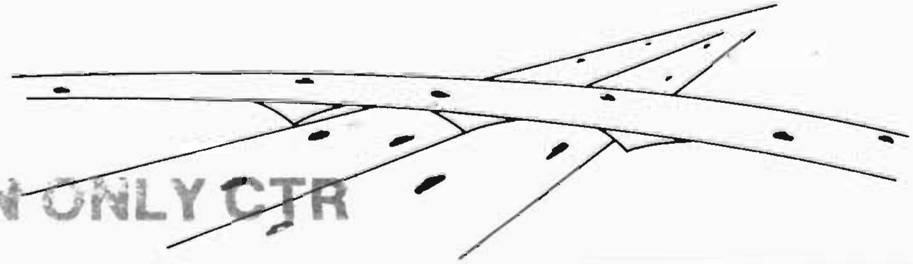


DEPARTMENTAL RESEARCH

Report Number 226-IF

ECONOMICAL PRECAST CONCRETE BRIDGES

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

TE... TLE PAGE

1. Report No. FHWA/TX/83/08+226-1F	2. Government Accession No.	
4. Title and Subtitle ECONOMICAL PRECAST CONCRETE BRIDGES		5. Report Date March 1982
		6. Performing Organization Code
7. Author(s) John J. Panak		8. Performing Organization Report No. 226-1F
9. Performing Organization Name and Address The Bridge Division, Texas State Department of Highways and Public Transportation, Austin, Texas 78701		10. Work Unit No.
		11. Contract or Grant No. 1-5-78-226
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation, Transportation Planning Division, Box 5051, Austin Texas 78763		13. Type of Report and Period Covered Final, Aug 1978 - March 1982
		14. Sponsoring Agency Code

15. Supplementary Notes

Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Research Study Title: "Development of Economical Precast Concrete Bridges"

16. Abstract

The research completed under this contract has resulted in the development of five different precast structural superstructure types with details completed which are suitable for inclusion in a set of contract plans. The five types are: (1) Precast Concrete Box Beams, (2) Prestressed Concrete PCI Box Beams, (3) Precast Concrete Double Stem Tee Beams, (4) Precast Concrete Solid Slabs, and (5) Precast Concrete Voided Slabs.

Bent and abutment details compatible with the developed superstructure details were also prepared.

A trial contract was let in April 1981 with two of the developed types allowed as alternates to a regular type of standard structure. Neither of the alternates was the low bid.

It was determined that one of the primary reasons that the alternates were not competitive with the standard structure was that the precast producers were not willing to invest in new forms and associated production hardware which might be used for only one job. It is recommended that some means be found to separate this cost from the contract, thus allowing a true comparison of the new bridge types to be made.

17. Key Words Highway Bridges, Precast Concrete, Prestressed Concrete, Costs	18. Distribution Statement No restrictions. This document is available through NTIS, Springfield, Va 22161

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 34	22. Price

Form DOT F 1700.7 (8-69)

ECONOMICAL PRECAST CONCRETE BRIDGES

by

John J. Panak

Research Report 226-1F

Development of Economical
Precast Concrete Bridges

Research Study 1-5-78-226

Conducted by

The Bridge Division

Texas State Department of Highways
and Public Transportation

in cooperation with the
U.S. Department of Transportation
Federal Highway Administration

March 1982

PREFACE

This report presents the results of a study intended to develop economical precast bridge designs with primary emphasis given to box beam and double tee configurations. Complete details were prepared for five roadway widths and six different span lengths for both the box and double tee superstructures.

A trial contract was let with the developed details as alternates to the regular standard structure. Neither of the alternates was the chosen low bid.

The work was supported by the Texas State Department of Highways and Public Transportation in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

Mr. Robert L. Reed, Bridge Design Engineer of the Bridge Division provided guidance throughout the course of the project, and his help is appreciated.

John J. Panak

March 1982

SUMMARY

The research completed under this contract has resulted in the development of five different precast structural superstructure types with details completed which are suitable for inclusion in a set of contract plans. The five types are: (1) Precast Concrete Box Beams, (2) Prestressed Concrete PCI Box Beams, (3) Prestressed Concrete Double Stem Tee Beams, (4) Precast Concrete Solid Slabs, and (5) Precast Concrete Voided Slabs. Bent and abutment details compatible with the developed superstructure details were also prepared.

A trial contract was let in April 1981 with two of the developed types allowed as alternates to a regular type of standard structure. Neither of the alternates was the low bid.

It was determined that one of the primary reasons that the alternates were not competitive with the standard structure was that the precast producers were not willing to invest in new forms and associated production hardware which might be used for only one job. It is recommended that some means be found to separate this cost from the initial contract, thus allowing a true comparison of the new bridge types to be made.

IMPLEMENTATION

This project was intended to develop more economical precast bridge types. Five different precast structural superstructure types were completed which are suitable for inclusion in a set of contract plans. It is recommended that a contractural procedure be devised to separate the initial investment in forms and production hardware from the contract cost so that a fair comparison of the new bridge types can be made.

DISCLAIMER

This report reflects the views of the author who is responsible for the facts presented. The contents do not necessarily reflect the views or policies of the Bridge Division, Texas State Department of Highways and Public Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

There was no invention or discovery made under this contract which is patentable.

KEY WORDS

Bridges, Precast Concrete, Multi-beam Bridges, Prestressed Concrete, Shear Keys, Costs

TABLE OF CONTENTS

PREFACE ii

SUMMARY iii

IMPLEMENTATION iv

DISCLAIMER iv

KEY WORDS iv

LIST OF FIGURES, DRAWINGS, AND TABLES vi

CHAPTER 1. INTRODUCTION
Background 1
Configurations Considered 3
Evaluation of Proposed Sections 3
Implementation 4

CHAPTER 2. DETAILS OF PRECAST SUPERSTRUCTURES
Precast Concrete Box Beams 11
Prestressed Concrete PCI Box Beams 16
Prestressed Concrete Double Tee Beams 17
Precast Concrete Solid Slabs 19
Precast Concrete Voided Slabs 23

CHAPTER 3. CONTRACT PLANS 25

CHAPTER 4. SUMMARY AND RECOMMENDATIONS 32

REFERENCES 33

LIST OF FIGURES, DRAWINGS, AND TABLES

FIGURES

Figure 1. New Structure Coats in Texas 2

CONCEPTUAL DRAWINGS

Precast Concrete Box Beams 6
Prestressed Concrete PCI Box Beams 7
Precast Concrete Double Stem Tee Beams 8
Precast Concrete Solid Slabs 9
Precast Concrete Voided Slabs 10

CONTRACT DRAWINGS

Prestressed Concrete 20 in. Box Beams, Sheet B-RD 13
Prestressed Concrete 20 in. Box Beams, Sheet B-D. 14
Bents for Prestressed Concrete Box Beams,
34 ft Rdwy, Sheet 34 BB 45-55 15
Prestressed Concrete T Beams, Sheet T-RD 19
Prestressed Concrete T Beams, Sheet T-D. 20
Bents for Prestressed Concrete T Beams,
34 ft Rdwy, Sheet 34 BT 35-40 21

TABLES

Table 1. Engineer's Estimate and Low Bid
for CGC Regular Bid 27

Table 2. Second and Third Low Bids
for CGC Regular Bid 28

Table 3. Engineer's Estimate and Only Bid
for Prestressed Box Beam Alternate 29

Table 4. Engineer's Estimate and Only Bid
for Prestressed Tee Beam Alternate 30

CHAPTER 1. INTRODUCTION

The objective of this study was to evaluate and develop precast bridge superstructure details which lend themselves to rapid erection yet be economical to construct.

Background

The Texas Department of Highways and Public Transportation (hereinafter referred to as DHT) has achieved significant recognition within the last twenty years in the use of bridges composed of prestressed I-beams with cast-in-place slab decks. In 1969, the first state use was made of precast box beams placed side by side with nominal cast-in-place concrete used for shear connection between the boxes. This need for a totally precast super-structure such as the box beam type has been recognized for many years. Unfortunately, the cost of current precast box beams as now detailed is significantly greater than the other two common and most economical bridges built in Texas. These two types are prestressed I-beams with cast-in-place slabs, and the so-called pan girder spans.

Pan girder spans (also termed concrete girder spans or CGC spans) were first developed in about 1955, and are composed of concrete beams flaring into an integral slab. Only two span lengths are available for the CGC units, 30.33 ft and 40.0 ft. The CGC steel formwork is in reuseable three foot wide sections self suported at the bents. The forms have half circular segments forming the underside of the slab. An average of 30 to 50 of these structures are built in Texas each year.

The prestressed I-beam and CGC structure types have proven to be the most economical bridges constructed in Texas for about the last 25 years. Figure 1 shows the costs for new bridges built in Texas for the last 10 years.

Precast panels (Ref 1) placed on prestressed or steel beams with a subsequent cast-in-place topping are variations which have also been used for a number of bridges with success. The precast box beams set side-by-side are the only superstructure type now used in Texas which does not require a significant amount of field concrete and associated formwork. Approximately 15 to 25 structures of this type have been built each year in Texas since about 1974.

Configurations Considered

During the course of this project, seven different precast configurations were considered for possible additional development.

These were:

(1) the current standard DHT box beams with modifications,

(2) the PCI box beams,

(3) single tees,

(4) double tees,

(5) bulb single tees,

(6) solid slabs, and

(7) voided slabs.

Evaluation of Proposed Sections

Preliminary evaluation by the principal investigator and other staff of the Bridge Division of the DHT was made of the above seven sections, with the result that five were selected for more detailed evaluation. The two not selected were the single tee and bulb tee sections. The main reasons for not selecting these two types are their instability during transport and erection and the shear connection and construction damage problems associated with their very thin top flanges.

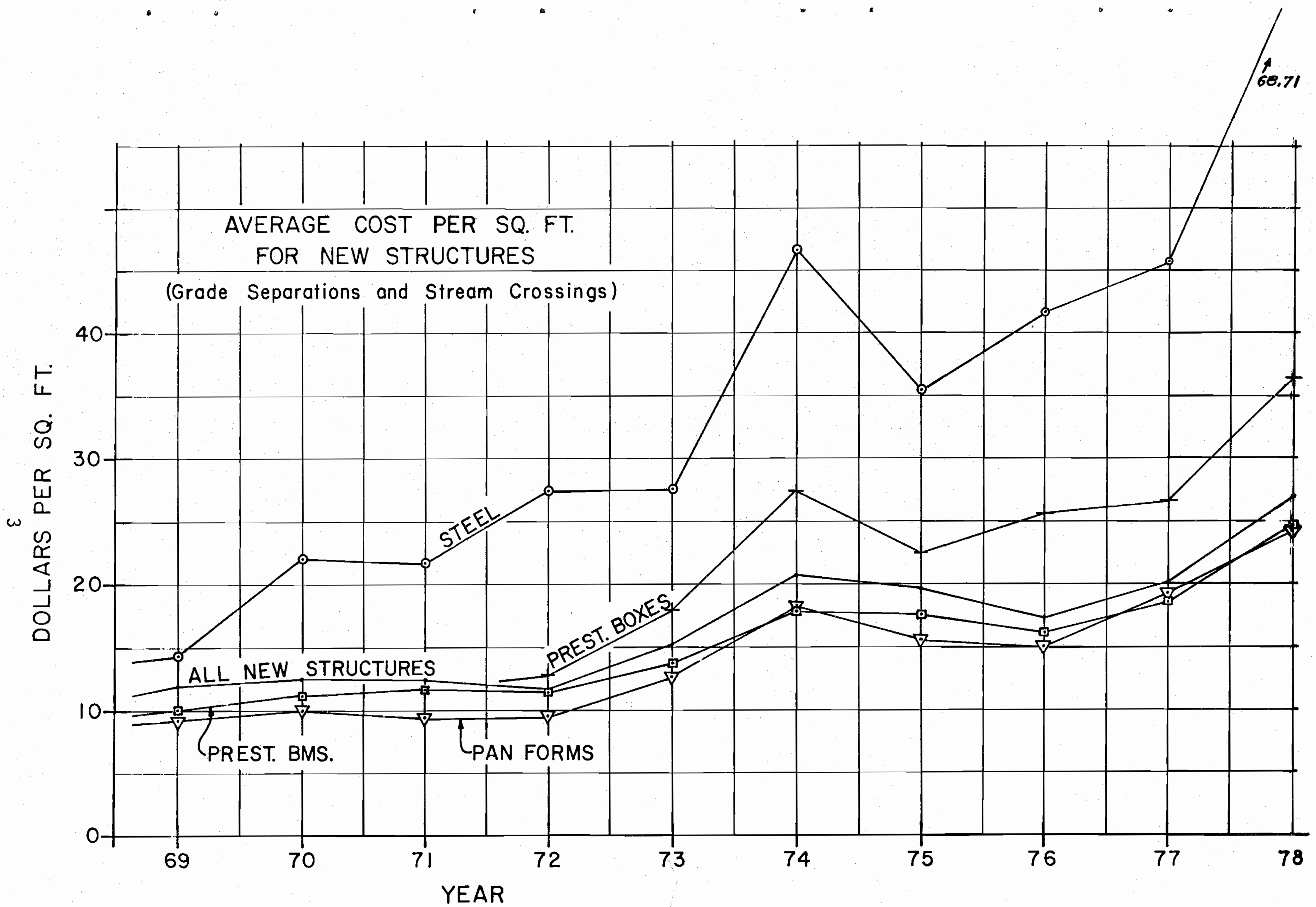


Figure 1. New structure costs in Texas.

Implementation

The five selected configurations were distributed as conceptual drawings to other DHT District personnel. Additional comments were also recieved from two producers of precast products.

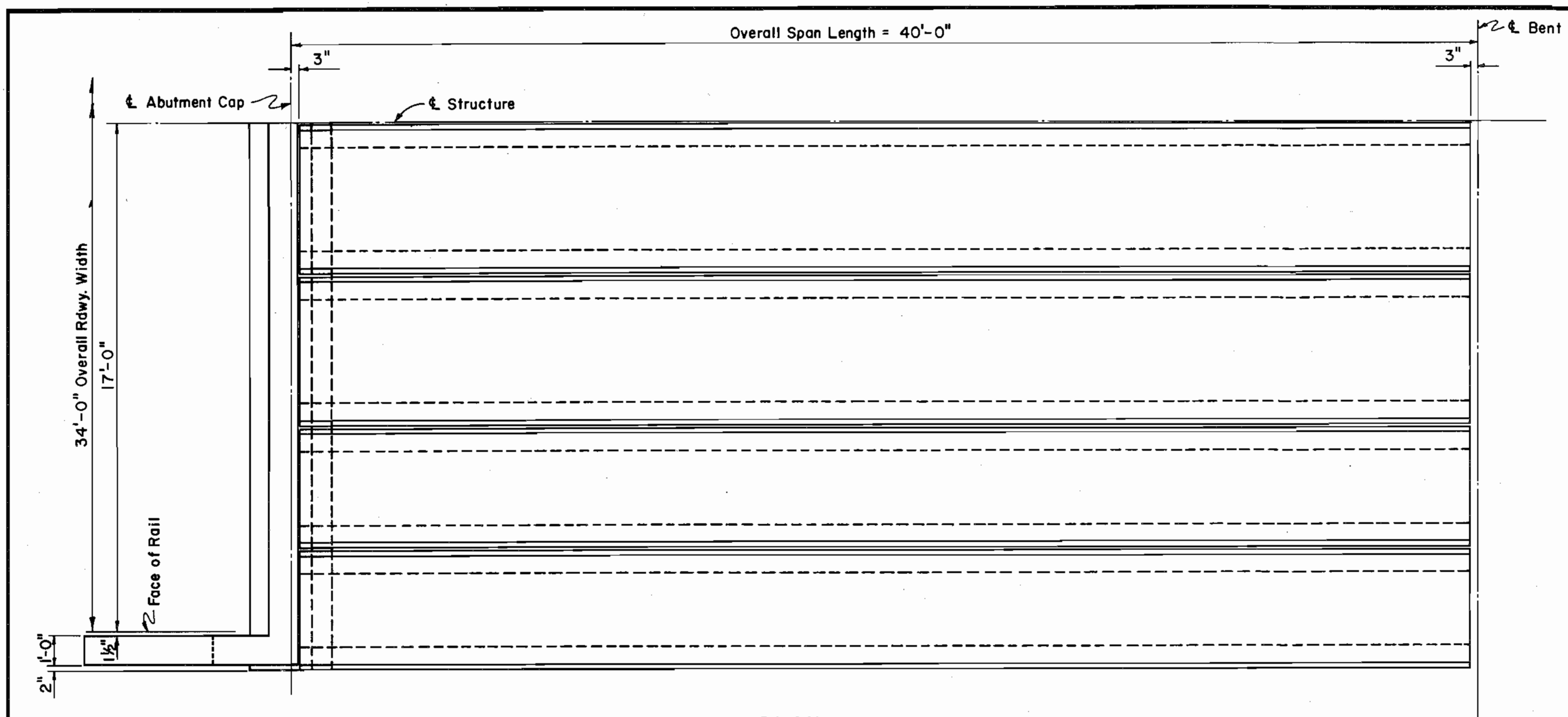
The five drawings distributed for comment are shown in the following pages. Certain minor details have been changed from the initial distribution to reflect the suggested changes compiled from those who reviewed the first versions. A subsequent major change in the box beam details at their ends will be seen when they are compared to the final details given in the next chapter.

After further evaluation of the five configurations, and with consideration of comments recieved, details suitable for inclusion in contract plans were then prepared. These are described in the next chapter.

One project in Floyd County on FM 1065 near Quitaque with structures over Los Linguish and Quitaque Creeks was selected to be let with two of the developed new precast details. The regular bid was conventional 40 ft CGC spans, the first alternate was modified (through void) DHT box beams with 50 ft spans, and the second alternate was double tee beams with 50 ft spans. One structure is 600 ft long and the other is 500 ft long. The project was let in March of 1981 with the result that the conventional CGC spans were the selected option by the low bidder.

As of the date of the last revision of this report, a second contract is being prepared to allow the same three options for the Interstate 20 South Frontage Road over the Colorado River in Mitchell County, just west of Colorado City. This bridge is to be 360 ft long with the regular bid planned to be nine 40 ft CGC spans. The first alternate is for nine 40 ft modified (through void)

DHT box beam spans. The second alternate is for nine double tee 40 ft spans.



