \frac{5530}{9.25} = 3530^{\#}$

$x_0 = 1600 - 320x - 51\frac{x^2}{2}$ $x = 3.8'$ from C

$+M = 1600 \times 3.8 + 200 - 320 \times \frac{3.8^2}{2} - 194 \times \frac{3.8^2}{6} = 3500^{'\#}$

Member FG



$H_F = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .33 + \frac{2550}{4.25} = 2510$

$H_G = 810 \times 4.25 \times .5 + 270 \times 4.25 \times .5 \times .67 - \frac{2550}{4.25} = 1510$

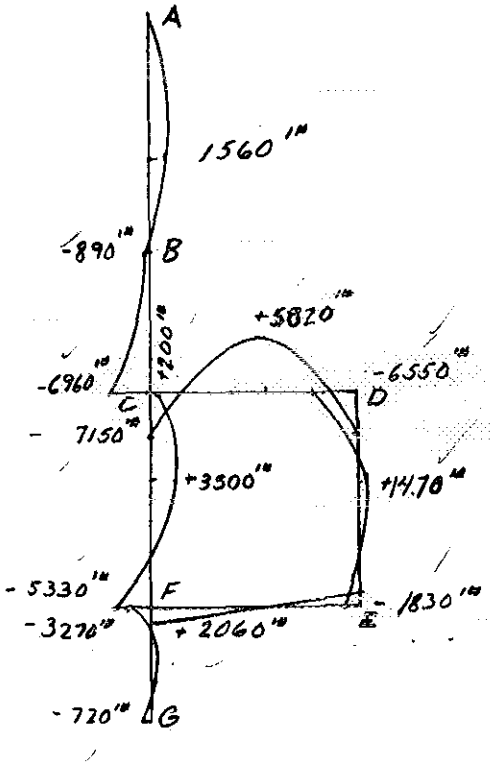
$x_0 = 2510 - 810x - 62.5\frac{x^2}{2}$ $x = 2.8'$ from F

$M = 2510 \times 2.8 - 3270 - 810 \times \frac{2.8^2}{2} - 175 \times \frac{2.8^2}{6} = 3500^{'\#}$

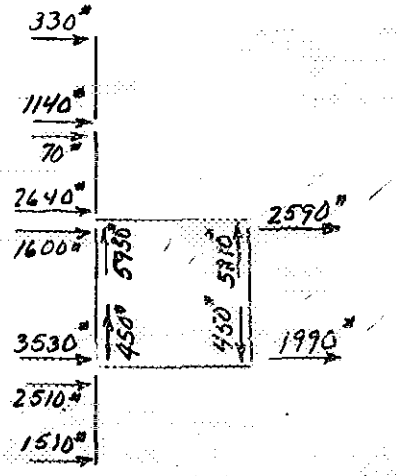
Subject: Bushnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H. E. W. Checked by: A. C. K. Date: 17-April-44

Case II

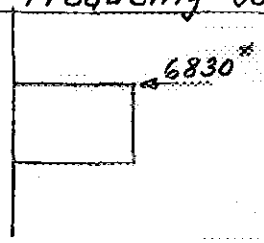
Moment Curve



End Reactions



Force Producing Joint Def.



Trial Moments for joint deflection will be the same as Case I

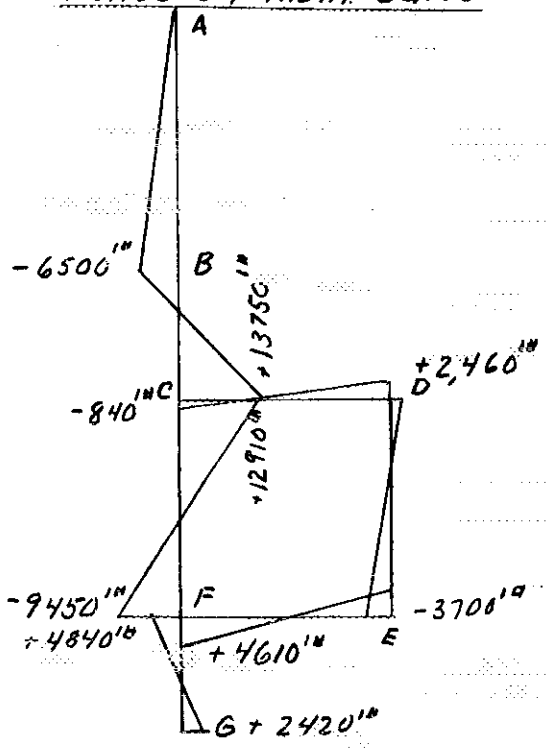
Mom. Mult = $\frac{6830}{7750} = .88$

Member	Trial M	Mult.	Moment
AB@A	0	.88	0
@B	-7400		-6510'#
BC@B	+7400		+6510'#
@C	+15630		+13750'#
CD@C	-960		-840'#
@D	+2790		+2460'#
DE@D	-2790		-2460'#
@E	-4210		-3700'#
EF@E	+4210		-3700'#
@F	+5240		+4610'#
CF@C	-14670		-12910'#
@F	-10740		-9450'#
FG@F	+5500		+4840'#
@G	+2750		+2420'#

Subject: Bushnell Park Pumping Station
Computation: Section F-F Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 17-April-44

Case II (cont.)

Deflection Mom. Curve



Reactions

Member AB

$H_A = \frac{6500}{11.0} = 590^{\#} \leftarrow \quad H_B = 590^{\#} \rightarrow$

Member BC

$H_B = \frac{20260}{5.42} = 3740^{\#} \rightarrow \quad H_C = 3740^{\#} \leftarrow$

Member CD

$V_C = \frac{3300}{8.62} = 380^{\#} \uparrow \quad V_D = 380^{\#} \downarrow$

Member DE

$H_D = \frac{6160}{9.25} = 670^{\#} \leftarrow \quad H_E = 670^{\#} \rightarrow$

Member EF

$V_E = \frac{8310}{8.62} = 960^{\#} \downarrow \quad V_F = 960^{\#} \uparrow$

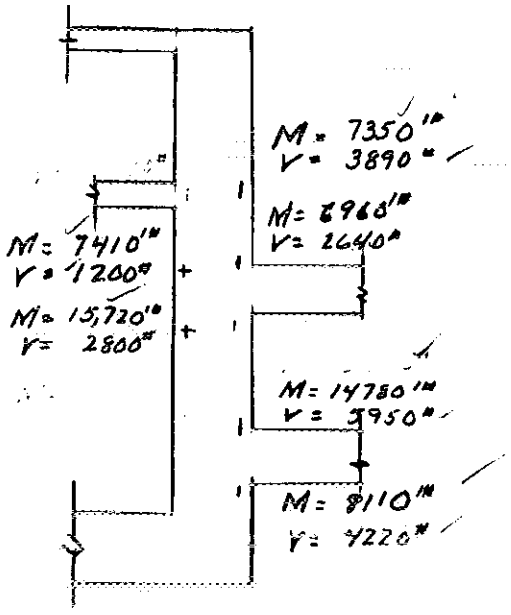
Member CF

$H_C = \frac{22360}{9.25} = 2420^{\#} \leftarrow \quad H_F = 2420^{\#} \rightarrow$

Member FG

$H_F = \frac{7260}{4.25} = 1710^{\#} \rightarrow \quad H_G = 1710^{\#} \leftarrow$

Design of Members



req'd $d = \sqrt{\frac{15720}{139}} = 10.6" < 17.5"$

$v = \frac{5950}{12 \times .88 \times 17.5} = 32^{\#}/\square''$

$-A_s = \frac{14780 \times 12}{20{,}000 \times .88 \times 17.5} = .58^{\square''}$ Use $\frac{7}{8}\phi$ @ 1'-0" cc

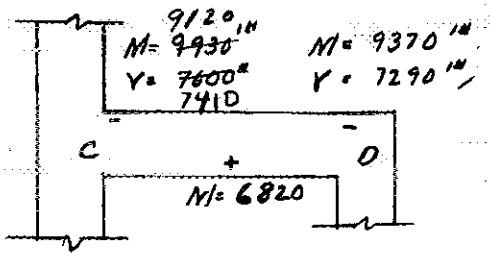
$u_0 = \frac{5950}{2.8 \times .88 \times 17.5} = 138^{\#}/\square''$ OK

$-A_s = \frac{7350 \times 12}{20{,}000 \times .88 \times 17.5} = .29^{\square''}$ Use $\frac{3}{4}$" ϕ @ 1'-0" cc

$+A_s = \frac{15{,}720 \times 12}{20{,}000 \times .88 \times 17.5} = .58^{\square''}$ Use $\frac{7}{8}$" ϕ @ 1'-0" cc

Subject Bushnell Park Pumping Station
Computation Section EF Thru Screening Chamber
Computed by H.E.W. **Checked by** A.L.K **Date** 17 April - 44

Member CD



$v = \frac{7410}{12 \times .88 \times 14.5} = 48$ ~~50~~ #/□"

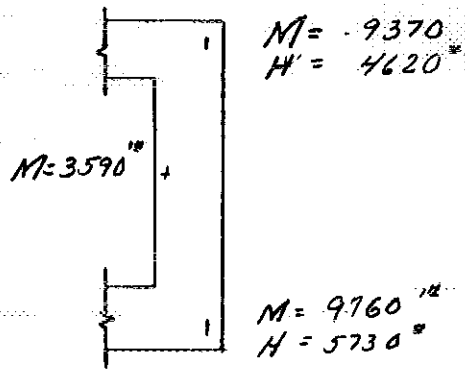
$- A_s = \frac{9930 \times 12}{20{,}000 \times .88 \times 14.5} = .47\square''$ Try 3/4"ϕ @ 11"cc

$u_o = \frac{7600}{2.6 \times .88 \times 14.5} = 223$ ~~229~~ #/□" Use 3/4"ϕ @ 9"cc

$u_o = \frac{7600}{3.1 \times .88 \times 14.5} = 187$ ~~192~~ #/□"

+As use 3/4"ϕ @ 12"cc

Member DE



req'd $d = \sqrt{\frac{9760}{139}} = 8.4''$

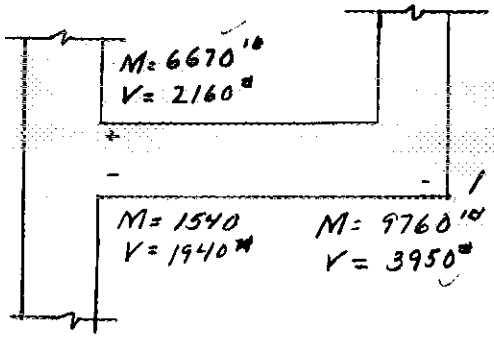
$v = \frac{5730}{12 \times .88 \times 14.5} = 38$ #/□"

$-A_s = \frac{9760 \times 12}{20{,}000 \times .88 \times 14.5} = .46$ Use 3/4"ϕ @ 1'-0"cc

$u_o = \frac{5730}{2.4 \times .88 \times 14.5} = 188$ #/□"

+As use 3/4"ϕ @ 12"cc

Member EF



$v = \frac{3950}{12 \times .88 \times 19.5} = 19$ #/□"

$-A_s = \frac{9760 \times 12}{20{,}000 \times .88 \times 19.5} = .34\square''$ 3/4"ϕ @ 1'-0"cc

+As use 3/4"ϕ @ 1'-0"cc

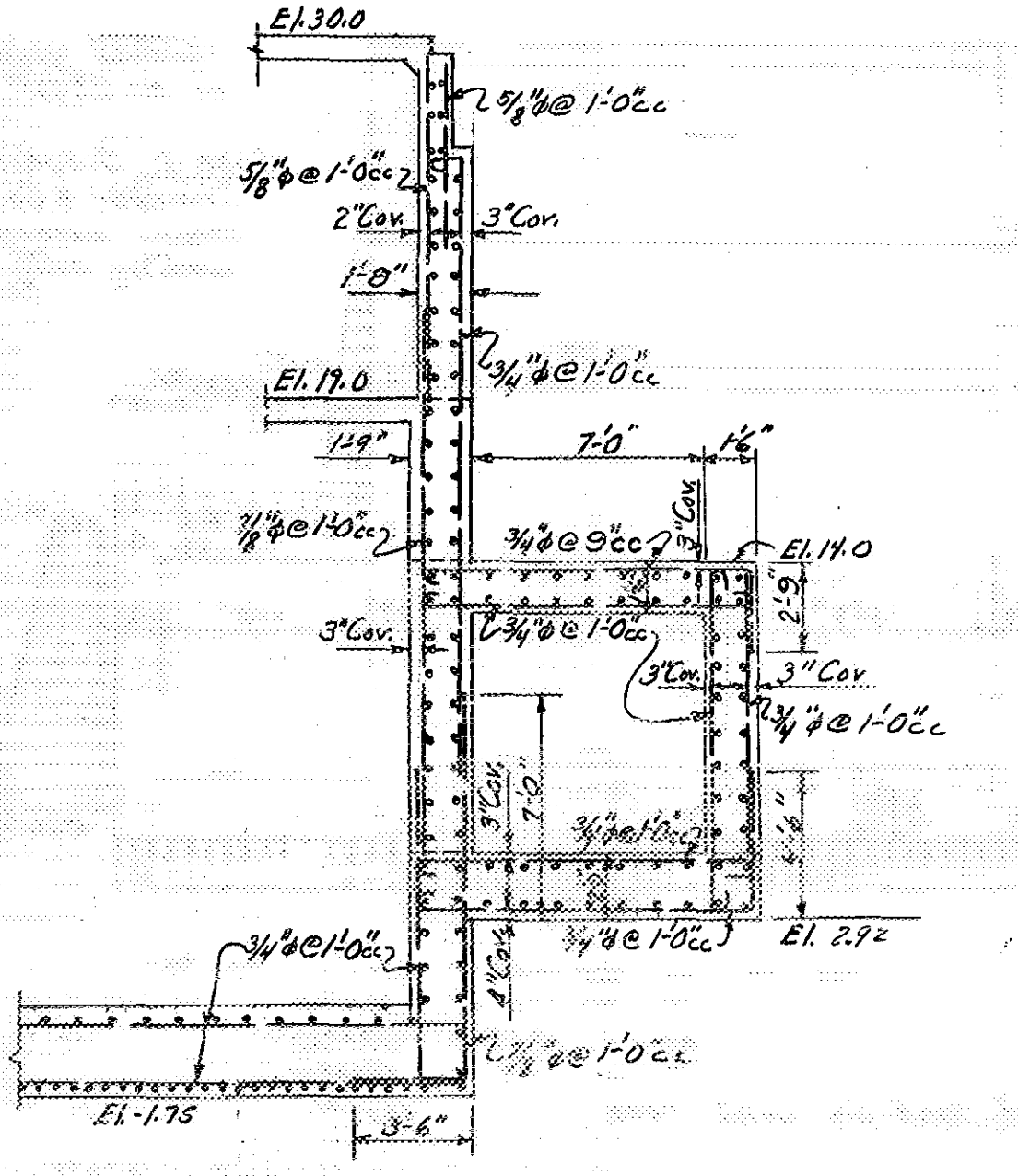
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

Computation: Section F-F Thru Screening Chamber

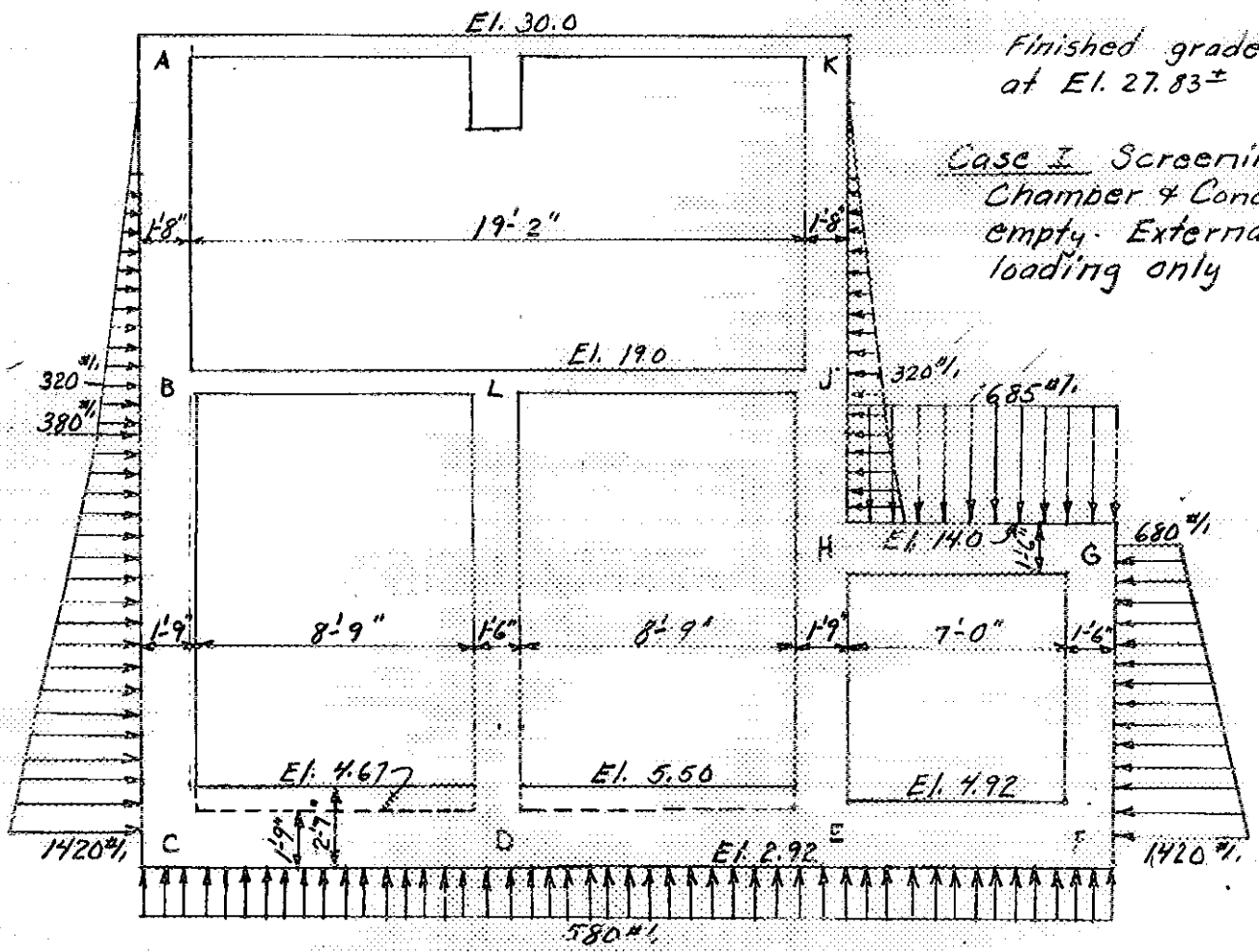
Computed by: H.E.W. Checked by: Date: 17 April - 44



Section F-F

Subject Bushnell Park Pumping Station
Computation Section G-G Thru Screening Chamber
Computed by H. E. W. **Checked by** A.L.K. **Date** 18- April - 44

Loading Diagram - Case I



Finished grade at El. 27.83±

Case I Screening Chamber & Conduit empty. External loading only

Horiz Ea. Pressure at El. 18.67 = 9.16 × 35 = 320 #/□'
" " " at El 17.0 = 380 #/□'
" " " at El. 13.75 = 680 #/□'
" " " at El 3.92 = 1420 #/□'
Vert load on cond roof = 1685 #/□'

Uplift on base slab (assume mat thickness = 2'-0")
uplift = (17 - 2.92)62.5 = -880 #/□'
wt. of slab = 300
580 #/□'

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.L. Date: 18 April 44

Case I (cont.)

Fixed End Moments

Members AB + KJ

$M^F_{AB} = M^F_{KJ} = 0.93^{'K}$
$M^F_{BA} = M^F_{JK} = 1.68^{'K}$ } see Sect. FF

Member BC

$M^F_{BC} = \frac{1}{12} \times 320 \times 14.75^2 + \frac{1}{15} \times 1100 \times \frac{14.75^2}{2} = 13.78^{'K}$

$M^F_{CB} = \frac{1}{12} \times 320 \times 14.75^2 + \frac{1}{15} \times 1100 \times \frac{14.75^2}{2} = 17.77^{'K}$

Member CD

$M^F_{CD} = \frac{1}{12} \times 580 \times 10.37^2 = 5.20^{'K} = M^F_{DC}$

Member DE

$M^F_{DE} = M^F_{ED} = 5.20^{'K}$

Member EF

$M^F_{EF} = M^F_{FE} = \frac{1}{12} \times 580 \times 8.62^2 = 3.59^{'K}$

Member GF

$M^F_{FG} = 8.02^{'K}$ $M^F_{GF} = 6.96^{'K}$ (see Sect. F-F)

Member HG

$M^F_{HG} = M^F_{GH} = 18.43$ (see Sect. BB)

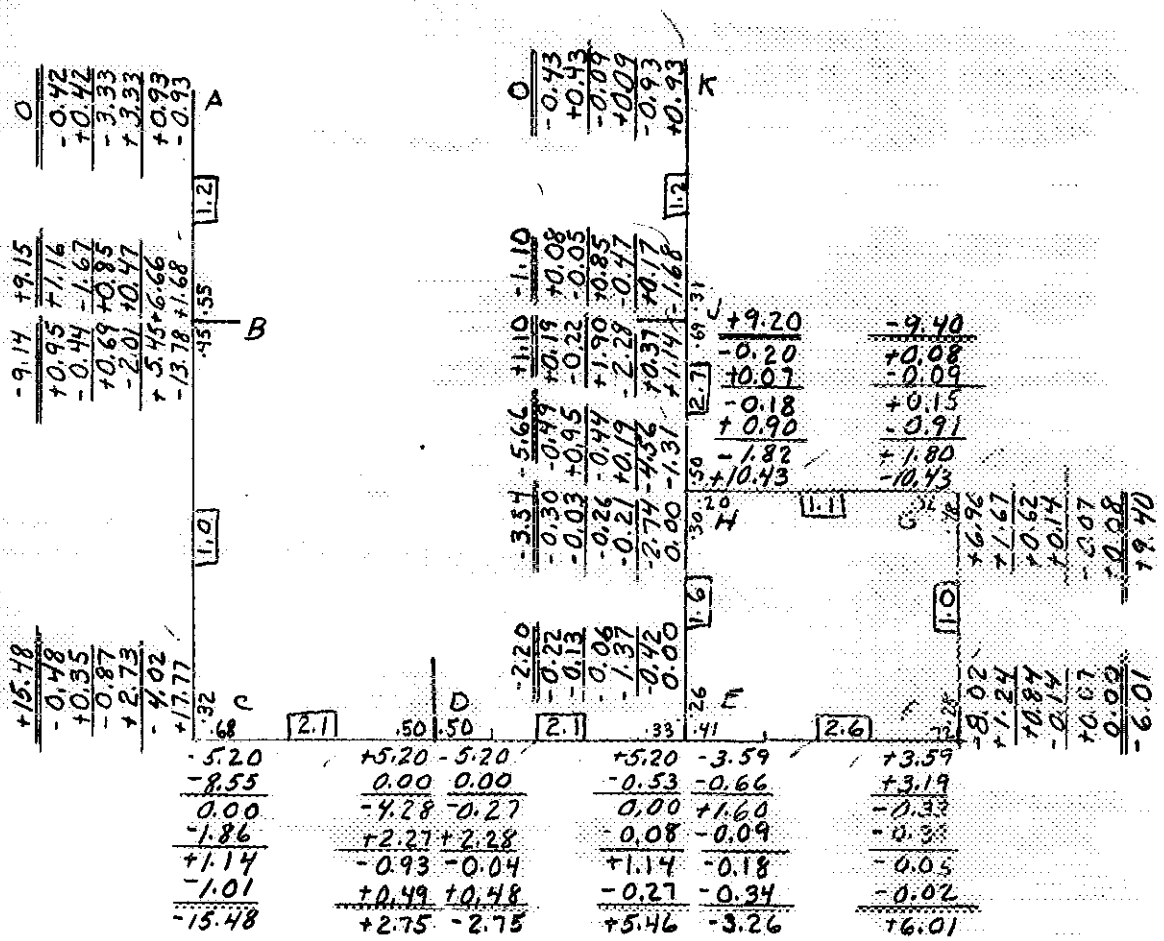
Member HJ

$M^F_{HJ} = 1.31^{'K}$ $M^F_{JH} = 1.14^{'K}$ (see Sect. F-F)

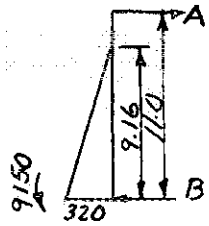
Stiffness

Member	d	d^3	L	d^3/L	K
AB	20	8000	132	60.6	1.2
BC	21	9261	177	52.3	1.0
CD	24	13824	124.5	111.0	2.1
DE	24	13824	124.5	111.0	2.1
EF	24	13824	103.5	133.6	2.6
FG	18	5832	111	52.5	1.0
GH	18	5832	103.5	56.3	1.1
HE	21	9261	111	83.4	1.6
HJ	21	9261	65	142.5	2.7
KJ	20	8000	132	60.6	1.2

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H. E. W. Checked by: A.L.K. Date: 18-April-44



Member AB

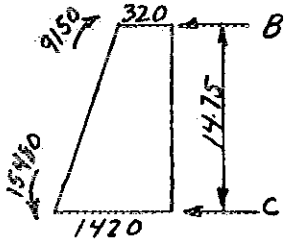


$$H_A = 320 \times 9.16 \times .5 \times \frac{3.05}{11} - \frac{9150}{11} = -420^{\#} \rightarrow$$

$$H_B = 320 \times 9.16 \times .5 \times \frac{7.95}{11} + \frac{9150}{11} = 1890^{\#}$$

No Pos. Mom. ✓

Member BC



$$H_B = 320 \times 14.75 \times .5 + 1100 \times 14.75 \times .5 \times .33 - \frac{6330}{14.75} = 4610^{\#}$$

$$H_C = 320 \times 14.75 \times .5 + 1100 \times 14.75 \times .5 \times .67 + \frac{6330}{14.75} = 8220^{\#}$$

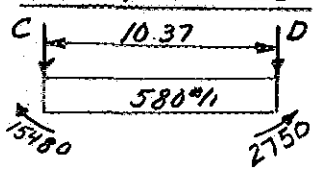
$$x_0 = 4610 - 320x - 74.5\frac{x^2}{2} \qquad x = 7.6' \text{ from } B$$

$$+M = 4610 \times 7.6 - 320 \times \frac{7.6^2}{2} - 566 \times \frac{7.6^2}{6} - 9150 = 11{,}200^{\prime\#}$$

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 18-April-44

Case I (cont.)

Member CD



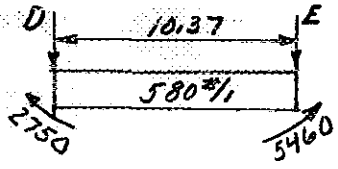
$V_C = 580 \times 10.37 \times .5 + \frac{12,730}{10.37} = 4230^{\#}$

$V_D = 580 \times 10.37 \times .5 - \frac{12730}{10.37} = 1780^{\#}$

$x_0 = \frac{4230}{580} = 7.3'$ from C

$M = 4230 \times 7.3 - 15480 - 580 \times \frac{7.3^2}{2} = -60^{'\#}$ No + M

Member DE



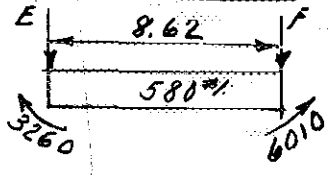
$V_D = 580 \times 10.37 \times .5 - \frac{2,710}{10.37} = 2750^{\#}$

$V_E = 580 \times 10.37 \times .5 + \frac{2,710}{10.37} = 3270^{\#}$

$x_0 = \frac{2750}{580} = 4.74'$ from D

$M = 2750 \times 4.74 - 2750 - 580 \times \frac{4.74^2}{2} = 3770^{'\#}$

Member EF



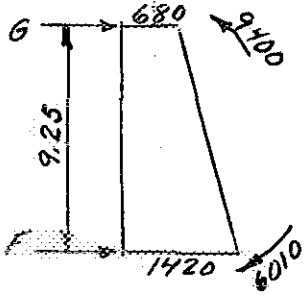
$V_E = 580 \times 8.62 \times .5 - \frac{2750}{8.62} = 2180^{\#}$

$V_F = 580 \times 8.62 \times .5 + \frac{2750}{8.62} = 2820^{\#}$

$x_0 = \frac{2180}{580} = 3.76$ from E

$M = 2180 \times 3.76 - 3260 - 580 \times \frac{3.76^2}{2} = 840^{'\#}$

Member FG



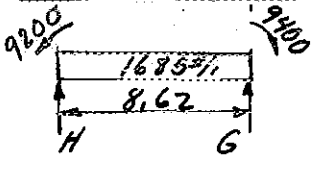
$H_G = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .33 + \frac{3390}{9.25} = 4640^{\#}$

$H_F = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .67 - \frac{3390}{9.25} = 5070^{\#}$

$x_0 = 4640 - 680x - 80\frac{x^2}{2}$ $\quad x = 5.2'$ from G

$M = 4640 \times 5.2 - 9400 - 680 \times \frac{5.2^2}{2} - 416 \times \frac{5.2^2}{6} = 3660^{'\#}$

Member HG



$V_H = 1685 \times 8.62 \times .5 - \frac{200}{8.62} = 7240^{\#}$

$V_G = 1685 \times 8.62 \times .5 + \frac{200}{8.62} = 7290^{\#}$

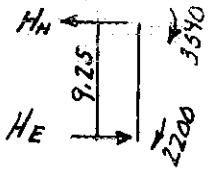
$x_0 = \frac{7240}{1685} = 4.3'$ from H

$M = 7240 \times 4.3 - 9200 - 1685 \times \frac{4.3^2}{2} = 6350^{'\#}$

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 19-April-44

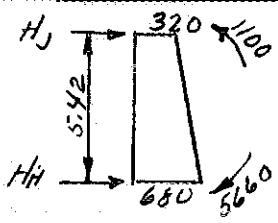
Case I cont.

Member HE



$$H_H = H_E = \frac{3740}{9.25} = 400^{\#}$$

Member HJ

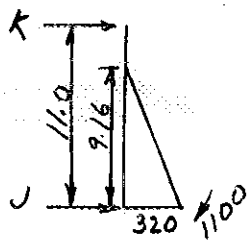


$$H_H = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .67 + \frac{4560}{5.42} = 2340^{\#}$$

$$H_J = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .33 - \frac{4560}{5.42} = 350^{\#}$$

No pos. Mom.

Member JK



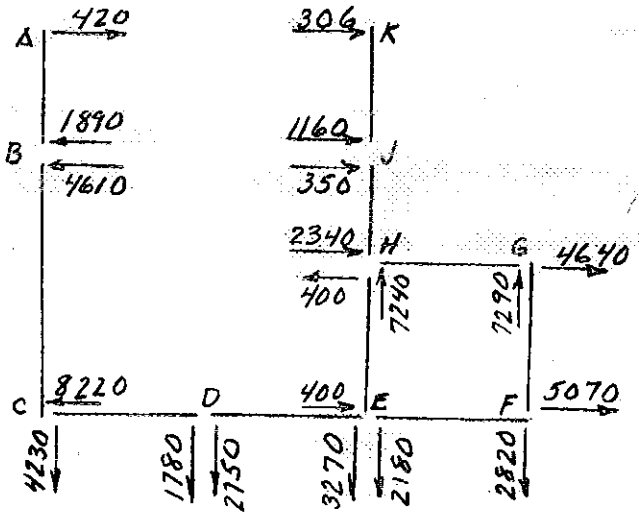
$$H_J = 320 \times 9.16 \times .5 \times \frac{7.95}{11} + \frac{1100}{11} = 1160^{\#}$$

$$H_K = 320 \times 9.16 \times .5 \times \frac{3.05}{11} - \frac{1100}{11} = 306^{\#}$$

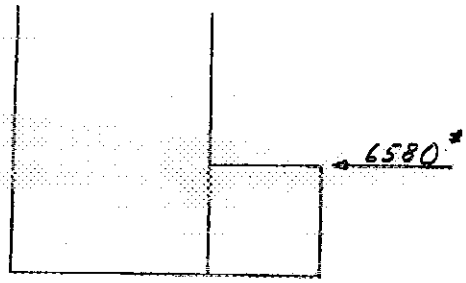
$$x_0 = 306 - 35 \frac{x^2}{2} \quad x = 4.18 \qquad x_0 = 6.02$$

$$+M = 306 \times 6.02 - 147 \times \frac{4.18^2}{6} = 1410^{'\#}$$

End Reactions



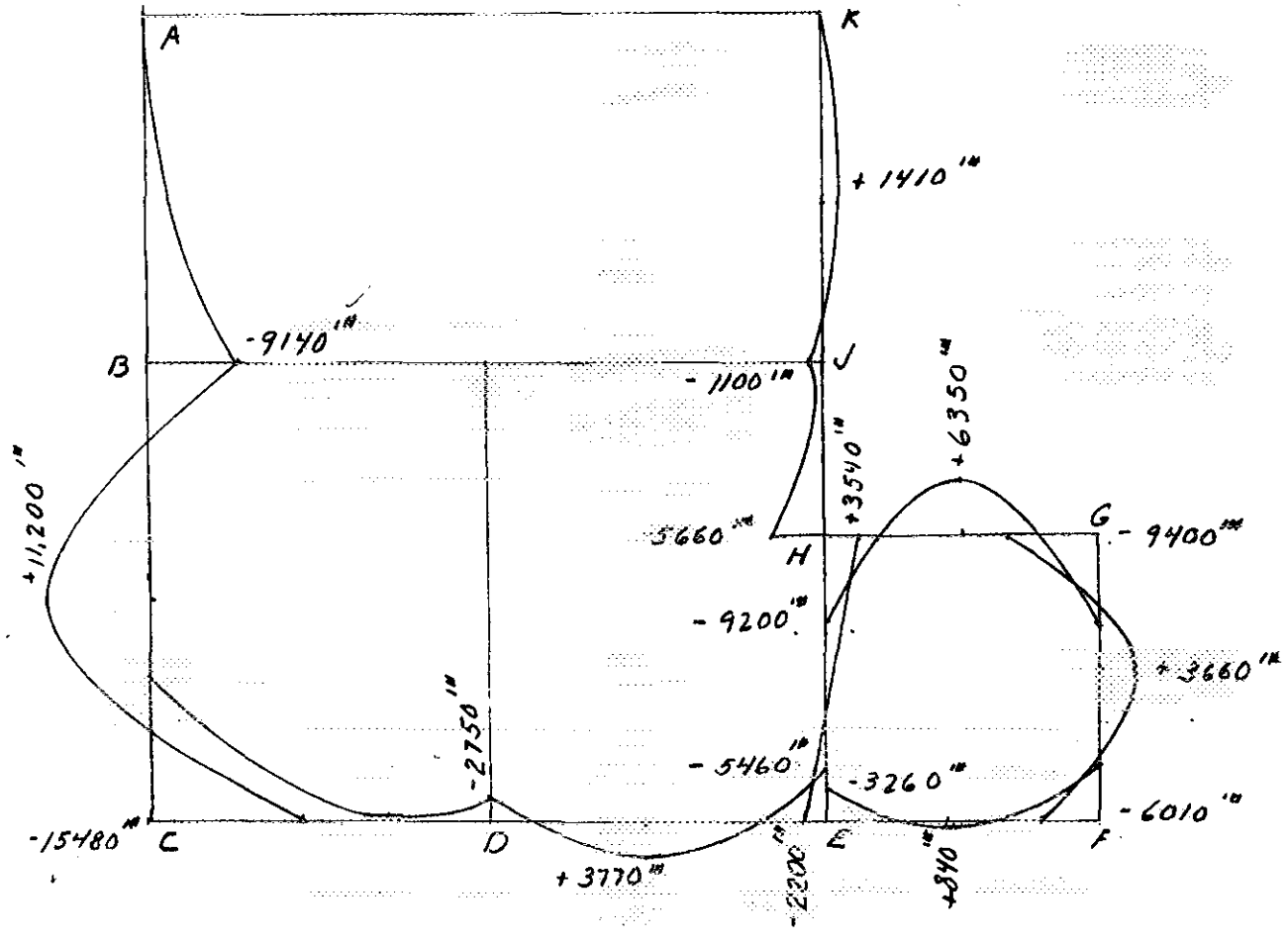
Force Causing Joint Def.



Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: [illegible] Date: 19-April-44

Case I

Moment Diagram



Case I Joint Deflection

Fixed End trial moments for joint deflection will be the same as in Section F-F

WAR DEPARTMENT

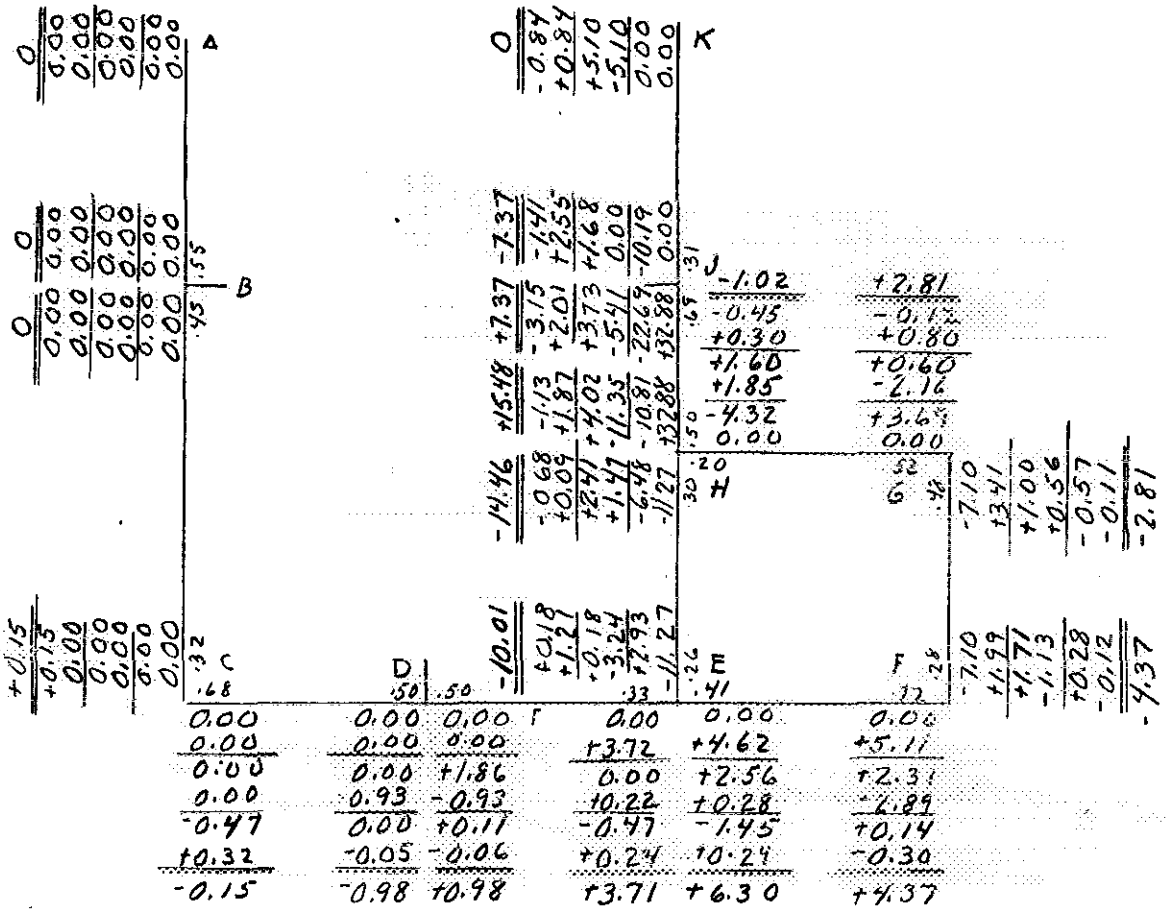
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Section G-G Thru Screening Chamber

Computed by H.E.W **Checked by** A.L.K. **Date** 19- April- 44

Case I



Member JH

$$H_H = \frac{22850}{5.42} = 4216$$

Member HE

$$H_H = \frac{24470}{9.25} = 2645$$

Member GF

$$H_G = \frac{7180}{9.25} = \frac{776}{7637}$$

$$\text{Mom. Mult} = \frac{6580}{7637} = .86$$

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W Checked by: A.L.L. Date: 19-April-44

Case I (cont.)

Member	Trial M	Mult.	Moment
AB @ A	0	.86	0
@ B	0	"	0
BC @ B	0	"	0
@ C	+150	"	+130'#
CD @ C	-150	"	-130'#
@ D	-980	"	-840'#
DE @ D	+980	"	+840'#
@ E	+3710	"	+3190'#
EF @ E	+6300	"	+5420'#
@ F	+4370	"	+3760'#
FG @ F	-4370	"	-3760'#
@ G	-2810	"	-2420'#
GH @ G	+2810	"	+2420'#
@ H	-1020	"	-880'#
HE @ H	-14460	"	-12440'#
@ E	-10,010	"	-8690'#
HJ @ H	+15480	"	+13,310'#
@ J	+7370	"	+6340
JK @ J	-7370	"	-6340
@ K	0	"	0

Member BC

$H_B = \frac{\cancel{150}\ 130}{14.75} = \cancel{10}\ 9\#$ → $H_C = \cancel{10}\ 9\#$ ←

Member CD

$V_C = \frac{\cancel{1130}\ 970}{10.37} = \cancel{110}\ 93\#$ ↑ $V_D = \cancel{110}\ 93\#$ ↓

Member DE

$V_D = \frac{\cancel{4690}\ 4030}{10.37} = \cancel{450}\ 388\#$ ↑ $V_E = \cancel{450}\ 388\#$ ↓

Member EF

$V_E = \frac{\cancel{10670}\ 9180}{8.62} = \cancel{1240}\ 1060\#$ ↑ $V_F = \cancel{1240}\ 1060\#$ ↓

Member FG

$H_F = \frac{\cancel{7180}\ 6180}{9.25} = \cancel{780}\ 670\#$ → $H_G = \cancel{780}\ 670\#$ ←

Member HG

$V_G = \frac{\cancel{1790}\ 1340}{8.62} = \cancel{210}\ 155\#$ ↓ $V_H = \cancel{210}\ 155\#$ ↑

Subject: Bushnell Park Pumping Station
Computation: Section GG Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 19-April-44

Case I cont.

