A
SELF-INSTRUCTIONAL
COURSE

BRIDGE AND CULVERT PLAN READING

prepared for the

IOWA STATE HIGHWAY COMMISSION

by

TECO INSTRUCTION, INC.

A SELF-INSTRUCTIONAL COURSE

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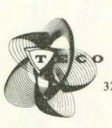


TECO INSTRUCTION, INC.
3236 N.E. 12th Ave., Ft. Lauderdale, Fla.

BRIDGE AND CULVERT PLAN READING

This is a self-instructional course designed in conjunction with *Highway Plan Reading*. Before taking this course students should either have taken the course, *Highway Plan Reading*, or have acquired equivalent plan reading skill through experience, or other instructional means.

HOW TO USE THIS MATERIAL

1. This course contains three different parts:

   One – This MANUAL you are reading
   Two – The ANSWER BOOKLET
   Three – A set of PLAN SHEETS for bridges and culverts.

   Be sure you have those three parts before you begin.

2. You will need a PENCIL with an ERASER. You will write in this manual and check your work by the ANSWER BOOKLET. You should always erase any wrong answer and write-in the correct one.

3. You may go through this course at your own best speed. Everything you will need to know will be written in this manual. All you need to do is follow the directions. Be sure you follow them *exactly*.

This course was designed to provide you with the most up-to-date, efficient, and enjoyable way to learn Bridge and Culvert Plan Reading. If you *want* to learn, this is the easy way to do it!

Do you have all the parts to this course?

Do you have a pencil and eraser?

When you can say yes to both questions above, go on to the next page and begin.

In your set of plans, turn now to the last sheet. This is Standard Sheet CIP, labeled in the right lower corner as:

Data Sheet for Standard
CONCRETE BOX CULVERTS
HEIGHTS 2' - 3' - 4' and 5'
PARALLEL WING WALLS

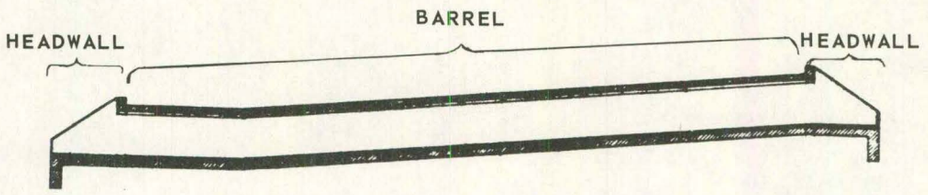
Note the date, April 1932. See the date of REVISION, June 1944.

In the left corner see the TYPICAL SITUATION PLAN. This shows a SPECIFIC culvert. The actual location and dimensions are given.

The other diagrams on that sheet are *standard* diagrams. They do *not* apply to any one specific culvert, but give *standard* requirements for *all* culverts of this type.

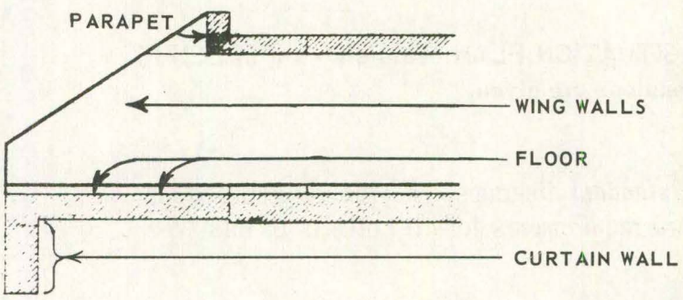
Look over that sheet briefly, then turn this page to learn more about it.

You need to know the *names* of the different culvert parts. **Examine the diagrams below very carefully.**



The barrel is shaped rather like a "square barrel". It may be long or short. The barrel is all the part between the headwalls.

The HEADWALL has these parts:

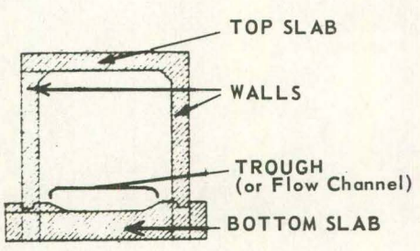


LONGITUDINAL CROSS SECTION

Remember –
The parapet goes *up*-
sounds like paratrooper.

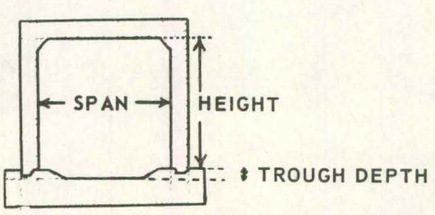
The curtain wall hangs *down*, like a curtain.

The BARREL has these parts:



CROSS SECTION

The dimensions are measured like this:



Refer to the opposite page as you write the answers to the following questions.

1. What are the two MAJOR parts of a culvert?

   1) _____ 2) _____

2. In the headwall, what is fastened to each end of the top slab?

   _____

3. In the headwall, what "hangs down" below the bottom slab?

   _____

4. Where the barrel WALLS reach the headwall, they become _____ walls. (Fill-in)

5. In the headwall, the top of the bottom slab is referred to as the

   _____.

6. What is the Trough (or flow channel)? _____

7. What distance is considered to be the culvert SPAN? _____

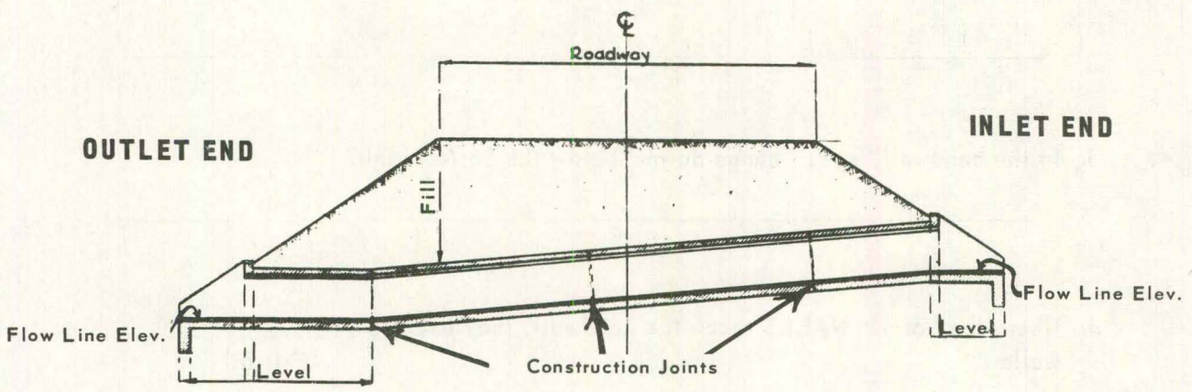
8. Does the HEIGHT include the trough depth? _____

NOW TURN TO THE FIRST PAGE IN THE ANSWER BOOKLET AND FIND THE ANSWERS TO PAGE 7.

If you made a mistake ERASE IT. Look back at page 6 and see why you were wrong. Then write in the CORRECT ANSWER.

NEVER LEAVE AN ANSWER WRONG! You're most likely to remember it the way you leave it.

Look next at the Longitudinal Section of the culvert. It looks like the one below on this page.



Notice these things particularly:

1. The FLOW LINE ELEVATION - This is shown to be at the top of the bottom slab, in the trough, "where the water flows".

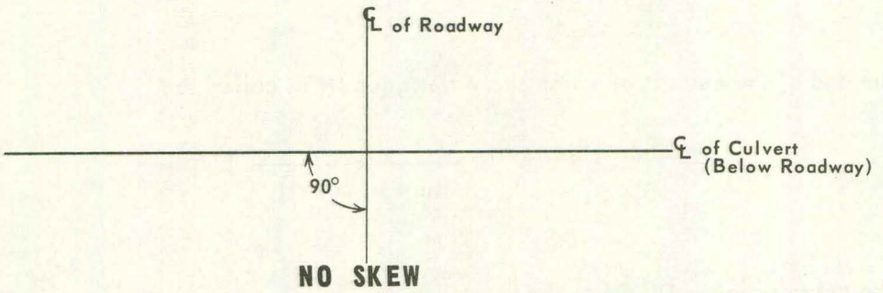
2. The INLET and OUTLET ends - The water goes *in* the INLET end and *out* the OUTLET end. The INLET end is, of course, always the higher end. The main elevations given for culvert construction are these *flow* line elevations at each end.

3. The SLOPE of the Fill, from the back of each parapet up toward the roadway.

4. The LEVEL distances at the inlet and outlet ends.

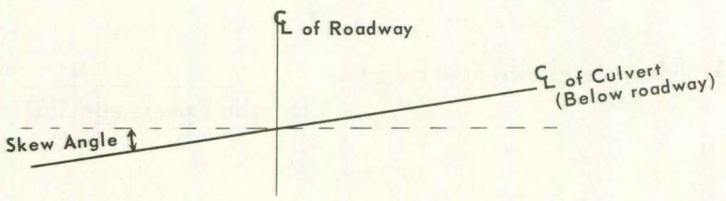
5. The CONSTRUCTION JOINTS - These show where one pour may end and another may begin.

Look at the PLAN VIEWS below the Longitudinal Section. These views show the culvert from the TOP. See the ℄ of roadway, drawn straight through all three diagrams. Notice that the straight culvert is on a line PERPENDICULAR to roadway ℄, as shown below.



NO SKEW

A *skewed* culvert is *not* on a line perpendicular to ℄ of roadway. The SKEW ANGLE is measured from a line perpendicular to roadway ℄. See this angle below.



See the angle of skew on the Plan view of the Typical Skewed Culvert on your standard sheet. (Specific plans will show the direction of skew, as Right or Left ahead, North or South, etc.)

Write the answers or fill-in the blanks below. Use your Standard Culvert sheet, C1P. Look back at pages 8 and 9, if you need to.

1. At what point on the culvert are the Flow Line Elevations taken?

   _____

2. The end of the culvert at which the water goes IN is called the

   _____ end. This is the _____ end.
   (higher, lower)

3. The culvert slopes DOWN to the _____ end.

4. A place at which one pour may end and join another is a _____ .

5. On what sections is the culvert level? _____

6. The toe of the fill slope meets the back of the _____ .

7. The main elevations given for construction of a specific culvert are the

   _____ elevations.

8. A straight culvert is constructed on a line _____ to the
   (parallel, perpendicular)
   roadway ℄.

9. For the skewed culvert on standard C1P, the angle of skew is formed by which two lines?

   _____

   _____

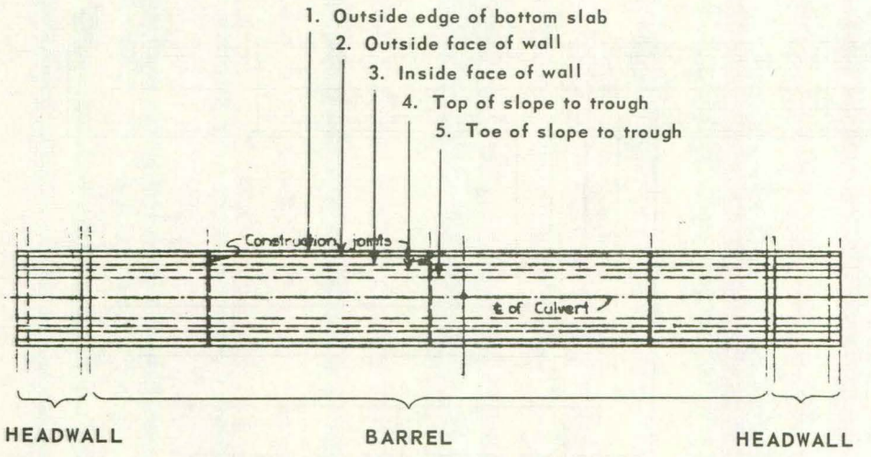
Check your answers very carefully by the ANSWER BOOKLET. Correct any error and be sure you understand the correction.

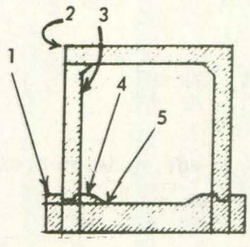
In the two plan views, look closely at the lines drawn the lengths of the culverts.

The solid lines show *outside edges*.

The dashed lines show *inside edges*.

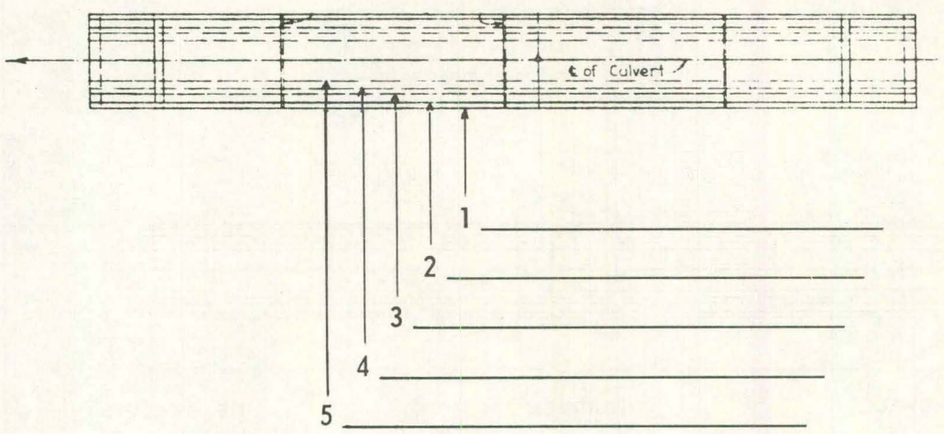
The edges shown are labeled below. **Examine them carefully.**





The same points are correspondingly numbered on this cross section. Compare these with those same points, shown on the plan view above.

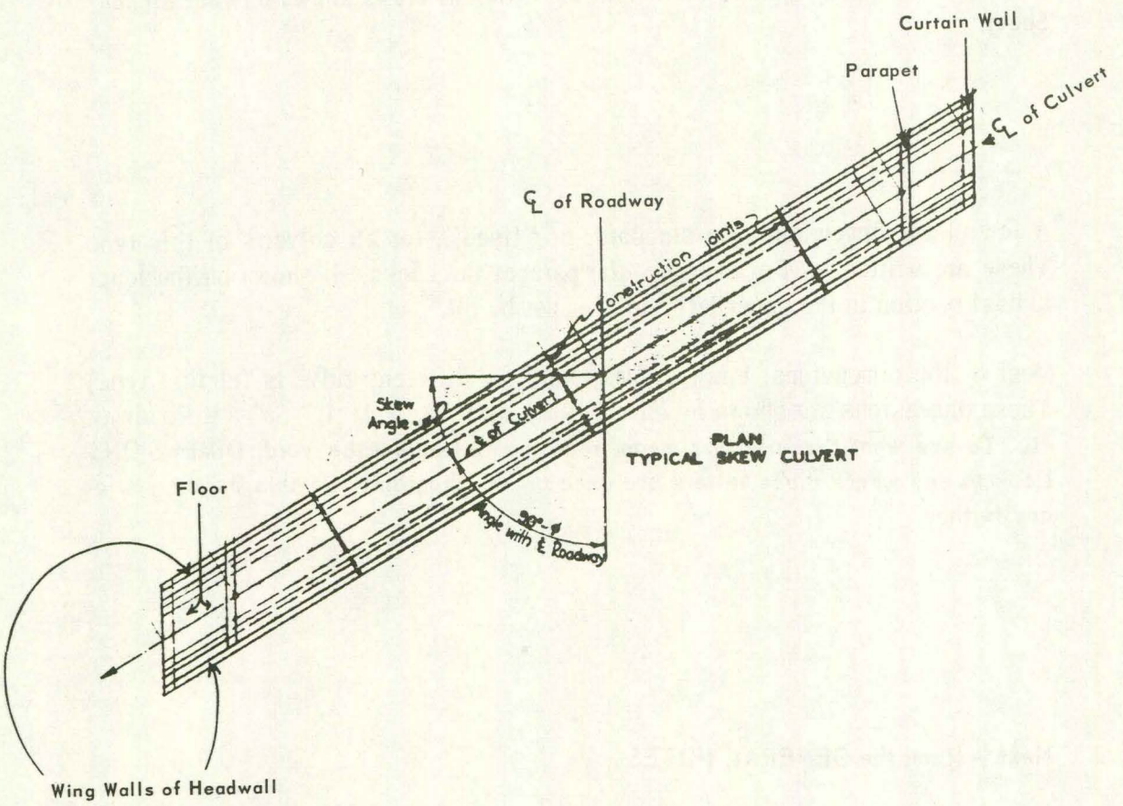
The culvert is SYMMETRICAL around $\mathbb{C}_L$, that is, the halves on either side of culvert $\mathbb{C}_L$ are just alike. **Now, YOU label the lines by writing in the spaces provided below. Use your standard sheet. Look back at page 11 only if you have to.**



Check your labels by the ANSWER BOOKLET. If you made an error, read page 11 again to see why you were wrong. Then correct your work.

In the TYPICAL SKEW CULVERT PLAN, notice that the Curtain Walls and the Parapets are still PARALLEL to the ROADWAY ℄.

Below, labels are added to the Typical Skew Culvert Plan. Examine these carefully.



Notice also, that these wing walls are parallel to each other and to the Culvert ℄.

Look now at the dimensions written on the different views shown on your Standard Sheet.

A few of the dimensions are standard, or "fixed", for all culverts of this type. These are written in. For example, the parapet thickness, as shown on the longitudinal section in the upper left corner, must be 8".

Most of the dimensions, however, may vary for different culverts (of this type). These dimensions are shown by *letters*, such as H, A, a, M, L', Sa' + ½ Roadway, etc. **To see what these letters mean, read the list below the word, DIMENSIONS. Look to see where these letters are used on the diagrams. Do this before you go any further.**

Next – Read the GENERAL NOTES.

Write the answers to the questions, or fill-in the blanks, below.

Do NOT look back at pages in this manual until you have answered every question. Use your Standard Sheet to find some of the answers.

1. The wing walls on this culvert are called Parallel Wing Walls. What are they parallel to? _____

2. What are the two major parts of a culvert?

   1) _____ 2) _____

3. What part of the headwall extends DOWN from the edge of the floor?

   _____

4. What part of the headwall extends UP, at the end of the top slab?

   _____

5. In the headwall part, the walls are called _____ walls.

6. What distance is the span of the culvert? _____

7. In the construction of a culvert what are the two most important elevations?

   1) _____ 2) _____

8. Describe the position of a STRAIGHT culvert.

   _____

9. What two lines form the Angle of a skewed culvert?

   1) _____ 2) _____

10. What distance does the L dimension represent? _____

11. What is the MAXIMUM length for M, between construction joints?

    _____

Check very carefully by the ANSWER BOOKLET. If you missed anything, go back and review the pages which presented that part. Be sure to leave all your answers correctly written.

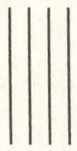
Turn now to CULVERT STANDARD C4P, for CONCRETE BOX CULVERTS, 4' – 0 SPAN PARALLEL WING WALLS.

This is the same type culvert you just saw on Culvert Standard C1P.

This standard, however, is primarily showing the REINFORCING BARS which are to be inside the concrete.

Notice that this standard is only for culverts with a *4' span*. The height may vary, the culvert may be on a skew or straight, but *the span is 4 feet*.

Look now at the Longitudinal Section and the two Plan views, on the left side of your Standard Sheet.

The many light lines and dots (or small circles) all represent steel reinforcing bars. The inspector must check to be sure these bars are properly placed before the concrete is poured. **Be sure you understand how you're seeing the same bars in the two different views.** Vertical bars are shown on the Longitudinal Section like this:  , as you'd see them from the *side*.

Those same vertical bars are shown by dots, or small circles, in the plan views, like this: . . . . . , as you'd see them from the *top*.

The reverse is true, of course, for bars which go *across* the culvert, in the top or bottom slabs.

READ and REMEMBER

This is about Bar Positions

Bars which go up and down, anywhere in the

culvert, are called ——————→ *VERTICAL BARS*

Bars which run horizontally along the lengths

of the ***walls***, are called ——————→ *HORIZONTAL BARS*

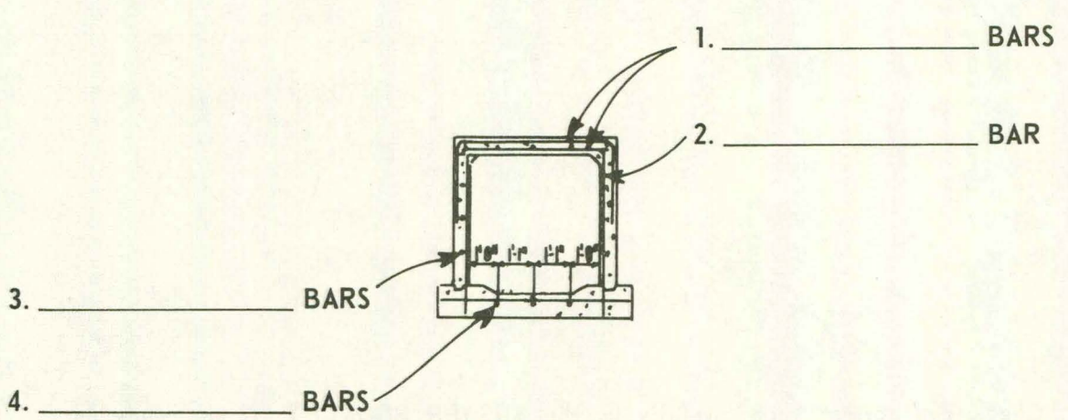
Bars which run horizontally along the lengths,

inside the top or bottom slabs, are called ——————→ *LONGITUDINAL BARS*

Bars which run *across*, inside the top or bottom

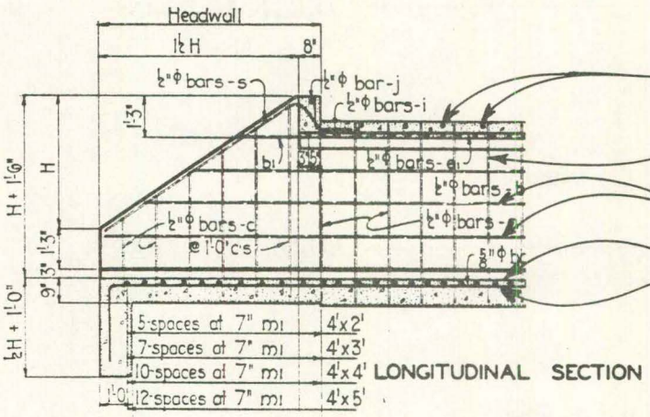
slabs ***from one wall to the next***, are called ——————→ *TRANSVERSE BARS*

Bars positioned in each of these four ways are pointed to in the cross section view shown below. **YOU label each one by writing the correct position in the space provided.**

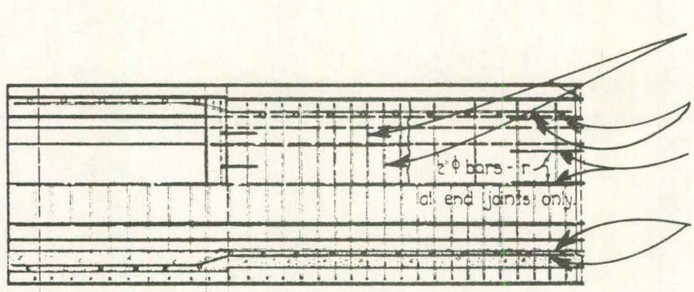


Check by the ANSWER BOOKLET. If you made a mistake, read this page again very carefully and correct your error.

