New Estimate

HOUSATONIC RIVER FLOOD CONTROL

DANBURY, CONN.

LOCAL PROTECTION

STILL RIVER, CONNECTICUT

DESIGN MEMORANDUM NO. 5

STRUCTURES

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

APRIL 1969

14

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:

NEDED-E

30 April 1969

SUBJECT: Danbury Local Protection Project, Still River, Housatonic River Basin, Connecticut, Design Memorandum No. 5, Structures

Chief of Engineers
ATTN: ENGCW-E

There is submitted herewith, for review and approval, Design Memorandum No. 5, "Structures," for the Danbury, Connecticut, Local Protection Project, Still River, Housatonic River Basin, in accordance with ER 1110-2-1150.

FOR THE DIVISION ENGINEER:

1 Incl (10 cys)
as

JOHN Wm. LESLIE
Chief, Engineering Division

FLOOD CONTROL PROJECT

DANBURY LOCAL PROTECTION PROJECT
STILL RIVER
HOUSATONIC RIVER BASIN
CONNECTICUT

DESIGN MEMORANDUM NO. 5

STRUCTURES

INDEX TO DESIGN MEMORANDA

No.	Title	Date Submitted	Date Approved
1	Hydrology and Hydraulic Design	29 August 1968	23 October 1968
2	General Design and Site Geology	21 January 1969	
3	Concrete Materials		
4	Embankments, Foundations and Channel Improvements		
5	Structures		

DANBURY LOCAL PROTECTION PROJECT
Still River
Housatonic River Basin
Connecticut

DESIGN MEMORANDUM NO. 5

STRUCTURES

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3	Structures	1
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	c. Highway Bridges	2
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5	Plan and Profile No. 4 Station 46+00 to Station 58+00
6	Plan and Profile No. 5 Station 58+00 to Station 72+60
7	Structural Details and Loading Diagrams

DANBURY LOCAL PROTECTION PROJECT
STILL RIVER
HOUSATONIC RIVER BASIN
CONNECTICUT

A. PERTINENT DATA

1. PURPOSE	Flood Control
2. LOCATION	
State	Connecticut
County	Fairfield
City	Danbury
River	Still
Distance from Stamford	29 Miles
Distance from New Haven	34 Miles
Distance from Hartford	58 Miles
Distance from New York, N.Y.	66 Miles
3. STRUCTURES	
a. Rectangular Reinforced Concrete Section	
Length	3,625 feet
Width	40 feet
Depth	13 feet
Invert Slope	0.002 ft./ft.
b. Railroad Bridges	
Number	4

* Riprapped trapezoidal channel

Location	No. 1 Station 10+58 No. 2 Station 24+72 No. 3 Station 38+31 No. 4 Station 70+64
Type	Nos. 1, 2, & 3 Twin Barrel Reinforced Concrete Box Culverts. No. 4 Two Span Through Plate Girder Bridge to be designed by the Owner.
Size	No. 1 Two Barrels Each Opening 20x13x60 feet. No. 2 Two Barrels Each Opening 20x13x220 feet. No. 3 Two Barrels Each Opening 20x13x110 feet*.

* Part of this structure is for use of Highway Bridge No. 1 at Station 37+56.

c. Highway Bridges.

Number	2
Location	No. 1 Station 37+56 (Chestnut Street). No. 2 Station 52+82 (Casper Street) to be designed by the Owner.
Type	No. 1 Twin Barrel Reinforced Concrete Box Culvert. No. 2 Two Span Highway Bridge.
Size	No. 1 Two Barrels Each Opening 20x13x110 feet*.

* See Note under b. above.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

FLOOD CONTROL PROJECT

DANBURY LOCAL PROTECTION PROJECT
Still River
Housatonic River Basin
Connecticut

DESIGN MEMORANDUM NO. 5

STRUCTURES

B. INTRODUCTION

1. PURPOSE. - The purpose of this design memorandum is to present for review and approval the basic design criteria for the structures for the Local Protection Project, Danbury, Connecticut. Basic criteria, typical structural computations and other pertinent data are presented.

C. HYDROLOGY AND HYDRAULICS

2. GENERAL. - Approved Design Memorandum No. 1 contains the basic hydrologic and hydraulic design criteria for the project.

D. GEOLOGY

3. GENERAL. - Submitted Design Memorandum No. 2 "General Design and Site Geology" contains the detailed geological studies for the project.

E. EMBANKMENTS, FOUNDATIONS AND CHANNEL IMPROVEMENTS

4. GENERAL. - Detailed design studies of the embankments, foundations and channel improvements will be presented in Design Memorandum No. 4.

F. CONCRETE

5. GENERAL. - Concrete materials will be discussed in detail in Design Memorandum No. 3 "Concrete Materials."

G. STRUCTURAL DESIGN

6. PURPOSE AND SCOPE. - This section presents the design criteria, basic data, assumptions and the procedure used in the structural design of the U-channel sections and box culverts. Typical computations are included showing the maximum loading conditions and design of critical sections. It does not present the design criteria for the railroad bridge at Station 70+64 nor the highway bridge at Station 52+82 which will be designed by the owners, The Penn Central Company and the City of Danbury, respectively.

7. DESIGN CRITERIA.

a. General. - All working stresses conform to those specified in the Engineering Manual EM 1110-1-2101, dated 1 November 1963. General loading conditions, design assumptions and other design criteria are based on the following applicable parts of the Engineering Manual for Civil Works: Standard Practice for Concrete (EM 1110-2-2000, Dec. 1965), Conduits, Culverts and Pipes (Draft) (EM 1110-2-2902, March 1966), Retaining Walls (EM 1110-2-2502, dated May 1961) and Wall Design (Part CXXV, Chapter 1, Change 2, dated 15 March 1961).

b. Concrete. - Concrete working stresses are in general accordance with ACI Standard Building Code Requirements for reinforced concrete, using concrete with a minimum ultimate compressive strength of 3,000 lbs. per square inch, except for the twin box culverts which is 4,000 lbs. per square inch.

Flexure (Extreme fiber stresses in comp.)	P.S.I.
Twin Box Culverts	1800
U-Channel Sections	1050

c. Reinforcement.

(1) Grade and Working Stresses. - All reinforcement in the structures, including temperature and shrinkage reinforcement, is designed for the working stresses of new billet steel, intermediate grade, deformed bars which is 20,000 p.s.i. in flexural tension. The reinforcement will conform to the requirements of Federal Specification QQ-S-632, Type II, Grade C, and to ASTM A-305-56T.

(2) Spacing. - The clear distance between parallel bars will not be less than 1-1/2 times the diameter of round bars except that in no case will the clear distance between parallel bars be less than 1-inch, or 1-1/2 times the maximum size of the coarse aggregate.

(3) Minimum Cover for Reinforcement.

Item	Min. Cover (Inches)
Interior face of channel sections and culverts	4
Exterior face of channel sections and culverts	3
Bottom of base slabs	4

(4) Splices. - All splices are in accordance with the ACI Building Code and as set forth in Table 14c of Reinforced Concrete Design Handbook, ACI Publication SP-3.

(5) Temperature and Shrinkage Reinforcement. - Temperature and shrinkage reinforcement is provided where the main reinforcement extends in only one direction. Such reinforcement provides for a ratio of steel area to concrete area (bd) of 0.002 with a minimum of .0012 in each face up to a maximum of #6 bars at 12" cc.

d. Increase in Normal Working Stresses. - There are no increased allowable working stresses.

e. Waterstops. - Rubber or polyvinyl waterstops will be used in all concrete contraction joints and expansion joints.

8. BASIC DATA AND ASSUMPTIONS.

a. Loads.

(1) Dead Loads

Concrete	150 p.s.f.
Soil (min. saturated wt.)	110 p.c.f.
Soil (max. saturated wt.)	140 p.c.f.

(2) Live Loads. - The following live loads are used:

General

Water		62.5 p.c.f.
R.R. Loading	Cooper	E 72
Highway Loading		H 20

R.R. Gate Structures

Track Loading	Cooper	E 72

b. External Water Pressure. - Hydraulic pressure under flood condition is assumed to act over the entire area in question under the full head available. Ground water elevation is assumed at 50% of height between drain invert and ground surface.

c. Earth Pressure. - Earth pressures are determined in general accordance with EM 1110-2-2502, Retaining Walls, dated 29 May 1961.

d. Earthquake Forces. - Earthquake forces are considered to be of no consequence on these structures and have been neglected.

e. Frost Protection. - All structures will have a minimum of 4'-0" cover for frost protection.

f. Uplift Factor of Safety. - All structures are investigated for an uplift safety factor using minimum soil weights. A safety factor of at least 1.1 is provided when considering only the vertical weight of soil on the projecting base.

9. PREPARATION OF DESIGN COMPUTATIONS. - Extensive use of computer programming has been used in preparing computations. The Mathatron desk top computer was used to analyze the structures. The U-channel base slab was also analyzed as a beam on an elastic foundation by means of a Fortran program based on the Popov method of successive approximations.

10. DESIGN OF STRUCTURES. -

a. General. - Between Stations 9+20 and 45+45 a concrete channel lining is used with the exception of two railroad and one combined railroad and roadway crossings. At these instances, a twin box culvert is utilized. The typical channel lining is in the form of a U-section 40 feet wide and 13 feet high. The box culverts are twin 20 feet wide by 13 feet high sections with the exception of the highway culvert whose twin sections will be 14 feet high. At the inlet the U-channel section will be in the form of a drop structure varying from approximately 70 feet in width to a width of 41.5 feet. The outlet structure will also widen out to 53 feet and will act as a stilling basin.

b. U-Channel Sections. - Due to the varying weights and characteristics of soil along the route of the channel's length, it is considered necessary to investigate for both the maximum and minimum values. Because of the large width to height ratio, it is also considered important to check the base slab as a beam on elastic foundation. Maximum values obtained from the following conditions of loading are used in the design.

Case I. - Rigid U-section using maximum soil weight with at rest coefficient of .50. Uplift safety factors found with vert. weight of earth on base projection and also with wedge of earth, using a tan. of internal friction of 25°. Channel assumed empty and ground water assumed drawn down to 50% from ground surface to drain inlet.

CASE II. - Same as Case I with minimum soil weight and active earth pressure.

CASE III. - Same as Case I, but treat base as a beam on elastic foundation with minimum foundation modulus of 50T.

Cases I and II were analyzed by the Mathatron computer. Case I produces the largest steel requirements in the wall stem. Case II is critical as far as floatation and maximum mom. at the center of the base slab. Case III is critical for the base slab at the outside edges.

c. Twin Box Culvert - Railroad Loading. -

(1) General. - There is included in the Appendix, computations for the box culvert at Station 10+20 to Station 10+90. These computations are typical for all the railroad crossings. Depth of fill, and assumed skew angle of railroad and conduit vary, but method of design is the same for all railroad crossings. Monoliths between Station 23+50 to Station 25+85 are normal to the channel, but at other crossings, monoliths are held parallel to the R.R. centerline. Minimum uplift factor of safety is based on ground water level half way between drain invert and ground surface. The computer program is based on ground water at top of conduit. It is considered that this variation will produce only minor differences in steel requirements.

(2) Loading Condition. - The twin box culvert is designed assuming a uniform distributed load is obtained from the AREA handbook, page 8-16-5, using the graph for Cooper E-72 loading. This is then changed to an equivalent earth surcharge. Maximum earth weights and K-factor produces the larger design requirements. The shear safety

factor is checked in the roof and base slabs. The computations presented cover a simultaneous loading of both sections of the conduit. Final computations will include only one side loaded and the other side unloaded.

d. Twin Box Culvert - Highway Loading. - The box culvert from approximately Station 37+18 to Station 38+00 is subjected to highway loadings. This has been determined the equivalent of 400 pounds per sq. ft. The method of design is the same as for the railroad culvert.

e. Miscellaneous Drainage Structures. - Manholes and structures incidental to the drainage system will be designed in accordance with standard practice.

11. CONSTRUCTION PROCEDURE. - Due to the necessity of maintaining stream flow, it will be necessary to construct half of the structures at a time while flow is directed in the adjacent half. This will be accomplished by temporary flume. Because of the close proximity of railroad tracks and roof of conduit, it will also be necessary to construct temporary relocation of railroad tracks and build one section at a time.

H. COST ESTIMATES

12. ESTIMATES OF COST. - The estimate of cost is as follows. It has been revised to reflect changes in unit quantities and unit prices due to more advanced design and data obtained from recent bid openings.