Member HE

$H_E = \frac{\cancel{24,470}\ 26130}{9.25} = \cancel{2650}\ 2280^{\#} \rightarrow H_H = \cancel{2650}\ 2280^{\#} \leftarrow$

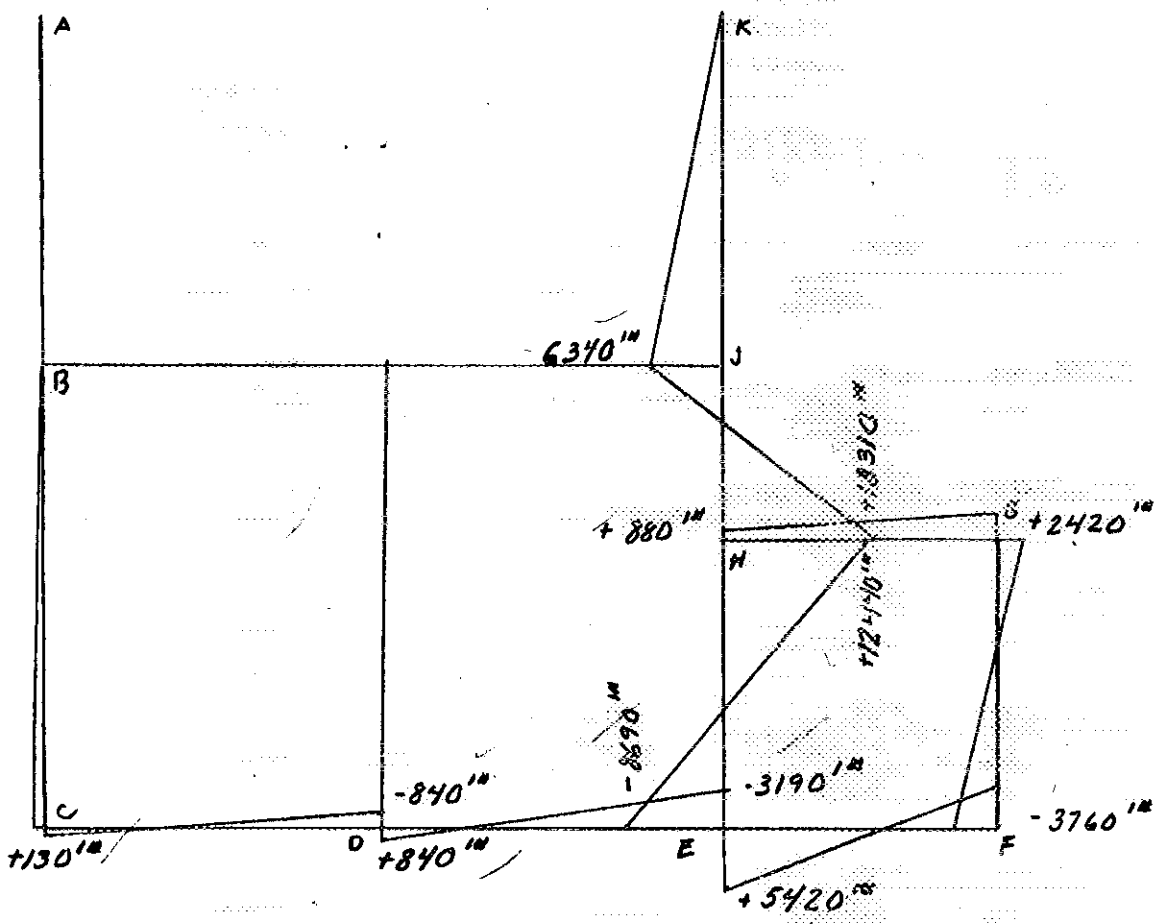
Member HJ

$H_H = \frac{\cancel{22,850}\ 19650}{5.42} = \cancel{4220}\ 3640^{\#} \leftarrow H_J = \cancel{4220}\ 3640^{\#} \rightarrow$

Member JK

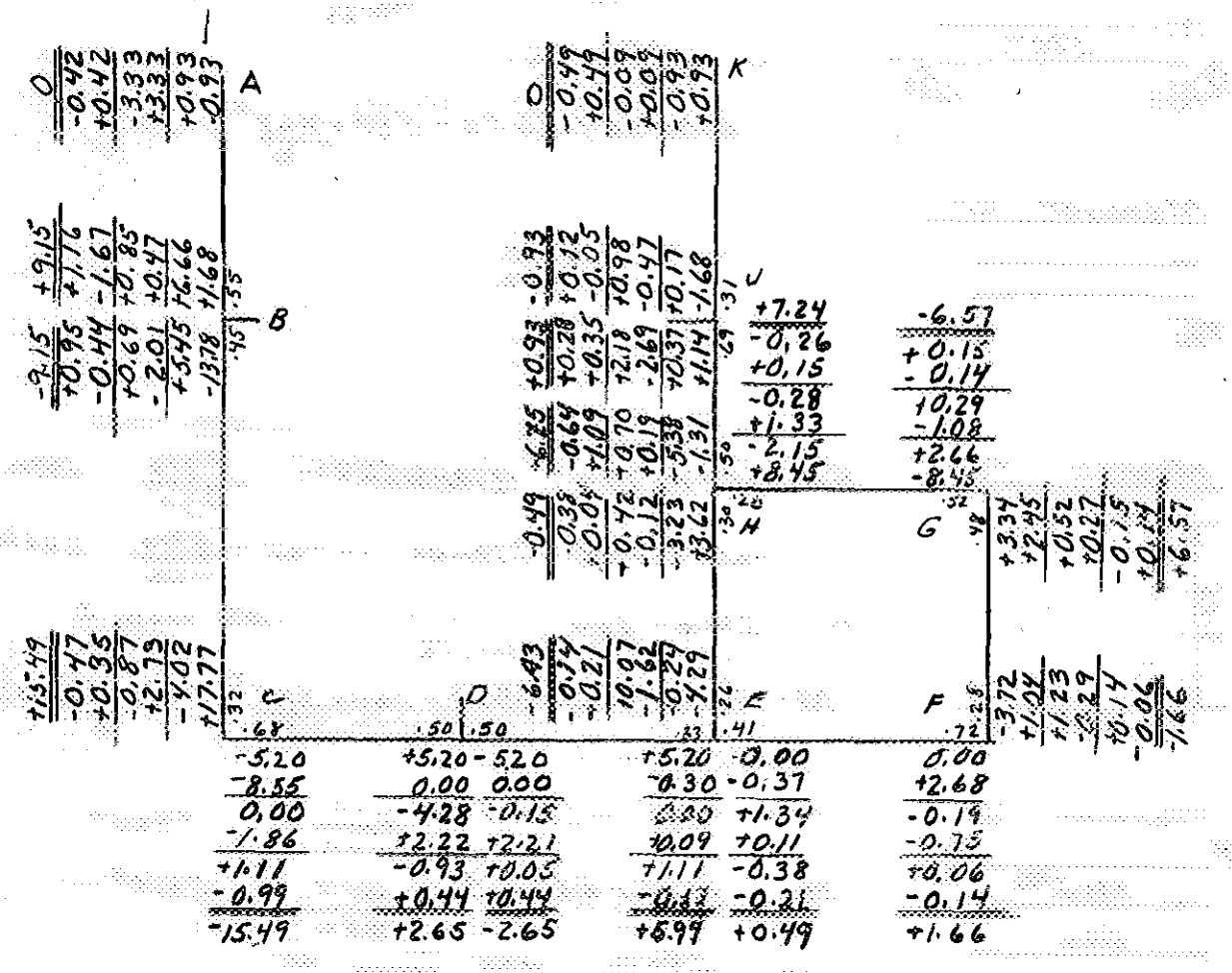
$H_J = \frac{\cancel{7370}\ 6340}{11} = \cancel{670}\ 585^{\#} \rightarrow H_K = 670^{\#} \leftarrow$

Mom. Deflection Curve



Subject: Bushnell Park Pumping Station
Computation: Section G G Thru Screening Chamber
Computed by: H. E. W. Checked by: A. L. F. Date: 19 April - 44

Case II - Section subject to external and internal loading from water in gravity flow conduit. The internal loading will be the same as in Section F.F For fixed end moments of members subjected to internal loading see Sect. F-F

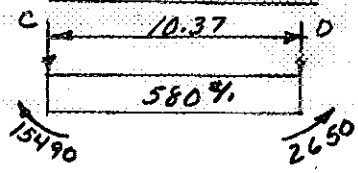


Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H. E. W. Checked by: A. L. K. Date: 20 - April - 44

Case II

End reactions and pos. moments for members AB & BC are the same as in Case I

Member CD



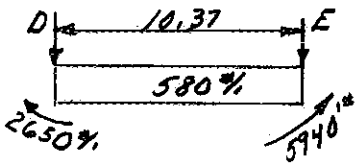
$V_C = 580 \times 10.37 \times .5 + \frac{12840}{10.37} = 4240^{\#}$

$V_D = 580 \times 10.37 \times .5 + \frac{12840}{10.37} = 1770^{\#}$

$x_0 = \frac{4240}{580} = 7.3$ from C

$M = 4240 \times 7.3 - 15490 - 580 \times \frac{7.3^2}{2} = 10^{'\#}$

Member DE



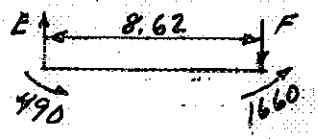
$V_D = 580 \times 10.37 \times .5 - \frac{3290}{10.37} = 2690^{\#}$

$V_E = 580 \times 10.37 \times .5 + \frac{3290}{10.37} = 3320^{\#}$

$x_0 \; \frac{2690}{580} = 4.64$

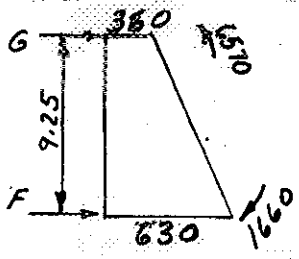
$M = 2690 \times 4.64 - 2650 - 580 \times \frac{4.64^2}{2} = 3590^{'\#}$

Member EF



$V_E = V_F = \frac{2150}{8.62} = 250^{\#}$

Member FG



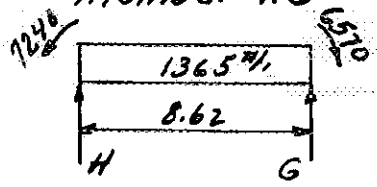
$H_F = 360 \times 9.25 \times .5 + 270 \times .5 \times .67 \times 9.25 - \frac{4910}{9.25} = 1970$

$H_G = 360 \times 9.25 \times .5 + 270 \times .5 \times .33 \times 9.25 + \frac{4910}{9.25} = 2610^{\#}$

$x_0 \quad 2610 - 360x - .29\frac{x^2}{2} \quad x = 5.85'$ from G

$M = 2610 \times 5.85 - 6570 - 360 \times \frac{5.85^2}{2} - 170 \times \frac{5.85^2}{6} = 1570^{'\#}$

Member HG



$V_H = 1365 \times 8.62 \times .5 + \frac{670}{8.62} = 5960^{\#}$

$V_G = 1365 \times 8.62 \times .5 - \frac{670}{8.62} = 5810^{\#}$

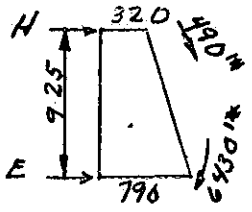
$x_0 = \frac{5960}{1365} = 4.36$ from H

$M = 5960 \times 4.36 - 7240 - 1365 \times \frac{4.36^2}{2} = 5780^{'\#}$

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 20 April 44

Case II (cont.)

Member HE



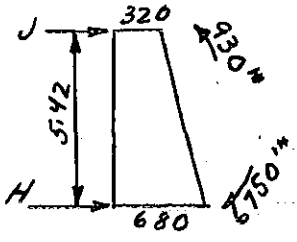
$H_H = 320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .33 - \frac{6920}{9.25} = 1450^{\#}$

$H_E = 320 \times 9.25 \times .5 + 470 \times 9.25 \times .5 \times .67 + \frac{6920}{9.25} = 3680^{\#}$

$x_0 \quad 1450 - 320x - 51\frac{x^2}{2} \qquad x = 3.55$ from H

$M = 1450 \times 3.55 + 490 - 181 \times \frac{3.55^2}{6} - 320 \times \frac{3.55^2}{2} = 3240^{\#}$

Member HJ

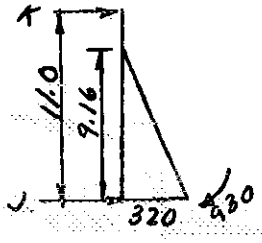


$H_J = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .33 - \frac{5820}{5.42} = 120^{\#}$

$H_H = 320 \times 5.42 \times .5 + 360 \times 5.42 \times .5 \times .67 + \frac{5820}{5.42} = 2600^{\#}$

No pos. mom.

Member KJ



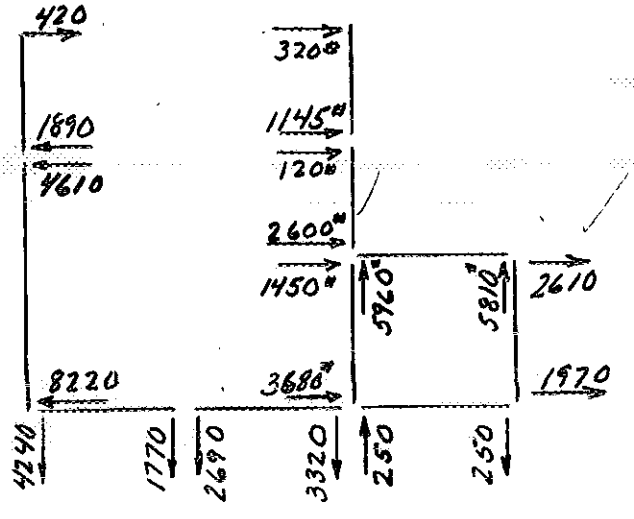
$H_K = 320 \times 9.16 \times .5 \times \frac{3.05}{11} - \frac{930}{11} = 320^{\#}$

$H_J = 320 \times 9.16 \times .5 \times \frac{7.95}{11} + \frac{930}{11} = 1145^{\#}$

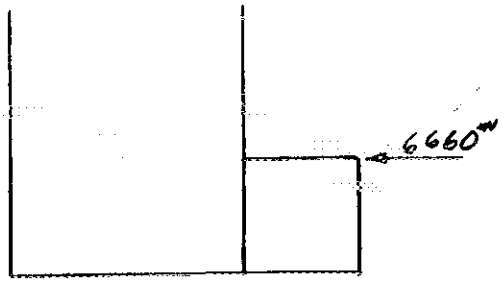
$x_0 = 320 - 35\frac{x^2}{2} = 0 \quad x = 4.27 \qquad x_0 = 6.11$

$+M = 320 \times 6.11 - 150 \times \frac{4.27^2}{6} = 1500^{\#}$

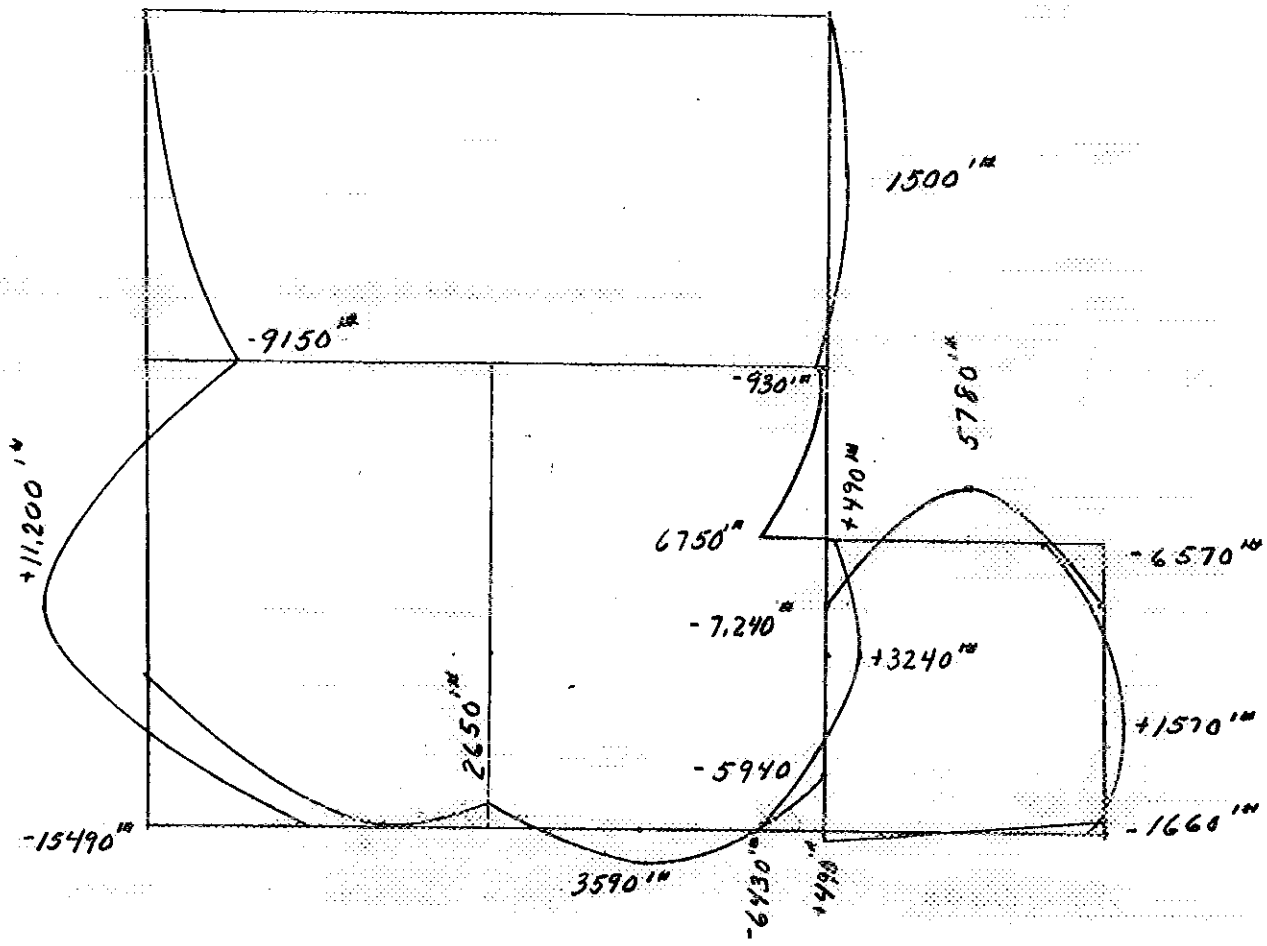
End Reactions



Force Causing Joint Deflection



Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H.E.W. Checked by: A.L.K. Date: 20-April-44



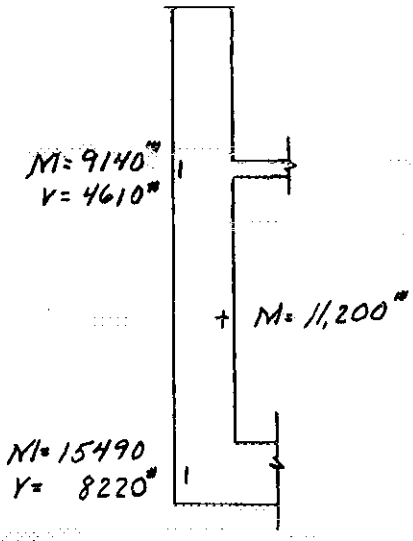
Case II Joint Deflection

Values of moment and shear for joint deflection under Case II are close enough to Case I to use the same values.

Subject: Bushnell Park Pumping Station
Computation: Section G-G Thru Screening Chamber
Computed by: H. E. W. Checked by: A. L. K. Date: 20 April 44

Design of Members

Wall ABC



req'd $d = \sqrt{\frac{15490}{139}} = 10.6" < 17.5"$

$v = \frac{8220}{12 \times .88 \times 17.5} = 45$ #/□"

$-A_s = \frac{15490 \times 12}{20{,}000 \times .88 \times 17.5} = .60$ □" Use 7/8"φ @ 1'-0" cc

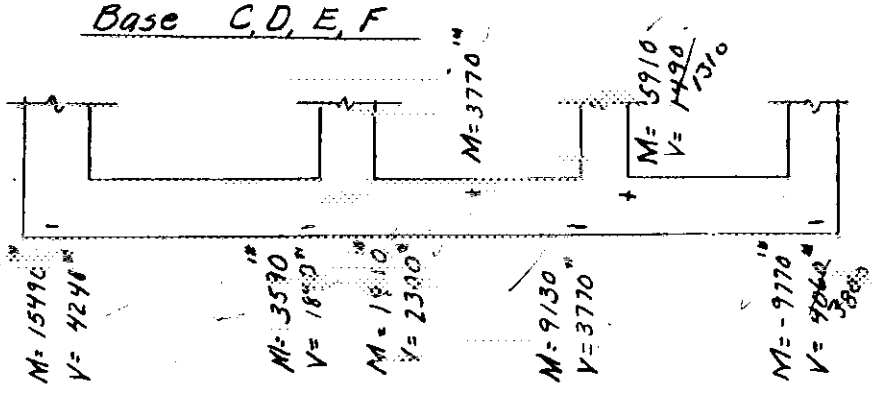
$u_0 = \frac{8220}{2.8 \times 88 \times 17.5} = 190$ #/□" OK

$+A_s = \frac{11{,}200 \times 12}{20{,}000 \times .89 \times 17.5} = .43$ □" Use 3/4"φ @ 1'-0" cc

$x_0 = 8220x - (1420 - 80x)\frac{x^2}{2} - 80\frac{x^3}{3} - 15490$

$x = 2.3'$ pt. of inflection

Base C, D, E, F



req'd $d = \sqrt{\frac{15490}{139}} = 10.6"$

$v = \frac{4240}{12 \times .88 \times 16.8} = 24$ #/□'

$-A_s = \frac{15{,}490 \times 12}{20{,}000 \times .88 \times 16.8} = .63$ □" use 7/8"φ @ 1'-0" cc

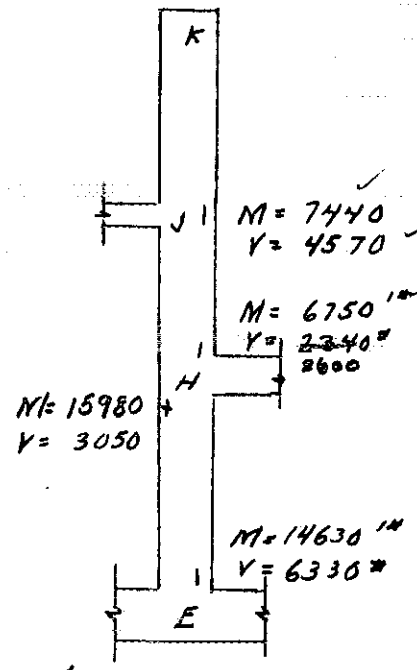
$-A_s = \frac{9770 \times 12}{20{,}000 \times .88 \times 16.8} = .40$ □" Use 3/4"φ @ 1'-0" cc

$u_0 = \frac{\cancel{4060}\ 3880}{2.4 \times .88 \times 16.8} = \cancel{115}\ 110$ #/□"

$+A_s$ Use 3/4"φ @ 1'-0" cc

Subject Bushnell Park Pumping Station
Computation Section G-G Thru Screening Chamber
Computed by H.E.W. **Checked by** A.L.K. **Date** 20, April-44

Member EHJK



reqd $d = \sqrt{\frac{15980}{139}} = 10.7" < 17.6"$

$v = \frac{6330}{12 \times .88 \times 17.6} = 34\ \#/\square''$

$-A_s = \frac{14630 \times 12}{20{,}000 \times .88 \times 17.6} = .57\ \square''$ use $\frac{7}{8}''\phi$ @ 1'-0" cc

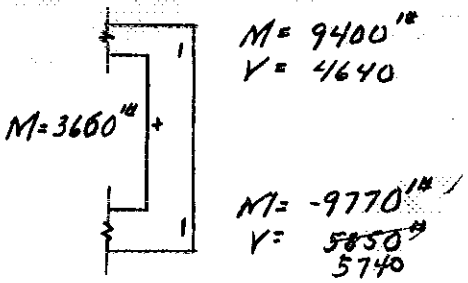
$u_o = \frac{6330}{2.8 \times .88 \times 17.6} = 146\ \#/\square''$

$-A_s = \frac{7440 \times 12}{20{,}000 \times .88 \times 17.6} = .29\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0" cc

$u_o \frac{4570}{2.4 \times .88 \times 17.6} = 123\ \#/\square''$

$+A_s = \frac{15980 \times 12}{20{,}000 \times .88 \times 17.6} = .62\ \square''$ use $\frac{7}{8}''\phi$ @ 1'-0" cc

Member FG



reqd $d = \sqrt{\frac{9770}{139}} = 8.4" < 14.6$

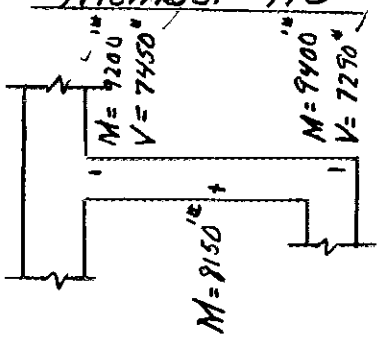
$v = \frac{5850}{12 \times .88 \times 14.6} = 38\ \#/\square''$

$-A_s = \frac{9770 \times 12}{20{,}000 \times .88 \times 14.6} = .45\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0" cc

$u_o = \frac{5850}{2.4 \times .88 \times 14.6} = 190\ \#/\square''$ OK

$+A_s = \frac{3660 \times 12}{20{,}000 \times .89 \times 14.6} = .17\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0" cc

Member HG



$v = \frac{7450}{12 \times .88 \times 14.6} = 48\ \#/\square''$

$-A_s = \frac{9400 \times 12}{20{,}000 \times .88 \times 14.6} = .44\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0" cc

$u_o = \frac{7450}{2.4 \times .88 \times 14.6} = 241\ \#/\square''$

use $\frac{3}{4}''\phi$ @ 9" cc then $u_o = 186\ \#/\square''$

$+A_s = \frac{8150 \times 12}{20{,}000 \times .88 \times 14.6} = .38\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0" cc

Subject: Bushnell Park Pumping Station
Computation: Section B-G Thru Screening Chamber
Computed by: H. E. W. Checked by: A. L. K. Date: 20-April-44

Design of horiz. beam in wall at pts B and J to carry reaction across open areas

$M^F_{AB} = \frac{1}{12} \times 6500 \times 7.5^2 = 30.47^{'K}$

$M^F_{BC} = \frac{1}{12} \times 6500 \times 5.08^2 = 13.98^{'K}$

$+M = 25{,}700 \times 3.95 - 33{,}770 - 6500 \times \frac{3.95^2}{2}$

$M = 17.05^{'K}$

$+M = 13{,}580 \times 2.09 - 9030 - 6500 \times \frac{2.09^2}{2}$

$M = 5.17^{'K}$

req'd $d = \sqrt{\frac{33{,}770}{139}} = 15.6$ OK

Assume width of beam = 2'-0"

6500#/'				
A 7.5	B		5.08 C	
.40	.60			
+30.47	-30.47	+13.98	-13.98	
0.00	+6.60	+9.89	0.00	
+3.30	0.00	0.00	+4.95	
0.00	0.00	0.00	0.00	
33.77	-23.87	23.87	-9.03	-M
25.70	23.06	19.42	13.58	V
→ 3.95		2.09 ←		x_0
17.05'K		5.17'K		+M

$v = \frac{25{,}700}{24 \times .88 \times 17.5} = 69\ \#/\square''$ OK

$A_s = \frac{33{,}770 \times 12}{20{,}000 \times .88 \times 17.5} = 1.32\ \square''$ Use 5-3/4" ϕ bars

$u_0 = \frac{25{,}700}{11.78 \times .88 \times 17.5} = 142\ \#/\square''$

$+A_s = \frac{17{,}050 \times 12}{20{,}000 \times .89 \times 17.5} = .66\ \square''$ Use 5-3/4" ϕ bars

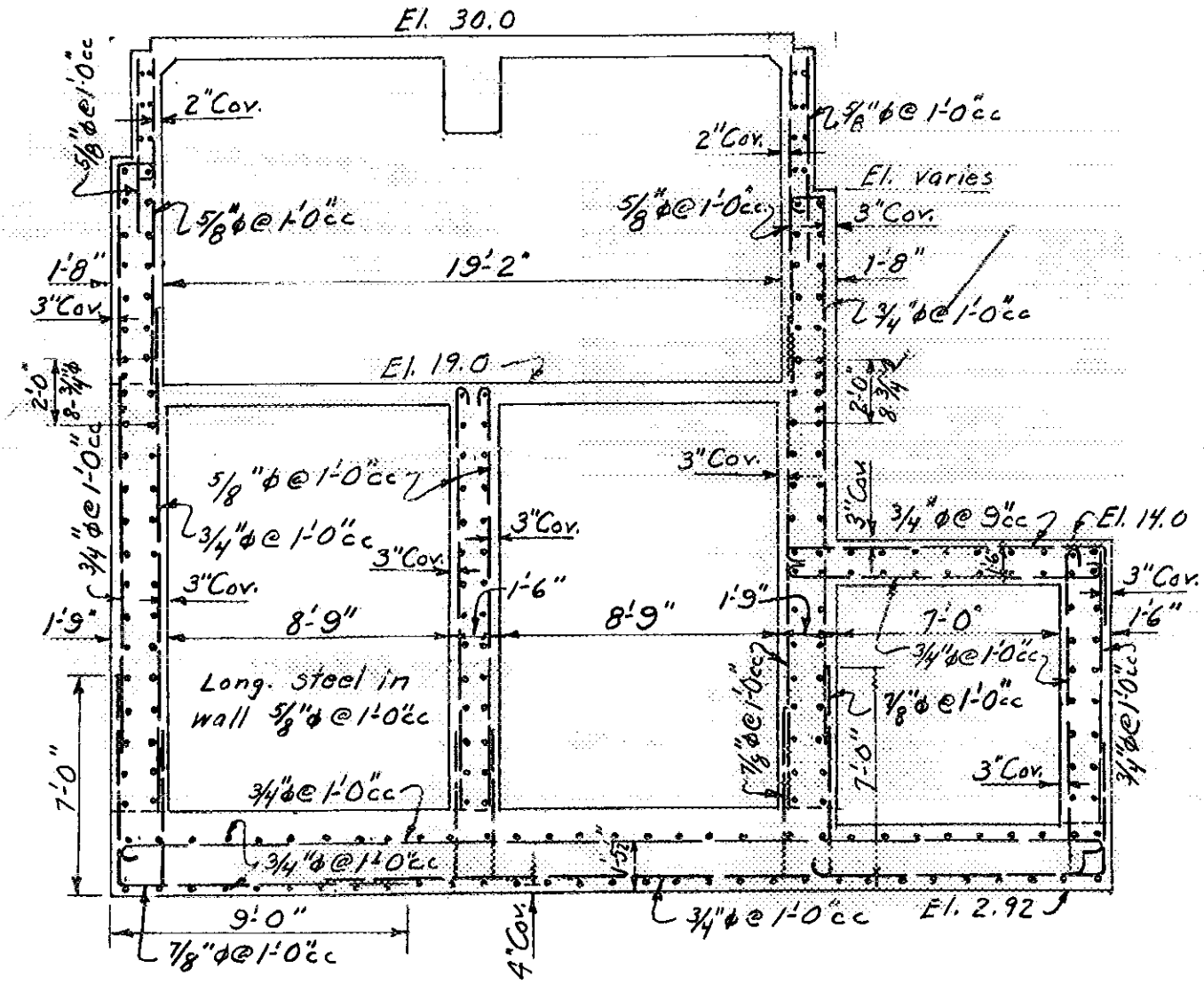
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Section G G Thru Screening Chamber

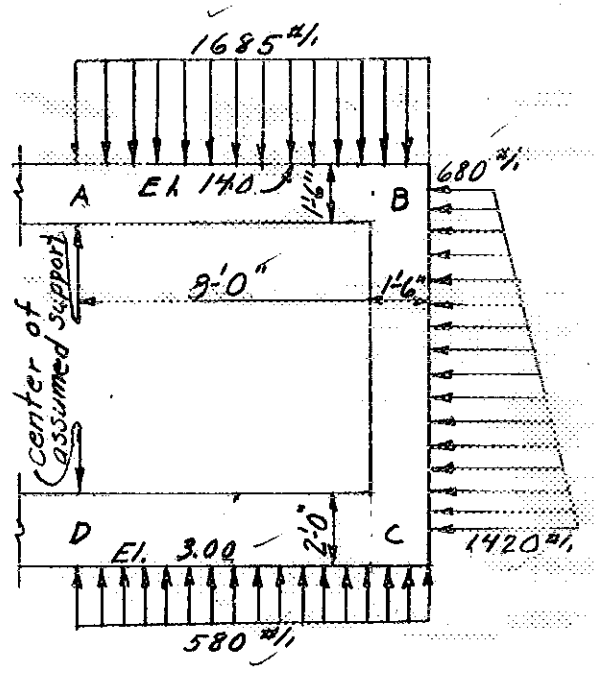
Computed by H. E. W. **Checked by** A.L.K. **Date** 21 April 44



Section G G

Subject: Bushnell Park Pumping Station
Computation: Section H-H Thru Intake Conduit
Computed by: H.E.W. Checked by: R.F.K. Date: 21-April-44

Loading Diagram



Loads on roof, wall and base will be the same as Section G-G

Fixed End Moments

Member AB

$M^F_{AB} = \frac{1}{12} \times 1685 \times 8.75^2 = 10.75'^K$

Member BC

$M^F_{BC} = 6.96'^K$
$M^F_{CB} = 8.02'^K$ } from Sect F-F

Member CD

$M^F_{CD} = \frac{1}{12} \times 580 \times 8.75^2 = 3.70'^K$

Stiffness

Member	d^3	L	d^3/L	K
AB	5832	105	55.5	1.1
BC	5832	111	52.5	1.0
CD	13824	105	131.7	2.5

A	B	C	D
+11.57	-9.04		
0.00	+0.07		
-0.17	0.00		
0.00	-0.33		
+0.99	0.00		
0.00	+1.97		
+10.75	-10.75		
	.52	.29	
	.48	.71	
	+6.96	-8.02	
	+1.82	+1.25	
	+0.63	+0.91	
	-0.30	-0.26	
	-0.13	-0.15	
	+0.06	+0.04	
	+9.04	-6.23	
		+3.70	-3.70
		+3.07	0.00
		0.00	+1.54
		-0.65	0.00
		0.00	-0.33
		+0.11	0.00
		+6.23	-2.49

Assume pts A + D are fixed

Member AB

$V_A = 1685 \times 8.75 \times .5 + \frac{2530}{8.75} = 7660^{\#}$

$V_B = 1685 \times 8.75 \times .5 - \frac{2530}{8.75} = 7080^{\#}$

$x_0 = \frac{7660}{1685} = 4.55'$ from A

$M = 7660 \times 4.55 - 11570 - 1685 \times \frac{4.55^2}{2} = 5840'^{\#}$

Subject: Bushnell Park Pumping Station
Computation: Section H-H Thru Intake Conduit
Computed by: H.E.W. Checked by: A.L.L. Date: 22 April 44

Member BC

$H_B = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .33 + \frac{2,810}{9.25} = 4580^{\#}$

$H_C = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .67 - \frac{2810}{9.25} = 5130^{\#}$

$x_0 = 4580 - 680x - \frac{80x^2}{2} = 0 \quad x = 5.15'$ from B

$M = 4580 \times 5.15 - 680 \times \frac{5.15^2}{2} - 412 \times \frac{5.15^2}{6} - 9,040 = 3720^{\#}$

Member CD

$V_D = 580 \times 8.75 \times .5 - \frac{3740}{8.75} = 2110^{\#}$

$V_C = 580 \times 8.75 \times .5 + \frac{3740}{8.75} = 2970$

$x_0 = \frac{2110}{580} = 3.64'$ from D

$M = 2110 \times 3.64 - 2490 - 580 \times \frac{3.64^2}{2} = 1350'^{\#}$

Design of Members

Roof slab AB

reqd $d = \sqrt{\frac{11,570}{139}} = 9.1'' < 14.5''$ OK

$v = \frac{7660}{12 \times .88 \times 14.5} = 50\ \#/\square''$

$-A_s = \frac{11570 \times 12}{20,000 \times .88 \times 14.5} = .55^{\square''}$ Use $\frac{3}{4}''\phi$ @ 9" cc

$u_0 = \frac{7660}{3.1 \times .88 \times 14.5} = 194\ \#/\square''$

$+A_s = \frac{5840 \times 12}{20,000 \times .89 \times 14.5} = .27^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

Wall BC

$-A_s = \frac{9040 \times 12}{20,000 \times .88 \times 14.5} = .42^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

$u_0 = \frac{4580}{2.4 \times .88 \times 14.5} = 150\ \#/\square''$

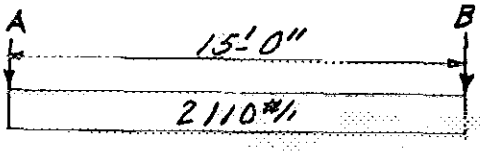
$+A_s = \frac{3720 \times 12}{20,000 \times .88 \times 14.5} = .18^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

Base slab CD

Use $\frac{3}{4}''\phi$ @ 1'-0" cc Top & Bot.

Subject: Bushnell Park Pumping Station
Computation: Section H-H Thru Intake Conduit
Computed by: H.E.W. Checked by: [illegible] Date: 22 April 44

Design of Beam in Base Slab at Pt. D



$M = \frac{1}{10} \times 2110 \times 15^2 = 47,475$ '#

$V = 2110 \times 7.5 = 15825$ #

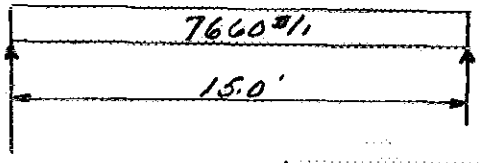
req'd $d = \sqrt{\frac{47,475 \times 12}{116 \times 18}} = 16.5"$ OK ∴ 16.8"

$v = \frac{15825}{18 \times .88 \times 16.8} = 60$ #/□"

$A_s = \frac{47475 \times 12}{20,000 \times .88 \times 16.8} = 1.92$ □" Use 3-1"φ Top and Bot @ 6" c.c.

$u_o = \frac{15825}{9.4 \times .88 \times 16.8} = 114$ #/□"

Design of Beam in Roof Slab at Pt. A



$M = \frac{1}{8} \times 7660 \times 15^2 = 215,440$ '#

$V = 7660 \times 7.5 = 57450$ #

Use WF steel beam

req'd $S = \frac{215440 \times 12}{20,000} = 129.3$ "³ Use 12" × 12" × 99# WF

$S = 134.7$ "³

Distance into wall

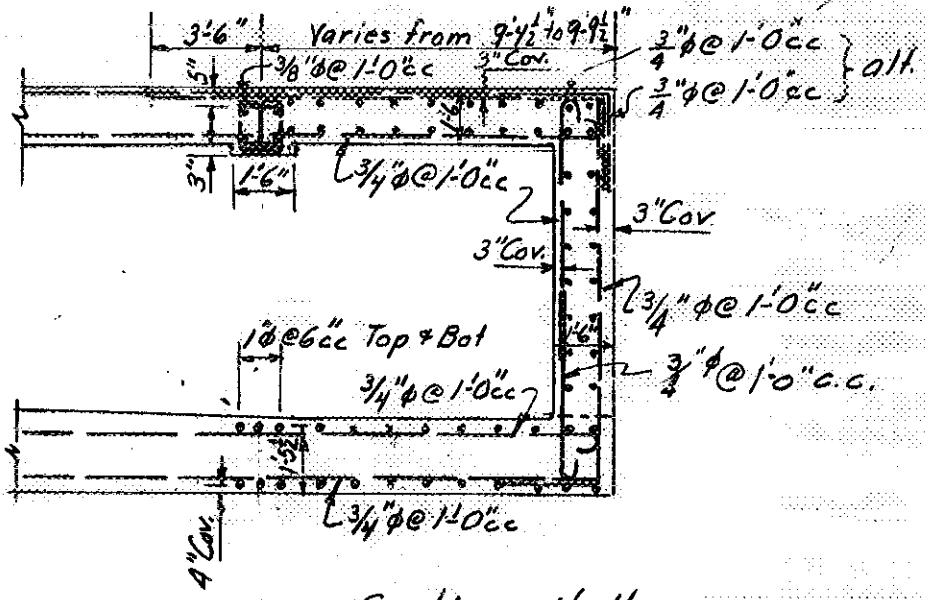
$12.25 \times 500\,x = 57450$ $x = 9.4"$ Carry beam 12" into wall

Assume Roof load carried on column 18" × 21"

Max. allow. load $= .225 f'_c A_g [1 + (n-1)p]$

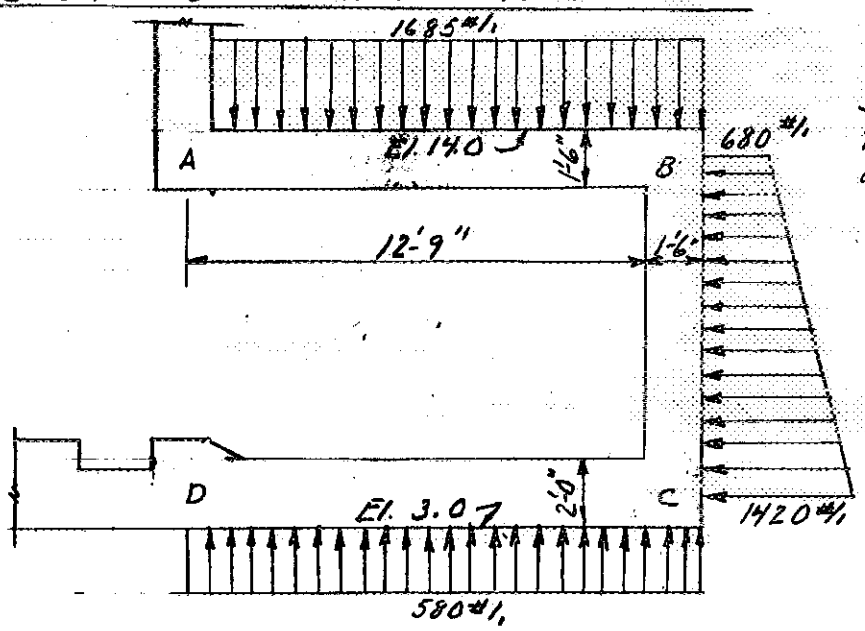
$P = .225 \times 3000 \times 18 \times 21 [1 + 11 \times .0049] = 308,100$ #

Subject: Bushnell Park Pumping Station
Computation: Section H-H Thru Intake Conduit
Computed by: H.E.W. Checked by: A.L.R. Date: 22-April-44



Section H-H

Section JJ Thru. Intake Conduit



Loading on section will be the same as on Section H-H

Subject: Bushnell Park Pumping Station
Computation: Section J-J Thru Intake Conduit
Computed by: Checked by: A.K. Date: 22-April-44

Fixed End Moments

Member AB

$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 1685 \times 13.5^2 = 25.59^{'K}$

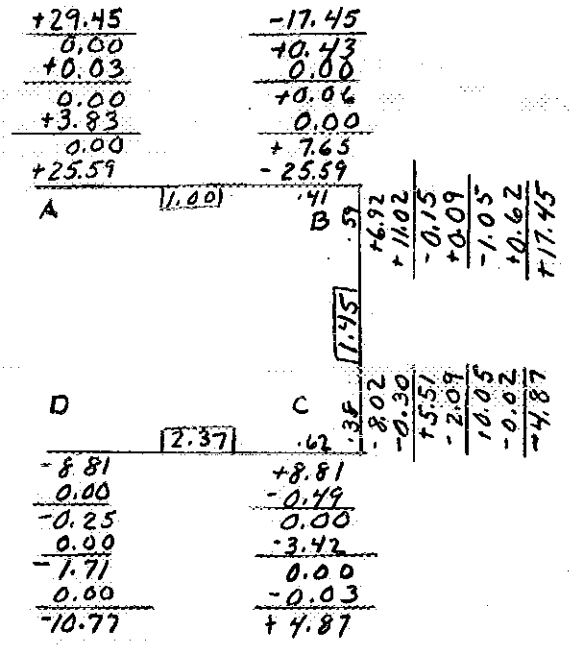
Member BC Same as Sect. H-H

Member CD

$M^F_{CD} = M^F_{DC} = \frac{1}{12} \times 580 \times 13.5^2 = 8.81^{'K}$

Stiffness

Member	d	d^3	L	d^3/L	K
AB	18	5832	162	36	1.00
BC	18	5832	111	52.5	1.45
CD	24	13824	162	85.3	2.37



Member AB

$V_A = 1685 \times 13.5 \times .5 + \frac{12,000}{13.5} = 12,260$

$V_B = 1685 \times 13.5 \times .5 - \frac{12000}{13.5} = 10,490^{'\#}$

$x_0 = \frac{12,260}{1685} = 7.27'$ from A

$+M = 12260 \times 7.27 - 29,450 - 1685 \times \frac{7.27^2}{2} = 15150^{'\#}$

Member BC

$H_B = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .33 + \frac{12,580}{9.25}$
$= 5630^{\#}$

$H_C = 680 \times 9.25 \times .5 + 740 \times 9.25 \times .5 \times .67 - \frac{12,580}{9.25}$
$= 4080^{\#}$

$x_0 = 6.1'$ from B

$M = 5630 \times 6.1 - 17,450 - 680 \times \frac{6.1^2}{2} - 488 \times \frac{6.1^2}{6}$
$= 1210^{'\#}$

Member DC

$V_D = 580 \times 13.5 \times .5 + \frac{5900}{13.5} = 4350^{\#}$

$V_C = 580 \times 13.5 \times .5 - \frac{5900}{13.5} = 3480^{\#}$

$x_0 = \frac{4350}{580} = 7.5'$

$+M = 4350 \times 7.5 - 10,770 - 580 \times \frac{7.5^2}{2} = 5540^{'\#}$

Subject: Bushnell Park Pumping Station
Computation: Section J-J Thru Intake Conduit
Computed by: H.E.W. Checked by: A.L.K. Date: 24- April - 44

Design of Members

Roof Slab AB

req'd $d = \sqrt{\frac{29,450}{139}} = 14.5''$ OK Actual $d = 13.9''$

$v = \frac{12260}{12 \times .88 \times 13.9} = 83\#/\square''$ OK as special anchorage will be provided

$-A_s = \frac{29,450 \times 12}{20,000 \times .88 \times 13.9} = 1.45\square''$ Use $1''\phi$ @ $6''$cc

$u_o = \frac{12260}{6.3 \times .88 \times 13.9} = 158\#/\square''$

$+A_s = \frac{15,150 \times 12}{20,000 \times .89 \times 13.9} = .74\square''$ Use $\begin{cases} 7/8''\phi \text{ @ } 9''\text{cc or} \\ 1''\phi \text{ @ } 1'\text{-}0''\text{cc} \end{cases}$

Wall BC

req'd $d = \sqrt{\frac{17,450}{139}} = 11.2'' < 14.5''$

$v = \frac{5630}{12 \times .88 \times 14.5} = 37\#/\square''$

$-A_s = \frac{17450 \times 12}{20,000 \times .88 \times 14.5} = .82\square''$ Use $7/8''\phi$ @ $9''$cc

$u_o = \frac{5630}{3.7 \times .88 \times 14.5} = 119\#/\square''$

$+A_s$ Use $3/4''\phi$ @ $1'\text{-}0''$cc.

Base Slab - DC

$-A_s = \frac{10,770 \times 12}{20,000 \times .88 \times 17.5} = .42\square''$ Use $3/4''\phi$ @ $1'\text{-}0''$cc

$u_o = \frac{4350}{2.4 \times .88 \times 17.5} = 117\#/\square''$

$+A_s$ Use $3/4''\phi$ @ $1'\text{-}0''$cc.

Object: Bushnell Park Pumping Station
Computation: Section J-J Thru Intake Conduit
Computed by: H.F.W. Checked by: R.L.K. Date: 24 April [illegible]

Design of Beam over Gate Opening

Span = 8'-0" load = 12260 #

$M = \frac{1}{10} \times 12260 \times 64 = 78460$ '#

reqd d = $\sqrt{\frac{78460 \times 12}{18 \times 116}} = 21.2"$ Actual d = 20.4"

$A_s = \frac{78460 \times 12}{20{,}000 \times .88 \times 20.4} = .27$ □" Use 3 - 5/8" ϕ bars

Design of Beam in Slab under Gate Opening

Span = 8'-0" load = 4350 #

$M = \frac{1}{10} \times 4350 \times 64 = 27{,}840$ '#

$V = 4350 \times 4 = 17{,}400$ #

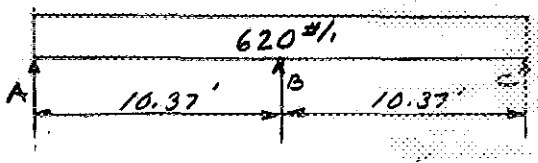
reqd d = $\sqrt{\frac{27840 \times 12}{18 \times 116}} = 12.7" < 16.9$

$A_s = \frac{27840 \times 12}{20{,}000 \times .88 \times 16.9} = 1.12$ □" Use 3 - 3/4" ϕ Top + Bot.

$v = \frac{17400}{18 \times .88 \times 16.9} = 65$ #/□" OK

$u_o = \frac{17400}{6.7 \times .88 \times 16.9} = 174$ #/□" OK

Design of End Wall from El. 14.0 to El. 19.0



Horiz thrust at El. 14.0 = 620 #/'

$-M' = \frac{1}{12} \times 10.37' \times 620 = 5.56$ 'K

$+M = 2.78$ 'K

$V = 620 \times 10.37 \times .5 = 3220$ #

reqd d = $\sqrt{\frac{5560}{13.9}} = 6.3 < 13.9$ OK

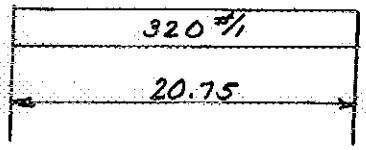
$v = \frac{3220}{12 \times .88 \times 13.9} = 22$ #/□"

$A_s = \frac{5560 \times 12}{20{,}000 \times .88 \times 13.9} = .27$ □" Use 3/4" ϕ @ 1'-0" c.c.