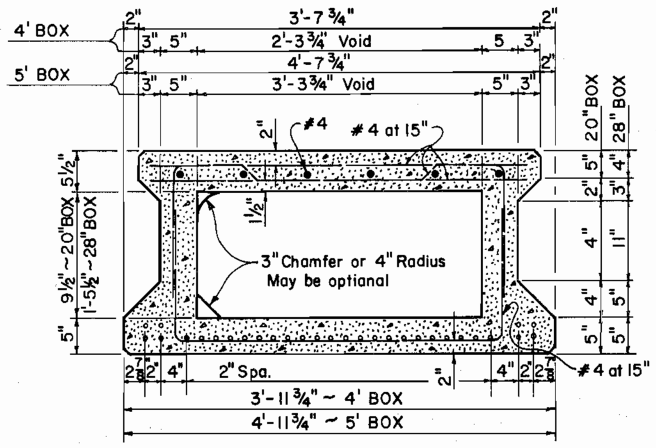
PLAN
Shown (34'-0" Rdwy. – 40'-0" Span)

JOINT ON ℄		
No. of Boxes Reqd.		
Rdw'y.	4'-0"	5'-0"
26'	2	4
34'	4	4
36'	2	6
38'	~	8
40'	8	2
42'	6	4
44'	4	6
48'	~	10

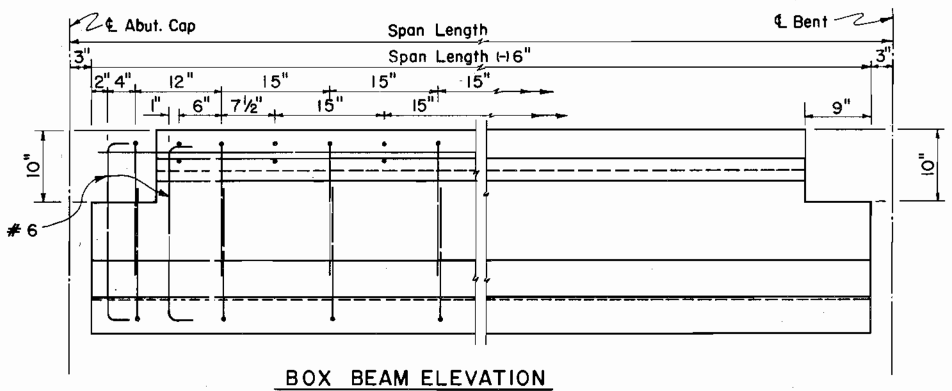
NO JOINT ON ℄		
No. of Boxes Reqd.		
Rdw'y.	4'-0"	5'-0"
26'	7	~
34'	9	~
36'	7	2
38'	5	4
40'	3	6
42'	11	~
44'	9	2
48'	5	6

LENGTHS

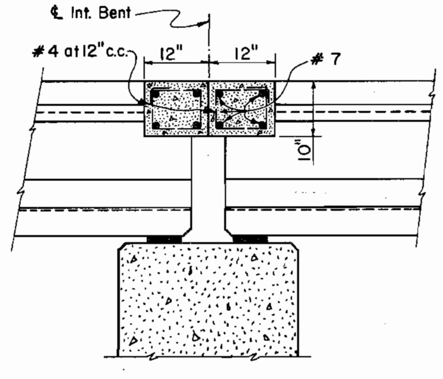
BOX UNIT DEPTH		
SPAN LENGTH	20"	28"
40'	✓	✓
45'	✓	✓
50'	✓	✓
55'	✓	✓
60'		✓
65'		✓
70'		✓
75'		✓
80'		✓



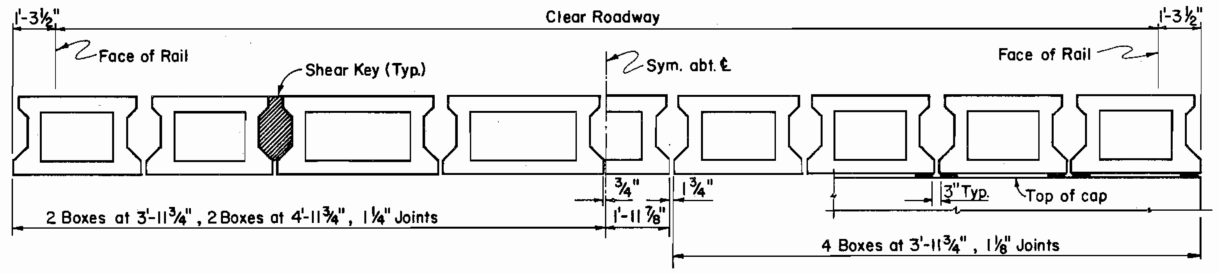
TRANSVERSE SECTION
Shown (5'-0" Box)



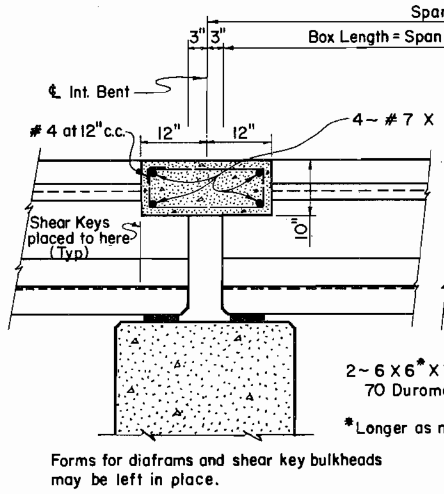
BOX BEAM ELEVATION



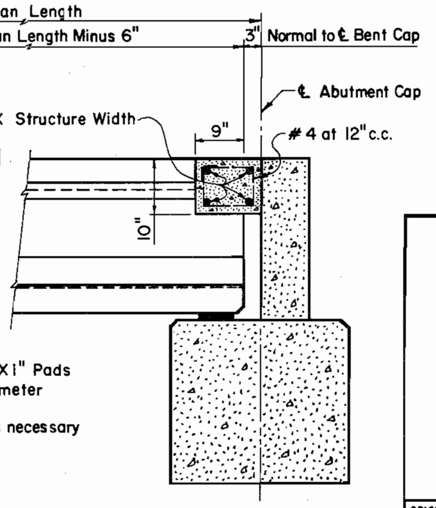
AT INTERIOR BENT
(Armor Joint or Sealed Cold Joint)



TRANSVERSE SECTIONS
Shown (34'-0" Roadways)



AT INTERIOR BENT
(Continuous)

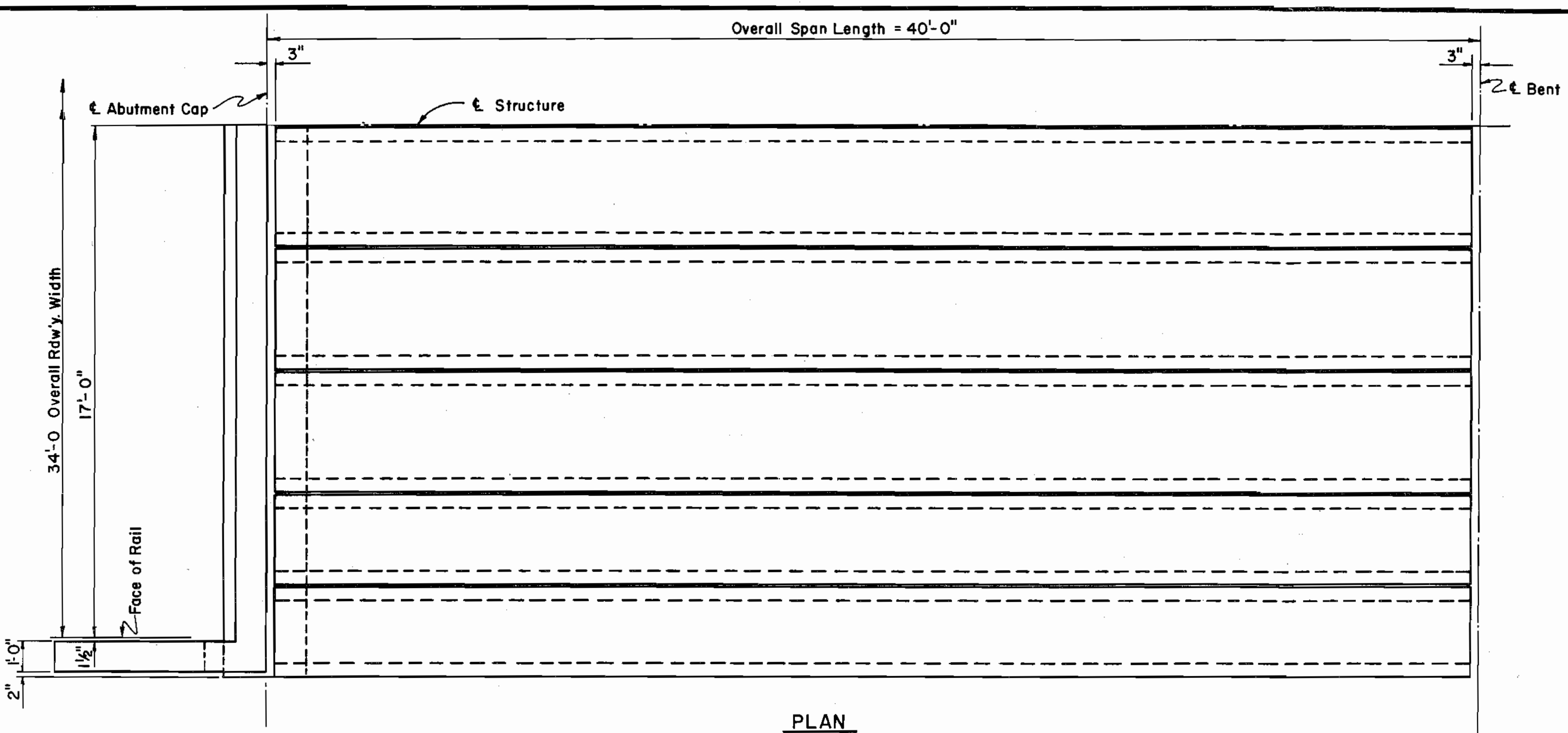


AT ABUTMENT

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRECAST CONCRETE BOX BEAMS

ORIGINAL DRAWING DATE:	REVISIONS	STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT ©	SHEET
DN.:-JJP					
CK.:-		COUNTY		CONTROL SECTION JOB	HIGHWAY
DW.:-EDS					
CK.:-					



PLAN

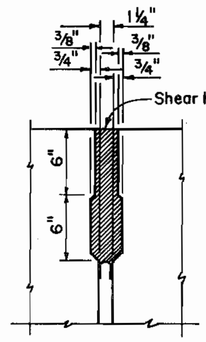
Shown (34'-0" Roadway ~ 40'-0" Span)

JOINT ON ℄

No. of Boxes Reqd.		
Rdw'y.	3'-0"	4'-0"
26'	4	4
34'	4	6
36'	2	8
38'	~	10
40'	6	6
42'	4	8
44'	2	10
48'	6	8

NO JOINT ON ℄

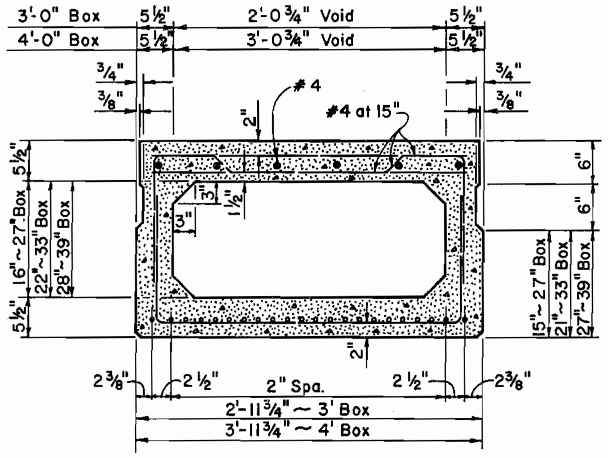
No. of Boxes Reqd.		
Rdw'y.	3'-0"	4'-0"
26'	~	7
34'	~	9
36'	6	5
38'	4	7
40'	2	9
42'	~	11
44'	6	7
48'	2	11



DETAIL A

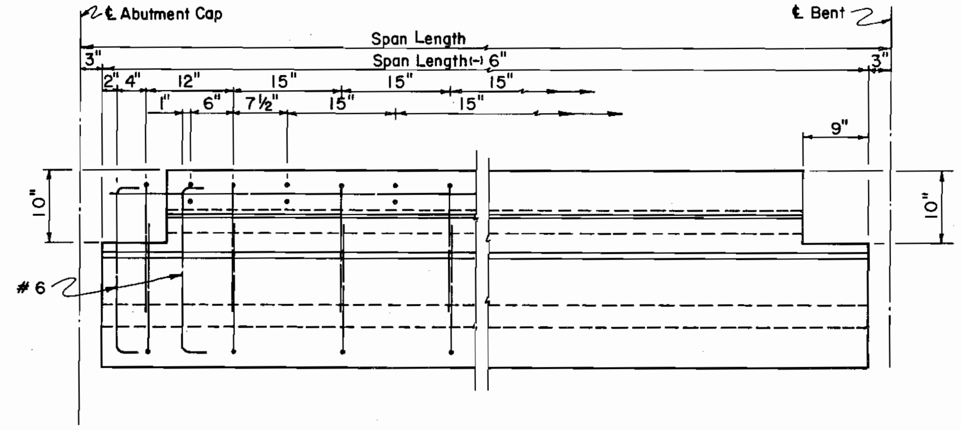
LENGTHS

PCI BOX UNIT DEPTH			
SPAN LENGTH	27"	33"	39"
60'	✓		
65'	✓		
70'	✓	✓	
75'	✓	✓	
80'		✓	✓
85'		✓	✓
90'			✓
95'			✓

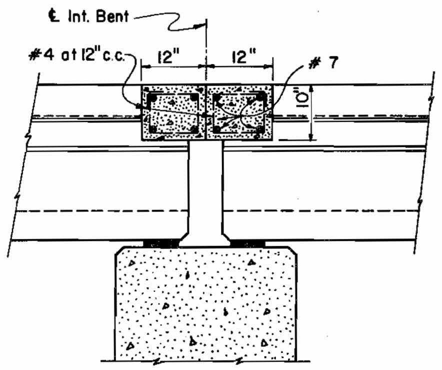


TRANSVERSE SECTION

Shown (4'-0" Box)

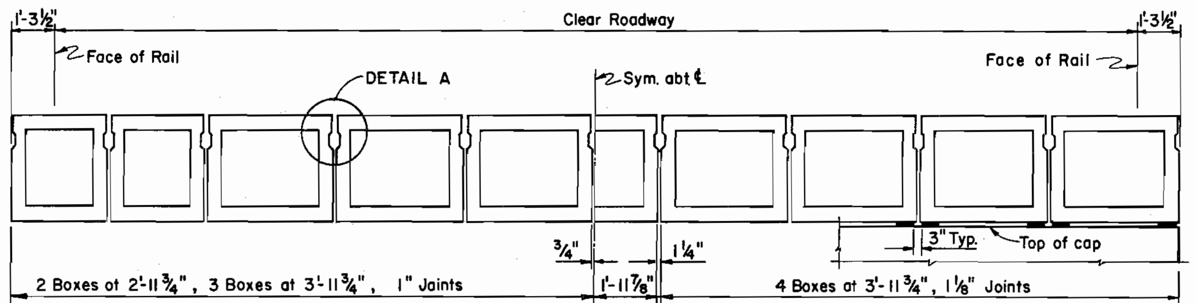


BOX BEAM ELEVATION



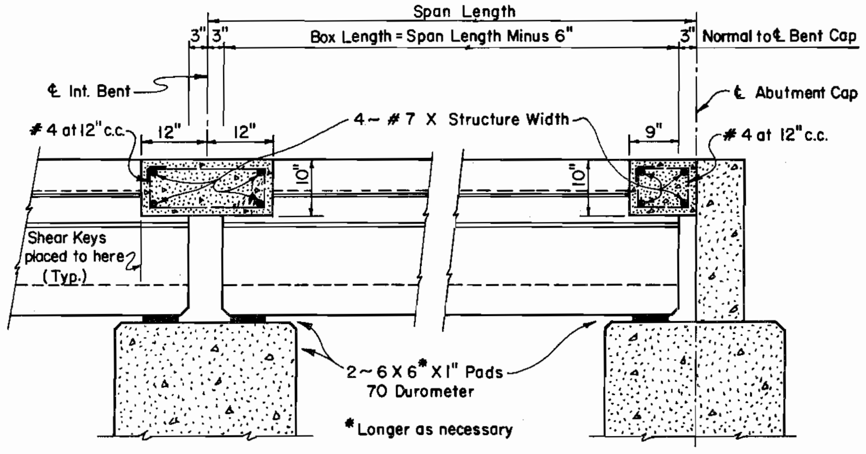
AT INTERIOR BENT

(Armor Joint or Sealed Cold Joint)



TRANSVERSE SECTIONS

Shown (34'-0" Roadways)



Forms for diafroms and shear key bulkheads may be left in place.

AT INTERIOR BENT

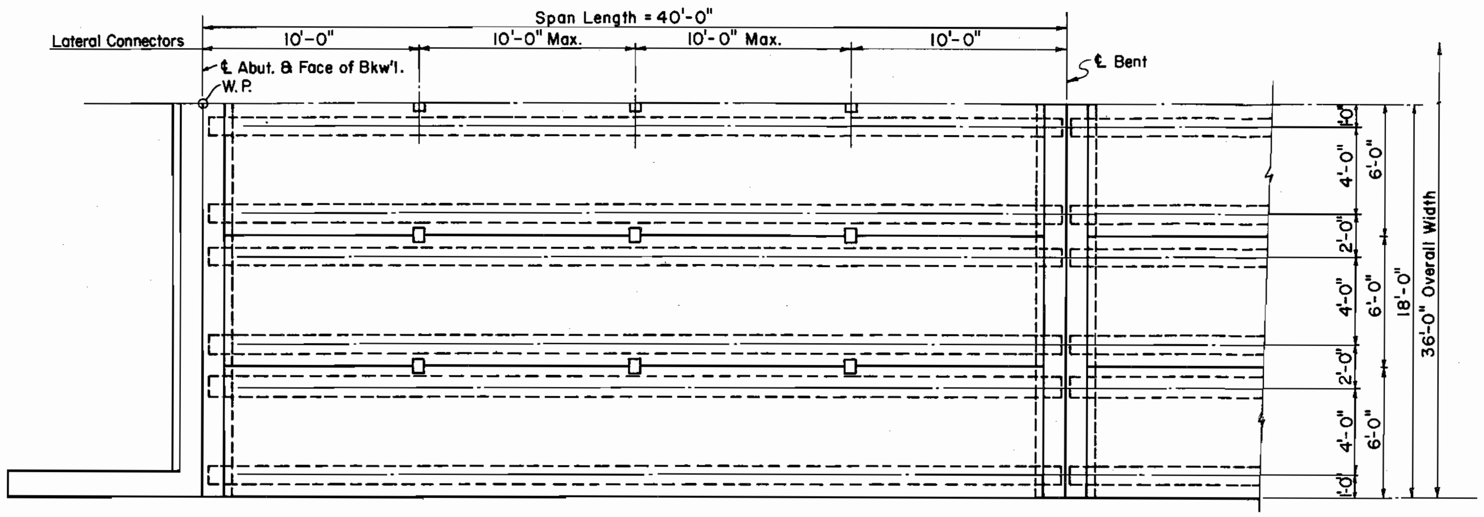
AT ABUTMENT

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRESTRESSED CONCRETE

PCI BOX BEAMS

ORIGINAL DRAWING DATE:
DN.:-JJP
CK.:-
DW.:-EDS
CK.:-
REVISIONS
STATE DISTRICT | FEDERAL REGION | FEDERAL AID PROJECT | SHEET
COUNTY | CONTROL | SECTION | JOB | HIGHWAY



PLAN

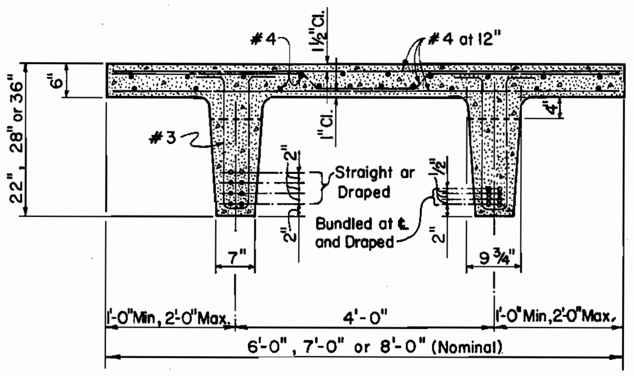
Shown (34'-0" Rdwy. ~ 40'-0" Span)

WIDTHS

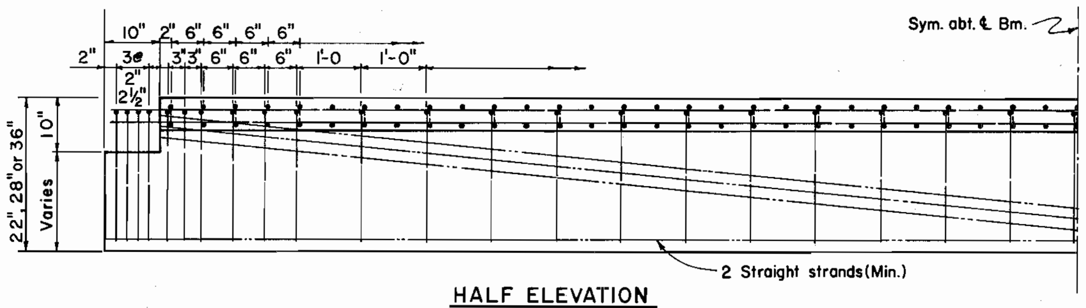
ROADWAY WIDTHS	NO. OF DOUBLE T UNITS 6'-0" WIDE	7'-0" WIDE	8'-0" WIDE
26'	2	~	2
34'	6	~	~
36'	4	2	~
38'	2	4	~
40'	2	2	2
44'	3	4	~
QUANTITIES P.L.F. PER UNIT			
22" CONC. C.Y.	.18	.20	.22
22" REINF. STL.	28	30	32
28" CONC. C.Y.	.21	.22	.24
28" REINF. STL.	29	31	32
36" CONC. C.Y.	.24	.26	.28
36" REINF. STL.	30	32	34

LENGTHS

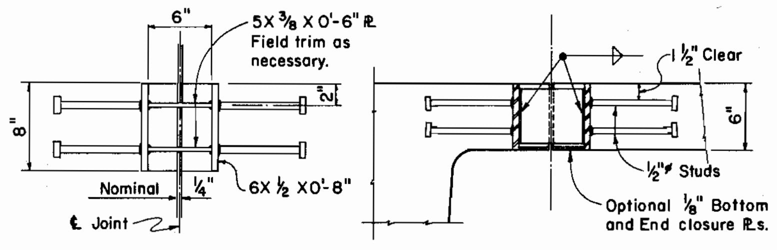
SPAN LENGTH	DOUBLE T DEPTH 22"	28"	36"
30'	✓	~	~
35'	✓	✓	~
40'	~	✓	✓
45'	~	✓	✓
50'	~	~	✓
55'	~	~	✓
60'	~	~	✓



