BRIDGE REPLACEMENT: ALTERNATE DESIGN

DHT-27

DEPARTMENTAL RESEARCH

STATE DEPARTMENT OF HIGHWAYS
AND
PUBLIC TRANSPORTATION

RESEARCH SECTION, FILE D10-R, P.O. BOX 5051 AUSTIN, TX 78763-5051, 512-465-7403, TexAn 241-7403

TEXAS DEPARTMENT OF TRANSPORTATION

BRIDGE REPLACEMENT: ALTERNATE DESIGN

by
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District 8

TECHNICAL REPORT STANDARD TITLE PAGE

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BRIDGE REPLACEMENT - ALTERNATE DESIGN	
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15. Supplementary Notes

16. Abstract

A money and time saving innovative design was used to convert two old slab bridges into multipipe culverts on an FM 18 widening project in District 8 (Abilene). Hydraulic analysis indicated that the existing structures had been overdesigned and that conversion to culverts would still meet design specifications for a hundred-year flood. Increased bearing and higher load capacity yielded by the design could easily handle the predicted future AADT.

The converson was made by placing pipes under the bridge. The pipes were the length the proposed widening was to be. Special head and wingwall forms were designed and constructed to enclose the exposed pipe ends. Flowable fill, a freely flowing grout mix containing fly ash, was used to fill up the spaces between the existing bridge and the inserted pipes.

This design enabled the district to stay within program funds, carry existing traffic on the roadway without a detour, and produce a sound hydraulically effective structure.

17. Key Words	18. Distribution Statement
Bridge, Culvert, Replacement, Rehabilitation Flowable Fill, Fly Ash, Widening, District 8, DHT-27, TXDOT, Flowable, Grout.	

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

Form DOT F 1700.7 (8-69)

PROBLEM STATEMENT

FM 18 was programmed to be reconstructed from SH 36 in Taylor County to FM 604 in Callahan County, control section 6-10-4, etc. The program estimate was based on widening two bridges that were in place on this project.

In the plan development stage, it was learned that the existing structures were not adequate to be widened. The Bridge Division advised our designers to remove and replace these structures instead of widening them.

To carry traffic on this new design would entail the building of detours at both locations. Because there is a railroad adjacent to our right-of-way on the north, the traffic could not be split in these areas so a two-way detour would have to be constructed on the south side of the right-of-way. To do this, additional right-of-way would have to be purchased or a temporary easement secured. It appeared that the temporary easement would be our only choice.

Estimates were prepared for this approach to the problem. The remove and replace items would exceed our program funds so we had to come up with another solution, request more funds, finance from other programs or not do the project at all. The last three options were not appropriate for our needs. We elected to come up with a new solution.

PURPOSE

The purpose of this experiment was to develop a design that would enable us to (a) stay within program funds, (b) carry existing traffic on the roadway without a detour, (c) produce a structurally sound structure, and (d) design a hydraulically effective structure.

FIGURE 1: Existing Structure.

DESIGN CONCEPT

The first approach that was considered was to use large pipes in lieu of a bridge-type structure. A pipe installation would work economically and hydraulically but there would still be a large expense in building the detours and removing the old structure.

It occurred to us that there could be a way to insert large pipes through the existing 10-foot spans and still have enough hydraulic capacity to carry the design water flow. If this worked out, there would still have to be a method or design to fill the void between the pipe insert and the existing bridge wall.

The original plan was to design a grout mix that would flow freely and fill the voids between the two structures. This idea was based on a grout mixture that had been used occasionally to fill voids under riprap and approach slabs. This idea led to the concept of a flowable fill.

The pipe inserts were longer than the existing bridges because our intent was to widen the existing facility. Because of these longer inserts and a need for each end to be closed, we designed special headwalls and wingwalls. These designs were exactly like any other headwall and wingwall design for metal pipe, except they were for 8-foot diameter pipes and arch design 15-foot pipes.

All other features of the design were standard and usual. Consideration was given to the type bedding for the proposed pipe. We opted to simply grade the flow line in the same manner as any other pipe installation.

This completed our design concept, and it was submitted to D-5 and was approved.