To be certain that you "see" the bars in their proper positions in the Longitudinal Section and in the Plan, label the bars below, by positions, as you did on the last page. Refer to page 17 if you need to.



1. _____ Bars
2. _____ Bars
3. _____ Bars
4. _____ Bars



PLAN

5. _____ Bars
6. _____ Bars
7. _____ Bars
8. _____ Bars

Check and correct very carefully by the ANSWER BOOKLET. If you made an error - LOOK MORE CLOSELY - you may have confused the intended bar with another one. Correct any error and be sure you understand the correction, so you will not make the same mistake again.

Information about the position, size, spacing, and length of each type of bar is given in the

BILL OF REINFORCING

This is shown and explained below. Examine it carefully as you read the explanations. See this same thing on your Standard Sheet, too.

B I L L O F R E I N F O R C I N G

If there is NO SKEW, use these columns

If the skew is 15,° use these

If 30,° use these

If 45,° use these

SKEW ANGLE		Φ - 0°				Φ - 15°				Φ - 30°				Φ - 45°			
Position of bars	Mark	Number	Size	Spacing	Length	Number	Size	Spacing	Length	Number	Size	Spacing	Length	Number	Size	Spacing	Length
Walls: Vertical	a	2L+2	½"Φ	1'-0"	H+2A+3"	2L+2	½"Φ	1'-0"	H+2A+3"	2L+2	½"Φ	1'-0"	H+2A+3"	2L+2	½"Φ	1'-0"	H+2A+3"
" Horizontal	b	2H	"	"	M-4"	2H	"	"	M-4"	2H	"	"	M-4"	2H	"	"	M-4"
" " ends	b_1	4H	"	"	Table 1	4H	"	"	Table 1	4H	"	"	Table 1	4H	"	"	Table 1
Wings: Vertical	c	Table 2	"	"	" 2	Table 2	"	"	" 2	Table 2	"	"	" 2	Table 2	"	"	" 2
Slab: Longitudinal	e	5	"	shown	M-4"	5	"	shown	M-4"	5	"	shown	M-4"	5	"	shown	M-4"
" " ends	e_1	10	"	"	10'-10"	10	"	"	Table 3	10	"	"	Table 3	10	"	"	Table 3
Floor: "	f	5	⅝"Φ	"	M-4"	5	⅝"Φ	"	M-4"	5	⅝"Φ	"	M-4"	5	⅝"Φ	"	M-4"
" " ends	f_1	10	"	"	Table 4	10	"	"	Table 4	10	"	"	Table 4	10	"	"	Table 4
Parapet: Vertical	i	8	½"Φ	1'-0"	1'-9"	8	½"Φ	1'-0"	1'-9"	10	½"Φ	1'-0"	1'-9"	12	½"Φ	1'-0"	1'-9"
" Transverse	j	2	"	shown	5'-0"	2	"	shown	5'-2"	2	"	shown	5'-9"	2	"	shown	7'-1"
Slab: "	k		Table 5				Table 5				Table 5				Table 5		
" " top	k_1		½"Φ	1'-3"	See Detail		½"Φ	1'-3"	See Detail		½"Φ	1'-3"	See Detail		½"Φ	1'3	See Detail
Floor: "	m		Table 5		5'-8"		Table 5		5'-8"		Table 5		5'-8"		Table 5		5'-8"
Parapet and Curtain	p	Skews only				8	⅝"Φ	4"	6'-5"	8	⅝"Φ	4"	7'-0"	8	⅝"Φ	4"	8'-4"
Slab: Dowels	r	10	½"Φ	1'-0"	4'-0"	10	½"Φ	1'-0"	4'-0"	10	½"Φ	1'-0"	4'-0"	10	½"Φ	1'-0"	4'-0"
Wing: Slope	s	8	"	4"	1.83H+10"	8	½"Φ	4"	1.67H+10"	8	½"Φ	4"	2.08H+10"	8	½"Φ	4"	2.54H+10"
Floor: Headwalls	m_1	shown	½"Φ	7"	5'-8"		½"Φ	7"	5'-8"		½"Φ	7"	5'-8"		½"Φ	7"	5'-8"

This column tells where the bars are and their positions.

This is the name of the bar.

The *Number* columns tell *how many* bars (of each type) are needed for the four different skew angles. See the four Number columns above.

The Size columns, right of each Number column, give the DIAMETER of the bar.

The Spacing columns give the required distance between the CENTERS of the bars. Most are to be placed at 1' centers. (They are parallel to each other, of course.)

The Length column tells you *how long* the bars must be.

Examine these columns carefully.

Now, read the **BILL OF REINFORCING** on your Standard Sheet, C4P, to find the answers. You may look back to page 19 if you need to.

1. Where do the p bars go? (Find p in the Mark column, then look on that same line to the Position of bars column.)

   _____

2. How many p bars will be used, in a **STRAIGHT** culvert?

   _____

3. How many p bars will be used in a 15° skew culvert? _____

   In a 30° skew culvert? _____

   In a 45° skew culvert? _____

4. What is the diameter of the p bar (in any skew)? _____

5. How is the p bar to be spaced? (Same in all skews)

   _____

6. What is the required length of the p bar:

   In a 15° skew? _____

   In a 30° skew? _____

   In a 45° skew? _____

Check very carefully by the **ANSWER BOOKLET**. If you made an error, **FIND OUT WHY**, and correct it.

Recall the letters used to represent dimensions on Culvert Standard C1P. For example, L is the Distance back to back of parapets, at right angles to center line of roadway (when the culvert is straight). Also, L' is the distance back to back of parapets, on a *skew* culvert. What these distances are, on a particular culvert, will determine *how many* bars of a certain type will be needed. For example, if two bars were needed for every foot of length, back to back of parapet, the number of bars would then be written as 2L or 2L'. When you know what L is, you multiply it by 2 and that's the number of bars you need. The same type of thing is done in the Length columns. The lengths of some of the bars may depend upon the barrel length, the span, the height, etc.

Examine the Number and Length columns on your Standard Sheet, C4P. Refer also to the DIMENSIONS, as given on Standard C1P, (the first sheet you read).

Next - look at the BAR DETAILS on Standard C4P. These show the shapes and dimensions for the CURVED reinforcing bars, bars c, i, k, k_1, and p.

Use Standard Sheet C4P to find the answers. You may also look back at pages in this manual as you work, if you like.

1. In a straight culvert ($\phi = 0°$), if the L distance is 50 feet, how many a bars will be used? _____

2. In straight and/or skew culverts,

   if the Height of Opening (H) were 5 FEET

   and

   the slab Thickness (A) were 6 INCHES,

   what would the LENGTH of the a bars be? _____

3. What is the correct position for the c bar, and where should it be placed?

   _____

4. Is the c bar curved at one end only, or at both ends? (See Bar Details for drawings) _____

5. You list three bars which are curved at BOTH ends, as shown on Standard C4P.

   1) _____ 2) _____ 3) _____

6. In this Bill of Reinforcing, the BOTTOM SLAB forming the barrel is referred to as the FLOOR. If the word, ENDS, is written beside the word, FLOOR; then the bars are to be placed all the way out to the ends of the headwalls. Those bars, listed as Floor ends, will be in the floor of the barrel and in the floor of the headwall. Bars to be in the floor of the headwall only, are indicated by the words, Floor: Headwalls. This is shown by the last line in the Bill of Reinforcing. You list the bars which will go in the Floor of the Headwalls.

   _____

7. What bars are required in the floor of the barrel part? (More than one type of bar)

   _____

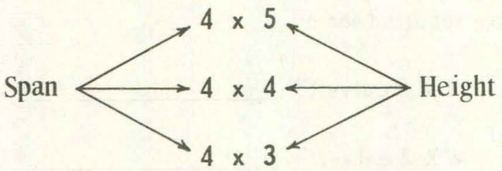
Check your answers very carefully by the ANSWER BOOKLET. Always correct any errors.

In the Bill of Reinforcing, you are referred to TABLES below for information about some of the bars. For example, to see the *Lengths* of the b1 bars you must go to TABLE 1.

Table 1 is shown below and on your Standard Sheet, just below the Bill of Reinforcing.

Read the explanation below very carefully.

This table is needed because the b1 bars are of *different lengths*. (This is due to the sloping top of the wing walls.) The specific different lengths needed depend upon the *height* of the culvert and the *skew* angle. The *height* is the second number here –



The dimensions given in this way are:

SPAN X HEIGHT

If the height of your culvert is 5' use these lengths.

If height is 4' use these.

If height is 3'

If height is 2'

TABLE - 1 b1 BARS TWO EACH LENGTH REQUIRED

SKEW	4 x 5												4 x 4												4 x 3												4 x 2											
ϕ = 0°	12'-9"	12'-9"	14'-3"	14'-3"	15'-9"	15'-9"	17'-3"	17'-3"	18'-4"	18'-4"	12'-9"	12'-9"	14'-3"	14'-3"	15'-9"	15'-9"	16'-10"	16'-10"	12'-9"	12'-9"	14'-3"	14'-3"	15'-4"	15'-4"	12'-9"	12'-9"	13'-0"	13'-0"																
ϕ = 15°	12'-3"	13'-7"	13'-9"	15'-1"	15'-4"	16'-8"	16'-10"	18'-2"	18'-0"	19'-4"	12'-3"	13'-7"	13'-9"	15'-1"	15'-4"	16'-8"	16'-5"	17'-9"	12'-3"	13'-7"	13'-9"	15'-1"	14'-11"	16'-3"	12'-3"	13'-7"	13'-4"	14'-8"																
ϕ = 30°	11'-9"	14'-8"	13'-6"	16'-5"	15'-3"	18'-2"	16'-11"	19'-10"	18'-2"	21'-1"	11'-9"	14'-8"	13'-6"	16'-5"	15'-3"	18'-2"	16'-6"	19'-5"	11'-9"	14'-8"	13'-6"	16'-5"	14'-9"	17'-8"	11'-9"	14'-8"	13'-0"	15'-11"																
ϕ = 45°	11'-3"	16'-3"	13'-5"	18'-5"	15'-6"	20'-6"	17'-8"	22'-8"	19'-2"	24'-2"	11'-3"	16'-3"	13'-5	18'-5"	15'-6"	20'-6"	17'-1"	22'-1"	11'-3"	16'-3"	13'-5	16'-5	14'-11"	19'-11"	11'-3"	16'-3"	12'-10"	17'-10"																

If you are constructing a *straight* culvert, read across this line.

If it is a culvert with a 15° skew, use the next line, and so on.

The numbers in the blocks are the *Lengths* of the b1 bars required. Notice the words: TWO EACH LENGTH REQUIRED. This means you will need twice as many bars as lengths are given for.

For culverts with a 5' height, you'll need a total of 20.
For culverts with a 2' height, you'll need only 8.

Now you read Table 1, on your Standard C4P, to find the answers to these questions.

Look back at page 23, if you like.

1. What is the length of the LONGEST bi bar listed in Table 1? Also, describe the culvert in which this bar would be required.

   _____

2. HOW MANY bi bars are required for a:

   4 X 5 culvert? _____

   4 X 4 culvert? _____

   4 X 3 culvert? _____

   4 X 2 culvert? _____

3. What is the length of the SHORTEST bi bar listed in Table 1? In what type culvert is it to be used? _____

4. In a STRAIGHT culvert with a height of 2' (4 X 2), how many 12'9" long, bi bars are required? _____

5. Make a list of the bi bars required in a 4 X 2 culvert with a 45° skew. Show HOW MANY of WHAT LENGTHS.

   _____

   _____

   _____

Check and correct by the ANSWER BOOKLET.

Look briefly at TABLE 2 for c bars.

Before studying that table, answer these questions about the c bars. Use your Standard Sheet to find the information you need.

1. Is bar c straight or curved? _____

2. Is it curved at one end only, or at both ends? _____

3. What is the position of the c bar and where will it be placed?

   _____

4. What is the diameter of the c bars? _____

5. How will the c bars be spaced? _____

6. To find the number and lengths of c bars, to what does the Bill of Reinforcing refer you? _____

Check very carefully by the ANSWER BOOKLET. Be sure you UNDERSTAND the corrections, if you need to make any.

Table 2 is shown and explained below. Read the explanations VERY CAREFULLY.

You must have FOUR bars of each Length written in the table.

TABLE - 2 c BARS FOUR EACH LENGTH REQUIRED

You read DOWN THE COLUMNS on this table, rather than across the lines, as you did on Table One. The different skews are listed for each height: 5, 4, 3, and 2. The NUMBER of bars required depends upon both the height AND the skew. For any ONE CULVERT, you would use only ONE of the 16 columns below. Be sure you know how to find the right one!

If the *height* is 5', use one of these columns.

For 4' heights

For 3' heights

For 2' heights

TABLE - 2 c BARS FOUR EACH LENGTH REQUIRED

4 x 5				4 x 4				4 x 3				4 x 2			
ϕ- 0°	ϕ-15°	ϕ-30°	ϕ-45°	ϕ- 0°	ϕ-15°	ϕ-30°	ϕ-45°	ϕ- 0°	ϕ-15°	ϕ-30°	ϕ-45°	ϕ- 0°	ϕ-15°	ϕ-30°	ϕ-45°
7'-10"	7'-10"	7'-10"	7'-10"	6'-10"	6'-10"	6'-10"	6'-10"	5'-10"	5'-10"	5'-10"	5'-10"	4'-10"	4'-10"	4'-10"	4'-10"
7'-2"	7'-2"	7'-3"	7'-4"	6'-2"	6'-2"	6'-3"	6'-4"	5'-2"	5'-2"	5'-3"	5'-4"	4'-2"	4'-2"	4'-3"	4'-4"
6'-6"	6'-6"	6'-8"	6'-11"	5'-6"	5'-6"	5'-8"	5'-11"	4'-6"	4'-6"	4'-8"	4'-11"	3'-6"	3'-6"	3'-8"	3'-11"
5'-10"	5'-11"	6'-1"	6'-5"	4'-10"	4'-11"	5'-1"	5'-5"	3'-10"	3'-11"	4'-1"	4'-5"				3'-5"
5'-2"	5'-3"	5'-6"	6'-0"	4'-2"	4'-3"	4'-6"	5'-0"	3'-2"	3'-3"	3'-6"	4'-0"				
4'-6"	4'-7"	4'-11"	5'-6"	3'-6"	3'-7"	3'-11"	4'-6"				3'-6"				
3'-10"	3'-11"	4'-4"	5'-0"			3'-4"	4'-0"								
3'-2"	3'-4"	3'-9"	4'-7"				3'-7"								
		3'-2"	4'-1"												
			3'-7"												
			3'-2"												

If the culvert is *straight*, use this column; skewed 15°, the next one; and so on.

You'd need 4 c bars of each of these lengths to build a 4 X 2 culvert with a skew of 45°. That's a total of <u>16</u> c bars.

Read TABLE 2 on your Standard Sheet to find the answers to the following questions. Refer also to page 26, if you need to.

1. Describe the culvert (height and skew) which requires the MOST c bars, as shown in Table 2. _____

   _____

2. The LEAST number of c bars required by any of these culverts is 12. Three different lengths, four of each length, make up the total of 12.

   Describe the three culverts which require 12 c bars each.

   _____

   _____

   _____

3. Make a list of the c bars required for a culvert with a 4' span, a 3' height and a skew of 15°. Show the number of each length required.

   _____

   _____

   _____

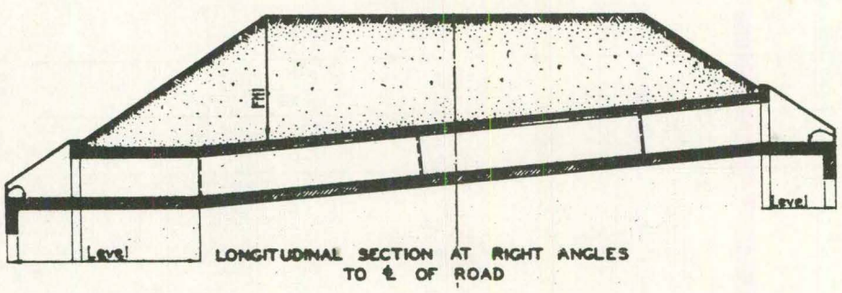
Check and correct very carefully by the ANSWER BOOKLET.

Table 3 is to be read in the same way as Table 2. The only difference is that the number and lengths of e1 bars are the same for *all heights*. They are different only as the skews are different. **Look at Table 3.**

Table 4 is to be read like Table 1. You find the height at the top then read *across* the lines according to the skew of the particular culvert. The lengths of the bars depend upon the degree of skew. **Look at Table 4.**

Table 5 contains various information about the entire barrel sections of culverts, such as the cubic yards of concrete needed, the pounds of steel (reinforcing bars), etc.

These quantities and dimensions depend upon the height of the FILL over the culvert. This is the distance from the top of foreslope to the top of the culvert, at the deepest side. This was shown on Standard C1P. **See it again below.**



LONGITUDINAL SECTION AT RIGHT ANGLES TO ℄ OF ROAD

The steel and concrete quantities also depend upon height of the culvert. These are given separately for 4 X 5, 4 X 4, 4 X 3, and 4 X 2 culverts. The quantities listed are *per foot* of *barrel* length. To get the total quantity you'd have to multiply the length of the barrel (in feet) by the proper quantity.

TABLE 5 DIMENSIONS AND QUANTITIES FOR BARREL SECTIONS

DIMENSIONS				k AND m BARS		LENGTH OF BARS		QUANTITIES PER FOOT OF BARREL							
								4X5		4X4		4X3		4X2	
FILL	A	E	G	Size	Spacing	k	m	Concrete	Steel	Concrete	Steel	Concrete	Steel	Concrete	Steel
0'	8"	6"	4'3"	5/8"Φ	5" c's	5'11"	5'8"	.551 C.Y.	58.32 #	.514 C.Y.	55.65 #	.477 C.Y.	52.98 #	.440 C.Y.	49.77 #
1'	7"	"	4'4"	1/2"Φ	6" c's	5'8"	"	.517 C.Y.	44.24 #	.480 C.Y.	41.57 #	.443 C.Y.	38.90 #	.406 C.Y.	35.69 #
2'	6"	"	"	"	5½" c's	"	"	.483 C.Y.	45.40 #	.446 C.Y.	42.73 #	.409 C.Y.	40.06 #	.372 C.Y.	36.85 #
3'-6'	6"	"	"	"	7" c's	"	"	" "	41.86 #	" "	39.19 #	" "	36.52 #	" "	33.31 #
7'-8'	6"	"	"	"	6" c's	"	"	" "	44.02 #	" "	41.35 #	" "	38.68 #	" "	35.47 #
9'-10'	6"	"	"	5/8"Φ	5" c's	5'8"	"	" "	47.06 #	" "	44.38 #	" "	41.71 #	" "	38.51 #
11'-12'	7"	"	4'3"	5/8"Φ	8" c's	5'11"	"	.517 C.Y.	47.23 #	.480 C.Y.	44.56 #	.443 C.Y.	41.88 #	.406 C.Y.	38.69 #
13'-14'	7"	"	"	"	7" c's	"	"	" "	49.81 #	" "	47.14 #	" "	44.46 #	" "	41.26 #
15'-16'	7"	"	"	"	6" c's	"	"	" "	53.26 #	" "	50.59 #	" "	47.91 #	" "	44.71 #
17'-20'	8"	6"	4'3"	5/8"Φ	6" c's	5'11"	5'8"	.551 C.Y.	53.48 #	.514 C.Y.	50.81 #	.477 C.Y.	48.14 #	.440 C.Y.	44.93 #

Now read across the top line, from the arrow above, to see these:

When there is no fill (O') –

The A dimension is 8"

The E dimension is 6"

The G dimension is 4'3"

The k and m bars should have a diameter of 5/8", and be spaced at 5" centers.

The k bars should be 5'11" long.

The m bars should be 5'8" long.

For a 4 X 5 culvert, for every foot of barrel length, .551 cubic yards of concrete and 58.32 pounds of steel reinforcing bars will be needed.

The quantities following become less, for smaller culverts.

Now you read Table 5 on your Standard Sheet, C4P, to find the answers. Look back to pages 28 and 29, if you need to.

1. What distance is measured to find the FILL depth over a culvert?

   _____

2. The A dimension is the (top) slab thickness. What should this slab thickness be when the fill is 9 to 10 feet? _____

3. What is the required diameter of the k and m bars when the fill is:

   0' ? _____

   9' – 10' ? _____

   15' – 16' ? _____

4. How many Cubic Yards of concrete would be needed to build a 50 foot long barrel section on a 4 X 4 culvert, when the Fill is 13' – 14' ?

   _____

5. How many pounds of steel (reinforcing bars) will be needed per foot of barrel length for a 4 X 2 culvert with one foot of fill?

   _____

6. When the fill is 3' – 6', how will the k and m bars be SPACED?

   _____

7. When the Fill is 11' – 12':

   How long should the k bars be? _____

   How long should the m bars be? _____

Check by the ANSWER BOOKLET.

Be sure to correct any error. Be sure you UNDERSTAND THE CORRECTION.

Look at the QUANTITIES IN TWO HEADWALLS, below Table 5. Notice that the headwall quantities are NOT dependent upon the Fill depths. They are dependent upon the skew angle and the span X height dimensions. Read that table and the notes just below it.

Lastly, look over the whole sheet again and read all notes. Be sure to read the GENERAL NOTES in the left corner.

On the next page you will have questions concerning that entire sheet.

The answers to the following questions may be found somewhere on Standard Sheet C4P. Use that sheet, but do NOT look back at pages in this manual until you have written all the answers.

1. Should the longitudinal reinforcing bars extend through the construction joints?

   _____

2. To splice longitudinal bars, how long should the lap be?

   _____

3. In a Longitudinal Cross Section, are TRANSVERSE bars shown as dots or lines? _____

4. On a Plan, are transverse bars shown as dots or lines?

   _____

5. Which two bars are curved, at ONE END ONLY? _____

6. What bars should be placed in a TRANSVERSE position in the parapet?

   _____

7. How LONG should the f1 bars be in a 4 X 3 culvert, on a 15° skew? (List each length)

   _____

8. HOW MANY c bars will be needed for a 4 X 4 culvert on a 45° skew?

   _____

9. The M length is from construction joint to next construction joint. The number of 3 bars, given in the Bill of Reinforcing, are for EACH SECTION OF LENGTH M. What three bars are those?

   _____

Check and correct very carefully by the ANSWER BOOKLET.