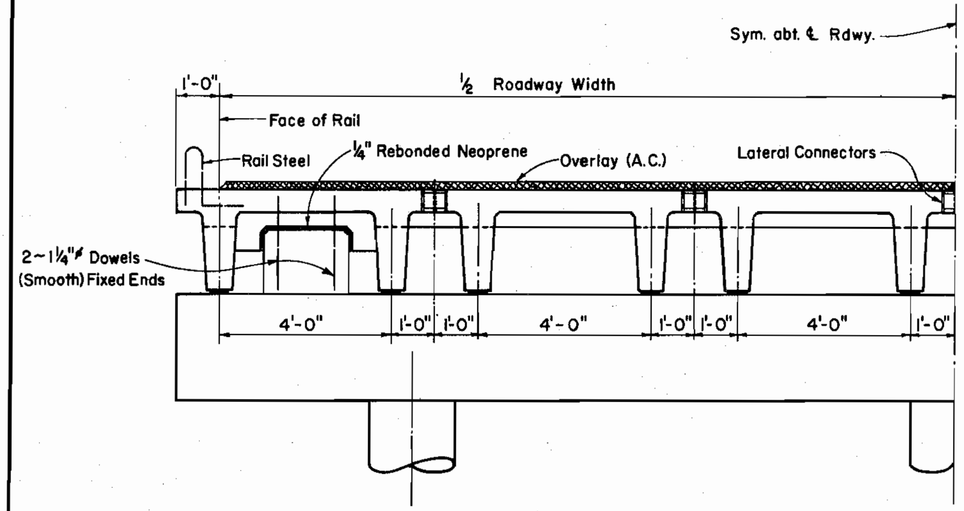
SECTION AT ℄



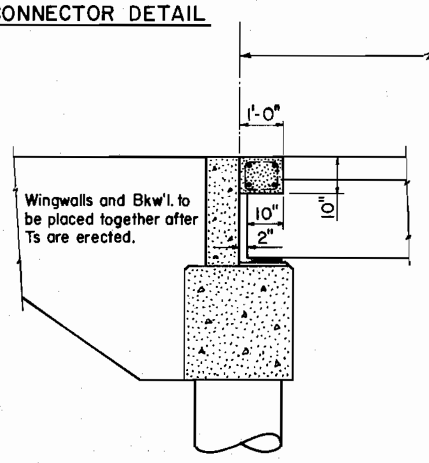
HALF ELEVATION



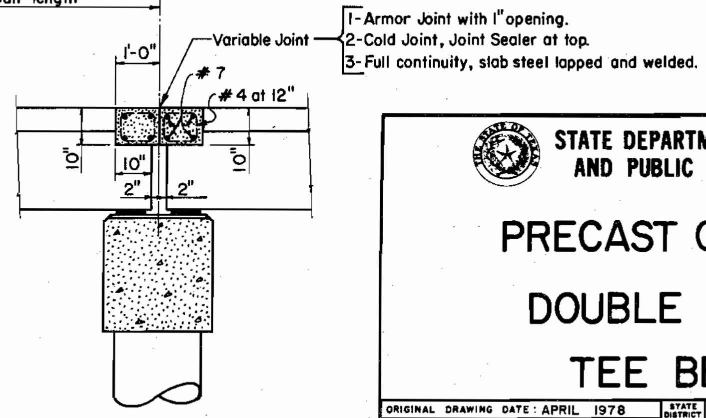
LATERAL CONNECTOR DETAIL



END ELEVATION



ABUTMENT CONDITIONS



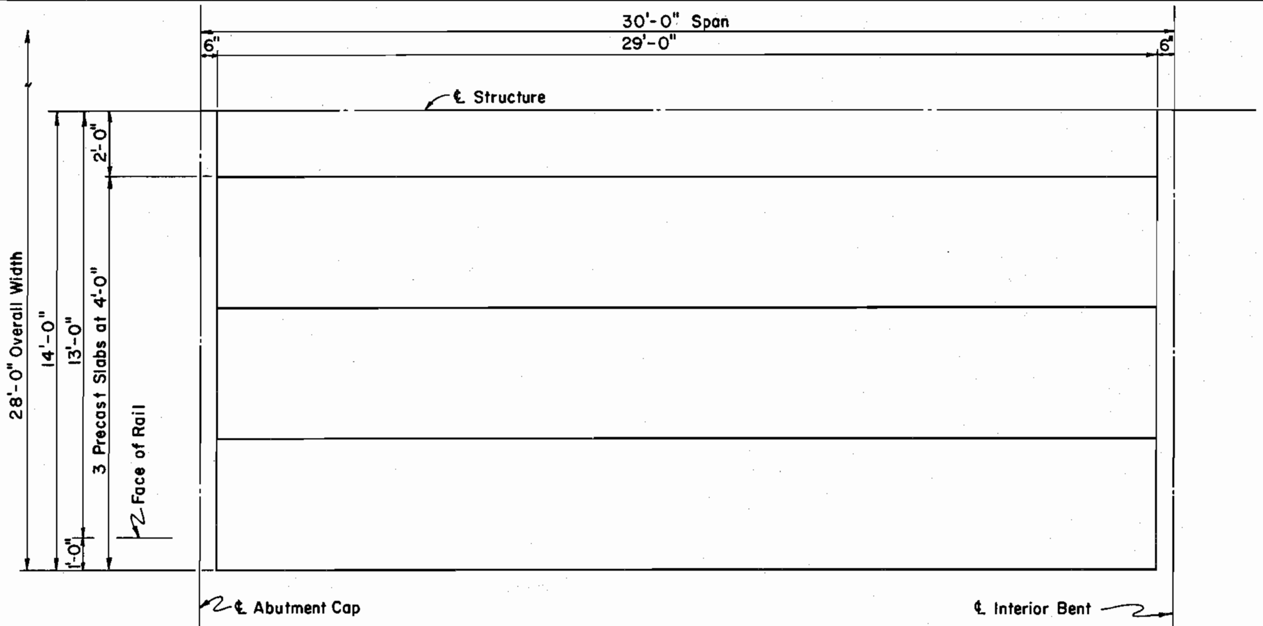
INT. BENT CONDITIONS

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRECAST CONCRETE DOUBLE STEM TEE BEAMS

ORIGINAL DRAWING DATE: APRIL 1978
DN.:-RLR
CK.:-
DW.:-EDS
CK.:-
REVISIONS

STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT	SHEET
COUNTY	CONTROL	SECTION	JOB	HIGHWAY

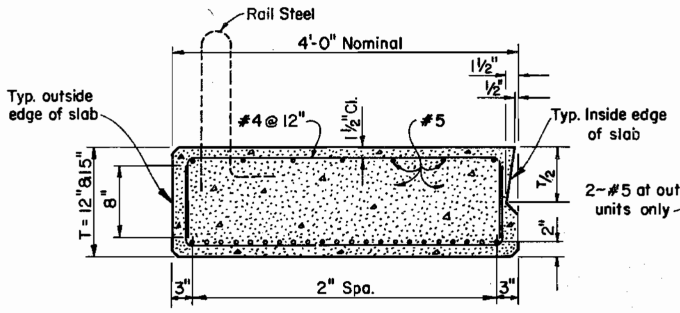


HALF PLAN
(Shown ~ 26'-0" Rdwy- 30'-0" Span)

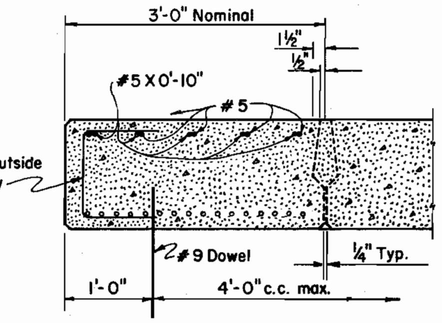
DIMENSIONS AND QUANTITIES			
WIDTH FT.	DEPTH IN.	CLASS C CONC. C.Y. L.F.	REINF. STEEL LB. L. F.
3	12	.11	10
3	15	.14	11
4	12	.15	14
4	15	.18	14

WIDTHS		
ROADWAY WIDTHS	NO. OF SLAB UNITS 3'-0" WIDE	NO. OF SLAB UNITS 4'-0" WIDE
26'	~	7
34'	~	9
36'	2	8
38'	~	10
40'	2	9
44'	2	10

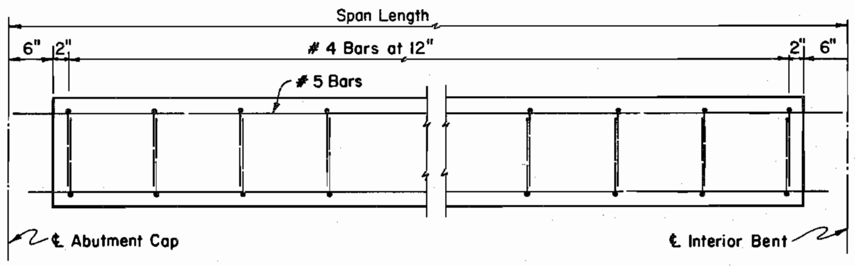
LENGTHS		
SPAN LENGTHS	SLAB UNIT DEPTHS 12"	SLAB UNIT DEPTHS 15"
20'	✓	~
25'	✓	✓
30'	✓	✓
35'	~	✓



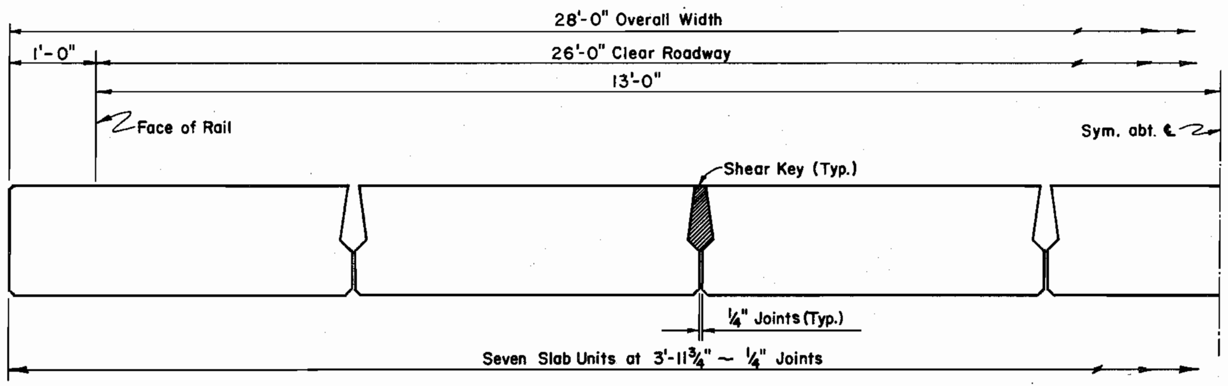
SECTION THRU SLAB UNIT



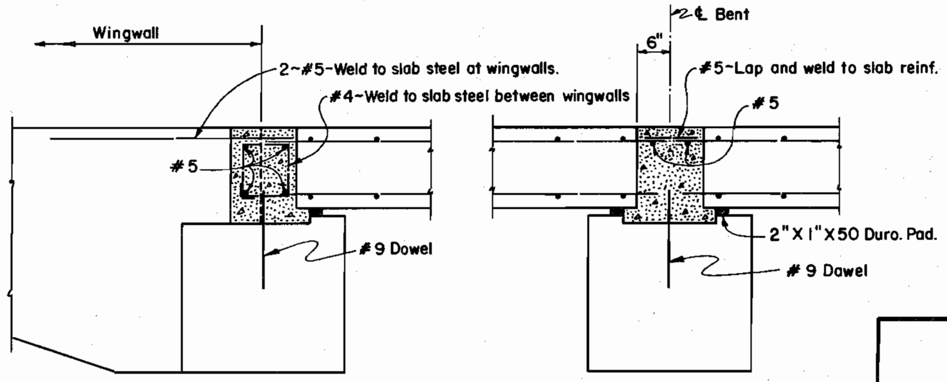
SECTION THRU END SECTION



ELEVATION



HALF ROADWAY ELEVATION
(Shown ~ 26'-0" Rdw'y.)



AT ABUTMENT

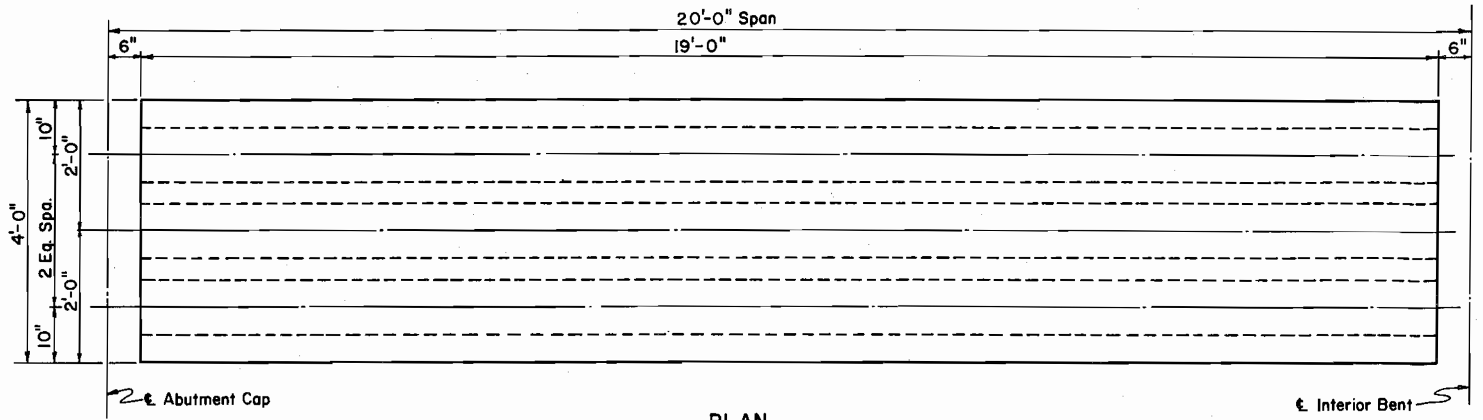
AT INT. BENT

ELEVATION

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRECAST CONCRETE SOLID SLABS

ORIGINAL DRAWING DATE:
DN.:-JJP
CK.:-
DW.:-EDS
CK.:-
REVISIONS
STATE DISTRICT | FEDERAL REGION | FEDERAL AID PROJECT | SHEET
COUNTY | CONTROL | SECTION | JOB | HIGHWAY



PLAN

Shown (4'-0" Slab ~ 20'-0" Span)

DIMENSIONS AND QUANTITIES

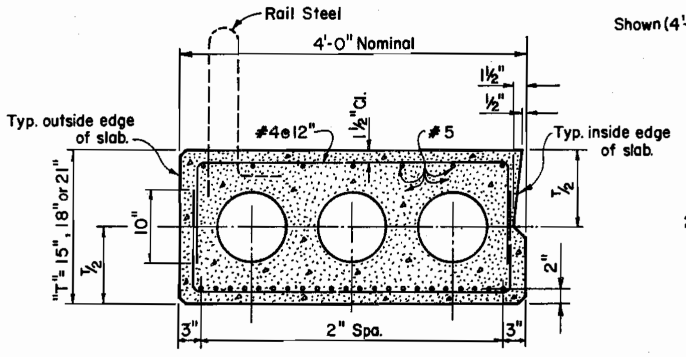
WIDTH FT.	DEPTH IN.	NO. OF VOIDS	VOID DIA. IN. D1	VOID DIA. IN. D2	CLASS C CONC. C.Y. L.F.	REINF. STEEL LB. L.F.
3	15	2	8	—	.10	11
3	18	2	10	—	.13	11
3	21	2	12	—	.15	12
4	15	3	8	8	.12	14
4	18	3	10	10	.16	15
4	21	3	12	10	.20	15

WIDTHS

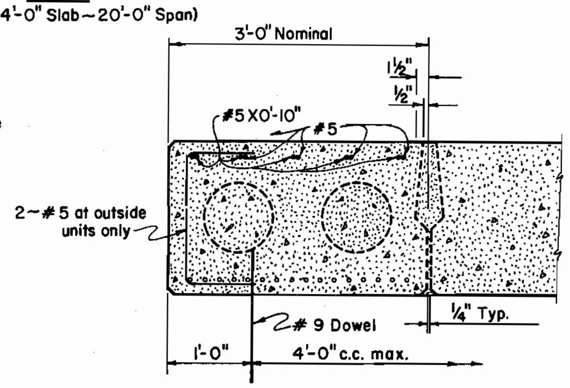
ROADWAY WIDTHS	NO. OF SLAB UNITS 3'-0" WIDE	NO. OF SLAB UNITS 4'-0" WIDE
26'	~	7
34'	~	9
36'	2	8
38'	~	10
40'	2	9
44'	2	10

LENGTHS

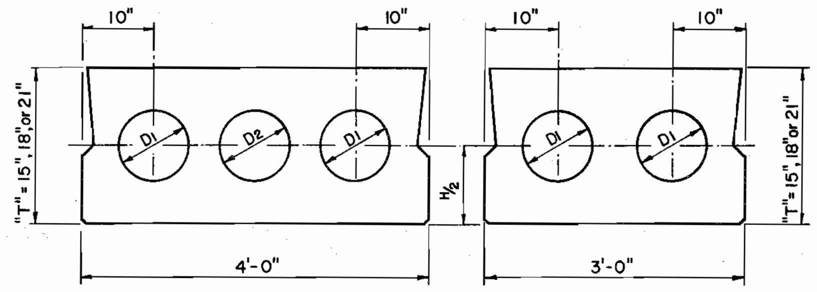
SPAN LENGTHS	SLAB UNIT DEPTHS 15"	18"	21"
20'	✓	~	~
25'	✓	✓	~
30'	✓	✓	~
35'	~	✓	✓
40'	~	✓	✓
45'	~	~	✓



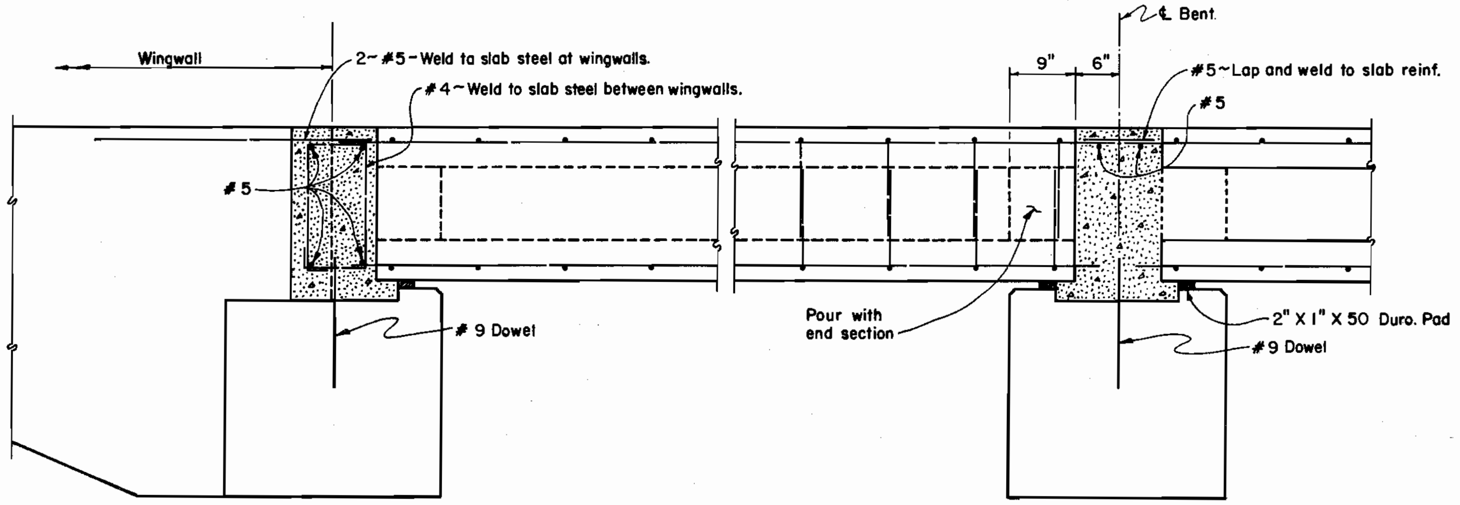
SECTION THRU SLAB UNIT



SECTION THRU END SECTION



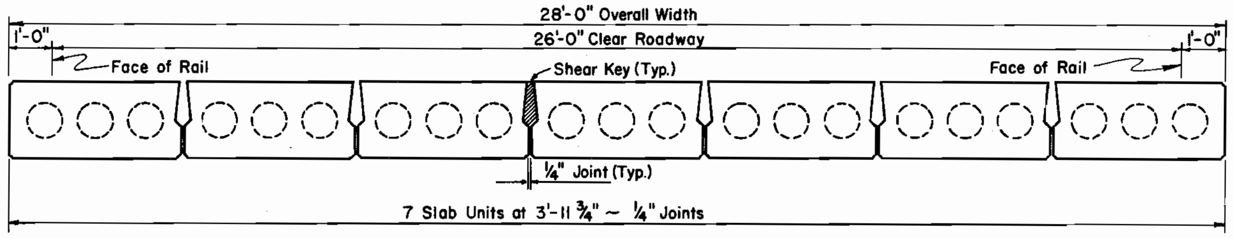
TYPICAL VOID ARRANGEMENT



AT ABUTMENT

AT INT. BENT

ELEVATION



ROADWAY ELEVATION

(Shown ~ 26'-0" Rdw'y.)