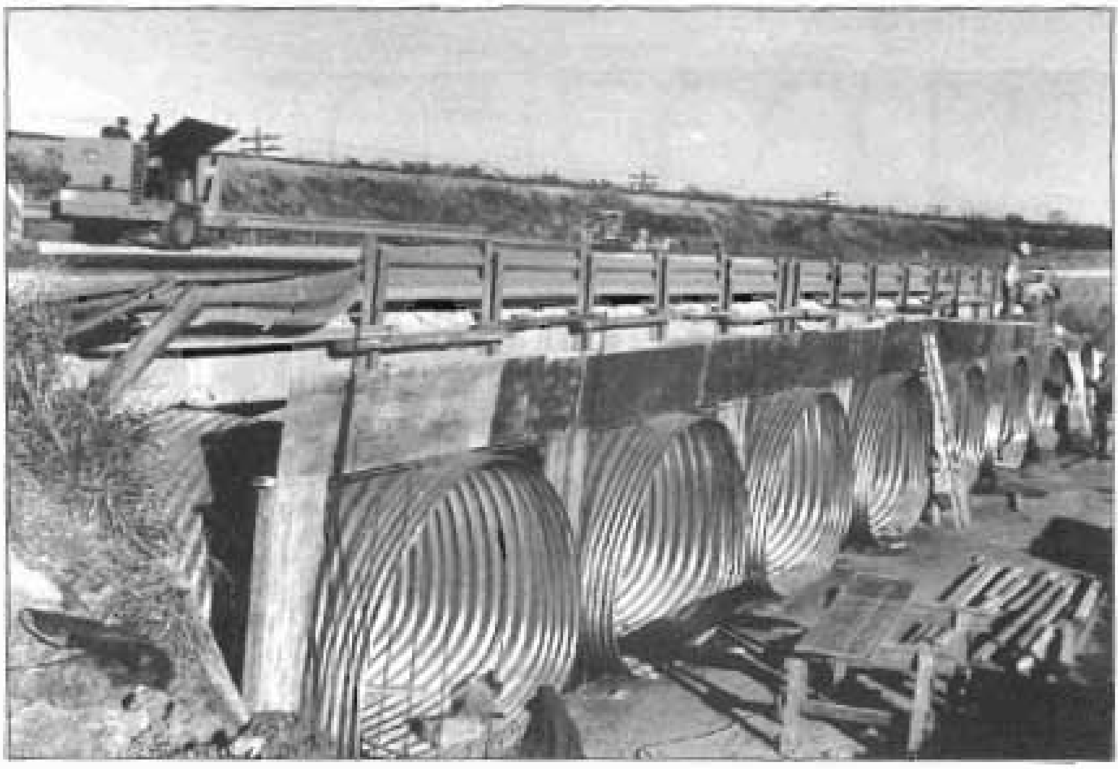
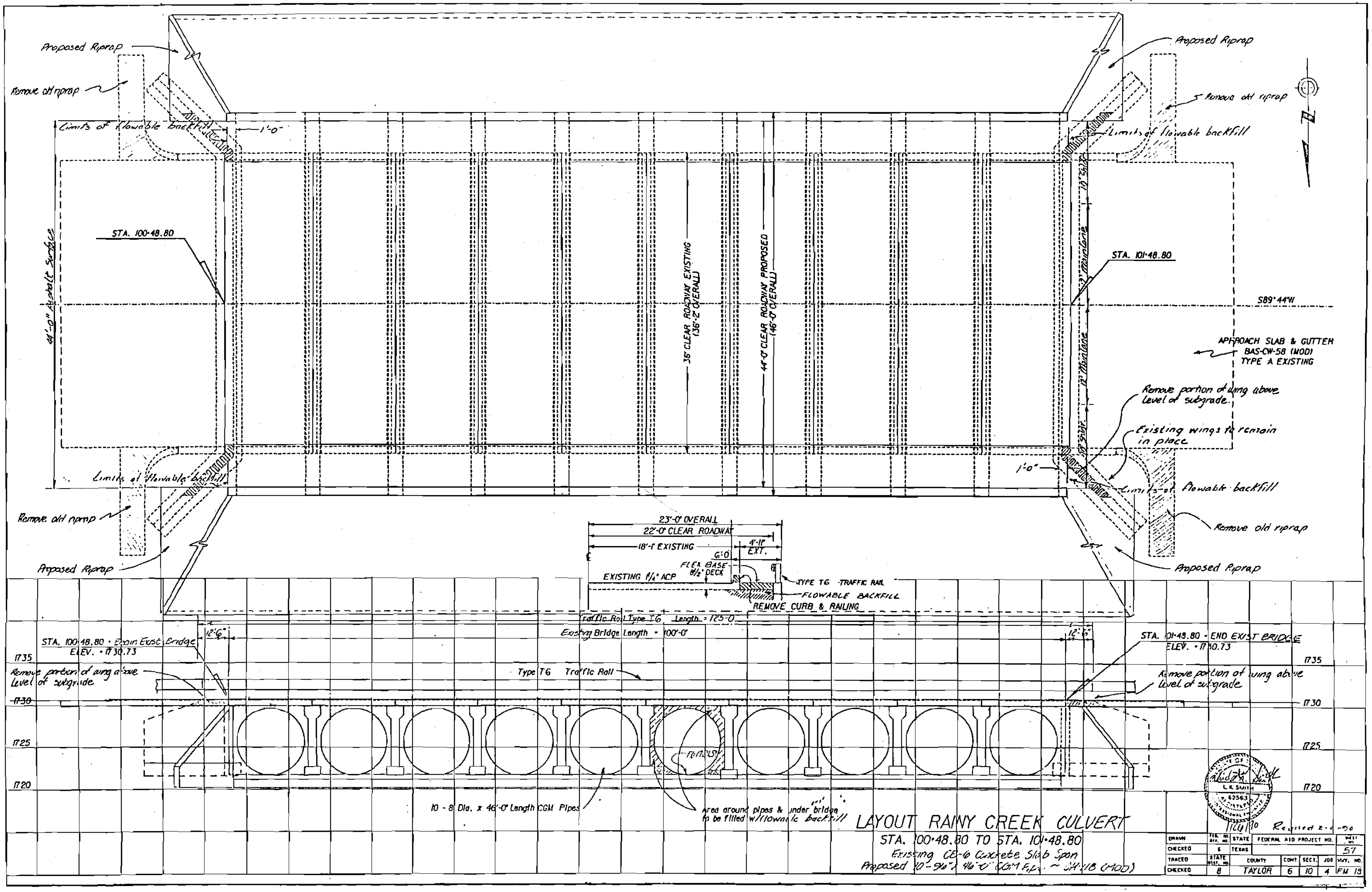
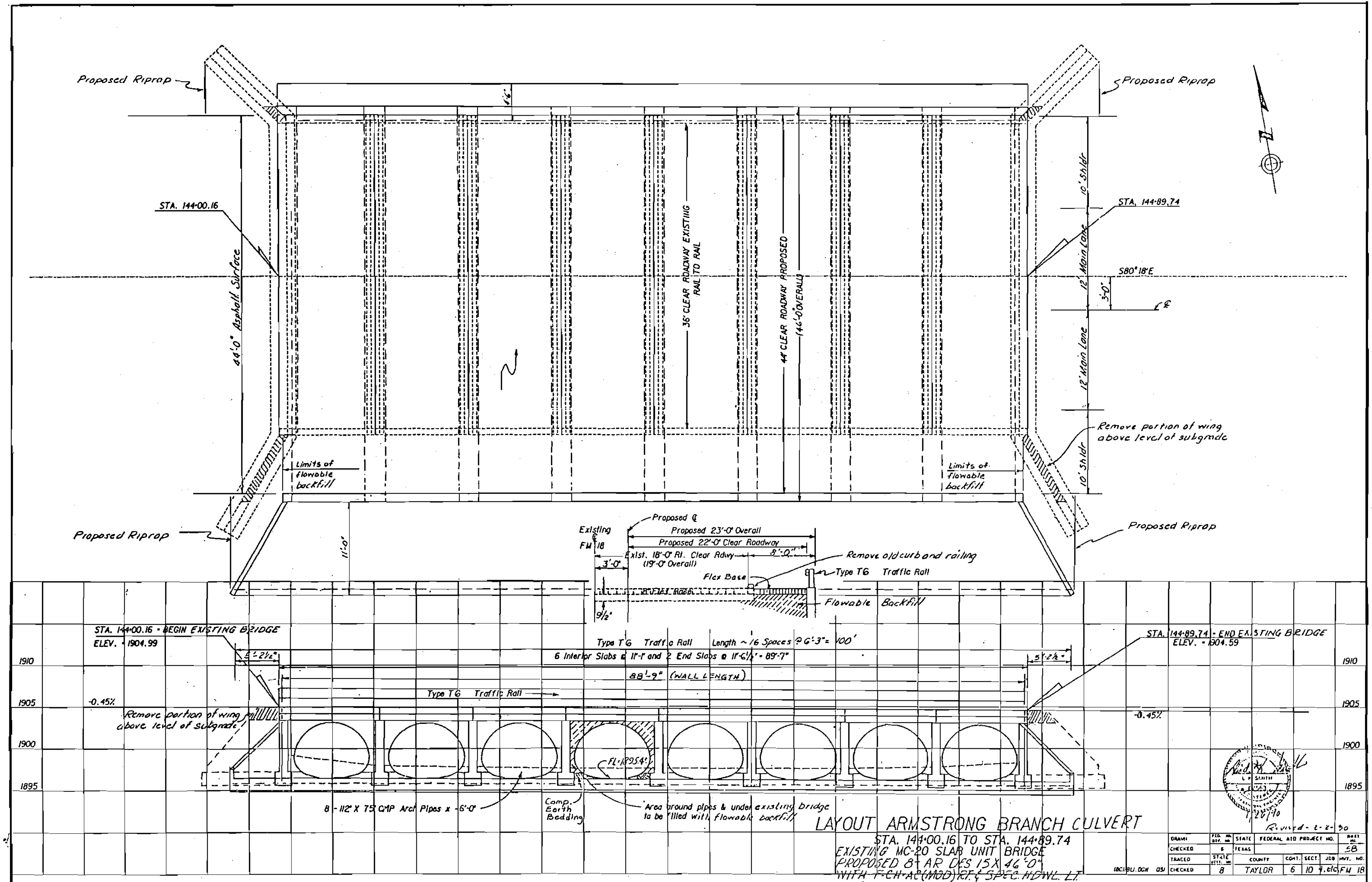