Turn now to your Standard Sheet for

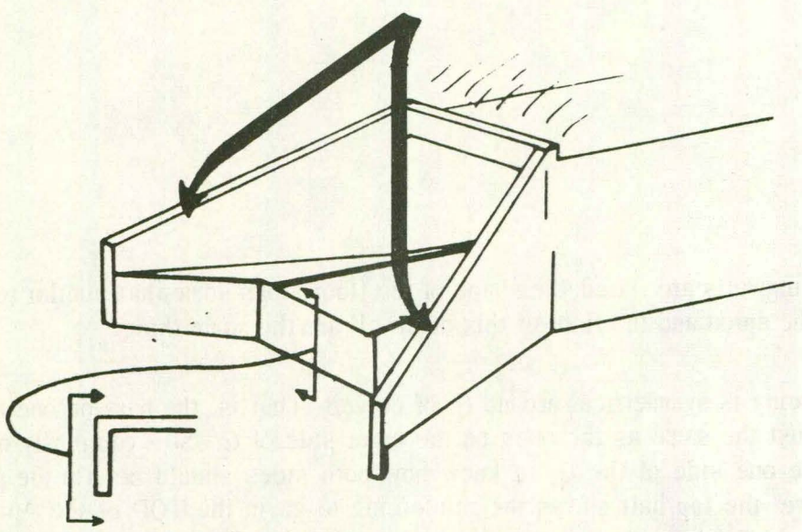
CONCRETE BOX HEADWALLS

0° SKEW

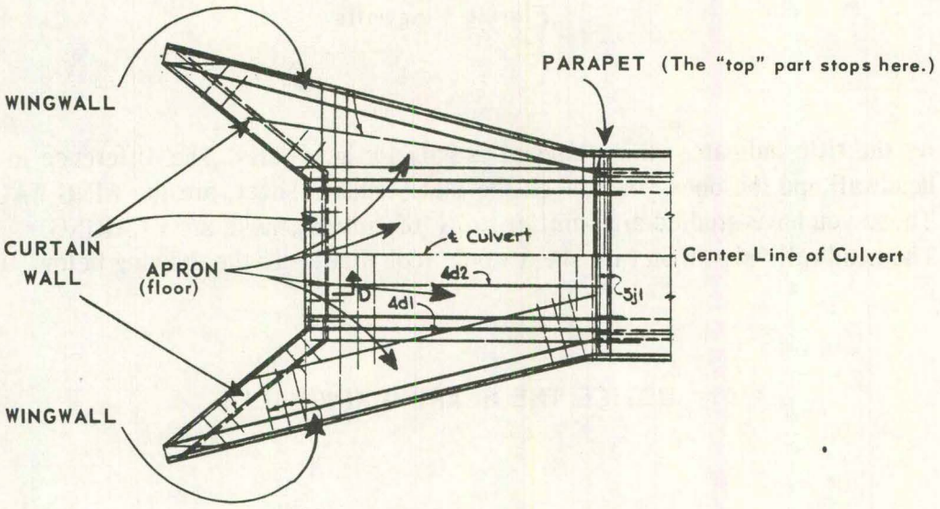
Flaring Wingwalls

As the title indicates, this standard is only for headwalls. The difference in this headwall and the ones you saw on the last Standard Sheet, are the WING WALLS. Those you have studied are *parallel* (to $\mathbb{C}_L$ of culvert); these are FLARING.
The headwalls shown on this sheet would look similar to the drawing below.

NOTICE THE FLARING WINGWALLS



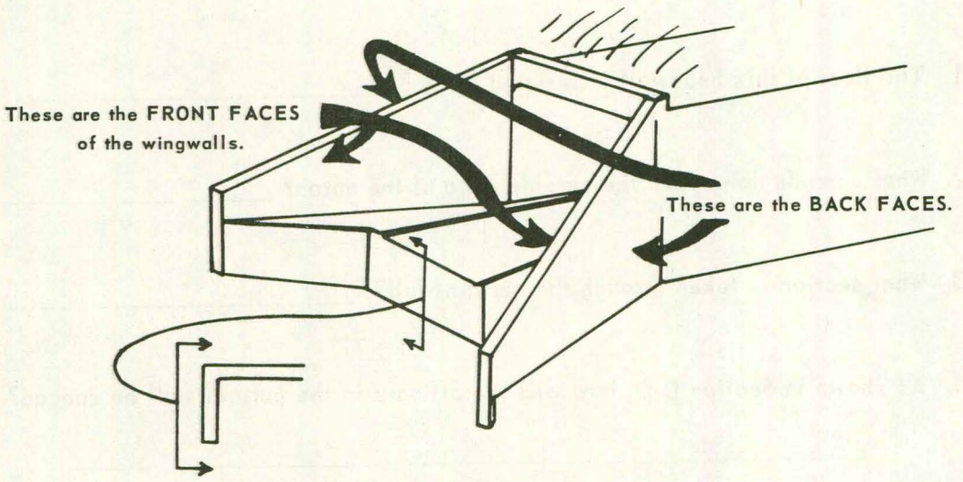
Look first at the PLAN. The general parts of this headwall are labeled below, to help you "see" this diagram easily.



When the wingwalls are flared, the shape of the floor looks somewhat similar to an APRON. The apron and the floor of this headwall are the *same thing*.

The reinforcing is symmetrical around $\mathbb{Q}_L$ of culvert. That is, the bars on one side of $\mathbb{Q}_L$ are just the same as the ones on the other side of $\mathbb{Q}_L$. So - you really only need to see one side of the $\mathbb{Q}_L$ to know how both sides should be. On the plan shown above, the *top* half shows the reinforcing to go in the TOP of the Apron. The *bottom* half (shown below $\mathbb{Q}_L$) shows the reinforcing to go in the BOTTOM part of the apron. **See how this is shown on the Plan on your sheet.** The top and bottom reinforcing is the same on both sides of culvert $\mathbb{Q}_L$, of course.

Also on the Plan, see where views A-A and B-B, C-C and D-D are taken. See these sections and views below the plan. Notice that View A-A shows the FRONT FACE reinforcing bars to be in the wingwalls, and View B-B shows the BACK FACE reinforcing.



The front face and back face reinforcing is, of course, the same for both wingwalls.

Section D-D is through the Curtain Wall. It is similar to the section shown above. **See the section through Parapet too.** These are not indicated on the plan on your standard sheet.

Notice the names of the bars, such as 5b1, 5t1, 6s1, etc.

Read the Bill of Reinforcing. It is similar to the one you read on the last standard.

See the Dimensions indicated by Letters, particularly on the plan and on View A-A. Read the dimension table to see what these dimensions would be for different sizes of culverts. Notice that the span varies here, as well as the height.

Read the Standard Sheet to find the answers to the following questions. As you work, look back to pages 34 and 35, if you like.

1. The floor of this headwall is referred to as an _____.

2. What extends down from the outside edge of the apron? _____

3. What section is taken through the curtain wall? _____

4. As shown in Section D-D, how will the 5t1 bars in the curtain wall be spaced?

   _____

5. What does a 5t1 bar look like?
   You DRAW one here ➘

6. On the Plan, the bars shown on the top half, above ℄, represent bars to be placed in which part of the apron? _____

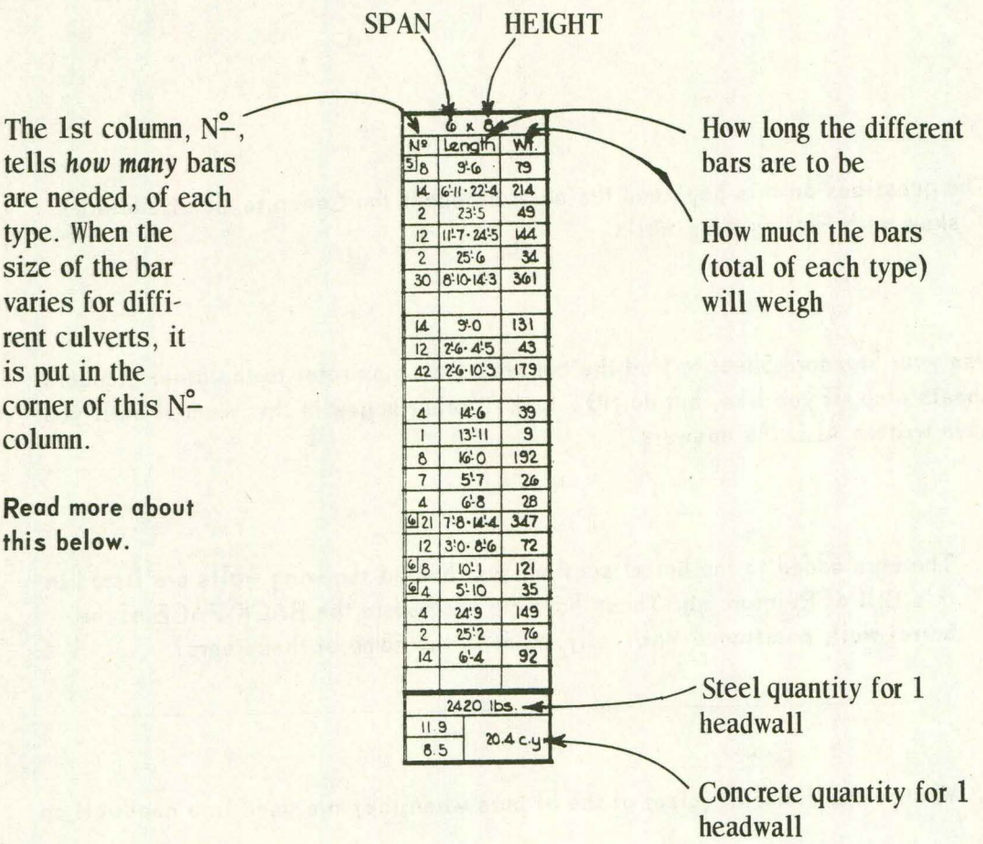
7. The bars shown on the bottom half, below ℄, represent bars to be placed in what part of the apron? _____

8. What reinforcing does View A-A show? _____

9. What reinforcing does View B-B show? _____

Check and correct by the ANSWER BOOKLET.

Look closely now at the Bill of Reinforcing. Eleven different sizes (span X height) are given. For each of these sizes, three columns are given.



6 x 6		
N°	Length	Wt.
5/8	9'-6	79
14	6'-11 · 22'-4	214
2	23'-5	49
12	11'-7 · 24'-5	144
2	25'-6	34
30	8'-10-14'-3	361
14	9'-0	131
12	2'-6 · 4'-5	43
42	2'-6 · 10'-3	179
4	14'-6	39
1	13'-11	9
8	16'-0	192
7	5'-7	26
4	6'-8	28
6/21	7'-8 · 14'-4	347
12	3'-0 · 8'-6	72
6/8	10'-1	121
6/4	5'-10	35
4	24'-9	149
2	25'-2	76
14	6'-4	92
2420 lbs.		
11.9	20.4 c.y.	
8.5		

The size of the bar is meant to be the diameter of the bar. The *number given must be placed over* 8, as 6, in the corner of the N°– column above, means the diameter is 6/8 INCH. 8 is the usual denominator for bar diameters.

Be sure you know these abbreviations:

B.F.V. **Back Face Vertical**

F.F.H. **Front Face Horizontal**

These are used to describe the locations of the different bars.

Don't go to the next page until you have read this one very carefully.

The questions on this page and the next are about the Concrete Box Headwalls, 0° skew with Flaring Wing Walls.

Use your Standard Sheet to find the answers. You may refer to the other Standard Sheets also, if you like, but do NOT look at other pages in this manual until you have written ALL the answers.

1. The bars added to the barrel section just behind the wing walls are listed in this Bill of Reinforcing. These bars are located in the BACK FACE of the barrel wall, positioned Vertically. What is the name of these bars?

   _____

2. What is the diameter (size) of the a1 bars when they are used in a headwall on a 12 X 12 culvert? _____

3. What is the diameter of the a1 bars when they are used in a headwall on a 12 X 10 culvert? _____

4. What is the HEIGHT of a culvert described as 10 X 6? _____

5. What is the SPAN of a 10 X 6 culvert? _____

6. Where do the 4i1 bars go? (4i1 is the name of the bar)

_____

7. How much will the 4i1 bars WEIGH, in one headwall, on a 10 X 10 culvert?

_____

8. How many 5t1 bars will be needed for one headwall on a 6 X 6 culvert?

_____

9. What distance does the E dimension on the plan show? _____

10. What does the Dimension Table state as the required E distance for a 12 X 8 culvert? _____

11. As stated in the Headwall Notes, what must the clear distance be from the face of concrete to nearest bar inside the concrete? _____

12. For bars with variable lengths, to be used in the same headwall, which lengths are listed in the Bill of Reinforcing? (See Headwall Notes)

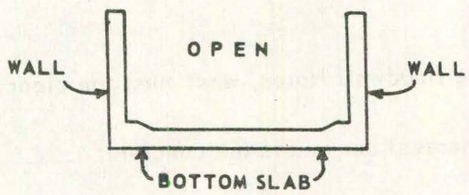
_____

Check very carefully by the ANSWER BOOKLET. Be sure you correct any errors and be sure you UNDERSTAND ANY CORRECTIONS.

Turn to your Standard Sheet for **CONCRETE FLUMES.**

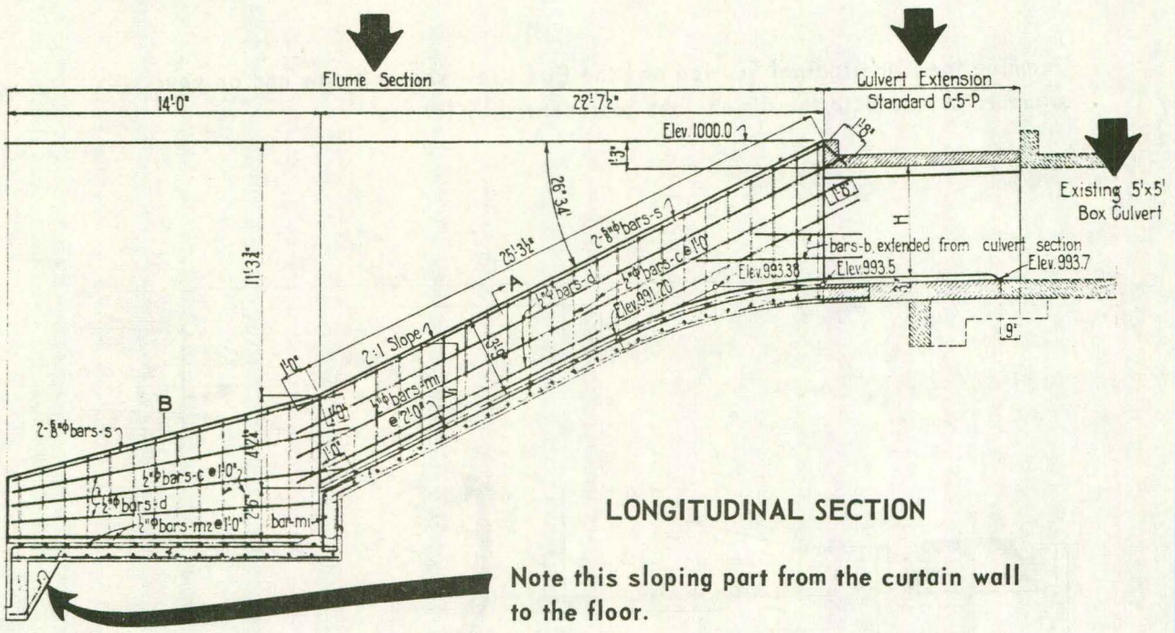
As you may know, culverts often outlet into flumes. Flumes carry the water on down, usually over a rather steep slope; then release the water at the bottom, possibly into a ditch.

Flumes have side walls of different heights, dependent upon the heights of the culverts to which they are attached. Flumes do *not* have a top slab. They are open at the top, as shown by this cross section:



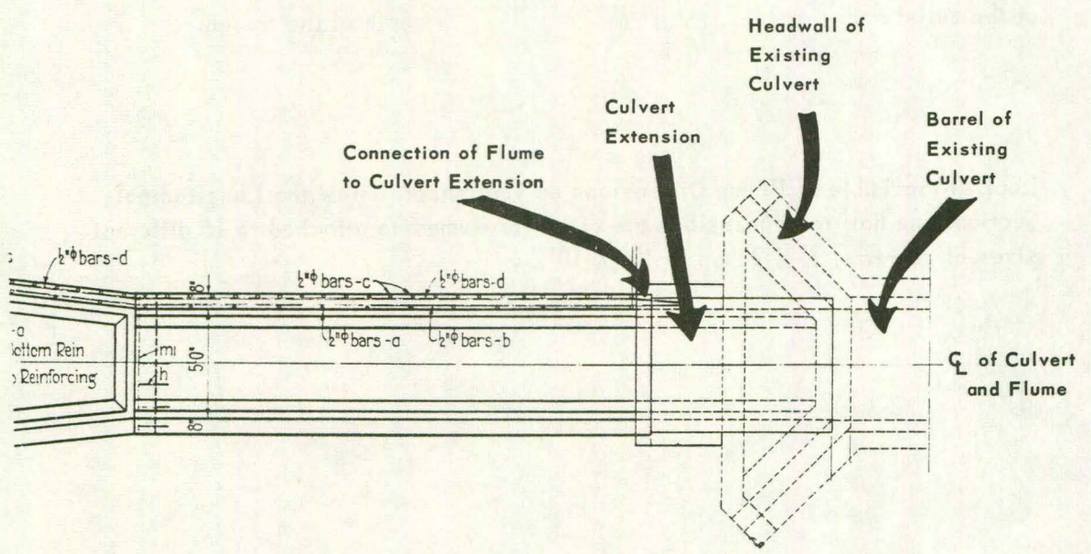
FLUME

The FLUME STANDARD you have shows an EXISTING CULVERT which is to be *extended*. The flume is to be attached to the Culvert Extension. The headwall of the existing culvert is to be left as is. The culvert extension will connect at the end of the barrel section. The Existing Culvert, the Culvert Extension, and Flume are shown on your standard sheet and below. Labels are added to the diagrams shown below. **Read these carefully.**



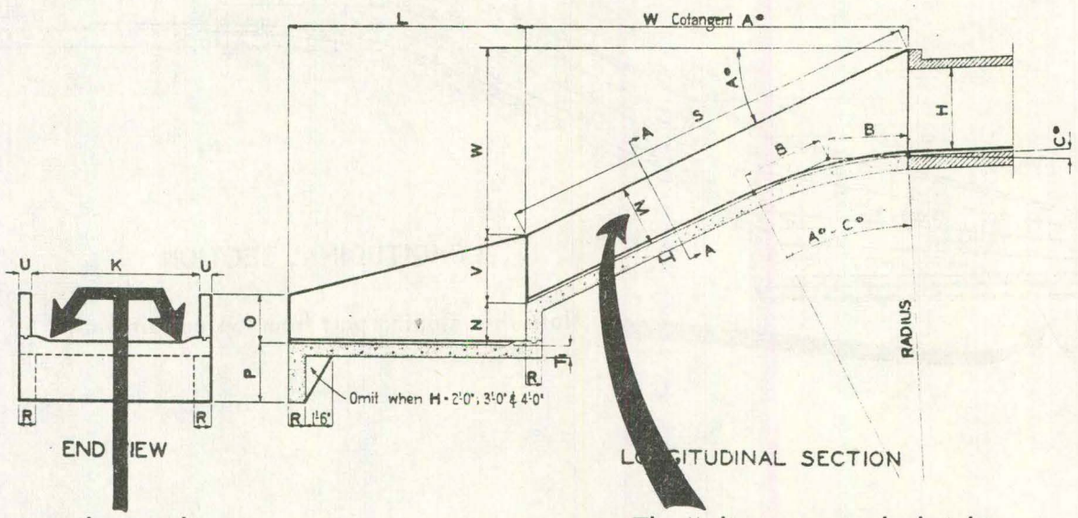
LONGITUDINAL SECTION

Note this sloping part from the curtain wall to the floor.



PLAN

Examine the Longitudinal Section and the End View shown below and on your standard sheet. Note the dimensions represented by letters.



Note the trough (or flow channel) at the outlet end.

The M dimension is the height of the flume wall plus the depth of the trough.

Look at the Table of Flume Dimensions on your sheet, below the Longitudinal Section. See how the dimensions are given for flumes as attached to 15 different sizes of culverts, 2' X 2' up to 10' X 10'.

The TABLE OF FLUME REINFORCING gives the name of the bar at the top of the columns, as bar a, b, c, etc. The number of bars needed is not given. The diameter and spacing is given for each bar. These depend upon the *height* (H) of the culvert to which the flume is attached.

Look at the first line of this table shown below.

TABLE OF FLUME REINFORCING

H	a	b	c	d	f	g	h	m1	m2	m3	s
2'-0			½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"						2-1½"φ shown
3'-0			½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"						2-1½φ shown
4'-0	½"φ @ 3'-0"	½"φ shown	½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"		½"φ @ 1'-0"				2-1½"φ shown
5'-0	½"φ @ 2'-0"	½"φ shown	½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"	2-1½"φ shown	½"φ @ 1'-0"	½"φ @ 2'-0"	½"φ @ 1'-0"		2-⅝"φ shown
6'-0	½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"	⅝"φ @ 1'-3"	2-⅝"φ shown	½"φ @ 1'-0"	½"φ @ 1'-0"	½"φ @ 1'-0"		2-⅝"φ shown
8'-0	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	½"φ @ 1'-0"	⅝"φ @ 1'-3"	2-⅝"φ shown	½"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 2'-0"	2-¾"φ shown
10'-0	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	½"φ @ 1'-0"	⅝"φ @ 1'-3"	2-⅝"φ shown	½"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 1'-0"	⅝"φ @ 2'-0"	2-¾"φ shown

When the Height of the culvert is 2', NO a or b bars are used. (See the blanks under a and b). The c bars have a diameter of ½" and are to be spaced at 1 foot centers. (The Plan and Longitudinal Section show where.)

You fill-in these blanks:

When the Height of the culvert is 4' - 0", a bars WILL be used. They will have a diameter of _____ and be spaced at _____ centers.

You should have written ½" and 3' in the blanks above.

Read your Standard Flume sheet to find the answers to the following questions.
Do NOT look back at pages in this manual until you have answered each question.

1. What is the main thing that a culvert HAS but a flume does NOT have?
   (This is a very easy question.)

   _____

2. As shown on your Standard Sheet, what structure is EXISTING already?

   _____

3. What will be connected to this existing structure, where?

   _____

4. To what will the flume be attached? _____

5. For a 10' X 10' culvert, what is the height of the flume wall plus the trough depth? _____

6. According to the note below the Table of Flume Dimensions, when should the V dimensions in the table be used? _____

7. When the flume is attached to an 8 X 6 culvert, what should the flume wall thickness be? _____

8. When the height of the culvert is 5', how should the f bars in the flume be spaced? _____

9. What is the location and position of the s bars? (See them on the Half Sections.) _____

10. What is the location and position of the a bars?

_____

11. Which bars are to be placed transversely, in the top of the flume floor near the outlet end? _____

12. For a 10' X 6' culvert, what will the flume span be? _____

Check very carefully by the ANSWER BOOKLET. If you made an error, turn back and review the pages that presented that part. Be SURE to leave your answers correctly written.