FIRST COST
(1969 Base)

Item	Quantity	Unit	Unit Price	Amount	Total Amount
NON-FEDERAL COST					
Lands and Damages					$300,000
Relocations					
Utilities				411,540	
Contingencies				60,460	
Engineering & Design				34,000	
Supervision & Administration				29,000	
					535,000
Railroad				55,000	
Contingencies				8,000	
Engineering & Design				5,000	
Supervision & Administration				4,000	
					72,000
Highway Bridges				192,200	
Contingencies				28,800	
Engineering & Design				18,000	
Supervision & Administration				14,000	
					253,000
TOTAL NON-FEDERAL COSTS					$1,160,000
FEDERAL COST					
Railroad Bridges					
Care & Maintenance of Existing R.R. Bridges During Construction		L.S.		125,000	

Item	Quantity	Unit	Unit Price	Amount	Total Amount
R.R. Track	860	L.F.	25.00	21,500	
R.R. Bridge #26.40, Remove) R.R. Bridge #26.06, Remove) R.R. Bridge #25.69, Remove)		L.S.		25,000	
R.R. Bridge #25.14, Remove and Reconstruct		L.S.		150,000	
R.R. Bridges				321,500	
Contingencies				48,500	
				370,000	
Engineering & Design				18,000	
Supervision & Administration				24,000	
TOTAL R.R. BRIDGES					412,000
Channels & Canals					
Preparation of Site	20	Ac.	500	10,000	
Stream Control		L.S.		275,000	
Structure Removal		L.S.		10,000	
Excavation, General	210,000	C.Y.	1.75	367,500	
Excavation, Rock	100	C.Y.	8.00	800	
Stone Protection	11,500	C.Y.	17.00	195,500	
1½" Crushed Stone	1,000	C.Y.	7.50	7,500	
Gravel Bedding	19,000	C.Y.	4.00	76,000	
Compacted Gravel Fill	7,000	C.Y.	3.75	26,250	
Uncompacted Processed Gravel	5,400	C.Y.	4.00	21,600	
Dumped Process Gravel	650	C.Y.	3.50	2,275	
Compacted Process Sand	2,600	C.Y.	5.00	13,000	
Dumped Process Sand	4,600	C.Y.	4.50	20,700	
Uncompacted Earth Fill	6,700	C.Y.	.75	5,025	
Compacted Earth Fill	60,400	C.Y.	1.75	45,300	
Channel Fill	16,000	C.Y.	.50	8,000	
6" Topsoil, Seeded	7,500	S.Y.	1.00	7,500	
Concrete	26,260	C.Y.	60.00	1,575,600	
Reinforcing Steel	2,485,000	LBS	.17	422,450	
Cement	39,400	BBL	5.00	197,000	

Item	Quantity	Unit	Unit Price	Amount	Total Amount
Steel Sheet Piling, Permanent	1,300	S.F.	6.00	7,800	
Const. Sheet Piling, Temporary	103,500	S.F.	3.50	362,250	
6" BCCMP	1,100	L.F.	4.00	4,400	
8" BCCMP Perf.	7,300	L.F.	5.00	36,500	
12" BCCMP	5,100	L.F.	6.00	30,600	
6' Chain Link Fence	6,700	L.F.	6.00	33,500	
Shoring	1,800	L.F.	6.00	10,800	
Manhole	14	EA.	700.00	9,800	
Drainage Structure	7	EA.	5,000.00	35,000	
36" Flap Gate	1	EA.	1,000.00	1,000	
				3,818,650	
Contingencies				572,350	
				4,391,000	
Engineering & Design				357,000	
Supervision & Administration				290,000	
TOTAL CHANNELS & CANALS					$5,038,000
TOTAL FEDERAL COST					
R.R. Bridges -				$412,000	
Channels & Canals -				5,038,000	
				$5,450,000	
TOTAL PROJECT CONSTRUCTION COSTS					$6,610,000

5724
488
6209

I. ECONOMICS

13. ANNUAL BENEFITS. - Average annual flood damage prevention benefits over the project life amount to $224,000 for the reach from White Street to Triangle Street. Additional benefits of $11,000 annually are realized in the Urban Renewal Area upstream of White Street from the effects of the project on the channel work done under Urban Renewal. Downstream of Triangle Street the replacement of the railroad bridge will make the State channel job more effective and benefits of $3,000 annually accrue to the project. Total average annual benefits credited to the project amount to $238,000.

14. ANNUAL COSTS. - Total annual charges amounting to $226,000 are summarized as follows:

ESTIMATED ANNUAL CHARGES
(100-Year Life)
LOCAL PROTECTION WORK
DANBURY LOCAL PROTECTION PROJECT, CONN.
STILL RIVER
HOUSATONIC RIVER BASIN
DESIGN MEMORANDUM NO. 5
STRUCTURES

Item No.	Item	Cost	Total Cost
1.	FEDERAL INVESTMENT		
	Federal First Cost	$5,450,000	
	Interest During Construction	* 0	
	TOTAL FEDERAL INVESTMENT	$5,450,000	
2.	FEDERAL ANNUAL CHARGES		
	Interest (@ 0.0325)	177,100	
	Amortization (@0.00138)	7,500	
	TOTAL FEDERAL ANNUAL CHARGES		$184,600
3.	NON-FEDERAL INVESTMENT		
	Lands, Easements & Rights-of-Way	300,000	
	Improvements	860,000	
	TOTAL NON-FEDERAL FIRST COST	$1,160,000	
	TOTAL NON-FEDERAL INVESTMENT	1,160,000	
4.	NON-FEDERAL ANNUAL CHARGES		
	Interest (@ 0.0325)	37,700	
	Amortization (@ 0.00138)	1,600	
	Maintenance and Operation	2,100	
	TOTAL NON-FEDERAL ANNUAL CHARGES		41,400
5.	TOTAL ANNUAL CHARGES		226,000
6.	TOTAL ANNUAL BENEFITS		$238,000

*Project will be operational before end of two year period, therefore no interest is charged.

15. BENEFIT-COST RATIO. - The ratio of benefit to cost is 1.05 to 1.

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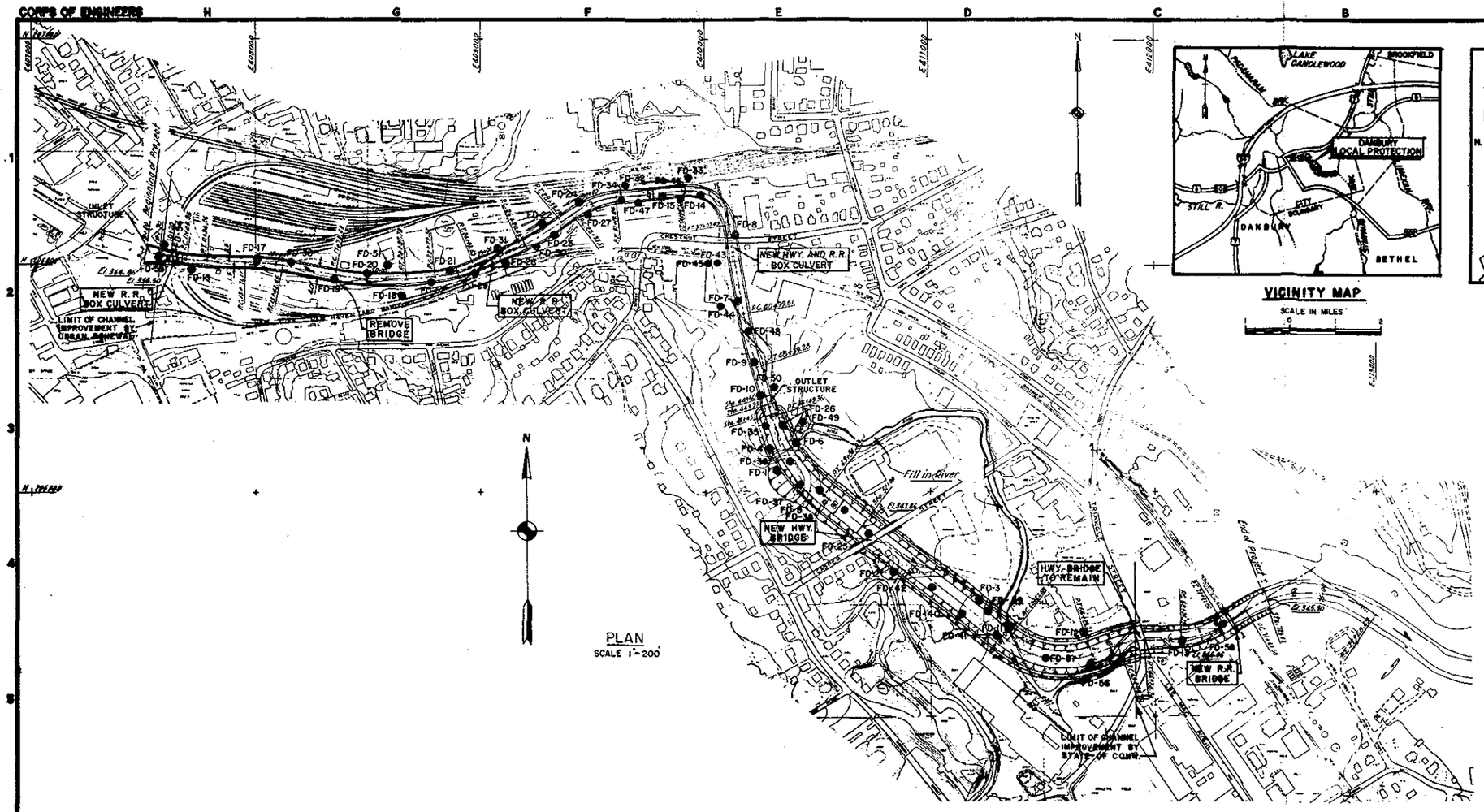
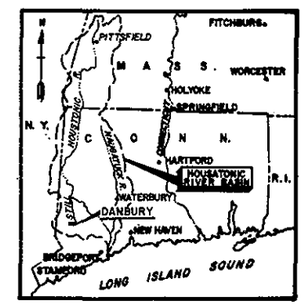


PLAN
SCALE 1"=200'

VICINITY MAP
SCALE IN MILES



LOCATION MAP
SCALE IN MILES

NOTES

ELEVATIONS REFER TO MEAN SEA LEVEL DATUM
CONTOUR INTERVAL IS 10 FEET

LEGEND

FD FOUNDATION TEST BORING

GRAPHIC SCALE
1"=200' 200' 0 200' 400'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
GENERAL PLAN
AND
PLAN OF FOUNDATION EXPLORATIONS
STILL RIVER CONNECTICUT

SCALE 1"=200'
HOU-
SHEET

PLATE NO. 5-1

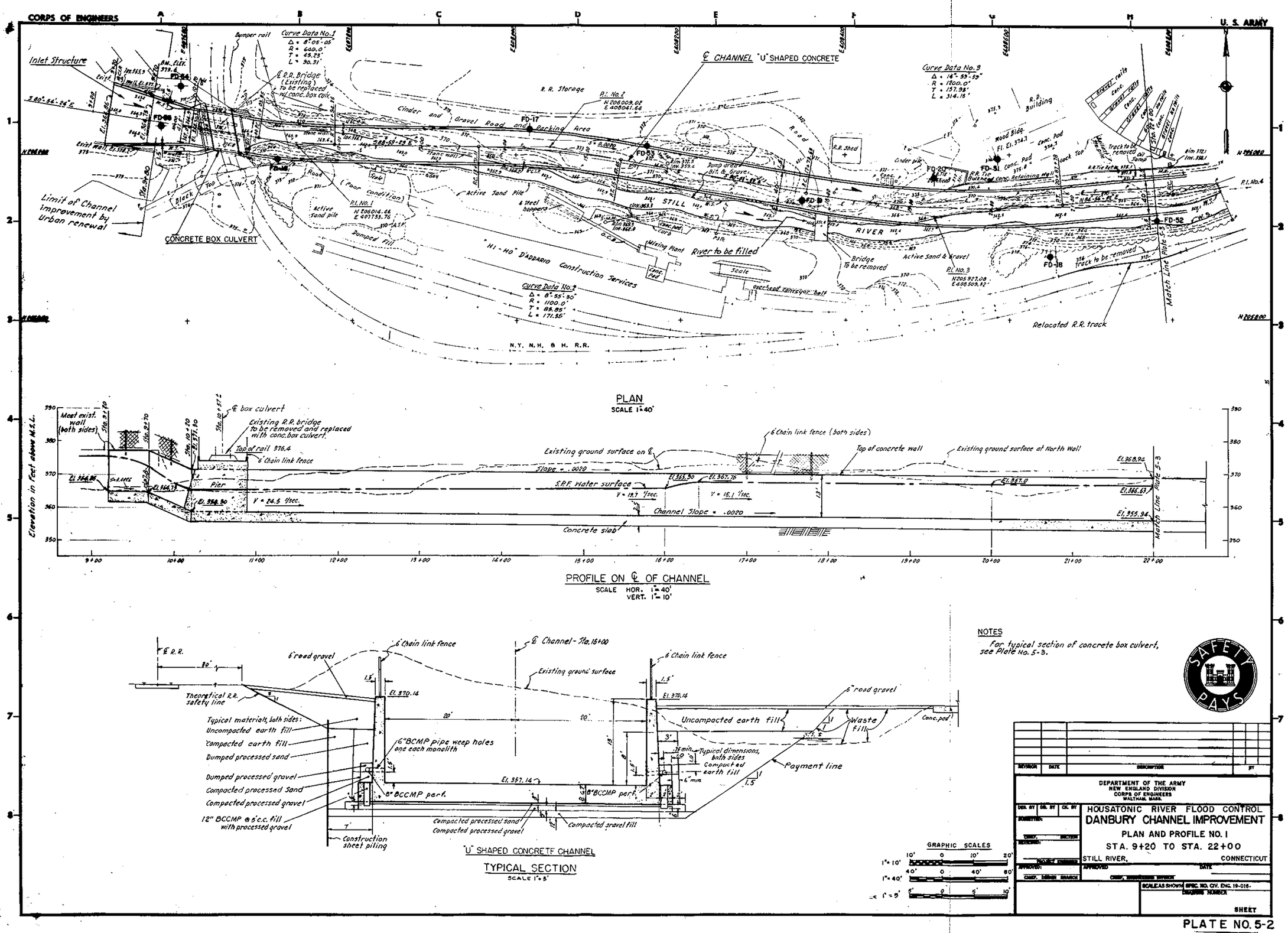
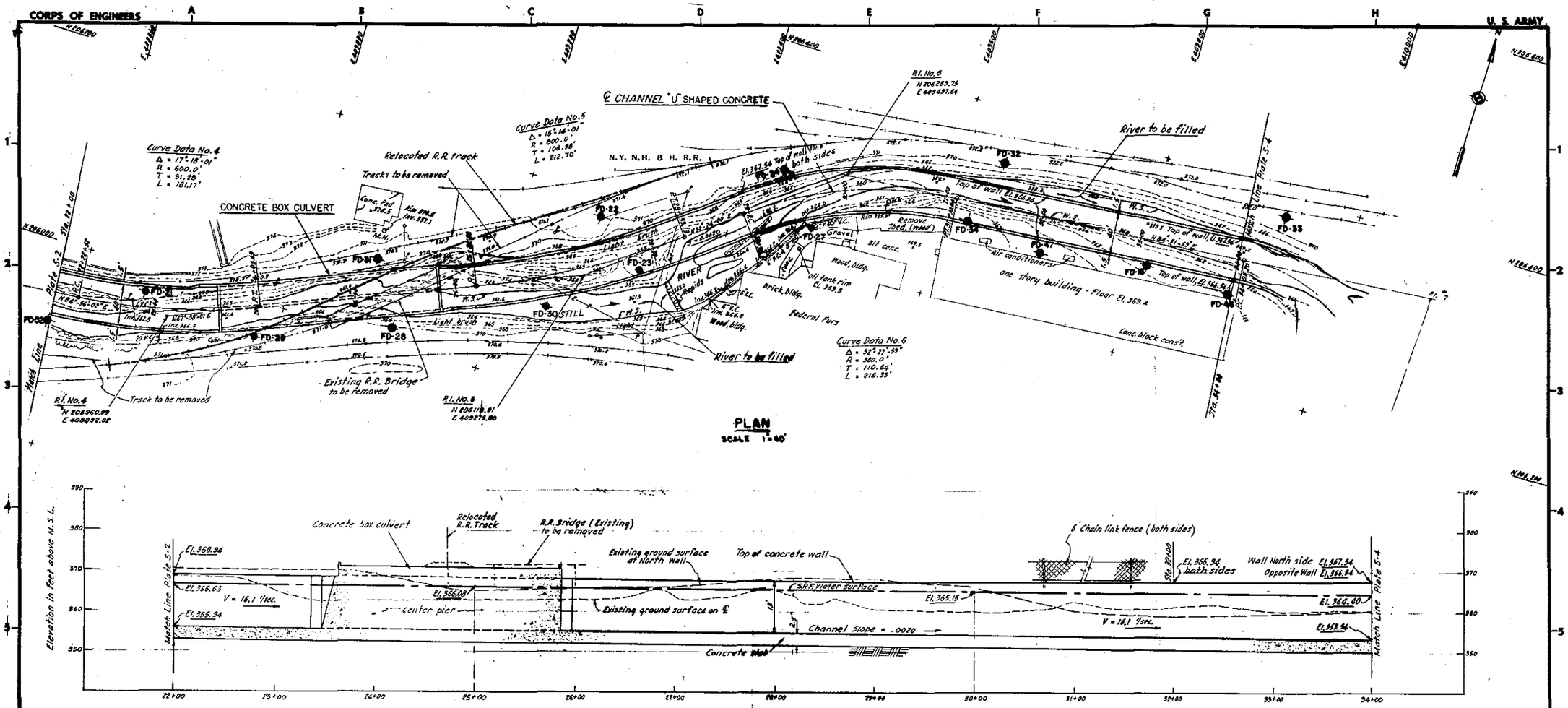