FIGURE 2: Arched Pipes being Installed.


Proposed Riprap
Remove old riprap
Limits of flowable backfill
1'-0"
44'-0" Asphalt Surface
STA. 100+48.80
36' CLEAR ROADWAY EXISTING (36'-2" OVERALL)
44'-0" CLEAR ROADWAY PROPOSED (46'-0" OVERALL)
STA. 101+48.80
S89°44'W
APPROACH SLAB & GUTTER BAS-CW-58 (MOD) TYPE A EXISTING
Remove portion of wing above Level of subgrade.
Existing wings to remain in place
23'-0" OVERALL
22'-0" CLEAR ROADWAY
18'-1" EXISTING
4'-11" EXT.
6'-0
FLEX BASE
8½" DECK
EXISTING 1¼" ACP
TYPE T6 TRAFFIC RAIL
FLOWABLE BACKFILL
REMOVE CURB & RAILING
Traffic Rail Type T6 Length = 125'-0
Existing Bridge Length = 100'-0"
12'-6"
STA. 100+48.80 = Begin Exist Bridge
ELEV. = 1730.73
STA. 101+48.80 = END EXIST BRIDGE
ELEV. = 1730.73
Remove portion of wing above Level of subgrade
Type T6 Traffic Rail
1735
1730
1725
1720
10 - 8' Dia. x 46'-0" Length CGM Pipes
Area around pipes & under bridge to be filled w/flowable backfill
LAYOUT RAINY CREEK CULVERT
STA. 100+48.80 TO STA. 101+48.80
Existing CE-6 Concrete Slab Span
Proposed 10-96" x 46'-0" CGM Pipes ~ SH-118 (MOD)
L.R. SMITH
62563
Revised 2-4-90
DRAWN
CHECKED
TRACED
CHECKED
FED. RD. DIV. NO.
6
STATE
TEXAS
FEDERAL AID PROJECT NO.
SHEET NO.
57
STATE DIST. NO.
8
COUNTY
TAYLOR
CONT.
6
SECT.
10
JOB
4
HWY. NO.
FM 19