Turn now to the first sheet in your set. This is a **TITLE SHEET** headed:

STATE OF IOWA

STATE HIGHWAY COMMISSION

Design For

BRIDGES AND CULVERTS

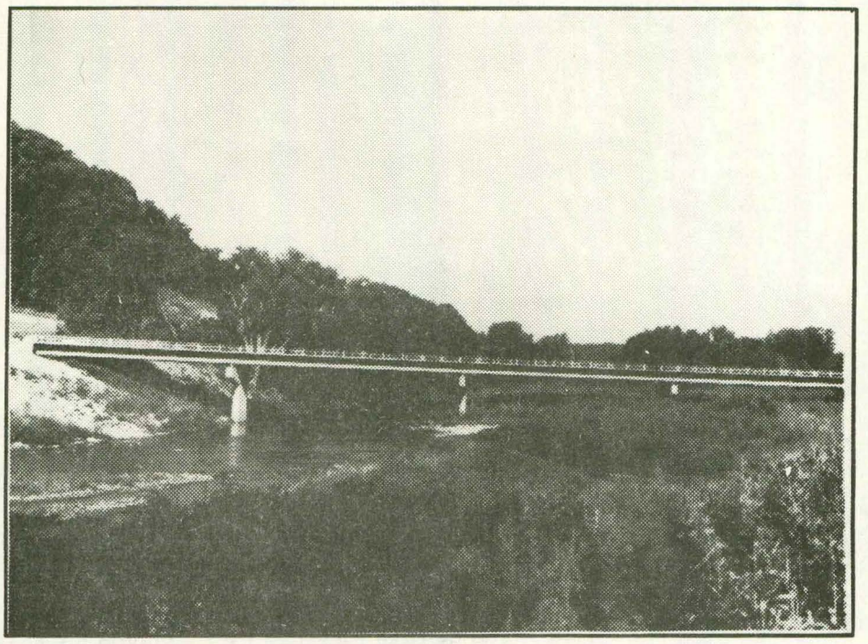
PRIMARY ROAD SYSTEM

Project No. F-1112(1)

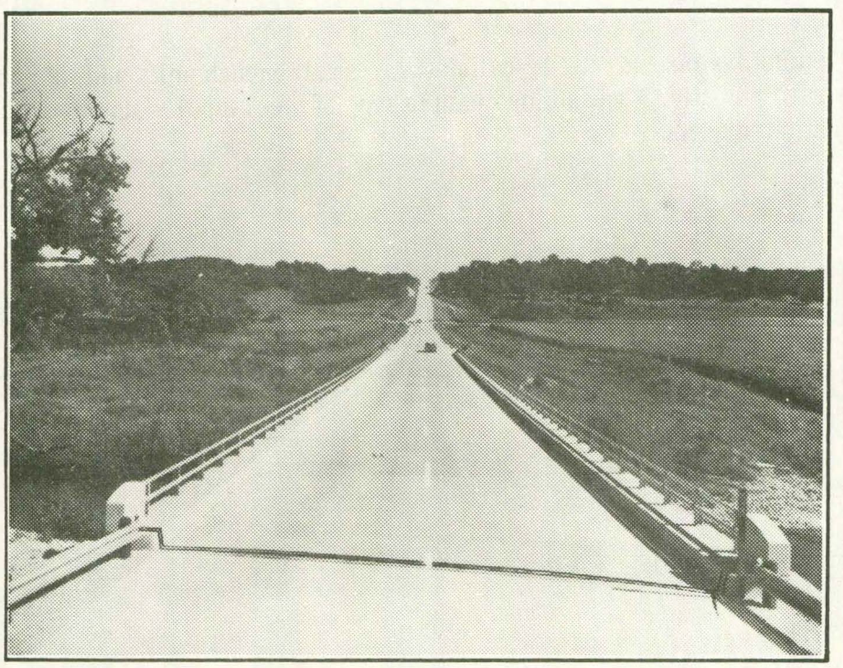
WINNESHIEK COUNTY

August 1962

The sheets that follow show a 410' X 30' Continuous I Beam Bridge. This bridge is listed on your title sheet in the upper right corner. Sheets showing the other bridges and culverts listed are not included.



The Bridge Sheets which you will study were used to build this Bridge.



The "Key Word" in Bridge Construction and Inspection is ACCURACY. Most of the details and measurements must be checked three or four times, in different ways. ALL measurements and details must be checked at least twice, in two different ways. For example, the distance from Pier 1 to Pier 2 should be measured by the inspector, like this:

1. Read the required distance on the plan.

2. Measure from the first pier to the second.

3. Measure from the *second* pier back to the *first*.

The measuring *instrument* must be calibrated in small enough units and, of course, must be used properly. A measuring chain (a type of steel tape) is an appropriate instrument often used.

On the Title Sheet look at the description of the 410'–0 X 30' Continuous I-Beam Bridge. This is in the upper right corner of the Title Sheet.
Pay particular attention to the following:

– The DESIGN NUMBER of the bridge is 1161. The 11 in that number means that this is the 11th bridge which was given a design number in that county (Winneshiek) in 1961. The 61 is for the year, 1961.

– The LOCATION by:

Survey Township	⟶	98 North
Range	⟶	8 West
Section	⟶	No. 8
Civil Township	⟶	Decorah

It is to be over the Upper Iowa River. The Station Number at *the center of the bridge* is 196+29.00.

– The date of LETTING is Nov. 6, 1962. This is the date it was *let* to a bridge contractor. Different bridges are usually let to different contractors, while the culverts on a project are usually all let to one contractor.

– The Bridge DIMENSIONS:

410' total length (distance between $\mathit{\text{℄}}_L$'s of abutment bearings)
30' roadway width (distance from front face of curb across to opposite front face of curb)

– The TYPE of bridge is stated to be Continuous I-Beam.

– A SKEW of 15° is specified. This skew refers to the angle of the piers and abutments. They are skewed (turned) in the direction of the flow of water in the river.

– The Project No., F-1112(1), and the County Name, Winneshiek, are given in the general TITLE, in the middle of the sheet at the top.

Read the Title Sheet to find the answers to most of the following questions. Refer to page 49, if you need to.

1. What is the design number of this Continuous I Beam bridge?

   _____

2. What is the design number of the 84' X 30' Open Spandrel Concrete Arch Bridge, also in this project? _____

3. In what year were all three bridges designed?

   _____

4. What is the location of the bridge, design No. 1161, by (survey) township, range, and section? _____

5. In what CIVIL township and county will bridge 1161 be built?

   _____

6. The center of the bridge (1161) is at Station _____

7. What is this bridge (1161) to go over? _____

8. The bridges and culverts listed on the title sheet are all included in Project No. _____

9. When were these bridges and culverts let to contractors? _____

10. For the Continuous I Beam Bridge, design No. 1161,

    1) What is the bridge length? _____

    2) What is the bridge roadway width? _____

    3) What is the degree of skew? _____

Check your answers by the ANSWER BOOKLET. ALWAYS correct any errors.

Read the ESTIMATE OF QUANTITIES for Bridge Design No. 1161.

Look next at the Layout and find Bridge Design No. 1161. Remember that it is in Section 8. The layout here is very much like the one for the ROAD PLANS on this project. The main difference is that the bridges are drawn in and labeled, by Design No., on this layout.

Read the Revisions and find those which apply to Bridge Design No. 1161. Notice the DATES of Revision and the SHEETS REVISED. Then, turn to the sheets listed and look along the bottom of each sheet for a note indicating that the revision has been made. Do this NOW, except for Sheet 10a which you do not have.

You should have found that the proper revisions have been made on each sheet. If you should find a sheet which has not been revised as stated on the title sheet, you should NOT USE THE SHEET. It is not up-to-date.

Lastly, look over the whole title sheet. Read any notes included. Be sure to see the Mileage Summary for the three bridges.

Use the entire Title Sheet to find the answers to the following questions. Do NOT look at any other pages in this manual until you have finished writing all the answers.

1. On what dates were revisions made to the bridge plans for design No. 1161?

   _____

2. Which of the three bridges on this project is to be farthest NORTH?

   _____

3. According to the Mileage Summary, the length of the bridge at Station 196+29.00 (Design 1161) is EXACTLY how many feet long? What part of a mile?

   _____ feet _____ mile

4. For bridge design 1161, how many cubic yards of concrete will be needed?

   _____

5. What Specifications will apply to construction on this project?

   _____

6. The Design Stresses for A-36 Steel are to be in accordance with what?

   _____

Check and correct very carefully by the ANSWER BOOKLET.

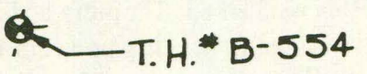
Turn now to Sheet 1. See the sheet number written as: Sheet 1 of 10, in the lower right corner. Remember that all these sheets will show the Continuous I Beam Bridge, Design 1161. There is nothing further about any of the other bridges and culverts listed on the Title Sheet.

Look first at the SITUATION PLAN, below the Longitudinal Section. Find the ℄ of Roadway over the bridge. It is labeled ℄ Office Relocation U.S. No. 52. This is a continuation of the regular Roadway ℄. It will be referred to as just the Roadway ℄.

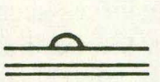
The Roadway ℄ over some bridges will *not* be an exact continuation of the Roadway ℄ back and ahead of the bridge. If the bridge is wider on one side, for example, the roadway ℄ over the bridge will be Lt. or Rt. of the regular roadway ℄. The two ℄'s will be parallel. The roadway ℄ over the bridge may occasionally but *incorrectly* be called the bridge ℄ or ℄ of bridge. *The* BRIDGE ℄, *or* ℄ *of bridge, is a line parallel to the skew, midway between the* ℄*'s of abutment bearings.*

Turn now to Sheet 6. See the BRIDGE ℄, as shown at the right end of the STRUCTURAL STEEL LAYOUT. Then turn back and continue to read the Situation Plan on Sheet 1.

Notice the directional arrow. See the *North* and *South* ends of the bridge. The station numbers get higher as you go *North. Ahead* means in the direction of stationing, in this case, to the north. Left of ℄ means what would be left if you were facing ahead. Right means what would be on your right if you were facing ahead. See the DIKE on the left side at the North end. It is 20' wide across its flat top. Note the circles, like this:

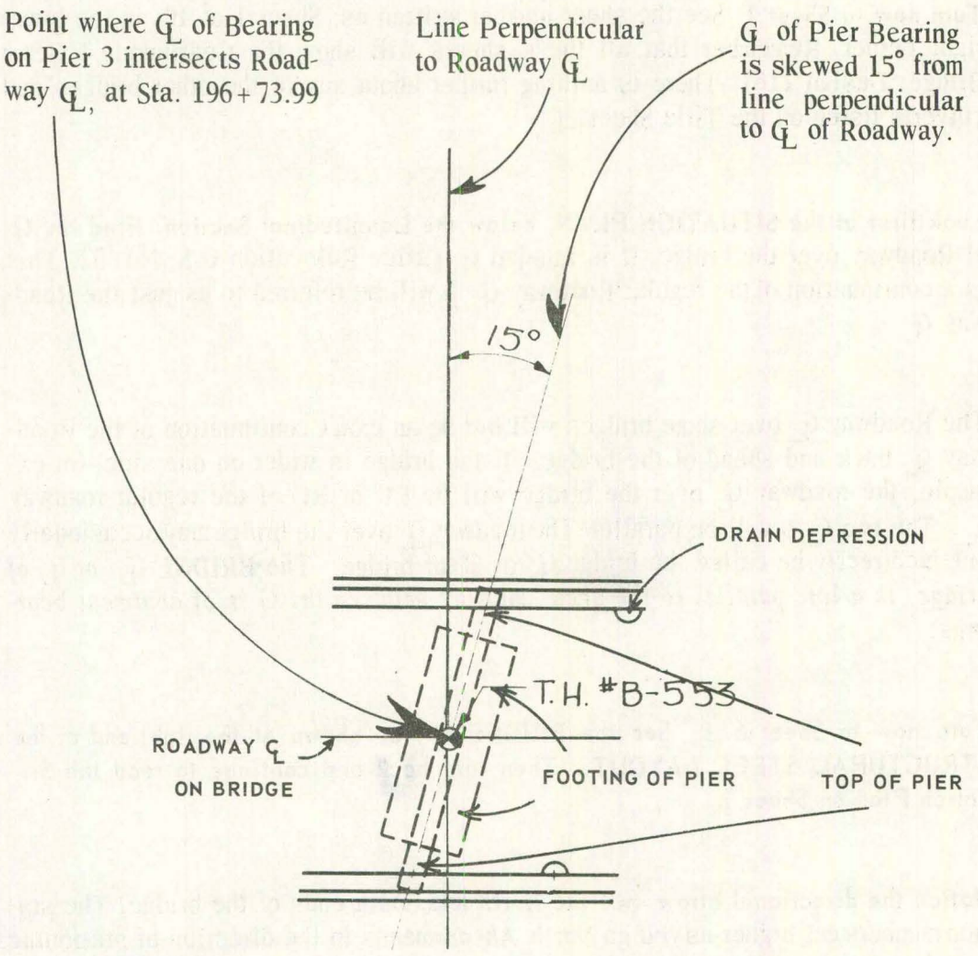


These show where Test Holes were dug. Most of these Test Holes were dug in the areas on which the piers were to be built. On the next sheet you'll see what was found in these test holes.

See the HALF CIRCLES, as  . These represent depressions, in front of the bridge curbing, which lead to drains under the curb. The water simply drains into these "holes" and falls into the river or onto the ground below.

Bridge ABUTMENTS, at the North and South ends, and the four PIERS are shown by dashed lines. They are drawn in with dashed lines because they are *below* the bridge floor. (You wouldn't see them if you were looking down at the bridge from above.)

The skew is written for Pier 3 as shown below. The other piers and the abutments are on the same skew, of course.



Examine the diagram above very carefully. Then see Pier 3 and the other piers and abutments on the Situation Plan on Sheet 1. The piers and abutments are skewed in the general direction of the *water flow*. This prevents unnecessary damage and lessens the interference with flow. That is why the piers and abutments are skewed.

Written on the Right of the bridge are the distances along Roadway ℄ between pier bearings. These are LEVEL (HORIZONTAL) distances. You will need a LEVELING instrument to measure these distances accurately because the bearings are not likely to be at the same elevation. **See the distance from Pier 2 to Pier 3 written as: 89'-11 7/8" ℄ - ℄ Pier Brgs. Brgs. means bearings. See the other distances given in the same way. The ℄ of Bearing is a line which passes through the centers of the points at which the beams will bear (rest) on the pier or abutment.**

See the ORIGINAL GROUND ELEVATIONS written at various places over the plan, as: 70.1, 69.0, 68.2. The elevation of the entire area is greater than 800. The 8 is NOT written in front of these elevations. Remember that it is understood.

Read the Situation Plan to find the answers to the following questions.
Refer also to page 54 when you need to.

1. Below which pier is Test Hole #B-553? _____

2. How far apart are the Drains to be spaced? _____

3. What is the station location at the Center of Bridge? _____

4. How many piers are required for this bridge? _____

5. At what station does the North ℄ Abutment Brg. cross the ℄ of roadway?

   _____

6. At what station does the South ℄ Abutment Brg. cross the ℄ of roadway?

   _____

7. Measured along Roadway ℄, what is the distance from the ℄ of the South Abutment Bearing to ℄ of Pier 1 bearing? _____

8. Measured along Roadway ℄, what is the distance from ℄ of Pier 3 bearing to ℄ of Pier 4 bearing? _____

9. These are L_____ or H_____ distances.
   (fill-in) (fill-in)

10. The Abutments and Piers are on a skew which is sometimes called a Left Forward Skew. What is the degree of this skew? _____

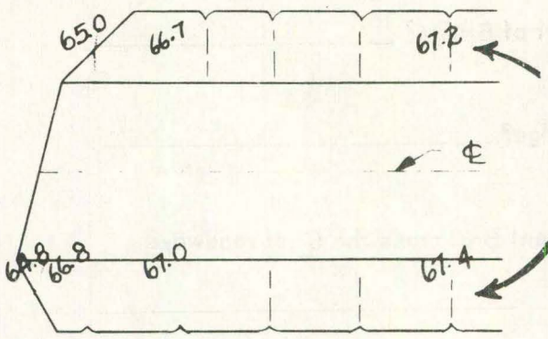
11. What is the ground elevation, Right of Pier 3, between the bridge and the special ditch? _____

Check very carefully by the ANSWER BOOKLET. If you made an error go back and find out where you went wrong. Always correct any error and be sure you understand the correction.

Still on the Situation Plan -

Look at the Proposed Special Ditch, 90' Right of ℄. Note that the ditch is Ahead of the River. (Only the back part of the bridge is over the main channel of the river.)

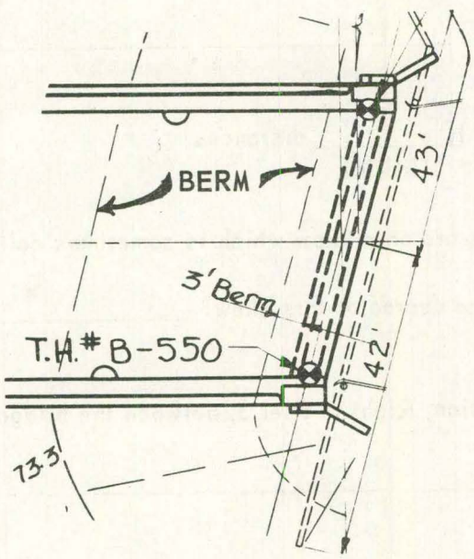
The sides of the ditch are to be raised.



These show the slopes to be on both sides of the ditch.

Notice the elevations given along the sides of the ditch. Remember that these are the PRESENT elevations, not the proposed elevations. Note that these elevations are lowest where the ditch will end, at the river. Water will be carried BACK and will outlet into the river.

Look next at the toes of the berms around each abutment. This is shown at the North end like this:



Similar lines show the berms ahead of the South abutment. Find those, too.

On the left side, look at the ditch and flume at the south end of the bridge.

These involve earth work, most of which must be done before the bridge construction is begun. The bridge contractor usually will not do this work. The inspector must be sure that the culvert contractor or road contractor has done the necessary earth work before the bridge contractor begins. You should look for Notes which may specify a required delay. For example, it may be necessary to wait for 30 days or so after the Berm is placed before beginning the bridge work.

Write the answers to these questions.

1. **What is the distance between the Right Special Ditch ℄ and the ℄ of roadway?**

   (The level distance) _____

2. **Will the ditch carry water back or ahead?** _____

3. **What are the approximate present ground elevations where the ditch will outlet?**

   _____

4. **What is the distance across the bridge from Front Face of curb to opposite Front Face of curb? (See dimension just back of South Abutment.)**

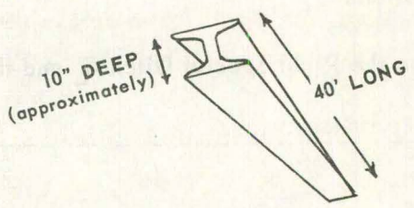
   _____

   This is the Bridge Roadway width.

Check and correct by the ANSWER BOOKLET.

Now look at the **LONGITUDINAL SECTION ALONG ℄ ROADWAY.** Keep in mind that this is a section, "sliced" at Roadway ℄. You only see what is to the left of ℄. Therefore, only *half* of the pier caps are shown and they are on a skew.

Starting at the bottom, look first at the Steel Piling. This is driven to the depth needed to provide a stable foundation. The piling extends up into the piers and abutments. See the Piling labeled below each pier and abutment , as 40' STEEL H PILES (10 BP 42). The 40' is the length. These are called H piles because, from the end, the shape is like an H. See illustration below.



The 10 BP means 10" deep Bearing Piles. See this 10" dimension illustrated above. The last number, 42, means that the bearing pile weighs 42 pounds per foot of pile length.

For Pier 1 notice that the piling description has been crossed out. This is because *no* piling was used. The design was changed to a rock footing on 10/24/62 and the piling was eliminated. During construction, rock was found near the proposed footing elevation. The pier footing was therefore lowered and placed on the rock, which provided a very stable foundation, without piling.

The lowest parts of the piers and abutments are the –

FOOTINGS

The piling is embedded in the footings. It extends up into the concrete. For each pier and abutment, the ELEVATION is specified for the Bottom of the Footing. This is abbreviated as: Bott. Ft. Elev. **See these elevations on the Longitudinal Section.**

Also see the ELEVATIONS given at both ends of the Longitudinal Section. These designate the elevation datum lines. See these drawn across the section every 10 feet, beginning at 840 and going up to 920 feet. (The top line, above 910, is not numbered but is at an elevation of 920.)

See the Present Ground Line. It is labeled between Pier 3 and Pier 4.

The following elevations are shown and labeled between Pier 1 and Pier 2.

Find them on the Longitudinal Section.

- **Stream Bed Elevation**
- **High Water Line (H.W.)** On March 27, 1961, the elevation of the water was 876.58.
- **Extreme High Water Elevation (EXT. H.W. ELEV.)**

See the Berm slopes and Elevations as shown at each abutment.

The questions below are about the Piling and Elevations shown on the Longitudinal Section. Use that section to find the answers.

1. What is the Berm Elevation given at the North abutment? _____

2. What is the rate of slope on the Berm? _____

3. What is the Berm Elevation at the South abutment? _____

4. The rate of slope should be the same on the North and South berms.

   What is the rate of slope on the South berm? _____

5. What is the Extreme High Water elevation? _____

6. When did the water reach an elevation of 876.58? _____

7. What is the Stream Bed Elevation, below the bridge? _____

8. What is the length of the piling to be used with the North abutment?

   _____

9. In the piling description, what does 10 BP 42 mean?

   _____

   _____

10. Why is the piling description crossed out for Pier No. 1? _____

    _____

11. Horizontal lines drawn across the section show the elevations every 10 feet.

    These datum line elevations begin at _____ and go

    up to _____ .

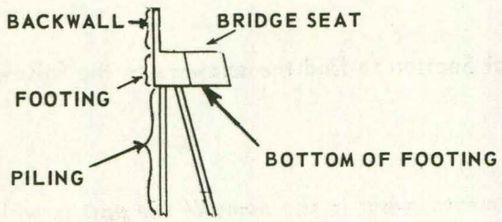
12. What is the elevation at the bottom of the South abutment footing?

    _____

13. What is the bottom footing elevation of Pier 3? _____

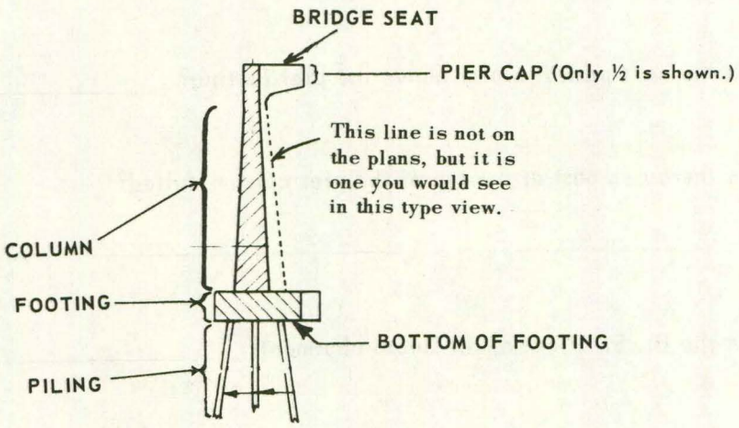
Check and correct by the ANSWER BOOKLET.