CORPS OF ENGINEERS
U. S. ARMY
Inlet Structure
Curve Data No. 1
Δ = 8°-05'-05"
R = 640.0'
T = 45.23'
L = 90.31'
℄ R.R. Bridge (Existing) To be replaced w/ conc. box culv.
℄ CHANNEL "U" SHAPED CONCRETE
Curve Data No. 3
Δ = 14°-59'-59"
R = 1200.0'
T = 157.98'
L = 314.15'
R.R. Storage
P.I. No. 2
N 206009.02
E 408041.64
Cinder and Gravel Road and Parking Area
FD-17
FD-53
FD-20
FD-51
FD-52
FD-18
Limit of Channel improvement by Urban renewal
CONCRETE BOX CULVERT
Active Sand Pile
Dumped Fill
STILL RIVER
River to be filled
Bridge To be removed
Active Sand & Gravel
P.I. No. 3
N 205927.08
E 408509.32
Track to be removed
Relocated R.R. track
Match Line Plate 5-3
"HI-HO" D'ADDARIO Construction Services
Curve Data No. 2
Δ = 8°-55'-30"
R = 1100.0'
T = 85.85'
L = 171.35'
N.Y. N.H. & H. R.R.
PLAN
SCALE 1"=40'
Elevation in Feet above M.S.L.
Meet exist. wall (both sides)
℄ box culvert
Existing R.R. bridge to be removed and replaced with conc. box culvert.
Top of rail 376.4
6' Chain link fence
Existing ground surface on ℄
6' Chain link fence (both sides)
Top of concrete wall
Existing ground surface at North Wall
Slope = .0020
S.P.F. Water surface
Channel Slope = .0020
Concrete slab
Pier
V = 24.5 ft/sec.
V = 19.7 ft/sec.
V = 16.1 ft/sec.
El. 368.94
El. 366.63
El. 355.94
Match Line Plate 5-3
PROFILE ON ℄ OF CHANNEL
SCALE HOR. 1"=40'
VERT. 1"=10'
℄ R.R.
6' road gravel
6' Chain link fence
℄ Channel - Sta. 16+00
Existing ground surface
Theoretical R.R. safety line
Typical materials, both sides:
Uncompacted earth fill
Compacted earth fill
Dumped processed sand
Dumped processed gravel
Compacted processed Sand
Compacted processed gravel
12" BCCMP @ 5' c.c. fill with processed gravel
6" BCMP pipe weep holes one each monolith
8" BCCMP perf.
Construction sheet piling
Compacted processed sand
Compacted processed gravel
Compacted gravel fill
Uncompacted earth fill
Waste fill
Conc. pad
Typical dimensions, both sides
Compacted earth fill
Payment line
"U" SHAPED CONCRETE CHANNEL
TYPICAL SECTION
SCALE 1"=5'
GRAPHIC SCALES
1"=10'
1"=40'
1"=5'
NOTES
For typical section of concrete box culvert, see Plate No. 5-3.
SAFETY PAYS
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
PLAN AND PROFILE NO. 1
STA. 9+20 TO STA. 22+00
STILL RIVER, CONNECTICUT
SCALE AS SHOWN
SPEC. NO. CIV. ENG. 19-016
DRAWING NUMBER
SHEET

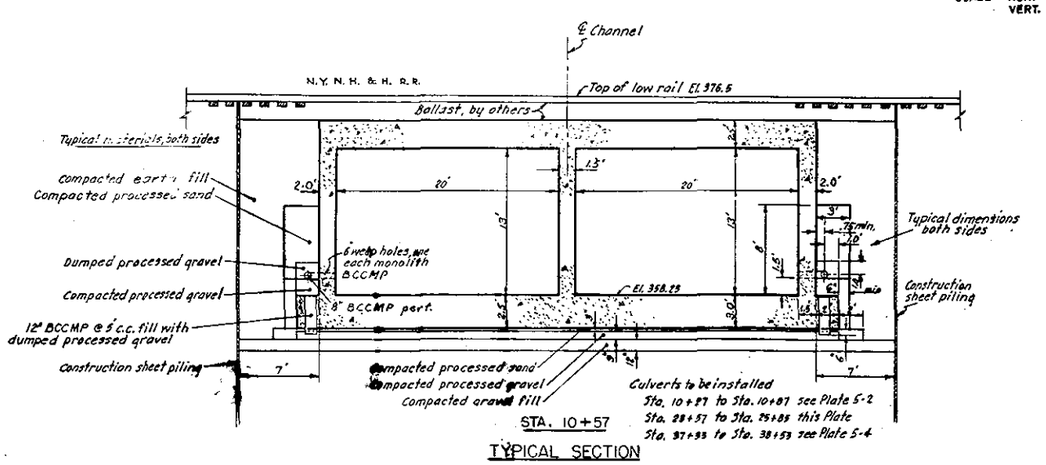
PLATE NO. 5-2

CORPS OF ENGINEERS — U. S. ARMY



PROFILE ON ℄ OF CHANNEL

SCALE: HOR. 1"=40'
VERT. 1"=10'



STA. 10+57

TYPICAL SECTION

CONCRETE BOX CULVERT — TWO BARREL

SCALE 1"=5'

NOTES

For typical section of "U" shaped concrete channel, see Plate No. 5-2.

GRAPHIC SCALES

1"=10' — 10' 0 10' 20'

1"=40' — 40' 0 40' 80'

1"=5' — 5' 0 5' 10'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:

CHIEF, SECTION

REVIEWED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, DESIGN BRANCH

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
PLAN AND PROFILE NO. 2
STA. 22+00 TO STA. 34+00
STILL RIVER — CONNECTICUT

APPROVED — DATE

CHIEF, ENGINEERING DIVISION

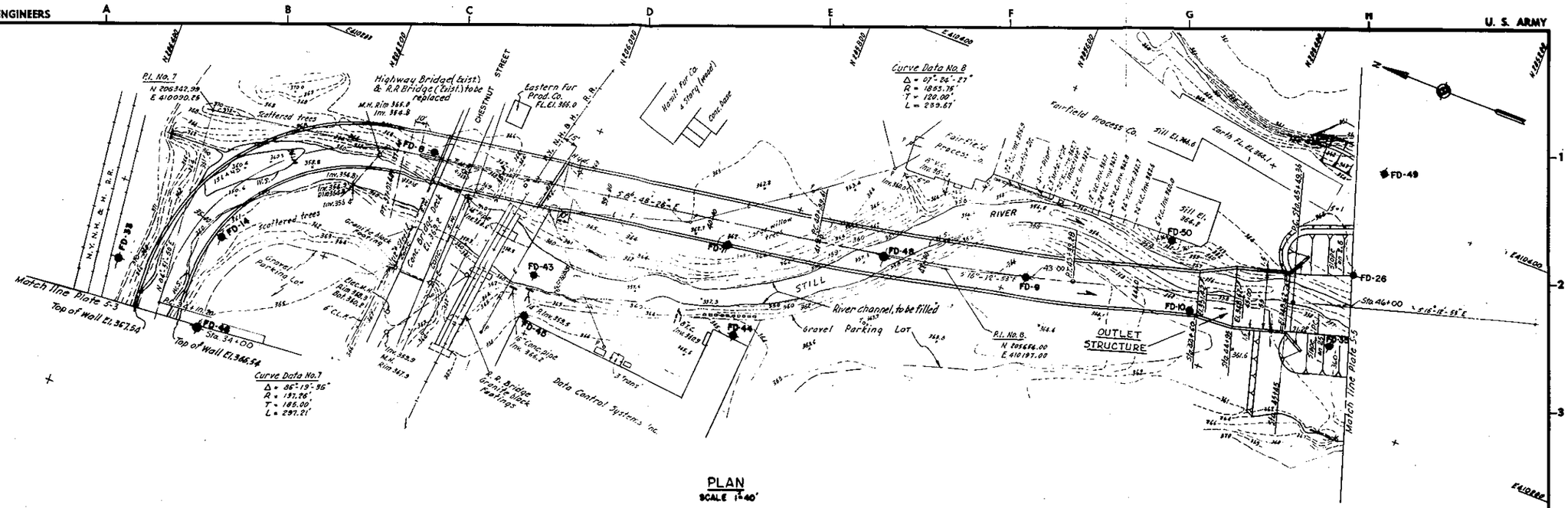
SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-016-

DRAWING NUMBER

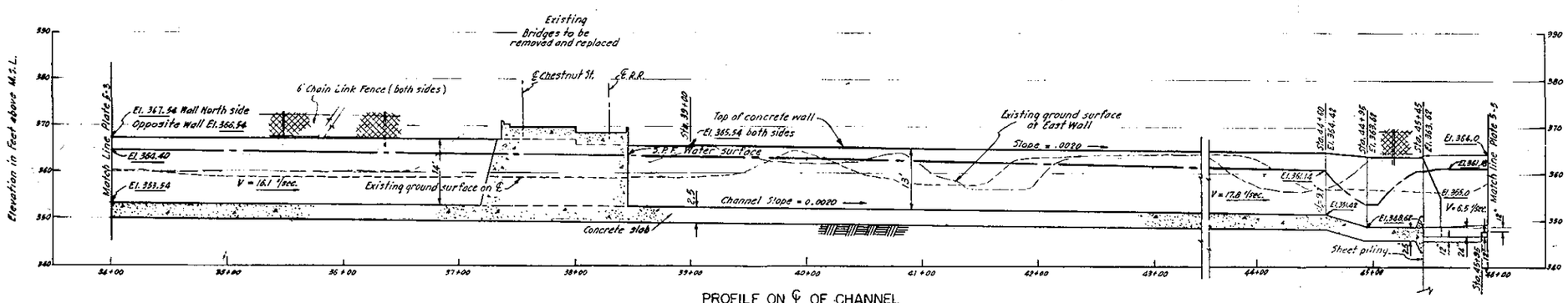
SHEET

PLATE NO. 5-3

CORPS OF ENGINEERS — U. S. ARMY



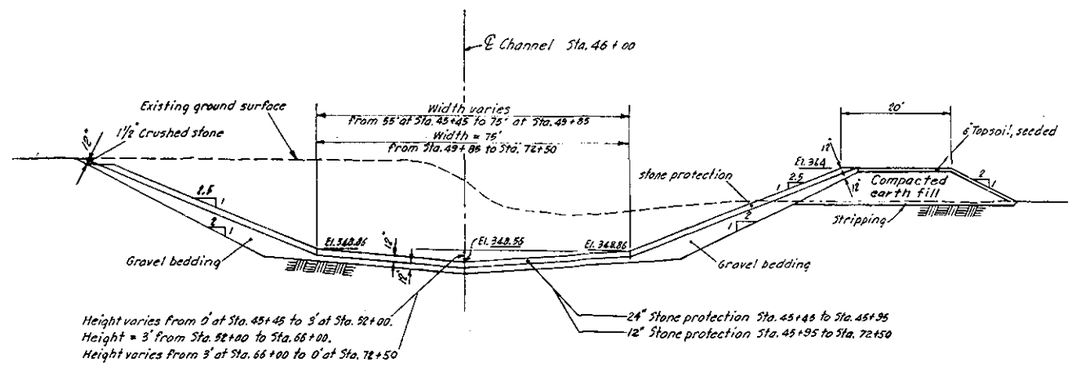
PLAN
SCALE 1"=40'



PROFILE ON ℄ OF CHANNEL
SCALE HOR. 1" = 40'
VERT. 1" = 10'

NOTES

For typical section of "U" shaped channel see Plate 5-2
For typical section of Concrete Box culvert (Sta. 31+33 to Sta. 38+33) see Plate No. 5-3.