$u_o = \frac{3220}{2.0 \times .88 \times 13.9} = 131$ #/□" OK

Subject Bushnell Park Pumping Station
Computation Section J-J Thru Intake Conduit
Computed by H.E.W. **Checked by** A.L.K. **Date** 24 April 47

Design of End Wall from El. 19.0 to 30.0



Horiz pressure at El. 19.0 = 320 #/'

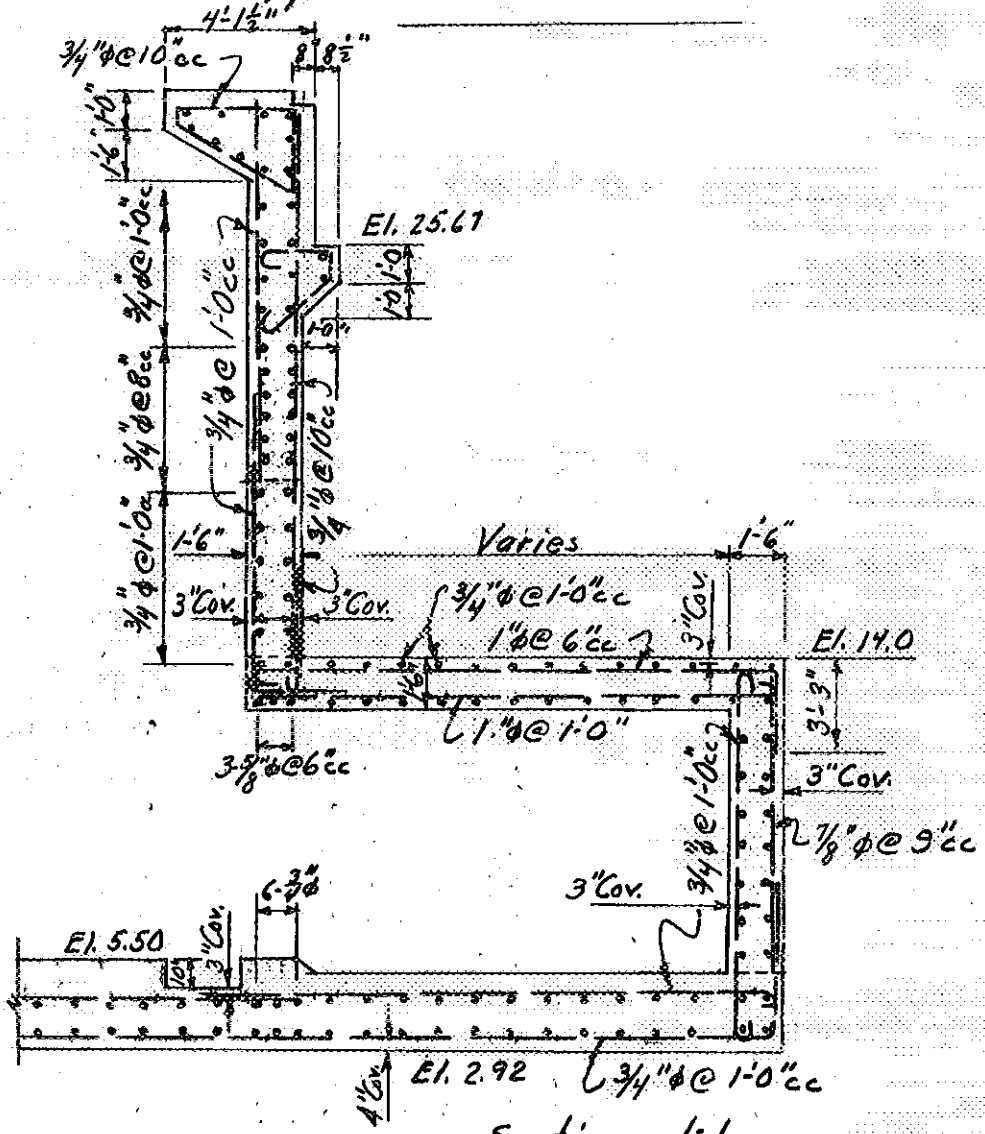
$M = \frac{1}{10} \times 320 \times 20.75^2 = 13,780$ '#

$V = 320 \times 20.75 \times .5 = 3320$ #

$A_s = \frac{13780 \times 12}{20,000 \times .88 \times 13.9} = .68$ □" use 3/4"φ @ 8" cc

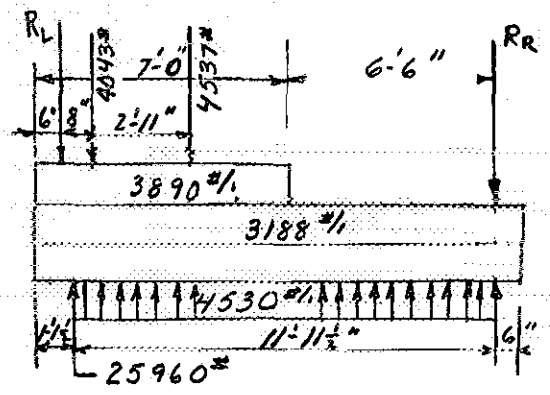
$u_0 = \frac{3320}{3.5 \times .88 \times 13.9} = 78$ #/□"

Use 3/4"φ @ 1'-0" cc at El 22.0



Section J-J

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Dividing Wall
Computed by: H.E.W. Checked by: ALK Date: 25 April 44



Dead wt of Center Wall

$1.5 \times 14.17 \times 150 = 3188^{\#}$

$1.83 \times 14.17 \times 150 \quad 3890^{\#}/'$

$\frac{1+2.28}{2} \times .58 \times 14.17 \times 150 \times 2 = 4043^{\#}$

$\frac{1+2.67}{2} \times .58 \times 14.17 \times 150 \times 2 = 4537^{\#}$

$R_L = 25{,}960 \times 11.96 + 4530 \times 11.96 \times 5.98 - 3188 \times 13.5 \times 6.25 - 3890 \times 7 \times 10$
$- 4043 \times 11.83 - 4537 \times 8.93 - R_L \times 12.5 = 0 \qquad R_L = 390^{\#} \downarrow$

The unbalanced upward thrust at R_L will be overcome by the dead weight of the floor system concentrated at R_L

Any upward thrust at R_R will be overcome by the downward weight of the end wall

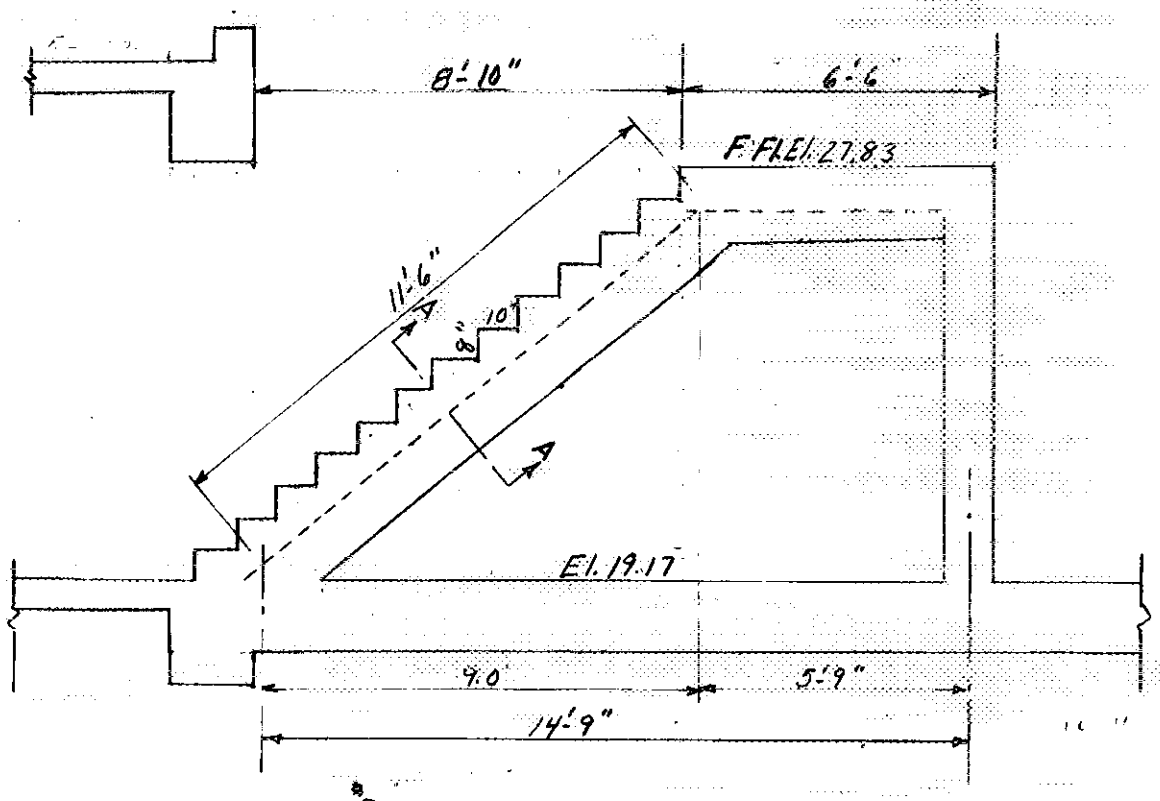
WAR DEPARTMENT

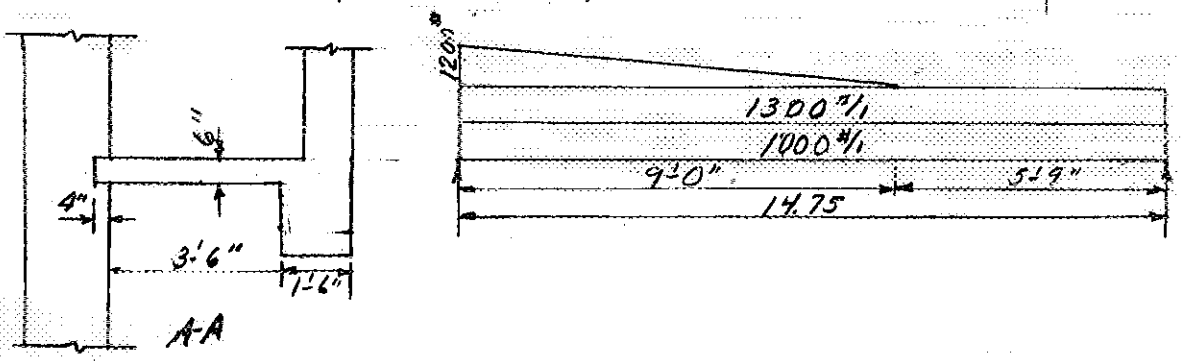
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Stairway to Screening Chamber

Computed by H.E.W. **Checked by** A.L.K. **Date** 25 April 79





Stairs

Slab = .5 x 150 x 3 $\frac{11.5}{9}$ = 287

Stairs .83 x .67 x .5 x 3 $\frac{10}{9}$ x 150 = 139

L.L. = 75 x 2.6 = 195

D.L. Beam = 1.5 x 1.5 x 150 x $\frac{11.5}{9}$ = 431

1052 #/'

Platform

Slab = .87 x 150 x 3.0 = 391

L.L. = 2.5 x 75 = 195

D.L. Beam = 1.5 x 1.5 x 150 338

924 #/'

Say L.L & D.L. stairs = 1000 #/' Horizontally

Load from Brick wall on

Av. ht wall = 9'-6" = 1.0 x 125 x 9.5 = 1188

L.L + D.L. roof = 2.5 x 55 = 138

1326 Say 1300 #/'

Subject: Bushnell Park Pumping Station
Computation: Stairway to Screening Chamber
Computed by: H.E.W. Checked by: H.L.K. Date: 25 April 44

Wt. of concrete wall

$8 \times 1 \times 150 = 1200^{\#}$

Reactions

$R_L = 2300 \times 14.75 \times .5 + 1200 \times 9 \times .5 \times \frac{11.75}{14.75} = 21260^{\#}$

$R_R = 2300 \times 14.75 \times .5 + 1200 \times 9 \times .5 \times \frac{3}{14.75} = 18060^{\#}$

$x_0 = 7'-9''$ from R_R

$M = 18060 \times 7.75 - 2300 \times \frac{7.75^2}{2} - 167 \times \frac{2^2}{6} = 70,700^{'\#}$

req'd $d = \sqrt{\frac{70,700 \times 12}{18 \times 116}} = d = 20.''$ < 20.5" OK

$v = \frac{21,260}{18 \times .88 \times 20.5} = 65^{\#}/\square''$

$A_s = \frac{70,700 \times 12}{20,000 \times .88 \times 20.5} = 2.35^{\square''}$ Use 3-1"ϕ bars bot.
Use 3-7/8"ϕ bars top

$u_0 = \frac{21,260}{9.42 \times .88 \times 20.5} = 125^{\#}/\square''$ OK

Design of slab

D.L slab = $.5 \times 1 \times 150 = 75^{\#}/'$
" " $.83 \times .67 \times .5 \times \frac{10}{9} \times 150 = 46$
L.L = $\frac{9}{11.5} \times 75 = 61^{\#}/'$
$182^{\#}/'$

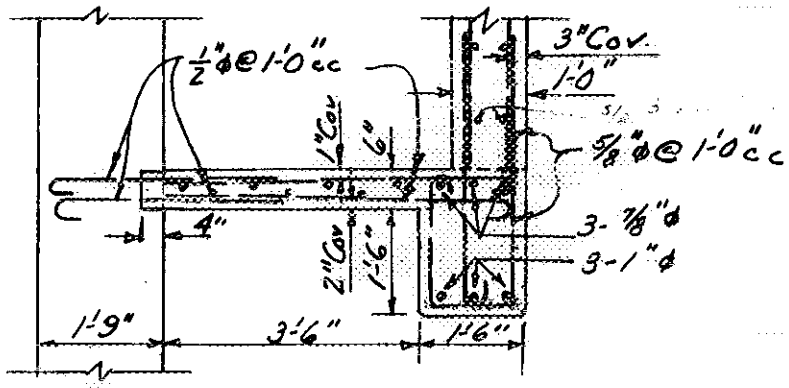
$M = \frac{1}{8} \times 182 \times 4.92^2 = 550^{'\#}$

$V = 182 \times \frac{4.92}{2} = 450^{\#}$

$v = \frac{450}{12 \times .88 \times 3.75} = 11^{\#}/\square''$ OK

Use $\frac{1}{2}$"ϕ @ 12" cc Top and Bot.

Subject Bushnell Park Pumping Station
Computation Stairway to Screening Chamber
Computed by H. E. W. **Checked by** R. L. K. **Date** 26. April-44



Design of Column

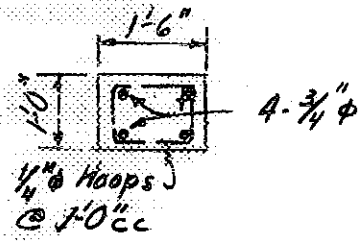
Try 12"x18" column with 4-3/4"φ bars

$p = \frac{1.77}{12 \times 18} = .0082$

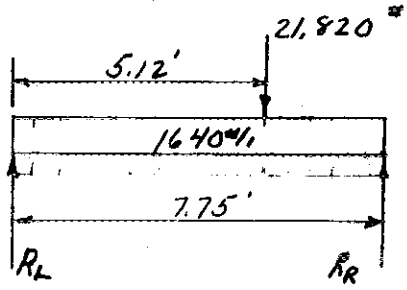
Max Allowable load = $.18 \times 3000 [216 - 1.77] + .8 \times 1.77 \times 16000 = 138,340^{\#}$

Actual Load

R_R =		18,060#
Endwall	1x7.5x125x2 =	1880
Beam	1x1.13x150x2 =	340#
wt. col =	1.5x1x150x6.83 =	1540#
		21,820# OK



Beam Action in Slab under Column



Assume load spread over 2' width.

$R_R = 21,820 \times \frac{5.12}{7.75} + 1640 \times 7.75 \times .5 = 20,770^{\#}$

$R_L = 13,760^{\#}$

$x_0 = 5.12'$ from R_L

$M = 13760 \times 5.12 - 1640 \times \frac{5.12^2}{2} = 48,960'^{\#}$

req'd $d = \sqrt{\frac{48,960 \times 12}{24 \times 116}} = 14.5''$ OK

$v = \frac{20,770}{24 \times .89 \times 14.6} = 67^{\#}/\square''$ OK

$A_s = \frac{48,960 \times 12}{20,000 \times .89 \times 14.6} = 2.26^{\square''}$ Use 5-3/4"φ bars in bot.

$u_0 = \frac{20,770}{11.78 \times .89 \times 14.6} = 135^{\#}/\square''$ OK

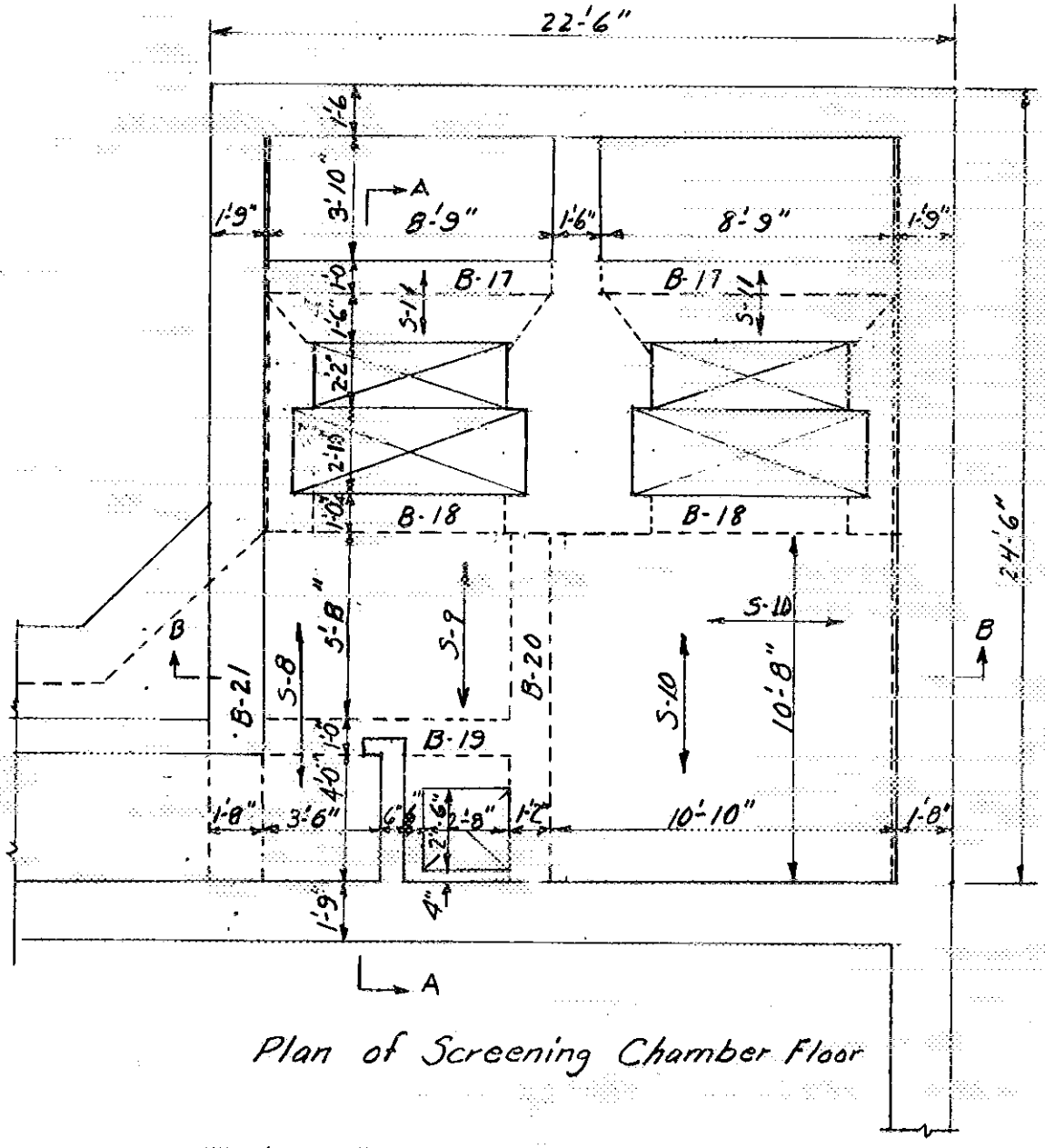
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

Computation Screening Chamber Floor

Computed by H. E. W. **Checked by** A. L. **Date** 26 April 44



Plan of Screening Chamber Floor

Floor will be designed for 300# L.L
Beams will be designed for 250# L.L.

Subject Bushnell Park Pumping Station
Computation Screening Chamber Floor
Computed by H.E.W. **Checked by** [illegible] **Date** 27-April 44

Slab S-8

D.L 8" slab = 100#
L.L on slab = 300
400#/'

Fixed		400#/'		Hinged
5.37		6.67		
	.55	.45		
+0.96	-0.96	+1.48	-1.48	
0.00	-0.29	-0.23	+1.48	
-0.15	0.00	+0.74	-0.12	
0.00	-0.41	-0.33	+0.12	
-0.20	0.00	+0.06	-0.17	
0.00	-0.03	-0.03	+0.17	
+0.61	-1.69	+1.69	0.00	-M
0.87	1.28	1.79	1.28	V
→ 2.18		3.20 ←		x_0
950'#		2050'#		

Fixed End Moments

$M^F = \frac{1}{12} \times 400 \times 5.37^2 = 0.96$ 'K

$M^F = \frac{1}{12} \times 400 \times 6.67^2 = 1.48$ 'K

req'd $d = \sqrt{\frac{2050}{116}} = 4.2'' < 5.75$ OK

$V = \frac{1790}{12 \times .88 \times 5.75} = 30$#/□" OK

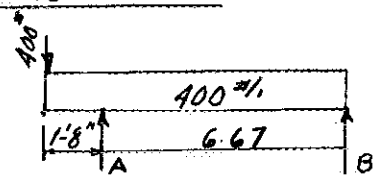
$-A_s = \frac{1690 \times 12}{20{,}000 \times .88 \times 6.75} = .17$ □"

Use $\frac{5}{8}$"φ @ 12"cc Top

$u_0 = \frac{1790}{1.96 \times .88 \times 6.75} = 154$#/□" OK

$+A_s = \frac{2050 \times 12}{20{,}000 \times .89 \times 5.75} = 24$ □" Use $\frac{5}{8}$"φ @ 1'-0"cc Bot.

Slab S-9



D.L Frame + Plate = 2.5 × 15 = 38
L.L on plate = 300 × 2.5 = 750
2 | 788
Concentration = 394

Neg Mom at A

$400 \times 1.67 + 400 \times \frac{1.67^2}{2} = 1230$ '#

Member AB

$R_A = 6.67 \times 400 \times .5 + \frac{1230}{6.67} = 1520$#

$x_0 = 3.8$

$+M = 1520 \times 3.8 - 400 \times \frac{3.8^2}{2} = 2900$ '#

$+A_s = \frac{2900 \times 12}{20{,}000 \times .89 \times 5.75} = .34$ □" Use $\frac{5}{8}$"φ @ 10"cc

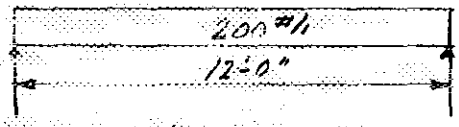
$-A_s$ Use $\frac{5}{8}$"φ @ 1'-0"cc

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
Page 217

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Floor
Computed by: H.E.W. Checked by: A.L.K. Date: 22 April 44

Slab S-10

Slab S-10 will be designed as a two way slab
$\frac{1}{8} w l^2$ will be used for pos. mom. at center
$\frac{1}{12} w l^2$ will be used for neg. mom at supports



$+M = \frac{1}{8} \times 200 \times 144 = 3600'^{\#}$

$-M = \frac{1}{12} \times 200 \times 144 = 2400'^{\#}$

$V = 1200^{\#}$

reqd $d = \sqrt{\frac{3600}{116}} = 5.55'' < 5.75''$ OK

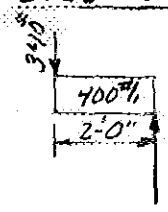
$v = \frac{1200}{12 \times .88 \times 5.75} = 24^{\#}/\square''$

$+A_s = \frac{3600 \times 12}{20{,}000 \times .89 \times 5.75} = .42^{\square''}$ Use $\frac{5}{8}''\phi$ @ 8"cc Bot.

$-A_s = \frac{2400 \times 12}{20{,}000 \times .88 \times 6.75} = .24^{\square''}$ Use $\frac{5}{8}''\phi$ @ 1'-0"cc Top

$u_o = \frac{1200}{1.96 \times .88 \times 6.75} = 103^{\#}/\square''$ OK

Slab S-11



Slab S-11 will act as a cantilever
Frame load

$1.07 \times 15 = 16$
$1.07 \times 300 = 321$
$337^{\#}/'$ concentration

$V = 1140^{\#}$
$M = 340 \times 2 + 400 \times 2 \times 1 = 1440'^{\#}$

$v = \frac{1140}{12 \times .88 \times 6.75} = 23^{\#}/\square''$ OK

$A_s = \frac{1440 \times 12}{20{,}000 \times .88 \times 6.75} = .15^{\square''}$ Use $\frac{5}{8}''\phi$ @ 1'-0"cc

Slab S-10 - Effect of 5540#/' Axial Load

$f_s = \frac{N}{j A_s i} \times \frac{e}{d}$ $\quad e = \frac{12M}{N} + d'' = \frac{12 \times 3600}{5540} + 1.69 = 9.5$ $\quad \frac{e}{d} = \frac{9.5}{5.75} = 1.65$

$i = 2.17$ from Table #10 Reinf. Conc. Design Handbook

$f_s = \frac{5540}{.89 \times .66 \times 2.17} \times 1.65 = \overset{10100}{\cancel{7200}}^{\#}/\square''$

$f_c = \frac{f_s}{n} \times \frac{k}{1-k}$ $\quad k = \overset{.45}{\cancel{.50}}$ Table #11 $\quad f_c = \frac{\overset{10100}{\cancel{7200}}}{12} \times \frac{\overset{.45}{\cancel{.50}}}{\underset{.55}{\cancel{.50}}} = \overset{.55}{\cancel{600}}^{\#}/\square''$ OK

Subject Bushnell Park Pumping Station
Computation Screening Chamber Floor
Computed by H.E.W. **Checked by** A.L.K. **Date** 27-April-44

Beam B-17

1260 #/'		1260 #/'		42,480#
10.37		10.37		
	.50	.50		
+11.30	-11.30	+11.30	-11.30	
-11.30	0	0	+11.30	
0	-5.65	+5.65	0	
0	0	0	0	
0	-16.95	+16.95	0	-M
4.90	8.17	8.17	4.90	V
→ 3.9		3.9 ←		xo
9.53		9.53		+M

D.L 3" Slab = 100 × 2.5 = 250
D.L Cover = 15 × 1.07 = 16#
D.L 12"×16" Bm = 1' × 150 × .67 = 100
L.L = 250 × 3.58 = 894
1260 #/'

Fixed End Moments

$M = \frac{1}{12} \times 1260 \times 10.37^2 = 11.30^{'k}$

$+M = 4900 \times 3.9 - 1260 \times \frac{3.9^2}{2} = 9530^{'k}$

$\text{reqd } d = \sqrt{\frac{16,950}{139}} = 11.1" < 13.5"$

$V = \frac{8170}{12 \times .88 \times 13.5} = 57 \text{ \#/□"}$

$-As = \frac{16,950 \times 12}{20,000 \times .88 \times 13.5} = .86 \text{ □"}$ Use 2 - 3/4"φ bars Beam 12"×16"

$u_o = \frac{8170}{4.71 \cdot 88 \times 13.5} = 146 \text{ \#/□"}$

+As Use 2 - 3/4"φ bars

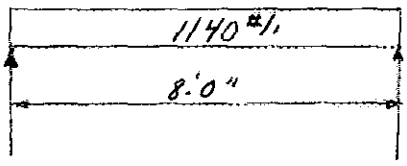
$f_c = \frac{N}{A_1}\left[\frac{1 + \frac{De}{t}}{1+(n-1)p_g}\right]$ $D = 6$ $e = \frac{16950 \times 12}{42480} = 4.8$ $\frac{e}{t} = .4$

$p_g = \frac{1.77}{12 \times 16} = .0092$

$f_c = \frac{42480}{12 \times 16}\left[\frac{1 + 6 \times .4}{1 + 11 \times .0922}\right] = 374 \text{ \#/□} \quad OK$

Beam B-18

Assume span = 8'-0"



D.L Slab = 50 × 5.33 = 270#
D.L Beam = 12"×14" = 80
L.L = 6.33 × 125 = 790
1140 #/'

$M = \frac{1}{8} \times 1140 \times 64 = 9120^{'k}$

$V = 1140 \times 4 = 4560^{\#}$

$\text{reqd } d = \sqrt{\frac{9120}{116}} = 8.9"$ Make beam 12"×12"

$v = \frac{4560}{12 \times .88 \times 9.5} = 46 \text{ \#/□"}$

$As = \frac{9120 \times 12}{20,000 \times .88 \times 9.5} = .66 \text{ □"}$ Use 2 - 3/4"φ Top & Bot.

$u_o = \frac{4560}{4.71 \times .88 \times 9.5} = 116 \text{ \#/□"}$

Subject: Bushnell Park Pumping Station
Computation: Screening Chamber Floor
Computed by: H. E. W. Checked by: A. L. K. Date: 27 April - 44

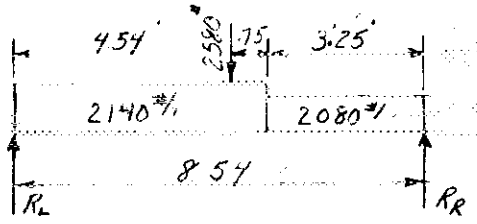
Beam B-18 (cont.)

Max possible Axial load = 25,700 + 5.83 x 5540 = 58,000#

D = 6 $e = \frac{12 \times 9120}{58000} = 1.9''$ $\frac{e}{t} = \frac{1.9}{12} = .16$ $p_g = .012$

$f_c = \frac{38000}{144}\left[\frac{1 + 6 \times .16}{1 + 11 \times .012}\right] = 375$ #/□" (690) OK

Beam B-19



D.L. Slab = 100 x 5.83 = 583#
L.L. = 250 x 5.83 = 1458
D.L. Beam = 1 x 150 x .67 = 100
2141#

D.L. Slab = 100 x 5 = 500#
L.L. = 250 x 6.25 = 1562
D.L. Covers 1.25 x 15 = 18
2080

D.L. conc. from wall
.75 x 2.5 x 10.16 = 1905#
.5 x 75 x 10.16 = 381
75 x 3.16 x 1.25 = 296
2582#

$R_L = 2140 \times 4.54 \times .734 + 2580 \times .468 + 2080 \times 3.25 \times .190 = 9620$ (5.29, .69) (10310)#

$R_R = 2140 \times 4.54 \times .266 + 2580 \times .532 + 2080 \times 3.25 \times .810 = 9430$ (5.29, .37) (10380)#

$x_0 = 4.5'$ from R_L (4.8)

$M = 9620 \times 4.5 - 2140 \times \frac{4.5^2}{2} = 21,620$ (10310 x 4.8; 4.8²; 24,900)#

reqd $d = \sqrt{\frac{21,620}{116}} = 13.6''$ (10380) / 14.6 > 13.6 OK (there will be T beam action)

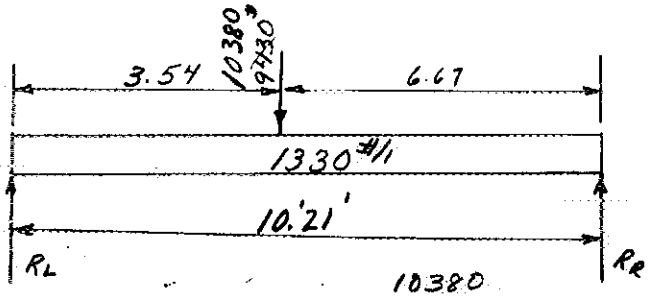
$v = \frac{9620}{12 \times .88 \times 13.6} = 67$ #/□" (12) OK Use 12" x 16" beam

$A_s = \frac{21,620 \times 12}{20,000 \times .89 \times 13.6} = 1.07$ □" (24900; 1.23) Use 2-7/8" φ bars bot

$u_0 = \frac{9620}{5.50 \times .89 \times 13.6} = 145$ #/□" (10380; 156) Use 2-3/4" φ bars top

Subject Bushnell Park Pumping Station
Computation Screening Chamber Floor
Computed by H.E.W. **Checked by** A.L.K. **Date** 28 April 44

Beam B-20



D.L. Slab = 50×6.58 = 329#
L.L = 125×6.58 = 823
D.L. 14"×20" = 117×1×150 = 176
1328#/'

$R_L = 1330 \times 10.21 \times .5 + \cancel{9430}\,10380 \times \frac{6.67}{10.21} = \cancel{12,950}\,13560\#$

$R_R = 1330 \times 10.21 \times .5 + \cancel{9430}\,10380 \times \frac{3.54}{10.21} = \cancel{10,060}\,10400\#$

$x_0 = 3.54$ from R_L

$M = \cancel{12950}\,13560 \times 3.54 - 1330 \times \frac{3.54^2}{2} = \cancel{37,510}\,39680'\#$

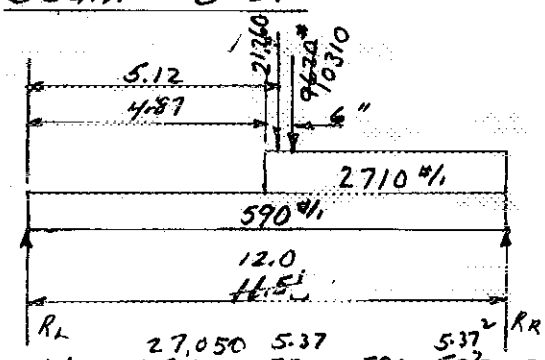
req'd $d = \sqrt{\frac{\cancel{37,510}\,39680 \times 12}{14 \times 116}} = \cancel{16.7}\,17.1'' < 17.5''$ OK

$v = \frac{\cancel{12950}\,13560}{14 \times .89 \times 17.5} = \cancel{60}\,62.4\#/\square''$ OK

$A_s = \frac{\cancel{37,510}\,39680 \times 12}{20,000 \times .89 \times 17.5} = \cancel{1.15}\,1.53\square''$ Use 3-7/8"⌀ bot
Use 3-3/4"⌀ top

$u_0 = \frac{\cancel{12950}\,13560}{8.25 \times .89 \times 17.5} = \cancel{100}\,105\#/\square''$ OK

Beam B-21



D.L. 21"×27" beam = 150×2.25×1.75 = 590'
D.L. wall = 10.83×1.67×150 = 2,710#/'

$R_L = 590 \times \cancel{11.5}\,12.0 \times .5 + 2710 \times \cancel{6.63}\,7.13 \times \cancel{.288}\,.296 + \cancel{9620}\,10310 \times \cancel{.533}\,.55 + 21,260 \times \cancel{.555}\,.574 = \cancel{25,500}\,27,050\#$

$R_R = 590 \times \cancel{11.5}\,12.0 \times .5 + 2710 \times \cancel{6.63}\,7.13 \times \cancel{.712}\,.704 + \cancel{9620}\,10310 \times \cancel{.467}\,.45 + 21260 \times \cancel{.445}\,.426 = \cancel{30140}\,30850\#$

$M = \cancel{25,500}\,27,050 \times \cancel{5.3}\,5.37 - 590 \times \frac{\cancel{5.3}^2\,5.37^2}{2} - 2714 \times \frac{\cancel{.43}^2\,.5^2}{2} - 21260 \times \cancel{.18}\,.25 = \cancel{122,800}\,130,850'\#$

req'd $d = \sqrt{\frac{\cancel{122,800}\,130,850 \times 12}{21 \times 116}} = \cancel{25.2}\,25.4''$ OK Use 21×27" beam d = 24.5 as there will be Tee Beam action

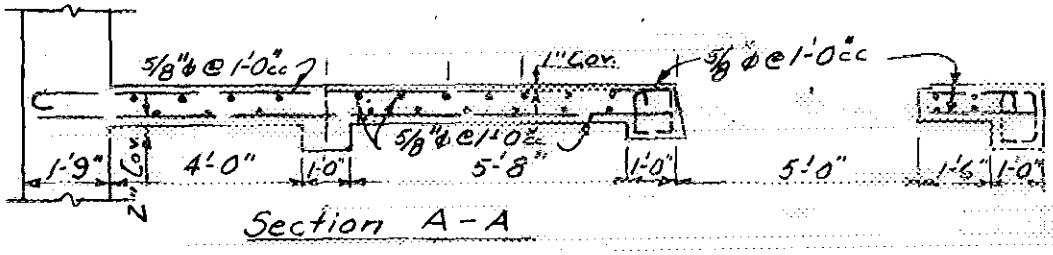
$v = \frac{\cancel{30,140}\,30850}{21 \times .89 \times 24.5} = \cancel{66}\,68\#/\square''$

Subject Bushnell Park Pumping Station
Computation Screening Chamber Floor
Computed by H.E.W. **Checked by** A.L.K. **Date** 28-April-44

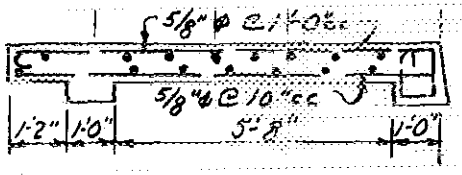
Beam B-21 cont.

$$A_s = \frac{\cancel{122\,800}\ 130{,}850 \times 12}{20{,}000 \times .89 \times 24.5} = \cancel{3.37}\ 3.6\ \square''$$ Use 4-1"□ bars bot
Use 2-1"□ bars & 2-3/4"φ top

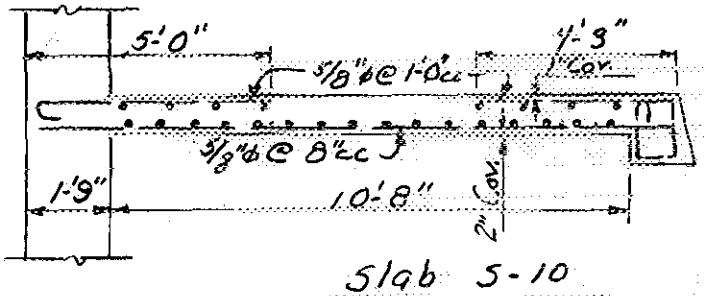
$$u_o = \frac{\cancel{29000}\ 30{,}850}{\cancel{12.57}\ 12.7 \times .89 \times 21.5} = \cancel{121}\ 727\ \#/\square''\ \text{OK}$$



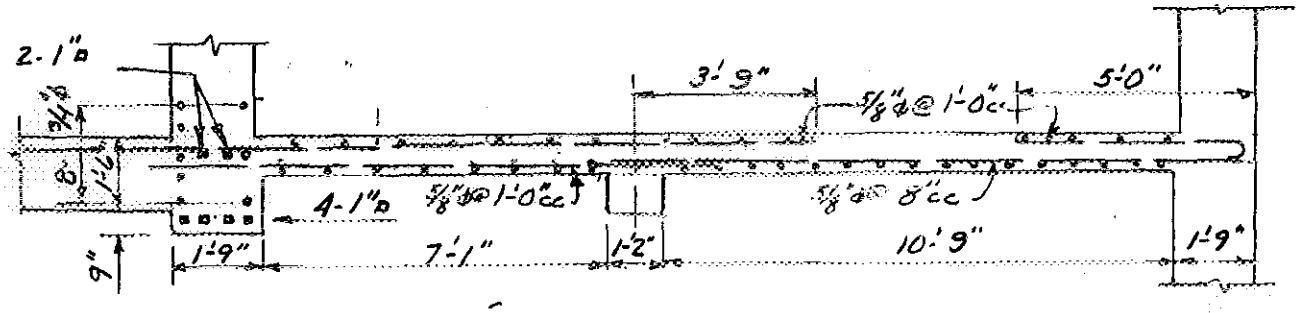
Section A-A



Slab S-9



Slab S-10



Section B-B

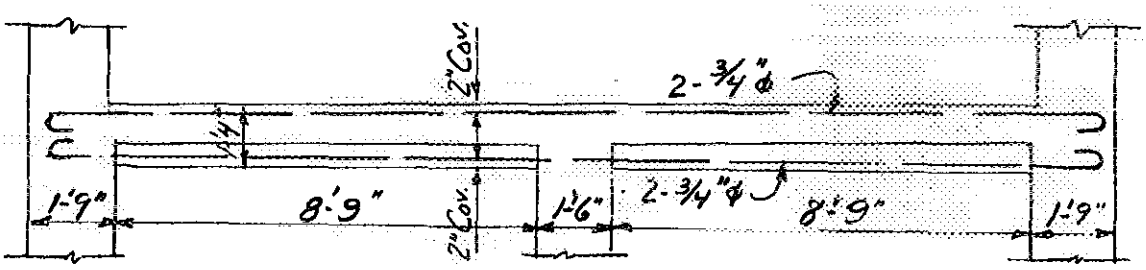
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station

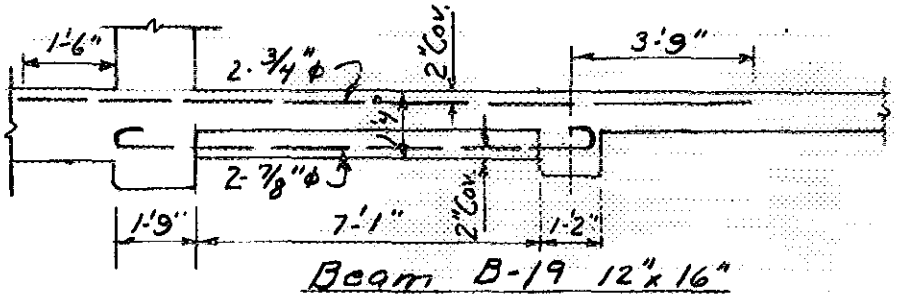
Computation Screening Chamber Floor

Computed by H.E.W. **Checked by** A.L.K. **Date** 28-April-44

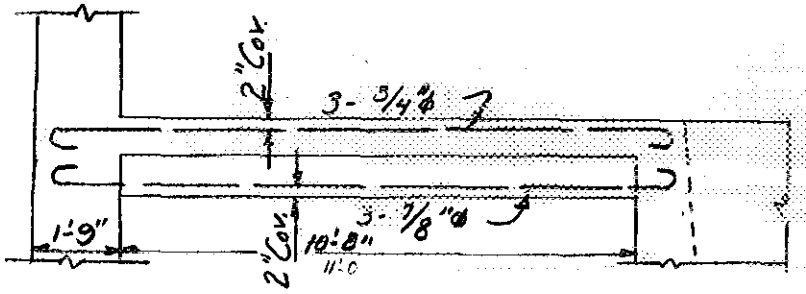


Beam B-17 12"x16"

Beam B-18 - 12"x12" Same steel as in B-17



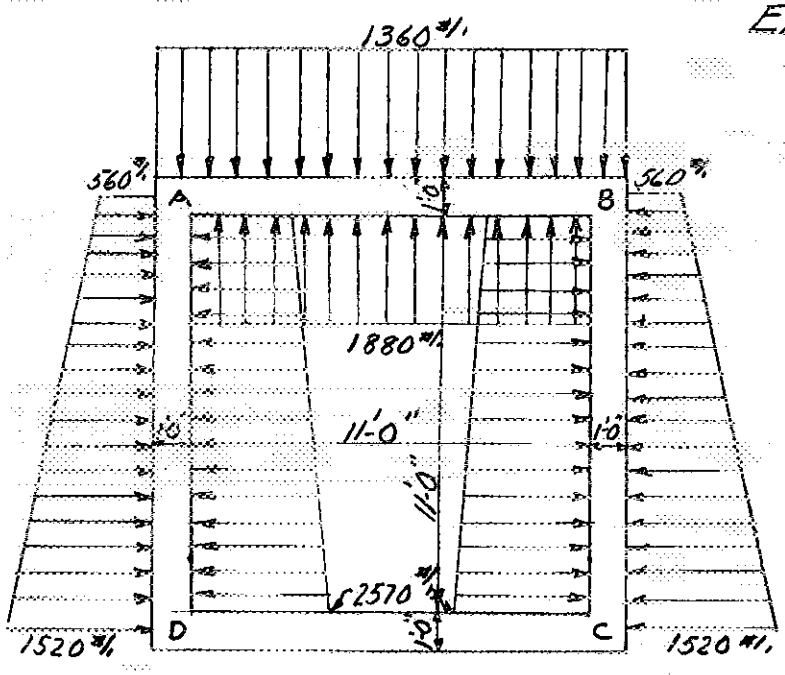
Beam B-19 12"x16"



Beam B-20 14"x20"

Subject: Bushnell Park Pumping Station
Computation: Collar at Park River Conduit Connection
Computed by: H.E.W. Checked by: A.L.K. Date: 10 - June - 44

Collar will be designed for an internal pressure of full hydrostatic head when conduit head is at El. 44.0



External Pressures

Ea. Pan roof
(27 - 14.92)100 = 1210 #/'
Wt. conc = 1×150 = 150
1360

Horiz. P at El 14.42
35(10) + 2.58×80 = 560 #/'

Horiz P at El. 2.42
35×10 + 14.58×80 = 1520 #/'

Internal Pressures

Water P at El. 13.92
30.08 × 62.5 = 1880 #/'

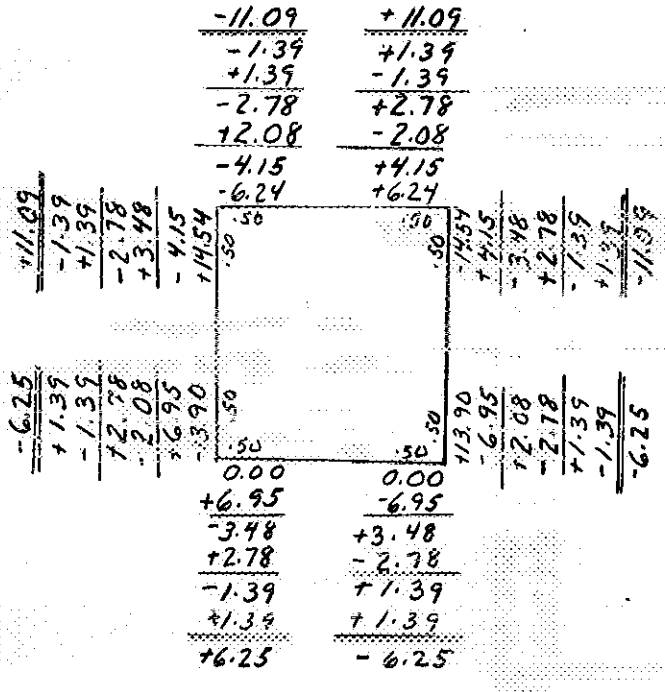
Water P at El. 2.92
41.08 × 62.5 = 2570 #/'

Fixed End Moments

Member AB
$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 520 \times 12^2 = 6240^{\prime\prime}$

Member AD + BC
$M^F_{AD} = M^F_{BC} = \frac{1}{12} \times 1050 \times 12^2 + \frac{1}{10} \times 270 \times \frac{12^2}{2} = 14540^{\prime\prime}$

$M^F_{DA} = M^F_{CB} = \frac{1}{12} \times 1050 \times 12^2 + \frac{1}{15} \times 270 \times \frac{12^2}{2}$
$= 13,900^{\prime\prime}$



Member AB
$V_A = V_B = 520 \times 12 \times .5 = 3120^{\#}$
$+M = \frac{1}{8} \times 520 \times 12^2 - 11,090 = -1730$

Member AD + BC
$H_A = 1050 \times 6 + 270 \times \frac{12}{2} \times 6.7 + \frac{4840}{12} = 7770^{\#}$
$H_D = 1050 \times 6 + [illegible] \times 5.33 - \frac{4840}{12} = [illegible]^{\#}$
$x = 5.85'$ from D
$M = 6930 \times 5.85 - 6250 - 1050 \times \frac{5.85^2}{2} - 132 \times \frac{5.85^2}{6}$
$= 12,630^{\prime\prime}$

Subject: Bushnell Park Pumping Station
Computation: Collar at Park River Conduit Connection
Computed by: H.E.W. Checked by: A.L.K. Date: 11 / June / 1944

Member AD + BC

reqd $d = \sqrt{\frac{12650}{116}} = 10.45$ Make collar 14" thick $d = 10.5"$

$v = \frac{7790}{12 \times .89 \times 10.5} = 70\ \#/\square''$ OK

$-As\ \frac{11,090 \times 12}{20,000 \times .89 \times 10.5} = .71\ \square''$ Use 3/4"φ @ 6" c c

$u_o = \frac{7790}{4.71 \times .89 \times 10.5} = 176\ \#/\square''$

$+As = \frac{12,650 \times 12}{20,000 \times .89 \times 10.5} = .81\ \square''$ Use 3/4"φ @ 6" cc

Member AB

$v = \frac{3120}{12 \times .89 \times 10.5} = 28\ \#/\square''$

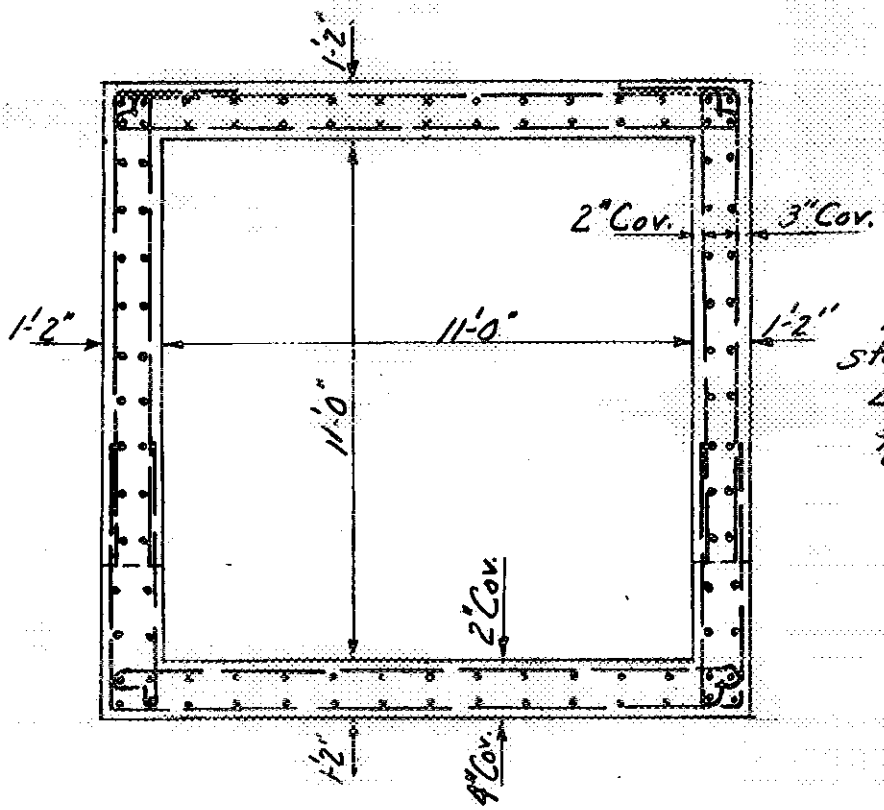
$-As$ Use 3/4"φ @ 6" c c

$+As$ Use 3/4"φ @ 1'-0" c c

For simplicity make all steel 3/4"φ @ 6" cc

Member CD

$-As = \frac{6250 \times 12}{20,000 \times .89 \times 10.5} = .40\ \square''$ Use 3/4"φ @ 1'-0" cc Top + Bot.