Below, the ABUTMENT parts are labeled.



The I beams of the bridge "sit on" the bridge seats. **See these on the Longitudinal Section.**

Be sure you know these parts of the piers, too.



– See the Bridge Seat Elevations given above each pier and abutment. Bridge Seat Elevation is abbreviated as Br. St. Elev.

– Above the Bridge Seat Elevations, the Grade Elevations (Gr. Elev.) are given. These are the required elevations at the top of the finished paving, at $\mathbb{Q}$ of roadway on the bridge.

– Both these elevations are at $\mathbb{Q}$ of roadway, where the $\mathbb{Q}$ of pier or abutment bearing crosses.

Read the Longitudinal Section to find the answers to the following questions.

1. On piers and abutments, what is the name of the part in which the piling is embedded? _____

2. Which part of an abutment is above the abutment footing?

   _____

3. On an abutment, the top line of the footing is the _____

   _____.

4. Where is the bridge seat on a pier? _____

5. What is the next part of a pier above the pier footing? _____

6. What is the cross part at the top of the pier column called?

   _____

7. What is the Br. St. Elev. of the South abutment? _____

8. What is the Bridge Seat Elevation of pier 4? _____

9. What is the Grade Elevation at the roadway ℄ , above the Bearing ℄ on the North abutment? _____

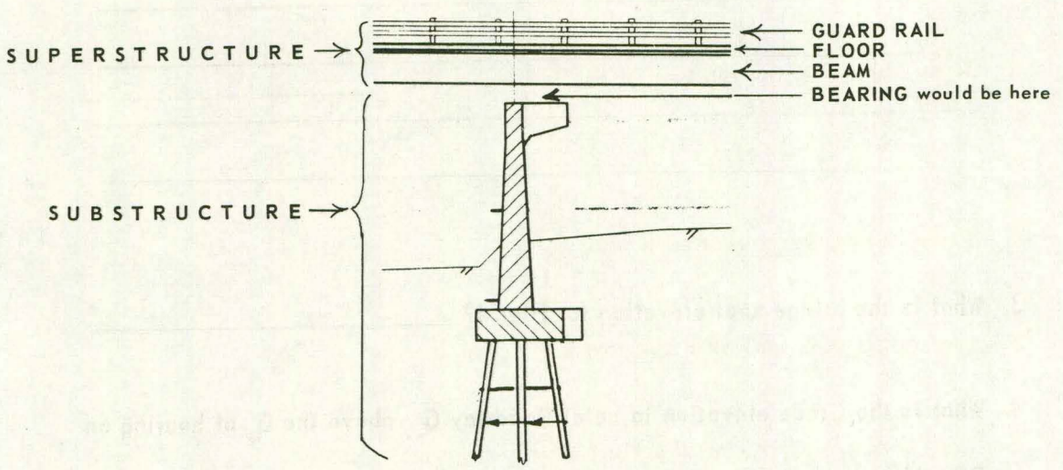
10. What "sits on" these bridge seats? _____

Check by the ANSWER BOOKLET.

Bearings (not shown) are used between each abutment or pier and the I beam. Two types of bearings are used on this bridge. One type is a Fixed Shoe and the other is a Rocker.

Everything *below* the bearing is a part of the SUBSTRUCTURE.

Everything *above* the bearing (beams, paving, guard rail, curb, etc.) is a part of the SUPERSTRUCTURE.



For use as a reference elevation, a mark, called a Bench Mark, is given. See this across the top of the sheet on the right side. Bench Mark No. 9 is a Rail Road Spike in the base of a double cottonwood tree on the North Bank. The station location is 194+77, 350' directly Right of Roadway ℄. The ELEVATION at that spike is 873.27.

Lastly on that sheet, look in the lower left corner at the TOTAL ESTIMATED QUANTITIES. Remember the quantities were listed on the title sheet, but they were not broken down as they are here. See the quantities of the various items which are required for the superstructure, the two abutments and the four piers.

Use all of sheet 1 to find the answers to the following questions.

Do NOT refer to other pages in this manual until you have answered all these questions.

1. At what station does the ℄ of bearing on Pier 4 cross below roadway ℄?

   _____

2. Write a COMPLETE description of the piling for Pier 4.

   _____

   _____

   _____

   _____

3. What is the bridge seat elevation for Pier 4? _____

4. What is the Grade elevation to be at Roadway ℄, above the ℄ of bearing on Pier 4? _____

5. What does the Superstructure include? _____

6. How many cubic yards of concrete are required for the Superstructure?

   _____

7. How many tons of Granular Backfill are needed for embankment around the abutments? _____

8. The road number of the road, which passes over this bridge, is _____

9. The bridge seat on an abutment is at the top of the _____

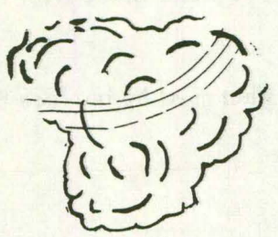
Check and correct by the ANSWER BOOKLET.

The following bridge plan sheets show details of the parts shown on the Situation Plan Sheet. As you read these details, you will turn back to the Situation Plan to see how various items fit into the overall structure.

Now turn to Sheet 2. Look briefly at the SOUNDING DATA (for the Test Holes) and the GENERAL PLAN. Then, continue with this page.

Notice that the Scale on the General Plan is 1"= 100' This is true when the sheets are REGULAR size. Your sheets are reduced to half size, so this scale would not apply. See the part of the bridge which is over the actual river.

See the brush and trees shown as: ⟶



Much of this will need to be cleared away before the bridge construction work can be begun.

Notice the directional arrow pointing North. Read the two station numbers. This shows you, again, that the stationing increases toward the North. Remember that when you speak of Ahead, you mean in the direction of stationing. Therefore, on this bridge North is ahead, and South is back. Right and left mean what would be on your right or left if you were FACING AHEAD.

See the SURVEY ℄, Right of the Relocated ℄ of U.S. No. 52. The ℄ surveyed is not to be used as construction ℄. That ℄ was relocated and the new one is the Office Relocation ℄. The Roadway ℄ to use on construction is the Office Relocation ℄.

Lastly, read the GENERAL NOTES.

The answers to the following questions can be found in the GENERAL PLAN or in the GENERAL NOTES.

1. What is the SCALE on the General Plan? _____

2. Why is this scale invalid for your sheet? _____

3. Is the Survey ℄ right or left of the Office Relocation ℄? _____

4. Which ℄ is the one to use as Roadway ℄ in construction? _____

5. The water in the river flows in which direction? _____

6. What must be in place BEFORE the abutment pile are driven?

   _____

7. Who will level and shape the berms to the elevations shown on these plans?

   _____

8. A tile drain is to be installed behind each abutment. Who will install it?

   _____

9. What manuals will apply to the Design and Construction on this bridge?

   (See Specification) _____

   _____

   _____

   _____

   _____

Check carefully by the ANSWER BOOKLET. Correct any errors.

Read the SOUNDING DATA and pay particular attention to the following:

1. *The elevation datum lines running across:* These are spaced 10' apart and labeled on the left and right. The elevations range from 790 to 880. (The top line is at an elevation of 890.)

2. *The Test Hole "name", as* B-548, B-547, *etc. and the test hole location;* by station number and distance right or left of $\mathbb{L}$

3. *The surface elevations given at the top of each test hole*

4. *The Elevations given at the bottom of each hole*

5. *The Layers of material found; what* they are, and how deep they are, as a 10' layer of silty sand, etc.

6. *The underground water table elevations when given:*
   On test hole B-554 this water elevation is shown to be 863.4. See this also on Test Hole B-553. For test holes F-4720 and F-4721, the distance from surface to water is given. See this on those test holes.

As you examine the test holes, look back at the situation plan to see where these test holes were drilled, in relation to the river and bridge.

Use the SOUNDING DATA on Sheet 2 and the SITUATION PLAN on Sheet 1 to find the answers to the following questions.

1. Which test hole was drilled where Pier 3 construction was to be done?

   _____

2. What was the surface (ground) elevation at the top of the test hole mentioned in 1 above? _____

3. Roughly estimating, what is the distance from this test hole to the river?

   _____

4. 1) On the same test hole, at what elevation did the testing crew hit water?

   _____

   2) What material was found in and around the area of this underground water?

   _____

5. For that test hole, at what elevation did the sampling (test hole digging) stop?

   _____

6. Read the note between the 2nd and 3rd rows of test holes on Sheet 2. On the Situation Plan see where test holes B-589 – 592 were taken. What was the approximate DEPTH of the Upper Iowa River when the soundings were taken?

   _____

7. At Station 198+30, 15' Right of ℄, how thick is the Bouldery Gravel?

   _____

   How far from the surface does it begin?

   _____

Check and correct by the ANSWER BOOKLET.

Turn now to Sheet 3, for the ABUTMENT DETAILS. Look over the sheet briefly to get an overall idea of what it contains. See the Rear Elevation, the Plan (view from top of abutment), the Footing Plan, the Pile Plan, and the ℄ Section. Do that before you go on with this page. This sheet applies to BOTH North and South abutments. Any way in which the abutments differ is noted. For example, elevations at certain points are given separately for the North and South abutments.

Read and Remember these basic points about ABUTMENTS:

- The abutment footing is on the ground. The piling below extends up into the abutment footing.

- The bridge seat is at the top of the footing. The ends of the beams, which support the bridge, rest on the abutment bridge seats. Bearing plates are placed between the bridge seat and the beams at the points where the beams "bear" on the bridge seat.

- The ℄ line of abutment BEARING runs the length of the bridge seat. It is *on the line of skew*. This ℄ is very often used in measurements. It is a very important line. The ℄ of ABUTMENT is *perpendicular* to the ℄ of abutment BEARING. The ℄ of ABUTMENT divides the abutment into Left and Right halves. See the ℄ Section on Sheet 3. This section was taken at ABUTMENT ℄. See the ℄ of abutment *BEARING* indicated at the bridge seat.

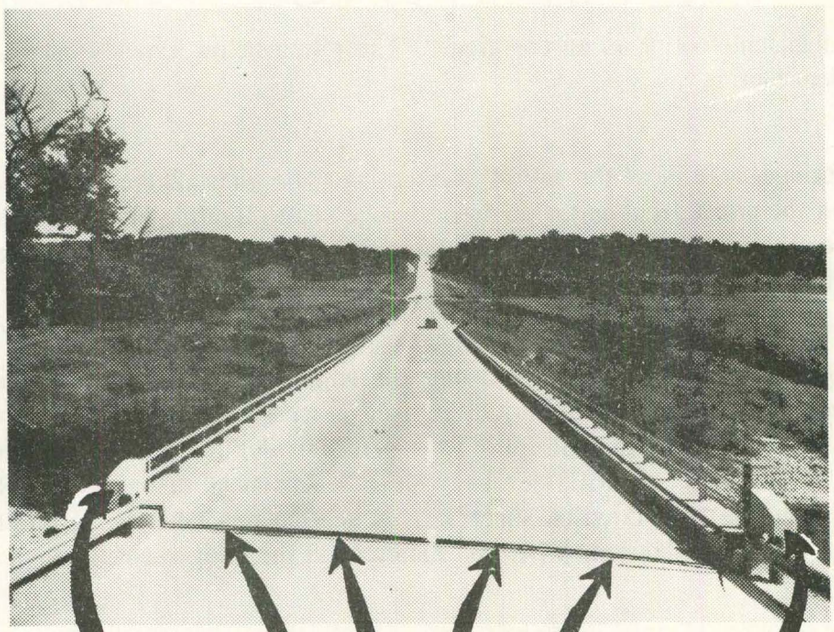
- The backwall of the abutment is the top most part of the abutment. It is on the *roadway side* of each abutment and extends up to the grade. (The roadway side means away from the bridge, toward the road.) The bridge seat is like the seat of a chair; and the backwall, like the back of the chair.

- The END WALLS begin at the front of the bridge seat, on each side, and extend back to the backwall. At the backwall, the end walls flare out and are called Wings. These Wings hold the fill back on the roadway side.

The pictures on this page and the next show parts of the actual bridge abutments which were built from the plans you are reading.

Examine the pictures and labels very carefully. Compare the pictures with the views shown on Sheet 3.

BRIDGE FROM SOUTH TO NORTH



Top of Backwall of

South abutment is

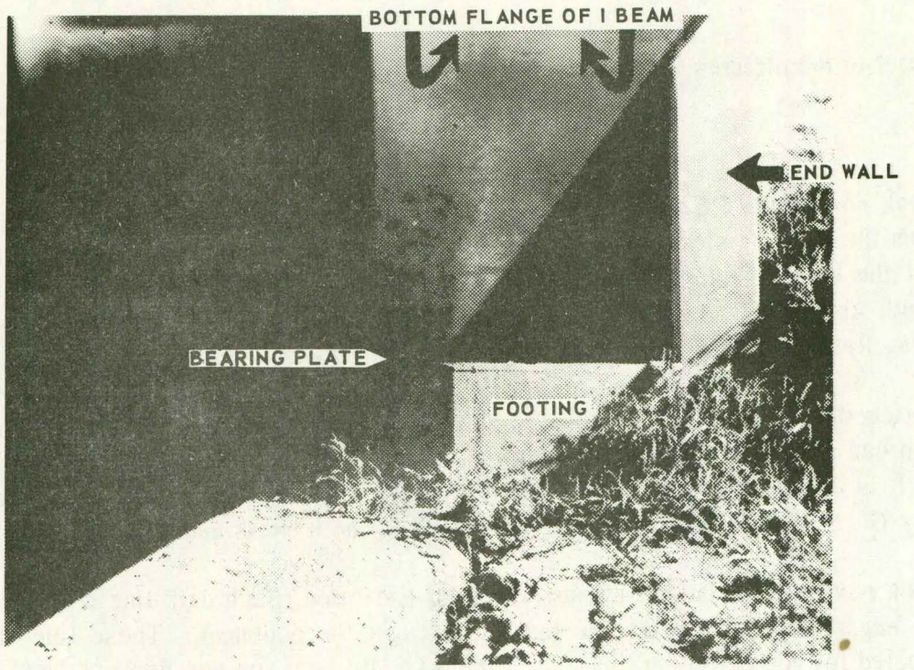
just below here.

These are Wing *Posts*.

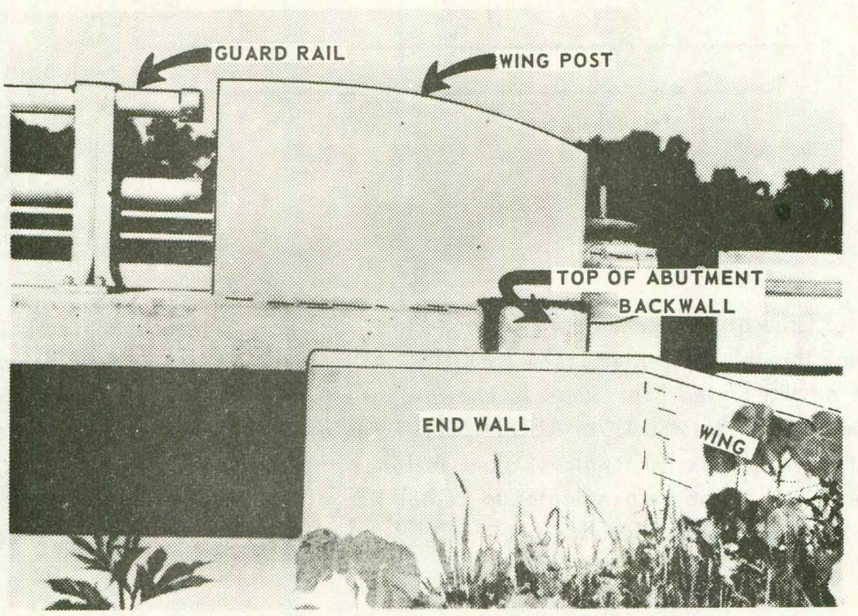
They are part of the superstructure,

NOT part of the abutment.

EAST END OF NORTH ABUTMENT



SIDE VIEW OF NORTH EAST WING POST AND PART OF NORTH ABUTMENT

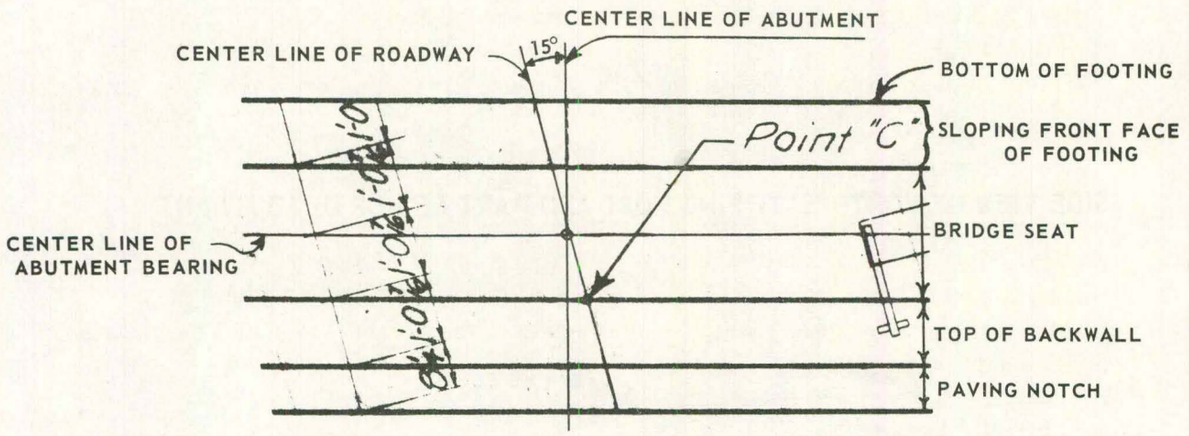


Refer to the pictures whenever you like.

Look now at the REAR ELEVATION. This shows an abutment as it would look from the roadway side. You would see the backwall and wings (or wingwalls) but not the bridge seat. See the dotted line (labeled on the right half) showing the South Abutment Bridge Seat Elevation. The elevation is 887.91. Be sure you see this. Remember that the bridge seat is on the "bridge" side of each abutment.

Notice that the reinforcing bars are shown only on the left side of the diagram. You can assume that the reinforcing is just the same on the right half. See point C. It is at the Front Face of the backwall at the top. Point C is also at the roadway ℄. **See the elevations given at point C for both North and South abutments.**

Look next at the Plan, just below the Rear Elevation. Each dark line represents an *edge* which you would see looking *down* at the abutment. These lines are labeled for you below, in the area of point C. Be sure you see these "edges" on the Plan on Sheet 3.



The Center Line of Abutment BEARING runs longways across the abutment. This line passes through the center of the BEARING AREAS, that is, where the I beams will bear on the bridge seat. This is shown above to be along the center of the bridge seat. Note that the ℄ of ABUTMENT is on a line perpendicular to ℄ of Abutment Bearing. The 15° angle of skew is formed by the intersection of the ℄ of Roadway and a line perpendicular to center line of Abutment Bearing (in this case the ℄ of abutment). See this angle of skew above on this page and on Sheet 3.

The paving notch is shown in cross section in the ℄ section, right of the rear elevation. **Examine that section.** The roadway paving "fits" into that paving notch. Remember that this ℄ section was "sliced" along the ℄ of ABUTMENT.

Look back at the plan. Note the dimensions given across all surfaces. The little "patch" shown on the right side of the bridge seat is one of the bearing plates on which an I beam will be placed. Four of these beams will rest on the bridge seat.

Next look at the Footing Plan. This shows the reinforcing to be placed inside the footing and backwall. The top of the H pile are dotted in where they will extend into the footing. See these pile in the ℄ section also. They are shown to extend 2 feet up into the footing.

Also see the Pile positions on the Pile Plan in the lower left corner. Read the note below which tells you that all the dimensions are at the BOTTOM of the footing. (The *Footing* Plan dimensions were at the top of footing.) The *Battered* (slanted) pile are to slope 1:4 in the direction shown. See this batter (slope) in the ℄ section. Four pile (on the roadway side) are *straight*. Five others are driven on a 1:4 slope.

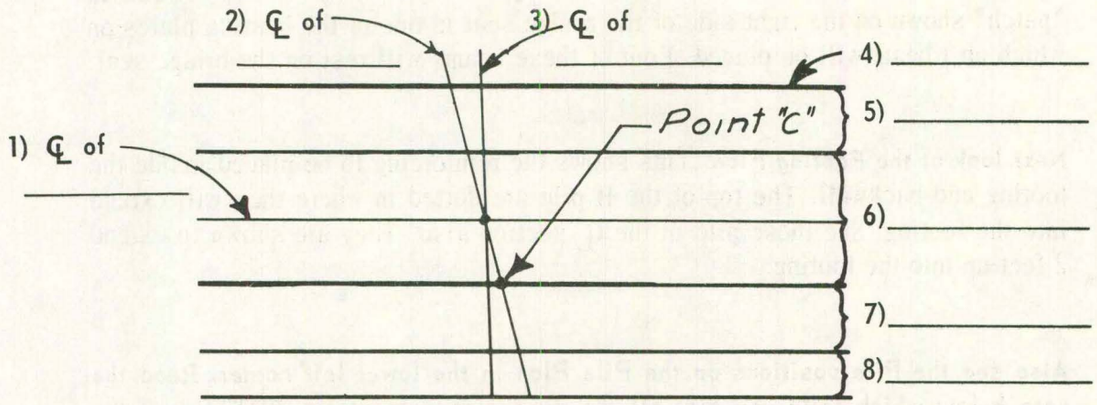
Read the Abutment views on Sheet 3 to find the answers.

1. At what point on the abutment is Point C? _____

2. What is the elevation of Point C on the NORTH abutment? _____

3. What is the elevation of Point C on the South abutment? _____

4. The lines below are taken from the Plan, around Point C. You label the ℄'s, edges, and surfaces, by writing in the blanks provided.



5. Most of those same lines are in the Footing Plan. The reinforcing lines are also drawn in with lighter dashed lines. What do the dotted lines in the shapes of H's show? _____

6. How many pile will be used for one abutment? _____

7. What will be the slope on the battered pile? _____

8. How many of the pile are driven STRAIGHT down? _____

Check and correct by the ANSWER BOOKLET.

Go on to the table of REINFORCING STEEL – ONE ABUTMENT, in the upper right corner. This reinforcing table is read in the same way as the reinforcing tables you saw for culverts. See the Name of the bar, the Location, the Shape, the Number needed, the Length, and the Weight.

The ***number*** in the name of the bar shows the ***diameter*** of the bar. It is the ***number*** of 1/8 inches in the diameter, as 8a1. The first bar has a diameter of 8/8", or 1". The next bar, 5b1, has a diameter of 5/8".

Also, as in the culvert standards,

F.F. stands for Front Face. B.F. stands for Back Face.

On an abutment:

Front Face means toward the bridge.

Back Face means toward the roadway.

Below the Reinforcing Steel Table and bar details, are the –

CONCRETE PLACEMENT QUANTITIES

for 1 ABUTMENT, and

the TOTAL ESTIMATED QUANTITIES

for 2 ABUTMENTS

Read this quantity information.