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRECAST CONCRETE VOIDED SLABS

ORIGINAL DRAWING DATE:	REVISIONS	STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT	SHEET
DN.:-JJP					
CK.:-		COUNTY	CONTROL	SECTION	JOB	HIGHWAY
DW.:-EDS					
CK.:-					

CHAPTER 2. DETAILS OF PRECAST SUPERSTRUCTURES

The five sheets of conceptual details were shown in Chapter 1. The details were then expanded and modified to be suitable for inclusion in contract plans. These details are described in this chapter.

No bridge can be constructed until suitable foundation and bent details are prepared, so these were also designed and detailed. All of the prepared details of each bridge type are not included within this report, but a list of those prepared and a sample of each is included. A brief description of the associated details and reasons for recommending the methods of construction as detailed are described.

Precast Concrete Box Beams

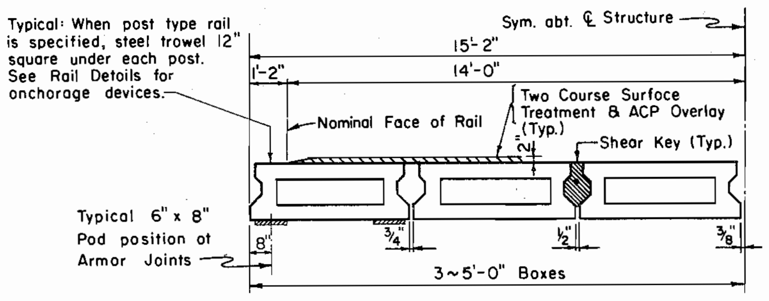
The box beam configuration shown in the following details labeled B-RD and B-D is essentially the same in cross-section as has been used for the 20 inch deep DHT box beam standards for about eight years. The major difference is the elimination of the heavily reinforced end blocks and all interior diaphragms. The interior diaphragms have been shown to be of little structural benefit by analysis (Refs 2 and 3), and also by test (Ref 4). The box as herein detailed can be fabricated with or without an integral end block. If the box is fabricated with the void passing completely through the box, then the fabricator or the contractor has the option of casting the 12 inch closure block at the ends of the box within the void. The closure block is unreinforced. It may be cast at the same time as the other cast-in-place concrete at interior bents and abutments and with the shear keys, or it may be placed at any time prior to erection of the boxes. The only purpose of the end block is to act on a support for the slab ends when subjected to wheel loads.

Another major modification which has been made in the box details is in the transverse reinforcement. Current standard DHT boxes require trussed (bent) transverse reinforcing steel in the top slab with some of the steel extending into the exterior top flanges of the box. These newer details show that the transverse top reinforcing can be placed as a simple two layer mat composed of straight bars and simply bent inverted U-bars. The U-bars also lap with the U-bars of the lower slab reinforcement, thus providing the necessary diagonal tension reinforcement in the side webs. The laps of the U-bars can be staggered or in alignment, but no ties are required between the upper and lower cages, thus simplifying fabrication. This will be especially helpful if the fabricator elects to pour the lower slab immediately prior to placement of the void form and upper cage of steel.

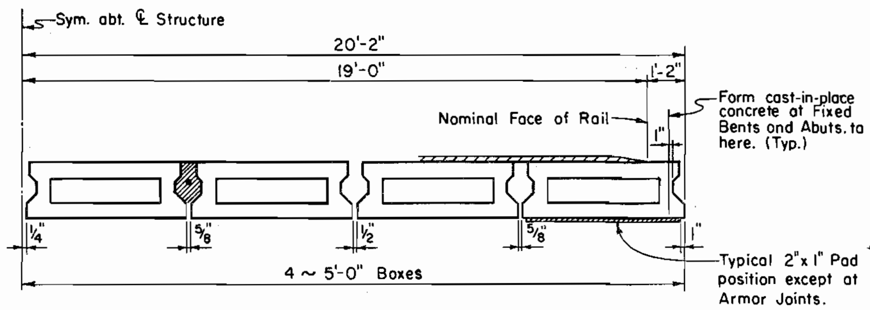
The total amount of conventional reinforcing steel in the revised boxes when compared to the current DHT standard boxes is about 17 percent less for the 4 ft width and 12 percent less for the 5 ft width. A final permissable fabrication procedure which should also decrease costs is to allow the use of welded wire fabric for any or all of the conventional non-prestressed reinforcement.

The blockouts indicated at the ends of each beam are for the transverse cast-in-place concrete which acts as the end of top slab support for wheel loads, and also as a transverse tie between the boxes. This eliminates the need for transverse post tensioning of the boxes or for interior diaphragms.

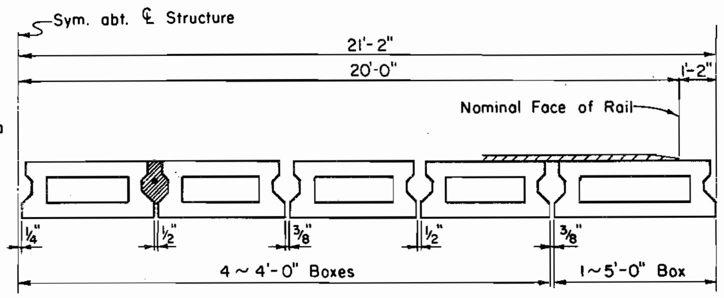
Details for both abutment and interior bents were prepared for all of the roadway widths and spans listed on sheet B-RD . These details are:



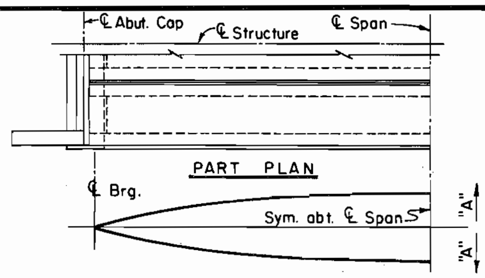
28'-0" ROADWAY

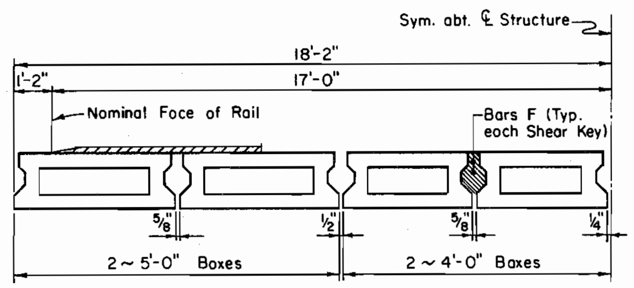


38'-0" ROADWAY

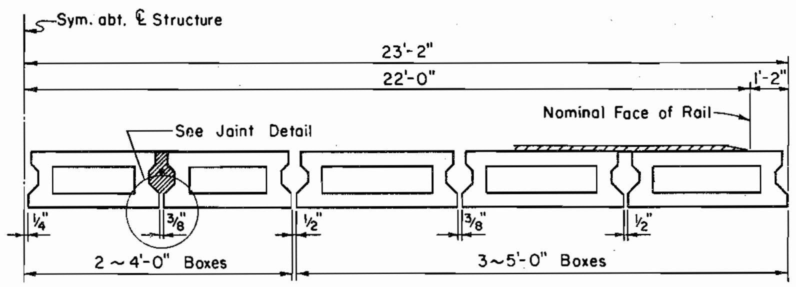


40'-0" ROADWAY





34'-0" ROADWAY



44'-0" ROADWAY

TABLE OF CAMBER & DEFLECTIONS (DIMENSION "A" IN FEET)

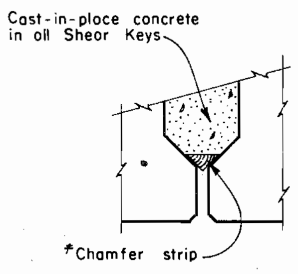
	SPAN	THEOR. CAMBER ↑	DEAD LOAD KEYS ↓	DEAD LOAD WEARING SURFACE ↓	SUMMATION ↑
4'-0" BOX	30'-4"	.014	.001	.001	.012
	35'-0"	.022	.002	.001	.019
	40'-0"	.043	.003	.002	.038
	45'-0"	.062	.004	.004	.054
	50'-0"	.106	.007	.006	.093
	55'-0"	.123	.010	.009	.104
5'-0" BOX	30'-4"	.012	.001	.001	.010
	35'-0"	.015	.001	.001	.013
	40'-0"	.031	.002	.002	.027
	45'-0"	.048	.003	.004	.041
	50'-0"	.074	.005	.006	.063
	55'-0"	.089	.008	.009	.072

TABLE OF VARIABLE QUANTITIES

ROADWAY		28'-0"	34'-0"	38'-0"	40'-0"	44'-0"
Cl. A Concrete (Cast-in-place)						
End Blocks	C.Y./Span	1.2	1.4	1.6	1.6	1.8
Fixed Joint	C.Y./Bent	1.2	1.4	1.6	1.6	1.8
Exp. Joint	C.Y./Bent	1.2	1.5	1.6	1.7	1.9
Abut. Bent	C.Y./Bent	.6	.7	.8	.8	.9
Structural Steel						
Armor Joint	Lbs.	915	1111	1241	1307	1437
Reinf. Steel						
Bars E at Exp. Jt.	Lbs.	78	94	105	110	121
Bars F at Fix. Jt.	Lbs.	145	202	202	260	260

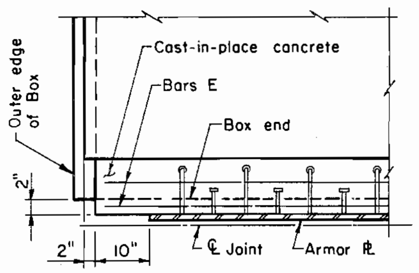
TABLE OF CONSTANT QUANTITIES

ROADWAY WIDTH	SPAN LENGTH	PRESTRESSED CONC. BOX BEAMS 4B20 L.F.	PRESTRESSED CONC. BOX BEAMS 5B20 L.F.	SHEAR KEY CL. A CONC. C.Y.
28'-0"	30'-4"		179.00	3.4
	35'-0"		207.00	4.0
	40'-0"		237.00	4.6
	45'-0"		267.00	5.1
	50'-0"		297.00	5.7
	55'-0"		327.00	6.3
34'-0"	30'-4"	119.33	119.33	4.8
	35'-0"	138.00	138.00	5.5
	40'-0"	158.00	158.00	6.3
	45'-0"	178.00	178.00	7.1
	50'-0"	198.00	198.00	7.9
	55'-0"	218.00	218.00	8.7
38'-0"	30'-4"		238.67	4.8
	35'-0"		276.00	5.5
	40'-0"		316.00	6.3
	45'-0"		356.00	7.1
	50'-0"		396.00	7.9
	55'-0"		436.00	8.7
40'-0"	30'-4"	238.67	59.67	6.0
	35'-0"	276.00	69.00	6.9
	40'-0"	316.00	79.00	7.9
	45'-0"	356.00	89.00	8.9
	50'-0"	396.00	99.00	9.9
	55'-0"	436.00	109.00	10.9
44'-0"	30'-4"	119.33	179.00	6.0
	35'-0"	138.00	207.00	6.9
	40'-0"	158.00	237.00	7.9
	45'-0"	178.00	267.00	8.9
	50'-0"	198.00	297.00	9.9
	55'-0"	218.00	327.00	10.9

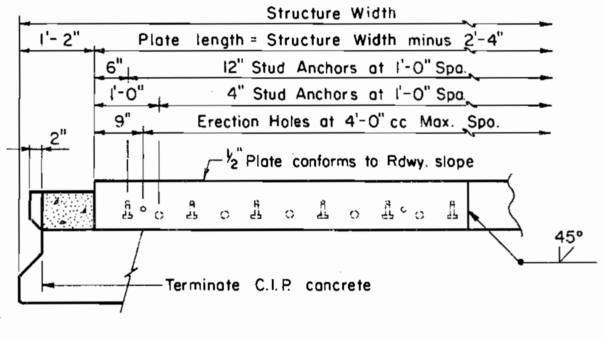


JOINT DETAIL

*(Other suitable Joint sealing materials may be used)

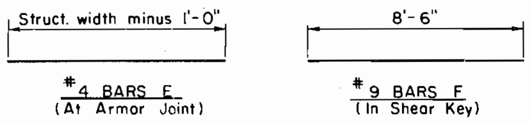


PART PLAN OF ARMOR JOINT

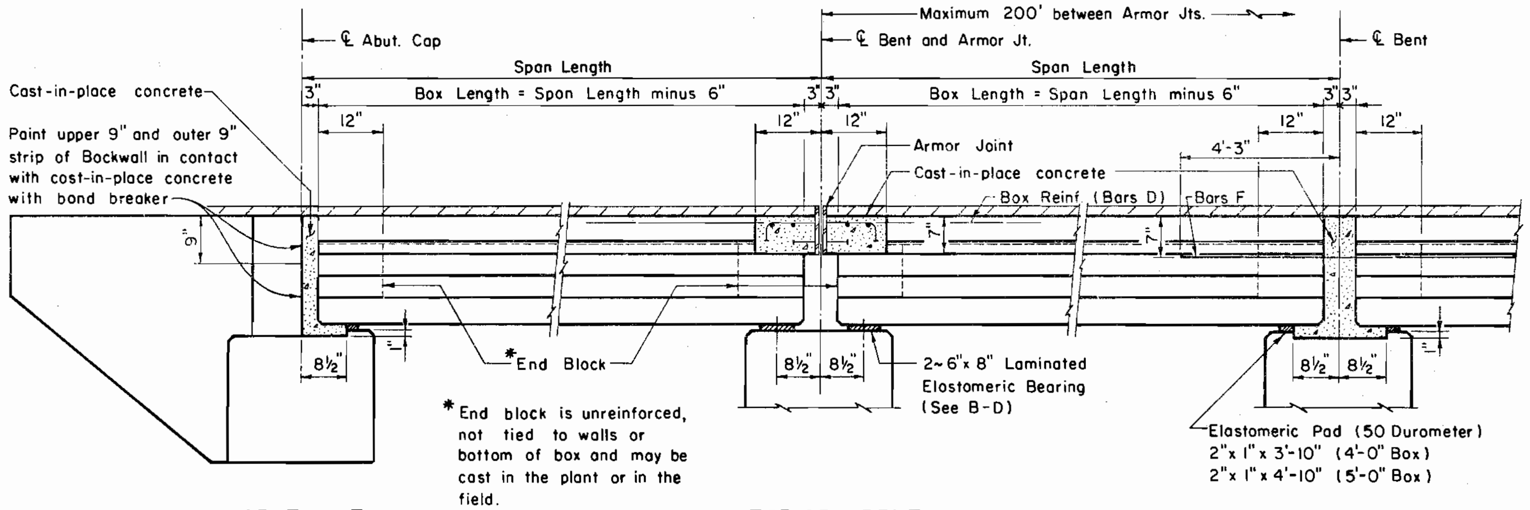


PART ELEVATION OF ARMOR PLATE

Note: Armor Plates shall be shipped in convenient lengths (20'-0" Max.- 10'-0" Min.) Corresponding plate sections shall be match marked and bolted together for shipment.



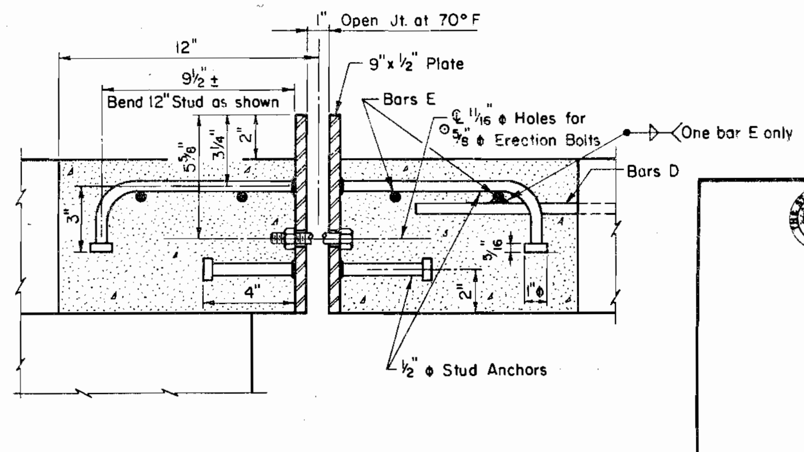
REINFORCING STEEL



ABUTMENT

INTERIOR BENT
(EXP. JOINT)

INTERIOR BENT
(FIXED JOINT)



SECTION THRU. ARMOR JOINT
(WEIGHT = 32.67 #/L.F.)

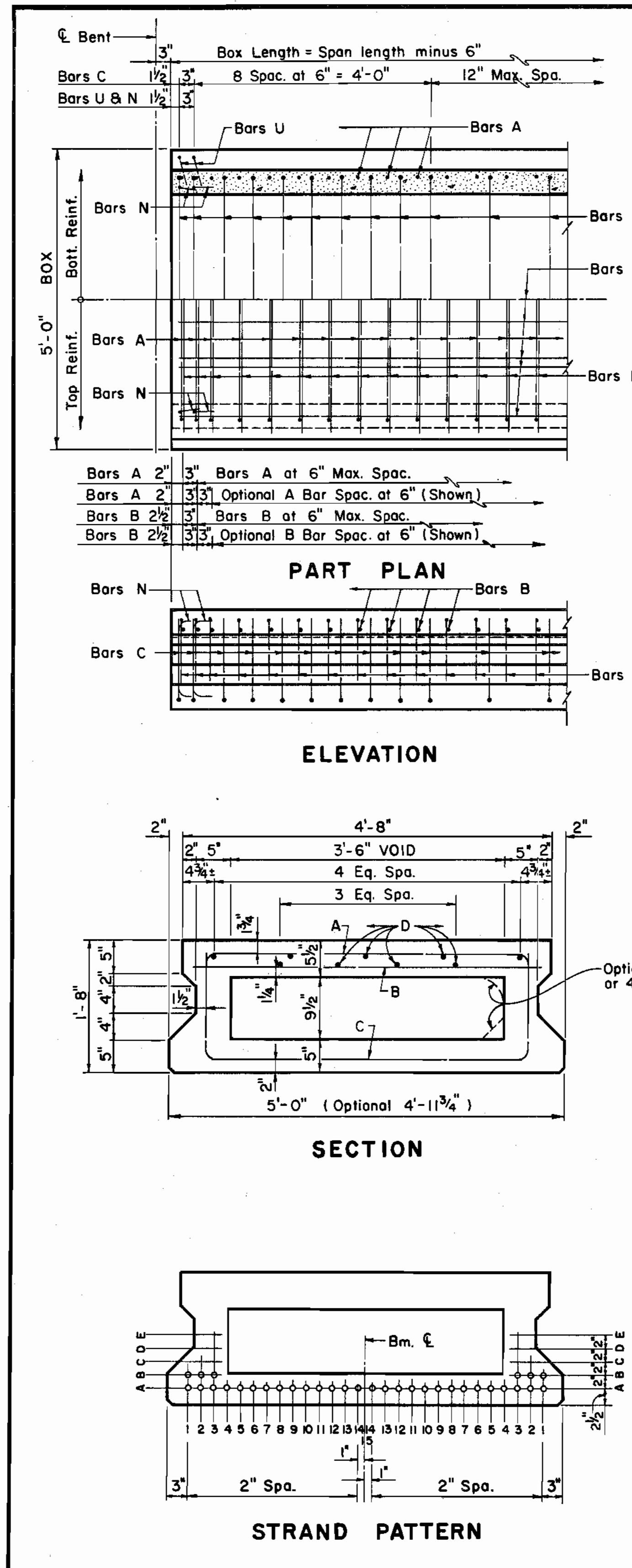
⊗Erection bolts shall be cut off flush with plates promptly after the concrete in the latter of the placements has taken initial set.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