All transverse steel 3/4"φ @ 6" cc
Long. steel 5/8"φ @ 1'-0" cc

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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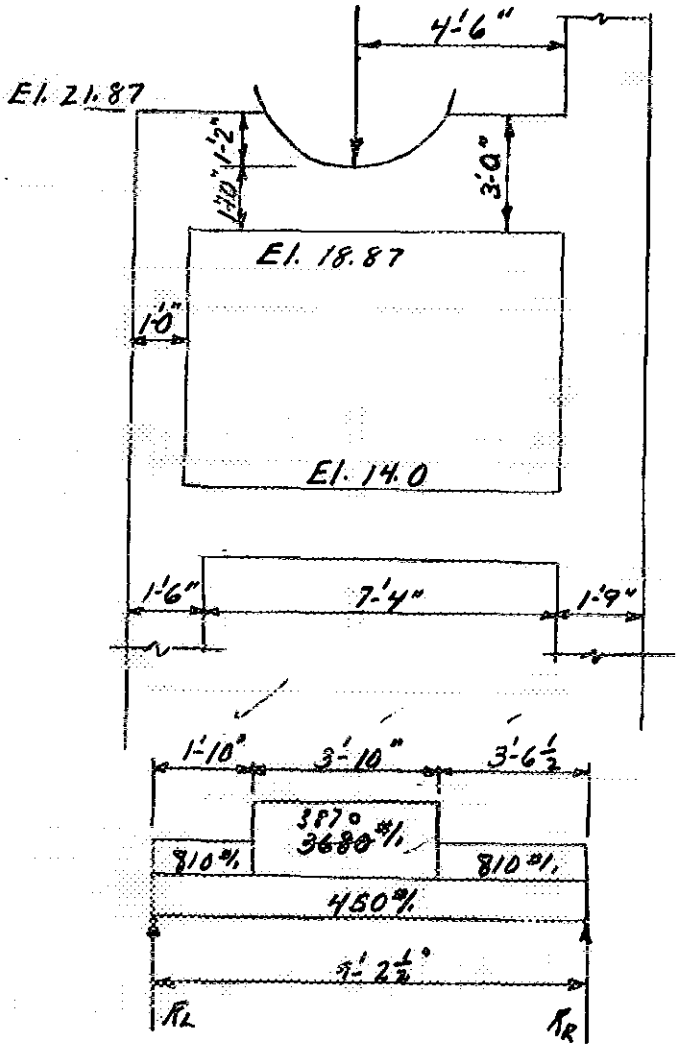
Subject: Bushnell Park Pumping Station

Computation: Supports for Diesel Fuel Oil Tank

Computed by: H. E. W. Checked by: A. L. K. Date: June 9, 1944



Wt. tank plus oil = ~~8000~~ 9500 #

Wt. 2'-0" ea. $2 \times 4.25 \times 9.5 \times 100 = 8080$ #

Wt. 3' surcharge $= 3 \times 4.25 \times 9.5 \times 100 = 12100$

29680 ~~28,180~~ #

Wt. per ft. on beam $= \dfrac{\cancel{28180}\ 29680}{3.83 \times 2} = \cancel{3680}\ 3870$ #/'

Wt. beam $= 3 \times 150 = 450$ #/'

Wt. earth + surcharge on beam

$\cancel{7.1}\ 8.1 \times 100 = \cancel{710}\ 810$ #/'

$R_L = 450 \times 9.21 \times .5 + \cancel{710}\ 810 \times 3.54 \times \dfrac{1.77}{9.21}$

$+ \cancel{3680}\ 3870 \times 3.83 \times \dfrac{5.46}{9.21} + \cancel{710}\ 810 \times 1.83 \times \dfrac{8.29}{9.21} = \cancel{12080}\ 12760$ #

$R_R = 450 \times 9.21 \times .5 + \cancel{710}\ 810 \times 3.54 \times \dfrac{7.44}{9.21}$

$+ \cancel{3680}\ 3870 \times 3.83 \times \dfrac{3.75}{9.21} + \cancel{710}\ 810 \times 1.83 \times \dfrac{.92}{9.21} = \cancel{9970}\ 10580$ #

$x_0 = \cancel{4.24}\ 4.25$ from R_L

$M = \cancel{12080}\ 12760 \times 4.25 - \cancel{1160}\ 1260 \times \dfrac{4.25^2}{2} - \cancel{2990}\ 3070 \times \dfrac{2.41^2}{2} = \cancel{32170}\ 32960$ #

req'd $d = \sqrt{\dfrac{\cancel{32170}\ 32960}{116}} = 16.8 < 18.5$ OK

$v = \dfrac{\cancel{12080}\ 12760}{12 \times .89 \times 32.5} = \cancel{35}\ 31$ #/□"

$A_s = \dfrac{\cancel{32170}\ 32960 \times 12}{20000 \times .89 \times 18.5} = \cancel{1.17}\ 1.20$ □" Use 2-⅞"ø

$u_0 = \dfrac{\cancel{12080}\ 12760}{5.5 \times .89 \times 32.5} = \cancel{75}\ 80$ #/□" OK

Make col 12" square with 4-¾"ø vert and ¼"ø ties 12" oc.

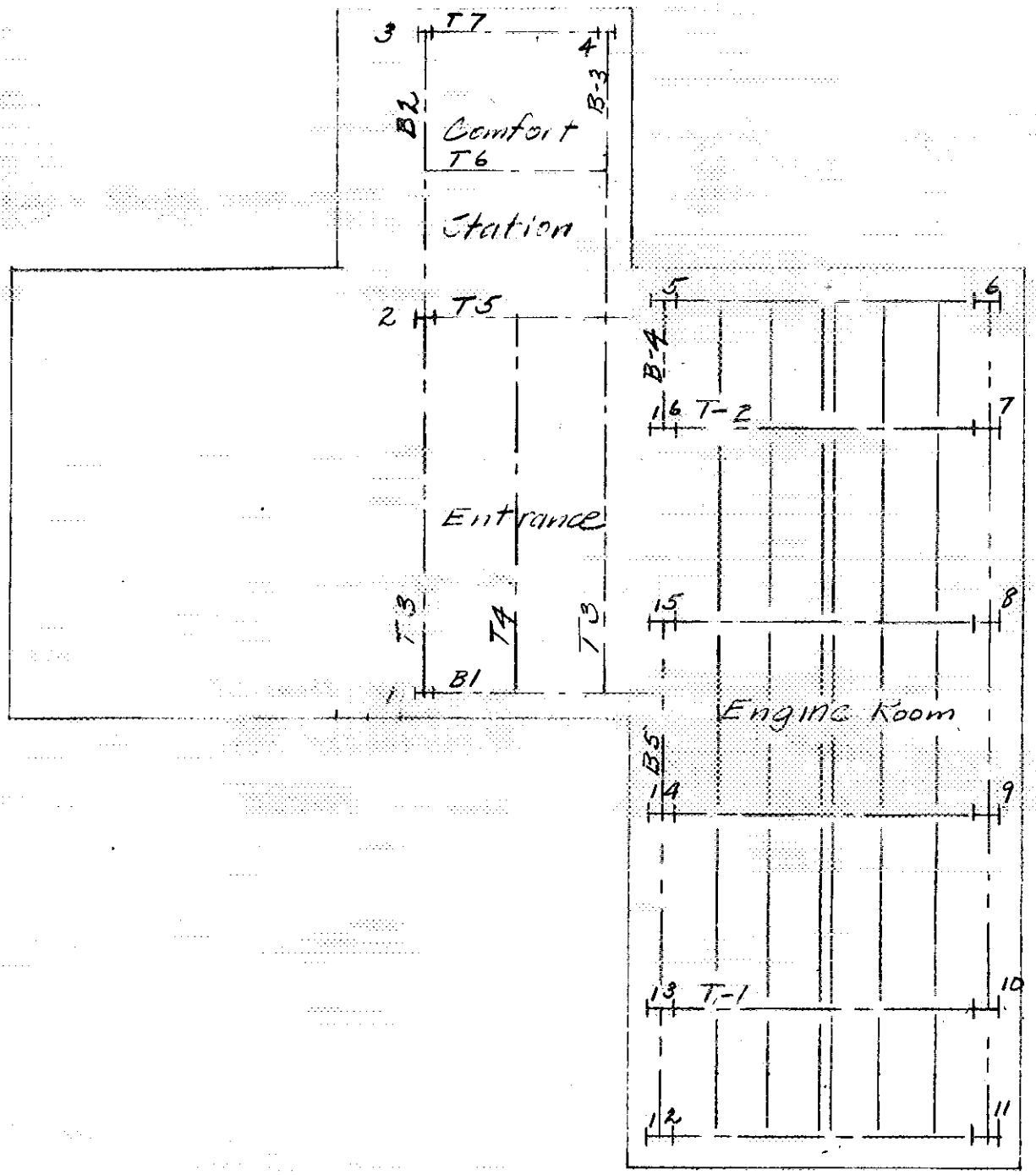
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Burnell Park Pumping Station, Stamford, Conn.

Computation Roof Trusses

Computed by D.M. **Checked by** **Date** 22 May 1942



WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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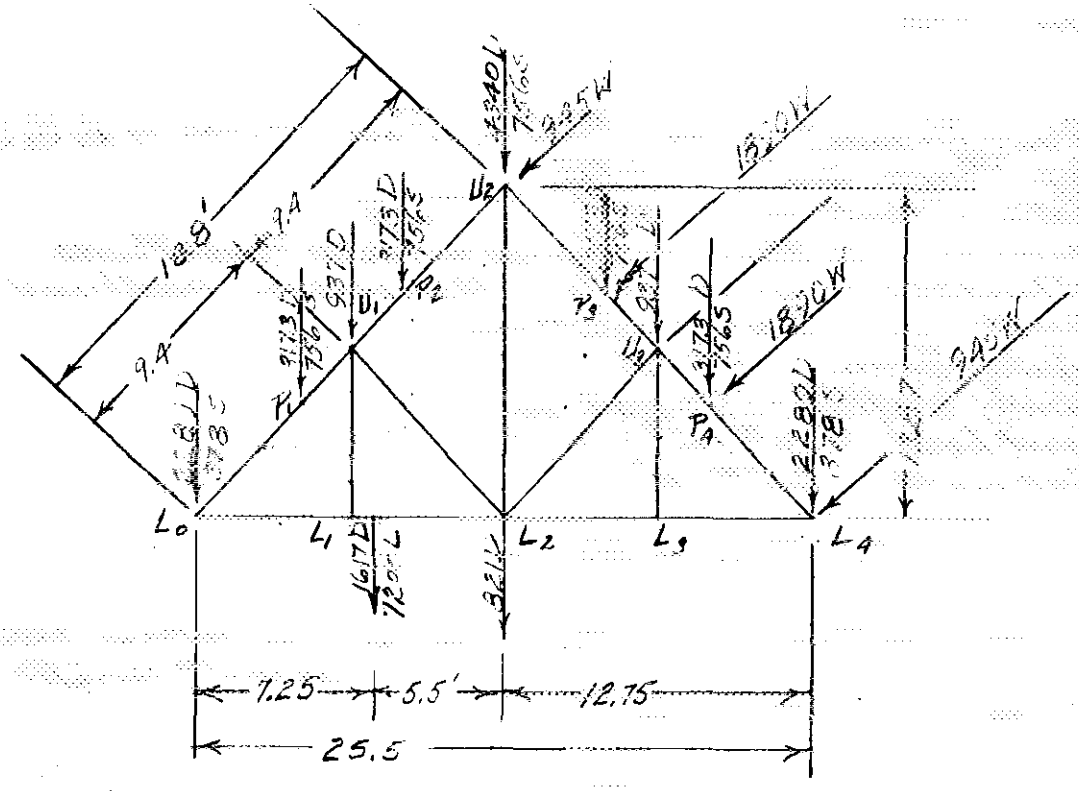
Subject Bushnell [illegible]
Computation Roof Trusses and Pump Room
Computed by [illegible] Checked by Date [illegible]



$L_0, P_1, P_2, U_2, P_3, P_4$ + L_4 Purlins

L- Live Load
D- Dead Load
S- Snow Load
W- Wind Load

For Load Computations see following sheets

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: [illegible] Checked by: Date: 16 May 1944

Continued from Page 1 T-1

Design Data

Truss Bracing Allow 3#/□' of Roof ⅓ Load at U_1 U_2 U_3 & L_2
Gyp Plank - 2½" 16#/□
Slate 2" thick 160#/cu.' 27#/□'
Weight of Truss Members divided between Panel Points
20% Added to Weight of Truss Members for Additional Weight required at Connections
Subway Grating 15#/□
Subway Grating - Live Load 75#/□'
Snow Load 10#/□'
Wind Load 25#/□'

Dead Load - Gyp Plank + Steel + Slate

L_0 $6.3 \times 12 \times 39/2 + 12 \times 15.5 \times 1.2' + 9.4 \times 52.4/2 \times 1.2 + 12.75 \times 21 \times 1.2/2'$
$+ 3 \times 18.85 \times 12 \times 2/10 = 2289$ #

P_1 $6.3 \times 12 \times 39 + 12 \times 15.5 \times 1.2'$ $= 3173$ #

U_1 $(9.4 + 9.4) \times 52.4/2 \times 1.2 + 9.4 \times 12.8/2 \times 1.2'$
$+ 3 \times 18.85 \times 12 \times 2/5$ 937 #

P_2 $6.3 \times 12 \times 39 + 12 \times 15.5 \times 1.2'$ 3173 #

U_2 $6.3 \times 12 \times 39 + 12 \times 15.5 \times 1.2 \times 2 + 9.4 \times 52.4 \times 1.2 + 13.9 \times 10/2 \times 1.2$
$+ 3 \times 18.85 \times 12 \times 2/5$ 4340 #

P_3 $6.3 \times 12 \times 39 + 12 \times 15.5 \times 1.2'$ 3173 #

U_3 $(9.4 + 9.4) \times 52.4/2 \times 1.2 + 9.4 \times 12.8/2 \times 1.2$
$+ 3 \times 18.85 \times 12 \times 2/5$ 937 #

P_4 $6.3 \times 12 \times 39 + 12 \times 15.5 \times 1.2'$ $= 3173$ #

L_4 $6.3 \times 12 \times 39/2 + 12 \times 15.5 \times 1.2' + 9.4 \times 52.4/2 \times 1.2 + 12.75 \times 21 \times 1.2/2'$
$+ 3 \times 18.85 \times 12 \times 2/10 = 2289$ #

L_2 $9.4 \times 12.8 \times 1.2 + 12.75 \times 21 \times 1.2 + 13.9 \times 10/2 \times 1.2$
$+ 3 \times 18.85 \times 12 \times 2/5 = 821$ #

L_1 $8 \times 12 \times 15 + 3 \times 12 \times 12.3 \times 1.2$ $= 1619$ #

Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Roof Trusses Over Pump Room
Computed by: D.M. Checked by: Date: 16 May 1944

Continued from Page 2 T-1

Live, Snow & Wind Loads

	Subway Grating	Snow Load	Wind Load-Either Side
L_0		$6.3 \times 12 \times 10/2 = 378$	$6.3 \times 12 \times 25/2 = 945$
P_1		$6.3 \times 12 \times 10 = 756$	$6.3 \times 12 \times 25 = 1890$
P_2		$6.3 \times 12 \times 10 = 756$ ✓	$6.3 \times 12 \times 25 = 1890$ ✓
U_2		$6.3 \times 12 \times 10 = 756$	$6.3 \times 12 \times 25/2 = 945$
P_3		$6.3 \times 12 \times 10 = 756$	$6.3 \times 12 \times 25 = 1890$
P_4		$6.3 \times 12 \times 10 = 756$	$6.3 \times 12 \times 25 = 1890$
L_4		$6.3 \times 12 \times 10/2 = 378$	$6.3 \times 12 \times 25/2 = 945$
L_1	$8 \times 12 \times 75 = 7200$		

Subject: Roxwell Fire Pumping Station, Stafford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: L. M. Checked by: Date: 17 May 1941

Continued from Page 3 T-1

Loads on Purlins Transferred to Panel Points

$L_0 + L_4$ - Total Dead Load

$2289 + 3173/3 = 3347^{\#}$

$L_0 + L_4$ Total Snow Load

$378 + 756/3 = 630^{\#}$

$L_0 + L_4$ Total Wind Load

$945 + 1890/3 = 1575^{\#}$

$U_1 + U_3$ Total Dead Load

$937 + \frac{4}{3}\, 3173 = 5168^{\#}$

$U_1 + U_3$ Total Snow Load $\quad 756 \times 4/3 = 1008^{\#}$

$U_1 + U_3$ Total Wind Load $\quad 1890 \times 4/3 = 2520^{\#}$

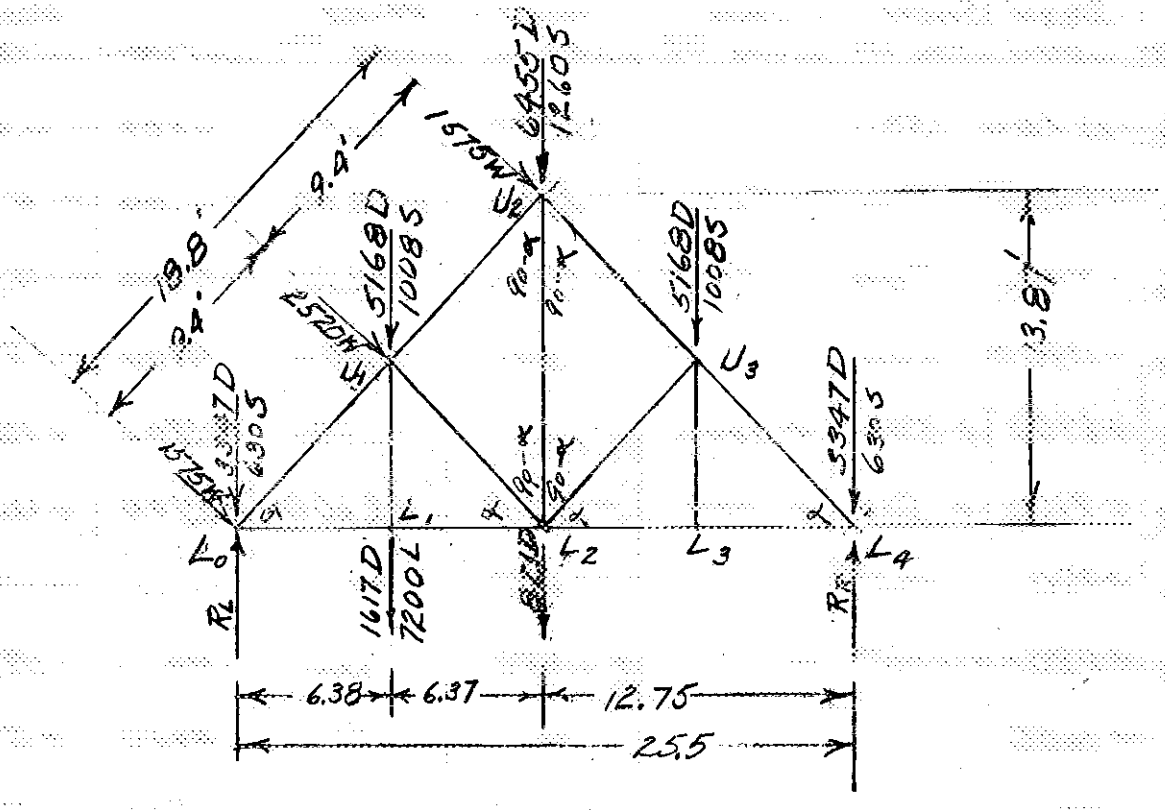
U_2 Total Dead Load $\quad 4340 + 3173 \times 2/3 = 6455^{\#}$

U_2 Total Snow Load $\quad 756 + 756 \times 2/3 = 1260^{\#}$

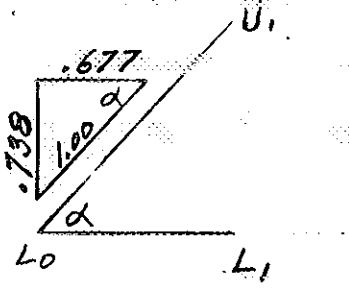
U_2 Total Wind Load $\quad 945 + 1890 \times 1/3 = 1575^{\#}$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: D.M. Checked by: Date: 15 May 1944

Continued from Page 4 T-1



Wind Load - One Side at a time



Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: D. M. Checked by: Date: 19 May 1944

Continued from Page 5 T-1

Member	Dead Load	Snow Load Lt.	Snow Load Rt.	Wind Load Lt.	Wind Load Rt.	catwalk	Design Stress
L_0U_1	-13100	-1500	-800	-2500	-1300	-6800	-22200
U_1U_2	-8400	-800	-800	-2700	-1300	-4100	-14100
U_2U_3	-8400	-800	-800	-1300	-2700	-4100	-14100
U_3L_4	-11900	-800	-1500	-1300	-2500	-4100	-18300
L_4L_3	+8100	+500	+1000	-1200	+2600	+2700	+12300
L_3L_2	+8100	+500	+1000	-1200	+2600	+2700	+12300
L_2L_1	+8800	+1000#	+500	+2600	+1200	+4600	+14900
L_1L_0	+8800	+1000#	+500	+2600	-1200	+4600	+14900
L_1U_1	+1600	0	0	0	0	+4000	+5600
L_2U_1	-4600	-700	0	-2500	0	-2700	-8000
L_2U_2	+5900	+600	+600	+1900	+1900	+6000	+13100
L_2U_3	-3500	0	-700	0	-2500	0	-4800
L_3U_3	0	0	0	0	0	0	0

- Compression
+ Tension

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Trusses over Pump Room
Computed by D. M. Checked by Date 19 May 1944

Continued from Page 6 T-1

Dead Load

$R_L = 3347 + 5168 + 6455/2 + 1617 \times 3/4 = 12958^{\#}$

$R_R = 3347 + 5168 + 6455/2 + 1617/4 = 12150^{\#}$

$L_0L_1 = L_1L_2 = (12958 - 3347)\,677/738 = 8820\ T$

$L_0U_1 = (12958 - 3347)/0.738 = 13070\ C$

$96.11 \times 12.75 - 6785 \times 6.38 - U_1U_2 \times 12.75 \times 0.738 = 0$
$U_1U_2 = 8400\ C$

$6785 \times 6.38 - L_2U_1 \times 12.75 \times 0.738 = 0$
$L_2U_1 = 4600\ C$

$U_2U_3 = U_1U_2$

$L_2U_2 = 2 \times 8400 \times 0.738 - 6455 = 5900\ T$

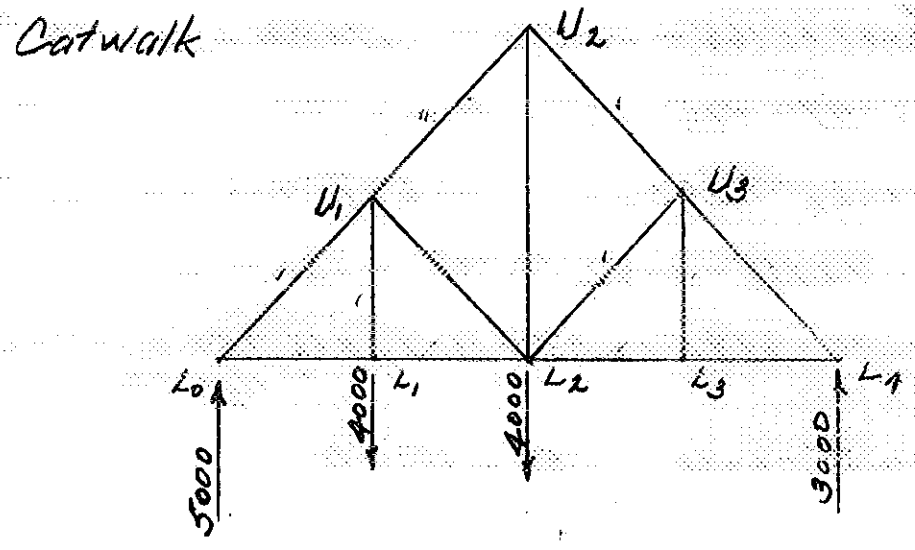
$L_4L_3 = L_3L_2 = 8803 \times 677/738 = 8100\ T$

$L_4U_3 = 8803/0.738 = 11900\ C$

$-5168 \times 6.38 + L_2U_3 \times 12.75 \times 0.738 = 0$
$L_2U_3 = 3500\ C$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Engine Room
Computed by: D. M. Checked by: Date: 8 June 1944

T-1



$L_0L_1 = L_1L_2 = 5000 \times 677/738 = 4600^{\#}$

$L_0U_1 = 5000/0.738 = 6800^{\#}$

$L_1U_1 = 4000^{\#}$

$L_2L_3 = L_3L_4 = 3000 \times 677/738 = 2700$

$U_3L_4 = 3000/0.738 = 4100$

$L_2U_2 = 2 \times 4100 \times 0.738 = 6000$

$L_2U_1 = 2000/0.738 = 2700$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: D.M. Checked by: ..... Date: 19 May 1944

Continued from Page 8 T-1

Snow Load-Left Side Only

$R_L = [630 + 1008 + 630] \times 3/4 = 1701^{\#}$

$R_R = 2268/4 = 567^{\#}$

$L_0L_1 = L_1L_2 = (1701 - 630)\,677/738 = 1000^{\#}$ T

$L_0U_1 = (1701 - 630)/0.738 = 1500^{\#}$ C

$1071 \times 12.75 - 1008 \times 6.38 - U_1U_2 \times 13.87 \times 6.77 = 0$
$U_1U_2 = 800^{\#}$ C

$+1008 \times 6.38 - U_1L_2 \times 12.75 \times 0.738 = 0$
$U_1L_2 = 700^{\#}$ C

$U_2L_2 = 2 \times 800 \times .738 - 630 = 600$ T

$L_4U_3 = U_2U_3 = U_1U_2$

$L_2L_3 = L_3L_4 = 567 \times 677/738 = 500^{\#}$ T

Wind Load - Left side Only

$R_L = 1575 \times 0.677 + 2520 \times 0.677 \times .75 + 1575 \times .677 \times 0.5 = 2880$

$R_R = 1575 \times 0.677 \times 0.5 + 2520 \times 0.677 \times 0.25 = 960$

H at $L_0 = H$ at $L_4 = 0.5 \times (1575 + 2520 + 1575) \times 0.738 = 2090$

$L_0U_1 = (2880 - 1575 \times 0.677)/0.738 = 2500^{\#}$ C

$L_0L_1 = L_1L_2 = 2500 \times 0.677 - 1575 \times 0.738 + 2090 = 2600$

$2520 \times 9.42 - L_2U_1 \times 12.75 \times 0.738 = 0$
$L_2U_1 = 520$ C

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: D.M. Checked by: Date: 22 May 1944

Continued from Page 9 T-1

$1810 \times 12.75 + 2520 \times 0.738 \times 6.93 - 2520 \times 0.677 \times 6.58 - U_1U_2 \times 9.42 = 0$

$U_1U_2 = 2700\ C$

$U_3L_4 = 960 / 0.738 = 1300^{\#}\ C$

$U_3L_4 = U_2U_3$

$1300 \times 0.677 - 2090 + L_3L_4 = 0$

$L_3L_4 = 1200^{\#}\ C$

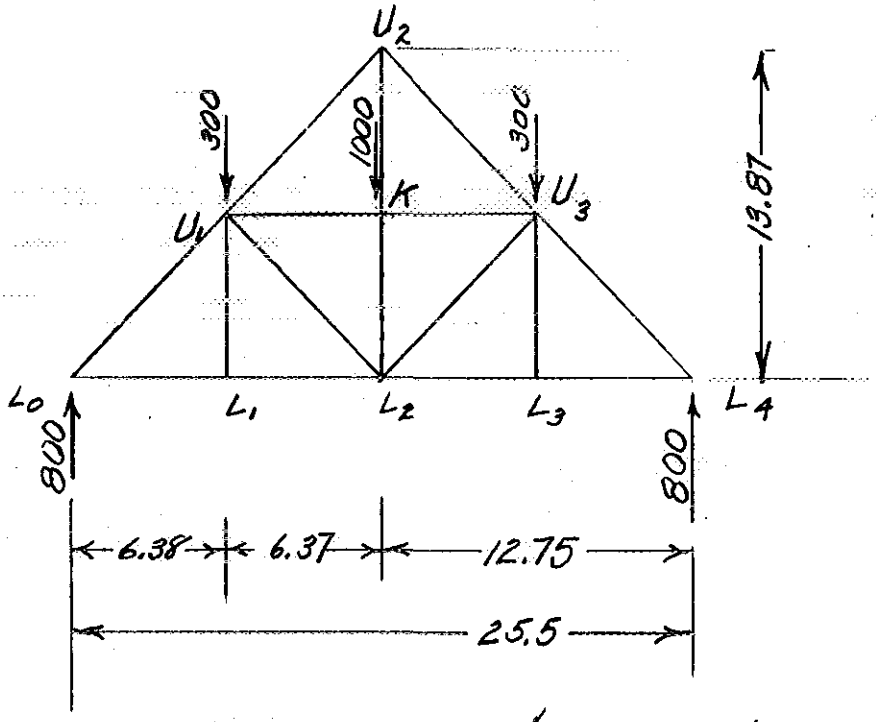
$L_2U_2 = 2520 \times 0.738 = 1900^{\#}\ T$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: W.M. Checked by: Date: 22 May 1949

Continued from Page 10 · T-2

Added Load on Members of 2nd Truss from end of Station caused by Blower and Platform.

Weight of Platform and Supports 20#/□'
Weight of Blower 400#
Impact Load 400#
Stress in Members caused by Live Load at L_1 enough to allow for Live Load on Blower Platform.



Load at $U_1 = U_3 = 3 \times 9.5 \times 20/2 = 285^{\#}$ Use $300^{\#}$

Load at $K = 6 \times 9.5 \times 20/2 + 800/2 = 970^{\#}$ Use $1000^{\#}$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Pump Room
Computed by: D.M. Checked by: Date: 22 May 1944

Continued from Page 11 T=2

Member	Blower + Platform	Design Stress
L_0U_1	-1100	
L_4U_3	-1100	
L_0L_1	+700	
L_1L_2	+700	
L_2L_3	+700	
L_3L_4	+700	
L_1U_1	0	
L_3U_3	0	
U_1U_2	-900	
U_2U_3	-900	
L_2U_1	-200	
L_2U_3	-200	
L_2U_2	+1300	

$L_0U_1 = 800/0.738 = 1100\ C$

$L_0L_1 = 1100 \times 0.677\ T$

$800 \times 12.75 - 300 \times 6.38 - U_1U_2 \times 13.87 \times 0.677 = 0$

$U_1U_2 = 900\ C$

$300 \times 6.38 - L_2U_1 \times 12.75 \times .738 = 0$

$L_2U_1 = 200$

$L_2U_2 = 2 \times 900 \times 0.738 = 1300\ T$

WAR DEPARTMENT

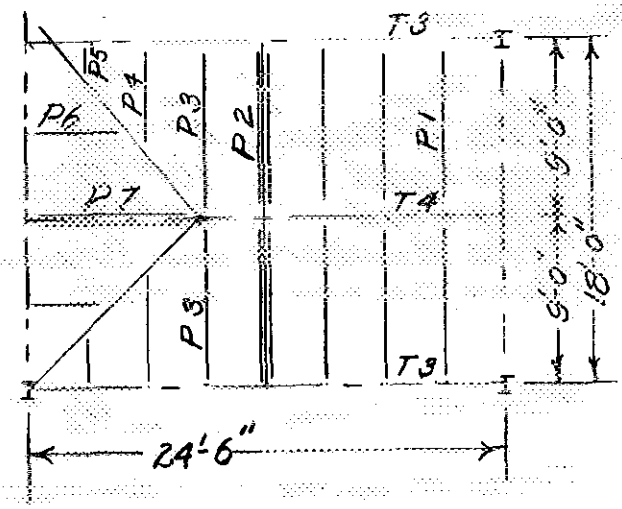
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

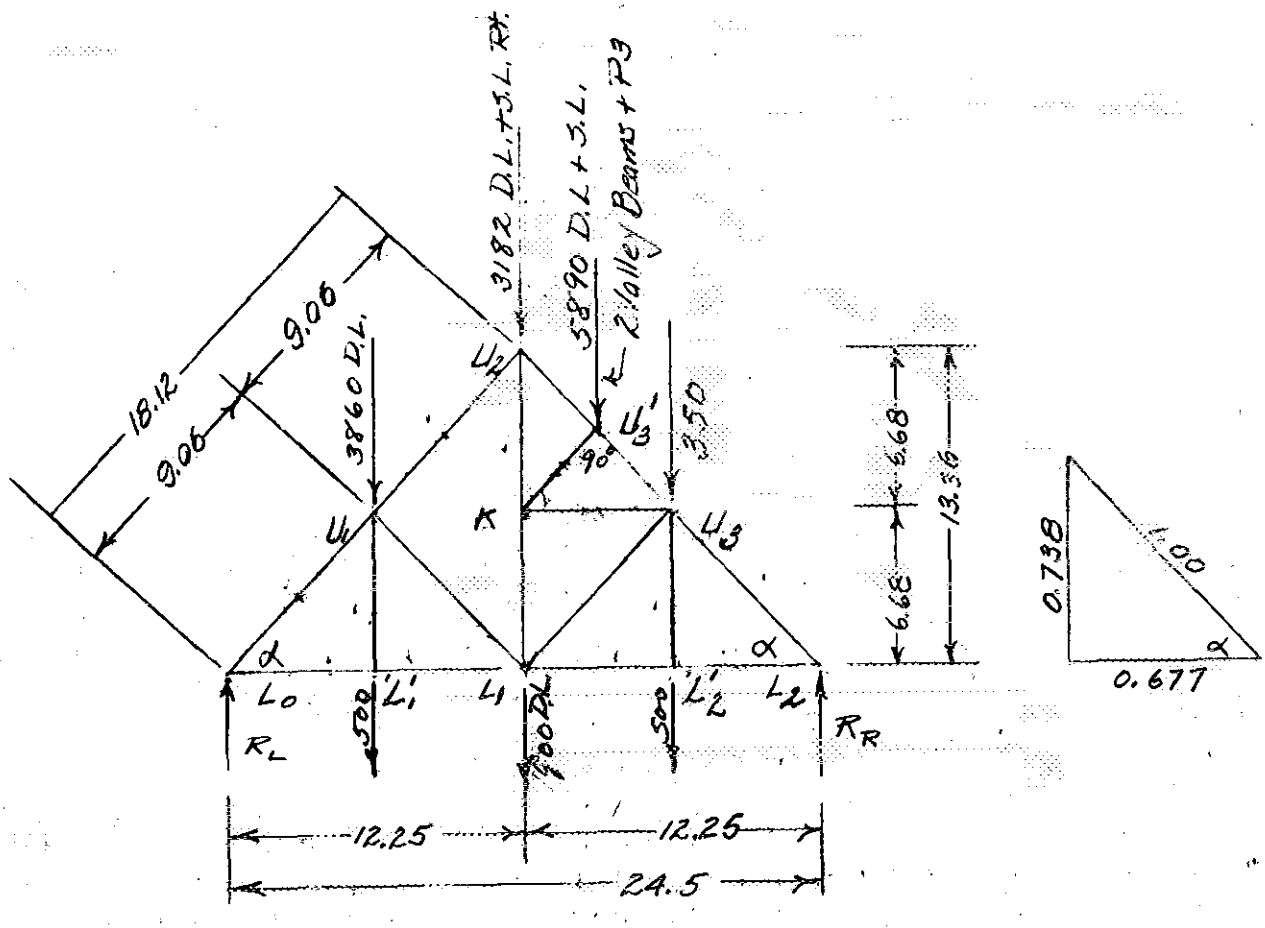
Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Roof Trusses over Entrance

Computed by: D.M. Checked by: Date: 26 May 1944

T-4





See following Pages for Dead Load and Live Load Computations

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: D.M. Checked by: Date: 25 May 1944

Continued from Page 13 T-4

Design Data

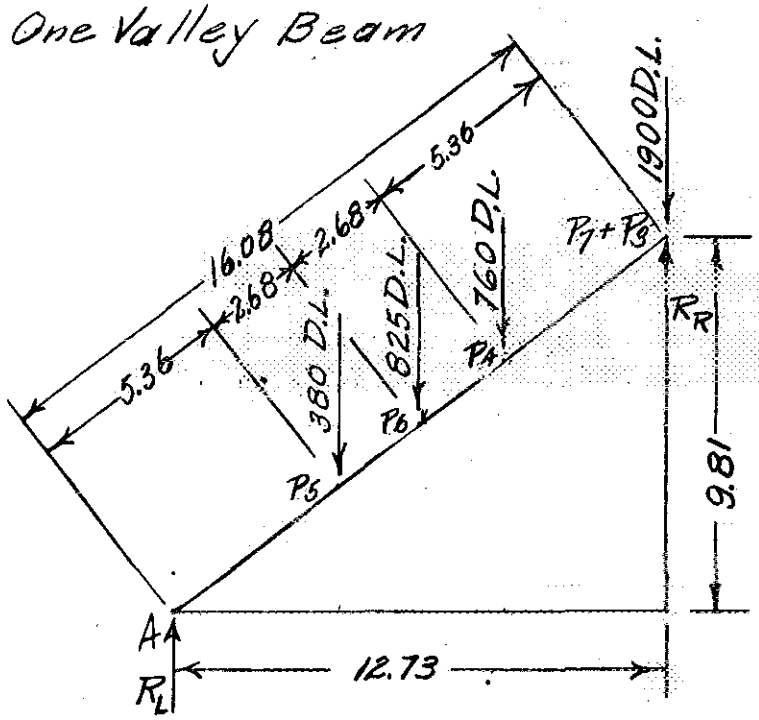
Gyp Plank $2\frac{1}{2}''$ 16#/□'
Slate 2" thick 27#/□'
Snow Load 10#/□'
Wind Load 25#/□'
Truss Members and Bracing 8#/□' H proj. of roof
Hung Ceiling 10#/□'

Purlins at L_0, U_1, U_2, U_3 + L_2 and mid points

Truss Bracing and Members ⅕ at U_1, U_2, U_3 + L_1

$9 \times 24.5 \times 8/5 = 352^{\#}$ D.L.

One Valley Beam

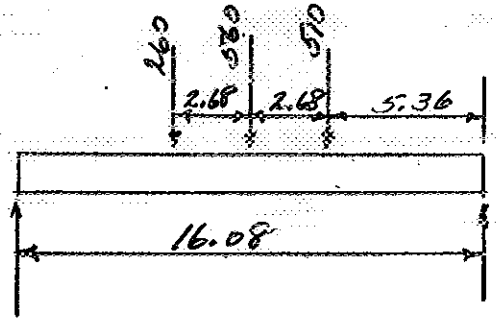


Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: D. M. Checked by: Date: 26 May 1944

Cont. from P 14 T 4

Loads on each valley beam from purlins Snow Load + D.L.

P_5 $3 \times 4.53 \times 53/2 + 20 = 380$
P_6 $6.66 \times 4.5 \times 53/2 + 30 = 825$
P_4 $6 \times 4.53 \times 53/2 + 40 = 760$
$P_7 + P_3 = 9 \times 4.53 \times 53/2 + 3.33 \times 8.0 \times 53/2 + 115 = 1900$



$$d = \frac{Pl^3}{48EI} \qquad \frac{1330 \times 16.08^3 \times 12^3}{48 \times 30000000 \times \frac{143}{360}} = I$$

$$I = 12.4$$

$$\frac{l}{r} = \frac{5.36 \times 12}{1.23} = 53 \qquad f = 15600 \text{ Allow}$$

Try 5" WF 13.5#

$$R_L = 170 + 280 + 170 = 620$$

$$S = \frac{(620 \times 8.04 - 260 \times 2.68) \times 12}{15600} = 3.3$$

Use 6" I 12.5 S = 7.3

Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Roof Trusses over Entrance
Computed by: D. M. Checked by: Date: 27 May 1944

Continued from Page 15 T-4

Dead Load at U_1

$352 + 9.06 \times 9 \times 43 = 3860^{\#}$

Dead Load at U_2 + Snow Load Rt. at U_2

$352 + 4.53 \times 9 \times 43 + 2.26 \times 9 \times 53 = 3182^{\#}$

Dead Load + Snow Load on T2 from 2 Valley Beams + P_3

$2 \times 1045 + 2 \times 1900 = 5890^{\#}$

Wind Load Lt.

$L_0 = U_2 = 4.53 \times 9.0 \times 25 = 1020^{\#}$

$U_1 = 9.06 \times 9 \times 25 = 2040^{\#}$

Dead Load L_1 Hung Ceiling

$10 \times 9 \times 12.25 + 350 = 1450^{\#}$

Snow Load Lt. U_1

$9.06 \times 9 \times 10 = 800^{\#}$

Snow Load Lt. at U_2

$4.53 \times 9 \times 10 = 400^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page 2K

Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Roof Trusses over Entrance

Computed by: D.M.T.E.H. Checked by: Date: 9 June 1944

Cont. from P. 16 T 4

Member	Dead Load + Snow Rt.	Snow Load Lt.	Wind Load Lt.
L_0U_1	-10400	-1100	-1900
U_1U_2	-7500	-500	-2100
U_2U_3'	-7500	-500	-800
$U_3'U_3$	-11900	-500	-800
U_3L_2	-10200	-500	-800
$L_2'L_2$	+6900	+400	-1000
L_1L_2'	+6900	+400	-1000
$L_1'L_1$	+7100	+700	+2100
$L_1'L_0$	+7100	+700	+2100
$L_1'U_1$	+500	0	0
L_1U_1	-3000	-500	-2000
L_1K	+5200	+400	+1500
L_1U_3	-4100	0	0
$L_2'U_3$	+500	0	0
KU_3'	-4000	0	0
KU_3	+5400	0	0
KU_2	+7900	+400	+1500

$R_L = 1950 + 1590 + 3860 \times 1.75 + 350 \times 0.25 + 5890 \times 0.38 = 7700$

$R_R = 1900 + 3860 + 3180 + 6240 - 7700 = 7500$

$L_0U_1 = 7700 / 0.738 = 10400$ C

$L_2U_3 = 7500 / 0.738 = 10200$ C

$L_0L_1' = L_1'L_1 = 7700 \times 677/738 = 7100$ T

$L_2'L_2 = L_1L_2' = 7500 \times 677/738 = 6900$ T

$7700 \times 12.25 - 4360 \times 6.13 - U_1U_2 \times 9.05 = 0$

$U_1U_2 = 7500$ C

$KU_2 = 2 \times 7500 \times 0.738 - 3180 = 7900$ T

$4360 \times 6.13 - L_1U_1 \times 9.05 = 0$

$L_1U_1 = 3000$ C

$KU_3' = 5890 \times 0.677 = 4000$ C

$U_3'U_3 = 7500 + 5890 \times 0.738 = 11900$ C

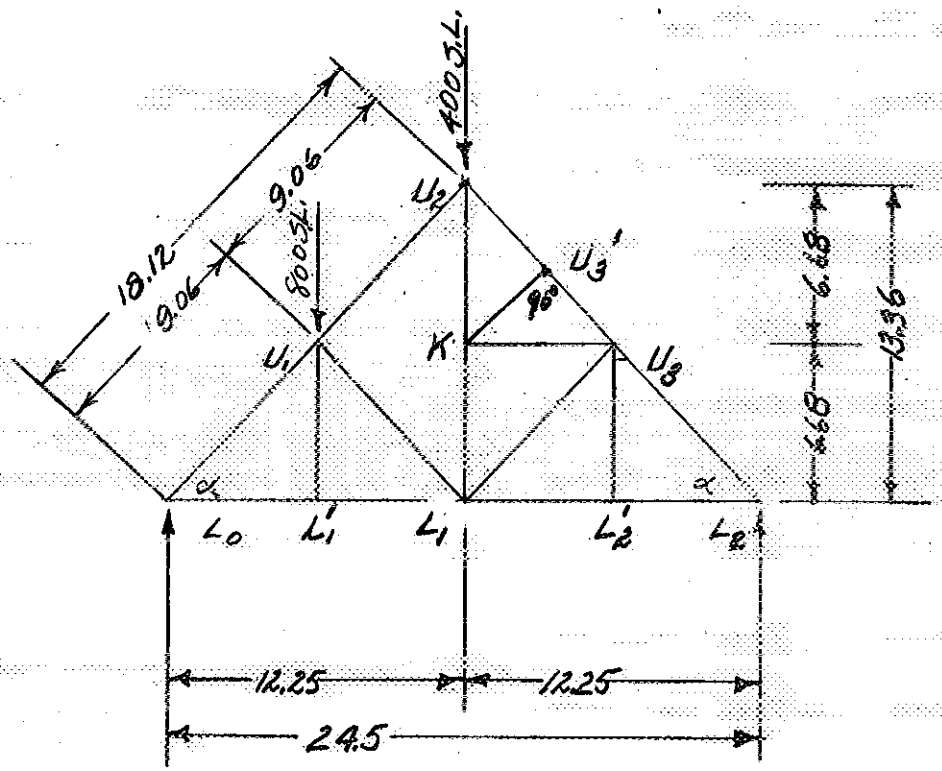
$KU_3 = 4000 / 0.738 = 5400$ T

$KL_1 = 7900 - 4000 \times 0.677 = 5200$ T

$L_1U_3 = [5200 - 3000 \times 0.738] / 0.738 = 4100$ C

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: D.M. Checked by: Date: 27 May 1944

Continued from Page 18 T A
Snow Load Left.