The following questions concern the Reinforcing bars to be placed in each Abutment. Find the answers on your Abutment Details Sheet.

1. For the 8a1 bar –

   1) The diameter is _____

   2) It goes in the _____

   3) Its position is _____

   4) Its shape is _____
   (bent or straight)

   5) The number required is _____

   6) The length is _____

   7) The weight is _____

2. What type of steel must the Paving Notch Dowels, 4f6, be made of?

   _____

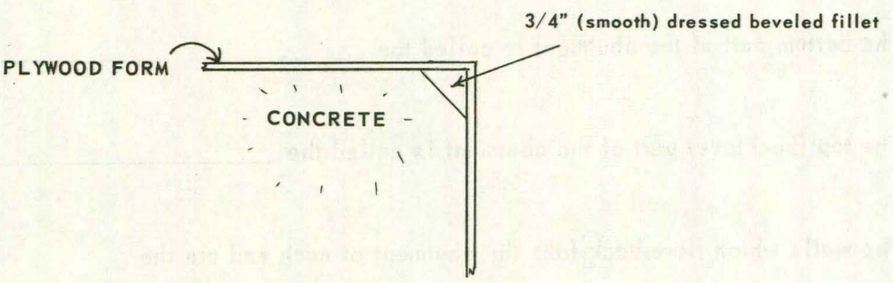
3. An end wall is at each end of the bridge seat. These become wings when they flare out behind. What bars should be placed VERTICALLY in the front face of the end walls? _____

4. The spacing of the bars is indicated on the plan views. The SPACE between the bars is given, as: 4 spaces @ 4'6. This is the same as saying 5 bars, at 4'6" centers. (To have four spaces you must have five bars.) How will the 4f1 bars in the front face of the backwall be spaced? _____

   _____

Read the Abutment Notes below the QUANTITIES. Look for any other notes anywhere on the sheet and read those, too. Do that NOW, then continue with this page.

To make outside concrete corners smooth, they are to be formed with a 3/4" dressed and beveled fillet. This is stated in the Abutment Notes. It means that the plywood form holding the concrete must have a triangular piece of wood in the corner, like this:



As you can see, this prevents the concrete from forming into a 90° angle at the corner.

In the Granular Backfill Detail, you should have seen the note specifying the line to which approach fills must be completed before starting the construction of the abutment. **If you did not see this, find it now.**

Look next at the TILE DRAIN shown in the Granular Backfill Detail. It is to be placed on the roadway side of each abutment. Turn back to the situation plan on Sheet 1 and see this drain. It is drawn in with double dashed lines behind both abutments.

On Sheet 1, look again at the Longitudinal Section along ℄. Pay particular attention to the ABUTMENTS at each end. Recall the details concerning abutments and see how they relate to this overall view.

The questions on this page and the next concern different aspects of abutments. Do NOT refer to other pages in this manual until you have answered them all. Use your plan sheets (particularly Sheet 3) to find the answers.

1. The bottom part of the abutment is called the _____.

2. The top (backface) part of the abutment is called the _____.

3. The walls which flare back from the abutment at each end are the

   _____.

4. Where are the End Walls? _____

   _____

5. Starting at the backface (roadway side) of the abutment, name the surfaces you would see if you were looking down, over the center of the abutment.

   _____

   _____

6. When construction is completed, what will be in the paving notch?

_____

7. The Bridge Contractor is to backfill the abutments between the wings (wing walls) with compacted granular backfill material. This material must conform to requirements which are stated where? _____

8. What must the clear distance from face of concrete to the nearest reinforcing bar be? (Unless otherwise shown or noted) _____

9. Piling for the South Abutment is to be driven to what? _____

10. What is the diameter of the 5dl bar? _____

11. How many cubic yards of concrete are required for the FOOTING on ONE abutment? _____

12. How many cubic yards of concrete are required for ALL of TWO abutments?

_____

13. What is the diameter of the tile drain to be placed behind each abutment?

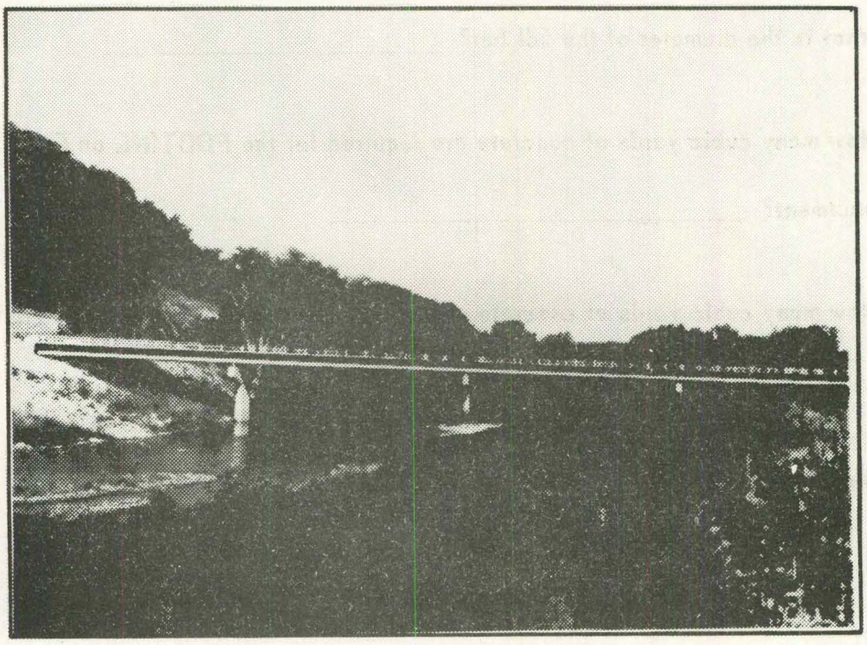
_____

Check and correct by the ANSWER BOOKLET.

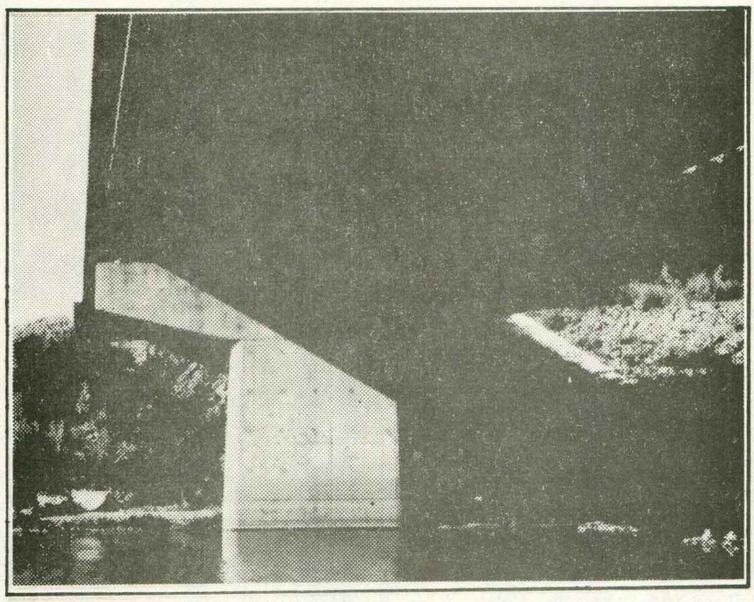
Turn now to Sheet 4 and look over the Details for Pier 2. This bridge requires four piers, all of which are similar in many ways. Sheet 4A contains the details for Pier 1. Sheet 5 shows the details for Piers 3 and 4. Look over those sheets very briefly to see how much all the piers look alike.

The piers built by these plans are shown in the pictures on this page and the next. **Look closely at the PIERS.** You may refer back to these pictures as you study the plan details, or whenever you like.

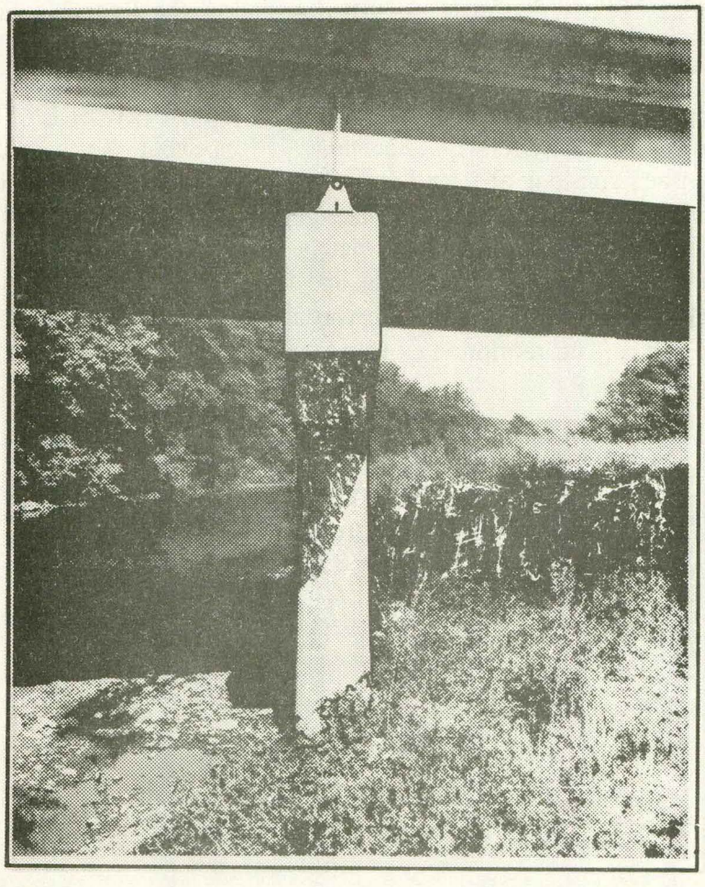
Only three of the piers are shown here. Notice the skew.



Compare this picture with the PIER ELEVATION on Sheet 4.



Compare this picture with the END ELEVATION on Sheet 4. The views are the same.



The pier views and information on Sheets 4, 4A, and 5 are very clear and straightforward. You should be able to read them with little or no trouble.

NOTICE THESE THINGS PARTICULARLY:

- On each PIER ELEVATION, construction *joints* are shown between the top of the column and the pier cap; also, between the bottom of the column and the pier footing. These are permissible stopping points.

- Also on the Pier Elevation, at the top of the pier cap, notice that the middle part is higher than the sides. Toward the *left* side there is a "step down". **See this labeled as: LOW STEP ELEV. (SEE TABLE A).** The "step down" distance is Dimension "a". **See this indicated also on the right side at the top.** The "step down" on the right side is Dimension "b". Dimension "c", shown at the right edge, is the difference between Dimension "a" and Dimension "b". **See these in Table A on the right side of each sheet. Read the other dimensions and elevations, too.**

- The abutments also have steps on the bridge seat (top of the footing). **Turn back to Sheet 3 and see the South Abutment steps as shown by the dotted line on the REAR ELEVATION.** This dotted line shows the bridge seat elevation all the way across. It is dotted because it is on the other side. You wouldn't see it from the rear. **See the bridge seat elevation and the steps for the North Abutment.** This is shown by a solid line below the Rear Elevation Diagram, above the words; REAR ELEVATION.

- **Now turn back to the pier sheets.** Below the title, PIER ELEVATION, are the words; (LOOKING NORTH). **See them.** Remember, North is *ahead* on this bridge. When you look at Pier 2 from the *South* side, you are looking *toward the North, ahead*. What is shown on the right side of this diagram must be on the right side on the actual pier, and what is shown on the left must be on the left. The *steps* are different on the right and left sides. This is also true of abutments, of course. You must be sure you are facing ahead to determine which *is* right or left. (The reinforcing, shown only on the right, is the same on both sides, of course.)

On Sheet 4 *disregard* the diagram at the bottom labeled ROCKER PIER 1. It has been crossed out. As you can tell from other places on the sheet too, Sheet 4 has been changed to no longer include Pier 1. Sheet 4A was added to show Pier 1. Sheet 4 only shows Pier 2.

On Sheet 4, see the diagram labeled: Fixed Shoe, Pier 2. See the Anchor Bolt Location Diagrams on Sheets 4A and 5. These show how the bearings will be attached to the pier caps. The bearings used on these piers will be either rockers or fixed shoes. Remember, these are used between the piers and the beams. **Look back at page 81 and see the bearing at the top of the pier.** You will learn more about these on later sheets.

See how the pier columns are larger at the bottom than at the top. A ¼ inch in 12 inch slope is specified for the sides of the columns. See this on the END ELEVATIONS. It is written on both sides of each column, about halfway between the bottom and the top.

As you look over the views on the three Pier Detail sheets, turn back to Sheet 1 and see the piers on the Situation Plan and Longitudinal Section again.

Use your plan sheets, especially Sheets 4, 4A and 5, to find the answers to the following questions.

1. How many bearing pile are required for Pier 2? _____

2. How many bearing pile are required for Pier 1? _____

3. What is the total number of bearing pile required for Piers 3 and 4 together?

   _____

4. On Pier 2, what is the Low Step Elevation? _____

5. The reinforcing is the same in each pier. Describe the reinforcing to go at the TOP of the footing. _____

   _____

6. What is the shape of the stirrups (reinforcing bars)?

   _____

7. Which end of the column is smaller? _____

8. On each pier, the left side is just like the right side except for one difference. What is it? _____

   _____

9. On Pier 1, what is the Bottom Footing Elevation? _____

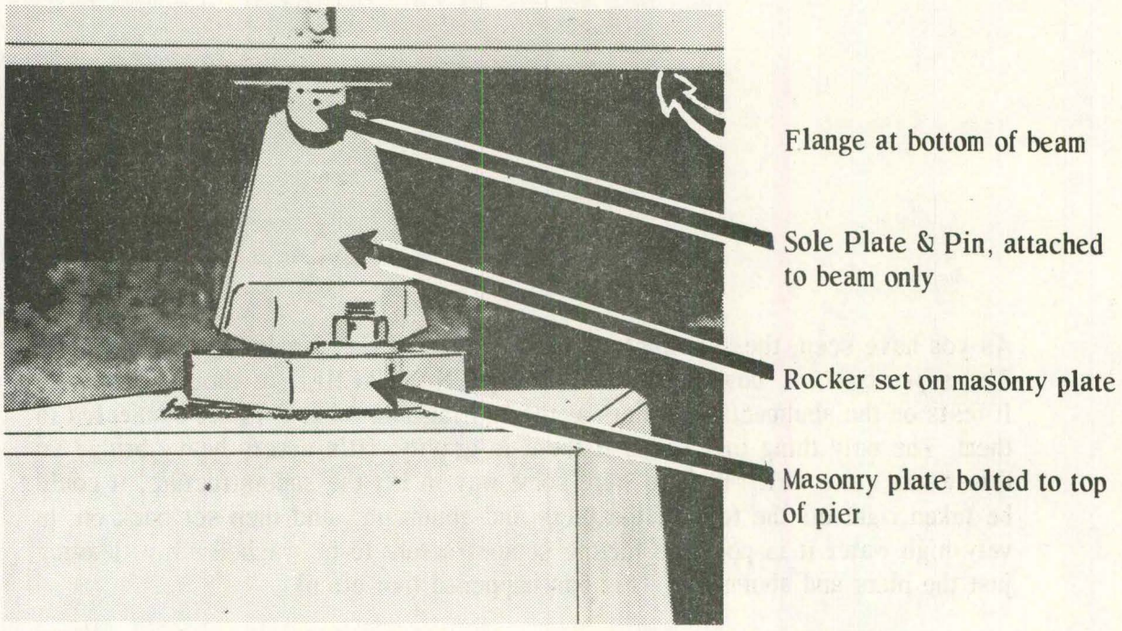
Check very carefully by the ANSWER BOOKLET. Correct any errors!

As you have seen, the ***substructure*** of the bridge is very firmly secured in place. The ***superstructure***, however, is completely UNATTACHED to the substructure. It rests on the abutments and piers at the bearing points but it is ***not connected*** to them. The only thing that keeps it there is gravity. (It's a very heavy bridge so this works quite well.) If there were some way to lift the superstructure, it could be taken right off the tops of the piers and abutments, and then set back on. In very high water it is possible for the superstructure to be washed away, leaving just the piers and abutments. This has happened (not often).

To some extent, the bridge will expand during hot weather and shrink during cold weather. If the superstructure were attached, the points of attachment would be broken, or the bridge might crack.

Keep in mind that the bridge, above the piers and abutments, must be *free*.

The type of bearing used between the pier and beam shown below is a ROCKER. **Examine the picture and explanation very carefully.**

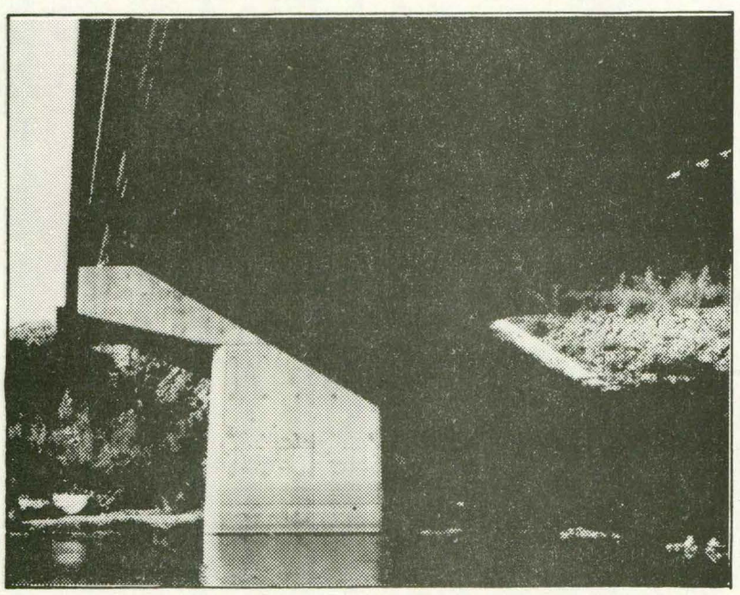


The pin attached to the beam is just set into the top of the rocker. It is ***not*** attached to the rocker.

The rocker is free to "rock" forward and back. It is *fitted* onto the masonry plate but not bolted. The bolt you see fastens the *masonry plate* to the top of the pier.

A *fixed* shoe may be used instead of a rocker. The main difference between a rocker and a fixed shoe is that the fixed shoe is bolted to the pier and the rocker is not. The rocker is, therefore, free to "rock" back and forth, while the fixed shoe is "fixed" in one position. The pin arrangement at the top is the same for both. The pin is attached only to the beam. It rests on the shoe or rocker, but is *not* attached to either. See illustration above again.

To see these Pier Bearing Details, turn now to Sheet 8 and look in the left lower corner. Find the diagram above the heading - ROCKER R3A. This shows the same view of the rocker as does the picture on page 86. Compare them. The left half of the diagram is from the front. See the front bolt. The right half is a cross section through the middle of the rocker. Just Right of that diagram see the front and side views of the Sole Plate and Pin, as attached to the beam. In the bottom left corner of the sheet see the top view of the Pier Masonry Plate. On the left half of this plan view the rocker is shown; on the right half it is not. Above that diagram see the side view of the rocker, as it would appear from the angle shown in the picture below.



Next, examine the three diagrams over the heading: FIXED SHOE S3. Compare the fixed shoe with the rocker.

Find and write the answers to the questions below.

1. What is the Weight (Wt.) of each of the parts below?

   Pier Masonry Plate MP3P _____ pounds

   Rocker R3A _____ pounds

   Fixed Shoe S3 _____ pounds

2. What is bolted to the top of the pier when a rocker is to be used? How many bolts are needed?

   _____ _____

3. The rocker is FITTED on to the masonry plate by way of 1½" PINTLES. (See diagram midway up left side of sheet.) How many pintles are present in each rocker? _____

4. What is the distance from the bottom of the masonry plate to the top of the rocker? (Remember - inches are not always indicated as such.)

   _____

5. How many bolts are used to attach the FIXED shoe to the pier?

   _____ How much does each bolt weigh? _____

6. In your own words describe what the Sole Plate and Pin are used for.

   _____

   _____

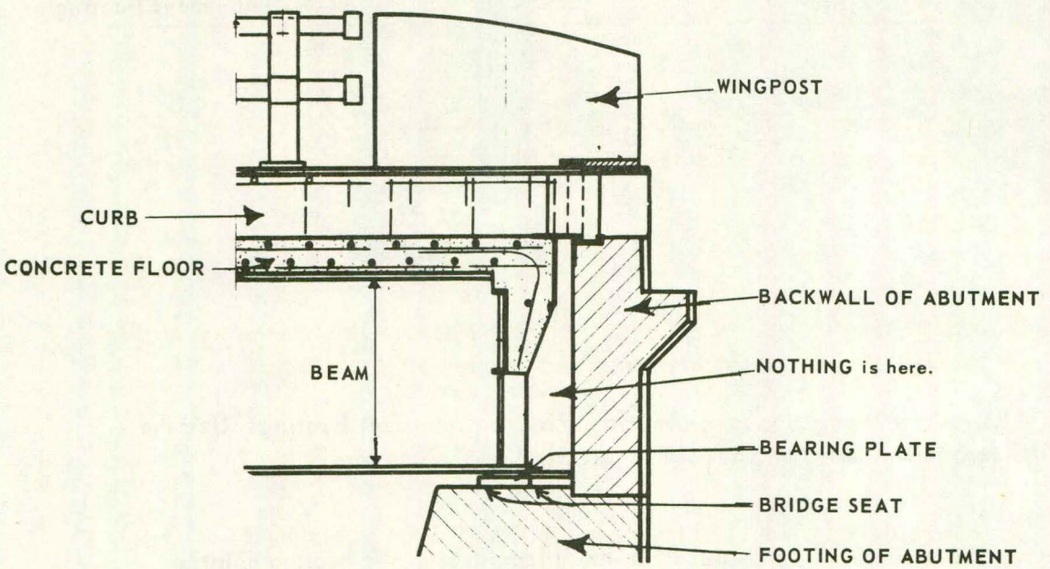
   _____

   _____

Check and correct very carefully by the ANSWER BOOKLET.

Turn to Sheet 7 and look at the LONGITUDINAL SECTION AT EXTERIOR BEAM. See the fixed shoe on the middle pier. See the rockers on the other piers. (Pier 4 is not shown.)