3



Proposed Riprap
Proposed Riprap
STA. 144+00.16
STA. 144+89.74
44'-0" Asphalt Surface
36' CLEAR ROADWAY EXISTING RAIL TO RAIL
44' CLEAR ROADWAY PROPOSED (46'-0" OVERALL)
10' Shldr
12' Main Lane
S80° 18' E
3'-0"
12' Main Lane
Remove portion of wing above level of subgrade
10' Shldr
Limits of flowable backfill
Limits of flowable backfill
Proposed Riprap
Proposed Riprap
11'-0"
Existing FM 18
Proposed ℄
Proposed 23'-0" Overall
Proposed 22'-0" Clear Roadway
Exist. 18'-0" Rl. Clear Rdwy
(19'-0" Overall)
8'-0"
3'-0"
Remove old curb and railing
Flex Base
Type T6 Traffic Rail
Flowable Backfill
9½"
STA. 144+00.16 - BEGIN EXISTING BRIDGE
ELEV. = 1904.99
STA. 144+89.74 - END EXISTING BRIDGE
ELEV. = 1904.59
Type T6 Traffic Rail Length ~ 16 Spaces @ 6'-3" = 100'
6 Interior Slabs @ 11'-1" and 2 End Slabs @ 11'-6½" = 89'-7"
5'-2½"
5'-2½"
88'-9" (WALL LENGTH)
Type T6 Traffic Rail
-0.45%
-0.45%
Remove portion of wing above level of subgrade
FL = 1895.4'
8 - 112" X 75" CMP Arch Pipes x 46'-0"
Comp. Earth Bedding
Area around pipes & under existing bridge to be filled with flowable backfill
1910
1905
1900
1895
LAYOUT ARMSTRONG BRANCH CULVERT
STA. 144+00.16 TO STA. 144+89.74
EXISTING MC-20 SLAB UNIT BRIDGE
PROPOSED 8 - AR DES 15 X 46'-0"
WITH T-CH-AC(MOD) RT. & SPEC. HDWL. LT.
Revised - 2-2-90
1/26/90
18CI/BU.DGN
DRAWN
CHECKED
TRACED
CHECKED
FED. RD. DIV. NO. 6
STATE TEXAS
FEDERAL AID PROJECT NO.
SHEET NO. 58
STATE DIST. NO. 8
COUNTY TAYLOR
CONT. 6
SECT. 10
JOB 4, etc.
HWY. NO. FM 18

HYDRAULIC CONSIDERATIONS

A hydraulic analysis was made of the existing structures. There were two possible conclusions: either the drainage areas had changed over the years; or the original structures had been overdesigned. Whichever was the case, it does not matter because the overdesign of the existing structure gave us the latitude of reducing the area of opening. Had the existing structures been underdesigned, this design would probably have had to have been cancelled. Hydraulic analysis (next page) indicated that these two structures would meet design specifications for a hundred-year flood. Since this is a Farm-to-Market Highway, our design was more than ample.

FIGURE 3: Eight-foot Diameter Pipe.

CALCULATIONS BY THYSYS

RAINY CREEK (D.A. = 17.7 SQ. MI.) (S = 10.6 '/MI.)

ANALYZE SINGLE OPENING CULVERT
CULVERT ID = 401
FLOW = [illegible] CFS FREQUENCY = 25 YEAR
TAILWATER = [illegible]

BBLS	SPAN	WIDE	HIGH	LENGTH	H.W. ELEV.	CALC. H.W.	VELOC.	TOTAL COST(K)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

INLET STATION = [illegible] ELEVATION = [illegible]
OUTLET STATION = [illegible] ELEVATION = [illegible]

SLOPE	PROFILE	SHAPE	INLET TYPE	KE	MATERIAL	"N"
[illegible]	STRAIGHT	[illegible]	NORMAL	[illegible]	[illegible]	[illegible]

HUNDRED YEAR FLOOD ANALYSIS

CULVERT 401 [illegible]
BASIC FLOOD APPLIED (100 YEAR FREQ) = [illegible] CFS
HUNDRED YEAR VELOCITY AT STRUCTURE OUTLET = [illegible]
HUNDRED YEAR TAILWATER ELEVATION = [illegible]
ELEVATION OF WATER SURFACE OVER ROAD = [illegible]
LOW ELEVATION OF ROAD PROFILE = [illegible]
GREATEST DEPTH OF FLOW OVER ROAD = [illegible]
PERCENTAGE OF BASIC FLOOD OVER ROAD = [illegible]

ARMSTRONG BRANCH (D.A. = 4 SQ. MI.) (S = 10.6'/MI.)

