State of California | Transportation Agency

Memorandum

To : Mr. John L. Beaton

Attention: Mr. C. R. Sundquist

Date: July 31, 1972

File : Research Project No. 646634

From : Department of Public Works—Division of Highways

Subject: "Evaluation of Corrugated Plastic Pipe Underdrains"

Attached is a copy of the final report for this project titled "Evaluation of Corrugated, Perforated Plastic Pipe for Highway Underdrains".

The major finding of this research project is that the corrugated plastic pipe studied does not have adequate strength to support heavy wheel loads under a shallow depth of cover (3 ft. or less). Thus the strength of the pipe would be inadequate to support truck loads imposed on it during the construction of the pavement structural section. Therefore no changes in present specifications or practices are recommended to allow the use of this pipe.

It is estimated that $3,000 was expended on this study.

Original Signed by Eric F. Nordlin

Eric F. Nordlin
Assistant Materials and Research
Engineer - Structural

RSF:mw

Attachment

cc: GAHill
CCPeterson
M&R Library

A P P R O V E D

Original Signed
JOHN. L. BEATON

John L. Beaton
Materials & Research Engineer

FORM H-AD 38B

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Materials & Research Dept.

MEMO TO FILE

Date: July 20, 1972

File: Research No. 646634

X-File: Pipe, Underdrains

Subject: Evaluation of corrugated, perforated plastic pipe for highway underdrains.

The investigation of corrugated, perforated plastic pipe was undertaken to evaluate its feasibility and economic advantage as a highway underdrain and for possible inclusion in Section 68 of the Standard Specifications.

Corrugated, perforated plastic pipe has been used for several years in agricultural drainage applications and is being proposed for highway drainage use. In agriculture, it has provided considerable savings over other materials. Highway underdrains are usually in 6 in. or 8 in. diameters and made from metal, concrete, clay, asbestos-cement or bituminous fibre. Underdrain pipe of these materials may cost up to $2.00 per linear foot. Plastic pipe costs approximately $0.40 per linear foot and is sold in continuous lengths up to 500 ft. Continuous trenching methods to install these lengths of pipe would also realize savings over conventional pipe laying methods.

Test samples of the corrugated, perforated plastic pipe had a minimum internal diameter of 8 in. and a wall thickness of .05 in. The pipe had a 1" x 2/3" annular corrugation profile. The wall cross sectional area was calculated to be 1.36 sq. in./ft.; the moment of inertia of the pipe wall was calculated to be 0.0345 in.^{4}/ft. The pipe weighed 1.20 lbs./ft. and was made from black polyethylene. Perforations, 2" x 3/32", were cut into every other corrugation valley at the circumferential third points.

A series of sand box crushing strength tests was run on 7- 24 in. long specimens of the 8" diameter plastic pipe. Depths of cover varied in 0.5 ft. intervals from 1.0 ft. to 3.0 ft. A 24 in. square steel and plexiglass box with 23-1/2" sidewalls, extended to 48" with plywood walls, was used. This box complies to the Conservation Service Engineering Standard Code 606 for 8" diameter pipe. Attached is a diagram of the sand box (Figure 1). Load was applied with a hydraulic jack and was transferred through a pyramidal stack of steel plates to a 16 in. x 16 in. x 3/4 in. plate bearing on the fine grain sand backfill.

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The pipe specimen was placed on a 3" sand bed. Deflection was measured through the movement of a wood strip secured longitudinally to the inside top of the pipe. All movements were observed and recorded through the plexiglass walls. Graphs of load vs. deflection for various depths of cover (Figure 2) and load vs. depth of cover for various deflections (Figure 3) are attached.

A legal maximum wheel load of 9^k and a standard 12^k Orange Overload were plotted on the load vs. depth of cover for various deflections graph (Figure 3). The Orange Overload was considered typical for off-road construction vehicles traveling on the incomplete highway structural section. Impact was included and based upon the AASHO "Standard Specifications for Highway Bridges" recommendation for culverts. Impact factors for various depths of cover are summarized below:

Depth of Cover	Impact Factor
0'-0" - 1'-0"	30%
1'-1" - 2'-0"	20%
2'-1" - 2'-11"	10%
3'-0" and greater	0%

If a 5% nominal pipe diameter deflection is used as a failure criteria, then the pipe cannot support a legal 9^k wheel load with 3.0 ft. or less of cover. However, if a 7-1/2% deflection is permitted, the same wheel load may be carried with a minimum of 2.3 ft. of cover. These figures are based on a factor of safety of 1.0 and load distribution through the soil cover.