$R_L = 600 + 200 = 800$

$R_R = 200 + 200 = 400$

$L_0U_1 = 800/0.738 = 1100$ C

$L_2U_3 = 400/0.738 = 500$ C

$L_0L_1 = 1100 \times 0.677 = 700$ T

$L_1L_2 = 500 \times 0.677 = 400$ T

$800 \times 12.25 - 800 \times 6.13 - U_1U_2 \times 13.36 \times 0.677 = 0$ $\quad U_1U_2 = 500^{\#}$ C

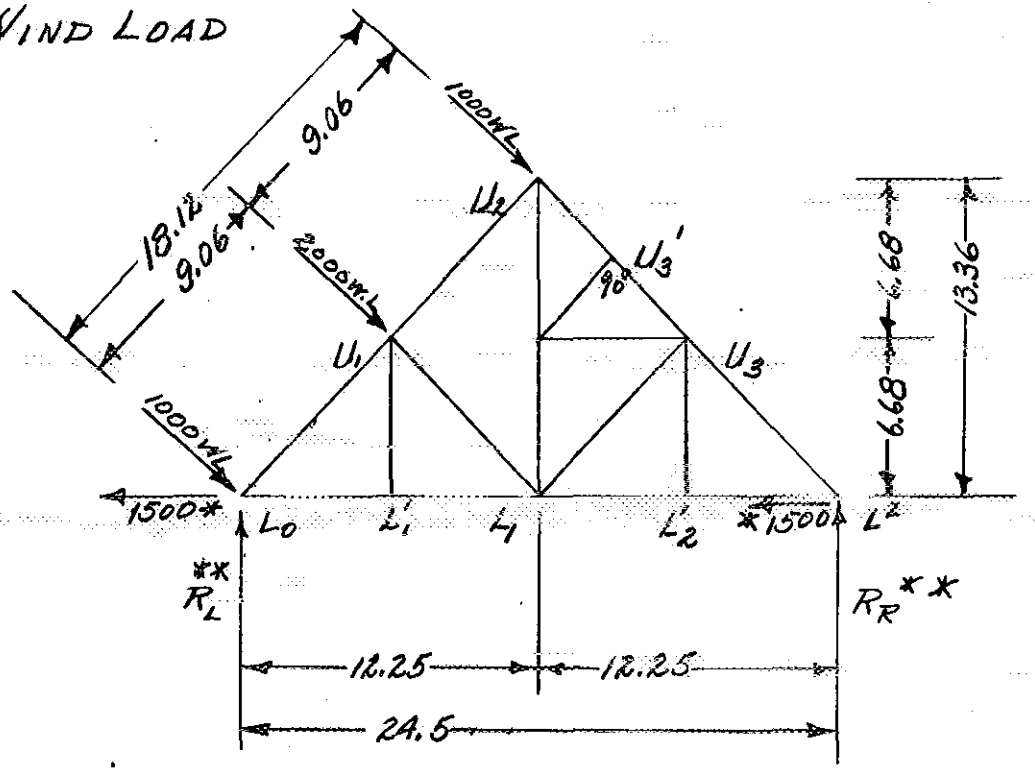
$800 \times 6.13 - U_1L_1 \times 12.25 \times 0.738 = 0$ $\quad U_1L_1 = 500^{\#}$ C

$L_1U_2 = 2 \times 500 \times 0.738 - 400 = 400^{\#}$ T

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: W.M. Checked by: Date: 27 May 1944

Continued from Page 19 T 4

WIND LOAD



Wind Load at U_1 = 9.06 × 9 × 25 = 2000#

Wind Load at $L_0 = U_2 = \frac{1}{2} \times 2000\# = 1000\#$

H Reaction at L_0 = H Reaction at L_2 = 2000 × 0.738 = 1500#

** $R_L = \frac{3}{4}(2000 \times 0.677) + \frac{1}{2}(1000 \times 0.677) = 1400\#$

** $R_R = -1400\# + 3000 \times 0.677 = 600\#$

** R_L & R_R Lack V. Component of Wind Load at L_0

* H Component of Wind Load at L_0 contained in 1500# H Reactions

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: D.M. Checked by: Date: 27 May 1944

Continued from Page 20 T4

$L_0U_1 = 1400/0.738 = 1900^{\#}$ C

$L_2U_3 = 600/0.738 = 800^{\#}$ C

$L_0L_1 = -1000 \times 0.738 + 1500 + 1900 \times 0.677 = 2100$ T

$L_1L_2 = -800 \times 0.677 + 1500 = 1000^{\#}$ C

$-U_1L_1 \times 12.25 \times 0.738 + 2000 \times 6.68 \times 0.738 + 2000 \times 6.13 \times 0.677 = 0$

$U_1L_1 = 2000^{\#}$ C

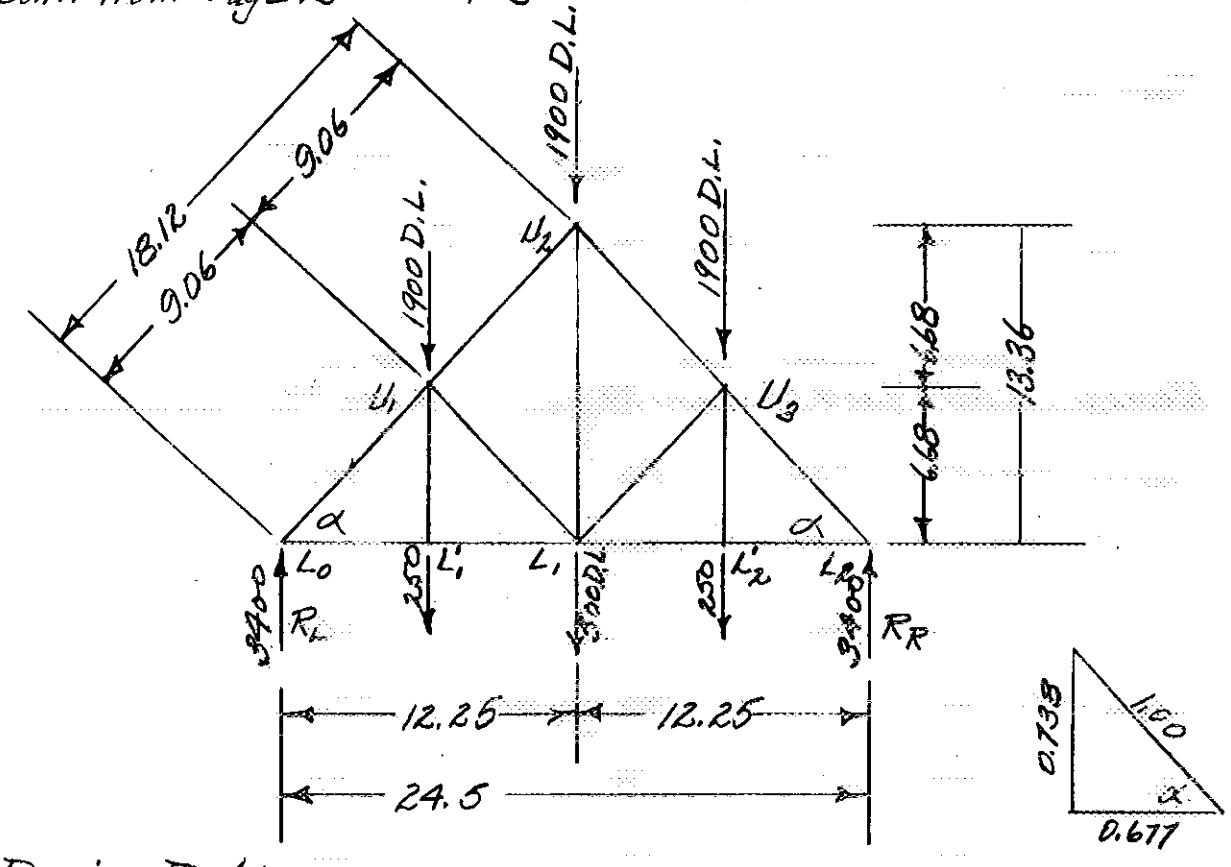
$1400 \times 12.25 + 2000 \times 6.68 \times 0.738 - 2000 \times 6.13 \times 0.677 - U_1U_2 \times 13.36 \times 0.677 = 0$

$U_1U_2 = 2100^{\#}$ C

$L_1U_2 = 2000 \times 0.738 = 1500$ T

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: D.M. Checked by: Date: 23 May 1944

Cont. from Page 13 T 3



Design Data
Gyp Plank 2½" 16#/□'
Slate 2" thick 27#/□'
Snow Load 10#/□'
Wind Load 25#/□'
Truss Members and Bracing 8#/□' Hproj. of roof
Hung Ceiling 10#/□'

Purlins at L_0, U_1, U_2, U_3, & L_2 and mid points.

Truss Bracing and Members ⅕ at U_1 U_2 U_3 & L_1

$4.5 \times 24.5 \times 8/5 = 176^{\#}$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Entrance
Computed by: L.M. Checked by: Date: 29 Nov 1944

Cont. from Page 22 T=3

Dead Load

$U_1 = U_2 = U_3 = 176 + 9.06 \times 4.5 \times 43 = 1900^{\#}$

$L_1 = 176 + 12.25 \times 4.5 \times 10 = 700^{\#}$

Member	Dead Load	Snow Load Lt.	Snow Load Rt.	Wind Load Lt.	Wind Load Rt.
$L_0 U_1$	-4600	-550	-250	-950	-400
$U_1 U_2$	-3200	-250	-250	-1050	-400
$U_2 U_3$	-3200	-250	-250	-400	-1050
$U_3 L_2$	-4600	-250	-550	-400	-950
$L_1 L_2$	+3100	+200	+350	-500	+1050
$L_0 L_1$	+3100	+350	+200	+1050	-500
$L_1 U_1$	-1500	-250	0	-1000	0
$L_1 U_2$	+2800	+200	+200	+750	+750
$L_1 U_3$	-1500	0	-250	0	-1000
$L_1' U_1$	+500	0	0	0	0
$L_2' U_3$	+500	0	0	0	0

$L_0 U_1 = 3400/0.738 = 4600$ C

$L_0 L_1 = 3400 \times 677/738 = 3100$ T

$3400 \times 12.25 - 2150 \times 6.12 - U_1 U_2 \times 13.36 \times 0.677 = 0$ $\quad U_1 U_2 = 3200$ C

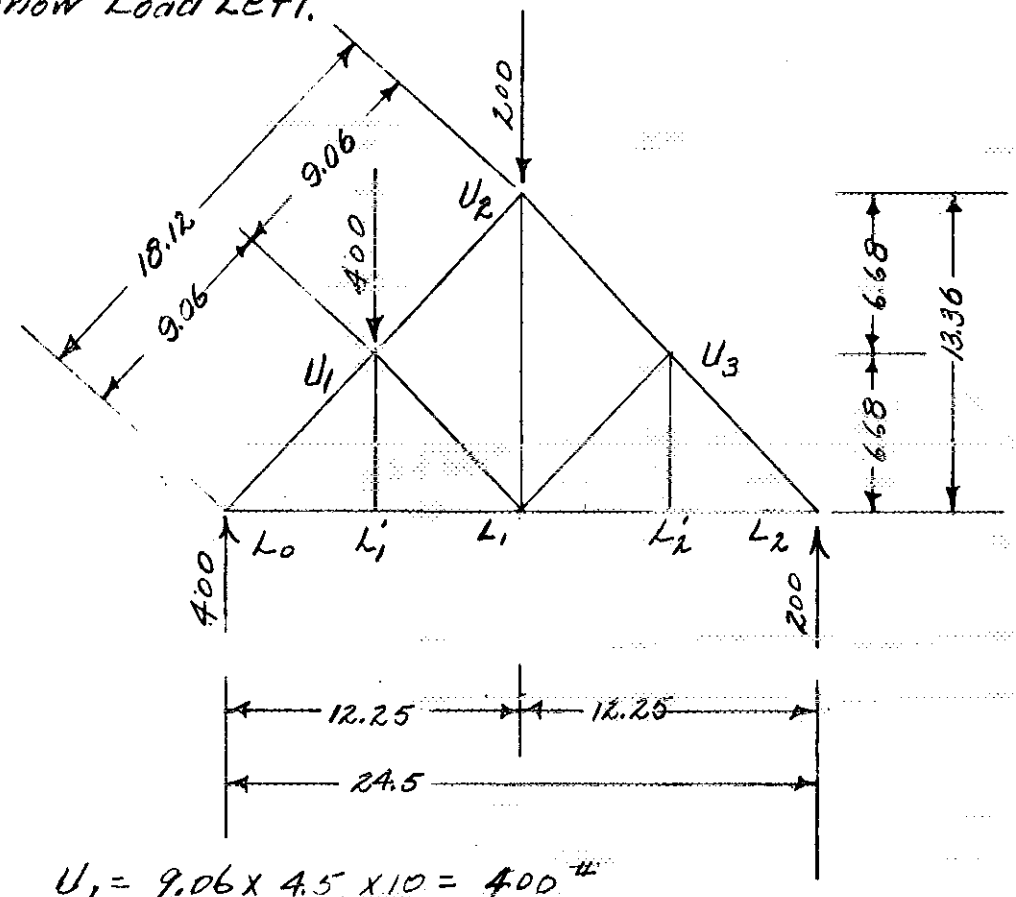
$2150 \times 6.13 - L_1 U_1 \times 12.25 \times 0.738 = 0$ $\quad L_1 U_1 = 1500$ C

$L_1 U_2 = 2 \times 3200 \times 0.738 - 1900 = 2800$ $\quad L_1 U_2 = 2800$ T

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Trusses over Entrance
Computed by D.M. Checked by Date 23 May 1944

Cont. from Page T-3

Snow Load Left.

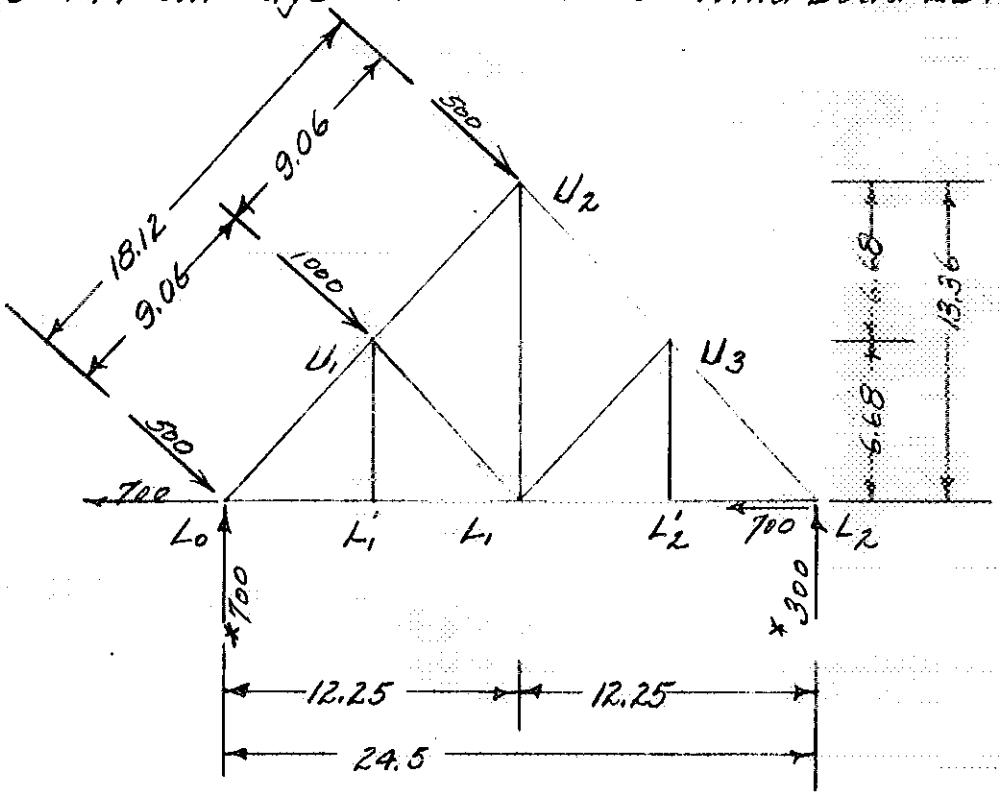


$U_1 = 9.06 \times 4.5 \times 10 = 400^{\#}$
$U_2 = U_1/2 = 200^{\#}$

Snow Loads are ½ Those shown on Truss of same dimensions on Page 19. Stresses in Members will be ½ those in Table on Page 11 for Snow Load Left Column

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Trusses over Entrance
Computed by D.M. **Checked by** ..... **Date** 29 May 1944

Cont. from Page 2A T-3 Wind Load Left



$L_0 = U_2 = 4.53 \times 4.5 \times 25' = 500^{\#}$
$U_1 = 9.06 \times 4.5 \times 25' = 1000^{\#}$

V component of $1000^{\#}$ wind force $= 1000 \times 0.677 = 677^{\#}$
H " " $1000^{\#}$ " " $= 1000 \times 0.738 = 738^{\#}$

$R_L = 3 \times 677/4 + 340/2 = 700$ } $R_L + R_R$ Lack V Component of Wind
$R_R = 677/4 + 340/2 = 300$ } Load at L_0

Stresses in members will be ½ those in Table on Page 17 for Wind Load Left Column

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

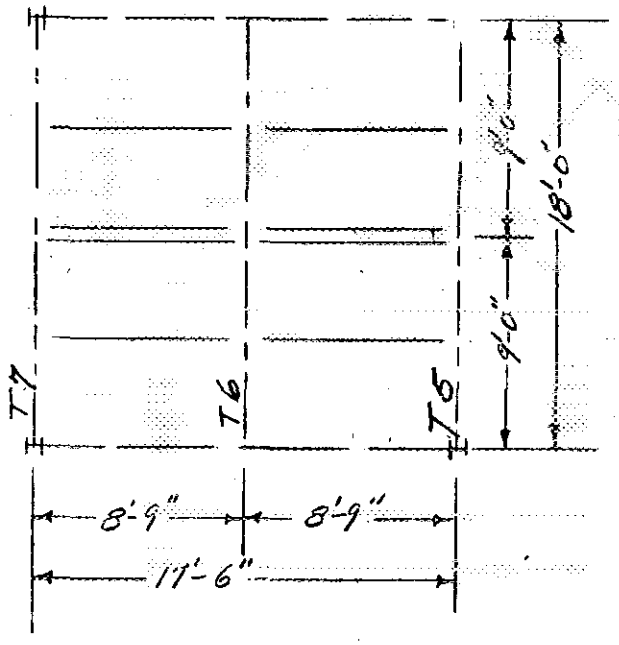
Subject Pumping Station, Montreal, Canada

Computation Roof Trusses and Comfort Station

Computed by L.M. **Checked by** ..... **Date** 30 May 1944

Design Data

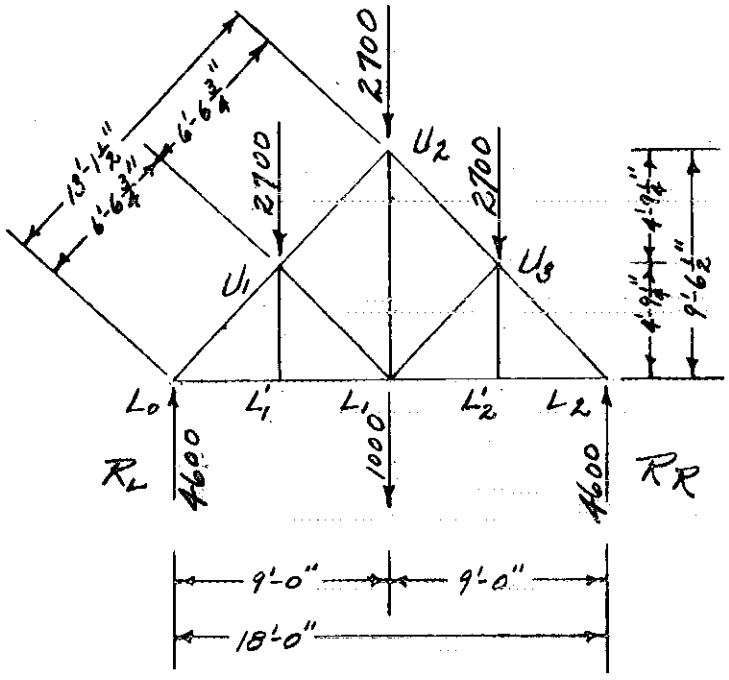
Gyp Plank	16#/□'
Slate 2"	27#/□'
Snow Load	10#/□'
Wind Load	25#/□'
Hung Ceiling	10#/□'
Truss Members + Bracing	8#/□'



Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Trusses over Comfort Station
Computed by D.M. Checked by Date 30 May 1944

Cont. from P. 26

DEAD LOAD T6



$U_1 = U_2 = U_3 = 6.56 \times 8.75 \times 43 + 8 \times 18 \times 8.75/5 = 2700^{\#}$

$L_1 = 8.75 \times 9 \times 10 + 8 \times 18 \times 8.75/5 = 1000^{\#}$

$R_L = R_R = (3 \times 2700 + 1000)/2 = 4600$

$L_0 U_1 = 4600/0.738 = 6200^{\#}$ C
$L_0 L_1 = 4600 \times 677/738 = 4200^{\#}$ T

$4600 \times 9 - 2700 \times 4.5 - U_1 U_2 \times 9 \times 0.738 = 0$ $\quad U_1 U_2 = 4400$ C

$2100 \times 4.5 - L_1 U_1 \times 9 \times 0.738 = 0$ $\quad L_1 U_1 = 1400$ C

$L_1 U_2 = 2 \times 4400 \times 0.738 - 2700$ $\quad L_1 U_2 = 3800$ T

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Trusses over Comfort Station
Computed by: W. M. Checked by: Date: 30 May 1944

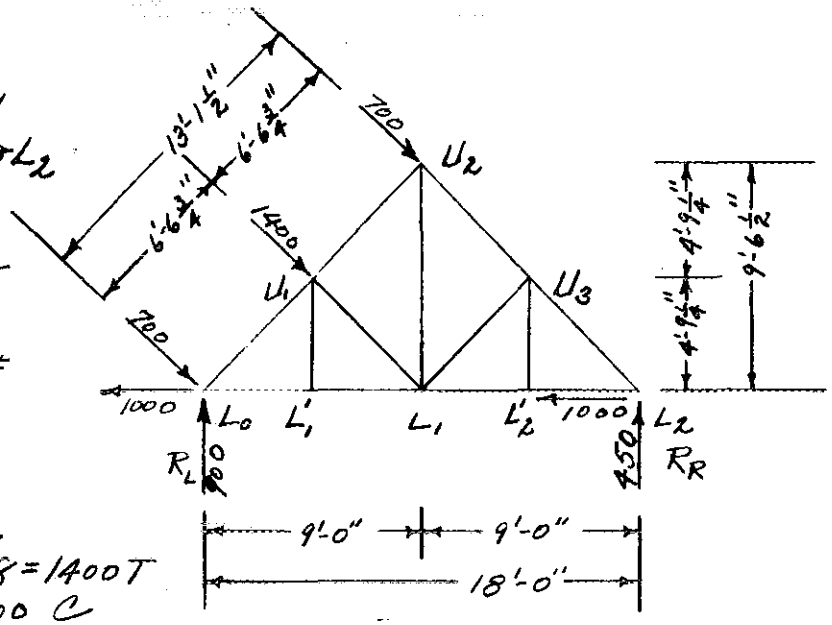
Cont. from P. 231 T 6

Member	Dead Load	Snow Load Lt	Snow Load Rt.	Wind Load Lt	Wind Load Rt.	Cupola Dead load	Cupola Wind load
L_0U_1	-6200	-800	-400	-1200	-600	-680	-900
U_1U_2	-4400	-400	-400	-1300	-600	-230	-300
U_2U_3	-4400	-400	-400	-600	-1300	-230	-300
U_3L_2	-6200	-400	-600	-600	-1200	-680	-900
L_1L_2	+4200	+300	+600	-600	+1400	+460	+600
L_0L_1	+4200	+600	+300	+1400	-600	+460	+600
L_1U_1	-1400	-400	0	-1400	0	-340	-440
L_1U_2	+3800	+300	+300	+1000	+1000	+340	+440
L_1U_3	-1400	0	-400	0	-1400	-340	-440

Wind Load Left.

H component of Wind Load evenly divided between L_0 & L_2

V component of Wind Load at L_0 not included in R_L or R_R



$U_1 = 6.56 \times 8.75 \times 25 = 1400^{\#}$
$L_0 = U_2 = U_1/2 = 700^{\#}$

L_0U_1 $900/0.738 = 1200$ C
$L_2U_3 = 450/0.738 = 600$ C
$L_0L_1 = 1000 - 450 + 900 \times 677/738 = 1400$ T
$L_1L_2 = -450 \times 677/738 + 1000 = 600$ C

$900 \times 9 + 1400 \times 0.738 \times 4.77 - 1400 \times 0.677 \times 4.5 - U_1U_2 \times 6.64 = 0$
$1400 \times 0.738 \times 4.77 + 1400 \times 0.677 \times 4.5 - L_1U_1 \times 6.64 = 0$
$L_1U_2 = 1900 \times 0.738 - 450 = 1000$ T

$U_1U_2 = 1300^{\#}$ C
$L_1U_1 = 1400^{\#}$ C

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station, Hartford, Conn.

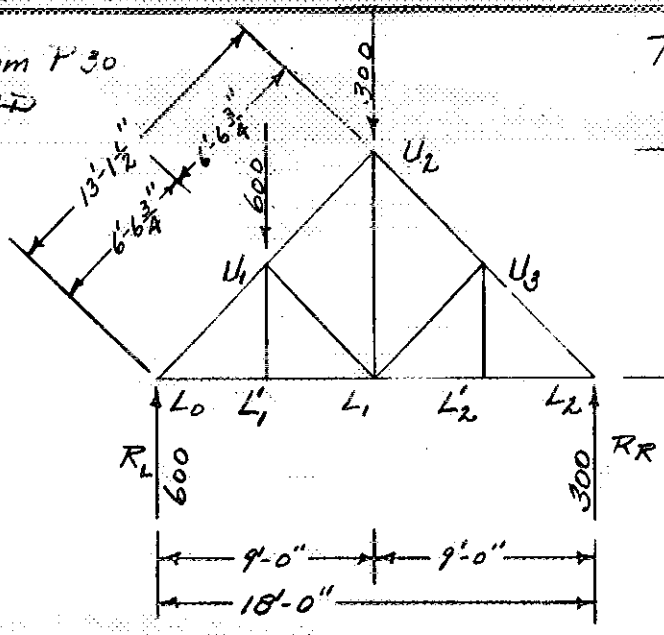
Computation Roof Trusses over Control Station

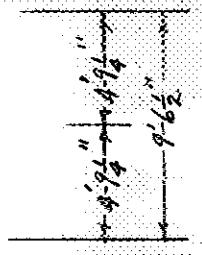
Computed by L.M. **Checked by** ..... **Date** May 1949

Cont. from P 30

SNOW LOAD

T 6





$U_1 = 6.56 \times 8.75 \times 10 = 600$

$U_2 = U_1/2 = 300$

$L_0U_1 = 600/0.738 = 800$ C

$L_0L_1 = 600 \times 677/738 = 600$ T

$600 \times 9 - 600 \times 4.5 - U_1U_2 \times 6.64 = 0$

$600 \times 4.5 - L_1U_1 \times 6.64 = 0$

$L_1U_2 = 2 \times 400 \times 0.738 - 300 = 300$ T

$L_2U_3 = 300/0.738 = 400$ C

$L_1L_2 = 300 \times 677/738 = 300$ T

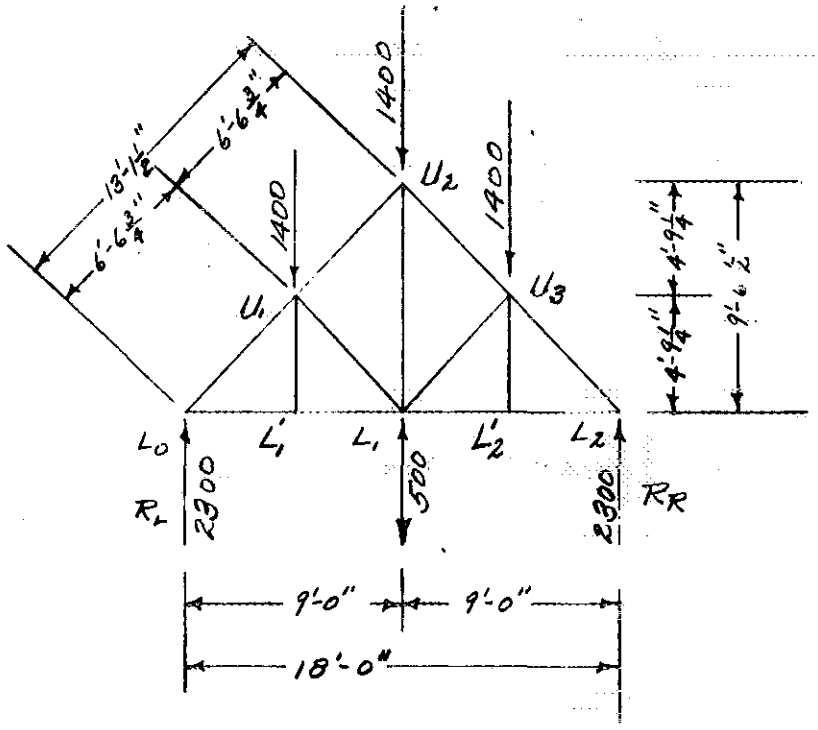
$U_1U_2 = 400$ C

$L_1U_1 = 400$ C

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Trusses over Control Station
Computed by D.M. Checked by Date 30 May 1949

Cont. from P. 26

DEAD LOAD T 7



$U_1 = U_2 = U_3 = 6.56 \times 8.75 \times 43/2 + 8 \times 18 \times 8.75/(5 \times 2) = 1400^{\#}$

$L_1 = 8.75 \times 9 \times 10/2 + 8 \times 18 \times 8.75/(5 \times 2) = 500^{\#}$

$R_L = R_R = (1400 \times 3 + 500)/2 = 2300$

Dead Load Stresses will be ½ Dead Load Stresses of Members of T 6

Snow Load Stresses will be ½ Snow Load Stresses in Table for T 6

Wind Load Stresses will be ½ Wind Load Stresses in Table for T 6

Loads and Reactions will be ½ those of T 6

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Roof Trusses over Comfort Station

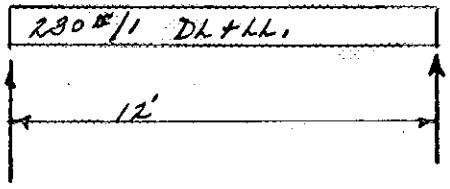
Computed by: D.M. Checked by: Date: May 1944

Cont. from P. 32 T 7

Member	Dead Load	Snow Load Lt.	Snow Load Rt.	Wind Load Lt	Wind Load Rt.
L_0U_1	-3100	-400	-200	-600	-300
U_1U_2	-2200	-200	-200	-650	-300
U_2U_3	-2200	-200	-200	-300	-650
U_3L_2	-3100	-200	-400	-300	-600
L_1L_2	+2100	+150	+300	-300	+700
L_0L_1	+2100	+300	+150	+700	-300
L_1U_1	-700	-200	0	-700	0
L_1U_2	+1900	+150	+150	+500	+500
L_1U_3	-700	0	-200	0	-700

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation All Purlins in Engine Room except those at Truss Peak
Computed by D. M. **Checked by** **Date** 21 June 1944

Tangential load partly taken up by rods tied to centers of Purlins.



Dead + Live Loads
Normal Load/1' = 53×6.3×0.677 = 230#/1

$$S = \frac{M}{f} = \frac{230 \times 12 \times 12 \times 12}{8 \times 18000} = 2.8$$

Dead + Wind Loads
Normal Load = 43×6.3×0.677 + 6.3×25 = 355#/1

$$S = \frac{M}{f} = \frac{355 \times 12 \times 12 \times 12}{8 \times 24000} = 3.2$$

Tangential Load Dead+Live = 53×6.3×0.738 = 246#/1

$$S = \frac{M}{f} = \frac{246 \times 6 \times 6 \times 12}{8 \times 17000} = 0.78$$

Try 6" WF 15.5#/1 $S_x = 10.1$ $S_y = 3.2$

$$f = \frac{240 \times 12 \times 12 \times 12}{8 \times 10.1} + \frac{257 \times 6 \times 6 \times 12}{8 \times 1.6} = 13800\#/\square'' \text{ DL+LL.}$$

$$f = \frac{365 \times 12 \times 12 \times 12}{8 \times 10.1} + \frac{257 \times 6 \times 6 \times 12}{8 \times 1.6} = 16500\#/\square'' \text{ DL+LL+W.L.}$$

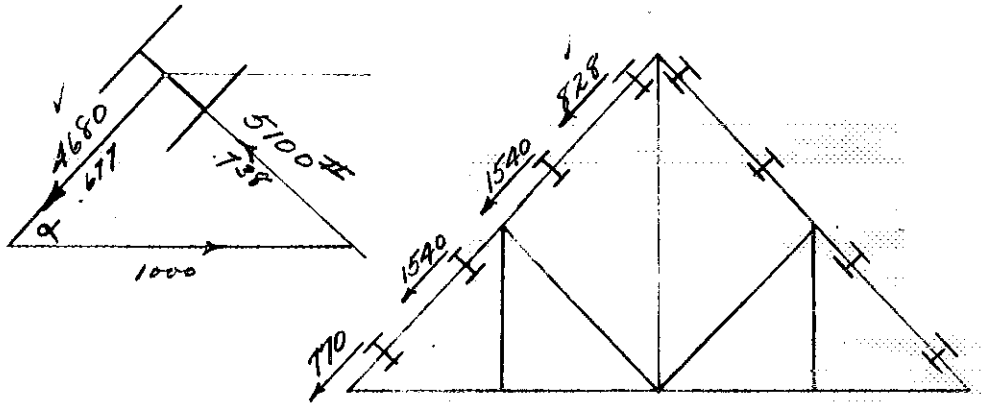
$$\frac{L}{b} = \frac{12 \times 12}{6} = 24 \quad f = 17000 \text{ Allow.}$$

Use 6" WF 15.5#/1 Purlins

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Purlins at Peak of Truss in Engine Room
Computed by: L. M. Checked by: Date: 21 June 1944.

Cont. from P 34

Purlin at peak of Truss in Engine Room



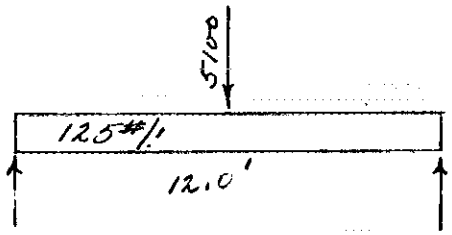
Purlin at peak of Truss.

Tangential Load Dead+Live = 53 x 6.3 x 0.738/2 = 123 #/'
Try 20# beam 123 + 15 = 138 #/'

On the rod joining the centers of purlins

Load = 6 x 138 = 828

Try 6" WF 20 $S_x = 13.4$ $S_y = 1.4$



DL+LL about XX Axis 125#/'
DL+LL about YY Axis 140#/'

$$f = \frac{5100 \times 12 \times 12}{4 \times 13.4} + \frac{125 \times 12 \times 12 \times 12}{8 \times 13.4} + \frac{140 \times 6 \times 6 \times 12}{8 \times 2.2} = 19200$$

$$\frac{l}{b} = \frac{6 \times 12}{6} = 12 \quad f = 20000 \text{ \#/□" Allow.}$$

Use 6" WF 20 $S_x = 13.4$ $S_y = 4.4$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Purlins over Entrance and Comfort Station
Computed by: D.M. Checked by: Date: 22 June 1944

Purlins over Entrance - All Purlins

Try 6" WF 15.5# Purlins $S_x = 10.1$ $S_y = 3.2$ With no tie rod thru centers

Normal DL+LL = 53 × 4.5 × 0.677 = 160 #/'
Tangential DL+LL = 53 × 4.5 × 0.738 = 180 #/'

Normal DL+W.L. 43 × 4.5 × 0.677 + 20 × 4.5 = 220 #/'
Tangential DL. 43 × 4.5 × 0.738 = 145 #/'

$$f = \frac{7.5 \times 160 \times 7.5 \times 12}{8 \times 10.1} + \frac{7.5 \times 180 \times 7.5 \times 12}{8 \times 1.6} = 10800 \text{ DL+LL}$$

$$f = \frac{220 \times 7.5 \times 7.5 \times 12}{8 \times 10.1} + \frac{145 \times 7.5 \times 7.5 \times 12}{8 \times 1.6} = 9530 \text{ DL+WL}$$

Use 6" WF Purlins 15.5# No Center Ties.

$$\frac{l}{b} = \frac{7.5 \times 12}{6} = 15 \qquad f = 20000 \#/\square'' \text{ Allow}$$

Purlins over Comfort Station.

Try 6" WF 15.5# $S_x = 10.1$ $S_y = 3.2$ With no center Ties

Normal DL+LL 53 × 6.6 × 0.677 = 240 #/'
Tangential DL+LL 53 × 6.6 × 0.738 = 260 #/'

Normal DL+WL 43 × 6.6 × 0.677 + 20 × 6.6 = 330 #/'
Tangential D.L. 43 × 6.6 × 0.738 = 210 #/'

$$f = \frac{8.6 \times 240 \times 8.6 \times 12}{8 \times 10.1} + \frac{8.6 \times 260 \times 8.6 \times 12}{8 \times 1.6} = 20600 \#/\square'' \text{ DL+LL}$$

$$f = \frac{8.6 \times 330 \times 8.6 \times 12}{8 \times 10.1} + \frac{8.6 \times 210 \times 8.6 \times 12}{8 \times 1.6} = 18200 \#/\square'' \text{ DL+W.L.}$$

$$\frac{l}{b} = \frac{8.6 \times 12}{6} = 17.2 \qquad 9300 \#/\square'' \text{ Allow.}$$

Use 6" WF 15.5# for All but Cupola Purlins. Use 6" WF 12# for Cupola Purlins
No Center Ties

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Truss Members over Engine Room
Computed by D.M. & E.H. Checked by ✓ Date 7 June 1944

T-1

$L_0 U_1$

Assume $\frac{P}{A} = 5000\#/\square''$ Allowable

$\frac{M}{S} = 10000\#/\square''$ Allowable

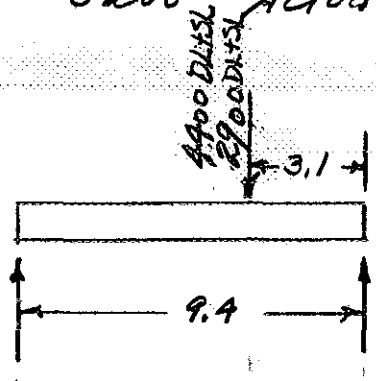
$\frac{P}{A} = \frac{22700}{5000} = 4.4\square''$

Try $2 - 6 \times 4 \times \frac{3}{8}''$ ∠s $A = 7.2\square''$ $S = 6.6$ $I = 27$

$\frac{l}{r} = \frac{6.3 \times 12}{1.62} = 47.0$

$f = 16000\#$ Allow.

$\frac{P}{A} = \frac{22700}{7.2} = 3200\#$ Actual D.L. + S.L.



$f = \frac{M}{S} = \frac{2 \times 2900 \times 3.1 \times 12 \times 0.8}{3 \times 6.6} = 8700\#$ DL + SL.

$f = \frac{M}{S} = \frac{2 \times 4400 \times 3.1 \times 12 \times 0.8}{3 \times 6.6} = 13200\#$ DL + WL Lt. + SL. Rt.

Dead Load + Snow Load = 8700 + 3200 = 11900

Dead Load + Snow Load Rt + Wind Load Lt = 13200 + 3200 = 16400

∠s considered Large, try 2 ∠s $5 \times 3\frac{1}{2} \times \frac{3}{8}$

Subject: Bushnell Park Pumping Station, Hartford, Conn
Computation: Truss Members over Engine Room
Computed by: D.M. & E.H. Checked by: Date: 7 June 1944

Cont. from P 35 T-1

Try $5 \times 3\frac{1}{2} \times \frac{3}{8}$ $A = 6.1$ $S = 4.6$ $r = 3.2$

$\frac{P}{A} = \frac{22700}{6.1} = 3700$ #

$f = 8700 \times 6.6/4.6 = 12500$ #/□ D.L. + S.L.

$f = 13200 \times 6.6/4.6 = 18900$ #/□" D.L. + W.L. Lt + S.L. Rt.

$\frac{P}{A} = \frac{23700}{6.1} = 3900$ # D.L. + W.L. Lt + S.L. Rt.

Dead Load + Snow Load = 12500 + 3200 = 15700 #/□"

D.L. + S.L. Rt. + W.L. Lt = 18900 + 3900 = 22800

$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1$ $\frac{l}{b} = \frac{6.3 \times 12 \times 2}{7} = 21.6$

17900 + 6000 = 23900

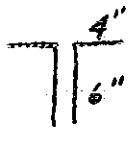
$\frac{18900}{23900} + \frac{3900}{17400} = 1.01$

$\frac{l^2}{r^2} = \frac{6.3^2 \times 12^2}{3.2^2} = 560$

$\frac{18000}{1 + \frac{560}{18000}} = 17400$

2 - $5 \times 3\frac{1}{2} \times \frac{3}{8}$" ⊔ Not Strong Enough

USE 2 ⊔ 6 × 4 × $\frac{3}{8}$"



Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Truss Members over Engine Room
Computed by: D.M. & L.H. Checked by: _____ Date: 1 June 1944

T-1

Bottom Cord L_0L_1, L_1L_2, L_2L_3, L_3L_4

$L_1L_0 = 14900$ T

Use 2 - 4 x 3 x 1/4" ∟ A = 3.38
Net Area 3.38 - 0.44 = 2.94 □"

14900/2.94 = 5100 #/□"

L_2U_2, L_1U_1, L_3U_3

Use 2 - 2 1/2 x 2 1/2 x 7/16 ∟ A = 2.38 Net Area = 1.94

$L_1U_1 = 5600$ T
$L_2U_2 = 13100$ T

13100/1.94 = 6800 #/□" Allow. 10000 #/□"

$L_2U_1 = 8000$ C
$L_2U_3 = 5300$ C

Use 2 - 3 x 2 1/2 x 1/4" ∟ A = 2.62 r = 0.95

l/r = 9 x 12/.95 = 114

f_s = 8000/2.62 = 3100 #/□" Allow. 10700 #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page 263

Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Roof Truss Members over Engine Room

Computed by: D. M. Checked by: Date: 8 June 1944

T-2

L_2U_1 & L_2U_3

$L_2U_1 = 8000 + 200 = 8200\,C$

$L_2U_3 = 5300 + 200 \quad 5500\,C$

Use 2-3 × 2½ × ¼" L A = 2.62 r = 0.95

$l/r = 114$

$f_s = 8200/2.62 = 3100$ #/□" Allow 10700 #/□"

L_1U_1 & L_3U_3 Use 2- 2½ × 2½ × ¼ L No stress change

$L_2U_2 = 13100 + 1300 = 14400\,T$

Use 2- 2½ × 2½ × ¼" L A = 2.38 Net Area = 1.94

$f_s = 14400/1.94 = 7400$ #/□" Allow. 20000 #/□"

L_0L_1 L_1L_2 L_2L_3 L_3L_4

Use 2- 4 × 3 × ¼" LS A = 3.38 Net A = 2.94

$L_0L_1 = 14900 + 700 = 15600$

$f_s = 15600/2.94 = 5300$ #/□" Allow. 20000 #/□"

L_0U_1 U_1U_2 U_2U_3 U_3L_4

Use 2-6 × 4 × ⅜" LS A = 7.2 □" S = 6.6 I = 27

Additional stress caused by blower platform = 1100/7.2 = 150 #/□"

$f_s = 16400 + 150 = 16550$ #/□"

Allow. 16800 × 1/3 = 22000 #/□"

~~Use same truss throughout as T-1~~

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station, Hartford, Conn.

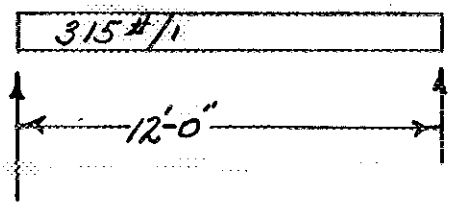
Computation: Beams under Catwalk + Silencers

Computed by: D.M.+E.H. Checked by: ..... Date: 7 June 1944

$$\frac{l}{b} = \frac{12 \times 12}{3\frac{1}{2}} = 25$$

Allow $f_s = 16700$
Use 16000

Try 6" WF 15.5#/'

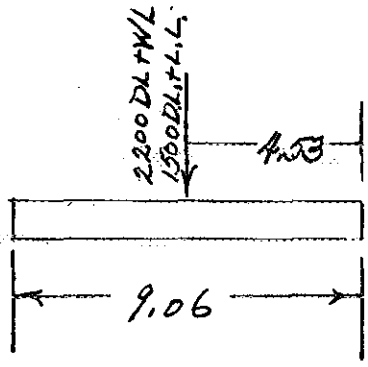


$$S = \frac{M}{f} = \frac{315 \times 12 \times 12 \times 12}{8 \times 16000} = 4.3$$

Use 6" WF 15.5#/'

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Truss Members over Entrance
Computed by Checked by Date

T-4



Normal Load on Truss from P, D.L.+L.L.

$= 9.0 \times 53 \times 4.53 \times 0.677 = 1500^{\#}$

Normal Load on Truss from P, D.L.+W.L.

$= 9 \times 43 \times 4.53 \times 0.677 + 9 \times 4.53 \times 25 = 2200^{\#}$

$S = \frac{M}{f} = \frac{1500 \times 9.06 \times 12 \times 0.8}{4 \times 13000} = 2.5$

Try 2-4×3½×⅜ LS 18.2# S 2.98 r = 1.56 A = 5.34

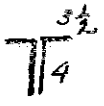
$f = \frac{1500 \times 9.06 \times 12 \times 0.8}{4 \times 2.98} + \frac{11500}{5.34} = 13200^{\#}/\square''$ D.L.+L.L.