ANALYZE SINGLE OPENING CULVERT
CULVERT ID = 401
FLOW = [illegible] CFS FREQUENCY = 25 YEAR
TAILWATER = [illegible]

BBLS	SPAN	WIDE	HIGH	LENGTH	H.W. ELEV.	CALC. H.W.	VELOC.	TOTAL COST(K)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

INLET STATION = [illegible] ELEVATION = [illegible]
OUTLET STATION = [illegible] ELEVATION = [illegible]

SLOPE	PROFILE	SHAPE	INLET TYPE	KE	MATERIAL	"N"
[illegible]	STRAIGHT	[illegible]	NORMAL	[illegible]	[illegible]	[illegible]

HUNDRED YEAR FLOOD ANALYSIS

CULVERT 401 [illegible]
BASIC FLOOD APPLIED (100 YEAR FREQ) = [illegible] CFS
HUNDRED YEAR VELOCITY AT STRUCTURE OUTLET = [illegible]
HUNDRED YEAR TAILWATER ELEVATION = [illegible]
HEADWATER ELEVATION ON STRUCTURE = [illegible]
LOW ELEVATION OF ROAD PROFILE = [illegible]
GREATEST DEPTH OF FLOW OVER ROAD = NONE
PERCENTAGE OF BASIC FLOOD OVER ROAD = [illegible]

HYDRAULIC DATA

6	[illegible]	
TEXAS	[illegible]	

FM 18 Taylor and Nolan Counties, etc.
CRP 90(82)S
6-10-4, etc.

ACTUAL COST

		Quantity	Price ($)	Total ($)
Rainey Creek Sta. 100+98.8 Taylor County				
0421001037	C1 A Conc (Culv)	101.12 CY	400.00 CY	$40,448.00
0432008	Riprap	8.55 CY	195.00 CY	$1,667.25
0460090005	CMP (Gal Stl 96 In)	460.00 LF	90.00 LF	$41,400.00
8027001	Flowable Backfill	453.47 CY	10.00 CY*	$4,534.70
	Total			$88,049.95
Armstrong Creek Sta. 144+44.95 Callahan County				
0421001037	C1 A Conc (Culv)	67.04 CY	400.00 CY	$28,816.00
0432008	Riprap	3.13 CY	195.00 CY	$610.35
0460082005	CMP Ar (Gal Stl Des 15)	368.00 LF	100.00 LF	$36,800.00
8027001	Flowable Backfill	264.00 CY	10.00 CY*	$2,640.00
	Total			$66,866.35
*717.47 CY @ $45.00 CY additional to compensate for unbalanced bid.				$32,286.15
Total Actual Cost for Two Bridges				$187,202.45

BENEFITS

Actual cost of this installation and estimated cost for removing and replacing the two bridges are enclosed.

Note that our final cost reduction is fifty-one percent less than the standard design. This is a substantial savings that should not be overlooked, especially in terms of the tremendous savings that it could mean statewide on the "on- and off-system" designs.

There are other savings that cannot be defined in terms of dollar values, for instance the safety factor. All detours are hazardous to some extent. Anytime traffic is moved from its original path, there is a potential problem, especially in bad weather. The ability to move traffic through a project swiftly is always an asset.

The added strength of this type design is of some value. Consider the fact that the original structure was carrying the load without difficulty and the CGM pipe inserts are designed to carry the load also. Closing the void between these two structures will double the load carrying capacity.

FM 18 Taylor and Nolan Counties, etc.
CRP 90(82)S
6-10-4, etc.

ESTIMATED COST
REMOVE EXISTING STRUCTURE AND REPLACE
WITH COMPARABLE NEW STRUCTURE

Str #56	Existing 10-10' slab spans.	Proposed 10-10'X10' MBC
Str #39	Existing 8-10' slab spans.	Proposed 8-10'X10' MBC

		Quantity	Price ($)	Total ($)
Item 421	C1 A Conc	693 CY	400.00 CY	277,200.00
Item 508	Construction Detours	2 CY	2,800.00 EA	56,000.00
Item 496	Remove Old Structure	2 CY	1,500.00 EA	30,000.00
Item 502	Barricade Sign & Traffic	3 MO	6,000.00 MO	18,000.00
	Total Actual Cost for Two Bridges			381,200.00

CRITICAL CONSTRUCTION FACTORS

FLOWABLE FILL – The use of fly ash in this mixture is extremely important. This material is very unusual in that it takes a lot of water for it to flow. Notice in the design specifications that it calls for 55 gallons for a cubic yard. If you exclude fly ash from the design, this material will separate and the aggregate will fall out and the water and cement will flow. Fine "blow sand" will not work, even with fly ash, because the sand will not remain in suspension.

The aggregate does not have to be clean and in most cases a waste gravel sand will perform extremely well.

The best test for segregation that was discovered was to mix a three or four-gallon batch and pour it from one container to another, letting it fall three or four feet. If the aggregate stays in suspension, the mix will probably flow very well; however, if the liquid remains on the top and all aggregate particles sink to the bottom, then a change should be made.

Flowable fill has very little flexible strength, but it is dense and void free.

HOLDING PIPE IN PLACE – The contractor on this project leveled the flow line to grade and poured a narrow concrete pad for the pipe to rest on. It was concave to fit the pipe exactly so that it would not roll from the designed position. The concrete pad was nonreinforced and only served to hold the pipe in place.

He also used concrete blocks between the existing structure and the pipe to keep the pipe from "floating" when the flowable fill is placed. If this is not done, the pipe will move around, even though both ends are poured in the concrete headwalls.