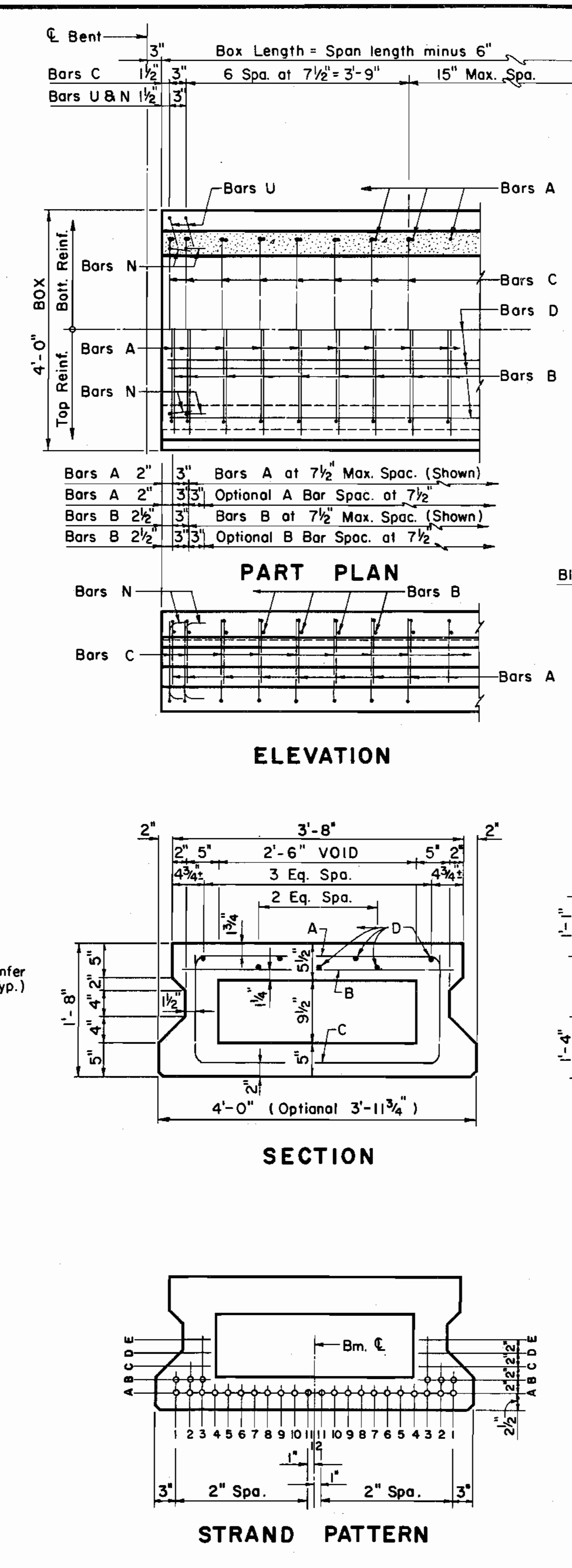
PRESTRESSED CONCRETE 20" BOX BEAMS

.B-RD

ORIGINAL DRAWING DATE: NOV. 1980
DN.:-JJP
CK.:-GHO
DW.:-AS
CK.:-GHO
REVISIONS
STATE DISTRICT | FEDERAL REGION 6 | FEDERAL AID PROJECT | SHEET
COUNTY | CONTROL | SECTION | JOB | HIGHWAY



5'-0" BOX BEAM
(5B20)

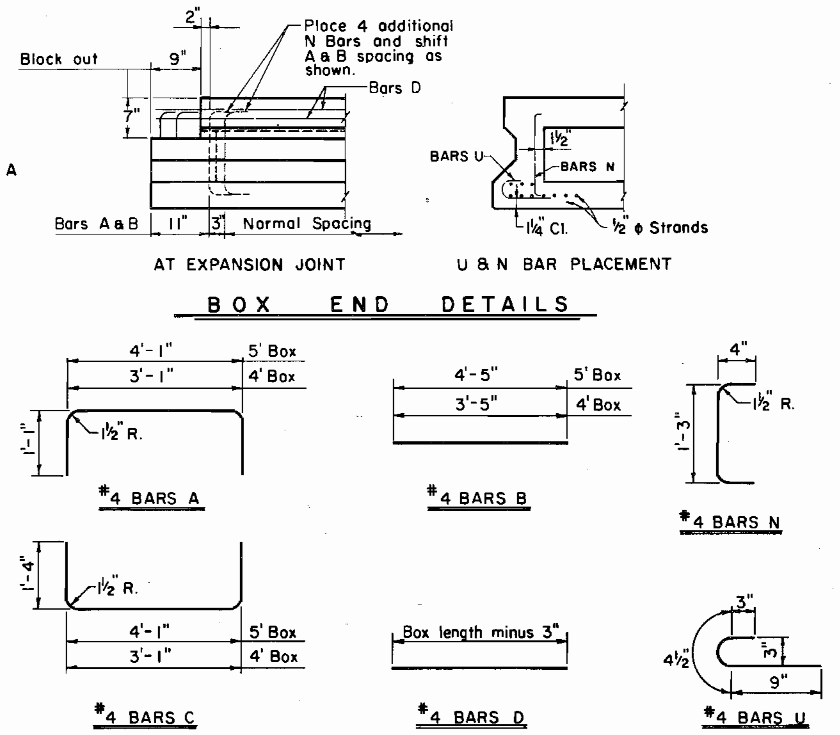


4'-0" BOX BEAM
(4B20)

STANDARD BEAMS (DEBONDED STRANDS)									OPTIONAL DESIGN		
		PRESTRESSING STRANDS					CONCRETE				
		TOTAL		DEBONDING							
SPAN	BEAM TYPE	NO.	"e" ℄ In.	NO.	FROM BEAM END IN ROW A for 3'	for 6'	RELEASE STRENGTH f'ci (psi)	MINIMUM 28 DAY COMP. STRENGTH f'c (psi)	DN. LOAD COMP. STRESS (TOP ℄) fct (psi)	DN. LOAD TENSILE STRESS (BOTT. ℄) fcb (psi)	REQUIRED MINIMUM ULTIMATE MOMENT CAPACITY (Ft Kips)
30'-4"	4B20	7	7.30				4000	5000	847	820	368
	5B20	8	7.37						727	707	386
35'-0"	4B20	9	7.30						1130	1095	487
	5B20	9	7.37						973	945	501
40'-0"	4B20	13	7.30	6	6				1457	1412	624
	5B20	13	7.37	2	2				1259	1223	658
45'-0"	4B20	16	7.30	8	6	2			1797	1741	763
	5B20	17	7.37	6	6				1555	1512	805
50'-0"	4B20	21	7.30	12	6	6			2168	2101	913
	5B20	21	7.37	10	4	6		5000	1884	1832	966
55'-0"	4B20	26	6.99	16	8	8		5220	2558	2478	1067
	5B20	26	7.37	16	10	6	4000	5000	2221	2158	1131

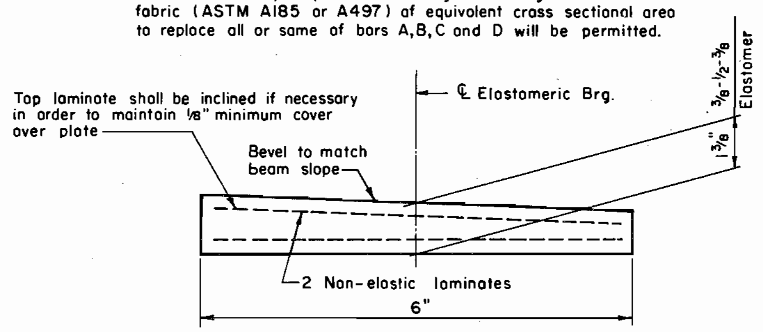
BEAM PROPERTIES

BEAM TYPE		4B20	5B20
Area	In²	594.4	720.4
Y top	In	10.20	10.13
Y bot	In	9.80	9.87
I NON COMP.	In⁴	28,235	35,383
I COMP.	In⁴	30,014	37,144
Wt. P.L.F.	Lb.	619	750



REINFORCING STEEL DETAILS

At Fabricators option, alternate designs utilizing welded wire fabric (ASTM A185 or A497) of equivalent cross sectional area to replace all or some of bars A, B, C and D will be permitted.



LAMINATED BEARING
(6"x 8") (60 DUROMETER)

GENERAL NOTES:

These prestressed concrete box beams are designed for HS-20 loading in accordance with A.A.S.H.T.O. 1977 Standard and Interim Specifications. Prestress losses for the designed beams have been calculated for a relative humidity of 50 %. Optional designs shall likewise conform.

The fabricator has the option of furnishing either the designed debonded strand beam or an approved optional beam design. Low relaxation strands may be used.

For standard designed beams, fill row A with strands first, and then row B etc. Strands and debonding shall be evenly distributed in rows symmetrically about the beam centerline.

All reinforcing steel shall be Grade 60.

All prestressing strands shall be 1/2" diameter. 270K. Initial pretension for regular stress relieved strand is 28.9 K and for low relaxation strand is 31.0 K. Strands with bond breakage shall be tightly wrapped with waterproof tape. Plastic tubing may be used provided both ends and the seam of the tube are sealed with waterproof tape.

All concrete shall be Class H with strength as shown.

If cardboard forms are used for voids, they shall be waterproofed.

The optional A bar spacing may be used for either 4 ft. or 5 ft. boxes. The optional spacing will be most effective if the fabricator elects to pour the 5" bottom slab immediately prior to placement of the void forms and upper reinforcement. It is not necessary that Bars A or B be tied to Bars C.

The end blocks are unreinforced and may be placed integrally with the box at the time of casting, separately after the box is cast, or integrally with the cast-in-place bent concrete and shear keys. If separately cast end blocks are used, the void forms shall be removed completely or the 12 inch end block thickness with an appropriate header then placed to retain the end block concrete. The end block voids may be alternately formed with removable forms in which case suitable draft may be included to assist in form removal.

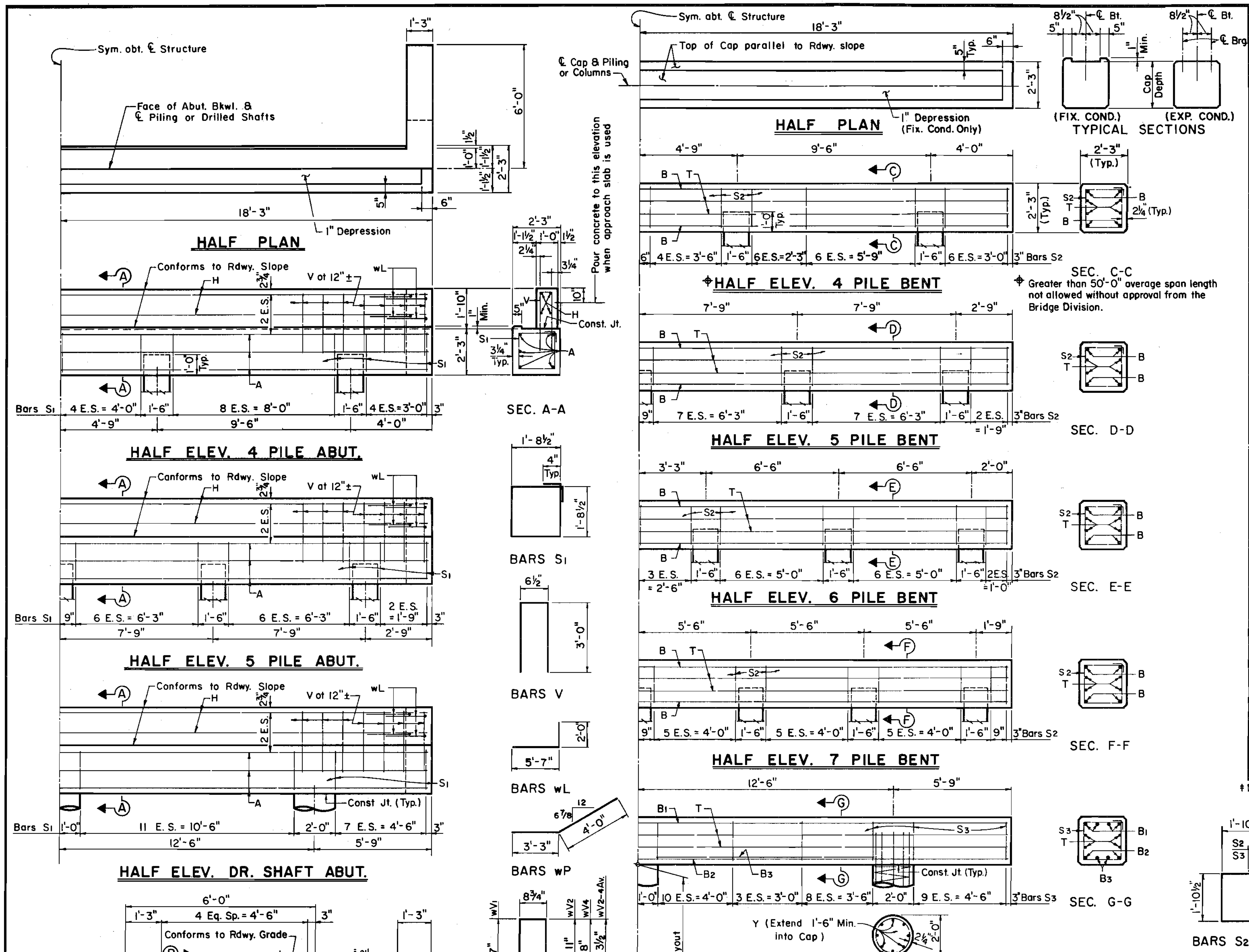
The bottom corners of all beams shall be chamfered 3/4" or rounded to a 3/4" radius. Tops of all boxes shall have a rough wood float finish, except that the portion under the railing posts on exterior boxes shall have a smooth finish. Strands may extend 2 1/2" maximum past the beam ends except at expansion joints. No finish or treatment is necessary at the ends except at expansion joints.

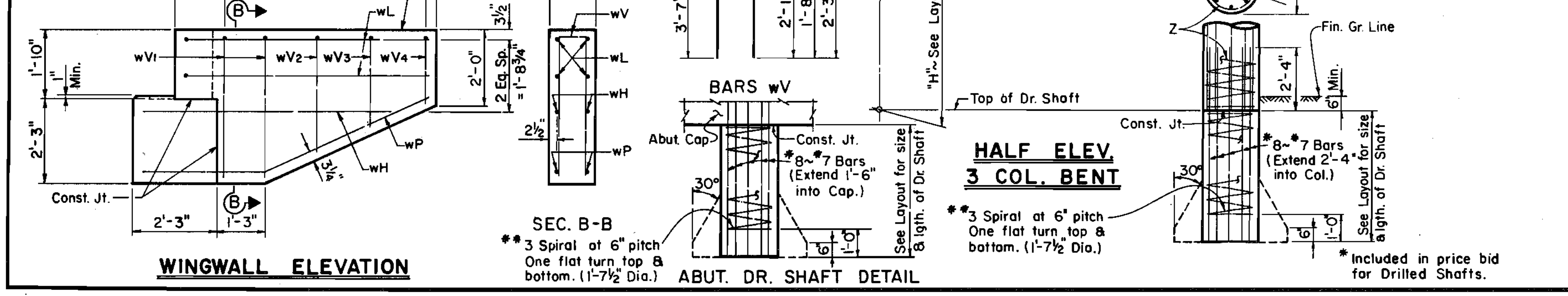
STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

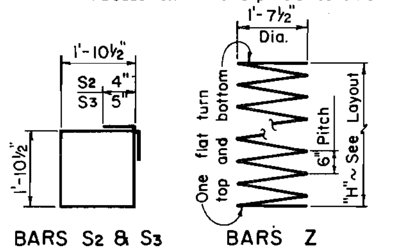
PRESTRESSED CONCRETE 20" BOX BEAMS

B-D

ORIGINAL DRAWING DATE: MAY 1980
REVISIONS
DN.:-GHO
CK.:-LEC
DW.:-AS
CK.:-GHO
STATE DISTRICT | FEDERAL REGION: 6 | FEDERAL AID PROJECT | SHEET
COUNTY | CONTROL | SECTION | JOB | HIGHWAY







TABLES OF ESTIMATED QUANTITIES

4 PILE ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	36'-2"	961
H	4	#5	36'-2"	151
S1	37	#4	7'-6"	185
V	37	#4	6'-7"	163
wH	4	#6	6'-5"	39
wL	8	#6	7'-7"	91
wP	4	#4	7'-3"	19
wV1	4	#4	7'-11"	21
wV2-4	6	#4	5'-4"Av.	21
Reinf. Steel			Lb.	1,651
Cl. C Conc.			C.Y.	10.9

5 PILE ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	36'-2"	961
H	4	#5	36'-2"	151
S1	34	#4	7'-6"	170
V	37	#4	6'-7"	163
wH	4	#6	6'-5"	39
wL	8	#6	7'-7"	91
wP	4	#4	7'-3"	19
wV1	4	#4	7'-11"	21
wV2-4	6	#4	5'-4"Av.	21
Reinf. Steel			Lb.	1,636
Cl. C Conc.			C.Y.	10.9

DR. SHAFT ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	36'-2"	961
H	4	#5	36'-2"	151
S1	40	#4	7'-6"	200
V	37	#4	6'-7"	163
wH	4	#6	6'-5"	39
wL	8	#6	7'-7"	91
wP	4	#4	7'-3"	19
wV1	4	#4	7'-11"	21
wV2-4	6	#4	5'-4"Av.	21
Reinf. Steel			Lb.	1,666
Cl. C Conc.			C.Y.	10.9

⌖4 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#11	36'-2"	769
S2	50	#4	8'-2"	273
T	4	#4	36'-2"	97
Reinf. Steel			Lb.	1,139
Cl. C Conc.			C.Y.	‡ 6.9

5 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#10	36'-2"	623
S2	38	#4	8'-2"	207
T	4	#4	36'-2"	97
Reinf. Steel			Lb.	927
Cl. C Conc.			C.Y.	‡ 6.9

6 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#10	36'-2"	623
S2	41	#4	8'-2"	224
T	4	#4	36'-2"	97
Reinf. Steel			Lb.	944
Cl. C Conc.			C.Y.	‡ 6.9

7 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#9	36'-2"	492
S2	40	#4	8'-2"	218
T	4	#4	36'-2"	97
Reinf. Steel			Lb.	807
Cl. C Conc.			C.Y.	‡ 6.9

FOUNDATION LOADS

SPAN	45'	50'	55'		
4 PILE ABUT. (T/P)	41	44	46		
5 PILE ABUT. (T/P)	33	35	37		
DR. SHAFT ABUT. (T/D.S.)	54	58	62		
4 PILE BENT (T/P)	62	67	⌖N.A.		
5 PILE BENT (T/P)	49	53	57		
6 PILE BENT (T/P)	41	44	48		
7 PILE BENT (T/P)	35	38	41		
3 COL. BENT (T/D.S.)	86	93	99		

3 COL. INT. BENT

Bar	No.	Size	Length	Weight
B1	4	#11	36'-2"	769
B2	2	#10	36'-2"	311
B3	4	#10	10'-6"	181
S3	64	#5	8'-4"	556
T	4	#5	36'-2"	151
Reinf. Steel			Lb.	1,968
Cl. C Conc.			C.Y.	‡ 6.9

‡ Deduct 0.1 C.Y. for expansion condition.

TABLE OF VARIABLE QUANTITIES 3 COL. INT. BENT / TOTAL EST. QUANTITIES 3 COL. INT. BT.

"H"	Cl. C Conc.	BARS Z 3~ #3		BARS Y 24~ #7		Reinf. Steel	‡ Cl. C Conc.
Ft.	C.Y.	Length	Weight	Length	Weight	Lbs.	C.Y.
8	2.8	92'	104	9'-6"	466	2,538	9.7
9	3.1	103'	116	10'-6"	515	2,599	10.0
10	3.5	113'	127	11'-6"	564	2,659	10.4
11	3.8	123'	139	12'-6"	613	2,720	10.7
12	4.2	133'	150	13'-6"	662	2,780	11.1
13	4.5	144'	162	14'-6"	711	2,841	11.4
14	4.9	154'	174	15'-6"	760	2,902	11.8
15	5.2	164'	185	16'-6"	809	2,962	12.1
16	5.6	174'	196	17'-6"	858	3,022	12.5
17	5.9	185'	209	18'-6"	908	3,085	12.8
18	6.3	195'	220	19'-6"	957	3,145	13.2

HS 20 LOADING

GENERAL NOTES:

Designed according to A.A.S.H.T.O. 1977 Standard and Interim Specifications.
These bents shall be used when the average of adjacent span lengths is equal to or less than 55'-0" except as noted.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

BENTS FOR PRESTRESSED CONCRETE BOX BEAMS

34'-0" RDWY. 45'-50'-55' SPANS

34 BB .45-55

ORIGINAL DRAWING DATE: DEC. 1980		STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT ⊕	SHEET
DN.:-GHO	REVISIONS		6		
CK.:-JCW		COUNTY		CONTROL / SECTION / JOB	HIGHWAY
DW.:-DRG					
CK.:-GHO					

Bent Sheet Identification	Roadway Width	For Use With Span Lengths
28 BB 30	28 ft	30.33 ft
28 BB 35-40	28 ft	35 and 40 ft
28 BB 45-55	28 ft	45, 50, and 55 ft
34 BB 30	34 ft	30.33 ft
34 BB 35-40	34 ft	35 and 40 ft
34 BB 45-55	34 ft	45, 50, and 55 ft
38 BB 30	38 ft	30.33 ft
38 BB 35-40	38 ft	35 and 40 ft
38 BB 45-55	38 ft	45, 50, and 55 ft
40 BB 30	40 ft	30.33 ft
40 BB 35-40	40 ft	35 and 40 ft
40 BB 45-55	40 ft	45, 50, and 55 ft
44 BB 30	44 ft	30.33 ft
44 BB 35-40	44 ft	35 and 40 ft
44 BB 45-55	44 ft	45, 50, and 55 ft

The two box detail sheets labeled B-RD and B-D can be used with any of the above 15 bent detail sheets. Only the sheet labeled 34 BB 45-55 has been herein included. The other bent detail sheets are similar.