TYPICAL SECTION
SCALE 1"=10'

GRAPHIC SCALE
1" = 10' — 10' 0 10' 20'
1" = 40' — 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

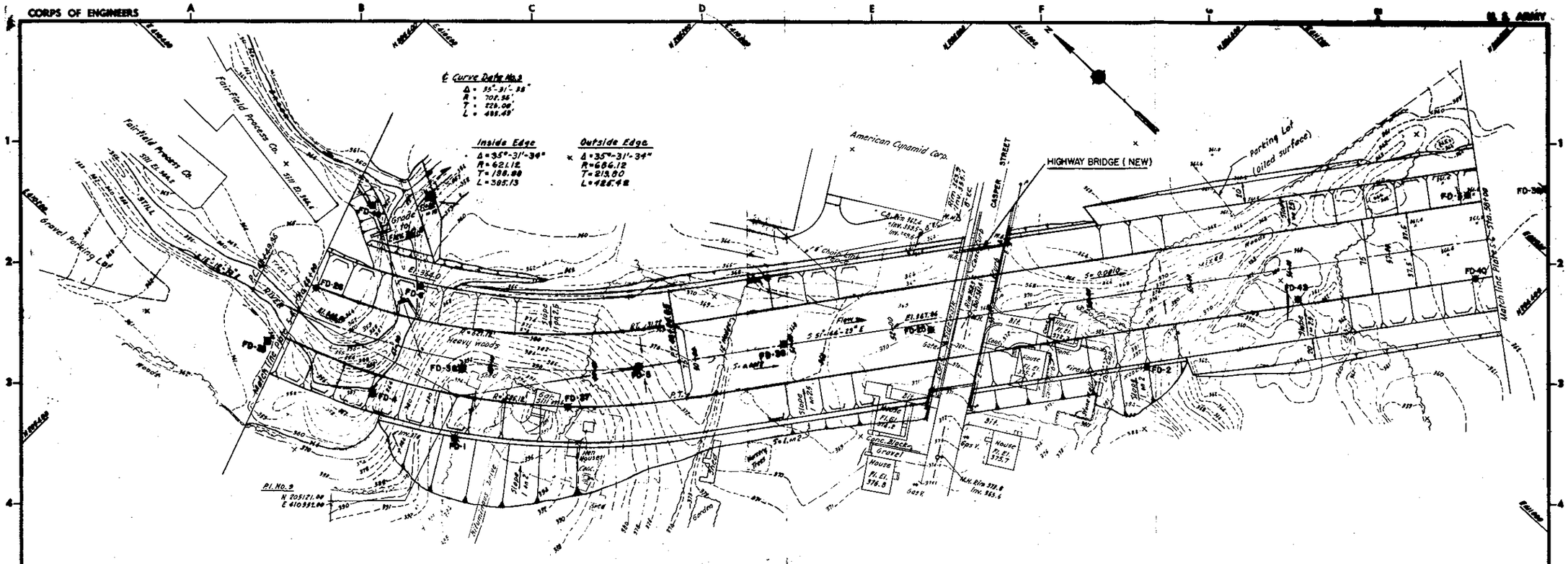
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
PLAN AND PROFILE NO. 3
STA. 34+00 TO STA. 46+00
STILL RIVER — CONNECTICUT
APPROVED — DATE
CHIEF, ENGINEERING BRANCH
SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE NO. 5-4

CORPS OF ENGINEERS — U. S. ARMY

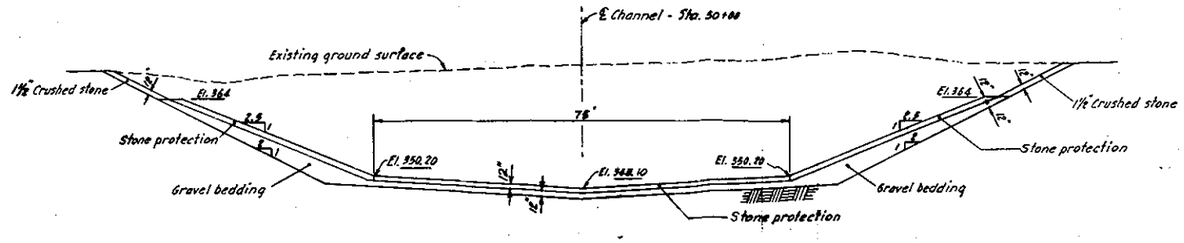


PLAN
SCALE 1" = 40'

PROFILE ON ℄ OF CHANNEL
SCALE HOR. 1" = 40'
VERT. 1" = 10'

NOTES

For typical section from Sta. 46+00 to Sta. 49+65, see Plate No. 5-4.



TYPICAL SECTION
SCALE 1" = 10'

GRAPHIC SCALES
1" = 10' — 10' 0 10' 20'
1" = 40' — 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, HYD. DIV. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
PLAN AND PROFILE NO. 4
STA. 46+00 TO STA. 58+00
STILL RIVER — CONNECTICUT

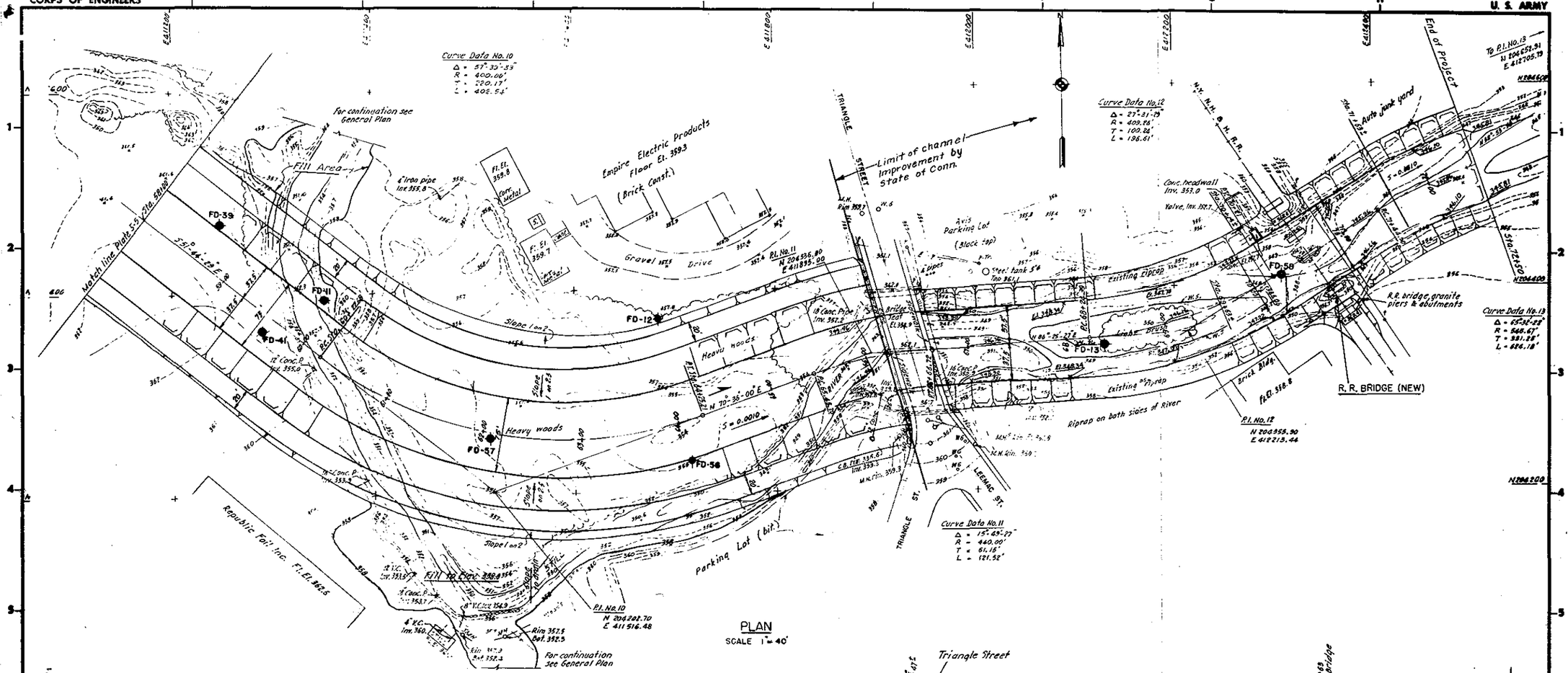
APPROVED: — DATE:
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
HOU
SHEET

PLATE NO. 5-5

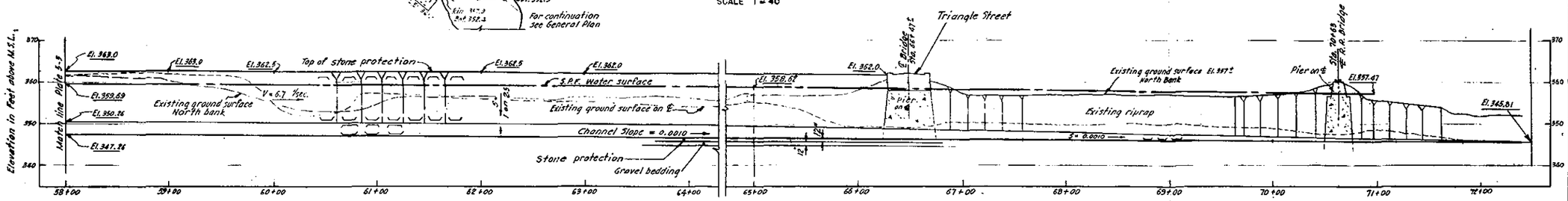
CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE 1" = 40'

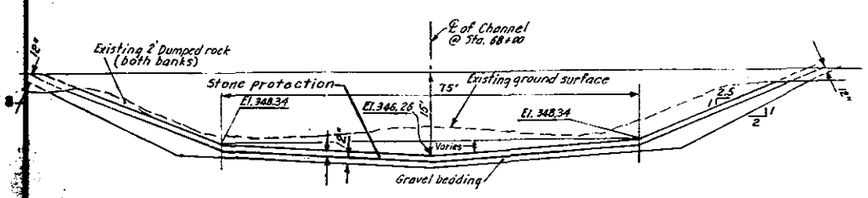


PROFILE ON ℄ OF CHANNEL

SCALE HOR. 1" = 40'
VERT. 1" = 10'

NOTES

For typical section from Sta. 58+00 to Sta. 67+07, and from Sta. 69+63 to 71+63 see Plate No 5-4.



STA.66+50 TO STA.72+50

SCALE 1" = 10'

GRAPHIC SCALES

1" = 10' 10' 0 10' 20'

1" = 40' 40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:

CHIEF, SECTION

APPROVAL RECOMMENDED:

CHIEF, TECH. DIV. BRANCH

REVIEWED:

PROJECT ENGINEER

APPROVAL RECOMMENDED:

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
PLAN AND PROFILE NO. 5
STA. 58+00 TO STA. 72+60
STILL RIVER CONNECTICUT

APPROVED DATE

CHIEF, ENGINEERING DIVISION

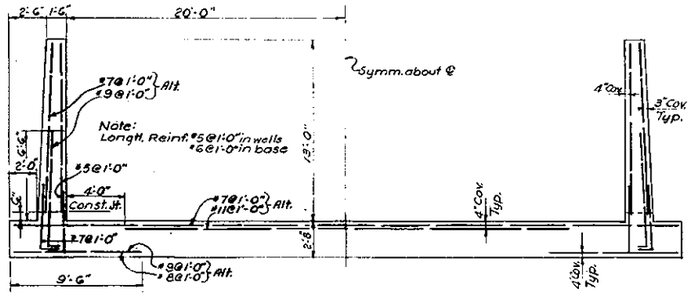
SCALE AS SHOWN | SPEC. NO.