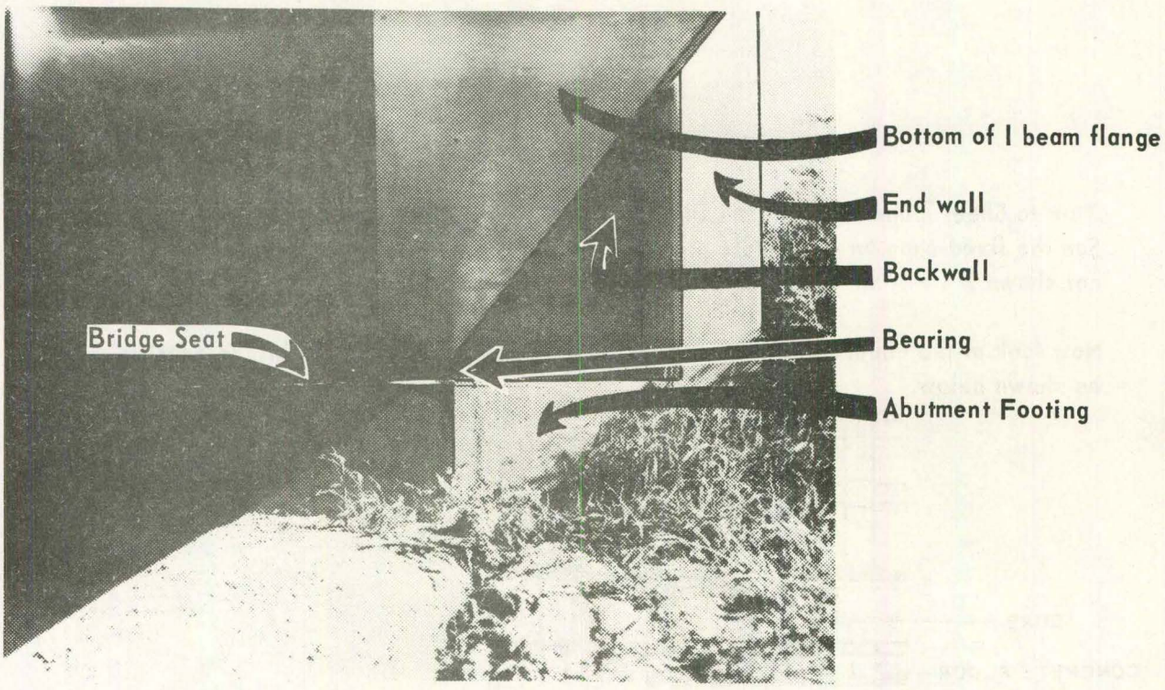
Now look at the abutment bearings. See where the beam rests on the bridge seat, as shown below.



Now turn back to Sheet 8 and, for the ABUTMENT BEARING DETAILS---

Look at the diagrams of the Masonry Plate and the curved Sole Plate. The masonry plate is anchored into the abutment backwall. You saw this plate as a "patch" on Sheet 3. The Sole Plate is attached to the bottom of the beam. A BLOCKING PLATE is sometimes required between the sole plate and the beam. Examine these diagrams carefully. Then, read the BEARING NOTES.

The picture below shows one of the exterior beams, from underneath. See where it "bears on" the bridge seat of the abutment.



The following questions are about the Pier and Abutment Bearings. Use the diagrams and notes on your plan sheets to find the answers.

1. What type of plate is placed on the bridge seat at the bearing point?

   _____

2. How is the masonry plate anchored at the abutment? _____

3. What is the name of the curved plate attached to the beam at the abutment bearing point? _____

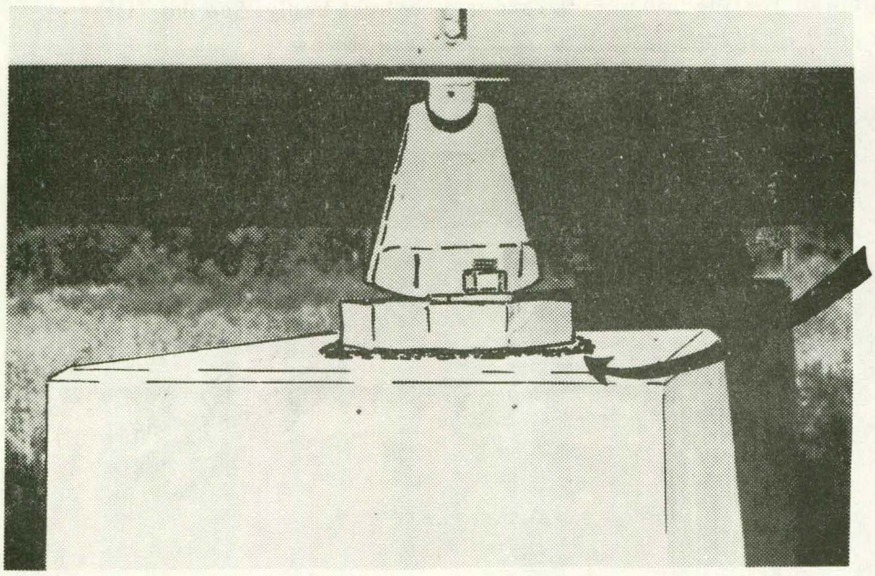
4. What may be between the sole plate and the beam?

   _____

GO ON TO THE NEXT PAGE

5. What informational source, OTHER THAN these plans, tells how the anchor bolts should be set? _____

6. All bearings are to be set in _____ and _____ . See picture below.



7. What do you call the fittings used to keep the rocker from sliding on the masonry plate? _____

8. What is attached to the sole plate at a pier bearing, but not at an abutment bearing? _____

9. List two ways in which a fixed shoe differs from a rocker.

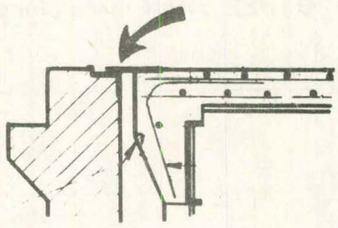
   1) _____

   2) _____

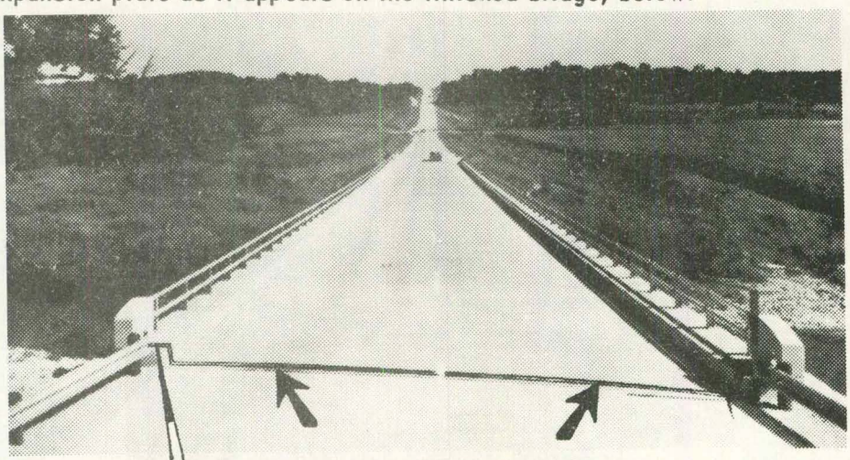
Check and correct by the ANSWER BOOKLET.

Turn again to Sheet 7. Look at the ends of the bridge floor, at both abutments.

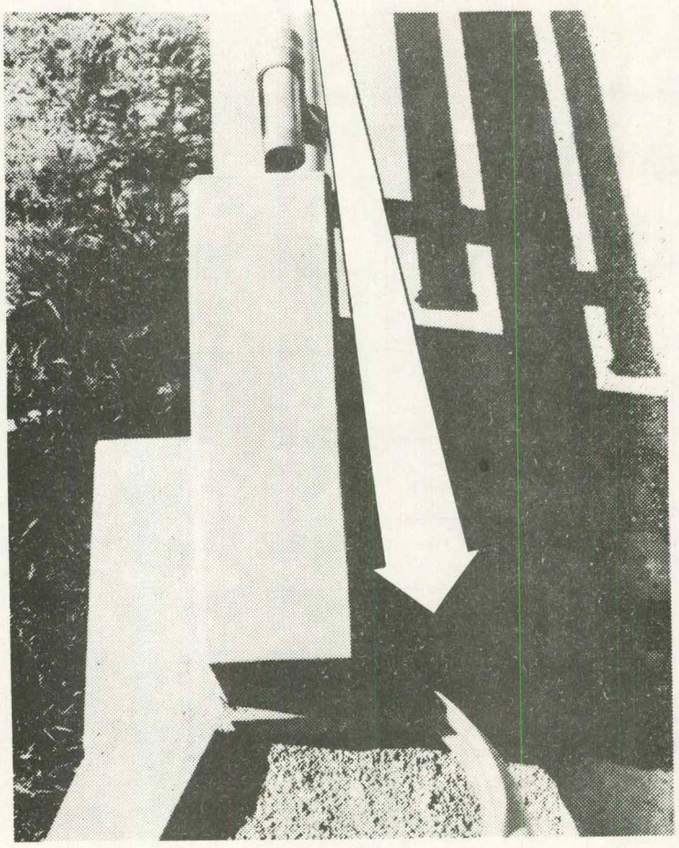
See this Expansion Assembly



The expansion plate allows the bridge to expand and contract freely. See the TOP of the expansion plate as it appears on the finished bridge, below.



TOP OF EXPANSION PLATE



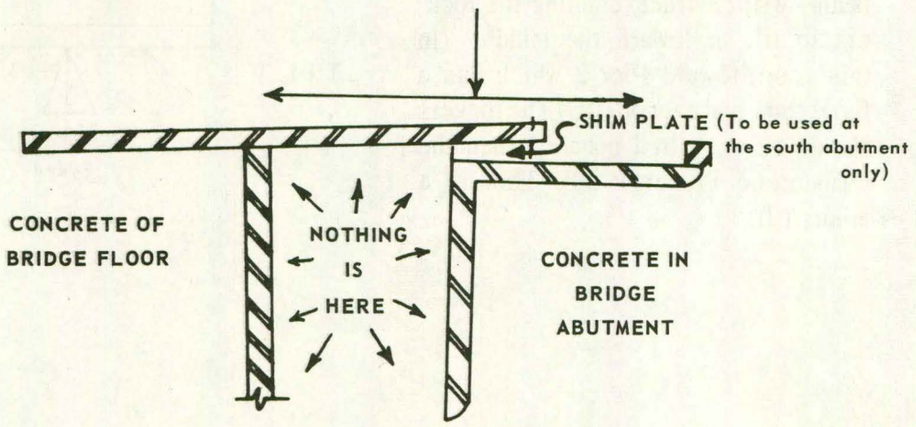
ONE CORNER OF BRIDGE

Turn now to Sheet 9 to see the

EXPANSION PLATE DETAILS

Look at the bottom of the sheet, on the left. See the plan view there and the sections. Note that Section A-A is taken at the curb. Above and right of the plan is a diagram which shows a cross section of the expansion plate assembly. That diagram is presented below, also. Read the explanation and labels given below.

This slides back and forth as needed.



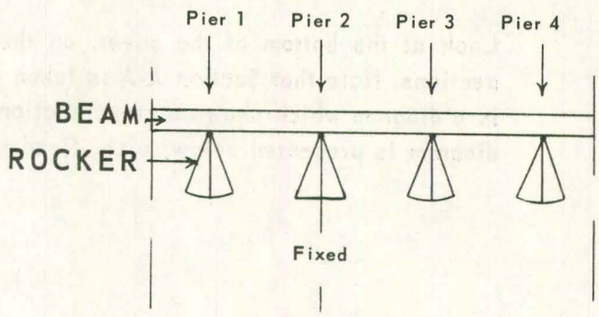
CROSS SECTION OF EXPANSION

PLATE ASSEMBLY

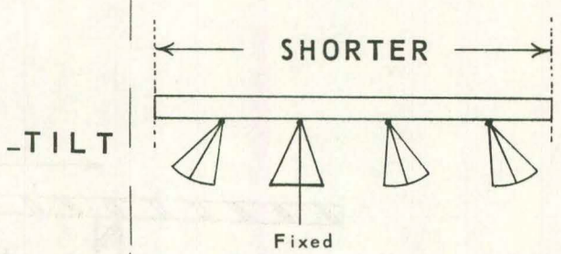
Now turn back to Sheet 8 and find the table: **ROCKER AND EXPANSION PLATE SETTING.**

As you know, in hot weather metal expands and in cold weather it contracts. The expansion assembly and the pier rockers must be set accordingly.

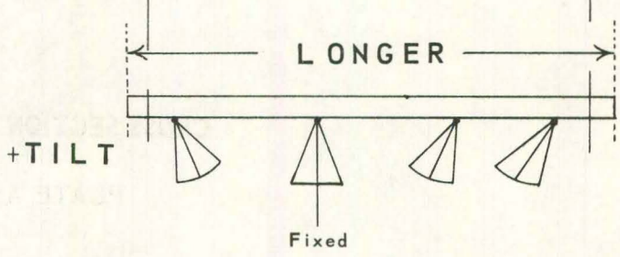
Assuming a mean temperature of 50°, the rockers should be set straight up, if the temperature *is* 50°.



When the temperature is *below* 50°, the beams will *contract*, causing the rockers to tilt *in* toward the middle. (In this case, toward Pier 2 which has a *fixed* shoe and cannot tilt.) The rockers should be set *tilted inward*, when the temperature is below 50°. This is a *minus* tilt.



When the temperature is *above* 50° the beams will expand. See the "plus tilt" illustrated in the table. Notice that a + tilt for Pier 1 is in the opposite direction from a + tilt for Piers 3 and 4.



The settings, according to temperature as shown in the table, equalize the + and - tilting which occur as the temperature rises and drops around 50°.

See the D distance indicated between the two parts of the expansion assemblies also. This distance is measured on a line perpendicular to the expansion plate at the top. The distance set must be shorter in warm weather and longer in cool weather.

Write the answers or fill-in the blanks below.

1. Which pier has a bearing which will NOT tilt at all? _____

2. If the temperature at the time of setting is 50°, how should the rockers be set?

   _____

3. Which two rockers should maintain a tilt in the SAME direction?

   _____

4. When the Pier 1 rocker is at a "plus tilt", will it be tilted in toward Pier 2 or away from Pier 2? _____

5. When the Pier 3 and 4 rockers are at a "plus tilt" will they be tilted in toward Pier 2 or away from Pier 2? _____

6. When the temperature is BELOW 50° all rockers should be set at a

   _____ tilt.
   (+ or −)

7. What is the tilt of each rocker as illustrated in the table? _____
   (+ or −)

8. For the expansion plate assembly, will distance D become greater or lesser as the temperature goes UP ? _____

Check very carefully by the ANSWER BOOKLET. If you made an error read page 94 again and find out why. Then correct your error.

The degree of tilt is measured by the level distance at the bottom of the rocker, shown in the table. These distances, plus or minus, are given in the table for settings in 10°F, 50°F, and 90°F temperatures. Settings for other temperatures are proportional to those shown. (See note below table.) Remember, the 0 setting point is 50°. If the temperature were 70°, for example, the "tilt distance" would be +1/8". 70 is halfway between 50 and 90, and 1/8" is halfway between 0 and 1/4".

Read the table to find the answers to the following questions.

1. **When the temperature is 10°, what is the D distance for the SOUTH Abutment?** _____

2. **When the temperature is 10°, what is the D distance for the NORTH Abutment?** _____

3. **When the temperature is 50°, what is the D distance for the North and for the South Abutments?** _____

4. When the temperature is 10°, what is the "tilt distance" listed in the table

   for Pier 4 rockers? _____

   for Pier 3 rockers? _____

   for Pier 1 rockers? _____

5. If the rockers are properly set, and all are STRAIGHT UP, what must the temperature be? _____

6. A "minus tilt" is correct for all rockers when the temperature is

   _____ 50°.
   (above or below)

7. The tilts illustrated in the table are all _____ tilts. (See the sign
   (+ or –)

   at the right corner of each.)

8. "Plus tilts" go with expansion or contraction? _____

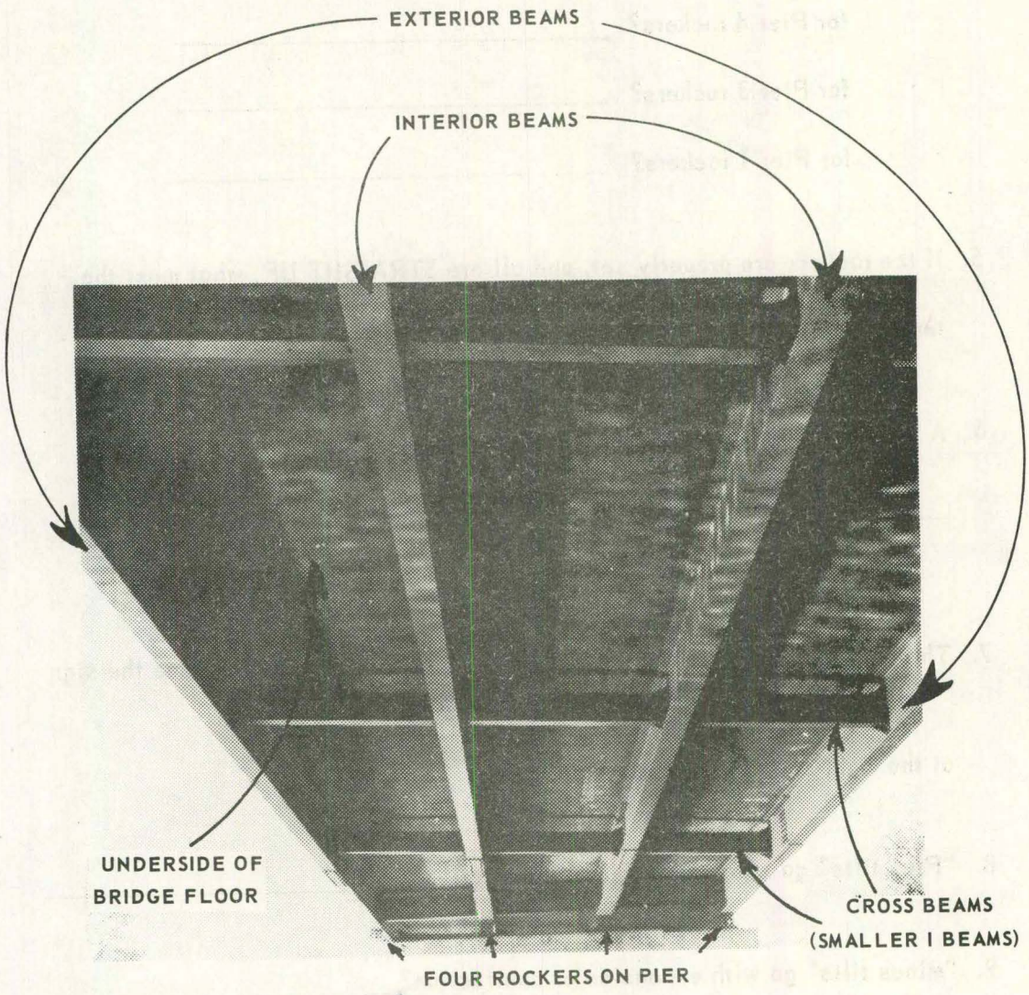
9. "Minus tilts" go with expansion or contraction? _____

10. What should the tilt be for the Pier 1 rocker when the temperature is 30°?

    _____

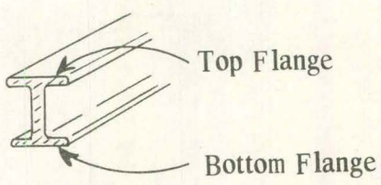
Check and correct very carefully by the ANSWER BOOKLET.

You are ready now to see more of the I Beams which support the bridge floor. The picture below shows the four Continuous I beams along the length of the bridge. See also the smaller cross beams. **Examine this picture and the accompanying information very carefully.** (This picture is taken from *beneath* the bridge.)



The beams are called I beams because they look like an I from the end.

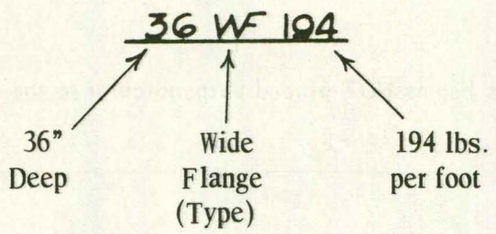
See illustration below.



Turn to Sheet 6 and look at the diagram above the title - STRUCTURAL STEEL LAYOUT.

The four heavy lines going across the sheet represent the I beams which run the length of the bridge. The heavy lines between represent the cross beams. Short lines on both sides of a line, like this, —‡— , represent SPLICE POINTS. A light broken line is drawn through the splice points. The distances between all beams, cross and longitudinal, are given at the sides of the diagram. **Look at these.**

On each beam, the depth, type of flange, and the weight per linear foot is given like this:



See these descriptions as written in the diagram. Notice that the two interior beams are heavier than the two exterior beams. (194 lbs. int.; 160 lbs. ext.)

Notice also that the cross beams are perpendicular to the longitudinal beams, EXCEPT at the piers and abutments. At the piers, the cross beams are heavier and deeper. They follow the skew over the pier.

Read the STRUCTURAL STEEL LAYOUT on Sheet 6 to find the answers to the following questions.

1. What is the distance from one EXTERIOR beam to the other EXTERIOR beam?

   _____

2. What is the nominal depth of each of the four longitudinal beams?

   _____

3. How much do the exterior beams weigh per linear foot?

   _____

4. Are the splice points across the four longitudinal beams on a line perpendicular, or skewed, in relation to the ℄ of roadway?

   _____

5. When are the cross beams NOT placed perpendicular to the longitudinal beams? _____

6. What are two differences between the cross beams placed BETWEEN the piers, and those placed OVER the piers?

   1) _____

   2) _____

7. What is the distance from one exterior beam to the nearest interior beam?

   _____

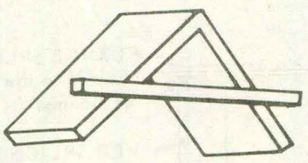
8. What is the distance between the two interior beams?