On large pipes, it is advisable to place the flowable fill at intervals. It is not advisable to pour all the fill at one time. This large pipe was poured over a period of several days.

PLACEMENT HOLES – Since it is almost forty-five feet across this structure, the contractor cut holes in the concrete deck to funnel the flowable fill into the box from the center of the structure. This shortened the flow distance as well as ensured that the center part of the structure was completely filled.

A hole is cut through the deck and a funnel placed in the hole so that the material will flow directly from the truck into the void area.

CURING TIME – Very little free water rises to the top but small (1-inch) weep holes should be drilled in end forms for water to go through. They have to be plugged as the fill rises to keep from losing the flowable fill.

If equipment is going to place base material or other materials over the top of the fill, there should be three or four days of curing time. When the material drys, it will not tear out very easily, but when it is wet, it has very little strength and will crumble easily.

Visual inspection should be used to determine when the material is set enough to handle backfilling operations.

FIGURE 4: Flowable Fill Placement

CONCLUSION

The conversion procedure of the bridge to a culvert proved to be relatively simple, and everything worked as planned. The structures have a pleasing appearance and are functioning very well. There is no evidence that the existing structures are still there, and to the casual observer, this is a simple multiple pipe installation.

Metal pipe is manufactured in many sizes and the pipe companies are very anxious to custom fit any design. If the design warrants, the pipe sleeves can be used in many places, regardless of the size.

Flowable fill has proven to be a very useful tool in this design and has many other applications. It has been used as backfill material in open trenches, to fill voids under riprap, to fill erosion under approach slabs and bridge abutments, and many other places.

This application may play a very important role in our Off-System Bridge Replacement Program. Many counties have a hard time paying their twenty percent of the bridge cost under our standard design system. This design may relieve that burden or may permit more replacements in each county.

FIGURE 5: Flowable Fill Placement

FIGURE 6: Placement holes.

SPECIAL SPECIFICATION
ITEM 8027
FLOWABLE BACKFILL

8027.1. DESCRIPTION. This Item shall govern for the backfilling of structures and pipe on this project. It may be used as backfill between pipe inserts and existing concrete walls, as backfill of new culverts in lieu of soil backfill, as fill in abandoned structures, and other uses as approved by the engineer.

The flowable backfill shall be composed of Portland cement, fly ash, fine aggregate, water, and a shrinkage compensator, proportioned as hereinafter provided or an acceptable mix as approved by the engineer.

8027.2. MATERIALS.

(1) Cement. The cement shall be either Type I or II Portland cement conforming to the Item, "Hydraulic Cement".

(2) F1Y Ash. Fly ash shall conform to the Department Materials Specification D-9-8900, "Fly Ash". Copies of Departmental Materials Specifications are available from the State Department of Highways and Public Transportation, Materials and Tests Division, West 38th and Jackson Street, Austin, Texas 78701-2483.

Type B fly ash shall not be used when Type II cement is used.

(3) Fine Aggregate. Fine aggregate shall consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. It shall be free from frozen materials or injurious amounts of salt, alkali, vegetable matter of other objectionable material. When subjected to the color test for organic impurities (Test Method TEX-408-A), it shall not show a color darker than standard.

It is intended the fine aggregate to be fine enough to stay in suspension in the mortar to the extent required for proper flow. When tested by Test Method TEX-200-F, the fine aggregate shall conform to the following grading:

Sieve Size	Percent Passing
3/4 inch	100
No. 200	0-10

The engineer reserves the right to reject the sand if a flowable mixture cannot be produced.

(4) Mixing Water. Water used shall be free from oils, acids, organic matter of other deleterious substances and shall not contain more than 1000 parts per million of chlorides ad Cl nor more than 1000 parts per million of sulfates as 504.

Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources must be approved by the engineer prior to use.

8027.3. MIX DESIGN. The following is given as a typical mix design for trial mixes. Adjustments of the proportions of fine aggregate and/or water may be made to achieve proper solid suspension and optimum flowability with the approval of the engineer. The mix design shall contain a shrinkage compensator as approved by the engineer.

Cement	100 lbs.
Fly Ash	250 lbs.
Fine Aggregate	2,990 lbs.
Water (approx.)	55 gal.

In addition, the mix design shall contain a shrinkage compensator in proportions as recommended by the manufacturer.

8027.4. CONSISTENCY. Consistency shall be tested by filling an open ended three-inch diameter cylinder six inches high to the top with flowable fill. The cylinder shall be immediately pulled straight up and the correct consistency of the flowable fill shall produce a minimum eight inch diameter circular-type spread with no segregation.

8027.5. CONSTRUCTION METHODS. As detailed in the plans, the general procedure will be to plug open ends as shown in plan details. The contractor will be required to submit a plan for approval of the engineer. He must provide a means of filling the entire void area and be able to demonstrate that this has been accomplished. This must be done without the use of a vibrator. Any inspection holes will be patched after completion and treated accordingly. Care will be taken to prevent the movement of the insert structure from its designed location. If voids are found in the fill or if any of the requirements are not met as shown on the plans, it will be the contractors responsibility to remove and replace or correct the problem without additional cost to the state.

8027.6. <u>MEASUREMENT</u>. Flowable backfill will be measured by the cubic yard based on plan quantities, adequate calculations have been made in accordance with Article 9.1. If no adjustment is required under "Payment" described below, additional measurements or calculations will not be required.