DRAWING NUMBER

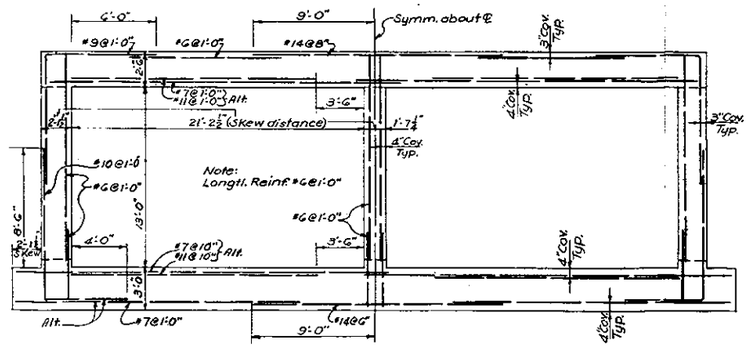
HOU-

SHEET

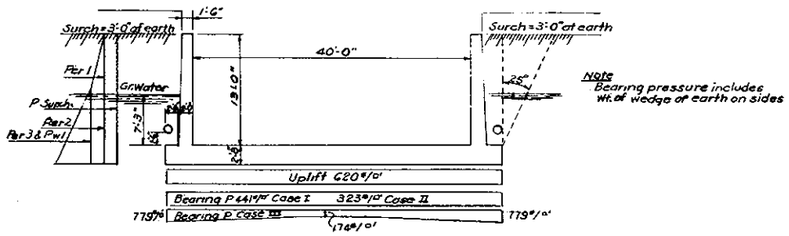
PLATE NO. 5-5



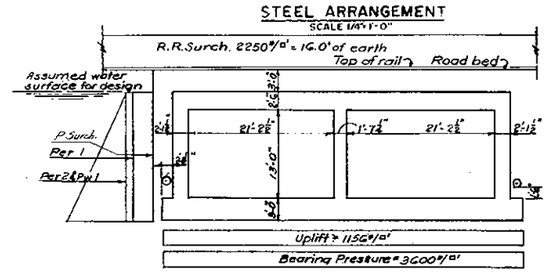
STEEL ARRANGEMENT
SCALE 1/4" = 1'-0"



STEEL ARRANGEMENT
SCALE 1/4" = 1'-0"



LOADING DIAGRAM



LOADING DIAGRAM

Note:
Design Section and Culvert Monoliths to be at 70° Angle to Channel Center Line

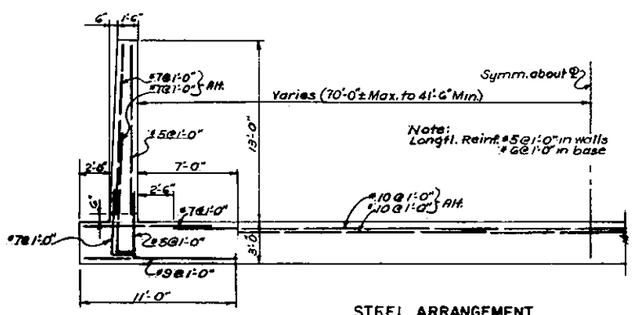
Case I
Maximum weight of soil and at rest coefficient equal to .50.
Uplift safety factor found with vert. weight of earth on base projection and also with weight of wedge of earth on sides using a tangent of internal friction of 25°
Channel assumed empty and ground water half way between drain invert and ground surface.

Case II
Same as Case I with Min. soil weight and active earth pressures

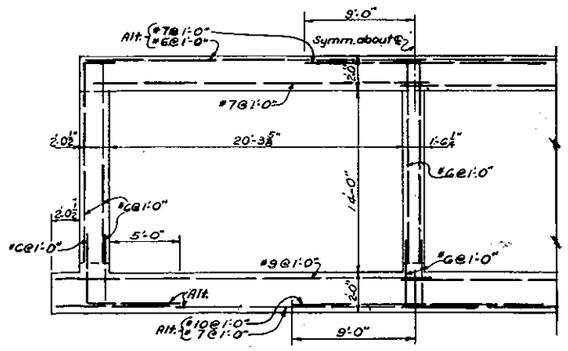
Case III
Same as Case I but treat base slab as a beam on elastic foundation with a foundation modulus of 50T

TYPICAL CHANNEL SECTION

RAILROAD CULVERT
STA. 10 + 50 ±



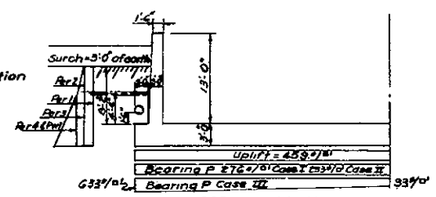
STEEL ARRANGEMENT
SCALE 1/4" = 1'-0"



STEEL ARRANGEMENT
SCALE 1/4" = 1'-0"

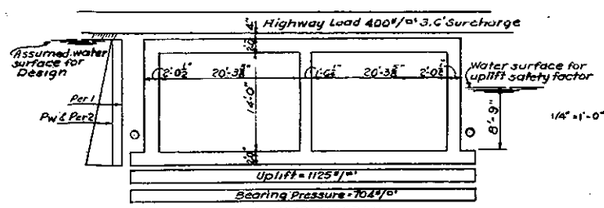
Note:
Design Section and Culvert Monoliths to be at 80° Angle to Channel Center Line

Note
Loading conditions are the same as for Typical Section



LOADING DIAGRAM

TYPICAL INLET SECTION



LOADING DIAGRAM

HIGHWAY CULVERT

GRAPHIC SCALES
1/4" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY H.E.W. | DR. BY A.J.Z. | CK. BY
SUBMITTED: CHIEF, STRUCT. SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH
REVIEWED: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION — DATE

HOUSATONIC RIVER FLOOD CONTROL
DANBURY CHANNEL IMPROVEMENT
STRUCTURAL DETAILS AND LOADING DIAGRAMS
HOUSATONIC AND NAUGATUCK RIVERS, CONNECTICUT

SCALE AS SHOWN | SPEC. NO. | DRAWING NUMBER HOU - 15 | SHEET

APPENDIX

STRUCTURAL COMPUTATIONS

STRUCTURAL COMPUTATIONS

INDEX

Item	Page
Design Assumptions and Considerations	DM-1
Typical Channel Section - Case I	DM-2 to 3
Typical Channel Section - Case II	DM-4 to 5
Typical Channel Section - Case III	DM-6 to 7
Inlet Structure - Case I	DM-8 - 10
Inlet Structure - Case II	DM-11 - 12
Inlet Structure - Case III	DM-13 - 14
Railroad Culvert	DM-15 - 17
Highway Culvert	DM-18 - 21

Design Assumptions and Considerations

Soil conditions at the site are such that a variation in weights will be prevelent. The Section selected must have the capability to with stand both max. and min. values. Min weights of soil will produce the lowest safety factor for uplift. Max. weights with at rest pressure will produce largest steel requirements in the walls. Active pressure will produce max. steel requirements in the top of the base slab

Soil Values

Unit Weights of Fill (lbs per cu. ft.

Saturated Condition	140 max	110 min
Submerged "	78 "	48 min.

At Rest Co-efficient .50

Active Earth Coefficient .30

Subgrade Modulus (1 sq. Ft. Plate)

Max 150 T/cu ft Min 50 T/cu. ft.

The U Sections will be analyzed in the following manner

Case I. – Rigid U Section useing max. soil weight with at rest coefficient of .50. Uplift safety factor found with vert. weight of earth on base projection and with wedge of earth, useing a tan. of int. friction of 25°. Channel assumed empty and ground water assumed drawn down 50% from ground surface to drain inlet

Case II - Same as Case I with min soil weight and active earth pressure

Case III Same as Case I but treat base as a beam on elastic foundation with found mod = 50 T (Min found. mod. will give min requirements for steel at center of slab and max. values at ends)

NED FORM 223
27 Sept 49

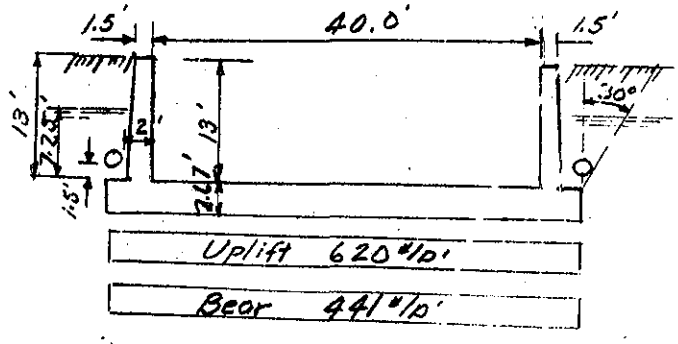
NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W CHECKED BY DATE Mar. 1969

PROJECT TITLE -DANBURY LOCAL PROTECTION DATE -MARCH 1969
Case I Loading
STEP NO. 1 CHECK SECTION FOR FLOATATION AND FIND BASE PROJECTION

ENTER FOLLOWING DATA:

CHANNEL WIDTH	=40.0
CHANNEL HEIGHT	=13.0
BASE THICKNESS	=2.67
WALL THICKNESS AT TOP	=1.5
WALL THICKNESS AT BOTTOM	=2.0
BASE PROJECTION (GUESS)	=2.0
HEIGHT OF WATER OUTSIDE	=7.25
HEIGHT OF WATER INSIDE	=0
HEIGHT OF EARTH OUTSIDE	=13.0
TAN. OF INTERNAL FRICTION	=.4663
"K" FACTOR	=.5
SATURATED WEIGHT OF EARTH	=140
SURCHARGE	=3.0



BASE PROJECTION	=	2.0
UPLIFT F.S. (VERT. PROJECTION OF EARTH)	=	1.15
UPLIFT F.S. (INCLUDING WEDGE ACTION ON SIDES)	=	1.46

STEP NO. 2 FIND MOMENTS AND END REACTIONS

STEM MOMENTS AT TOP OF BASE AND AT QUARTER POINTS
.....&02
.....&02
.....&02
.....&02

M AT TOP OF BASE = 45361.44 HORIZ REACT = 9466.28

M AT 1/4 POINT = 21128.25

M AT 1/2 " = 7642.40

M AT 3/4 " = 1509.55

BASE SLAB MOMENTS AND REACTIONS

BEARING PRESSURE = 441.07

UPLIFT PRESSURE = 620.00

CANTILEVER M = 10455.23 V = 10455.23

M AT INSIDE OF WALL STEM = -41872.43 V = 13211.57

M AT CENTER LINE = 86043.34

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

PAGE D-3

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W. CHECKED BY DATE Mar 1969

STEP NO. 3 FIND REQ'D D, AS, AND UNIT SHEAR

```
F'C = 3000
 FC = 1050
  K = 152
    -..........&02
    -..........&02
    -..........&02
```

WALL STEM

TOP OF BASE	AS =	1.49	REQ'D D =	17.27	V =	43.18
1/4 POINT	AS =	.74				
1/2 "	AS =	.29				
3/4 "	AS =	.06				

BASE SLAB

-MS = 54616.76 +MS = 106931.01

CANTILEVER	AS =	.25				
INDSIDE STEM	AS =	.72	REQ'D D =	18.95	V =	44.36
AT CENTER	AS =	2.00	" " =	26.52		

END

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

PAGE DN-4

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W CHECKED BY DATE Mar. 1969

Case II Loading

STEP NO. 1 CHECK SECTION FOR FLOATATION AND FIND BASE PROJECTION

ENTER FOLLOWING DATA:

CHANNEL WIDTH	=40.0
CHANNEL HEIGHT	=13.0
BASE THICKNESS	=2.67
WALL THICKNESS AT TOP	=1.5
WALL THICKNESS AT BOTTOM	=2.0
BASE PROJECTION (GUESS)	=2.0
HEIGHT OF WATER OUTSIDE	=7.25
HEIGHT OF WATER INSIDE	=0
HEIGHT OF EARTH OUTSIDE	=13.0
TAN. OF INTERNAL FRICTION	=.4663
"K" FACTOR	=.30
SATURATED WEIGHT OF EARTH	=110
SURCHARGE	=3.0

BASE PROJECTION	=	2.0
UPLIFT F.S. (VERT. PROJECTION OF EARTH)	=	1.09
UPLIFT F.S. (INCLUDING WEDGE ACTION ON SIDES)	=	1.33

STEP NO. 2 FIND MOMENTS AND END REACTIONS

STEM MOMENTS AT TOP OF BASE AND AT QUARTER POINTS

.....&02
.....&02
.....&02
.....&02

M AT TOP OF BASE = 23227.69 HORIZ REACT = 5225.30

M AT 1/4 POINT = 10269.98

M AT 1/2 " = 3604.88

M AT 3/4 " = 711.64

BASE SLAB MOMENTS AND REACTIONS

BEARING PRESSURE = 323.15

UPLIFT PRESSURE = 620.00

CANTILEVER M = 8003.43 V = 8003.43

M AT INSIDE OF WALL STEM = -13848.69 V = 10853.12

M AT CENTER LINE = 91382.56

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT Danbury, Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W. CHECKED BY DATE Mar 1969

STEP NO. 3 FIND REQ'D D, AS, AND UNIT SHEAR

```
F'C = 3000
 FC = 1050
  K = 152
    -..........&02
    -..........&02
    -..........&02
```

WALL STEM

TOP OF BASE	AS =	.76	REQ'D D =	12.36	V =	23.83
1/4 POINT	AS =	.36				
1/2 "	AS =	.13				
3/4 "	AS =&01	.29				

BASE SLAB

-MS = 21346.37 +MS = 103671.10

CANTILEVER	AS =	.19				
INDSIDE STEM	AS =	.16	REQ'D D =	11.85	V =	36.85
AT CENTER	AS =	2.17	" " =	26.11		

END

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT Danbury - Channel Improvement
PUTATION Typical Channel Section
COMPUTED BY H.E.W. CHECKED BY DATE Mar 1969

Determination of loads for application to Beam on Elastic Foundation Program

Loads can be determined by useing Moments and shears found in Case I

Moment from lateral pressure on side wall

Mot top of base = 45361.44 H React = 9466.3

$\frac{45361.44}{9466.28} = 4.79'$

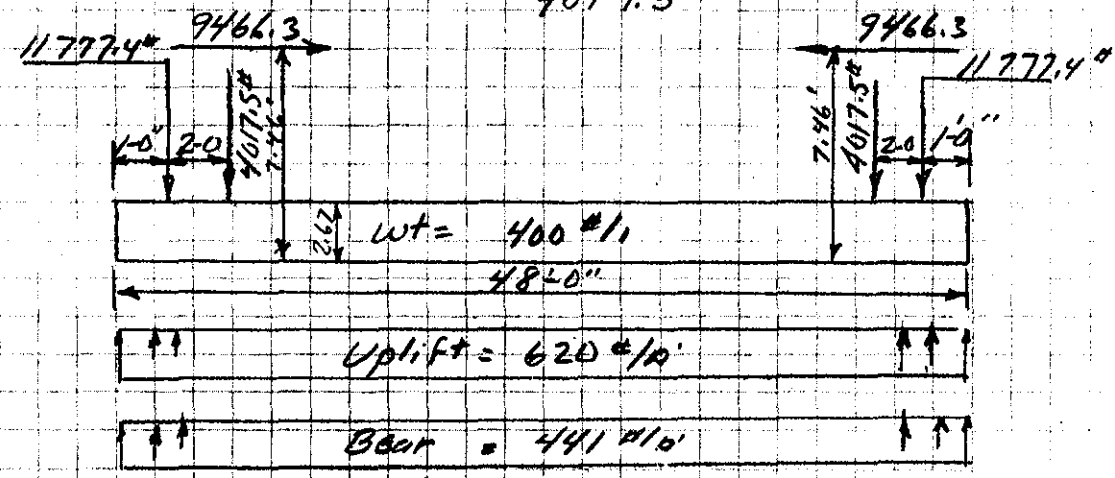
A Force of 9466.28 applied 4.79' above top of base

Force application on cantilever projection

Net shear at face		=	10455.3
Wt base	2x400		- 800.0
Uplift	2x620	=	+1240.0
Bearing	2x441.07	=	+882.1
			11777.4 #

Wt. of sidewall + earth + surch

1.75x13x150	=	3412.5
.5x13x.5x140	=	455.0
300x.5	=	150.0
		4017.5 #



Case III Loading

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

PAGE DN7

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W. CHECKED BY DATE Mar. 1969

Case III (Base slab as a Beam on Elastic Found.)