$f = \frac{2200 \times 9.06 \times 12 \times 0.8}{4 \times 2.98} + \frac{13400}{5.34} = 18600^{\#}/\square''$ D.L.+W.L.

$l/r = 9.06 \times 12/1.56 = 70$ $14600^{\#}/\square''$ Allow. DL.+LL.

$14600 \times 4/3 = 19200^{\#}/\square''$ DL+WL.

Use 2-4×3½×⅜ LS 18.2# Top Cord



Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Truss Members over Entrance
Computed by D. M. + E.H. **Checked by** ..... **Date** 10 June 1944

T4.

Bottom Cord Members $L_2'L_2$ L_1L_2' $L_1'L_1$ L_0L_1' and

$L_1'U_1$ L_1U_2 $L_2'U_3$ KU_3

Use 2-2½ × 2½ × ¼ LS $A = 2.38$ Net $A = 1.94 \square''$

$\frac{P}{A} = 8300/1.94 = 4300\#/\square''$ Allow. $20000\#/\square''$

L_1U_3 L_1U_1

$\frac{l}{r} = \frac{9.06 \times 12}{0.95} = 114$

Use 2-3 × 2½ × ¼ LS $r = 0.95$ $A = 2.62$

$f = -8000/2.62 = 3100\#/\square''$ Allow. $10700\#/\square''$

KU_3'

$\frac{l}{r} = \frac{4.5 \times 12}{0.77} = 70$ Allow. $14600\#/\square''$

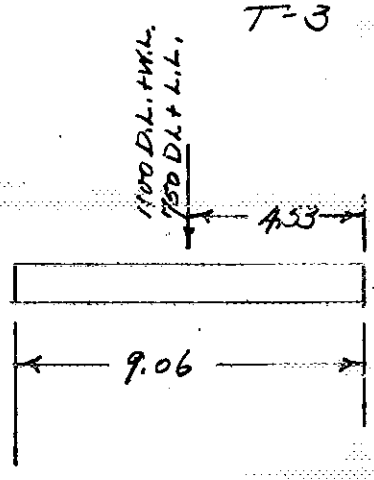
Use 2-2½ × 2½ × ¼" LS $A = 2.38$

$f = 4000/2.38 = 1700\#/\square''$

Subject Bushnell Park Pumping Station Hartford, Conn.
Computation Roof Truss Members over Entrance.
Computed by D.M. & E.H. Checked by ..... Date 10 June 1944

T-3

Top Cord



$S = \frac{M}{f} = \frac{750 \times 9.06 \times 12 \times 0.8}{4 \times 13000}$ 1.3

Try 2 ∠s $4 \times 3 \times \frac{1}{4}$ 11.6 #/' $S = 2.0$ $r = 1.28$

$\frac{l}{r} = \frac{9.06 \times 12}{1.28} = 85$ $f = 13500$ #/□" Allow

$f = \frac{M}{S} = \frac{750 \times 9.06 \times 12}{4 \times 2} = 10200$ #/□" D.L. + L.L.

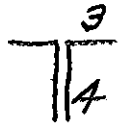
$f = \frac{1100 \times 9.06 \times 12}{4 \times 2} = 15000$ #/□" D.L. + W.L.

$\frac{P}{A} = \frac{5800}{3.38} = 1700$ #/□"

$10200 + 1700 = 11900$ #/□" 13500 #/□" Allow.

$15000 + 1700 = 16700$ #/□" $13500 \times \frac{4}{3} = 18000$ Allow.

Use 2 - $4 \times 3 \times \frac{1}{4}$ ∠s



Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Truss Members over Entrance
Computed by: D.M. & E.H. Checked by: Date: 10 June 1944

T3

L_1L_2 L_0L_1 L_1U_2 $L_1'U_1$ $L_2'U_3$

Use Min. Section 2-2½×2½×¼" ∟s

L_1U_1 L_1U_3

$$\frac{l}{r} = \frac{9.06 \times 12}{0.95} = 114$$

Use 2-3×2½×¼ ∟s

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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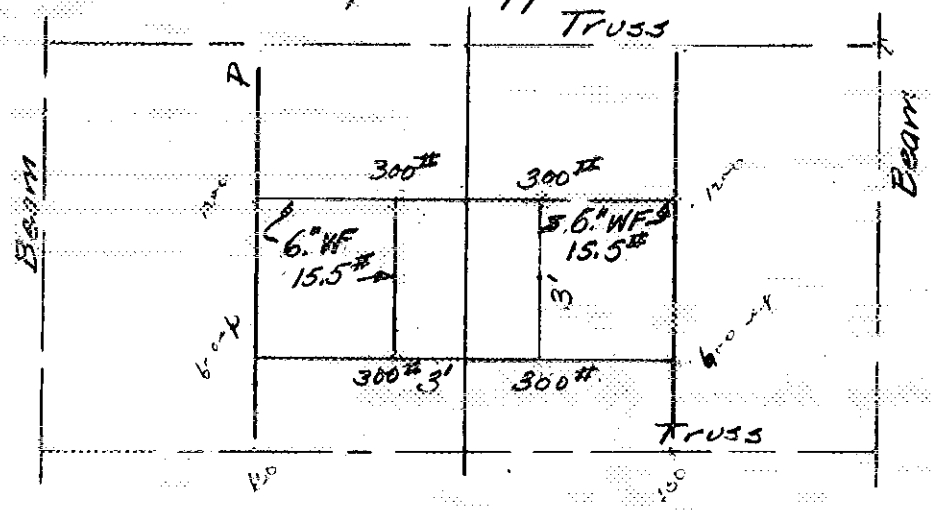
Subject: Bushnell Park Pumping Station Hartford Conn.

Computation: Roof Truss Members over Comfort Station

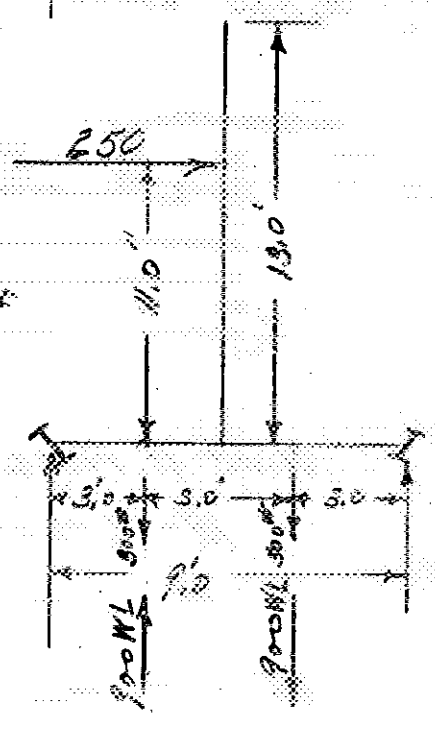
Computed by: D.M. & E.H. Checked by: Date: 12 June 1944

Cupola Support



Wgt. of Cupola

Loaded Copper	400#
Steel Frame	400#
Gyp Plank	400#
	1200#



Wind Load on each beam $8 \times 3 \times 20/2 = 250^{\#}$

$250 \times 11 = 3 \times F$

$F = 900^{\#}$

Wind Load 90° to plane of paper

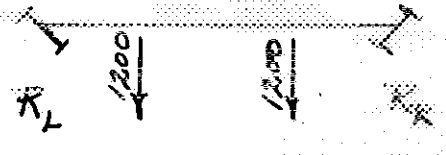
$500 \times 11 = 3F$

$F = 1800^{\#}$

$M = 1200 \times 3 = 3600'^{\#}$

$S = \frac{M}{f} = \frac{3600 \times 12}{10000} = 4.32$

Use 2-6" WF 15.5# S = 9.7



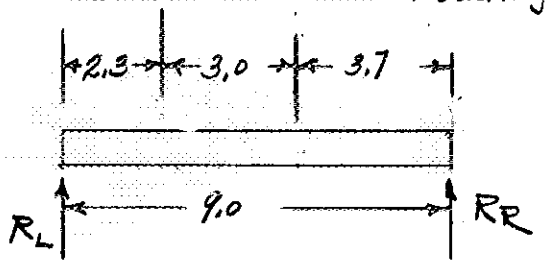
Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Roof Truss Members over Comfort Station
Computed by: D. M. & E. H. Checked by: Date: 12 June 1944

Cont. from P 44

Cupola Purlins

U 600 D 1200 / D 1200 U 600 } Two Separate Loadings

Wind Blowing ∥ ridge pole

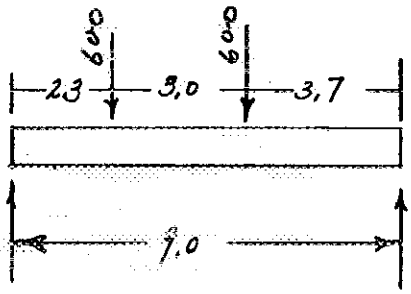


$R_L \times 9 - 1200 \times 6.7 + 600 \times 3.7 = 0$
$R_L = 650 \quad R_R = -50$

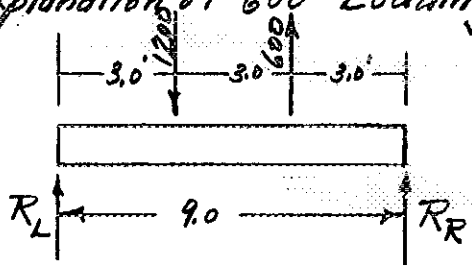
$R_L \times 9 + 600 \times 6.7 - 1200 \times 3.7 = 0$
$R_L = 50 \quad R_R = 550$

Wind Blowing Normal to ridge pole

$R_L \times 9.0 - 600 \times 6.7 - 600 \times 3.7 = 0$
$R_L = 700^{\#} \quad R_R = 500^{\#}$



Explanation of 600# Loadings



$R_L \times 9 + 600 \times 3 - 1200 \times 6 = 0$
$R_L = 600^{\#}$
$R_R = 0$

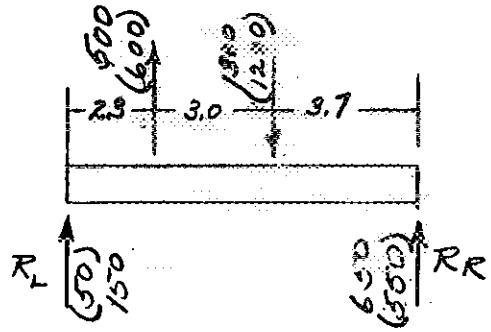
Wind ∥ ridge pole

$M = 650 \times 2.3 = 1500'^{\#}$

$M = 550 \times 3.7 = 2040'^{\#}$

Wind Normal to ridge pole

$M = 500 \times 3.7 = 1850'^{\#}$



Add 100# to each reaction for steel wgt. in cupola supports

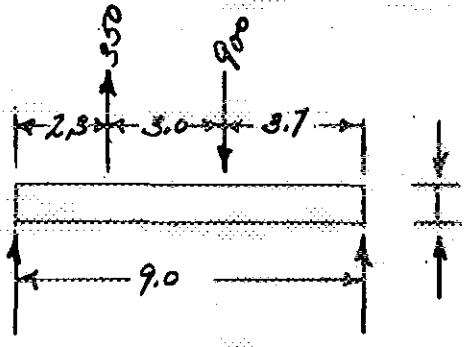
Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Roof Truss Members over "Comfort" Station
Computed by D.M. & E.H. Checked by ..... Date 12 June 1944

Const. from P 45 Cupola Purlins

Loading in plane of web

$500 \times 0.677 = 350$

$1300 \times 0.677 = 900$



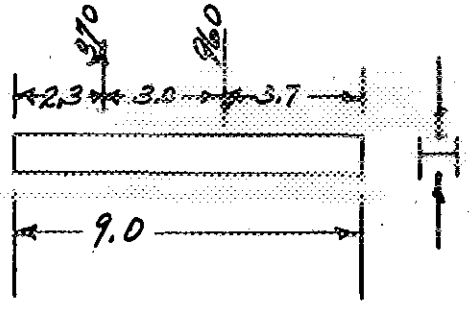
$9 \times R_L + 350 \times 6.7 - 900 \times 3.7 = 0$

$R_L = 100 \quad R_R = 450$

Loading Normal to plane of web

$500 \times 0.738 = 370$

$1300 \times 0.738 = 960$



$9R_L + 370 \times 6.7 - 960 \times 3.7 = 0 \quad R_L = 120$

$R_R = 470$

$S = \frac{M}{f} = \frac{470 \times 3.7 \times 12}{10000} = 2.1$

Try 6" WF 20#/' $S_y = 4.5$ $S_x = 13.1$

$f = \frac{M}{S} = \frac{470 \times 3.7 \times 12}{4.5} + \frac{450 \times 3.7 \times 12}{13.1} = 6100$ #□"

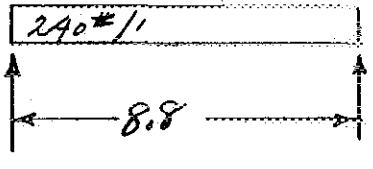
Use 6" WF 20#/' see P 259

$f = \frac{470 \times 3.7 \times 12}{3.23} + \frac{450 \times 3.7 \times 12}{9.7} = 8600$ #

Roof Load carried by Purlin

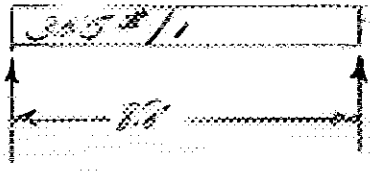
Dead Load + Live Load

$= 6.56 \times 53 \times 0.677 = 240$ #/'



Dead Load + Wind Load

$= 6.56 \times 43 \times 0.677 + 6.56 \times 25 = 355$ #/'



Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Roof Truss Members over Comfort Station.
Computed by: D.M.T.E.H. Checked by: ..... Date: 13 June 1944

Cont. from P 46

$$f = 8600 + \frac{240 \times 8.8 \times 8.8 \times 12}{8 \times 9.7} = 11500 \quad DL + L.L$$

$$f = 8600 + \frac{355 \times 8.8 \times 8.8 \times 12}{8 \times 9.7} = 12900 \quad D.L + W.L.$$

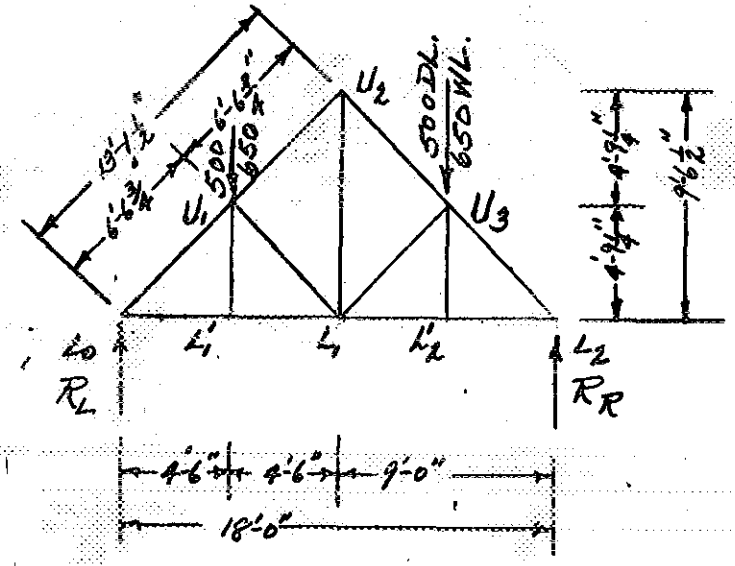
$$\frac{l}{b} = \frac{8.8 \times 12}{6} = 17.6 \qquad f = 19200\#/\square'' \text{ Allow.}$$

T 6 and T 7

Use 2 - $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$" Ls for all Members

Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Roof Truss over Comfort Station
Computed by: D. M. T. E. H. Checked by: ..... Date: 13 June 1944

Cupola Load



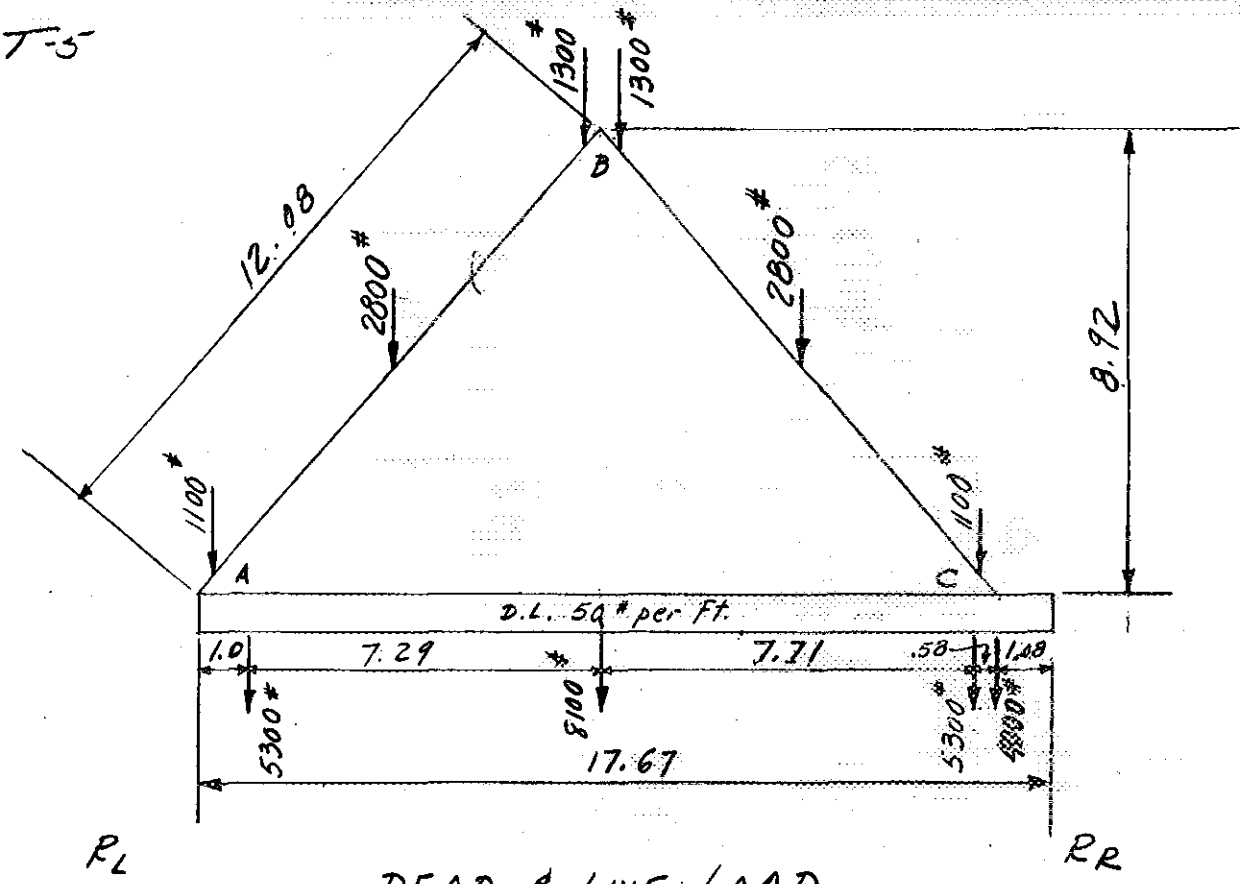
Dead Load from Cupola - Allow 200# for purlin + supporting beam wgts at each panel point.

300 + 200 = 500#

D.L.	W.L.
$L_0U_1 = 500/0.738 = 680$	$L_0U_1 = 1.3 \times 680 = 900$# C
$L_0L_1 = 500 \times 677/738 = 460$	$L_0L_1 = 460 \times 1.3 = 600$ T
$L_1U_1 = 500 \times 4.5/(9 \times 0.738) = 340$	$L_1U_1 = 340 \times 1.3 = 440$ C
$U_1U_2 = (500 \times 9 - 650 \times 4.5)/(9 \times 0.738) = 230$	$U_1U_2 = 230 \times 1.3 = 300$ C
$L_1U_2 = 2 \times 230 \times 0.738 = 340$	$L_1U_2 = 340 \times 1.3 = 440$ T

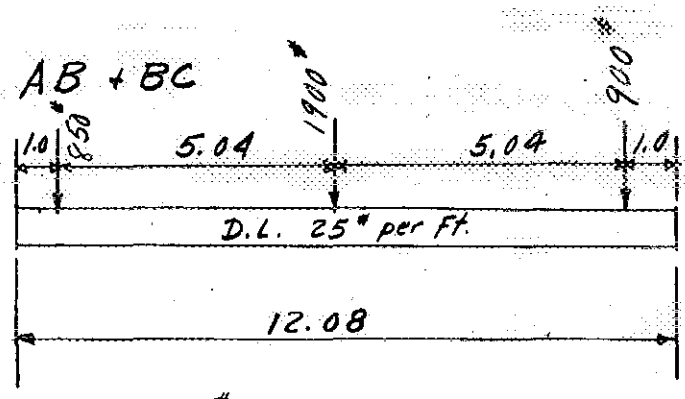
Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Roof Truss over Contact Station
Computed by: D.M.+E.H. Checked by: Date: 14 June 1944

T-5



DEAD & LIVE LOAD

MEMBER AB + BC



2800 x .677 = 1900#
1300 x .677 = 900#
1100 x .677 = 850#

Loading parallel to beam = 2100 + 1100 + 600 = 3800#

Subject: BUSHNELL PARK PUMPING STATION
Computation: ROOF TRUSSES OVER COMFORT STATION
Computed by: D.M. & E.H. Checked by: Date: 14 JUNE, 1944

T-5
MEMBER AB + BC (continued)

$R_L =$

$900 \times \frac{1}{12.08} = 75$

$1900 \times \frac{6.04}{12.08} = 950$

$850 \times \frac{11.08}{12.08} = 780$

$25 \times 6.04 = 150$

1955 #

$R_R = 4100 - 1955 = 2145$ #

$M = 1955 \times 6.04 = 11800$

$850 \times 5.04 = 4300$

$25 \times 6.04 \times 3.02 = 450$ $\quad 4750$

7050 '#

$S = \frac{7050 \times 12}{18000} = 4.7$

Try a 6" WF @ 15.5 $\quad S = 9.7$

Combined stress due to bending & column action

$\frac{M}{S} + \frac{P}{A} = \frac{7050 \times 12}{9.7} + \frac{3800}{4.57} =$

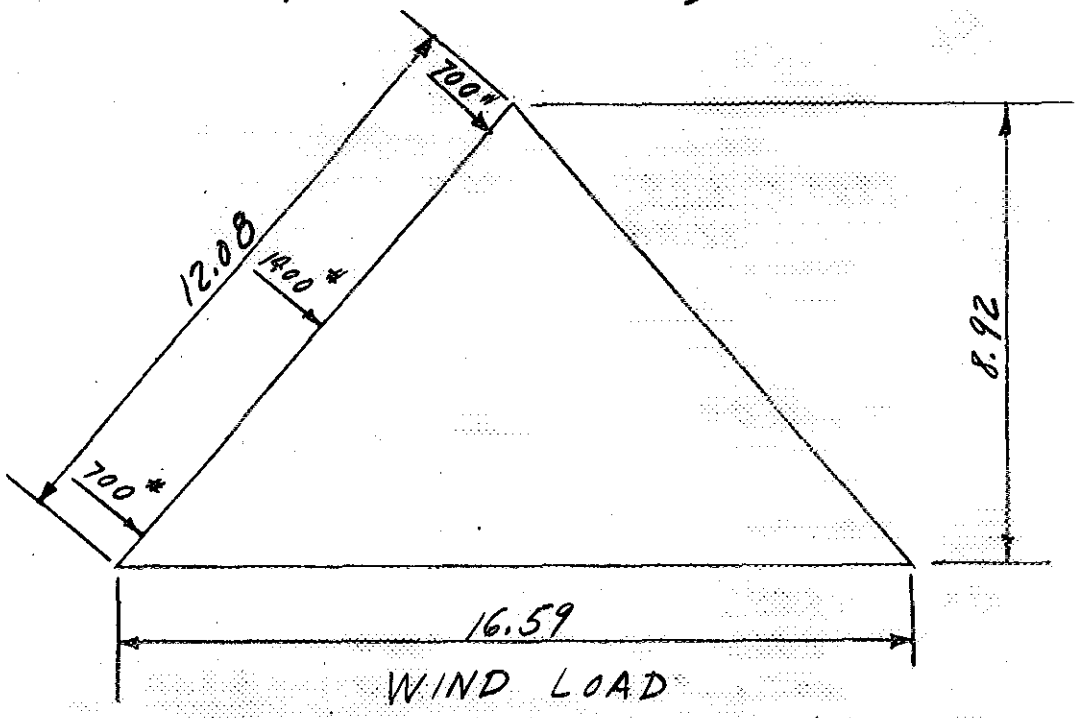
$8700 + 850 = 9650$ #/□"

Use a 6" WF @ 15.5

$\frac{l}{r} = \frac{12.1 \times 12}{1.45} = 101$ Allow. f'c = 12000 #/□"

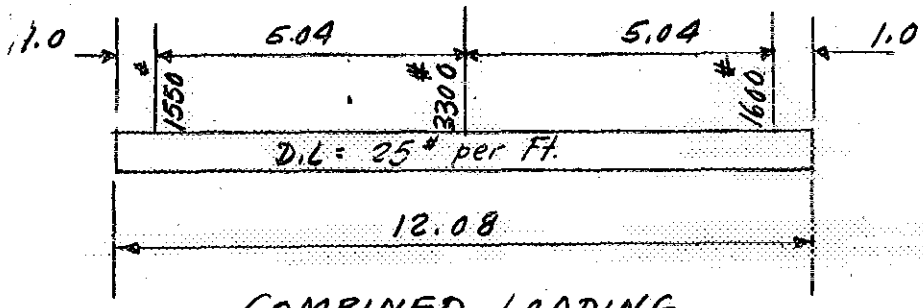
Subject: BUSHNELL PARK PUMPING STATION
Computation: ROOF TRUSSES OVER COMFORT STATION
Computed by: D.M. & E.H. Checked by: Date: 14 JUNE, 1944

T-5
MEMBER AB & BC (continued)



WIND LOAD

Wind load on cupola neglected since it causes an uplift with wind blowing in direction shown.



COMBINED LOADING
(Dead, live, snow & wind)

$R_L = 1600 \times \frac{1}{12.08} = 130$

$3300 \times \frac{6.04}{12.08} = 1650$

$1550 \times \frac{11.08}{12.08} = 1420$

$25 \times 6.04 = 150$

3350

Subject: BUSHNELL PARK PUMPING STATION
Computation: ROOF TRUSSES OVER COMFORT STATION
Computed by: D.M. & E.J.H. Checked by: Date: 14 JUNE 1944

T-5

MEMBERS AB & BC (continued)

$R_R = 3400^{\#}$

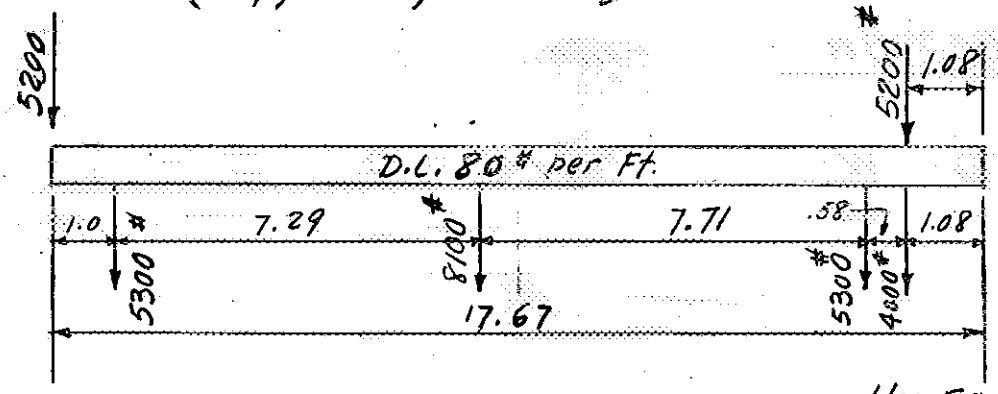
$M = 3350 \times 6.04 = 20200$
$1550 \times 5.04 = 7800$
$25 \times 6.04 \times 3.02 = 450$ $\quad 8250$
11950 '#

$F = \frac{11950 \times 12}{9.7} = 14{,}800^{\#}/\square''$ Allow. $16000^{\#}/\square''$

O.K Use a 6" WF @ 15.5#

$D = \frac{3300 \times 144 \times 144 \times 144}{48 \times 30{,}000{,}000 \times 30.3} = .22$ Allowable .4

BEAM AC (Supporting trusses)



UNIFORM LOAD
Beam = 30#
Ceiling 50
80#

$R_L = 9200 \times \frac{1.08}{17.67} = 570$

$5300 \times \frac{1.67}{17.67} = 500$

$8100 \times \frac{9.38}{17.67} = 4300$

$5300 \times \frac{16.67}{17.67} = 5000$

$80 \times 8.83 = 700$
11070 #

$R_R = 5300 + 8100 + 5300 + 4000 + 5200 + 1400 - 11070 = 18230^{\#}$

Subject: BUSHNELL PARK PUMPING STATION
Computation: ROOF TRUSSES OVER COMFORT STATION
Computed by: P.M. & E.J.H. Checked by: Date: 14 JUNE, 1944

T=3"

M =	11070 x 8.29 =		91600
	5300 x 7.29 =	38600	
	80 x 8.29 x 4.15 =	2750	41350
		41350	50250 '#

$S = \frac{50250 \times 12}{16000} = 37.8$

Use a 10" WF @ 37# S = 39.9

Unsupported width of top Flange

$\frac{l}{b} = \frac{212}{8} = 26.5$ allowable = 16100 #□"

10" WF @ 37# O.K

DEFLECTION (center load only)

$D = \frac{Wl^3}{48EI} = \frac{8100 \times 212 \times 212 \times 212}{48 \times 30{,}000{,}000 \times 196.9} = .27$

$\frac{212}{360} = .59$ O.K.

WAR DEPARTMENT
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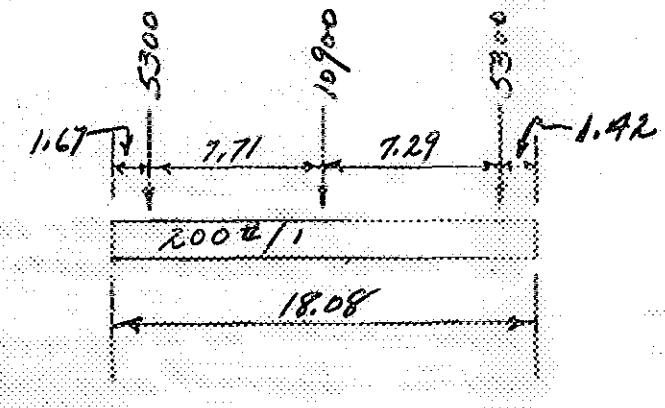
Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: B-1
Computed by: D.M. & E.H. Checked by: Date: 14 June 1944



$$R_L \times 18.08 - 5300 \times 16.42 - 10900 \times 8.71 - 5300 \times 1.42 - 200 \times 18.08 \times 9.04 = 0$$

$$R_L = 12300$$

$$R_R = 5300 + 10900 + 5300 + 3600 - 12300 = 12800$$

$$S = \frac{M}{f} = \frac{[12300 \times 9.38 - 5300 \times 7.71 - 200 \times 9.04 \times 4.54] \times 12}{16000}$$

$$= 49.6$$

Use 10" WF 49 $S = 54.6$

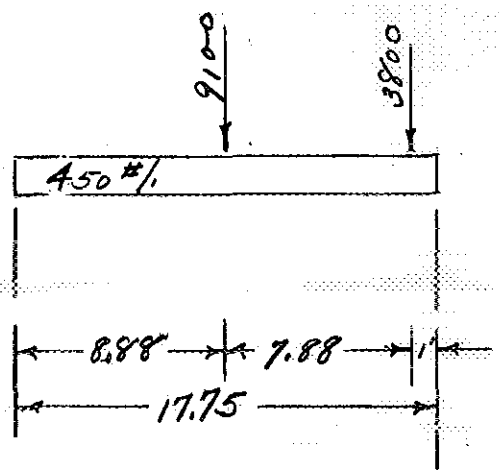
$$d = \frac{wl^3}{48EI} = \frac{10900 \times 18.08^3 \times 12^3}{48 \times 30000000 \times 272.9} = 0.28''$$

$$\frac{18.08 \times 12}{360} \quad 0.60 \text{ Allow.}$$

$$\frac{l}{b} = \frac{18.08 \times 12}{10} = 21.7 \qquad f = 17800 \text{ Allow.}$$

1.67 Dimension changed to 2.00. This requires no change in size of beam.

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: B-2
Computed by: D.M. Checked by: Date: 6 June 1944



See B3 for loads
Add 1500# to center load for valley beam reaction

Add 250 #/' to fireproofing load for shed roof and gable roof over comfort station

$R_L = 450 \times 8.88 + 4550 + 3800 / 17.75 = 8800$ #

$R_R = 9100 + 3800 + 450 \times 17.75 - 8800 = 12100$ #

$M = 8800 \times 8.88 - 450 \times 8.88 \times 4.44 = 60\,500$ '#

$S = \frac{M}{f} = \frac{60500 \times 12}{16000} = 45.4$

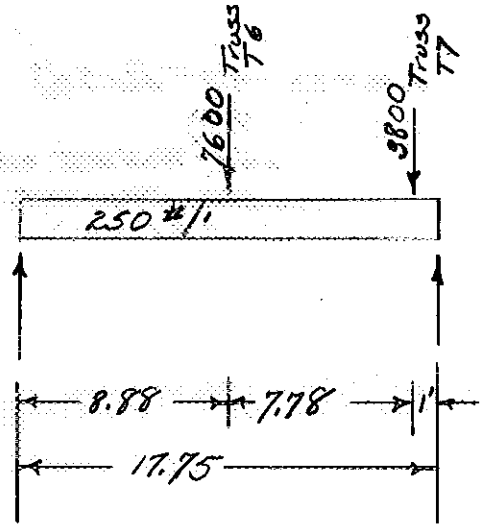
Try 10" WF 45 $S = 49.1$

$\frac{l}{b} = \frac{17.75 \times 12}{8.02} = 26.6$ 16100 #/□" Allow.

$d = \frac{wl^3}{48EI} = \frac{13100 \times 17.75^3 \times 12^3}{48 \times 30000000 \times 248.6} = 0.36''$

Use 10" WF 45 $S = 49.1$

Subject Cushman Park Pumping Station, Hartford, Conn.
Computation B-3
Computed by D. M. Checked by ..... Date 5 June 1944



200# Fireproofing
50# Beam wgt.
250#/' Total

4600 D.L.
1350 D.L.
600 S.L.
300 S.L.
300 S.L.
500 Ceiling
7650

$R_L = 3800 + 3800/17.75 + 8.9 \times 250 = 6200$

$R_R = 7600 + 3800 + 4440 - 6234 = 9600$

$M = 6200 \times 8.88 - 250 \times 8.88 \times 4.44 = 45100$ '#

$S = \frac{M}{f} = \frac{45100 \times 12}{16000} = 33.8$

Try 12" WF 28#

$\frac{l}{b} = \frac{17.75 \times 12}{6.5} = 32.7$

$f = \frac{M}{S} = \frac{45100 \times 12}{35.6} = 15200$

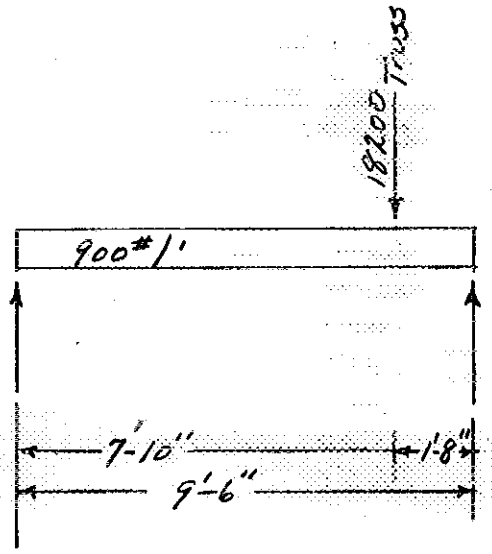
Try 10 WF 33

$\frac{l}{b} = \frac{17.75 \times 12}{7.96} = 26.8$ $f = 16000$ Allow.

$d = \frac{wl^3}{48EI} = \frac{9850 \times 17.8^3 \times 12^3}{30000000 \times 48 \times 170.9} = 0.39''$ O.K.

Use 10" WF 33 S = 35.0

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: B-4
Computed by: D. M. Checked by: Date:



$240 \times 9.5 \times 4.75 / (2 \times 9.5)$
$= 570$
240 Wall wgt. on beam
20 Beam wgt.
860 #/'

$R_R = 900 \times 4.75 + 7.83 \times 18200 / 9.5 = 19300$

$R_L = 900 \times 9.5 + 18200 - 19300 = 7500$

$M = 19300 \times 1.67 - 900 \times 1.67 \times 0.83 = 31000'\#$

$S = \frac{M}{f} = \frac{31000 \times 12}{18000} = 20.7$

Try 10" W.F. 21#

$\frac{l}{b} = \frac{9.5 \times 12}{5.75} = 19.5$ $f = 18400$ Allow.

Use 10" W.F. 21#

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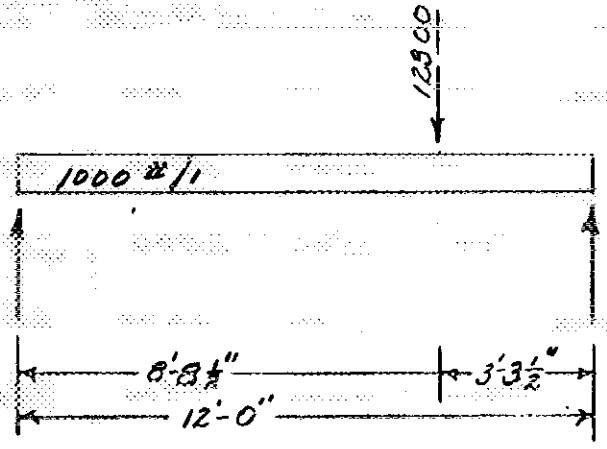
Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: B5
Computed by: D. M. Checked by: Date: [illegible] June 1944



240 x 12 x 6 / (2 x 12)
= 720 } Wall wgt. on
240 } beam
80 Beam Wgt.
1010

$R_R = 1000 \times 6 + 8.71 \times 12300/12 = 15000^{\#}$

$R_L = 9300^{\#}$

$M = 15000 \times 3.29 - 1000 \times 3.29 \times 1.65 = 44000'^{\#}$

$S = \frac{M}{f} = \frac{44000 \times 12}{18000} = 29.3$

Try 12" WF 25 $S = 30.9$

$\frac{l}{b} = \frac{12 \times 12}{6.5} = 22.2$ 17600 = f Allow.

$f = \frac{44000 \times 12}{30.9} = 17100^{\#}$

Use 12" WF 25

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Engine Room Columns

Computed by: D.M. & E.H. Checked by: Date: 16 June 1944

Description of Load	Col. No 5 & 12	Col No 6 & 11	Col. No. 13, 14, 15, 16	Col No. 7, 8, 9 & 10
Dead Load excl. Catwalk-Truss	8700	8200	13000	12200
Catwalk-Truss	3300	2000	5000	3000
Snow Load Roof	1500	1500	2300	2300
Dead Load, Wall above Bot. Flange of Eave Struts	3300	3300	6600	6600
Crane Load	9400	9400	9400	9400
Impact Load-Crane	2200	2200	2200	2200
Lateral Crane Force	700	700	700	700
Impact Lateral Force	200	200	200	200
Total	29300	27500	39400	36600
Beam Load, Col. No 5 Only	19300			
Beam Load, Col. No. 14 Only				9300
Beam Load, Col. No. 15 Only				15000
Beam Load, Col No. 16 Only				7500
Wall Wind Load 12x8.5x10 Acts at Top of Col.	500	500	1000	1000
Axial Wind Load Roof	1400	1400	2900	2900
Hor. Wind Load Roof	1000	1000	2100	2100

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Columns 1, 2, 3, & 4
Computed by: W. E. H. Checked by: Date: 16 June 1944

Col No.	Axial Load	Eccen. Load
1		12800
2	8800	11100
3	12100	
4	9600	

Try 8" WF 17# $A = 5.00$ $I = 56.4$
$r = 1.16$ $S = 14.1$

$$\frac{l}{r} = \frac{10 \times 12}{1.16} = 104$$

$f = 11800\#/\square''$ Allow.

$$f = \frac{P}{A} + \frac{M}{S} = \frac{19900}{5.0} + \frac{11100 \times 4}{14.1} = 7100\#/\square''$$

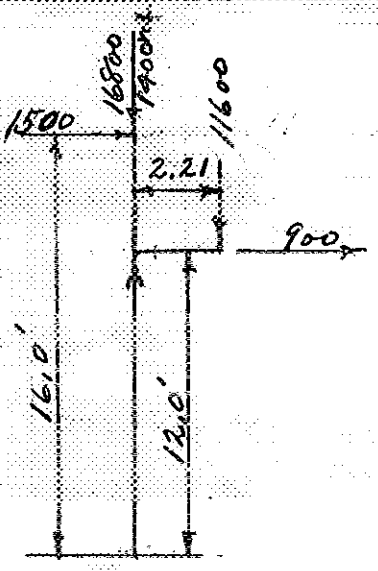
Use 8" WF 17# for Columns 1, 2, 3, & 4

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Engine Room Columns
Computed by D. M. & E. H. **Checked by** ..... **Date** 12 June 1944.

Cont. from P 59

Col. No. 5 & 12

Col 12 only W.L. 1500



$$f = \frac{P}{A} + \frac{M}{S} = \frac{28400}{14.4} + \frac{11600 \times 2.21 \times 12}{54.6} + \frac{900 \times 12 \times 12}{54.6} = 9970$$

Try 10" WF 49 $S = 54.6$ $A = 14.4$
$r = 2.54$

$$\frac{l}{r} = \frac{16 \times 12}{2.54} = 75.5 \quad f = 14200 \text{ Allow.}$$
$$f = 18900 \text{ Allow. with Wind.}$$

Wind

$$\text{Additional } f = \frac{2000}{14.4} + \frac{1500 \times 16 \times 12}{54.6} = 5400$$

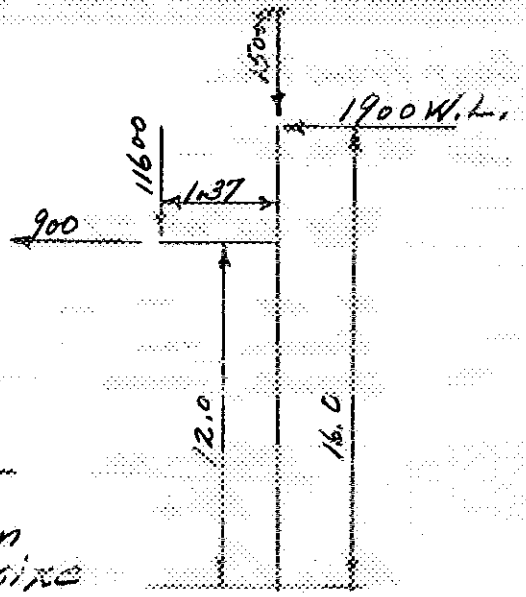
Total $f = 10000 + 5400 = 15400$ #/□"

Use 10" WF 49 $S = 54.6$ $A = 14.4$ $r = 2.54$

Subject Bushnell Park Pumping Station Hartford Conn.
Computation Engine Room Columns.
Computed by D.M.T.E.H. Checked by ____ Date 16 June 1944

Cont. from P 61

Col. No. 6 & 11



Use 10" WF 49 S = 54.6 A = 14.4

These columns are larger than necessary but taken the same size as columns 5 & 12.

Subject: Bushnell Park Pumping Station Hartford Conn.
Computation: Engine Room Columns
Computed by: D.M. & E.H. Checked by: Date: 16 June 1944

Cont. from P62

Col 13, 14, 15, 16

Try 10" WF 49

Wind 3100 × 16.25 — 50400
Crane 900 × 12.2 — 11000
Crane [14000 − 3500 × 1.37] 2.21/2 — 13200
74600 #

$$\frac{74600 \times 12}{54.6} = 16500\ \#/\square''$$

Max fiber stress on column 16500 + 4400 = 21000 #/□"

$$\frac{16500}{24800} + \frac{4000}{18900} = 0.67 + 0.21 = 0.88 \text{ O.K.}$$

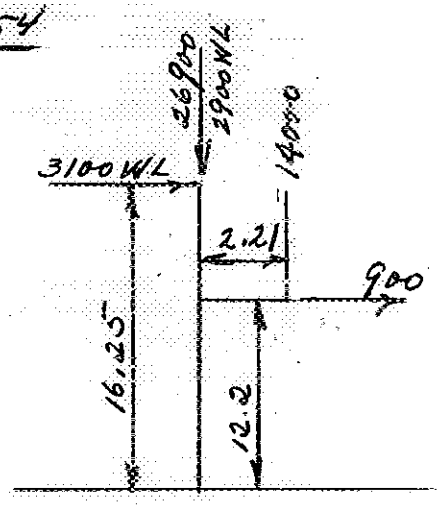
$$\frac{l}{r} = \frac{16.25 \times 12}{2.54} = 76$$

f = 14200 Allow
14200 × 4/3 = 18900 #/□"

$$\frac{l}{b} = \frac{16.25 \times 12}{10} = 19.5$$

f = 18600 Allow.
18600 × 4/3 = 24800

Use 10" WF 49 # S = 54.6 A = 14.4 r = 2.54



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

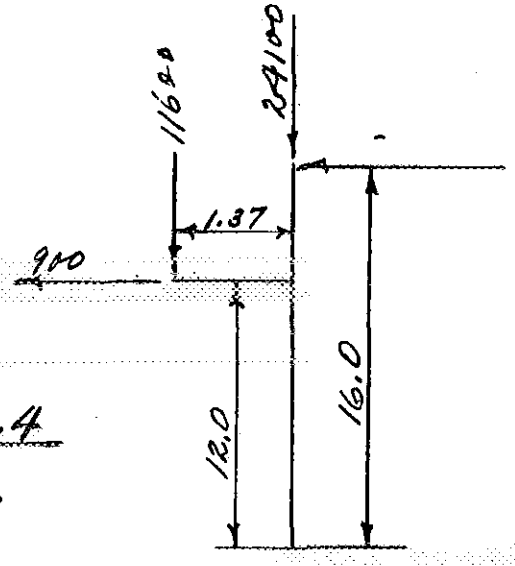
Subject: Bushnell Park Pumping Station, Hartford Conn.

Computation: Engine Room Columns

Computed by: D.M.T.E.H. Checked by: Date: 16 June 1944

Cont from # 63

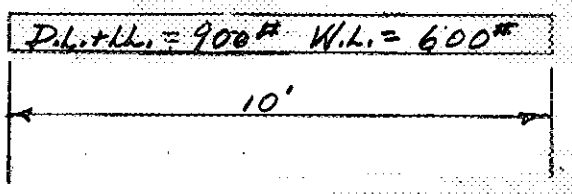
Col 7, 8, 9, + 10



Use 10" WF 49# S=54.6 A=14.4

These columns are larger than necessary but taken the same size as columns 13, 14, 15, + 16.