8027.7. <u>PAYMENT</u>. Flowable backfill quantity, measured as provided above, will be paid for at the unit price bid per cubic yard, which shall be full compensation for furnishing, hauling, and placing all materials and for all tools, labor, equipment, and incidentals necessary to complete the work. The quantity to be paid for will be that quantity shown on the contract plans and in the proposal, regardless of errors in calculations, except as may be modified by the following:

Plan quantities will be adjusted:

1. When a complete structure element has been erroneously included or omitted from the plans, the quantity shown on the plans for that element will be added to or deducted from the plan quantity and included for payment. A complete structure element will be the smallest portion of a total structure for which a quantity is included on the plans.
2. When the plan quantity for a complete structure element is in error by 5 percent or more, a recalculation will be made and the corrected quantity included for payment.
3. When quantities are revised by a change in design the plan quantity will be increased or decreased by the amount involved in the design change.

FIGURE 7: Forms at Side of New Headwalls

The party to the contract requesting the adjustment shall present to the other, three copies of the description and location, together with calculations of the quantity for the structure element involved. When this quantity is certified correct by the engineer, it will become the revised plan quantity.

GENERAL NOTES AND SPECIFICATION DATA
–ITEMS 1128-1129–, CONT'D
PERTAINING TO THE ITEMS "EXCAVATION" AND "EMBANKMENT".
–ITEM 1129–
THE TOLERANCES AS OUTLINED UNDER ARTICLE 1129.3, SECTION 5 FOR DENSITY 7 TEST WILL BE ALLOWED.
EXISTING PAVEMENT SHALL BE INCORPORATED INTO THE EMBANKMENT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
–ITEM 6350–
TEMPORARY FLEXIBLE REFLECTIVE ROADWAY MARKER TABS (TF-RRMT) SHALL BE APPLIED IN A MANNER THAT WILL ALLOW EASY AND COMPLETE REMOVAL LEAVING NO CONFLICTING MARKS TO THE SATISFACTION OF THE ENGINEER.
THE CONTRACTOR SHALL MAINTAIN THE TF-RRMT AS LONG AS THEY ARE REQUIRED FOR TRAFFIC OPERATIONS THROUGH THE CONSTRUCTION AREA.
TF-RRMT WHICH, IN THE OPINION OF THE ENGINEER, FAIL TO MEET THE REQUIREMENTS OF THIS SPECIFICATION SHALL BE REPLACED AS DIRECTED BY THE ENGINEER AT THE SOLE EXPENSE OF THE CONTRACTOR.
–ITEM 6570–
REFER TO "STANDARD HIGHWAY SIGN DESIGNS FOR TEXAS" FOR DIMENSIONS FOR ANY SIGNS NOT DESCRIBED IN THE PLANS AND SPECIFICATIONS.
–ITEM 8027–
THE FLOWABLE BACKFILL WILL BE PLACED IN A MINIMUM OF TWO LIFTS.
BEFORE PLACEMENT OF THE FLOWABLE BACKFILL, THE CONTRACTOR SHALL PLACE BLOCKING TO MAINTAIN THE GRADE AND LINE OF THE CORRUGATED METAL PIPE. THE METHOD OF BLOCKING SHALL BE IN A MANNER ACCEPTABLE TO THE ENGINEER.
THE CONTRACTOR SHALL PROVIDE ACCEPTABLE OPENINGS IN THE DECK OF THE EXISTING STRUCTURE TO PLACE THE FLOWABLE BACKFILL. SUFFICIENT NUMBER OF FLAGMEN AND TRAFFIC CONTROL DEVICES WILL BE PROVIDED TO HANDLE TRAFFIC THROUGH THE WORK AREA.
THE CONTRACTOR SHALL ASSURE WATERTIGHT JOINTS ON THE CORRUGATED METAL PIPE PRIOR TO PLACEMENT OF THE FLOWABLE BACKFILL.

SPECIFICATION DATA
Sheet G ≈

DISTRICT CONTACT PERSONNEL

General Information	B. R. Lindley, P. E. Assistant District Engineer	(915) 676-6803
	Blair Haynie, P. E. Resident Engineer	(915) 676-6930
	Roy Roberson, P.E. Construction Engineer	(915) 676-6895
	Glen Bohannan, Construction Manager	(915) 676-6890
Flowable Fill	B. R. Lindley, P.E. Assistant District Engineer	(915) 676-6803
	Bob Satterwhite, District Laboratory	(915) 676-6892
	Buck Whitehead, District Laboratory	(915) 676-6894