DANBURY - CONN. 6 MARCH 1969
CHANNEL STRUCT. U SHAPED INLET 1 FT WIDTH

11777.40	4017.50	0.00	0.00	0.00		
0.00	4017.50	11777.40	0.00	0.00		
0.00	0.00					
47.00	45.00	0.00	0.00	0.00		
0.00	3.00	1.00	0.00	0.00		
0.00	0.00					
0.00	0.00	150.00	1.00	48.00	0.00	0.00
0.00	0.00	2.67	0.00	0.00	0.00	0.00
441.00	441.00	620.00	620.00	-9466.30	7.46	0.00
0.00	0.00	0.00	100000.00	3000.00	152.00	1450.00

SECT.FT	SHEARLB	MOMENTFTLB	SBP PLF	DREQIN	DGIVIN	V PSI	REINF
48.00	0.	-70618.	-779.	21.55	27.54	0.00	-1.76
45.60	9517.	-56842.	-722.	19.33	27.54	28.79	-1.42
43.20	10649.	-30719.	-648.	14.21	27.54	32.22	-0.76
40.80	8770.	-7410.	-564.	6.98	27.54	26.53	-0.18
38.40	7098.	11632.	-478.	8.74	28.54	20.72	0.28
36.00	5622.	26898.	-395.	13.30	28.54	16.41	0.64
33.60	4323.	38833.	-322.	15.98	28.54	12.62	0.93
31.20	3171.	47827.	-260.	17.73	28.54	9.25	1.15
28.80	2129.	54188.	-214.	18.88	28.54	6.21	1.30
26.40	1157.	58132.	-185.	19.55	28.54	3.37	1.40
24.00	210.	59774.	-174.	19.83	28.54	0.61	1.44
21.60	-754.	59121.	-182.	19.72	28.54	-2.20	1.42
19.20	-1784.	56074.	-209.	19.20	28.54	-5.21	1.35
16.80	-2920.	50427.	-253.	18.21	28.54	-8.52	1.21
14.40	-4200.	41881.	-313.	16.59	28.54	-12.26	1.01
12.00	-5656.	30052.	-386.	14.06	28.54	-16.51	0.72
9.60	-7310.	14492.	-469.	9.76	28.54	-21.34	0.35
7.20	-9174.	-5289.	-557.	5.89	27.54	-27.76	-0.13
4.80	-11243.	-29791.	-643.	13.99	27.54	-34.02	-0.74
2.40	-9377.	-57010.	-720.	19.36	27.54	-28.37	-1.42
0.00	0.	-70618.	-779.	21.55	27.54	0.00	-1.76

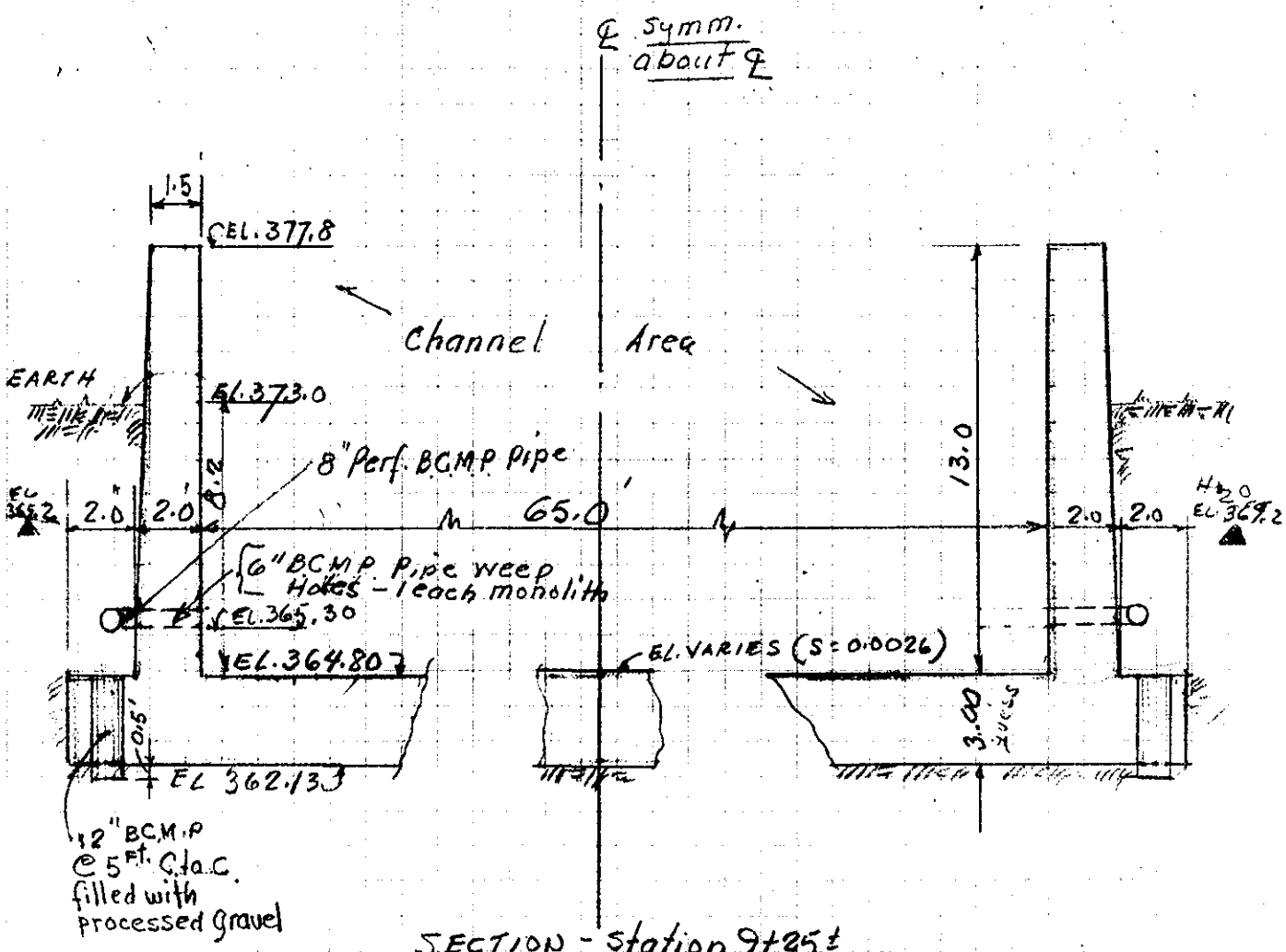
UNBALANCED LD.RIGHT, 104.
UNBALANCED LD.LEFT , -804.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT: DANBURY CHANNEL IMPROVEMENT
COMPUTATION: INLET STRUCTURE – SECTION STATION 9+25±
COMPUTED BY: [illegible] CHECKED BY: DATE: Feb. 1964

SECTION TAKEN @ station 9+25±



SECTION - Station 9+25±
3/16 = 1'-0"

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Section Thru Intake Structure
COMPUTED BY H.E.W CHECKED BY DATE

PROJECT TITLE -DANBURY LOCAL PROTECTION DATE -MARCH 1969

STEP NO. 1 CHECK SECTION FOR FLOATATION AND FIND BASE PROJECTION

ENTER FOLLOWING DATA:

CHANNEL WIDTH	=65.0
CHANNEL HEIGHT	=13.0
BASE THICKNESS	=3.0
WALL THICKNESS AT TOP	=1.5
WALL THICKNESS AT BOTTOM	=2.0
BASE PROJECTION (GUESS)	=2.0
HEIGHT OF WATER OUTSIDE	=4.35
HEIGHT OF WATER INSIDE	=0
HEIGHT OF EARTH OUTSIDE	=8.17
TAN. OF INTERNAL FRICTION	=.4663
"K" FACTOR	=.5
SATURATED WEIGHT OF EARTH	=140
SURCHARGE	=3.0

BASE PROJECTION	=	2.0
UPLIFT F.S. (VERT. PROJECTION OF EARTH)	=	1.33
UPLIFT F.S. (INCLUDING WEDGE ACTION ON SIDES)	=	1.44

STEP NO. 2 FIND MOMENTS AND END REACTIONS

STEM MOMENTS AT TOP OF BASE AND AT QUARTER POINTS
.....&02
.....&02
.....&02
.....&02

M AT TOP OF BASE = 34202.73 HORIZ REACT = 4347.57

M AT 1/4 POINT = 11974.26

M AT 1/2 " = 347.17

M AT 3/4 " = 216.10

BASE SLAB MOMENTS AND REACTIONS

BEARING PRESSURE = 276.45

UPLIFT PRESSURE = 459.37

CANTILEVER M = 6059.01 V = 6059.01

M AT INSIDE OF WALL STEM = -24071.65 V = 9289.55

M AT CENTER LINE = 123511.46

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Section Thru. Intake Structure
COMPUTED BY H.EW CHECKED BY DATE Mar 1969

STEP NO. 3 FIND REQ'D D, AS, AND UNIT SHEAR

```
F'C = 3000
 FC = 1050
  K = 152
    -...........&02
    -...........&02
    -...........&02
```

WALL STEM

TOP OF BASE	AS =	1.12	REQ'D D =	15.00	V =	19.83
1/4 POINT	AS =	.42				
1/2 "	AS =&01	.13				
3/4 "	AS =&01	.09				

BASE SLAB

-MS = 32233.35 +MS = 136176.17

CANTILEVER	AS =	.12				
INDSIDE STEM	AS =	.35	REQ'D D =	14.56	V =	27.58
AT CENTER	AS =	2.57	" " =	29.93		

END

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Section Thru Inlet Structure
COMPUTED BY H.E.W. CHECKED BY DATE Mar 1969
Case II

PROJECT TITLE -DANBURY LOCAL PROTECTION DATE -MARCH 1969

STEP NO. 1 CHECK SECTION FOR FLOATATION AND FIND BASE PROJECTION

ENTER FOLLOWING DATA:

CHANNEL WIDTH	=65.0
CHANNEL HEIGHT	=13.0
BASE THICKNESS	=3.0
WALL THICKNESS AT TOP	=1.5
WALL THICKNESS AT BOTTOM	=2.0
BASE PROJECTION (GUESS)	=2.0
HEIGHT OF WATER OUTSIDE	=4.35
HEIGHT OF WATER INSIDE	=0
HEIGHT OF EARTH OUTSIDE	=8.17
TAN. OF INTERNAL FRICTION	=.4663
"K" FACTOR	=.33
SATURATED WEIGHT OF EARTH	=110.0
SURCHARGE	=3.0

BASE PROJECTION	=	2.0
UPLIFT F.S. (VERT. PROJECTION OF EARTH)	=	1.29
UPLIFT F.S. (INCLUDING WEDGE ACTION ON SIDES)	=	1.38

STEP NO. 2 FIND MOMENTS AND END REACTIONS

STEM MOMENTS AT TOP OF BASE AND AT QUARTER POINTS

.....&02
.....&02
.....&02
.....&02

M AT TOP OF BASE = 21046.31 HORIZ REACT = 2497.39

M AT 1/4 POINT = 7101.65

M AT 1/2 " = 180.03

M AT 3/4 " = 112.06

BASE SLAB MOMENTS AND REACTIONS

BEARING PRESSURE = 233.62

UPLIFT PRESSURE = 459.37

CANTILEVER M = 4664.73 V = 4664.73

M AT INSIDE OF WALL STEM = -8215.71 V = 7897.43

M AT CENTER LINE = 117468.09

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Section Thru Inlet Structure
COMPUTED BY H.E.W CHECKED BY DATE Mar 1969

STEP NO. 3 FIND REQ'D D, AS, AND UNIT SHEAR

```
F'C = 3000
 FC = 1050
  K = 152
    -..........&02
    -..0.......&0
    -..........&02
```

WALL STEM

TOP OF BASE	AS =	.69	REQ'D D =	11.76	V =	11.39
1/4 POINT	AS =	.25				
1/2 "	AS =&01	.06				
3/4 "	AS =&02	.47				

BASE SLAB

-MS = 13285.96 +MS = 125335.72

CANTILEVER	AS =	.09				
INDSIDE STEM	AS =	.07	REQ'D D =	9.34	V =	23.44
AT CENTER	AS =	2.46	" " =	28.71		

END

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Channel Section
COMPUTED BY H.E.W. CHECKED BY DATE Mar 1969