Based upon the results of the sand box crushing tests, the corrugated perforated plastic pipe does not appear feasible for a highway underdrain. Underdrains are usually placed with the subbase of the highway structural section and backfilled with 2 ft. to 3 ft. of cover. Attached are typical cross section diagrams of two underdrain installations under current contract (Figure 4). Overloading of the pipe from heavy construction equipment during placement of base and paving material would be very difficult to control or eliminate. The combination of shallow depth of cover and heavy construction live loads would more than likely fail the plastic pipe. The plastic pipe may have adequate strength when used in subsurface drainage applications if placed out of the structural section where heavy construction equipment traffic is unlikely. Unfortunately, this is not very common in highway construction.

R. S. Ferwerda

R. S. Ferwerda
Assoc. Materials and Research
Engineer - Structural

RSF:JSM/mw
Attachments

cc: CRSundquist
JRStoker
WAWhitnack
MNagami
BChew
RAForsyth

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Sand Box Test Apparatus

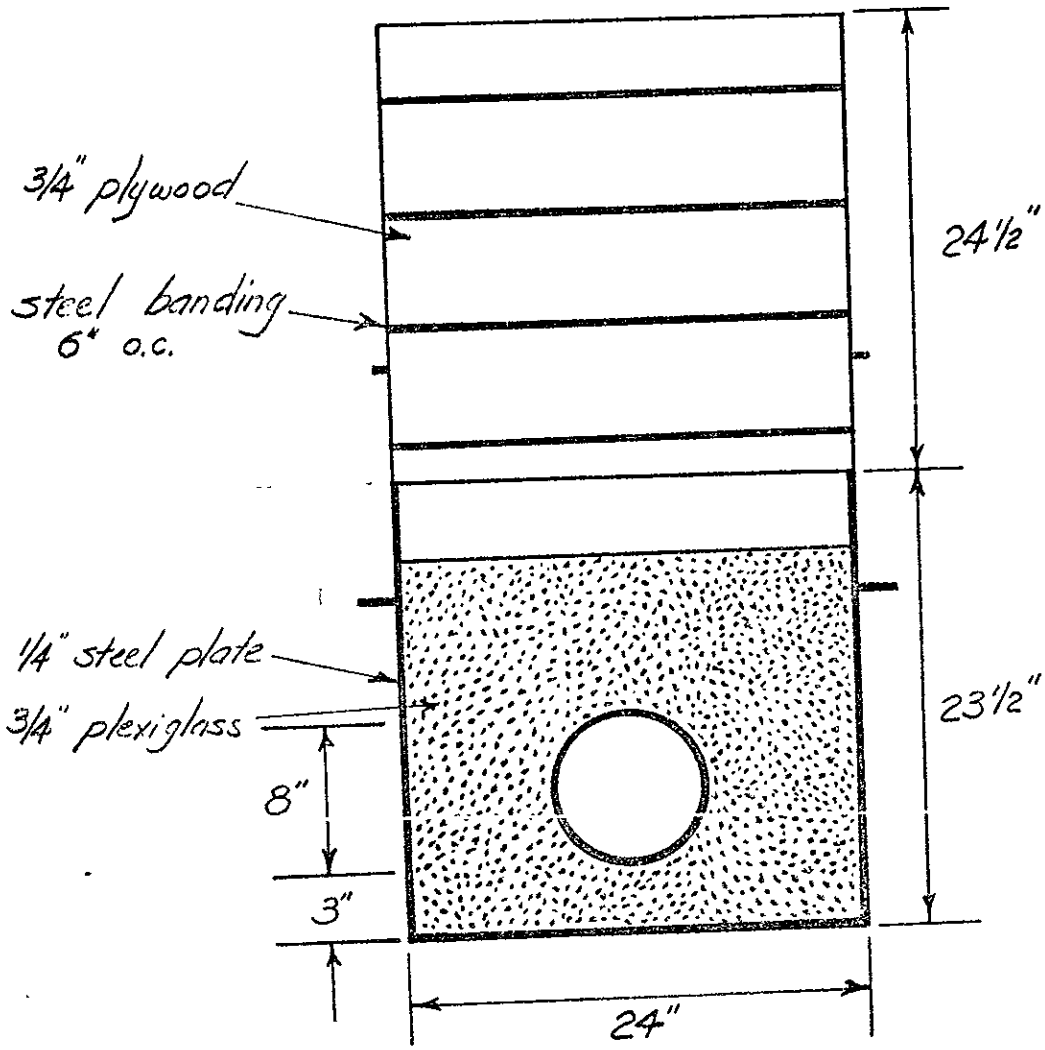

Figure 1

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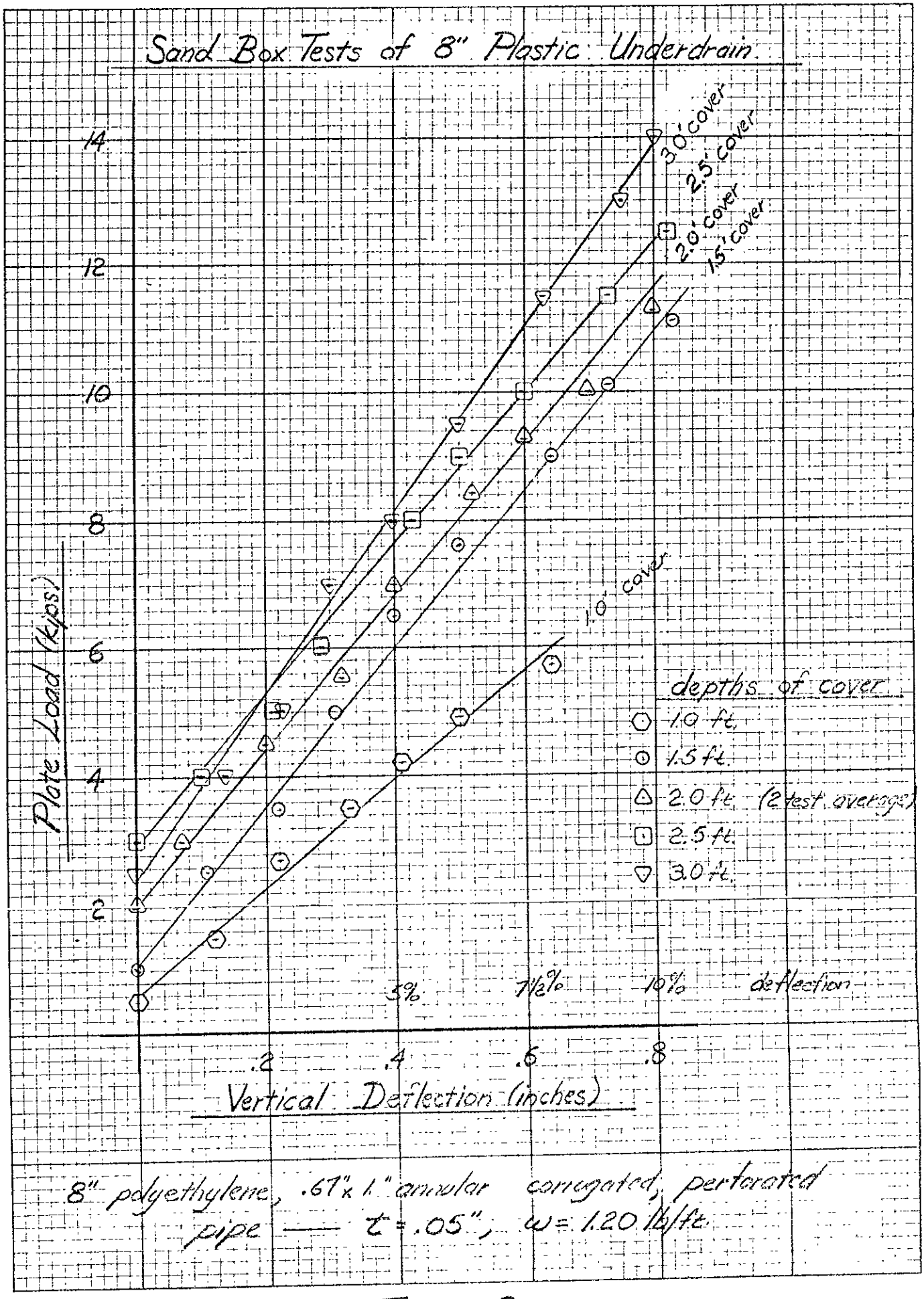