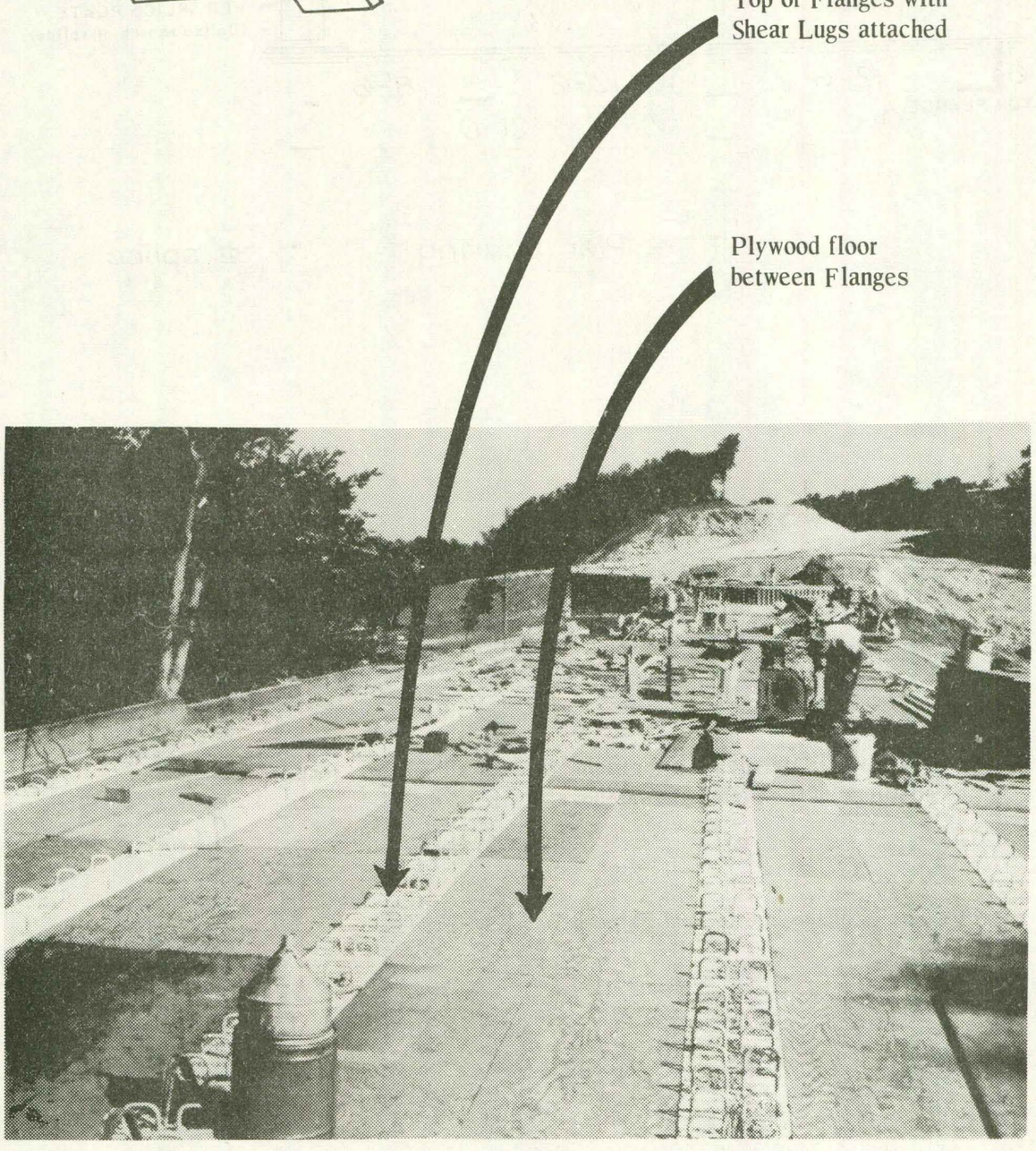
   _____

Check and correct very carefully by the ANSWER BOOKLET.

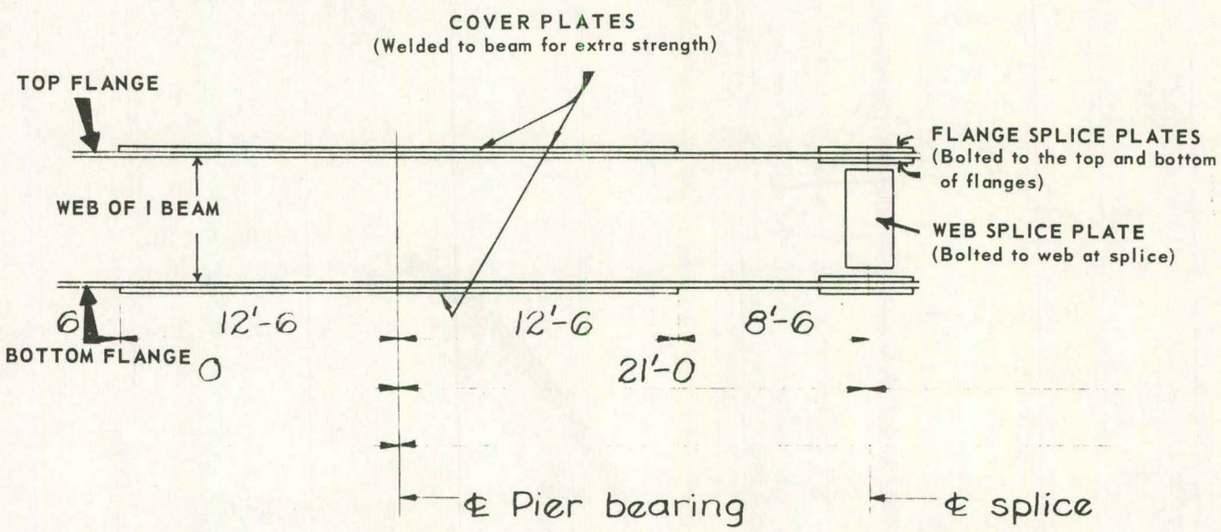
Concrete for the bridge floor is poured directly onto the top of the Longitudinal I Beam Flanges. Plywood forms are put between the flanges to hold the concrete in place, until it hardens. To create a mechanical bond between the flange and the concrete slab, SHEAR LUGS are attached to the top flanges. These "stick up", from the beam, into the concrete. See the SHEAR LUG SPACING diagrams for the interior and exterior beams. The shear lugs to be used on this bridge are shaped with "corners". The picture below shows a *different type* of shear lug. Those are bent into a U shape. **Examine the picture below very carefully.**

The shear lugs shown on Sheet 6, for bridge design 1161, look like the sketch below rather than the inverted U in the picture below. They are placed much the same, however.





Below the plan views showing the Shear Lugs, are side views of the EXTERIOR BEAM and of the INTERIOR BEAM. Various plates are shown to be welded and bolted to the beams. **See them labeled below.**



The COVER plates are all WELDED.

The SPLICE plates (flange and web) are all BOLTED.

See the Cover Plate detail on the right. On your side views, read the dimensions and positions of the plates shown above.

For Details of the Interior and Exterior Beam Splices --

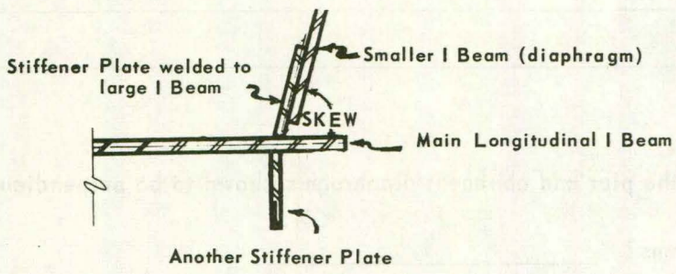
TURN NOW TO SHEET 8

On the side views of the Beam Splice Details, note the spacing of the bolt holes on the Web Splice Plate.

The plan views, just above each side view, show the spacing of the bolt holes through the Flange Splice Plates and Flanges. (These are the same for top and bottom flanges.) **Examine these diagrams carefully.**

On the same sheet, upper right, see the PIER AND ABUTMENT DIAPHRAGM CONNECTION DETAIL. (The diaphragm is the cross beam at the piers and abutments.)

To connect the cross beams (diaphragms) at these points, plates must be welded to the main longitudinal beams. These plates are called stiffeners. The top flanges of the diaphragms are cut to allow a close fit against the stiffeners. The connection is shown and labeled below. **Examine it and be sure you see the same thing on the diagrams.**



Use Sheet 6 and Sheet 8 to find the answers to the following questions.

1. At each splice on the I beams, where are the SPLICE plates placed?

   _____

2. Where are the COVER plates placed?

   _____

3. As stated in the Cover Plate Detail, what should be done to the end of each cover plate? _____

   _____

4. What plate is bolted to the web of the I beam, at the splices?

   _____

5. Which web plates have more bolts, those at the EXTERIOR Beam Splice Points, or those at the INTERIOR Beam Splice Points? _____

6. How are the pier and abutment diaphragms connected to the main I beams?

   _____

   _____

   _____

7. Are the pier and abutment diaphragms shown to be perpendicular to the main I beams? _____

8. Where are the cross beams which are perpendicular to the main I beams?

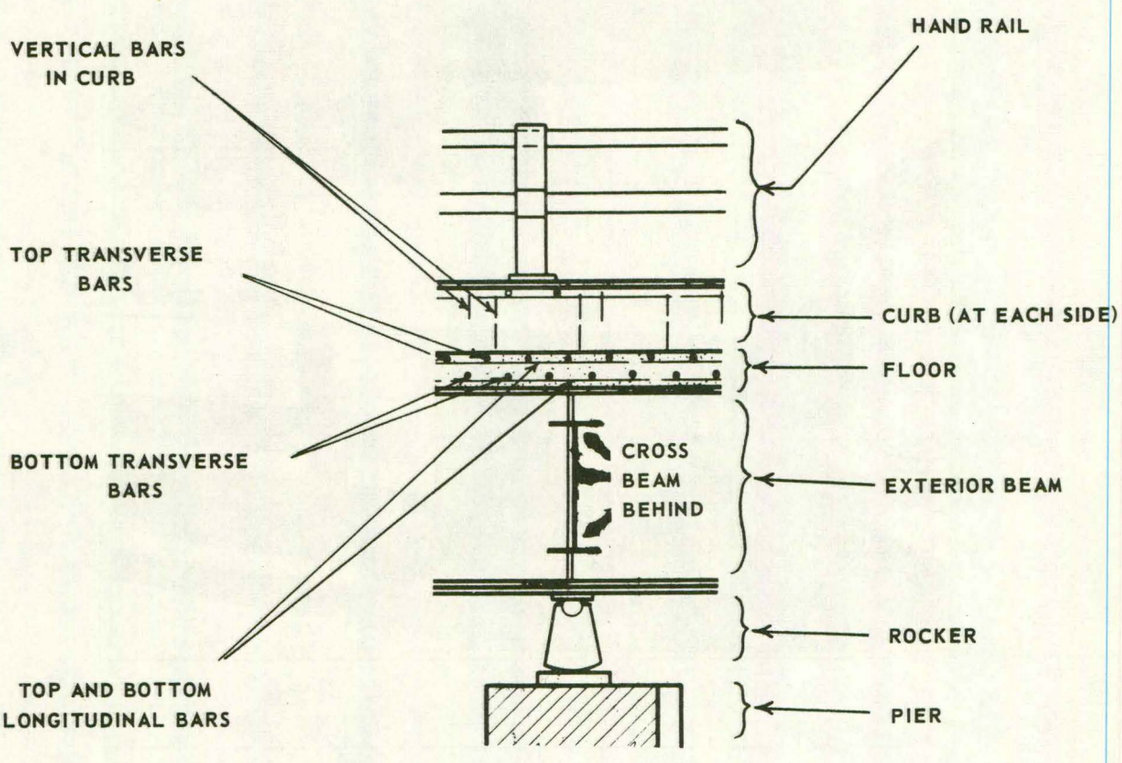
   _____

   (These are also called diaphragms.)

Check and correct very carefully by the ANSWER BOOKLET.

Turn now to Sheet 7. Look again at the Longitudinal Section at Exterior Beam. See the bridge floor, the curb, and guard rail to be placed on top of the curb. See the transverse and longitudinal REINFORCING BARS to be inside the floor and curb.

See these labeled below.

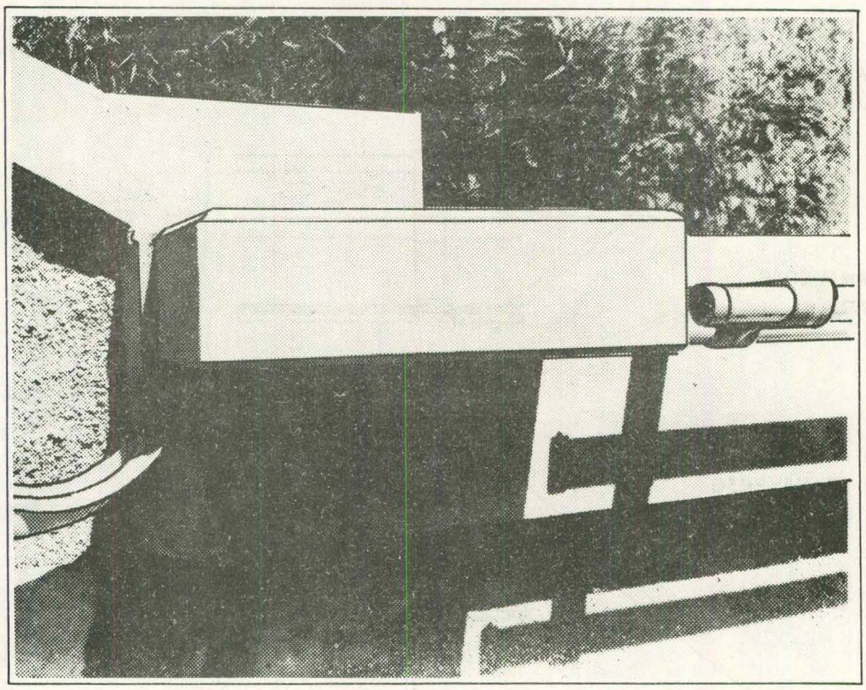


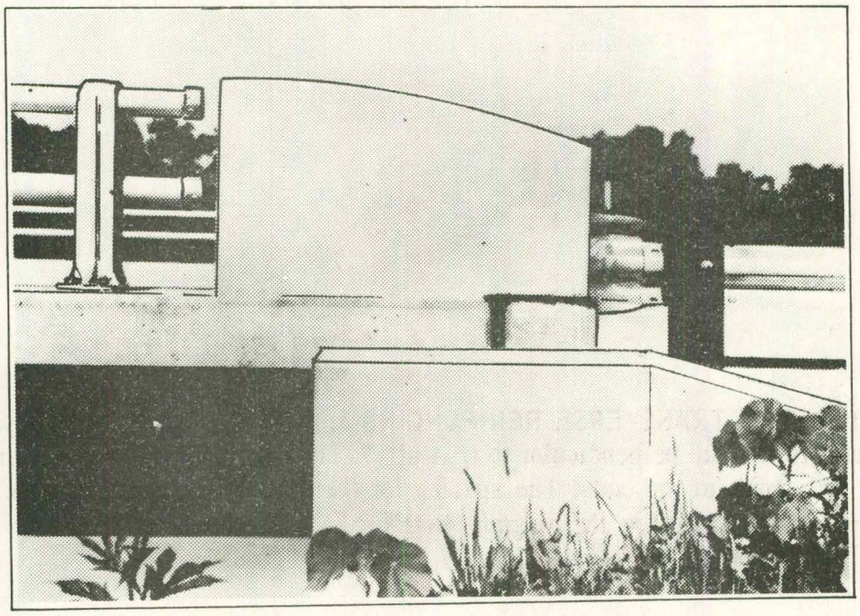
See the SLAB TRANSVERSE REINFORCING LAYOUT. This is a very simple layout. All bars are perpendicular to ℄. Only 7a (1-14) bars are used. The lengths vary, as shown, at the ends. The spacing for the top and bottom transverse bars is given above and below the diagram. Both are to be spaced 7-1/2" apart.

See the Reinforcing Bar List in the top right corner. This is similar to the other Lists of Reinforcing which you have read earlier in this course. You should have no trouble with it.

Look also at the PART PLAN showing the curb reinforcing. Then examine the WINGPOST PLAN and SECTION B-B taken from that plan.

The Wing post pictures below show similar views. Compare them with the diagrams.

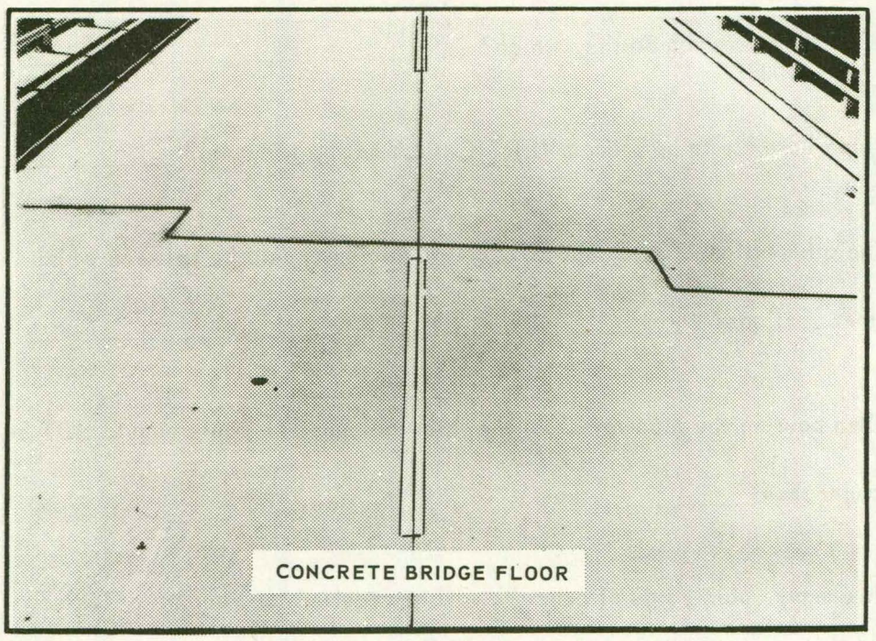




Look next at the CONCRETE PLACEMENT DIAGRAM. See how the slab sections are staggered in the direction of the SKEW. See the bearing ℄'s of piers and abutments, drawn in with a light broken line.

Read the SLAB PLACEMENT NOTES below that diagram.

The picture below shows the end of a section, as it was poured by these plans.



The circled numbers show the sequence in which *the slab sections are to be poured.* As, pour 1, skip over 42 feet and pour 2, etc. **See these numbers.**

THIS SEQUENCE IS IMPORTANT!

Notice, particularly, that the ℄'s of the pier bearings pass under the *middles* of the slab sections poured. The section poured should *never* end at a ℄ of pier bearing.

The following questions are about the concrete floor, curbs, and wing posts. Read Sheet 7 to find the answers.

1. Answer these questions about the LONGITUDINAL BARS to be placed in the slab (bridge floor):

    1) What is the name of the bars? _____

    2) What is the shape? _____

    3) How many are needed? _____

    4) What is the length? _____

    5) How much do they weigh? _____

2. Which bars are to be placed VERTICALLY in the wingpost? _____

3. The 6th section of the roadway concrete poured should be between which two other sections? _____

4. When pouring the roadway slab, the intervals between pours should NOT be longer than _____ hours.

5. How many cubic yards of concrete will be required for Four Wing Posts?

    _____

6. The ends of the slab floor sections are staggered in the direction of what?

    _____

7. In relation to the slab sections, where should the $\mathbb{L}$'s of pier bearings be?

    _____

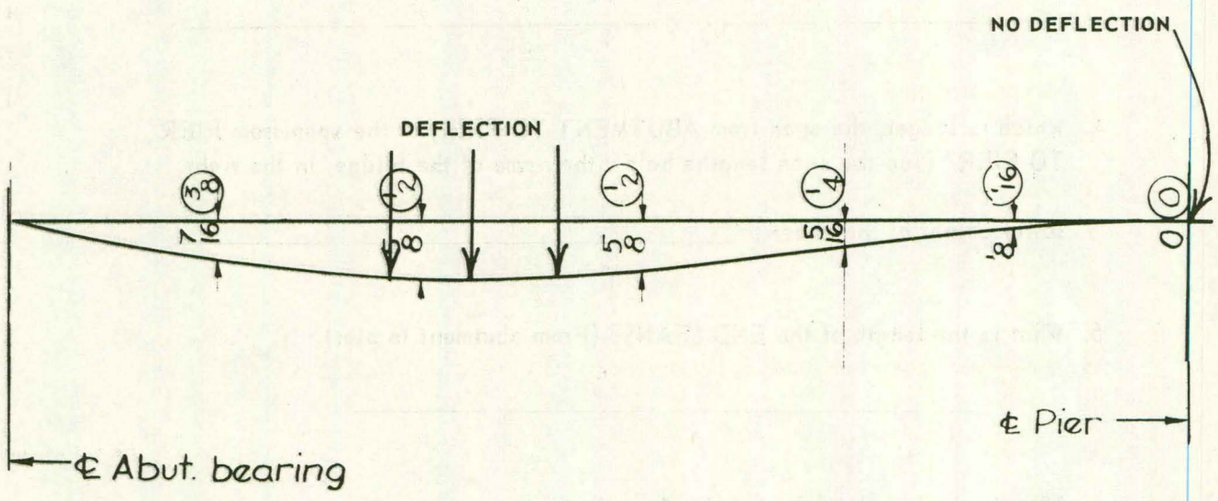
Check and correct very carefully by the ANSWER BOOKLET.

Turn back now to Sheet 6. Look at the diagram above this title:

TOTAL ANTICIPATED

DEAD LOAD DEFLECTION

The bottom line shows the Deflection ("sag") expected from the weight of the concrete and reinforcing steel. The deflection ("sag") is *between* the piers and abutments. See the light vertical lines drawn at the pier and abutment bearing $\mathbb{L}$'s.



To compensate for this anticipated deflection, the concrete forms over the deflection areas must be set at elevations *higher* than those stated for the bridge grade. The *circled numbers show how many inches higher* than the proposed grade, at specific points.

Answer these questions about the

TOTAL ANTICIPATED DEAD LOAD DEFLECTION

1. At what points is there NO deflection? _____

   _____

2. What do the circled numbers show? _____

3. In what general location is the GREATEST deflection? _____

   _____

4. Which is longer, the span from ABUTMENT TO PIER, or the span from PIER TO PIER? (See the span lengths below the name of the bridge, in the right lower corner of the sheet.) _____

5. What is the length of the END SPANS? (From abutment to pier)

   _____

6. What is the length of the Interior Spans? _____

7. How much higher should the forms be above the proposed grade elevation, 10' 6" on either side of Pier 1? _____

Check and correct by the ANSWER BOOKLET.

Turn again to Sheet 9.

This time pay particular attention to the Cross Sections shown at the top of the sheet. See the reinforcing shown in the HALF SECTION NEAR ABUTMENT. Read the reinforcing description given above that section. Note the PARABOLIC CROWN shown on the Half Intermediate Section.

Read the CURB AND DRAIN DETAILS.

These diagrams are similar to those you have read before. You should have no trouble interpreting these. **Examine them carefully.** Take your time. Read all the accompanying notes. The next page will present questions about these Sections and Details.

When you have read Sheet 9 thoroughly, go on to Sheet 10. You should be able to read these diagrams all on your own! Do that before you turn this page. Don't forget the *Notes*. They are a *very important part of every sheet.*

The answers to the following questions are to be found on Sheets 9 and 10.

1. What type of crown will be across the middle 24' of bridge?

   _____

2. What type of cross slope extends from the end of the parabolic to the edge of the slab (below the curb)? _____

3. The surface between curb and slab should be R _____ .
   (Fill-in)

4. As shown on the HALF SECTION NEAR ABUTMENT, what is the proper SPACING for the Longitudinal 6b bars? _____

5. What is the depth of the depression in front of the drain, at the edge of curb?

   _____

6. What sheet are you directed to see for drain spacing? _____

Go on to the next page

7. What is the distance across the curb? _____

8. What type of GROOVE should be on the underside of the curb, 3" from the edge? _____

9. What are the two major component parts of the Bridge Railing?

   1) _____

   2) _____

10. The post spacing is not to exceed what distance? _____

11. To allow for expansion, an open joint is left at points along the tubing. What is to be placed INSIDE that tubing, on both sides of the opening?

    _____

12. What shall the Specifications for Construction of the rail be?

    _____

    _____

    _____

    _____

Check and correct by the ANSWER BOOKLET.

CONGRATULATIONS

You have just completed your course in BRIDGE AND CULVERT PLAN READING. Using what you have learned, you should be able to interpret and apply the greater part of those Bridge and Culvert Plans which you will encounter on your job.