Determination of loads for application to Beam on Elastic Foundation Program

Moment from lateral pressure on sidewall

M at top of base = 34202.73 H React = 4347.57

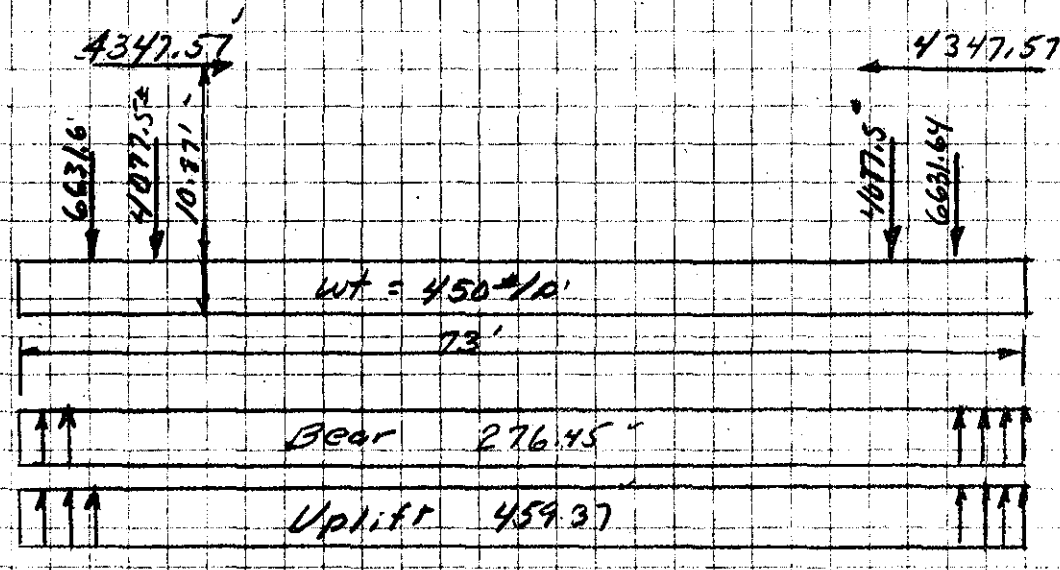
$\frac{34202.73}{4347.57} = 7.87'$

A force of 4347.57 applied 7.87' above top of base

Force application on cantilever projection

Net shear at face	= +	6059.01
wt. of base 2x450	= −	900.00
Uplift 2x459.37	= +	918.74
Bearing 2x276.45	= +	553.90
		6631.67

Wt. of Sidewall plus earth plus surch = 4077.5#



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NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

PAGE DM-14

SUBJECT Danbury Channel Improvement
COMPUTATION Typical Section Thru Intake
COMPUTED BY H.E.W. CHECKED BY DATE

Case III Loading

DANBURY - CONN. 24 MARCH 1969

CHANNEL	STRUCT.	U SHAPED INLET	1 FT WIDTH	73 FT BASE		
6631.60	4077.50	0.00	0.00	0.00		
0.00	4077.50	6631.60	0.00	0.00		
0.00	0.00					
72.00	69.85	0.00	0.00	0.00		
0.00	3.15	1.00	0.00	0.00		
0.00	0.00					
0.00	0.00	150.00	1.00	73.00	0.00	0.00
0.00	0.00	3.00	0.00	0.00	0.00	0.00
276.45	276.45	459.37	459.37	-4347.57	10.87	0.00
0.00	0.00	0.00	100000.00	3000.00	152.00	1450.00

SECT.FT	SHEARLB	MOMENTFTLB	SBP PLF	DREQIN	DGIVIN	V PSI	REINF
73.00	0.	-47258.	-623.	17.63	31.50	0.00	-1.03
69.35	7183.	-32103.	-551.	14.53	31.50	19.00	-0.70
65.70	5443.	-9059.	-470.	7.72	31.50	14.40	-0.19
62.05	4007.	8188.	-385.	7.33	32.50	10.27	0.17
58.40	2867.	20735.	-303.	11.67	32.50	7.35	0.44
54.75	1996.	29610.	-228.	13.95	32.50	5.11	0.62
51.10	1359.	35735.	-163.	15.33	32.50	3.48	0.75
47.45	915.	39888.	-109.	16.19	32.50	2.34	0.84
43.80	615.	42681.	-69.	16.75	32.50	1.57	0.90
40.15	407.	44547.	-44.	17.11	32.50	1.04	0.94
36.50	238.	45725.	-33.	17.34	32.50	0.61	0.97
32.85	53.	46259.	-38.	17.44	32.50	0.13	0.98
29.20	-203.	45986.	-58.	17.39	32.50	-0.52	0.97
25.55	-587.	44542.	-93.	17.11	32.50	-1.50	0.94
21.90	-1153.	41364.	-143.	16.49	32.50	-2.95	0.87
18.25	-1950.	35700.	-208.	15.32	32.50	-5.00	0.75
14.60	-3020.	26627.	-284.	13.23	32.50	-7.74	0.56
10.95	-4397.	13089.	-369.	9.27	32.50	-11.27	0.27
7.30	-6095.	-6059.	-458.	6.31	31.50	-16.12	-0.13
3.65	-8108.	-31981.	-546.	14.50	31.50	-21.45	-0.70
0.00	0.	-47258.	-623.	17.63	31.50	0.00	-1.03

UNBALANCED LD.RIGHT, -309.
UNBALANCED LD.LEFT , -1491.

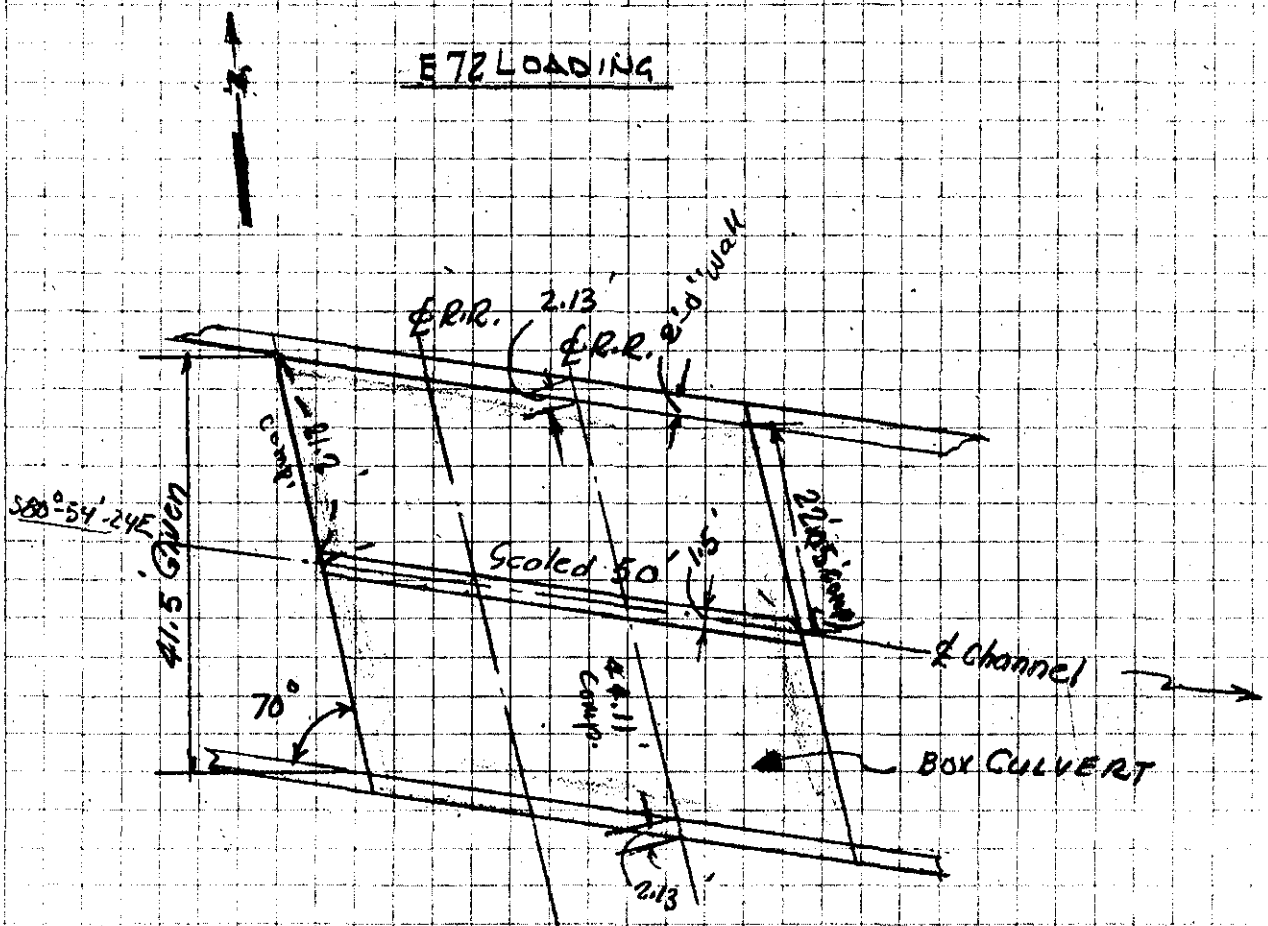
SUBJECT: DANBURY - CHANNEL IMPROVEMENT

COMPUTATION: RAILROAD BRIDGE REPLACEMENT = CONCRETE BOX CULVERT Sta 10+50±

COMPUTED BY: EJM CHECKED BY: DATE: Feb. 1969

RE: PLAN and PROFILE Sta 9+20 to 22+00

E72 LOADING



- PLAN -
1" = 20'

RE: AREA HANDBOOK
FROM GRAPH E72 LOADING PAGE 8-16-5
FOR UNIFORMLY DISTRIBUTED LOAD = L.L. + D.L. + IMPACT = 2250 psf
(CONSIDERING FILL TO P OF R.R. TIES TO TOP OF CULVERT = 3')

$$\frac{2250}{140} = 16' \text{ surcharge}$$

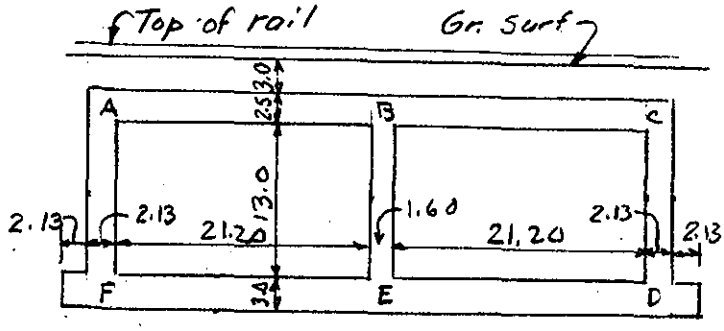
Critical condition will occur with R.R loading and max soil weights. Box culvert program assumes water to conduit roof or higher. U channel section assumed water 7.25' above base slab. The higher ground water assumption is on the conservative side and would have only minor effect on steel requirements

PROJECT TITLE - DANBURY LOCAL PROTECTION DATE - MARCH 1969

STEP NO. 1 - CHECK CONDUIT FOR FLOATATION AND FIND REQ. BASE PROJECTION

ENTER FOLLOWING DATA

INDSIDE WIDTH	=21.20
INDSIDE HEIGHT	=13.0
DIVIDING WALL THICKNESS	=1.60
OUTSIDE WALL THICKNESS	=2.13
BASE THICKNESS	=3.0
ROOF THICKNESS	=2.5
BASE PROJECTION	=2.13
HT. OF EARTH ON ROOF	=3.0
HT. OF WATER ABOVE ROOF	=0
WT. OF EARTH SATURATED	=140
TANGENT OF INT. FRICTION	=.4663
HT. OF WATER IN CONDUIT	=0
SURCHARGE (FEET)	=16.0
K FACTOR	=.50



BASE PROJECTION = 2.13
UPLIFT F.S. (VERT. PROJ. OF EARTH) = 1.39
UPLIFT F.S. (INCLUDING WEDGE ACTION ON SIDES) = 1.64

STEP NO. 2 - FIND FIXED END MOMENTS AND STIFFNESS RATIOS

MEMBER AB FEM @A = 134550.20 @B = -134550.20
" " STIFFNESS RATIO @ A = .52 @ B = .41

MEMBER AF FEM @A = -43295.94 @F = 49888.98
" " STIFFNESS RATIO @ A = .47 @ F = .34

MEMBER FE FEM @F = -190932.40 @E = 190932.40
" " STIFFNESS RATIO @F = .65 @ E = .45

CANTILEVER MOMENT @ F = -25577.42

BEARING PRESSURE = 3600.54

STEP NO. 3 - DISTRIBUTE MOMENTS, FIND REACTIONS AND POSITIVE MOMENTS.