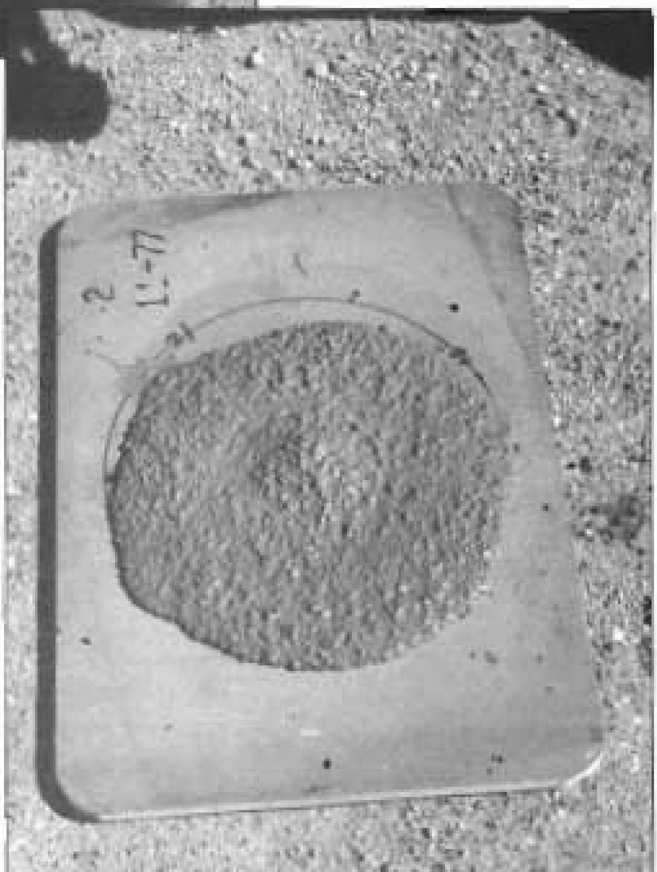
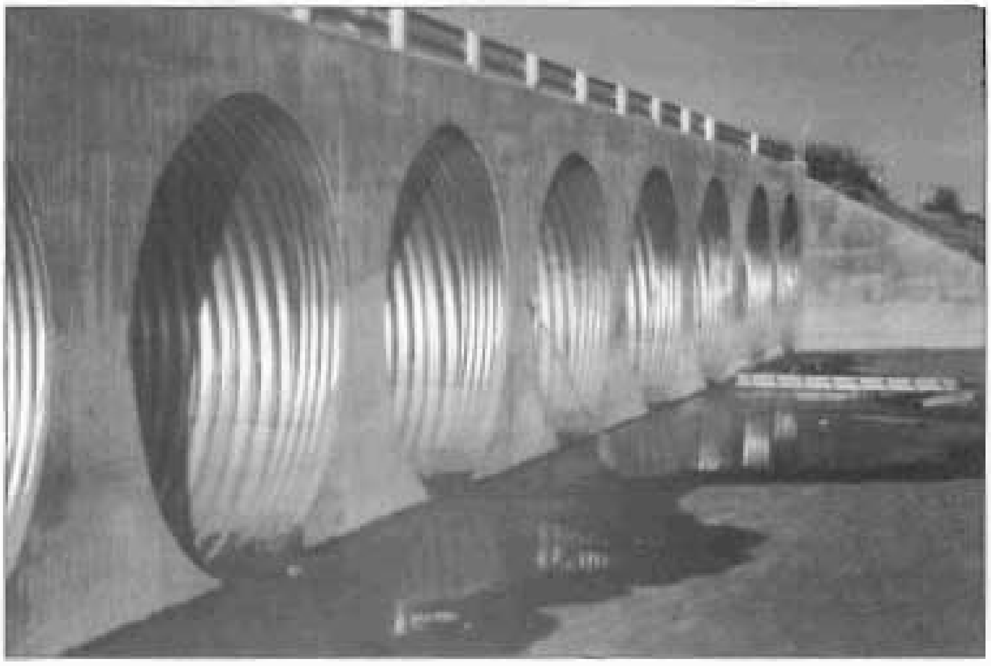


FIGURE 8: Test for Proper Consistency



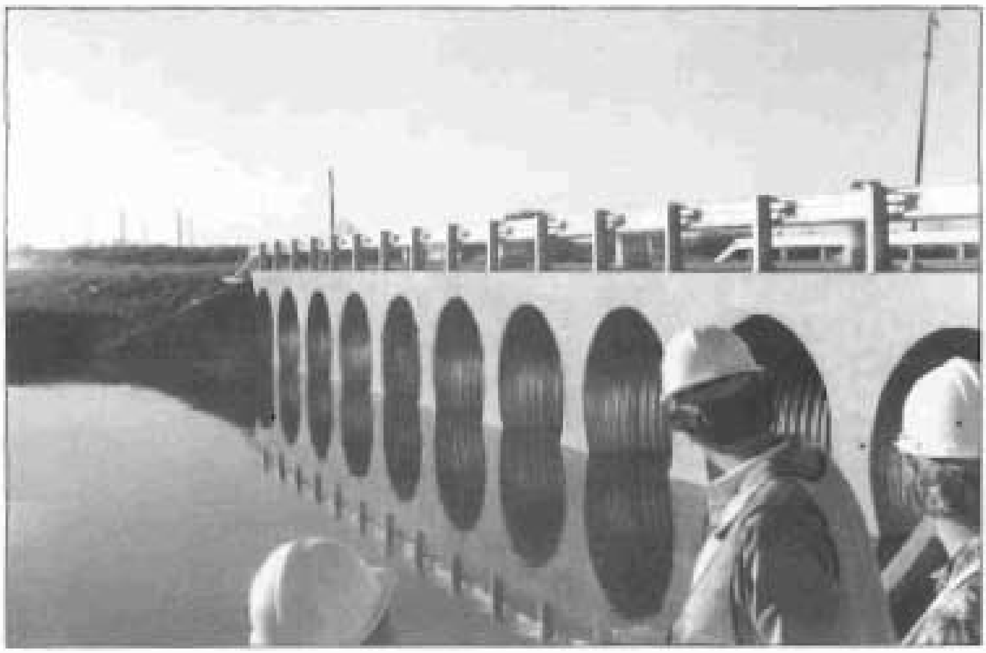


FIGURE 9: Completed Structure