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Rafters over Store Room
Computed by: D.M. Checked by: Date: 19 June 1944



Design Data.

2" Plank 5.2#/□'
2" Slate 27#/□'
Snow Load 10#/□'
Wind Load 20#/□'
Rafters 4.1#/l. 3'-0" C.C.

Load Normal to rafter

Dead Load $10 \times 3 \times 32.2 \times .677 + 10 \times 4.1 \times 0.677 = 700^{\#}$
Live Load $10 \times 3 \times 10 \times 0.677 = 200^{\#}$
Wind Load $10 \times 3 \times 20 = 600^{\#}$

Load Tangential to Rafter

Dead Load $10 \times 3 \times 32.2 \times 0.738 + 10 \times 4.1 \times 0.738 = 750$
Live Load $10 \times 3 \times 10 \times 0.738 = 220$

Try a 3"x 6" Rafter $S = 13.8$ $I = 38.9$

$f = \frac{M}{S} = \frac{900 \times 10 \times 12}{8 \times 13.8} = 980$ D.L. + L.L. 1400 Allow.

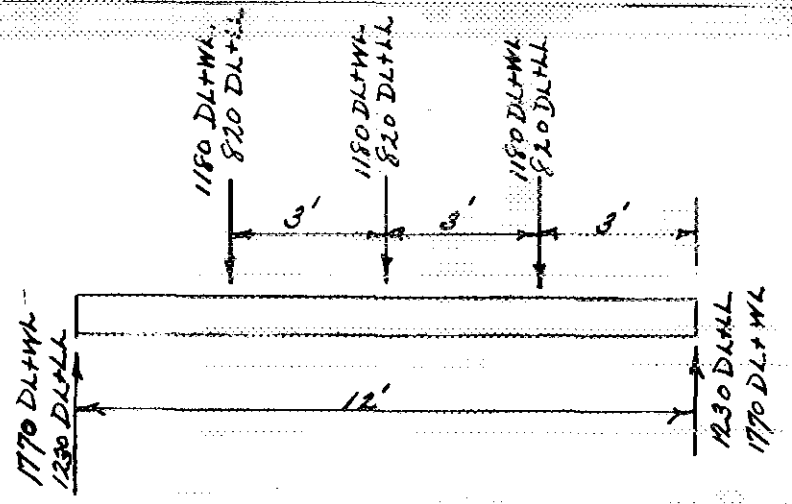
$f = \frac{M}{S} = \frac{1500 \times 10 \times 12}{8 \times 13.8} = 1600^{\#}$ D.L.+L.L.+W.L. 2100 Allow.

$d = \frac{5}{384} \frac{wl^4}{EI} = \frac{1500 \times 10^3 \times 12^3 \times 5}{38.9 \times 1600000 \times 384} = 0.55''$

$\frac{10 \times 12}{180} = 0.67''$ Allow.

Use 3"x6" Rafters 3'-0" C.C.

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Purlins over Store Room
Computed by: L.M. Checked by: Date: 20 June 1944



Load on Purlin from each Rafter
Normal to roof

D.L. $3 \times 9.0 \times (5.2 + 27 + 3.0) \times 0.677 = 640$
L.L. $3 \times 9.0 \times 10 \times 0.677 = 180$
W.L. $3 \times 9.0 \times 20 = 540$

Load ∥ to rafters

D.L. $3 \times 9.0 \times 35.2 \times 0.738 = 700$
L.L. $3 \times 9.0 \times 10 \times 0.738 = 200$

Try 6"×8" $S = 51.6$ $I = 193$

$$f = \frac{M}{S} = \frac{(1230 \times 6 - 820 \times 3)\,12}{51.6} = 1150 \text{ \#/□"} \quad \text{D.L.+L.L.}$$

$$f = \frac{M}{S} = \frac{(1770 \times 6 - 1180 \times 3) \times 12}{51.6} = 1650 \text{ \#/□"} \quad \text{D.L.+W.L.}$$

$$d = \frac{wl^3}{48EI} + \frac{Wa}{24EI}(3l^2 - 4a^2) = \frac{1180 \times 12^3 \times 12^3}{48 \times 1600000 \times 193} + \frac{1180 \times 3 \times 12}{24 \times 1600000 \times 193}(3 \times 12^2 - 4 \times 36^2)$$

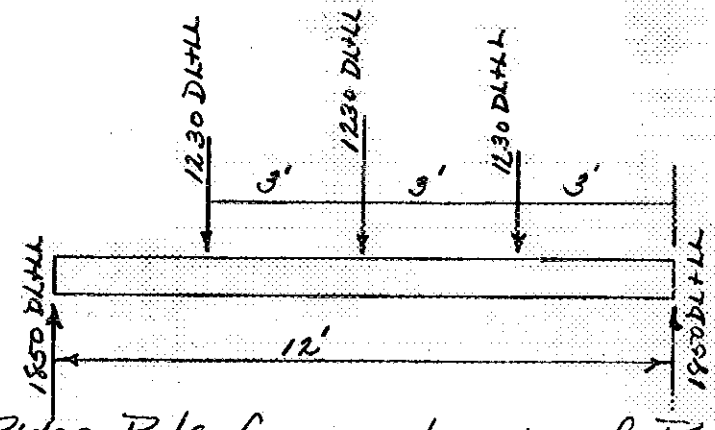
$$= 0.57''$$

$$d = \frac{12 \times 12}{180} = 0.8 \text{ Allow.}$$

Use 6"×8" Purlins $S = 51.6$ $I = 193$

Assumption 2" Plank is stiff enough to transmit tangential component of roof load into purlins only where purlins are directly over trusses.

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Connection to Truss at Peak in Storeroom
Computed by: D. M. Checked by: Date: 22 June 1944



Load on Ridge Pole from each pair of Rafters

$DL = 3 \times 9.0 \times (5.2 + 2.7 + 3.5) = 96.0$

$L.L. = 3 \times 9.0 \times 10 = 270$

$W.L. = 3 \times 9.0 \times 20 \times 0.677 = 370$

Assume Total Load Taken by Ridge Pole 2"×12"

$$f = \frac{(1850 \times 6 - 1230 \times 3)\,12}{35.8} = 2400 \ \#/\square'' \qquad f \text{ for Ridge Pole}$$

Assume Ridge Pole Distributes Load from Rafters uniformly on 6×6 beneath it and 6×6 carries entire Load.

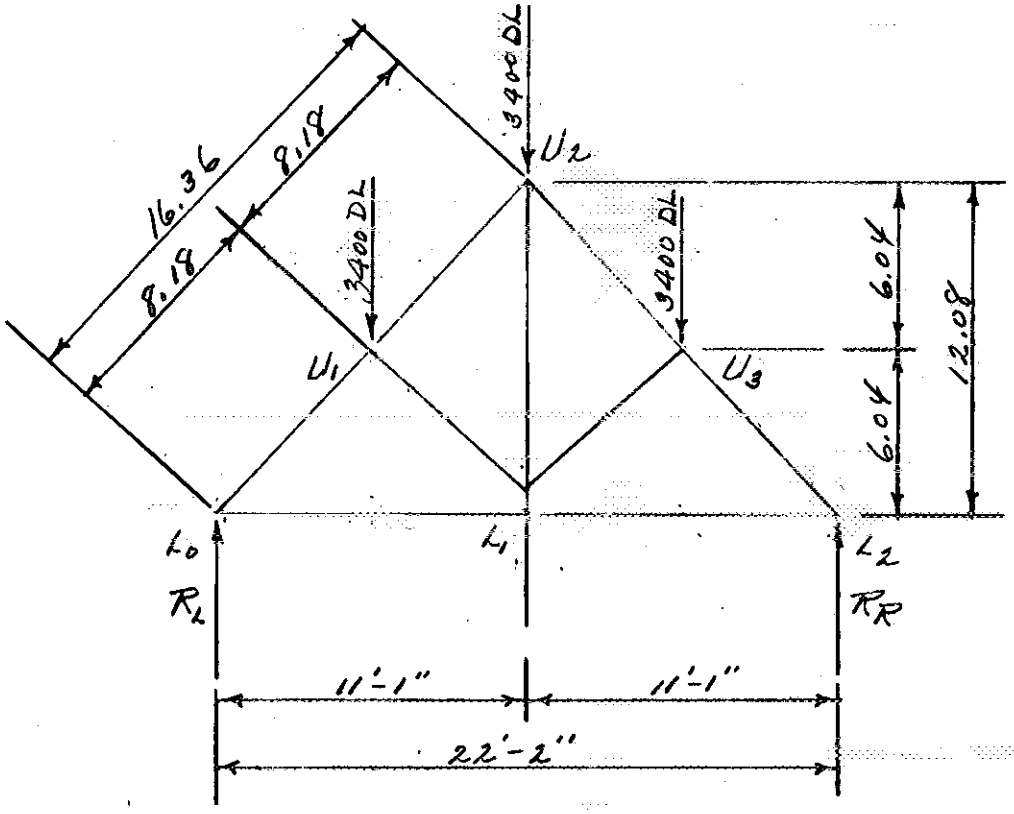
$$f = \frac{3700 \times 12 \times 12}{8 \times 27.7} = 2400 \ \#/\square'' \qquad f \text{ for } 6''\times 6'' \text{ beam}$$

It cannot be determined what proportion of the load the ridge pole or the 6×6 beam under it will carry. Lumber is not straight and one member might be overstressed before the other began to act. For this reason, <u>use 3"×12" Ridge Pole</u>.

$$f = \frac{(1850 \times 6 - 1230 \times 3)\,12}{57.9} = 1530 \ \#/\square''$$

Ridge Pole O.K. for deflection & shear.

Subject Bushnell Park Pumping Station, Hartford, Conn.
Computation Direct Stress in Truss Members over Store Room
Computed by D. M. **Checked by** ..... **Date** 22 June 1947

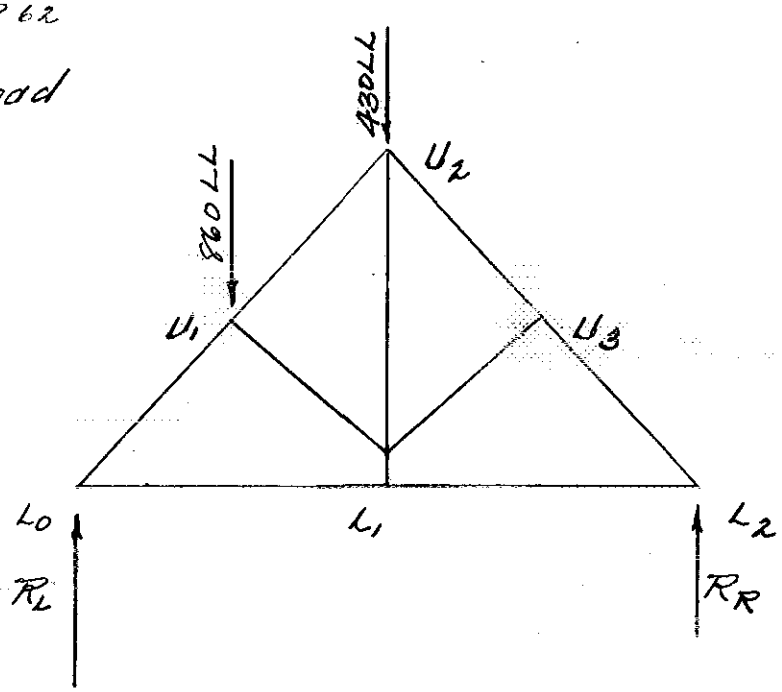


Truss Member	Dead Load	Live Load Lt.	Live Load Rt.	Wind Load Lt	Wind Load Rt.	Design Stress
$L_0 U_1$	-6900	-1500	-900	-900	-1700	-9300
$U_1 U_2$	-4400	-900	-900	-900	-1700	-6200
$U_2 U_3$	-4400	-900	-900	-1700	-900	-6200
$U_3 L_2$	-6900	-900	-1500	-1700	-900	-9300
$L_0 L_1$	+4700	+1000	+600	+1800	-100	+6300
$L_1 L_2$	+4700	+600	+1000	-100	+1800	+6300
$L_1 U_1$	-2300	-600	0.	-1700	0	-3100
$L_1 U_2$	+3100	+400	+400	+500	+500	+3900
$L_1 U_3$	-2300	0	-600	0	-1700	-3100

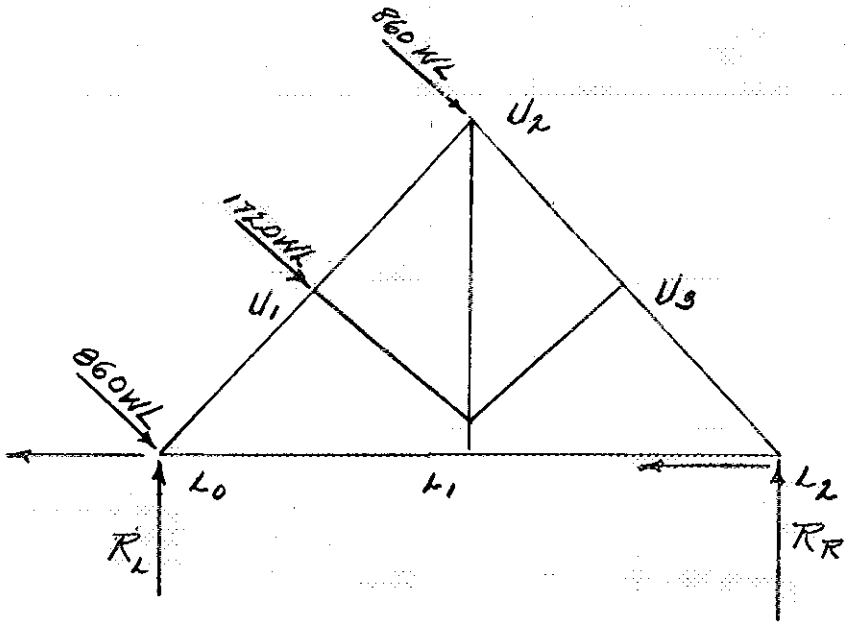
Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Direct Stress in Truss Members over Store Room
Computed by: D. M. Checked by: Date: 27 June 1944

Cont. from P 62

Live Load



Wind Load



Subject: Bushnell Park Pumping Station, Hartford Conn.
Computation: Direct Stress in Truss Members over Store Room
Computed by: D.M. Checked by: Date: 24 June 1944

Cont. from P 62A

U_1 & U_3 & U_2

Dead Load	$8.2 \times 10.5 \times 35.7 + 300 = 3400$
Live Load Left	$8.2 \times 10.5 \times 10 = 860$
Wind Load Left	$8.2 \times 10.5 \times 20 = 1720$

D.L. $R_L = R_R = 5100^{\#}$
L.L. Lt. $R_L = 1080^{\#}$ $R_R = 650$
W.L. Lt. $22.2 R_R - 1720 \times 8.2 - 860 \times 16.4 = 0$ $R_R = 1270$
$\therefore R_L = 3440 \times 0.738 - 1270 = 1270^{\#}$

D.L. $L_0U_1 = 5100/0.738 = 6900$ C
L.L. Lt. $L_0U_1 = 1080/0.738 = 1500$ C
W.L. Lt. $L_0U_1 = (1270 - 860 \times 0.677)/0.738 = 900^{\#}$ C

D.L. $L_2U_3 = 5100/0.738 = 6900$ C
L.L. Lt. $L_2U_3 = 650/0.738 = 900$ C
W.L. Lt. $L_2U_3 = 1270/0.738 = 1700$ C

D.L. $L_0L_1 = 5100 \times 677/738 = 4700$ T
L.L. Lt. $L_0L_1 = 1080 \times 677/738 = 1000$ T
W.L. Lt. $L_0L_1 = 1270 \times 677/738 + 1300 - 860 \times 0.738 = 1800$ T

D.L. $L_1L_2 = 5100 \times 677/738 = 4700$ T
L.L. Lt. $L_1L_2 = 650 \times 677/738 = 600$ T
W.L. Lt. $L_1L_2 = 1270 \times 677/738 - 1300 = 100$ C

Assumption: H Reaction from Wind Load divided evenly between L_0 & L_2

D.L. L_1U_1 $3400 \times 0.677 = 2300$ C
L.L. Lt. L_1U_1 $860 \times 0.677 = 600$ C
W.L. Lt. L_1U_1 $1720^{\#}$ C

D.L. L_1U_3 $3400 \times 0.677 = 2300$ C
L.L. Lt. L_1U_3 0
W.L. Lt. L_1U_3 0

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Direct Stress in Truss Members over Stage Room
Computed by: D. M. Checked by: Date: 24 June 1944

Cont from P 63

DL	$U_1 U_2$	$6900 - 3400 \times 0.738 = 4400$ C
LL Lt.	$U_1 U_2$	900 # C
W.L. Lt.	$U_1 U_2$	900 # C
DL	$U_2 U_3$	4400 C
LL Lt	$U_2 U_3$	900 # C
W.L. Lt.	$U_2 U_3$	1700 # C
D.L.	$L_1 U_2$	$8800 \times 0.738 - 3400 = 3100$ T
L.L. Lt	$L_1 U_2$	$600 \times 0.677 = 400$ T
W.L Lt.	$L_1 U_2$	$720 \times 0.677 = 500$ T

Wherever errors in stresses occur because of errors in L.L. Reactions, the errors are small and on the safe side

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Truss Member Design over Store Room
Computed by: D.M. Checked by: ✓ Date: 26 June 1949

Cont. from P 64

L_1U_1, L_1U_2, L_1U_3 6"×8"

$L_1U_1 = L_1U_3 = 3100/41 = 75^{\#}/\square''$

$\frac{l}{b} = \frac{8\times12}{6} = 16$ $750^{\#}/\square''$ Allow.

$L_1U_2 = 3900/35 = 110^{\#}/\square''$

L_0L_1, L_1L_2 8×10

$L_0L_1 = L_1L_2 = 6300/50 = 130^{\#}/\square''$

f due to bending is small (Caused only by weight of bottom cord) ✓

L_0U_1, U_1U_2, U_2U_3, U_3L_2, 8"×10"

$f = \frac{P}{A} = \frac{9300}{48.8} = 190^{\#}/\square''$

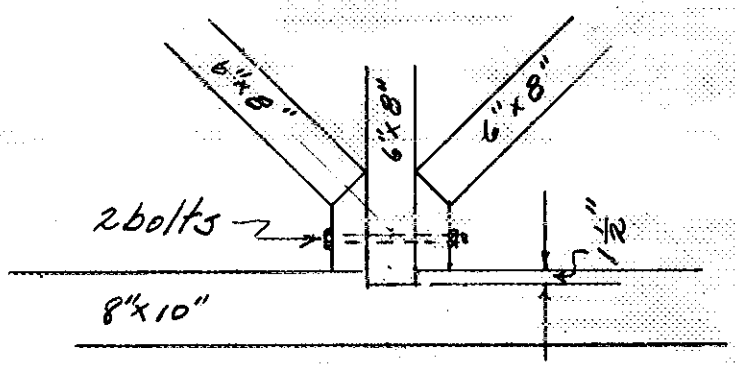
$\frac{l}{b} = \frac{8.2\times12}{6.5} = 15$ $f = 1140^{\#}/\square''$ Allow.

Assumption: Bottom Purlin takes entire tangential load from roof.

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Truss Joint Design over Store Room
Computed by: D. M. Checked by: Date: 28 June 1944

Cont. from P 65

L_1



Hor. Force on $L_1 U_2$ due to wind = 1700 × 0.738 = 1300#

Comp. Stress = 1300/(1.5 × 7.5) = 120 #/□" Allow. 350 #/□"

Vertical loads from $L_1 U_1$ + $L_1 U_3$ carried directly in $L_1 U_2$ by bolts.

Vertical Load = 3900#

Allow. Load on each bolt = 2359 Use 2 bolts 3 3/4" Apart

U_2

Vert. Component of Design Load in $U_1 U_2$ = $U_2 U_3$ = 6200 × 0.738 = 4600#

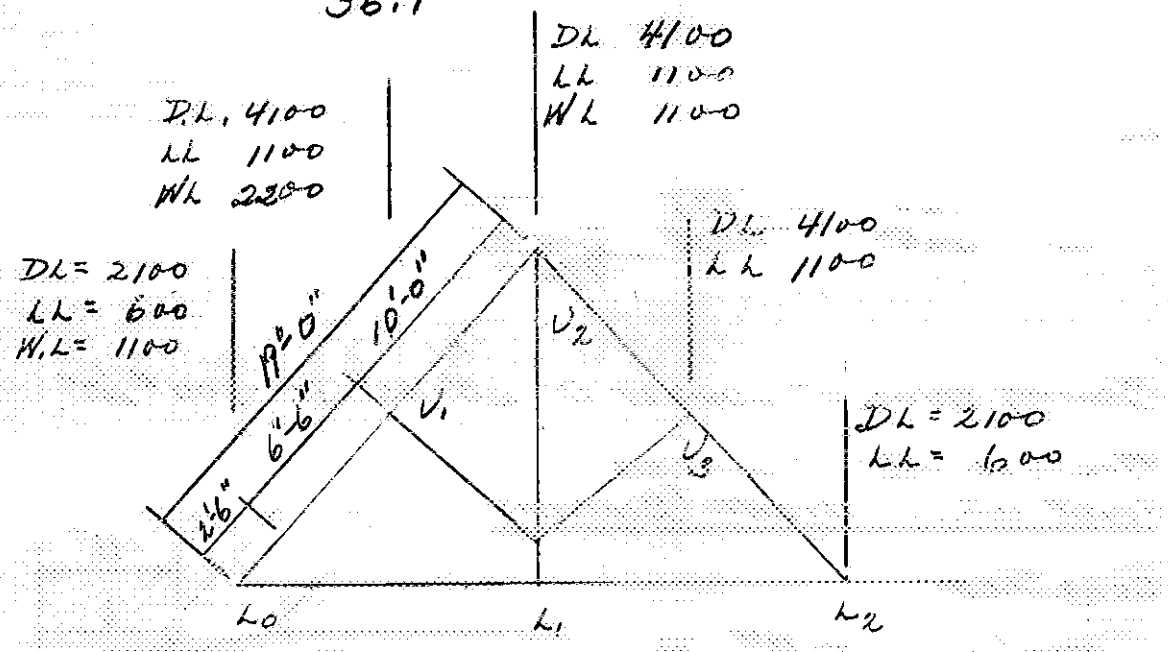
Use 2 No. 2 4" Split ring connectors, (one each side of $L_1 U_2$)

Subject: Bushnell Park Pumping Station Hartford Conn.
Computation: Top and Bottom Cord Truss Joint – Store Room
Computed by: D. M. Checked by: Date: 28 July 1941

Load / □' on Roof

Slate	27 #
Plank	5.2
Rafter	1.9
Purlins	2.0
	36.1

D.L. – Truss	36.1 #/□'
L.L.	10 #/□'
W.L	20 #/□'



U_2

DL = 10.5 × 10 × 36.1 = 3800 3800 + 300 = 4100
LL = 10.5 × 10 × 10 = 1050
W.L = 10.5 × 10 × 10 = 1050

$U_1 = U_3$

DL = 10.5 × 10 × 36.1 = 3800 3800 + 300 = 4100
LL = 10.5 × 10 × 10 = 1050
W.L. = 10.5 × 10 × 10 = 1050

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Top and Bottom Cord Truss Joint - Store Room
Computed by ..... Checked by ..... Date .....

$L_0 U_1$

DL. 8250/0.738 = 11200
LL. 2250/0.738 = 3050
14250 #

$L_0 L_1$

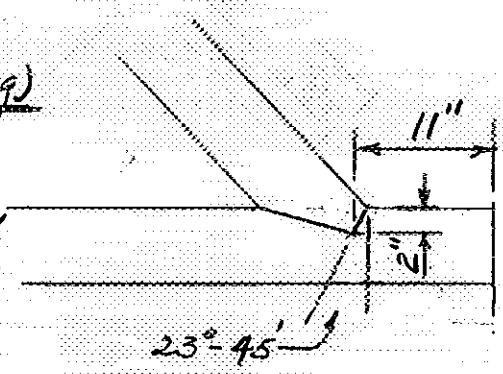
DL. 8250 × 677/738 = 7600
LL. 2250 × 677/738 = 2100
9700

Bearing value of Lumber θ = 23°-45' is 800 #/□"

9700/600 = 16 □" required
Joint O.K. as drawn (Bearing)

Long. Shear

9700/120 = 81 □" Required



Check of Bending in bottom cord

$M = 10\,500 \times 7 = 73500$ "#

$S = \frac{M}{f} = \frac{73500}{1200} = 61$ 2" notch OK

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
Page 298 C

Subject: Bushnell Park Pumping Station Hartford Conn.
Computation: Purlin Connection to Top Cord - Store Room
Computed by: D. M. Checked by: Date: 30 Oct. 1944

Center Trusses

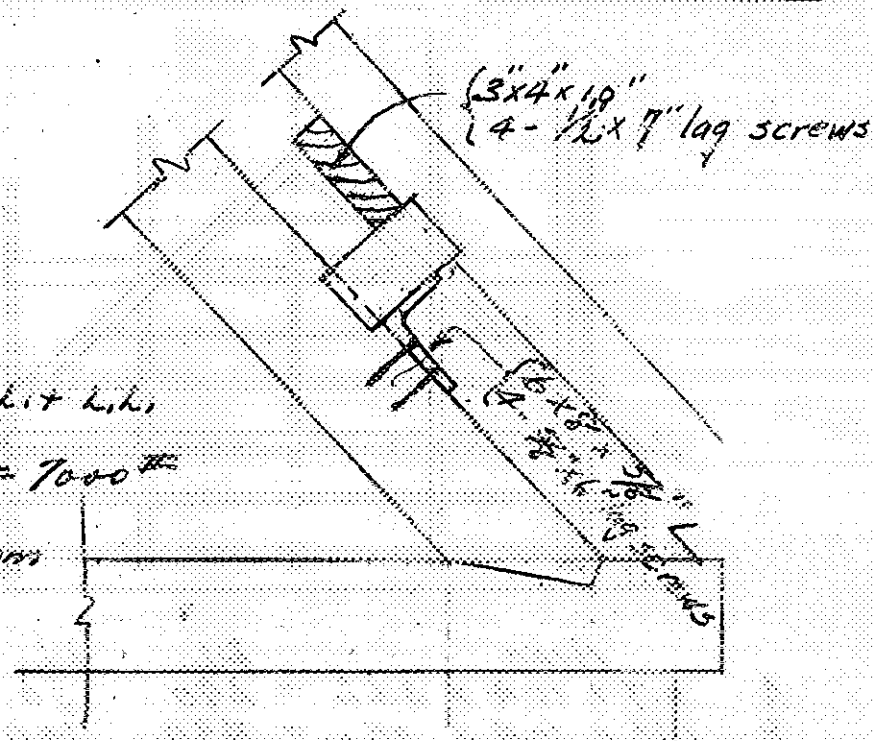
D.L. 36.1 #/□'
L.L. 10
46.1 #/□'

19 × 46.1 = 875 #/'

10.5 × 875 = 9200 # D.L. + L.L.

Tang Load = 9200 × 0.738 = 7000 #

3500 # each, bottom and middle purlins



Try 6×8×1/2" L

$$f = \frac{3500 \times 2.5 \times \frac{1}{4} \times 12}{7.5 \times \left(\frac{1}{2}\right)^3} = 28000 \text{ \#/□"}$$

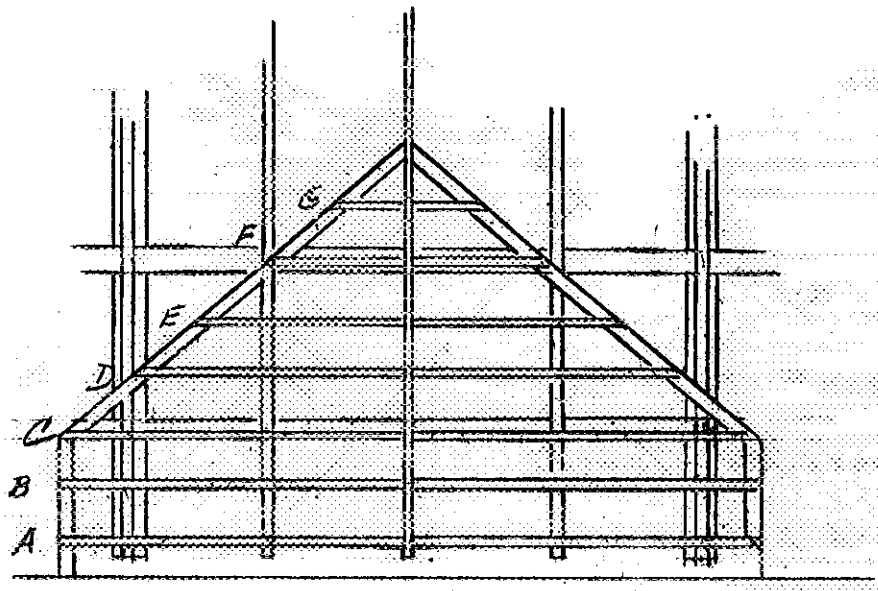
Try 6×8×3/4" L

$$f = \frac{3500 \times 2.25 \times \frac{3}{4} \times 12}{7.5 \times \left(\frac{3}{4}\right)^3} = 11000 \text{ \#/□"}$$

Use 6×8×5/8" L

$$\frac{3500 \times 2.37 \times 6}{7.5 \times \left(\frac{5}{8}\right)^2} = 17000 \text{ \#/□"}$$

Subject: Bushnell Park Pumping Station, Hartford, Conn.
Computation: Gable end over Store Room Doors
Computed by: D.M. Checked by: Date: 30 June 1944



	Area	DL.	LL.	Total
A	0.7 × 10.4 × 35.2 =	240	70	310
B	1.33 × 10.4 × 35.2 =	490	140	630
C	1.33 × 10.4 × 35.2 =	490	140	630
D	1.33 × 8.4 × 35.2 =	390	110	500
E	1.33 × 6.3 × 35.2 =	300	80	380
F	1.33 × 4.2 × 35.2 =	200	60	260
G	1.33 × 2.1 × 35.2 =	100	30	130

$LL = 10 \times DL / 35.2$

The slate on the gable end would weigh the same as the slate omitted on the roof under the gable end.

Considering the additional load caused only by the weight of lumber in the gable end, the shortened rafter span under the gable end, the shorted distance between purlins and the low fiber stress in the rafters and purlins, the truss member sizes, the rafter size and the purlin size need not be changed.

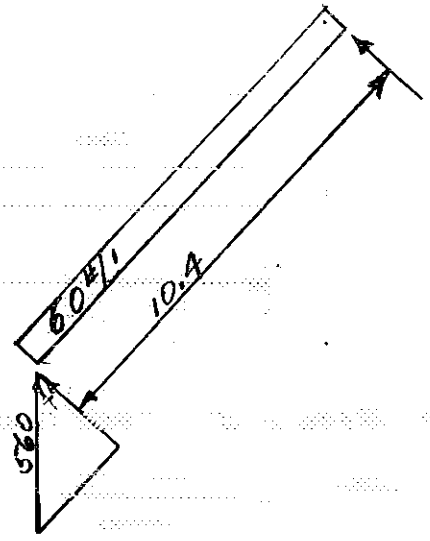
Top Cord Check for Bending
Load at intermediate purlin Normal to Roof
$= 6 \times 4.1 \times 5.5 \times 0.677 = 900$
Assume Load halfway between panel points
$f = \frac{900 \times 4.1 \times 12 \times 4.5}{2 \times 536} = 200 \#/\square''$ O.K.

Project Bushnell Park Pumping Station, Hartford, Conn.
Computation Rafters in gable end over Store Room Doors
Computed by D.M. Checked by ..... Date 30 June 1944

Reaction
Normal $630 \times 0.677 = 430$
Tang. $630 \times 0.738 = 460$

Load/ft
Normal $60 \times 0.677 = 41$
Tang. $60 \times 0.738 = 44$

$$S = \frac{M}{f} = \frac{60 \times 10.4 \times 10.4 \times 12}{8 \times 1400} = 0.7$$



Try 2 x 6 Rafter

$$d = \frac{5wl^4}{384EI}$$

$$= \frac{5 \times 41 \times 10.4 \times 10.4^3 \times 12^3}{384 \times 1600000 \times 8.57} = 0.8'' \quad \frac{1}{160} \text{ Span}$$

Use 2"x8" Rafters in Gable end over Store Room Doors 16" C.C.

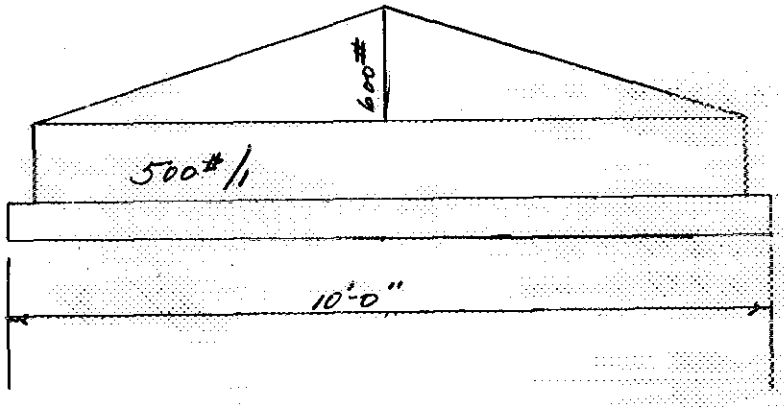
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Bushnell Park Pumping Station, Hartford, Conn

Computation Lintel over Store Room Doors

Computed by D.M. **Checked by** **Date** 1 July 1944



$M = 4000 \times 5 - 500 \times 5 \times 2.5 - 300 \times 5 \times 1.7 = 11200'^{\#}$

$S = \frac{M}{f} = \frac{11200 \times 12}{14800} = 9.1$

Try 2- 7" [s 9.8#

$d = \frac{5}{384} \frac{Wl^3}{EI} = \frac{5 \times 800 \times 10 \times 1000 \times 1728}{30 \times 42.2 \times 384} = 0.14''$ O.K.

Use 2-7" [s 9.8# and 8 x 8 x 3/8" Bearing Plates Welded to Channels

Assume 1/3 Total Load taken by L

$S = 3.03$

Use 6 x 3 1/2 x 3/8" L Supported by 1" x 1/4" x 6" Straps 18" O.C.

$d = 0.14+$ O.K.

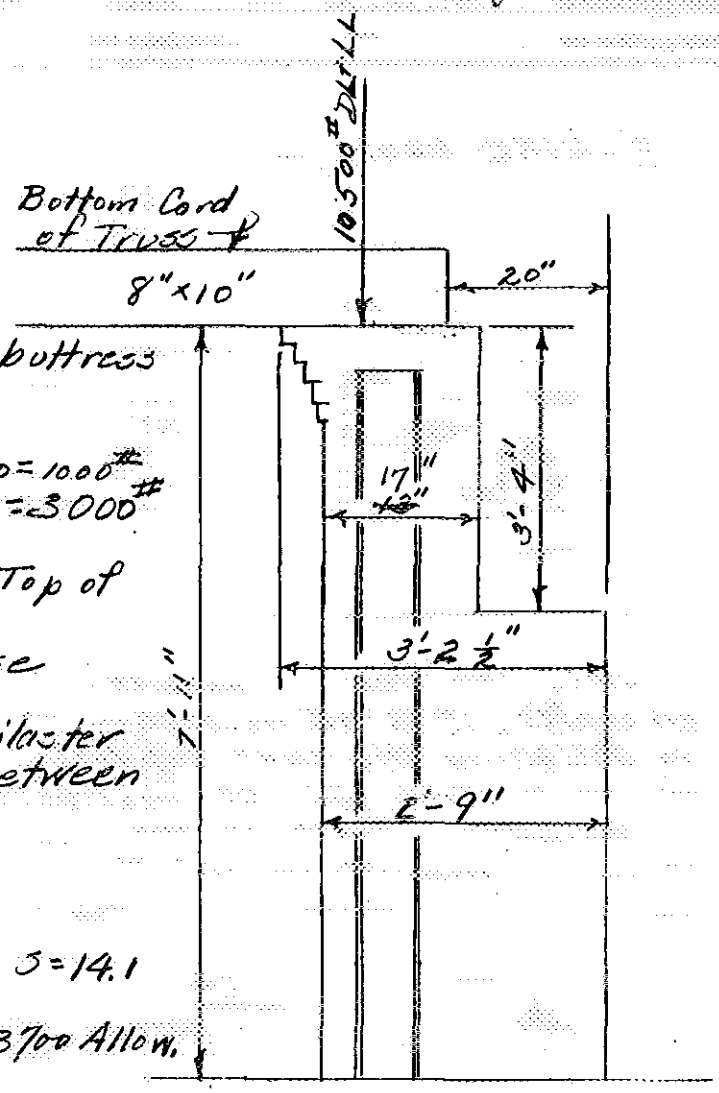
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station, Hartford, Conn.

Computation: Pilasters in Store Room

Computed by: D. M. Checked by: ..... Date: 3 July 1944



Assume all wind taken up on buttress on opposite side.

Load on Wall = 10.5×4.5×2.0 = 1000#
H. Load on Roof = 4000×0.738 = 3000#

Consider Section 3'-4" from Top of Pilaster
Resultant falls outside base

Use steel column inside pilaster and assume wind load split between both pilasters

$f = \frac{P}{A} + \frac{M}{S}$

Try 8" WF 17# A = 5.0 S = 14.1

$\frac{l}{r} = \frac{7.92 \times 12}{1.16} = 82$ f = 13700 Allow.

c = 4.75

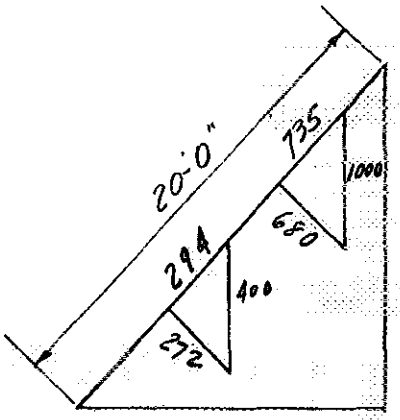
$f = \frac{10400}{5.0} + \frac{10400 \times 4.75}{14.1} + \frac{7.92 \times 12 \times 2000}{14.1} = 19000\ \#/\square''$

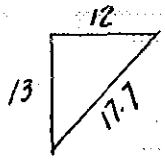
Use 8" WF 21#

Note
Truss to column detail changed, DL+LL are not eccentric.

Subject: BUSHNELL PARK PUMPING STATION
Computation: ANGLE SUPPORT FOR GYPSUM PLANK
Computed by: E. J. H. Checked by: Date: 29 SEPT. 1944

ENGINE ROOM ROOF (AT EAVES)

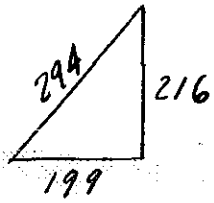




LOADS

	FINAL	DURING CONSTR.
Slate	27#	
Felt + pitch	1	1
Gypsum	16	16
Live	6	3
	50 #□'	20 #□'
Load per lin. ft =		
Total	1000 #	400#
Normal	680	272
Tang	735	294

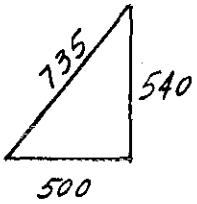
Since the slab is supported by purlins spaced 4' to 6' on center, it is not necessary to consider the normal component in designing the eave support. It is also assumed that the brick walls will be constructed before the slate roof is installed. Therefore the only roof load before brickwork is laid amounts to 20#/□'. This should be taken care of by the clips connecting gypsum to purlin.



$$\frac{294}{5 \text{ purlins}} = 60^{\#} \text{ per clip.}$$

Clips should take this.

After walls and slate roof are laid the 540# vertical load can be carried on brickwork.



$$\frac{3 \times 540}{3 \times 5} = 110^{\#}\ \square'' \text{ O.K.}$$

This leaves only the horizontal 500# load which is transmitted to eave strut.

Subject: BUSHNELL PARK PUMPING STATION
Computation: ANGLE SUPPORT FOR GYPSUM PLANK
Computed by: E.J.H. Checked by: Date: 29 SEPT. 1944

Try a 8" WF @ 17# with 8" [@ 11.5# on top Flange

$$M = \frac{500 \times 12 \times 12}{8} = 9000'\#$$

I of [= 32.3
I of ½ WF = 3.4
4 | 35.7
8.9 = S

$$F = \frac{9000 \times 12}{8.9} = 12{,}000^{\#\square''} \text{ O.K}$$

Acting as a column

$$r = \sqrt{\frac{I}{a}} = \sqrt{\frac{49}{8.36}} = 2.42$$

$$\frac{l}{r} = \frac{144}{2.42} = 60 \qquad 15{,}000^{\#\square''} \text{ allowable.}$$

Subject: BUSHNELL PARK PUMPING STATION
Computation: STABILITY OF FOOTINGS
Computed by: E.J.H. Checked by: Date: 31 OCT. 1944

VERTICAL DEAD LOAD

Load per sq. ft. =

Slate =	27 #
Plank =	5
Rafter =	2
Purlins =	2
	36 #/'

Load on column =

36 x 10 x 18 =	6500 #
D.L. Truss	750
Total D.L. from roof =	7250 #
D.L. steel column -	170
	7420 #

D.L. Pilaster

2.75 x 1.33 x 8 x 120	3500 #

D.L. Floor carried by Footing

Load per sq. ft =

Brick	60 #
Sand	15
Concrete	75
	150 # x 2.5 x 4.5 = 1680 #

D.L. Brick wall + wall Footing

3.2 x .67 x 9 x 120 =	2320 #
3.2 x 1.3 x 3.0 x 150	1870
3.2 x .62 x 1.25 x 150	370
	4560 #

D.L. Concrete footing

4.5 x 5.5 x 1 x 150 =	3700 #
2.92 x 1.33 x .81 x 150 =	470
.58 x 2.5 x 1.16 x 150	250
.37 x 1.42 x 1.16 x 150 =	90
	4490 #

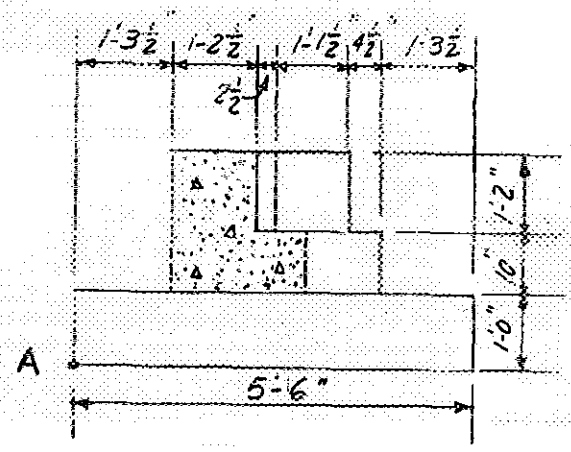
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

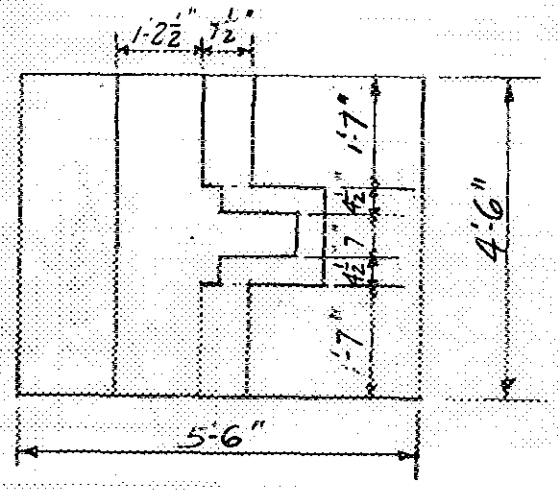
Subject: BUSHNELL PARK PUMPING STATION

Computation: STABILITY OF FOOTINGS

Computed by: E.S.H. Checked by: Date: 31 OCT 1944



ELEVATION



PLAN

POSITION OF RESULTANT (Moments about A)

Truss + column -	7400 x 2.08	=	15,400 '#
Pilaster	3500 x 3.0	=	10500
Floor load	1680 x 1.25	=	2100
Brick wall & Footing	4560 x 2.5	=	11400
Footing	4500 x 2.75	=	12400
	21640		51800 '#

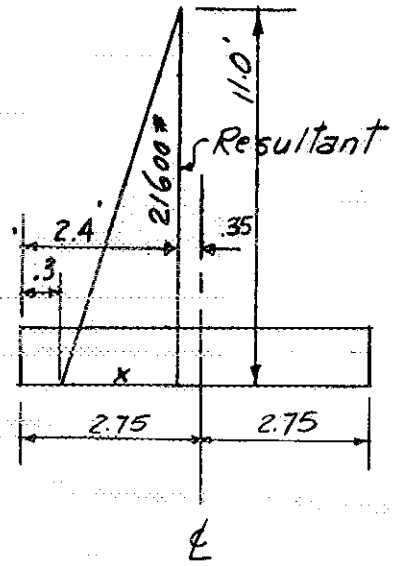
51800 ÷ 21640 = 2.4

WIND LOAD

Wind assumed at 20 #/□' horizontally

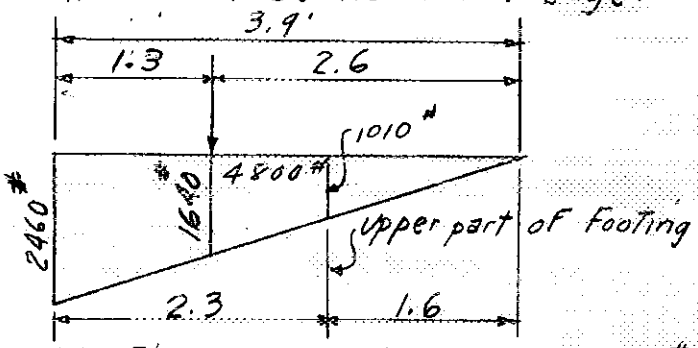
Wind load on roof = 15.5 x 10.5 x 20 =	3260
Wind load on sidewall 4 x 10.5 x 20 =	840
	4100 #

Subject: BUSHNELL PARK PUMPING STATION
Computation: STABILITY OF FOOTINGS
Computed by: E. J. H. Checked by: Date: 31 OCT. 1944



$$\frac{x}{11.0} = \frac{4100}{21600} = 2.1$$

Pressure is too close to edge of slab therefore footing will be increased 1'-0" on each side making slab 7'-6" wide. Pressure toe will then be 1.3 from edge.



Load per lin. ft. = 21600 ÷ 4.5 = 4800 #/ft.

$$\frac{3.9\,x}{2} = 4800\ \#$$

$$x = 2460\ \#$$

$$\frac{x}{2460} = \frac{1.6}{3.9}$$

$$x = 1010$$

$$\frac{x}{2460} = \frac{2.6}{3.9}$$

Subject: BUSHNELL PARK PUMPING STATION
Computation: STABILITY OF FOOTINGS
Computed by: E.J.H. Checked by: Date: 31 OCT. 1944.