-.....&02

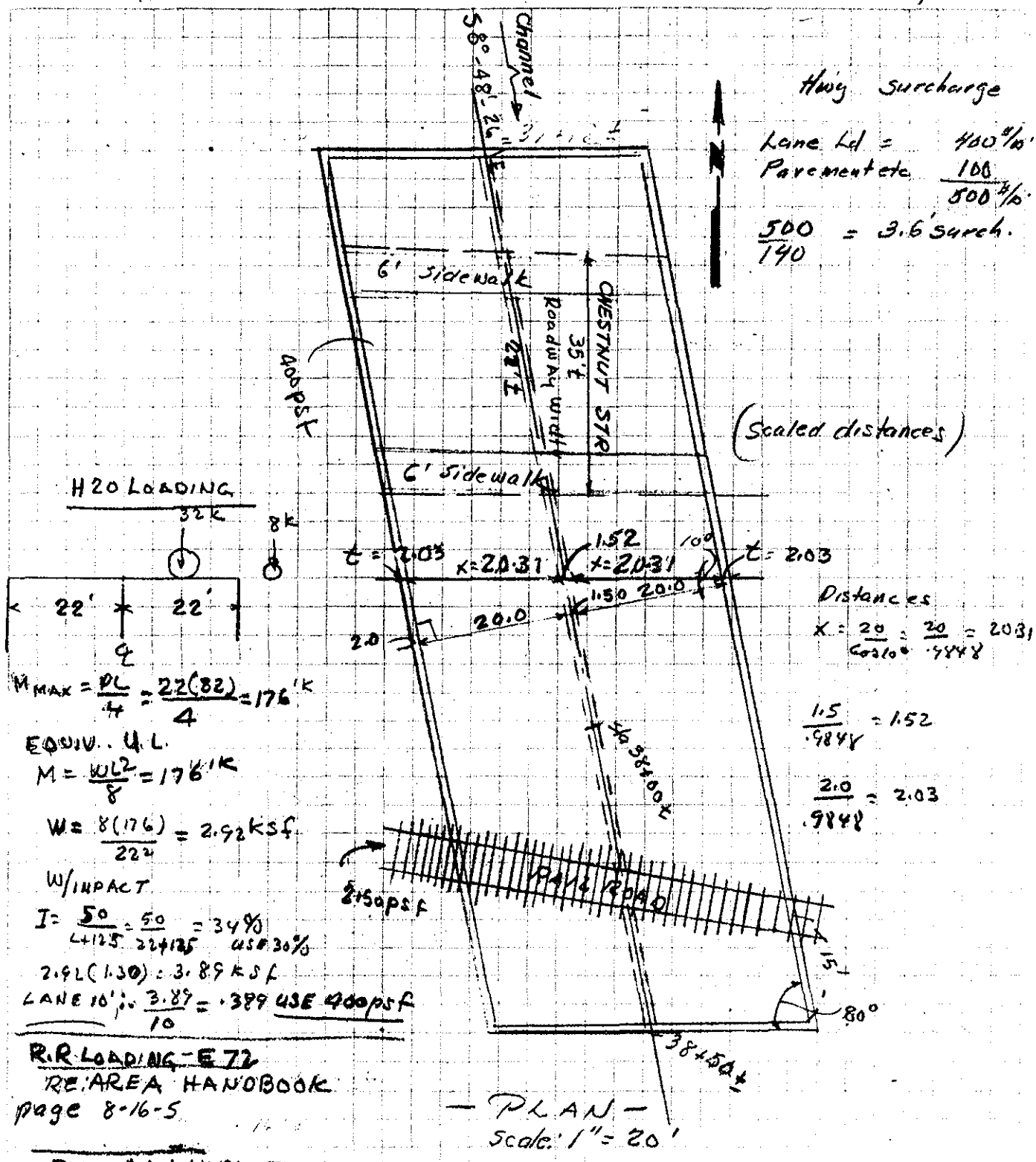
MEMBER AB	FINAL MOMENT AT A =	68956.70	AT B =	-167334.66
	END REACTION AT A =	30735.88	AT B =	39266.38
	XO FROM END AT A =	10.12	+ M =	86676.71
MEMBER AF	FINAL MOMENT AT A =	-68955.70	AT F =	87706.95
	END REACTION AT A =	14465.92	AT F =	21033.09
	XO FROM END AT A =	7.81	+ M =	-8436.02

```
MEMBER FE   FINAL MOMENT AT F =   -62128.53 AT E =   255322.13
            END REACTION AT F =    41292.03 AT E =    58044.13
            XO FROM END  AT F =        9.58 +  M =   135818.33

STEP NO. 4 - FIND -M AT FACE OF SUPPORTS AND MS MOMENTS

MEMBER AB   -M  AT A =    48281.67 AT B =  -147040.06
            -MS AT A =    62144.86 AT B =  -160903.24 +MS =     99334.40

MEMBER AF   -M  AT A =   -57675.86 AT F =    68933.82
            -MS AT A =   -81444.95 AT F =   100866.33 +MS =     12769.74

MEMBER FE   -M  AT F =   -34439.48 AT E =   225284.04
            -MS AT F =   -58101.71 AT E =   248946.27 +MS =    159480.56

STEP NO. 5 - FIND REQ'D D AND AREA OF STEEL

 ALLOWABLE STRESSES:  F'C  =4000
                      FC   =1300
                      FS   =20000
        -...........&02
        -...........&02
        -...........&02
        -...........&02
        -...........&02
        -...........&02

MEMBER AB REQ'D D AT A =       13.84 AT B =       22.28
          -AS AT A =            .91 AT B =        3.51 +AS =         1.99

MEMBER AF REQ'D D AT A =       15.85 AT F =       17.64
          -AS AT A =           1.03 AT F =        1.12 +AS =        -1.11

MEMBER FE REQ'D D AT F =       13.39 AT E =       27.71
          -AS AT F =            .23 AT E =        4.46 +AS =         2.48

CANTILEVER AS =        -.56

STEP NO. 6 - CHECK SHEAR SF IN ROOF AND BASE SLAB

        -...........&02
         ...........&02

MEMBER AB  FS AT A =          3.20  AT B =          3.20
           SFS ALLOW =         2.5
         ...........&02
         ...........&02

MEMBER FE  FS AT F =          2.77  AT E =          2.77
           SFS ALLOW =         2.5
```

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT: DANBURY - CHANNEL IMPROVEMENT
COMPUTATION: Station 38+00± - RAILROAD & STREET CROSSING
COMPUTED BY: Eym CHECKED BY: DATE: Feb 1965



— PLAN —
Scale: 1" = 20'

$M_{MAX} = \frac{PL}{4} = \frac{22(82)}{4} = 176'^k$

EQUIV. U.L.

$M = \frac{WL^2}{8} = 176'^k$

$W = \frac{8(176)}{22^2} = 2.92$ ksf

W/IMPACT

$I = \frac{50}{L+125} = \frac{50}{22+125} = 34\%$ USE 30%

2.92(1.30) = 3.89 ksf

LANE 10' ∴ $\frac{3.89}{10} = .389$ USE 400psf

R.R. LOADING - E72
RE: AREA HANDBOOK
page 8-16-5

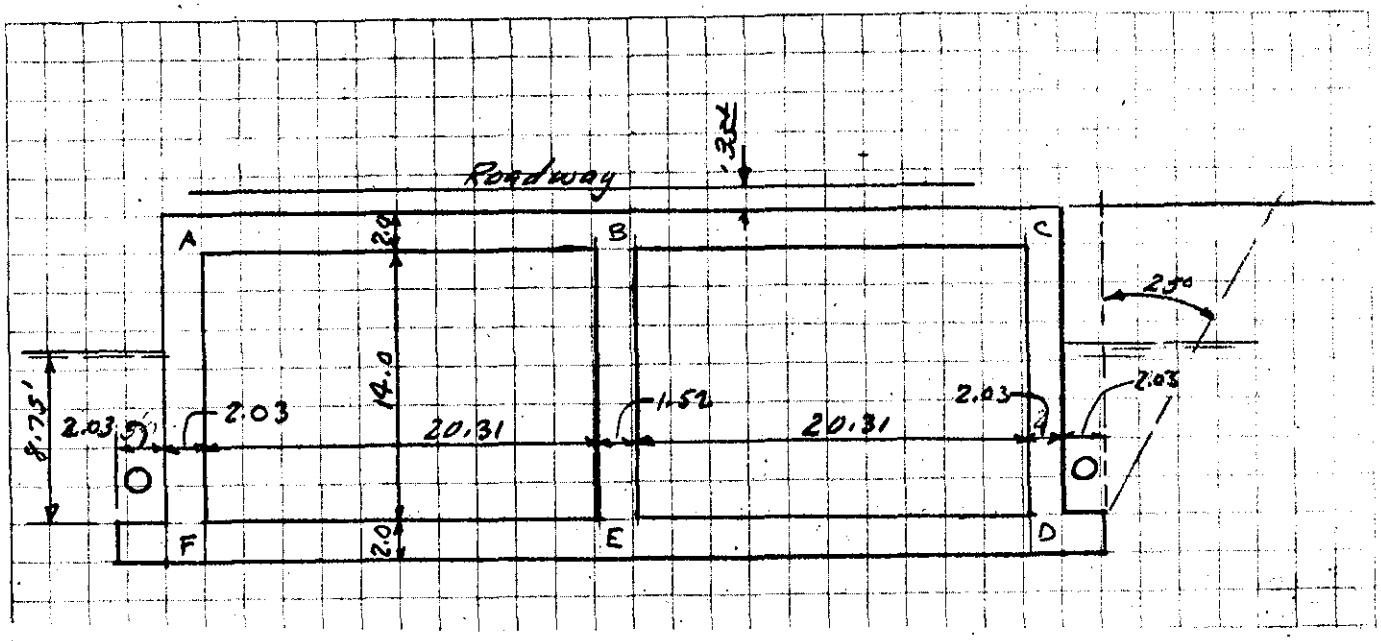
D.L + LL + IMPACT

FILL 1.5' TO BOT OF RAIL
GRAPH: 2125#/□ Say 2150#/□

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Highway Culvert. Sta
COMPUTED BY H.E.W. CHECKED BY DATE



STEP NO. 1 - CHECK CONDUIT FOR FLOATATION AND FIND REQ. BASE PROJECTION

ENTER FOLLOWING DATA

INDSIDE WIDTH	=20.31
INDSIDE HEIGHT	=14.0
DIVIDING WALL THICKNESS	=1.~~59~~ 1.52
OUTSIDE WALL THICKNESS	=2.03
BASE THICKNESS	=2.0
ROOF THICKNESS	=2.0
BASE PROJECTION	=~~3.05~~ 2.03
HT. OF EARTH ON ROOF	=0
HT. OF WATER ABOVE ROOF	=0
WT. OF EARTH SATURATED	=140 (use 110 for uplift safety factor)
TANGENT OF INT. FRICTION	=.4663
HT. OF WATER IN CONDUIT	=0
SURCHARGE (FEET)	=3.6
K FACTOR	=.50

Check useing vert proj of earth

		↓	↑
Roof	2 x 46.27 x 150	13881	
Out. walls	2 x 2.03 x 14 x 150	8526	
Int wall	1.59 x 14 x 150	3339	
Base	2 x 50.33 x 150	15099	
Ea.	2 x 2.03 x 110 x 14	6252	
Roadway	.33 x 140 x 46.27	2137	
Uplift	10.75 x 625 x 50.33		33816
		49234	

S.F = 49234 / 33815 = 1.46
Adequate S.F

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Danbury Channel Improvement
COMPUTATION Highway Culvert
COMPUTED BY H.EW CHECKED BY DATE

Note: The following steps accomplished in the computer program. This program assumes ground water to top of roof slab. This is a more severe loading but is considered to have only minor effect on steel requirements

STEP NO. 2 - FIND FIXED END MOMENTS AND STIFFNESS RATIOS

```
MEMBER AB  FEM @A =     32782.72 @B =   -32782.72
  "    "   STIFFNESS RATIO @ A =          .40 @ B =          .37

MEMBER AF  FEM @A =    -21360.00 @F =    28272.00
  "    "   STIFFNESS RATIO @ A =          .59 @ F =          .59

MEMBER FE  FEM @F =    -62363.72 @E =    62363.72
  "    "   STIFFNESS RATIO @F  =          .40 @ E =          .37

CANTILEVER MOMENT @ F =    -10396.05

BEARING PRESSURE  =       704.47
```

STEP NO. 3 - DISTRIBUTE MOMENTS, FIND REACTIONS AND POSITIVE MOMENTS.

```
        -..........&02

MEMBER AB  FINAL MOMENT AT A =    21781.88 AT B =   -38262.83
           END REACTION AT A =     8147.16 AT B =     9637.31
           XO FROM END  AT A =       10.13 +  M =    19496.95

MEMBER AF  FINAL MOMENT AT A =   -21780.88 AT F =    51330.44
           END REACTION AT A =     5299.15 AT F =    13312.84
           XO FROM END  AT A =        7.32 +  M =      926.15

MEMBER FE  FINAL MOMENT AT F =   -40933.39 AT E =    73073.42
           END REACTION AT F =    15463.03 AT E =    18369.00
           XO FROM END  AT F =       10.11 +  M =    37232.35
```

STEP NO. 4 - FIND -M AT FACE OF SUPPORTS AND MS MOMENTS

```
MEMBER AB  -M  AT A =    16545.06 AT B =   -33324.44
           -MS AT A =    20298.63 AT B =   -37078.01 +MS =    22808.92

MEMBER AF  -M  AT A =   -18374.30 AT F =    43104.53
           -MS AT A =   -24267.42 AT F =    54289.45 +MS =     6140.33

MEMBER FE  -M  AT F =   -30995.30 AT E =    63660.07
           -MS AT F =   -39315.83 AT E =    71980.60 +MS =    45552.88
```

SUBJECT
COMPUTATION
COMPUTED BY CHECKED BY DATE

STEP NO. 5 - FIND REQ'D D AND AREA OF STEEL

ALLOWABLE STRESSES: F'C =4000
FC =1800
FS =20000

-..0.....&0
-.....&02
-..0.....&0
-.....&02
-.....&02
-.....&02

MEMBER AB REQ'D D AT A = 7.91 AT B = 10.69
-AS AT A = .42 AT B = .99 +AS = .55

MEMBER AF REQ'D D AT A = 8.65 AT F = 12.94
-AS AT A = .40 AT F = 1.04 +AS = -.19

MEMBER FE REQ'D D AT F = 11.01 AT E = 14.90
-AS AT F = .74 AT E = 1.90 +AS = .96

CANTILEVER AS = -.37

STEP NO. 6 - CHECK SHEAR SF IN ROOF AND BASE SLAB

-.....&02
.....&02

MEMBER AB FS AT A = 9.04 AT B = 9.04
SFS ALLOW = 2.5
-.....&02
.....&02

MEMBER FE FS AT F = 5.00 AT E = 5.00
SFS ALLOW = 2.5

END