Prestressed Concrete PCI Box Beams

The details shown in Chapter 1 for the PCI boxes are essentially the same as the conceptual details given in the PCI publication (Ref 5) and a joint AASHTO-PCI report (Ref 6). The states of California and Pennsylvania have also used this section as reported in Refs 7 and 8. One disadavantage with this type of box is the extremely small size of shear key. A number of states have reported difficulty with placement and long term stability of this type of shear key. A high quality grout is usually used which is composed of epoxy and sand. Placement of the epoxy grout must be carefully controlled. Long term creep and stability information for epoxy grouts is not available in the research or from suppliers and the continued use of epoxy for structural applications has not yet been proven by experience. Most epoxies have an affinity for moisture, with a subsequent loss in strength and decreased modulus.

The proposed transverse reinforcement for these boxes is similar to that described previously for the modified DHT boxes, wherein two independent U-shaped cages of steel can be lapped together with no required tying of the steel in the webs. The blockouts indicated at the ends of each beam are for the transverse cast-in-place concrete which acts as end of top slab support for wheel loads, and also as a transverse tie between the boxes. This eliminates the need for transverse post tensioning of the boxes or for interior diaphragms.

The bent details recommended to be used with these boxes are the same as those listed and shown previously for the modified DHT boxes.

Prestressed Concrete Double Tee Beams

The prestressed concrete double tee beams shown in the following details labeled T-RD and T-D are essentially identical in formwork configuration to currently available double tee forms used for commercial garage and other building construction. The thicker 6 inch top slab and greater amount of prestressed steel allow it to also be suitable for highway bridge superstructures. A trussed transverse top bar is shown, but optional straight bars may be substituted.

The web reinforcement is with conventional U-bars, with the anticipation that a single layer of welded wire fabric can be substituted. The lateral connector details shown are spaced at 10 ft maximum and are designed to provide the necessary live load shear transfer between adjacent beams. Most commercial double tee beams have lateral connectors only for alignment and as a small necessary shear transfer when placing the subsequent cast-in-place top slab. It was determined that a continuous shear key for the double tees would not be necessary as is provided for the box beams. The shear key for the DHT box beams is more than enough for shear transfer, and is used mainly to fill the gap between the beams.

One serious deficiency of the proposed double tee beam configuration is the lack of sufficient slab thickness to adequately anchor normal bridge railings. It has been determined by crash tests (Ref 9), maintenance experience, and analysis methods, that a 6 inch slab cannot be reinforced enough to develop the full strength of railings designed to AASHTO requirements. This deficiency has also existed for many years in the thin 6 inch overhangs used for most CGC spans. No immediate changes or modifications to eliminate the overhang or strengthen the slabs for the double tees or the CGC spans is planned as of this date. By not providing sufficient anchorage strength for the railings, the design strength of the railing systems is seriously reduced. The need for required slab repair whenever the railing is severely impacted will also continue.

Another anticipated deficiency in the double tee section is that the longitudinal joints will most likely leak, even though sufficient asphalt surfacing and sealing membranes are provided. Similar details were prepared several years ago by the Oklahoma Highway Department (Ref 10) which exhibited this leakage problem. Their details, however, showed a much weaker lateral connector configuration than herein proposed. For locations which will not have winter salt applications, the leakage could be acceptable. Oklahoma has since changed their double tee details (Refs 11 and 12) to show a thinner 3 inch top slab for the double tees, with a subsequent cast-in-place slab tapered from 5 inch to 7.75 inch at the center which has conventional reinforcement. No lateral connectors are now used. This modification has reportedly decreased or eliminated their joint leakage problems to acceptable levels, although the necessary field reinforcing and concrete placement detract from the simplicity of their original concept.

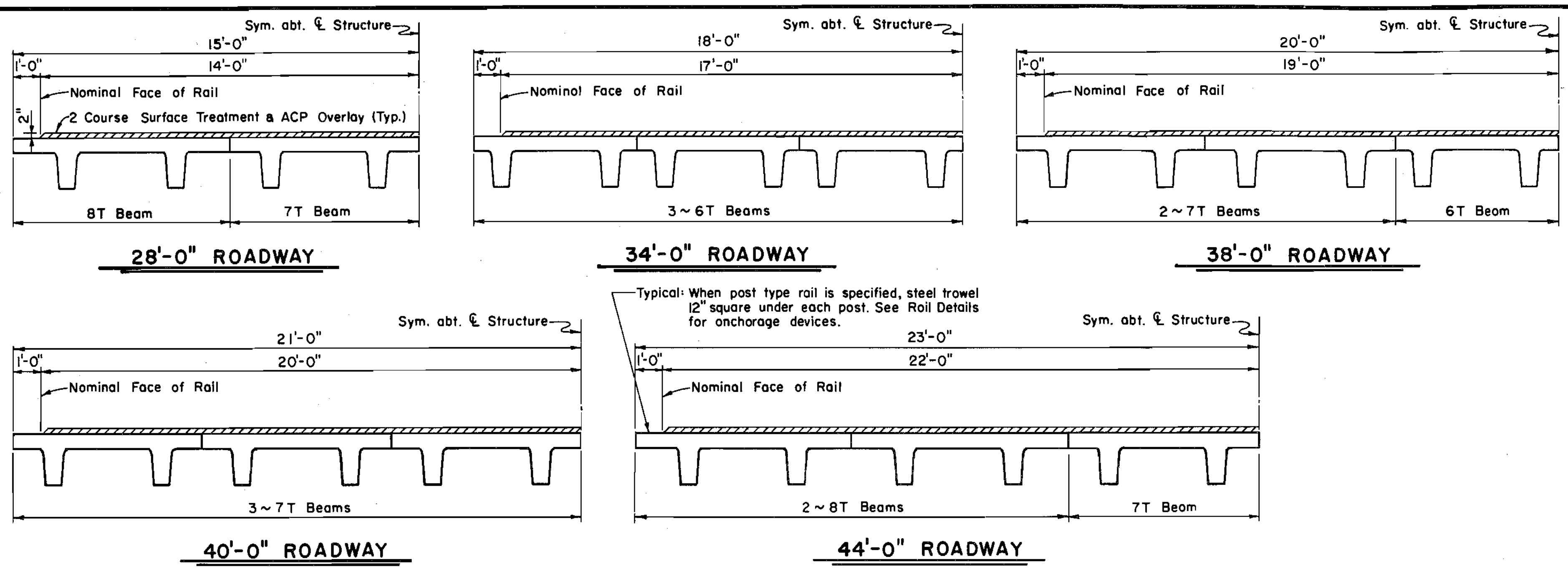
Bent details for the double tee beams were also prepared for the same five roadway widths and six spans as for the box beams. These details are:

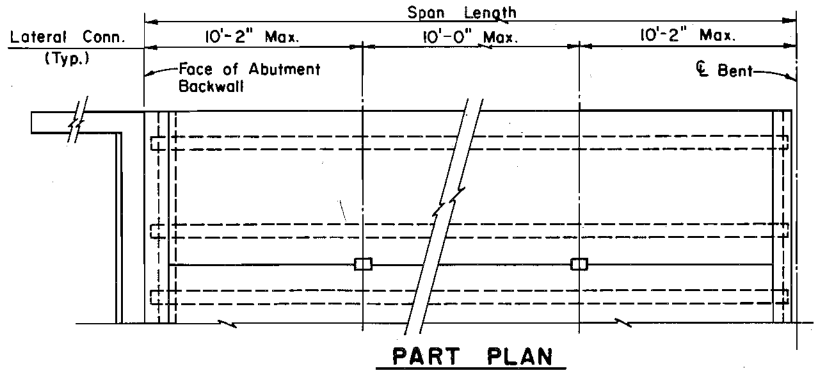
Bent Sheet Identification	Roadway Width	For Use With Span Lengths
28 BT 30	28 ft	30.33 ft
28 BT 35-40	28 ft	35 and 40 ft
28 BT 45-55	28 ft	45, 50, and 55 ft
34 BT 30	34 ft	30.33 ft
34 BT 35-40	34 ft	35 and 40 ft
34 BT 45-55	34 ft	45, 50, and 55 ft
38 BT 30	38 ft	30.33 ft
38 BT 35-40	38 ft	35 and 40 ft
38 BT 45-55	38 ft	45, 50, and 55 ft
40 BT 30	40 ft	30.33 ft
40 BT 35-40	40 ft	35 and 40 ft
40 BT 45-55	40 ft	45, 50, and 55 ft
44 BT 30	44 ft	30.33 ft
44 BT 35-40	44 ft	35 and 40 ft
44 BT 45-55	44 ft	45, 50, and 55 ft

The two detail sheets labeled T-RD and T-D can be used with any of the above 15 bent detail sheets. Only the sheet labeled 34 BT 35-40 has been herein included. The other bent details are similar.

Precast Concrete Solid Slabs

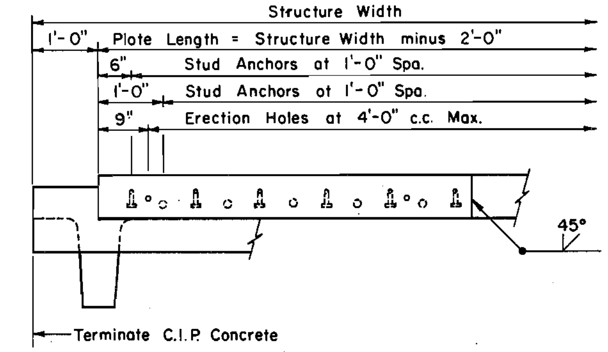
The design shown in Chapter 1 for the precast concrete solid slabs is similar to the conceptual cross-section shown in the PCI Short Span Bridges publication (Ref 5) with the exception that the shear key is significantly larger than indicated in their sketches. The Virginia Department of Highways and Public Transportation is successfully using a precast solid slab similar to the PCI cross-section prefabricated and stocked by their state forces (Ref 13). The long term success of the larger shear keys associated with the current DHT box





PART PLAN

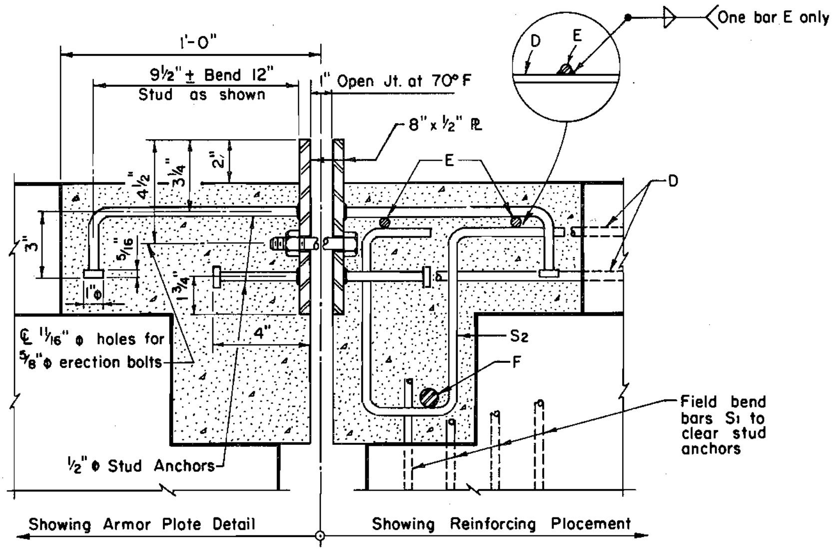
TABLE OF CONSTANT QUANTITIES				
ROADWAY WIDTH	SPAN LENGTH	PRESTRESSED CONCRETE T BEAMS		
		6T	7T	8T
		L.F.	L.F.	L.F.
28'-0"	30'-4"		60.00	60.00
	35'-0"		69.33	69.33
	40'-0"		79.33	79.33
	45'-0"		89.33	89.33
	50'-0"		99.33	99.33
	55'-0"		109.33	109.33
34'-0"	30'-4"	180.00		
	35'-0"	208.00		
	40'-0"	238.00		
	45'-0"	268.00		
	50'-0"	298.00		
	55'-0"	328.00		
38'-0"	30'-4"	60.00	120.00	
	35'-0"	69.33	138.67	
	40'-0"	79.33	158.67	
	45'-0"	89.33	178.67	
	50'-0"	99.33	198.67	
	55'-0"	109.33	218.67	
40'-0"	30'-4"		180.00	
	35'-0"		208.00	
	40'-0"		238.00	
	45'-0"		268.00	
	50'-0"		298.00	
	55'-0"		328.00	
44'-0"	30'-4"		60.00	120.00
	35'-0"		69.33	138.67
	40'-0"		79.33	158.67
	45'-0"		89.33	178.67
	50'-0"		99.33	198.67
	55'-0"		109.33	218.67



PART ELEV. OF ARMOR PLATE

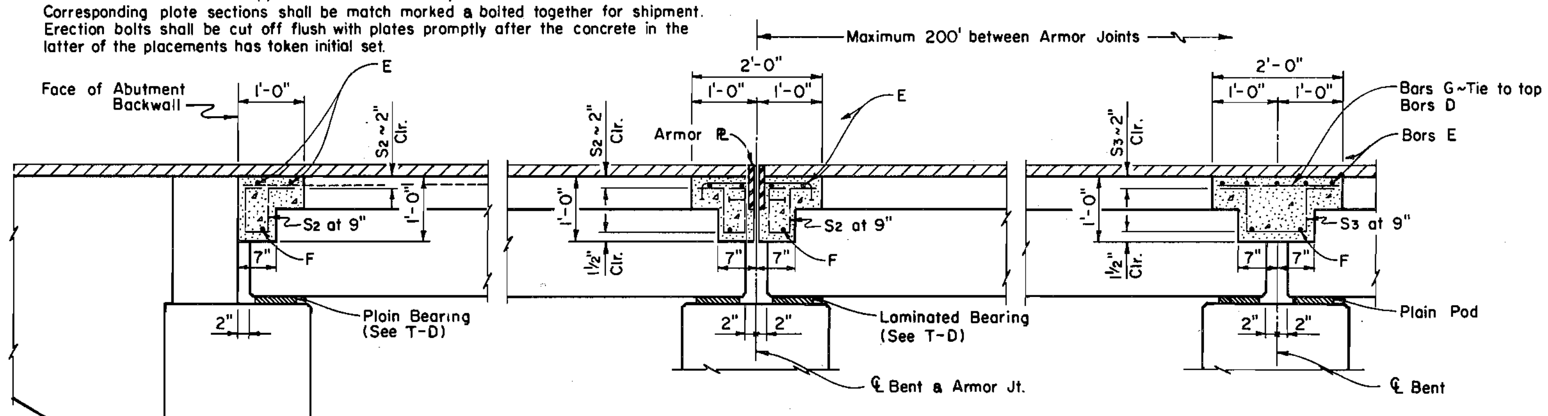
(28.57 #/L.F.)

Note: Armor Plates shall be shipped in convenient lengths (20'-0 Max.-10'-0" Min.) Corresponding plate sections shall be match marked & bolted together for shipment. Erection bolts shall be cut off flush with plates promptly after the concrete in the latter of the placements has taken initial set.



EXPANSION JOINT

(Reinforcing placement for Abutment & Fixed Joint similar)



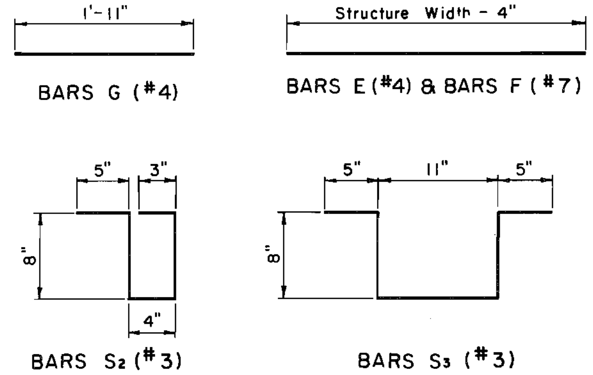
ABUTMENT JOINT

EXPANSION JOINT

(Locate as shown on the Layout)

FIXED JOINT

JOINT DETAILS



JOINT REINFORCING DETAILS

Note: All reinforcing shall be Grade 60

TABLE OF VARIABLE QUANTITIES						
ROADWAY		28'-0"	34'-0"	38'-0"	40'-0"	44'-0"
Class A Concrete (Cast-in-place)						
Expansion Joint	C.Y./Bent	1.7	2.0	2.1	2.3	2.6
Fixed Joint	C.Y./Bent	1.8	2.1	2.3	2.5	2.7
Abutment Joint	C.Y./Bent	0.9	1.1	1.2	1.2	1.3
Reinforcing Steel						
Expansion Joint	lbs.	328	390	437	456	502
Fixed Joint	lbs.	356	443	483	504	544
Abutment Joint	lbs.	164	197	219	230	251
Structural Steel						
Armor Joint	lbs.	800	971	1087	1143	1257

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRESTRESSED CONCRETE T BEAMS

T-RD

ORIGINAL DRAWING DATE: NOV. 1980

REVISIONS

DN.:-RLR
CK.:-GHO
DW.:-AS
CK.:-GHO

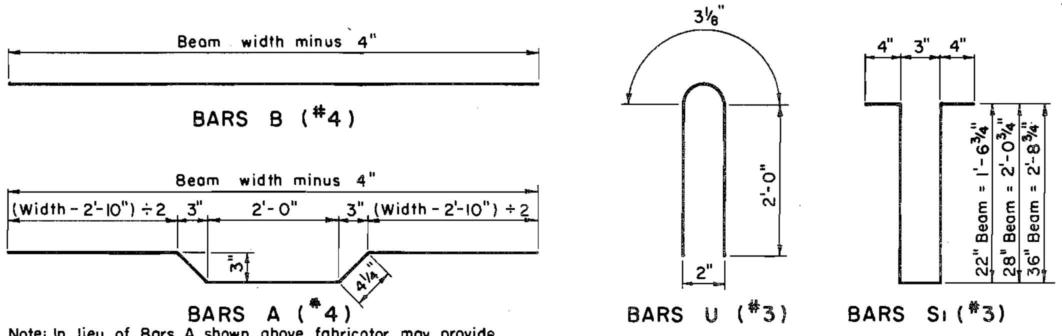
STATE DISTRICT 6 | FEDERAL REGION | FEDERAL AID PROJECT | SHEET | COUNTY | CONTROL | SECTION | JOB | HIGHWAY

DESIGNED BEAMS (DEPRESSED STRANDS) / OPTIONAL DESIGN

SPAN	BEAM TYPE	½" ϕ 270K STRANDS TOTAL NO.	"e" ℄ In.	"e" END In.	DEPRESSED NO.	DEPRESSED TO ROW	CONCRETE RELEASE STRENGTH f'ci (psi)	CONCRETE MINIMUM 28 DAY COMP. STRENGTH f'c (psi)	OPTIONAL DESIGN: DESIGN LOAD COMP. STRESS (TOP ℄) psi	DESIGN LOAD TENSILE STRESS (BOT. ℄) psi	REQUIRED MINIMUM ULTIMATE MOMENT CAPACITY Ft.-K	THEOR. CAMBER Ft.
30'-4"	6T 22	12	10.79	8.12	8	10	4000	5000	1029	2110	295	.044
	7T 22	16	10.18	7.18	12	12	4000	5000	1054	2346	339	.051
	8T 22	20	9.50	6.30	16	12	4460	5000	1082	2580	382	.058
35'	6T 28	12	14.83	10.83	8	12	4000	5000	920	1889	396	.039
	7T 28	16	14.34	9.84	12	14	4000	5000	935	2088	453	.048
	8T 28	16	14.77	10.27	12	14	4000	5000	954	2290	510	.047
40'	6T 28	20	12.83	8.03	16	16	4040	5000	1179	2421	505	.075
	7T 28	20	13.34	8.54	16	16	4000	5000	1199	2677	578	.072
	8T 28	24	12.77	7.77	20	18	4490	5000	1220	2931	649	.079
45'	6T 36	16	19.22	13.22	12	16	4000	5000	1005	2067	637	.051
	7T 36	20	18.87	14.07	16	16	4000	5000	1016	2271	725	.068
	8T 36	20	19.42	14.62	16	16	4000	5000	1029	2472	812	.066
50'	6T 36	20	18.22	13.42	16	16	4000	5000	1204	2474	756	.078
	7T 36	24	17.87	11.20	20	20	4070	5000	1215	2716	860	.090
	8T 36	28	17.42	8.85	24	24	4590	5000	1230	2954	963	.094
55'	6T 36	28	16.22	9.36	24	22	4500	5000	1412	2903	880	.103
	7T 36	32	15.87	8.87	28	24	4930	5000	1424	3182	1023	.115
	8T 36	40	14.42	9.02	36	26	5670	5670	1439	3456	1119	.122

BEAM DIMENSIONS & SECTION PROPERTIES

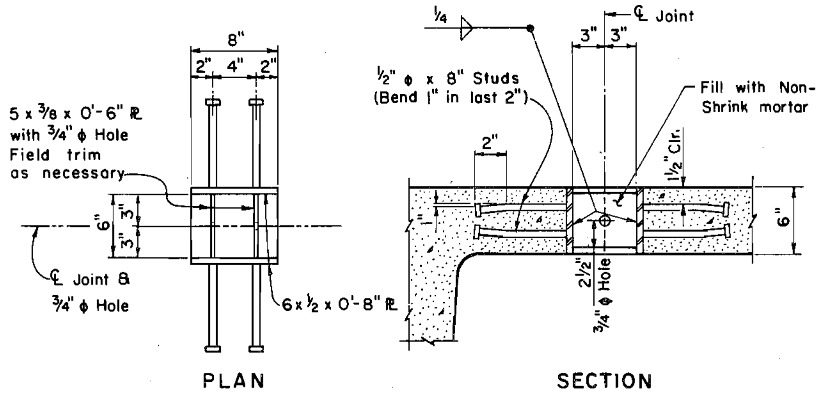
BEAM TYPE	WIDTH	DEPTH In.	Yb In.	Yt In.	AREA $In.^2$	I $In.^4$	WT. LBS/L.F.
6T 22	6'-0"	22	14.79	7.21	712	26,676	742
7T 22	7'-0"	22	15.18	6.82	784	28,050	817
8T 22	8'-0"	22	15.50	6.50	856	29,228	892
6T 28	6'-0"	28	18.83	9.17	801	51,724	834
7T 28	7'-0"	28	19.34	8.66	873	54,452	909
8T 28	8'-0"	28	19.77	8.23	945	56,798	984
6T 36	6'-0"	36	24.22	11.78	905	99,830	942
7T 36	7'-0"	36	24.87	11.13	977	105,188	1017
8T 36	8'-0"	36	25.42	10.58	1049	109,840	1092



Note: In lieu of Bars A shown above fabricator may provide straight #4 bars top and bottom.