BENDING MOMENT 2.3' FROM EDGE

$$(1010 \times 2.3 \times 1.15) + (1360 \times 2.3 \times 1.15 \times \tfrac{2}{3})$$
$$2675 + 2400 = 5100'\#$$

$$\sqrt{\frac{5100}{123}} = 6.5'' \quad \text{Depth is O.K}$$

$$\text{Shear} = 1010 \times 2.3 = \qquad 2300$$
$$\frac{2470-1010}{2} \times 2.3 = \qquad 1700$$
$$4000\ \#$$

$$A_s = \frac{5100 \times 12}{\frac{7}{8} \times 8 \times 18000} = .49 \quad \text{Use } \tfrac{5}{8}''\phi \text{ @ } 6'' = .62$$

$$\text{Bond} = \frac{4000}{2 \times 1.96 \times \frac{7}{8} \times 8} = 146\ \#\square''$$

$$\text{Unit Shear} = \frac{4000}{12 \times \frac{7}{8} \times 8} = 48\ \#\square''$$

OK use $\tfrac{5}{8}''\phi$ @ 6'

ADDITIONAL COMPUTATIONS

The following computations are for changes suggested by the Office, Chief of Engineers. The changes suggested involve moving the gate stands for the screening chamber gates, from the deck at El. 30.00 to El. 22.20. The pages of the original computations affected were revised as shown. Additional computations include figures for the aluminum framing to support gate stands, figures for the anchor bolts for the main crane columns and figures for the crane beams inadvertently omitted from the original computations.

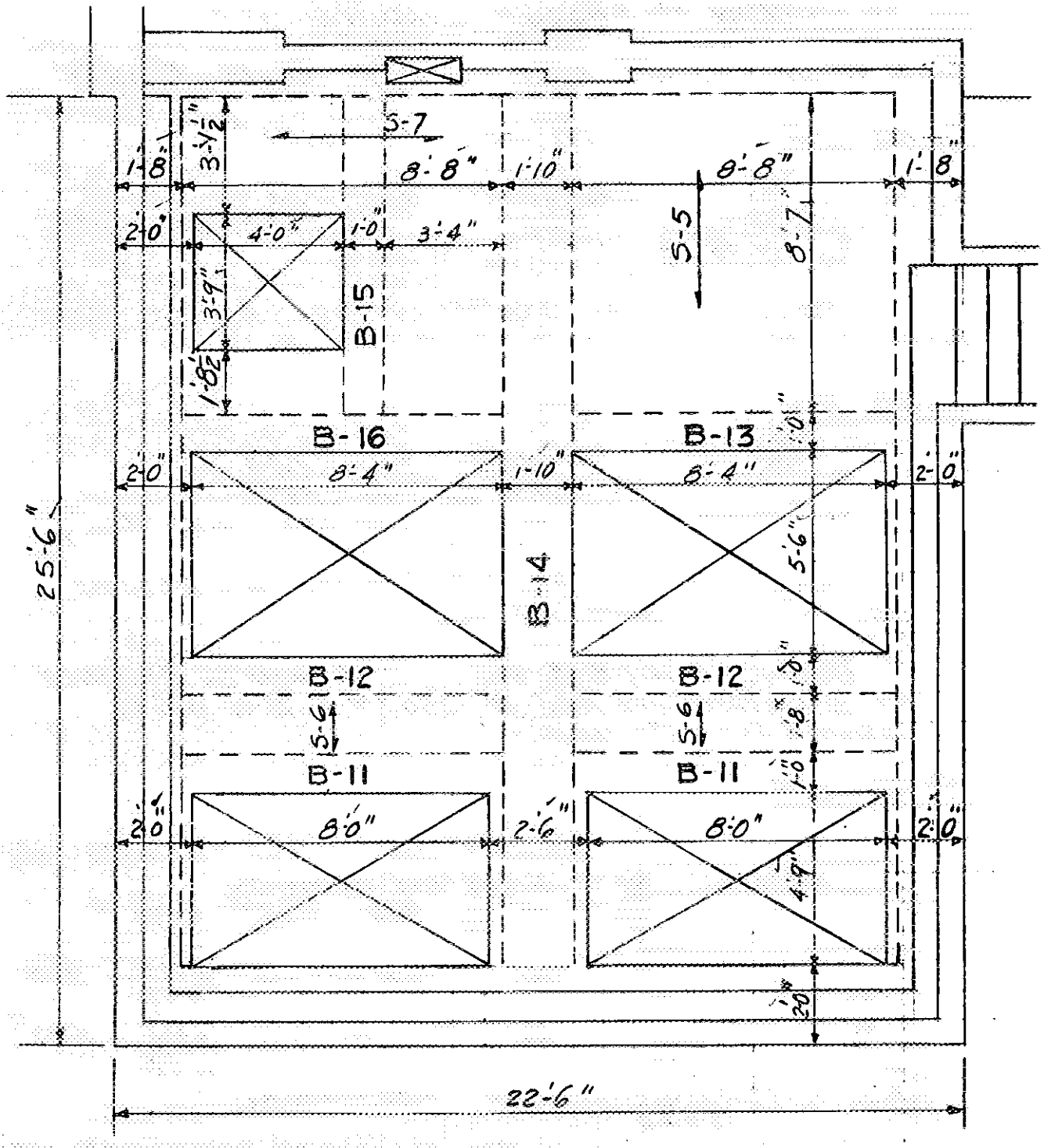
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject BUSHNELL PARK PUMPING STATION

Computation SCREENING CHAMBER ROOF SLAB & BEAMS

Computed by E.J.H. **Checked by** H.E.H. **Date** 2 NOV. 1945

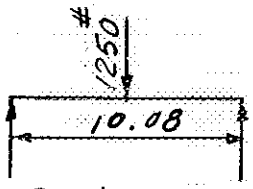


PLAN OF SCREENING CHAMBER FLOOR

DETERMINATION OF DESIGN LOADING

Gate weights 7500# equal 1250#/ft length of gate

SLAB S-5

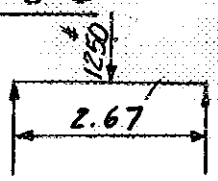


$M = 625 \times 5.04 = 3150^{\#}$

Equivalent uniform load =
$3150 = \frac{1}{8} \times W \times 10.08^2 \quad W = 250^{\#}/'$

Design S-5 for 250#/□' live load. Assume slab fixed at wall and simply supported at B-13

SLAB S-6

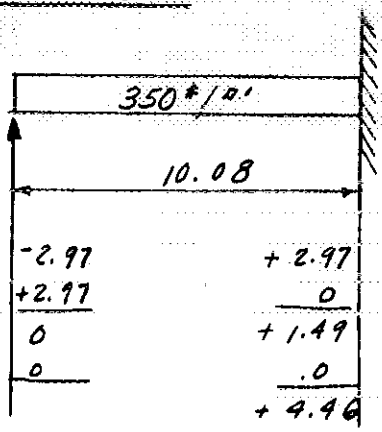


$M = 625 \times 1.34 = 840^{\#}$
Equivalent uniform load
$840 = \frac{1}{8} W \times 2.67^2 \quad W = 950^{\#}/'$

Design S-6 for 950#/□' live load and assume slab simply supported at ends.

Beams B-12, B-13, & B-15, B-16 will be designed for a uniform live load of 250#□'. B-11 will be designed for gate load.

SLAB S-5



Assume 8" slab - D.L. + L.L. = 100 + 250 = 350#/□'
Fixed end moments
$M = \frac{1}{12} \times 350 \times 10.08^2 = 2970'^{\#}$

$R_L = 350 \times 10.08 \times .5 - \frac{4460}{10.08} = 1320^{\#}$

$R_R = 350 \times 10.08 \times .5 + \frac{4460}{10.08} = 2210^{\#}$

$x_0 = 3.77'$ from R_L

$+M = 1320 \times 3.78 - 350 \times \frac{3.78^2}{2} = 2490'^{\#}$

req'd $d = \sqrt{\frac{4460}{139}} = 5.66 < 5.75$ O.K

$v = \frac{2210}{12 \times .9 \times 5.75} = 36^{\#}/\square''$ O.K

Subject: BUSHNELL PARK PUMPING STATION
Computation: SCREENING CHAMBER ROOF SLAB & BEAMS
Computed by: E.J.H. Checked by: J.S.M. Date: 6 NOV. 1945

SLAB S-5 (continued)

$-A_s = \frac{4460 \times 12}{20{,}000 \times .89 \times 5.75} = .52 \square''$ Use 5/8"φ @ 6"

$+A_s = \frac{2490 \times 12}{20{,}000 \times .89 \times 5.75} = .29 \square''$ Use 5/8"φ @ 1'-0"

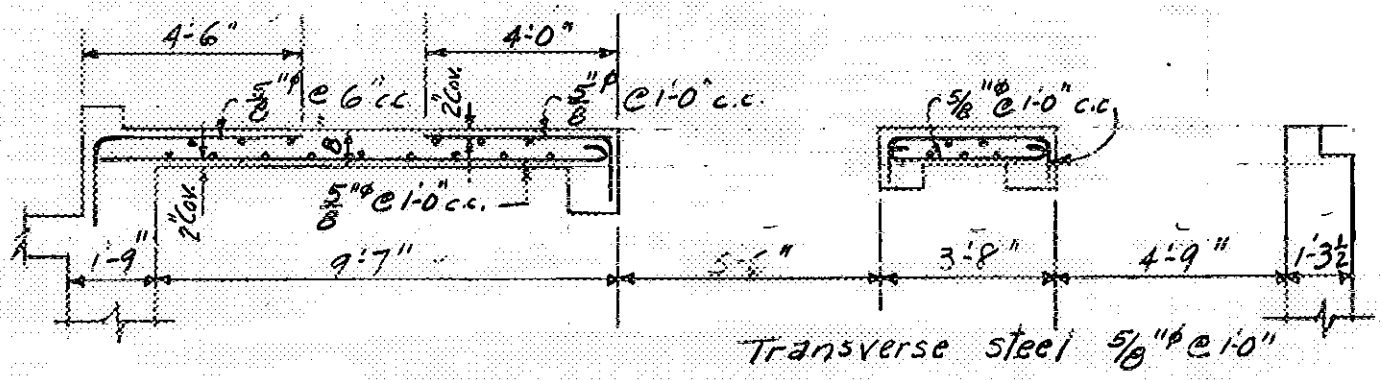
$u = \frac{2210}{3.93 \times .89 \times 5.75} = 110\#\square''$ O.K.

SLAB S-6

M = 840 Max Shear = Max Shear = 1250#

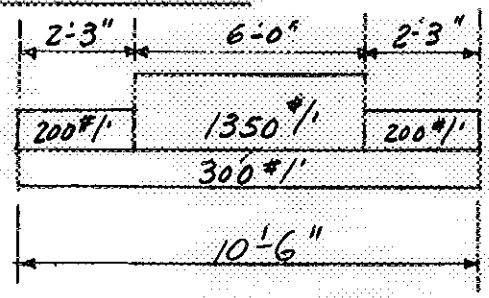
$A_s = \frac{840 \times 12}{20{,}000 \times .89 \times 5.75} = .09$ Use 5/8"φ @ 1'-0" Top + bottom

$u = \frac{1250}{1.96 \times .89 \times 5.75} = 125\#\square''$ O.K.



Subject BUSHNELL PARK PUMPING STATION
Computation SCREENING CHAMBER ROOF SLAB & BEAMS
Computed by E. J. H. **Checked by** H. M. **Date** 6 Nov. 1945

BEAM B-11



Assume area 1'-0" x 6'-0" loaded with gate and remaining area loaded with a live load equal to 100#/□'.

Gate load = 1250#/'
L.L. .83 x 100 = 83
1333 say 1350#/'

L.L. = 1.83 x 100 = 183 say 200#/'
D.L. Slab = 1.83 x 100 = 183
D.L. 12"x16" = 1.0 x .67 x 150 = 100
283 say 300#/'

$R_L = R_R$ = 300 x 10.5 x .5 = 1600
200 x 2.25 = 450
1350 x 6 x .5 = 4050
6100#

Max. M = 6100 x 5.25 - 500 x 2.25 x 4.12 - 1655 x 3 x 1.5 = 19900'#

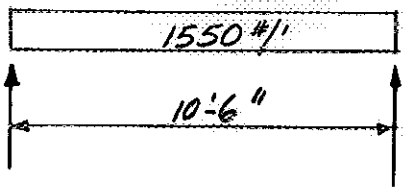
Req'd d = $\sqrt{\frac{19900}{116}}$ = 13.1" < 13.5"

$v = \frac{6100}{12 \times .89 \times 13.5}$ = 42#/□" O.K

$A_s = \frac{19900 \times 12}{20{,}000 \times .89 \times 13.5}$ = 1.0□" Use 3-3/4"ø bars

$w = \frac{6100}{7.07 \times .89 \times 13.5}$ = 72#/□" O.K.

BEAM B-12



D.L. cover plate = 15 x 2.75 = 41
D.L. 12"x16" Bm = 1 x .67 x 150 = 100
D.L. 8" Slab 100 x 1.83 = 183
L.L. = 250 x 4.58 = 1145
1469#/'

Original computations show load of 1550# and this load will be used.

$R_L = R_R$ 1550 x 5.25 = 8140#
M = $\frac{1}{8}$ x 1550 x 10.5^2 = 21360'#

req'd d = $\sqrt{\frac{21360}{116}}$ = 13.5" O.K.

WAR DEPARTMENT

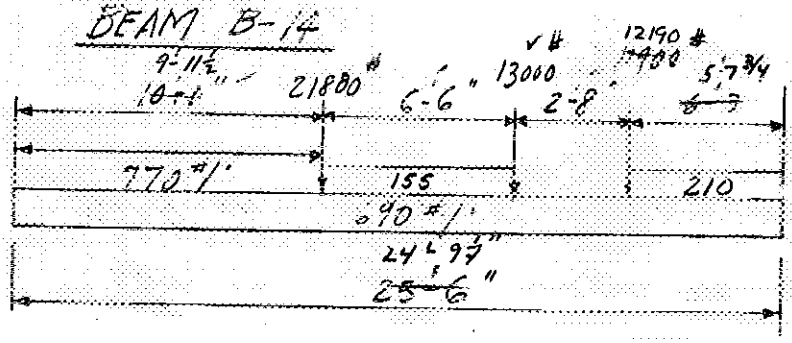
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject BUSHNELL PARK PUMPING STATION

Computation SCREENING CHAMBER ROOF SLAB & BEAMS

Computed by E. J. H. **Checked by** H. E. W. **Date** 7 NOV. 1945

BEAM B-14



For Beam B-14 live load will be reduced to 200 #/□'

Try 22" x 38" Beam

D.L. = 1.83 x 2.5 x 150 = 690#/'

D.L. Slab = 2.58 x 100 = 258#

L.L. Slab = 2.58 x 200 = 516

774#/'

Load concentration at B-13 & B-16

B-13 L.L. = 8.04 x 200 = 1610

D.L. = 41 + 162 + 529 = 732

2342#

Total load = $\frac{10.5}{2}$ x 2340 = 12300#

B-12

L.L. = 200 x 4.58 = 916

D.L. = 41 + 100 + 183 = 325

1240#

Total load = 1240 x 10.5 = 13000#

B-16

200 x 5.92 x 4.29 = 5080#

100 x 5.92 x 4.29 = 2540

125 x 4.29 = 540

8200 x 5.75 / 10.5 = 4500

3.75 x 200 x 5.25 = 3940

1.17 x 1 x 150 x 5.25 = 920

15 x 2.75 x 5.25 = 220

5080

5080

9580

B-11

L.L. = 200 x 4.21 = 842#

D.L. = 183 + 100 + 10 = 319 (36) 243

1135#

Total load = 1161 x 10.5 = 11900#

12190

Add. D.L. of bm at cover plates

1.83 x 85 = 155

2.5 x 85 = 210

210 x 5.65 x .114 = 130

155 x 6.5 x .467 = 470

R_L = 690 x 25.5 (24.77) x .5 = 8540 (8800)

21880 x .605 .598 = 13040 (13200)

13000 x .35 .336 = 4370 (4550)

12190 (11900) x .245 .228 = 2780 (2910)

770 x 9.96 (10.08) x .802 .799 = 6130 (6120)

35580#

35460

210 x 5.65 x .886 = 1050

155 x 6.5 x .533 = 540

R_R = 690 x 25.5 (24.77) x .5 = 8540 (8800)

21880 x .395 4.02 = 8760 (8600)

13000 x .65 .664 = 8630 (8450)

12190 (11900) x .755 .772 = 9410 (9000)

770 x 9.96 (10.08) x .198 .201 = 1540 (1530)

36380#

38470

x_0 = 9.96 (10.08) from R_L

Max M = 35460 (35580) x 9.96 (10.08) − 1460 x $\frac{9.96^2}{2}$ = 280,770 (284,000)'#

Req'd d = $\sqrt{\frac{280,770 \times 12}{116 \times 22}}$ = 36.6 (34.3)

V = $\frac{38470}{22 \times .89 \times 35.5}$ = 55 (52)# OK. no stirrups req'd.

As = $\frac{280,770 \times 12}{20,000 \times .89 \times 35.5}$ = 5.3 (5.4) Use 5-1" bars OK

Try bending 2 bars

Bending points

Moment taken by 3-1" = 3 x 20,000 x .89 x $\frac{35.5}{12}$ = 162,500'#

A-5

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject BUSHNELL PARK [illegible] STATION

Computation SCREENING CHAMBER

Computed by E.C.H. **Checked by** [illegible] **Date** [illegible]

Beam 14 (Continued)

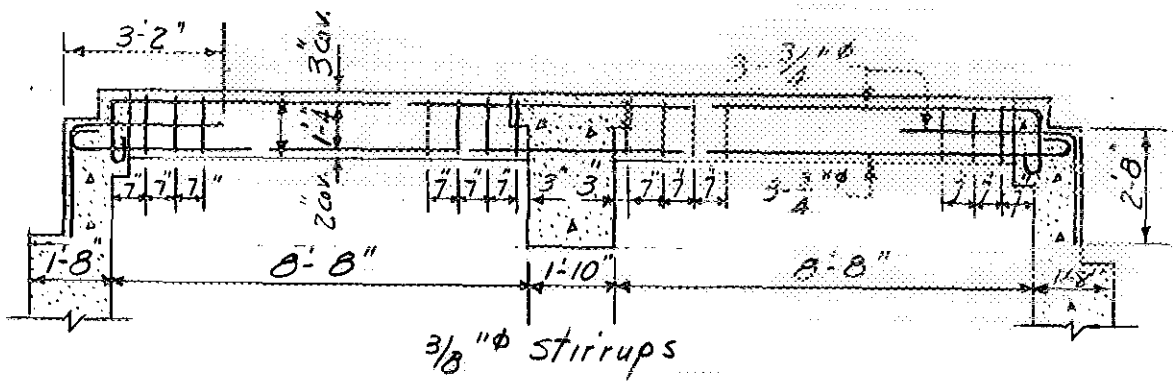
Bending points

Left side

$\cancel{35580}\,35460\,x - 1460\,\frac{x^2}{2} = 162500 \qquad x = 5.15$

Right side

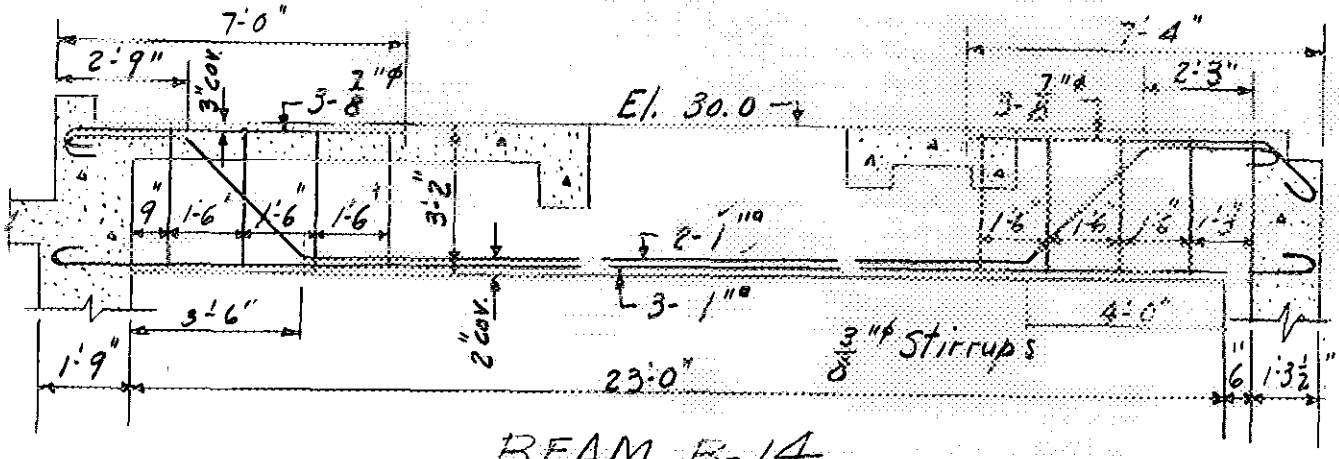
$\cancel{36380}\,38470\,x - \cancel{640}\,900\,\frac{x^2}{2} = 162500 \qquad x = \cancel{4.9}\ 4.5$



BEAMS B-11 & B-12

12" x 16"

Beams B-13, B-16 12" x 22" Same details as B-11 & B-12 except for depth and use 3-7/8"φ in top + bot.



BEAM B-14

22" x 38"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

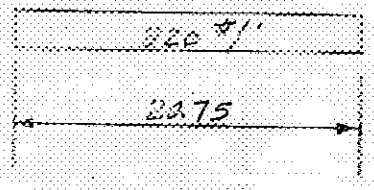
Subject: BUSHNELL PARK PUMPING STATION

Computation: SECTION J-J THRU INTAKE CONDUIT

Computed by: [illegible] Checked by: [illegible] Date: [illegible]

DESIGN OF END WALL FROM EL. 19.0 to 30.0

Hor. pressure at El. 19.0 = 320 #/'



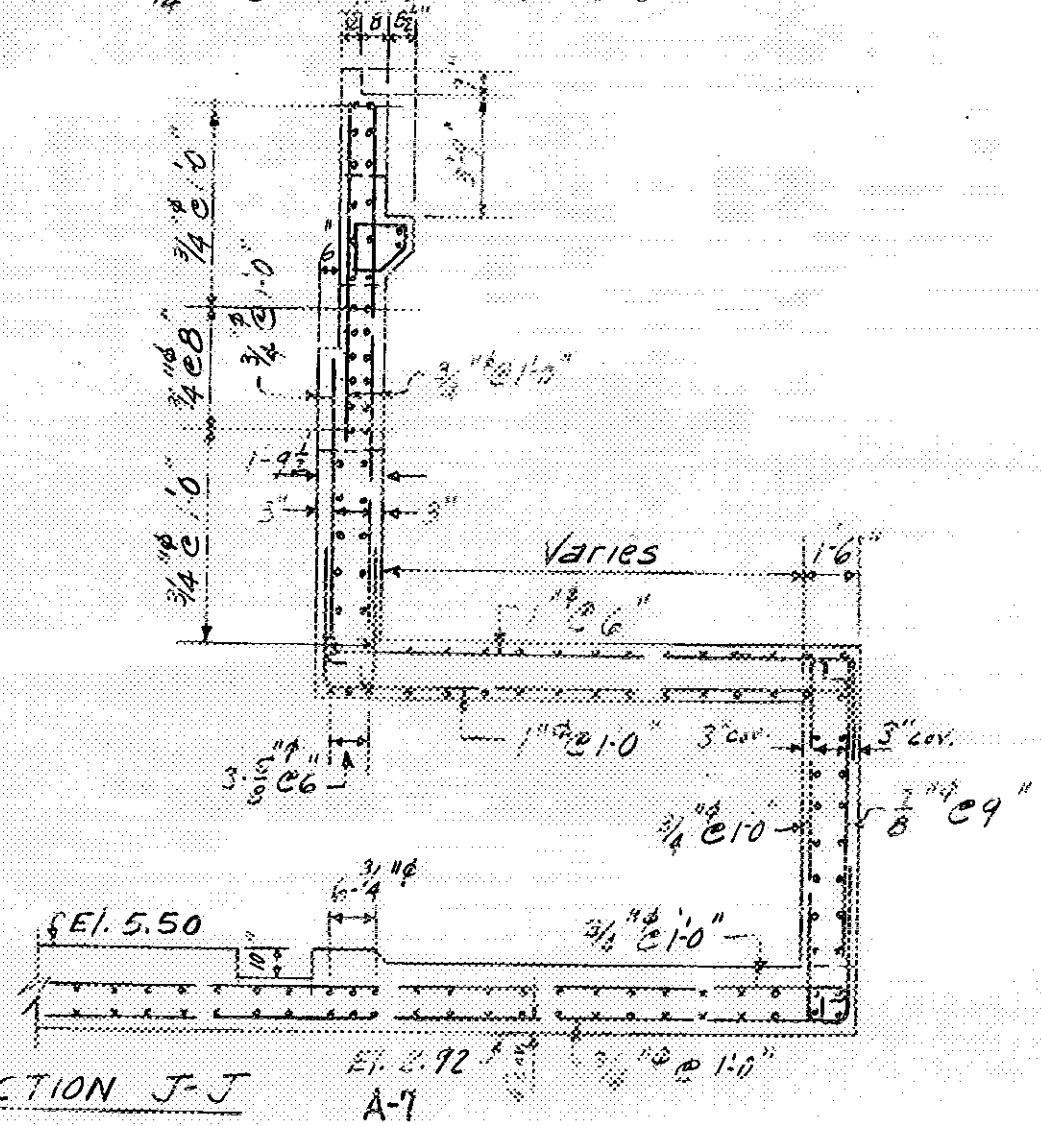
$M = \frac{1}{10} \times 320 \times 20.75^2 = 13780$ '#

$V = 320 \times 20.75 \times .5 = 3320$ #

$A_s = \frac{13780 \times 12}{20{,}000 \times .88 \times 13.9} = .68$ □" Use 3/4"φ @ 8" c.c.

$u = \frac{3320}{3.5 \times .88 \times 13.9} = 78$ #/□"

Use 3/4"φ @ 1'-0" at El. 22.0



SECTION J-J

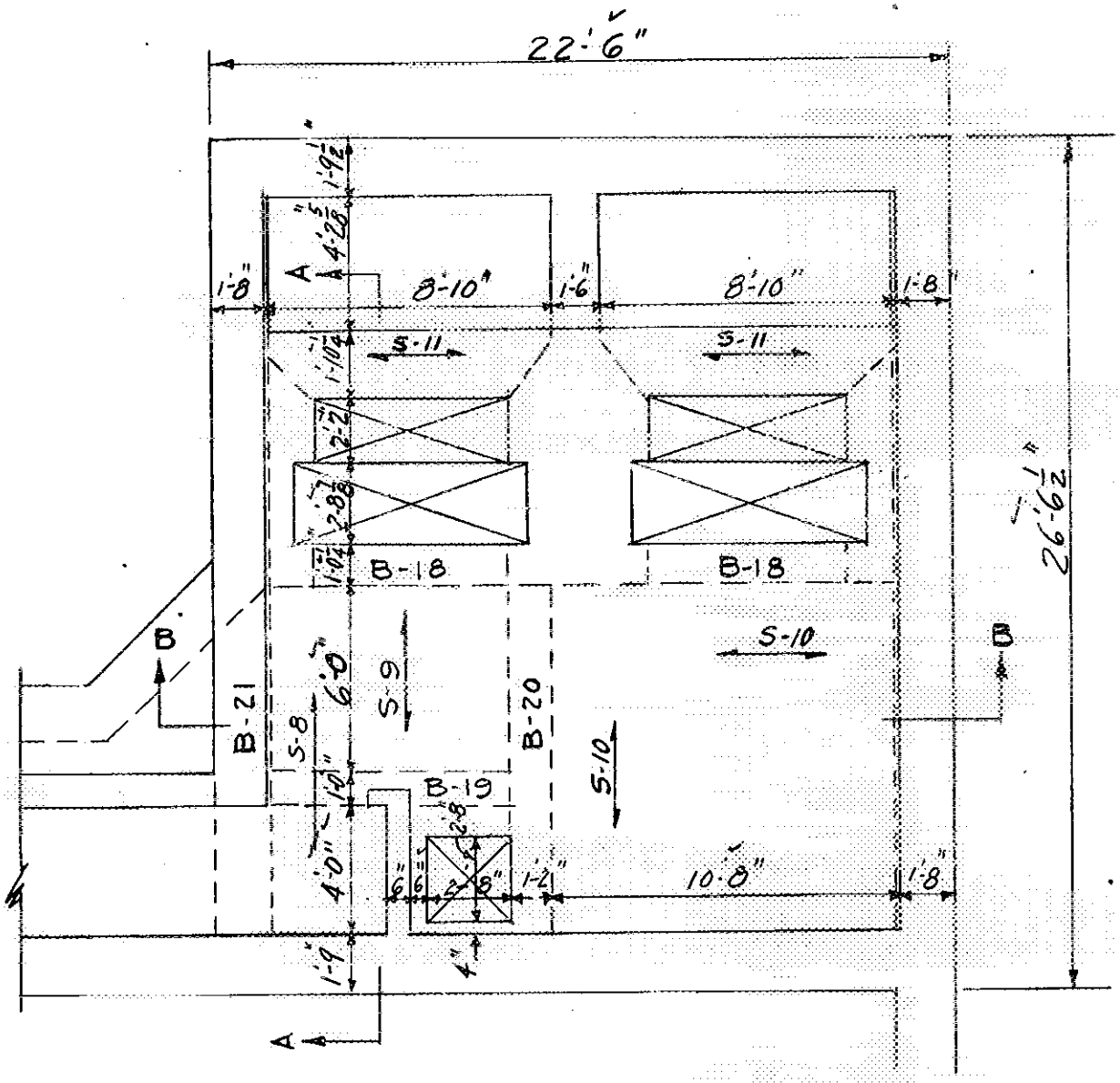
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject BUSHNELL PARK PUMPING STATION

Computation SCREENING CHAMBER FLOOR

Computed by E. J. H. **Checked by** H. E. N. **Date** 7 Nov. 1945



PLAN OF SCREENING CHAMBER FLOOR

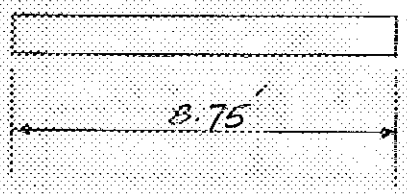
Floor designed for Live load of 300 #/□'
Beams designed for Live load of 250 #/□'

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject BUSHNELL PARK PUMPING STATION
Computation SCREENING CHAMBER FLOOR
Computed by E.J.H. **Checked by** [illegible] **Date** 9 NOV. 1945

SLAB S-11

Dead Load = 1.85×100 + 1.1×15 = 200#
Loaded area = 1.83 + 1.08 = 3 Ft.
Load per lin Ft = 3 × 300 = 900#



~~Consider a section 1'-0" wide~~

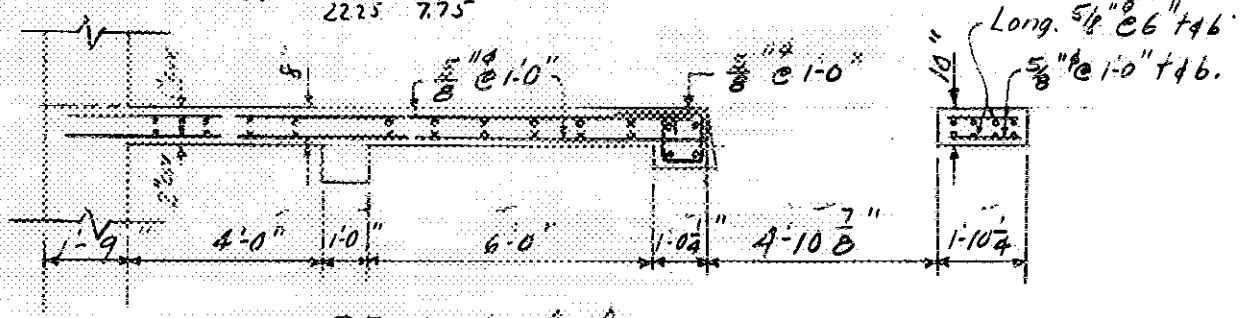
$M = \frac{\overset{1100}{\cancel{450}} \times 8.75^2}{8} = \overset{10,530}{\cancel{4300}}$ '#

$d = \sqrt{\frac{\overset{10,530 \times 12}{4300}}{\underset{116}{22.25 \times \cancel{12.3}}}} = \overset{7.0}{\cancel{5.9}}$" Slab is $\overset{10}{\cancel{8}}$" thick

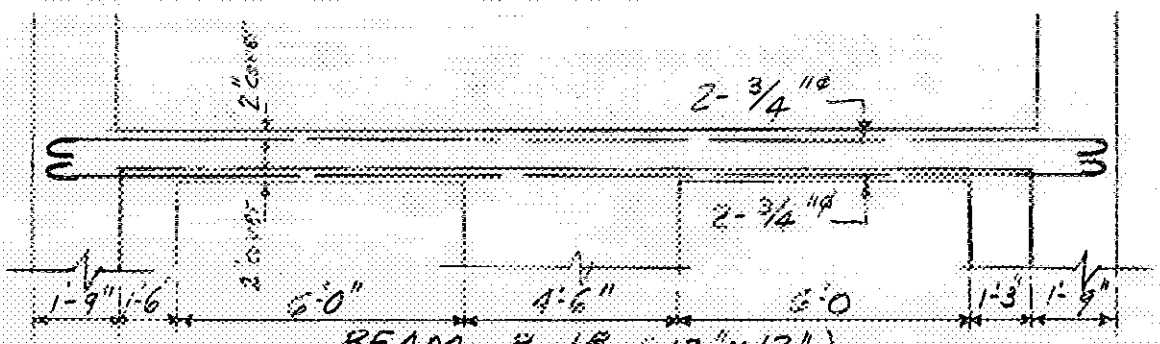
$AS = \frac{\overset{10,530}{4300} \times 12}{20,000 \times .88 \times \underset{7.75}{\cancel{6.0}}} = \overset{.92}{\cancel{.49}}$ Use 4-5/8"φ

$w = \frac{\overset{4810}{\cancel{450}}}{.88 \times \underset{7.86}{\cancel{3.92}} \times \underset{7.75}{\cancel{12}}} = \overset{90}{\cancel{48}}$ #□" O.K

$v = \frac{\overset{4810}{\cancel{450 \times 4.38}}}{.88 \times \underset{22.25}{\cancel{12}} \times \underset{7.75}{\cancel{6}}} = \overset{32}{\cancel{31}}$ #□" O.K.



SECTION A-A
(Supersedes SECTION A-A on page 221)



BEAM B-18 (12"×12")
(Called for but not shown on Page 222)

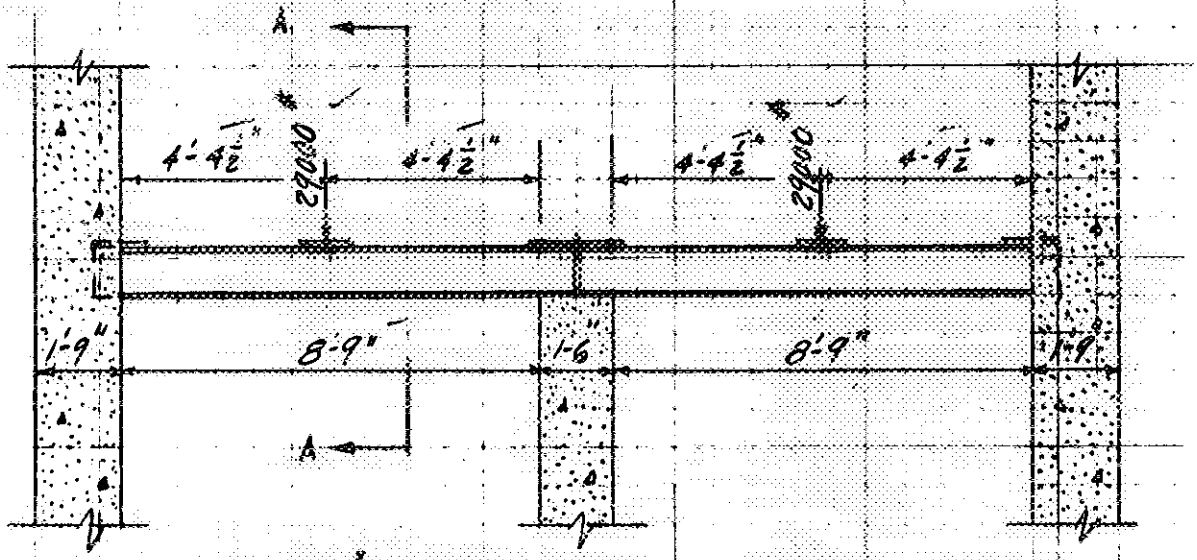
WAR DEPARTMENT

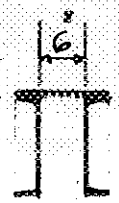
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: BUSHNELL PARK PUMPING STATION

Computation: BEAMS IN TRASH RACK CHAMBER

Computed by: E.J.H. Checked by: [illegible] Date: 5 OCT. 1945





SECTION A-A

Live load at 100 #□'

100 x 2.5 = 250#

$$M = \frac{29000 \times 10.37}{4} = 75000'\# \text{ (Gate)}$$

$$\frac{250 \times 10.37^2}{8} = \frac{3350}{78350'\#} \text{ (Live load)}$$

Assuming tie plates 12" long at points shown.

Assume 2-12" [s

$\frac{1}{b}$ For Full span = $\frac{105}{6}$ = 17.5

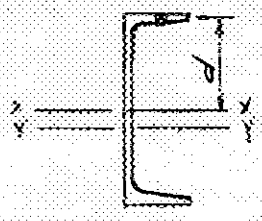
$\frac{1}{b}$ between plates = $\frac{40.5}{3}$ = 13.5

Using aluminum [s allowable F = 17,300 #□"

$$S = \frac{78350 \times 12}{17300} = 54.0$$

Subject: BUSHNELL PARK PUMPING STATION
Computation: BEAMS IN TRASH RACK CHAMBER
Computed by: E.J.H. Checked by: [illegible] Date: 5 OCT. 1945

Try 2 - 12" [s @ 12.45 #
1 - 1" hole out



$I_{xx} = I - (\text{area of hole} \times d)$
$= 179.65 - (.5 \times 5.75) = 176.77$ (.625, 5.692; 159.35)

New center of gravity $= \dfrac{.5 \times 5.75}{10.29} = .28$ (.625, 5.688; 9.66; .37)

$I_{yy} = I_{xx} - (\text{net area} \times .28^2)$
$= 176.77 - (9.79 \times .28^2) = 176.00$ (159.35; 9.66; .37; 158.03)

$S = \dfrac{176.00}{6.28} = 28.0$ (158.03; 6.37; 24.8)

S for two [s = 56 (49.6) O.K. f = 18,700 #/□"
(overstress considered OK as it will occur only momentary and infrequently)

OUTSIDE CHANNEL SUPPORTING FLOOR PLATE

Design load = 100 #/□' × 1.5 = 150 # lin. ft.

$M = \dfrac{150 \times 10.37^2}{8} = 2000$ '#

$\dfrac{L}{b} = \dfrac{115}{3} = 38$ Allowable = 11300

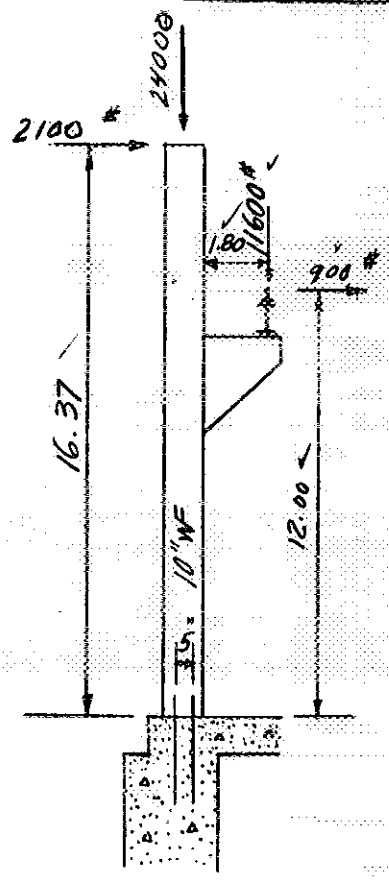
$S = \dfrac{2000 \times 12}{11300} = 2.1$

Use min 12" [12" [@ 7.33 S = 21.49

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: BUSHNELL PARK PUMPING STATION
Computation: ANCHOR BOLTS FOR COLUMNS
Computed by: E.J.H. Checked by: N.C.W. Date: 1 NOV. 1945

ENGINE ROOM COLUMNS



Neglect effect of 1000# wind load from wall at top of column as it is assumed that masonry walls 2'-0" thick can take this wind load.

For loads on column see Page 284

Vertical load =

Dead load	13000 #
Catwalk	5000
Snow	2300
D.L. Eave struts	6600
	26900
Less axial wind ld from rft	2900
	24000 #

$1\frac{1}{2}$" Bolts - 3'-6" in concrete

Moment at bottom of column due to crane load
= 11600 x 1.80 + 680 x 16 = 10,000 '#

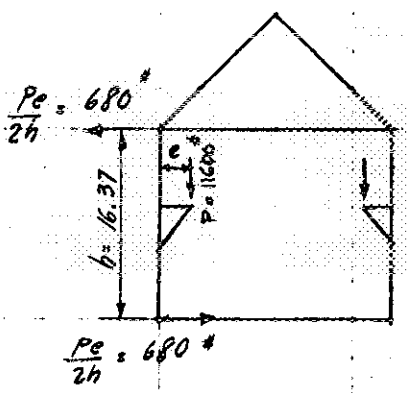
Net moment at face of column =

2100 x 16.37 = 34300
900 x 12.00 = 10800
10000

24000 x .42 = 10100

55100

$\Sigma M = \frac{45000}{.62}$ '# = 72500 # on two outside bolts



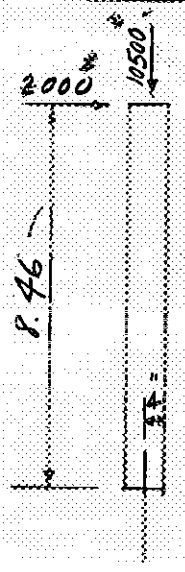
$\frac{72500}{2 \times 1.79}$ = 28000 #/" O.K.

EMBEDDMENT

Bolts are embedded in concrete a distance of 3'-6"
circumference = 4.72
4.72 x 42 x 200 x 2 = 79000 #
Total load on both bolts = 72500 #

Subject BUSHNELL PARK PUMPING STATION
Computation ANCHOR BOLTS FOR COLUMNS
Computed by _____ **Checked by** H.E.W. **Date** 1 Nov. 1945

STOREROOM



Hor. wall load = 1000#
Hor. roof load = 3000#
4000# ÷ 2 = 2000#

Moment at face of column =
2000# x 8.46" = 16920'#
10500 x .33 = 3500'
ΣM = 13420'#

2 - 1¼" anchor bolts - 2'-9" in concrete.

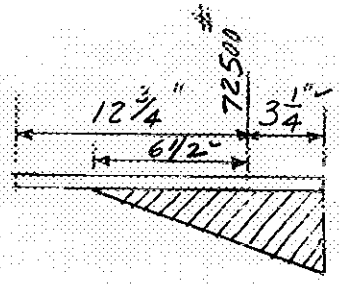
$\frac{13420}{.33}$ = 40500# on two bolts

$\frac{40500}{2 \times .89}$ = 23000#□" O.K

EMBEDDMENT

Circumference = 3.92"
3.92 x 33 x 200 x 2 = 51500#
Total load on two bolts = 40500# O.K.

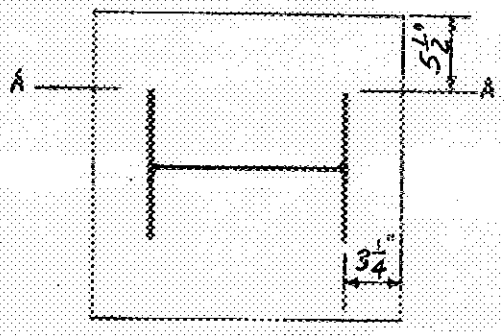
BASE PLATES - (Engine room columns)



Force exerted by inside flange = 72500#
Assume plate 16" wide
Maximum allowable pressure on concrete = 750#□"

$\frac{750}{2} \times 9.75$ = 3650# lin. in.

$\frac{72500}{3650}$ = 20 Make plate 21" long



Bending moment about A-A
Intensity under flanges = ⅔ x 750 = 500#

M = 500 x 5.5 x 2.75 = 7550"#
S = $\frac{7550}{27000}$ = .28

Assume plate 1½" thick
S of plate 1" wide =
$\frac{1}{6} \times 1.5^2$ = .375 OK

Make plate 16 x 1½ x 1'-9"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: BUSHNELL PARK PUMPING STATION

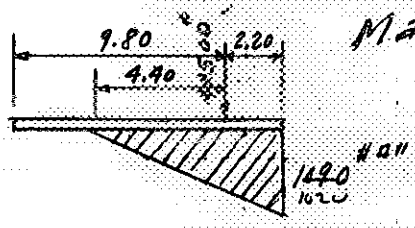
Computation: COLUMN & BASE PLATES

Computed by: E.J.H. Checked by: H.E.M. Date: 2 NOV. 1942

BASE PLATES (STOREROOM)

Force exerted by inside flange = 40,500 #

Assume plate 12" x 12" x 1"



Max F_c = $f_c \times \frac{6.60}{2} \times 12$ = 40500

F_c = 109.0 #/□" O.K.

$M = 1090 \times 2.2 \times 1.1 = 2640$ "#

$S = \frac{2640}{27000} = .098$

S of 1" plate = $\frac{1}{6} bd^2 = .16$ O.K.

Make plates 12" x 1" x 1'-0"

WAR DEPARTMENT

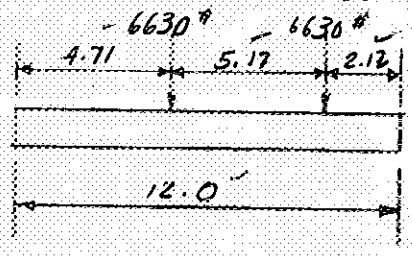
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: BUSHNELL PARK PUMPING STATION

Computation: CRANE BEAMS

Computed by: E.J.H. Checked by: K.N. Date: 2 NOV. 1945

Crane capacity = 5 Tons
wheel spacing = 5'-2"
Max. wheel load = 6630 #



L.L. Moment = $13260 \times \frac{4.71^2}{12} = 24550$ '#

25% Impact = 6150

D.L. Moment = $\frac{1}{8} \times 50 \times 12.0^2 = 900$

31500 '#

31600

Horizontal thrust = 20% crane capacity = $\frac{1}{5} \times 10{,}000 \times \frac{1}{4} = 500$ /wheel

Lateral L.L. Moment = $\frac{500}{6630} \times 24550 = 1850$ '#

try 12" WF @ 32#

$b = 6.5''$ $S_{x-x} = 40.7$ $S_{yy} = 6.3$ $\frac{L}{b} = \frac{144}{6.5} = 22$

Allowable fs = 17730 #□"

Actual fs = $\frac{31500 \times 12}{40.7} = 9300$ #□"

31600

$= \frac{1850 \times 12}{6.3 \times .5} = 7100$ / 16400 #□"

OK use 12" WF @ 32#