REINFORCING STEEL DETAILS

Note: At fabricator's option, alternate designs utilizing welded wire fabric (ASTM A185 or A497) of equivalent cross sectional area to replace all or some of bars A, B, D or S1 will be permitted.



LATERAL CONNECTOR DETAIL

(24#/CONNECTOR)

Note: No direct payment will be made for providing or welding of lateral connectors or for mortar which shall be considered subsidiary to the bid items.

GENERAL NOTES:

These prestressed concrete beams are designed for HS-20 loading in accordance with A.A.S.H.T.O. 1977 Standard and Interim Specifications. Prestress losses for the designed beams have been calculated for a relative humidity of 50%. Optional designs shall likewise conform.

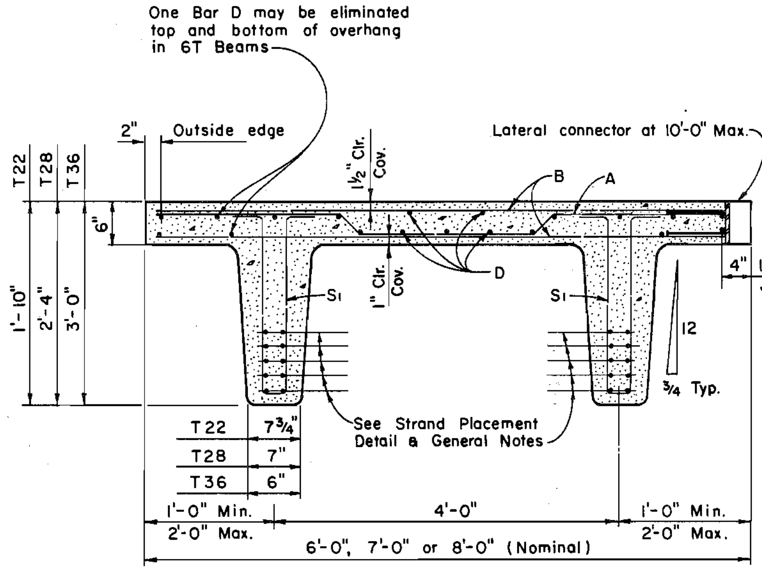
The fabricator has the option of furnishing the designed beam or an approved optional design. Low relaxation strands may be used.

Strands shall be placed filling row 2 first, then row 4, etc. The strands in row 2 shall be left straight, and the remaining strands depressed so that the upper most strands are at the position indicated in the table at the end of the stem.

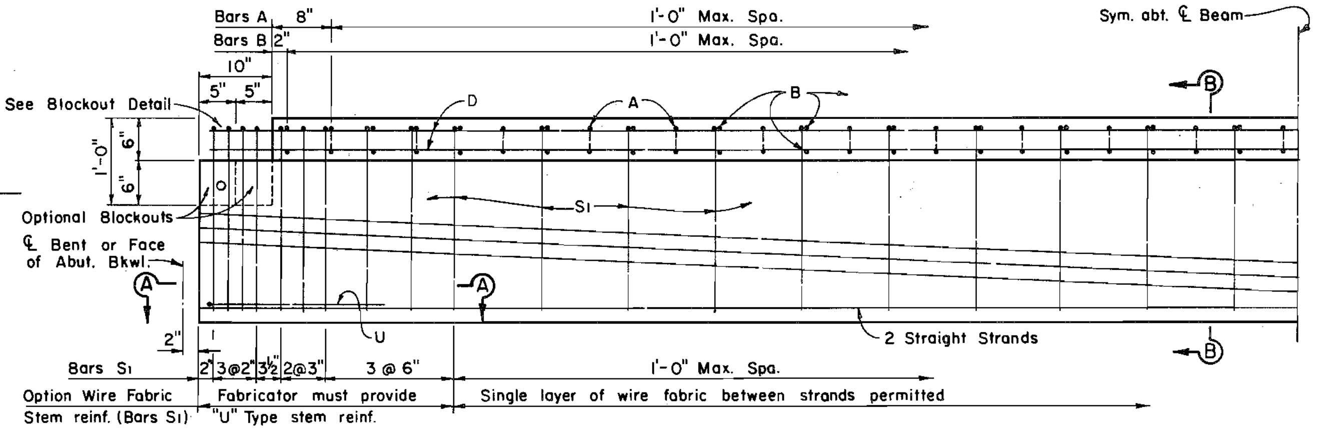
Initial pretension for regular stress relieved strands is 28.9 K and for low relaxation strands is 31.0 K.

All concrete shall be Class H with strength as shown. All reinforcing shall be Grade 60. Bars S1 & bars U need not be tied to each other or to the prestressing strands. No tie will be required between strands and wire fabric if used.

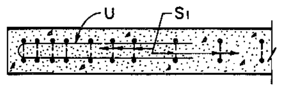
The tops of all beams shall have a rough wood float finish, except the portion under rail posts on exterior beams which shall be steel troweled.



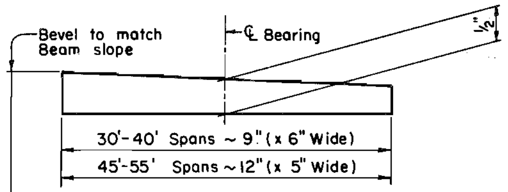
SECTION B-B



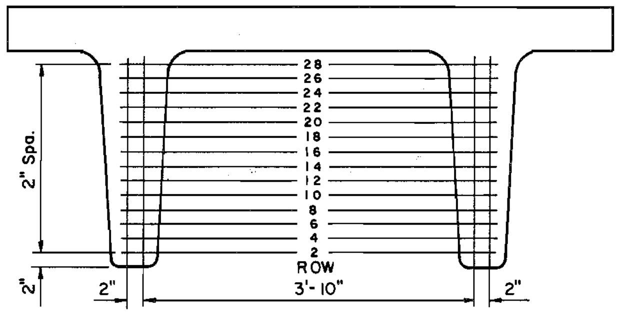
HALF ELEVATION



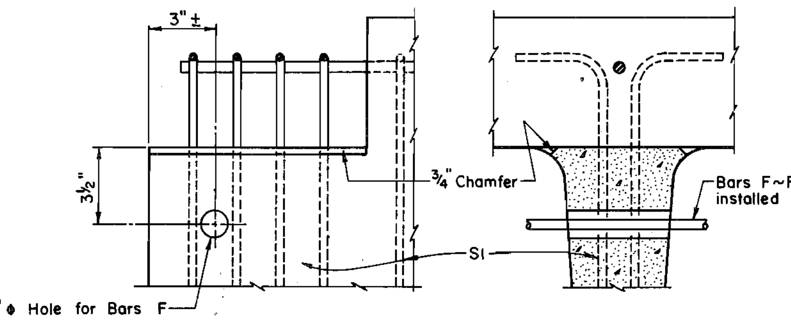
SECTION A-A



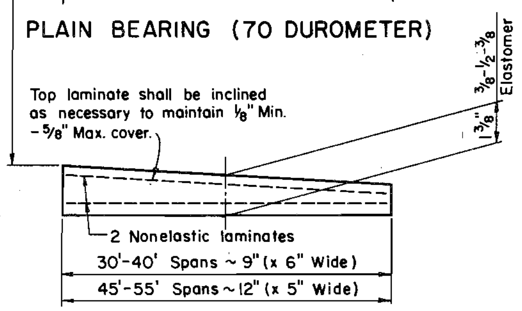
PLAIN BEARING (70 DUROMETER)



STRAND PLACEMENT DETAIL



BLOCKOUT DETAIL



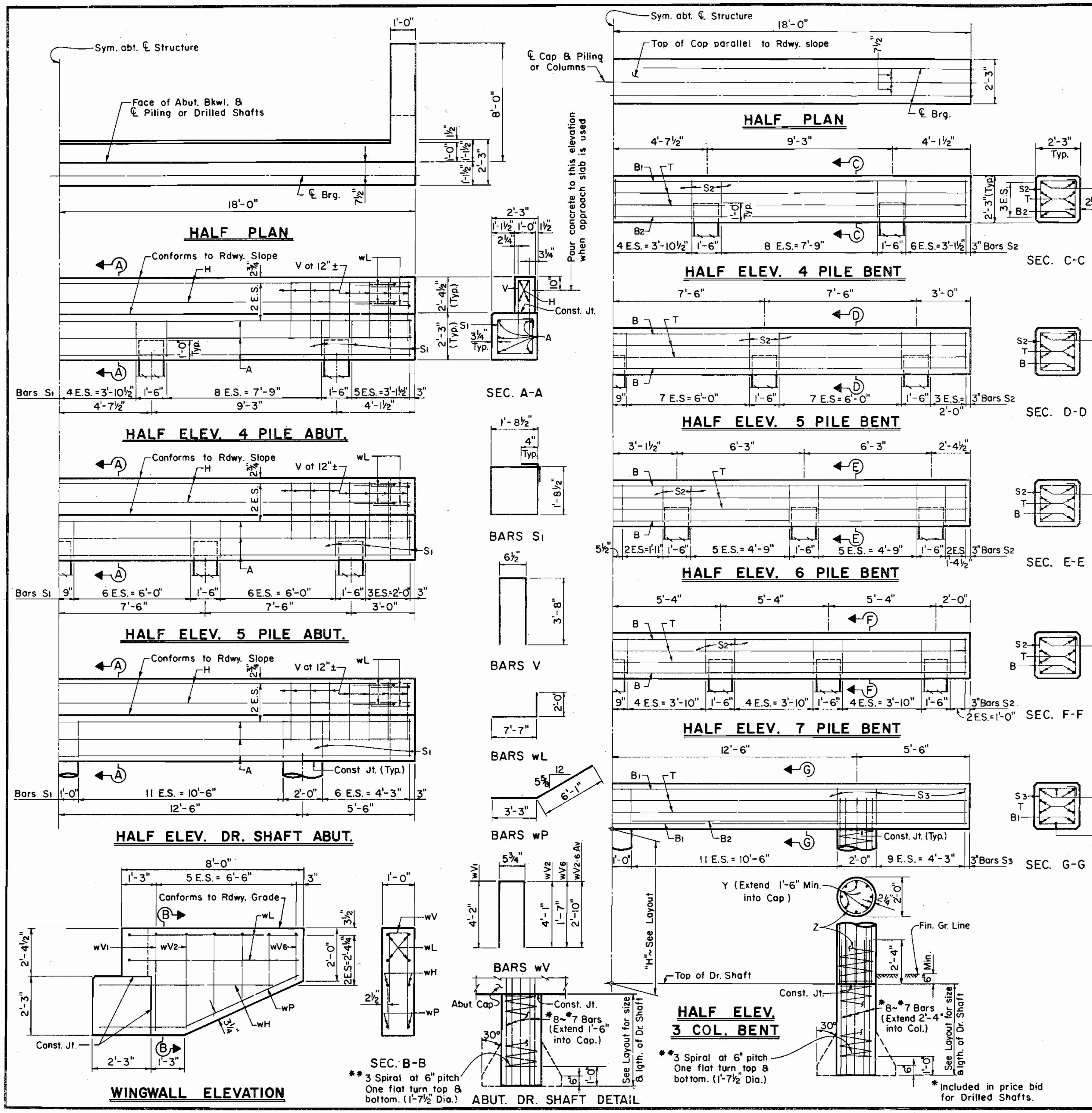
LAMINATED BEARING (60 DUROMETER)

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

PRESTRESSED CONCRETE T BEAMS

T-D

ORIGINAL DRAWING DATE: NOV. 1980	STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT	SHEET
DN.:-GHO / CK.:-LEC / DW.:-AS / CK.:-GHO — REVISIONS		6		



TABLES OF ESTIMATED QUANTITIES

4 PILE ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	35'-8"	948
H	4	#5	35'-8"	149
S1	39	#4	7'-6"	195
V	37	#4	7'-11"	196
wH	4	#6	6'-9"	41
wL	8	#6	9'-7"	115
wP	4	#4	9'-4"	25
wV1	2	#4	8'-10"	12
wV2-6	10	#4	6'-2" Av.	41
Reinf. Steel			Lb.	1722
Cl. C Conc.			C.Y.	11.7

5 PILE ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	35'-8"	948
H	4	#5	35'-8"	149
S1	36	#4	7'-6"	180
V	37	#4	7'-11"	196
wH	4	#6	6'-9"	41
wL	8	#6	9'-7"	115
wP	4	#4	9'-4"	25
wV1	2	#4	8'-10"	12
wV2-6	10	#4	6'-2" Av.	41
Reinf. Steel			Lb.	1707
Cl. C Conc.			C.Y.	11.7

DR. SHAFT ABUT.

Bar	No.	Size	Length	Weight
A	5	#11	35'-8"	948
H	4	#5	35'-8"	149
S1	38	#4	7'-6"	190
V	37	#4	7'-11"	196
wH	4	#6	6'-9"	41
wL	8	#6	9'-7"	115
wP	4	#4	9'-4"	25
wV1	2	#4	8'-10"	12
wV2-6	10	#4	6'-2" Av.	41
Reinf. Steel			Lb.	1717
Cl. C Conc.			C.Y.	11.7

4 PILE INT. BENT

Bar	No.	Size	Length	Weight
B1	2	#10	35'-8"	307
B2	2	#11	35'-8"	379
S2	41	#4	8'-2"	224
T	4	#4	35'-8"	95
Reinf. Steel			Lb.	1005
Cl. C Conc.			C.Y.	6.8

5 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#10	35'-8"	614
S2	40	#4	8'-2"	218
T	4	#4	35'-8"	95
Reinf. Steel			Lb.	927
Cl. C Conc.			C.Y.	6.8

6 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#9	35'-8"	485
S2	36	#4	8'-2"	196
T	4	#4	35'-8"	95
Reinf. Steel			Lb.	776
Cl. C Conc.			C.Y.	6.8

7 PILE INT. BENT

Bar	No.	Size	Length	Weight
B	4	#8	35'-8"	381
S2	36	#4	8'-2"	196
T	4	#4	35'-8"	95
Reinf. Steel			Lb.	672
Cl. C Conc.			C.Y.	6.8

FOUNDATION LOADS

SPAN	35'	40'
4 PILE ABUT. (T/P)	33	35
5 PILE ABUT. (T/P)	26	28
DR. SHAFT ABUT. (T/D.S.)	44	47
4 PILE BENT (T/P)	45	48
5 PILE BENT (T/P)	36	38
6 PILE BENT (T/P)	30	32
7 PILE BENT (T/P)	26	27
3 COL. BENT (T/D.S.)	63	67

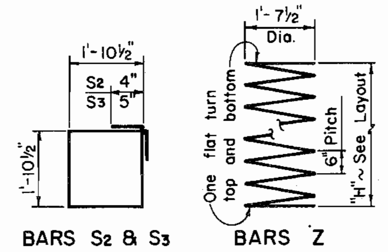
3 COL. INT. BENT

Bar	No.	Size	Length	Weight
B1	5	#11	35'-8"	948
B2	2	#11	10'-6"	112
S3	44	#5	8'-4"	382
T	4	#5	35'-8"	149
Reinf. Steel			Lb.	1591
Cl. C Conc.			C.Y.	6.8

TABLE OF VARIABLE QUANTITIES 3 COL. INT. BENT / **TOTAL EST. QUANTITIES 3 COL. INT. BT.**

"H"	Cl. C Conc.	BARS Z 3~ #3		BARS Y 24~ #7		Reinf. Steel	Cl. C Conc.
Ft.	C.Y.	Length	Weight	Length	Weight	Lbs.	C.Y.
8	2.8	92'	104	9'-6"	466	2161	9.6
9	3.1	103'	116	10'-6"	515	2222	9.9
10	3.5	113'	127	11'-6"	564	2282	10.3
11	3.8	123'	139	12'-6"	613	2343	10.6
12	4.2	133'	150	13'-6"	662	2403	11.0
13	4.5	144'	162	14'-6"	711	2464	11.3
14	4.9	154'	174	15'-6"	760	2525	11.7
15	5.2	164'	185	16'-6"	809	2585	12.0
16	5.6	174'	196	17'-6"	858	2645	12.4
17	5.9	185'	209	18'-6"	908	2708	12.7
18	6.3	195'	220	19'-6"	957	2768	13.1

HS 20 LOADING



GENERAL NOTES:

Designed according to A.A.S.H.T.O. 1977 Standard and Interim Specifications.
These bents shall be used when the average of adjacent span lengths is equal to or less than 40'-0".

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

BENTS FOR PRESTRESSED CONCRETE T BEAMS

34'-0" RDWY. 35'-40' SPANS

34.BT 35-40

ORIGINAL DRAWING DATE: DEC. 1980 — REVISIONS

DN.:-GHO
CK.:-JCW
DW.:-AS
CK.:-GHO

STATE DISTRICT: 6

beams is the main reason for recommending an increased size of shear key for this proposed superstructure system. The abutment and interior bent treatments at the ends of the precast slabs are similiar to those which have been very successful when used with the CGC units in Texas for over 25 years. The only transverse coupling of the slabs is by means of two No. 5 bars in the cast-in-place concrete as shown in the details.

The transverse conventional reinforcement is proposed to be as simple as possible without complete elimination. The upper and lower transverse steel is composed of the same U-bars with the intent that they not be tied at their laps. Alternate spacing would be permissible to avoid conflict when placing the upper assembly which will also have longitudinal No. 5 bars spaced at about 8 inches. The necessity of having special outside slab sections with no shear key recess is simply met by a smooth outside face. The outside sections will usually also have some special bridge railing anchorage reinforcement or anchor bolts.

The bent details recommended to be used with the solid slabs can in most respects be the same as those listed and shown above for the modified DHT boxes.

<u>Precast Concrete Voided Slabs</u>

The design shown in Chapter 1 for the precast concrete voided slabs is also similar to the cross-sections shown in the PCI Short Span Bridges publication (Ref 5). The shear key and end treatment details are again proposed to be larger than the PCI concept for the same reasons as described for the solid slabs. The advantage of the voided slabs over the solid slabs is that longer spans can be realized due to the reduction in dead weight from the voids.

The major difference in the proposed voided slab details from the solid slab details is the recommendation that a 9 inch plug of concrete be cast into the voids when the closure section between units is cast. A suitable left-in-place bulkhead would be placed within the void. It may be possible to eliminate this plug since irregularities in the end surfaces and the extension of the longitudinal reinforcing into the field cast end sections will provide enough shear to transfer any lateral forces into the two No. 5 bars which tie the units together.

Both the solid and voided slab transverse reinforcement could be welded wire fabric of equivalent areas in lieu of the conventional deformed bars. These fabric mats would be bent in the same shape with adequate longitudinal wires in the vertical legs to provide proper anchorages where the upper and lower mats lap.

The bent details recommended to be used with the voided slabs can again be essentially the same as those listed and shown previously for the modified DHT boxes.

CHAPTER 3. CONTRACT PLANS

As described in the original proposal, the intent of this project was to finish with a demonstration of the developed new details by incorporating them into an actual contract. Due to time constraints, and also the desire that the demonstration bridges not be skewed, a relatively small bridge replacement contract was selected as a trial application of the new sections. Two existing bridges were to be replaced, one which is 500 ft long and the other 600 ft long. The bridges are in Floyd County on FM 1065 over Los Linguish and Quitaque Creeks about four miles south of the town of Quitaque. The regular bid was for complete new structures with the use of 40 ft CGC units. The planned new roadway is to be 34 ft wide. The original bridges were about 20 ft wide.

For the Los Linguish Creek bridge, which is 600 ft long, the regular bid included provision for complete new bents and piling with the exception that three original 15 inch square piling are incorporated into the new abutments and into two of the 14 interior bents. There would be two additional piling installed at the four bents which reuse the original piling.

The Quitaque Creek bridge is 500 ft long. The regular bid bridge was for two 30.33 ft CGC units and eleven 40.0 ft CGC units. Again, four of the original bents, each having three piling, were planned to be reused. Both alternate bids allowed reuse of all of the existing piling so that only two additional piling would need to be driven at each bent.

The all new bents required for the regular bid bridges will each have four piling. The alternate bid bridges with either the precast box beams or the precast double tee beams were to have 50 ft spans instead of the regular bid 40 ft spans. The 50 ft spans matched the spans of the original structure, thus only about half as much piling would need to be used as in the regular bid.

The total combined piling length for the two regular bid structures was to be 2756 linear feet while the total length for either of the two alternate bid structures was 1254 linear feet. It was therefore anticipated that there would be a better chance of one or the other of the alternates being the selected structure.

The engineering estimate for the two alternates indicated that each should be about the same cost, with either one estimated to be one about 1 percent more than the CGC estimate. Unfortunately, neither of the alternates was the low bid. The lowest CGC regular bid was about 28 percent less than the engineering estimate with the major difference due to the bid cost for the CGC Class C concrete which was about 38 percent less than estimated. Tables 1 and 2 show the engineer's estimate and bidder tabulations for the lowest three bids on the CGC spans.

Only two of the bidders (there were 10) bid on the alternates. Tables 3 and 4 show the engineer's estimate and bidder tabulations for the two who bid on the alternate structures. The precast concrete box beam bid was about 12 percent above the estimate and the double tee bid was about 12 percent below the estimate. Contact was made with one precast producer after the job was let and he stated that the added transportation costs to the relatively remote bridge site in the Panhandle was one of the reasons he had not quoted a lower price to the contractors. He also said that the main reason the price was not as low as anticipated was the uncertainty of there being more bridges of like cross-section in the future to effectively repay him for the initial cost of the special forms and necessary new plant production hardware. Had this contract been larger, then the first cost of the forms and hardware could possibly have been absorbed.

One preliminary conclusion that can be drawn from this contract letting is that any new superstructure construction system is at a significant initial disadvantage due to the uncertainty of the system being used again. If the state has enough confidence in the new system being a viable future alternative to current construction systems, then a procedure must be found to somehow share in the initial cost of the new formwork which would remove this cost from being a burden on the first contract. The state could possibly set up within the contract a procedure wherein the cost of the new forms would be paid for directly to the producer, and the forms would remain the property of the state. If they were reused by that producer, pre-agreed upon rental rates would be assigned, with the producer having the option of paying two rates, either direct rental, with the state retaining ownership and control over where the forms might next be used, or a different rental rate wherein the producer would eventually obtain full ownership of the forms, that is, a lease-purchase arrangement. It must be understood that the formwork involved to produce a precast product does not just include the side forms. Both alternates in the trial contract used cross-sections whose side forms were already available. The casting bed must usually be modified to be compatible with the width of the product. Spacers, strand stressing templates, special reinforcment positioning jigs, and other miscellaneous hardware must also be fabricated. All these items should be included in the first cost of formwork for any new precast product.

FLOYD COUNTY FM 1065 CONTROL 0740-02-020 PROJECT BRS 1493(2)
DATE 04/15/81 175 WORKING DAYS
REPLACE BRIDGES AND WIDEN APPROACHES
LOS LINGUISH CREEK AND QUITAQUE CREEK BRIDGES

ENGINEERS ESTIMATE -- PAN FORM SPANS

ITEM DESCRIPTION	QUANTITY	ENGR ESTIMATE	EXTENSION
ASPHALT	4100 GAL	2.00	8,200.00
AGGREGATE (CL B TY A)	170 CY	35.00	5,950.00
CONCRETE PILING (15 IN. SQ)	2756 LF	40.00	110,240.00
CLASS C CONC (BENT)	134.4 CY	350.00	47,040.00
CLASS C CONC (ABUT)	38.2 CY	350.00	13,370.00
CLASS C CONC (PAN GIRD)	1905.2 CY	300.00	571,560.00
REINFORCING STEEL	375,928 LB	0.50	187,964.00
STRUCT STEEL (ARMOR JOINT)	9108 LB	1.50	13,662.00
RAIL (TYPE T202)	2257.32 LF	35.00	79,006.20
CLASS B CONC (RIPRAP)	126 CY	225.00	28,350.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	35,000.00	70,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	13.50	13,500.00
TERMINAL ANCHOR SECTION	8 EA	400.00	3,200.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.50	4,200.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	25,000.00	25,000.00
		TOTAL	1,191,242.20

FIRST LOW BIDDER -- PAN FORM SPANS

ITEM DESCRIPTION	QUANTITY	AMOUNT BID	EXTENSION
ASPHALT	4100 GAL	1.75	7,175.00
AGGREGATE (CL B TY A)	170 CY	40.00	6,800.00
CONCRETE PILING (15 IN. SQ)	2756 LF	43.00	118,508.00
CLASS C CONC (BENT)	134.4 CY	275.00	36,960.00
CLASS C CONC (ABUT)	38.2 CY	275.00	10,505.00
CLASS C CONC (PAN GIRD)	1905.2 CY	185.00	352,462.00
REINFORCING STEEL	375,928 LB	0.42	157,889.76
STRUCT STEEL (ARMOR JOINT)	9108 LB	1.25	11,385.00
RAIL (TYPE T202)	2257.32 LF	23.00	51,918.36
CLASS B CONC (RIPRAP)	126 CY	175.00	22,050.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	15,000.00	30,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	12.00	12,000.00
TERMINAL ANCHOR SECTION	8 EA	300.00	2,400.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.00	3,600.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	20,000.00	20,000.00
		TOTAL	853,653.12

Table 1. Engineer's Estimate and Low Bid for CGC Regular Bid.

FLOYD COUNTY FM 1065 CONTROL 0740-02-020 PROJECT BRS 1493(2)
DATE 04/15/81 175 WORKING DAYS
REPLACE BRIDGES AND WIDEN APPROACHES
LOS LINGUISH CREEK AND QUITAQUE CREEK BRIDGES

SECOND LOW BIDDER -- PAN FORM SPANS

ITEM DESCRIPTION	QUANTITY	AMOUNT BID	EXTENSION
ASPHALT	4100 GAL	2.00	8,200.00
AGGREGATE (CL B TY A)	170 CY	50.00	8,500.00
CONCRETE PILING (15 IN. SQ)	2756 LF	40.00	110,240.00
CLASS C CONC (BENT)	134.4 CY	350.00	47,040.00
CLASS C CONC (ABUT)	38.2 CY	350.00	13,370.00
CLASS C CONC (PAN GIRD)	1905.2 CY	175.00	333,410.00
REINFORCING STEEL	375,928 LB	0.38	142,852.64
STRUCT STEEL (ARMOR JOINT)	9108 LB	2.50	22,770.00
RAIL (TYPE T202)	2257.32 LF	25.00	56,433.00
CLASS B CONC (RIPRAP)	126 CY	175.00	22,050.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	30,000.00	60,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	11.00	11,000.00
TERMINAL ANCHOR SECTION	8 EA	300.00	2,400.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	2.00	2,400.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	500.00	5,000.00
MOBILIZATION	1 LS	50,000.00	50,000.00
		TOTAL	895,665.64

THIRD LOW BIDDER -- PAN FORM SPANS

ITEM DESCRIPTION	QUANTITY	AMOUNT BID	EXTENSION
ASPHALT	4100 GAL	1.50	6,150.00
AGGREGATE (CL B TY A)	170 CY	50.00	8,500.00
CONCRETE PILING (15 IN. SQ)	2756 LF	35.00	96,460.00
CLASS C CONC (BENT)	134.4 CY	350.00	47,040.00
CLASS C CONC (ABUT)	38.2 CY	350.00	13,370.00
CLASS C CONC (PAN GIRD)	1905.2 CY	175.00	333,410.00
REINFORCING STEEL	375,928 LB	0.25	93,982.00
STRUCT STEEL (ARMOR JOINT)	9108 LB	1.50	13,662.00
RAIL (TYPE T202)	2257.32 LF	20.00	45,146.40
CLASS B CONC (RIPRAP)	126 CY	175.00	22,050.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	57,500.00	115,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	15.00	15,000.00
TERMINAL ANCHOR SECTION	8 EA	400.00	3,200.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	2.00	2,400.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	100,000.00	100,000.00
		TOTAL	925,370.40

Table 2. Second and Third Low Bids
for CGC Regular Bid.

FLOYD COUNTY FM 1065 CONTROL 0740-02-020 PROJECT BRS 1493(2)
DATE 04/15/81 175 WORKING DAYS
REPLACE BRIDGES AND WIDEN APPROACHES
LOS LINGUISH CREEK AND QUITAQUE CREEK BRIDGES

ENGINEERS ESTIMATE -- ALTERNATE -A- PRESTRESSED BOX BEAM SPANS

ITEM DESCRIPTION	QUANTITY	ENGR ESTIMATE	EXTENSION
ASPHALT	2500 GAL	0.97	2,425.00
AGGREGATE (CL B TY A)	90 CY	40.00	3,600.00
ASPHALT (AC)	22 TON	118.00	2,596.00
AGGREGATE (TYPE D)	290 TON	30.00	8,700.00
CONCRETE PILING (15 IN. SQ)	1254 LF	40.00	50,160.00
CLASS C CONC (BENT)	138.0 CY	350.00	48,300.00
CLASS C CONC (ABUT)	44.8 CY	350.00	15,680.00
CLASS A CONC (SHEAR KEY)	173.8 CY	350.00	60,830.00
CLASS A CONC (DIAF)	62.2 CY	345.00	21,459.00
PRESTR CONC BOX BEAM (4 B 20)	4356.0 LF	75.00	326,700.00
PRESTR CONC BOX BEAM (5 B 20)	4356.0 LF	92.25	401,841.00
REINFORCING STEEL	34,988 LB	0.50	17,494.00
STRUCT STEEL (ARMOR JOINT)	6666 LB	1.50	9,999.00
RAIL (TYPE T202)	2256.0 LF	35.00	78,960.00
CLASS B CONC (RIPRAP)	126 CY	225.00	28,350.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	35,000.00	70,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	13.50	13,500.00
TERMINAL ANCHOR SECTION	8 EA	400.00	3,200.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.50	4,200.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	25,000.00	25,000.00
		TOTAL	1,202,994.00

10TH BIDDER -- ALTERNATE -A- PRESTRESSED BOX BEAM SPANS

ITEM DESCRIPTION	QUANTITY	AMOUNT BID	EXTENSION
ASPHALT	2500 GAL	2.00	5,000.00
AGGREGATE (CL B TY A)	90 CY	40.00	3,600.00
ASPHALT (AC)	22 TON	80.00	1,760.00
AGGREGATE (TYPE D)	290 TON	80.00	23,200.00
CONCRETE PILING (15 IN. SQ)	1254 LF	25.00	31,350.00
CLASS C CONC (BENT)	138.0 CY	250.00	34,500.00
CLASS C CONC (ABUT)	44.8 CY	250.00	11,200.00
CLASS A CONC (SHEAR KEY)	173.8 CY	110.00	19,118.00
CLASS A CONC (DIAF)	62.2 CY	155.00	9,641.00
PRESTR CONC BOX BEAM (4 B 20)	4356.0 LF	66.00	287,496.00
PRESTR CONC BOX BEAM (5 B 20)	4356.0 LF	81.00	352,836.00
REINFORCING STEEL	34,988 LB	0.40	13,995.20
STRUCT STEEL (ARMOR JOINT)	6666 LB	1.20	7,999.20
RAIL (TYPE T202)	2256.0 LF	35.00	78,960.00
CLASS B CONC (RIPRAP)	126 CY	155.00	19,530.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	100,000.00	200,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	14.00	14,000.00
TERMINAL ANCHOR SECTION	8 EA	400.00	3,200.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.00	3,600.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	750.00	7,500.00
MOBILIZATION	1 LS	223,000.00	223,000.00
		TOTAL	1,351,485.40

Table 3. Engineer's Estimate and Only Bid for Prestressed Box Beam Alternate.

FLOYD COUNTY FM 1065 CONTROL 0740-02-020 PROJECT BRS 1493(2)
DATE 04/15/81 175 WORKING DAYS
REPLACE BRIDGES AND WIDEN APPROACHES
LOS LINGUISH CREEK AND QUITAQUE CREEK BRIDGES

ENGINEERS ESTIMATE -- ALTERNATE -B- PRESTRESSED TEE BEAM SPANS

ITEM DESCRIPTION	QUANTITY	ENGR ESTIMATE	EXTENSION
ASPHALT	2500 GAL	0.97	2,425.00
AGGREGATE (CL B TY A)	90 CY	40.00	3,600.00
ASPHALT (AC)	22 TON	118.00	2,596.00
AGGREGATE (TY D)	290 TON	30.00	8,700.00
CONCRETE PILING (15 IN. SQ)	1254 LF	40.00	50,160.00
CLASS C CONC (BENT)	166.0 CY	350.00	58,100.00
CLASS C CONC (ABUT)	56.8 CY	350.00	19,880.00
CLASS A CONC (DIAF)	45.8 CY	345.00	15,801.00
PRESTR CONC TEE BEAM (6 T 36)	6556.0 LF	118.45	776,558.20
REINFORCING STEEL	46,810 LB	0.50	23,405.00
STRUCT STEEL (ARMOR JOINT)	5826 LB	1.50	8,739.00
RAIL (TYPE T202)	2256.0 LF	35.00	78,960.00
CLASS B CONC (RIPRAP)	126 CY	225.00	28,350.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	35,000.00	70,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	13.50	13,500.00
TERMINAL ANCHOR SECTION	8 EA	400.00	3,200.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.50	4,200.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	25,000.00	25,000.00
		TOTAL	1,203,174.20

8TH BIDDER -- ALTERNATE -B- PRESTRESSED TEE BEAM SPANS

ITEM DESCRIPTION	QUANTITY	AMOUNT BID	EXTENSION
ASPHALT	2500 GAL	2.25	5,625.00
AGGREGATE (CL B TY A)	90 CY	125.00	11,250.00
ASPHALT (AC)	22 TON	70.00	1,540.00
AGGREGATE (TY D)	290 TON	70.00	20,300.00
CONCRETE PILING (15 IN. SQ)	1254 LF	56.00	70,224.00
CLASS C CONC (BENT)	166.0 CY	300.00	49,800.00
CLASS C CONC (ABUT)	56.8 CY	300.00	17,040.00
CLASS A CONC (DIAF)	45.8 CY	300.00	13,740.00
PRESTR CONC TEE BEAM (6 T 36)	6556.0 LF	93.50	612,986.00
REINFORCING STEEL	46,810 LB	0.50	23,405.00
STRUCT STEEL (ARMOR JOINT)	5826 LB	1.50	8,739.00
RAIL (TYPE T202)	2256.0 LF	32.00	72,192.00
CLASS B CONC (RIPRAP)	126 CY	200.00	25,200.00
REMOVE OLD STRUCTURE (LARGE)	2 EA	25,000.00	50,000.00
GALV STEEL BEAM GUARD FENCE	1000 LF	16.50	16,500.00
TERMINAL ANCHOR SECTION	8 EA	500.00	4,000.00
REMOVE METAL BEAM GUARD FENCE	1200 LF	3.00	3,600.00
BARRICADES, SIGNS, TRAF HNDLG	10 MO	1000.00	10,000.00
MOBILIZATION	1 LS	43,000.00	43,000.00
		TOTAL	1,059,141.00

Table 4. Engineer's Estimate and Only Bid for Prestressed Tee Beam Alternate.

CHAPTER 4. SUMMARY AND RECOMMENDATIONS

Five different new precast superstructure configurations were studied with complete new details suitable for inclusion in contract plans developed for the precast box beams and precast double tee beams. A trial contract was let with the details included as two separate alternates to the regular bid CGC spans. Neither of the alternates was the low bid. As stated in the prior chapter, one of the reasons for the alternate not being the low bid on the trial contract was the fact that precast producers are reluctant to gear up to fabricate the new section due to the uncertainty that the state will let any further contracts with the new section.

It is therefore recommended that some means be found to remove the initial cost of new formwork and associated necessary production hardware from the cost of the initial contracts.

Another difficulty in acceptance of the proposed new details, especially the modified through void box beams and double tee beams, is the initial restriction of their use to non-skewed structures. It is recommended that moderately skewed details be prepared, since most modern highway crossings are skewed.

As of the date of the writing of this report, a second contract is being prepared for letting with the same two alternates as described in Chapter 3 for the Floyd County bridges. This new contract is in Mitchell County on Interstate 20. It is to be the South Frontage Road over the Colorado River. The structure is planned to be 360 feet in length with nine 40 ft CGC units as the regular bid and nine precast box beam or double tee beam units as the two alternates. No provision for separate payment to the fabricator for his initial first cost in producing the boxes or tees is planned.

REFERENCES

1. Furr, Howard L., H.L. Jones, C.E. Buth, and L.L. Ingram, "A Study of Prestressed Panels and Composite Action in Concrete Bridges Made of Prestressed Beams, Pre-stressed Sub-Deck Panels, and Cast-in-Place Deck," Four Research Reports, Project 145, Texas Trans-portation Institute, Texas A&M University, College Station, 1970 through 1972.

2. Panak, John J., "Skewed Multi-Beam Bridges with Precast Box Girders," Research Report 206-1F, Texas Department of Highways and Public Transportation, Austin, 1977.

3. Sack, R.L., "An Investigation of Precast and Prestressed Concrete Bulb Tee Multi-Beam Bridges," Report FHWA-RD-75-84, Department of Civil Engineering, University of Idaho, Moscow, 1975.

4. McClure, Richard M. and R.M. Barnoff, "Conventional and Through Voided Box Beams Subjected to Combined Loading," Transportation Research Record 785, Transportation Research Board, Washington, D.C. 1980.

5. Prestressed Concrete Institute, "Precast Prestressed Concrete Short Span Bridges," Second Edition, Chicago, Illinois, 1980.

6. American Association of State Highway and Transportation Officials, "Tentative Standards for Prestressed Concrete Piles, Slabs, I-Beams and Box beams for Bridges and an Interim Manual for Inspection of such Construction," Joint AASHTO and PCI Committee Report, Washington, D.C., 1962.

7. Transportation Research Board, "Precast Concrete Elements for Transportation Facilities," NCHRP Synthesis 53, Washington, D.C., 1978.

8. Commonwealth of Pennsylvania, Department of Transportation, "Standards for Bridge Design (Adjacent Box Beam Prestressed Concrete Structures)," 1972.

9. Hirsch, T.J., C.E. Buth, J.J. Panak, and A. Arnold, "Bridge Rail to Contain Heavy Trucks and Buses," Four Research Reports, Project 230, Texas Transportation Institute, Texas A&M University, College Station, 1978 through 1981.

10. Imel, K. Dean, "The Bridge Program for Rural Oklahoma," Paper presented to FCP Research Review Conference, Atlanta, Georgia, 1977.

11. Oklahoma Department of Transportation, "Index of County Bridge Standards," Oklahoma City, 1981.

12. Maciula, L.A., "Oklahoma Prefab Rural Bridges Cut Costs in Solving ADT Rise," Rural and Urban Roads, October 1979.

13. Sprinkel, Michael M., "In House Fabrication of Precast Concrete Bridge Slabs," Virginia Highway and Transportation Research Council, Report VHTRC 77-R33, 1976.