Figure 2

SQUARE 10 X 10 TO THE INCH AS-0806 GT
GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York Printed in U.S.A.
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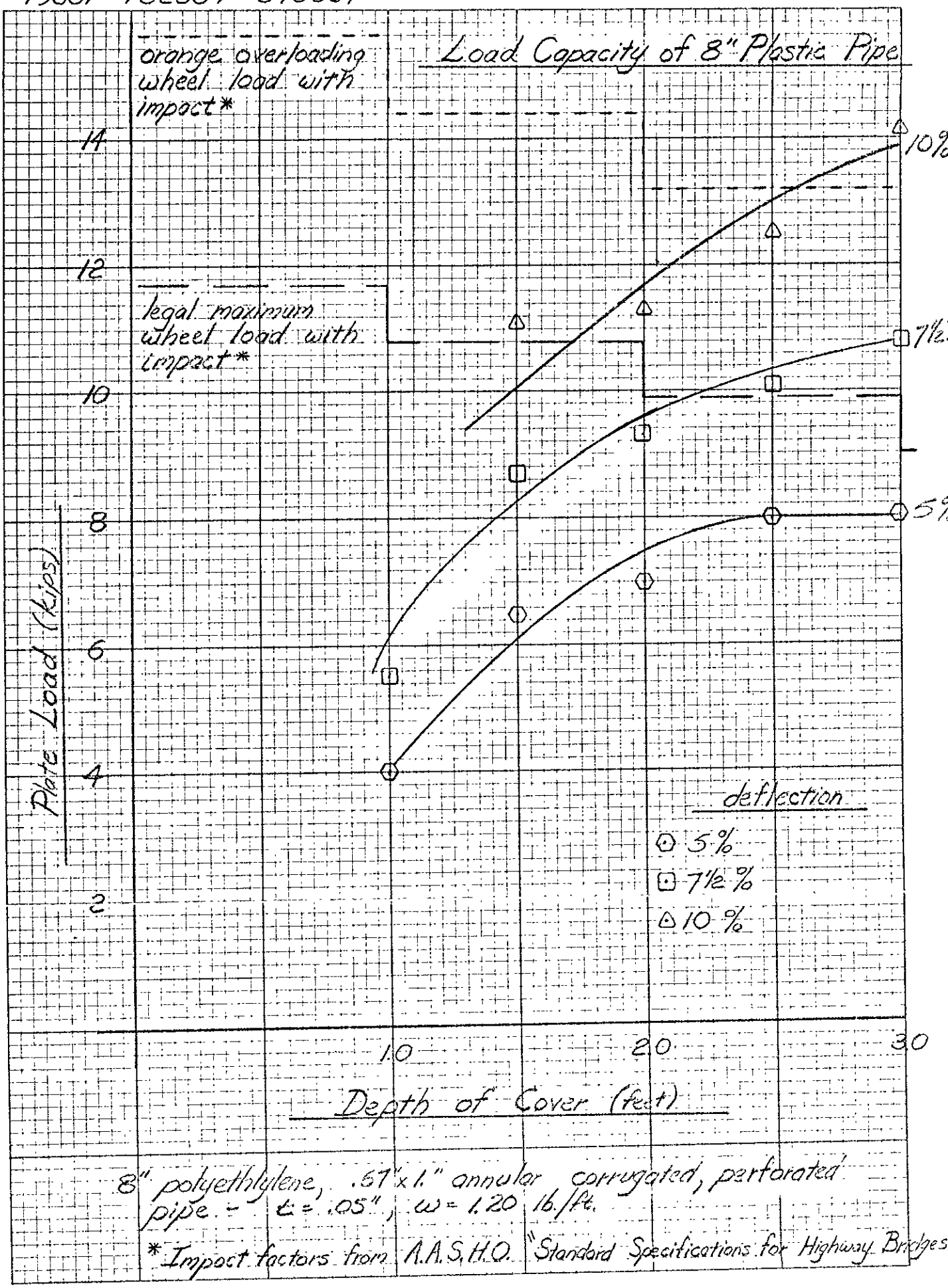

Figure 3

SQUARE 10 X 10 TO THE INCH AS-0806 GT
GRAPHIC CONTROLS CORPORATION Buffalo, New York Printed in U.S.A.

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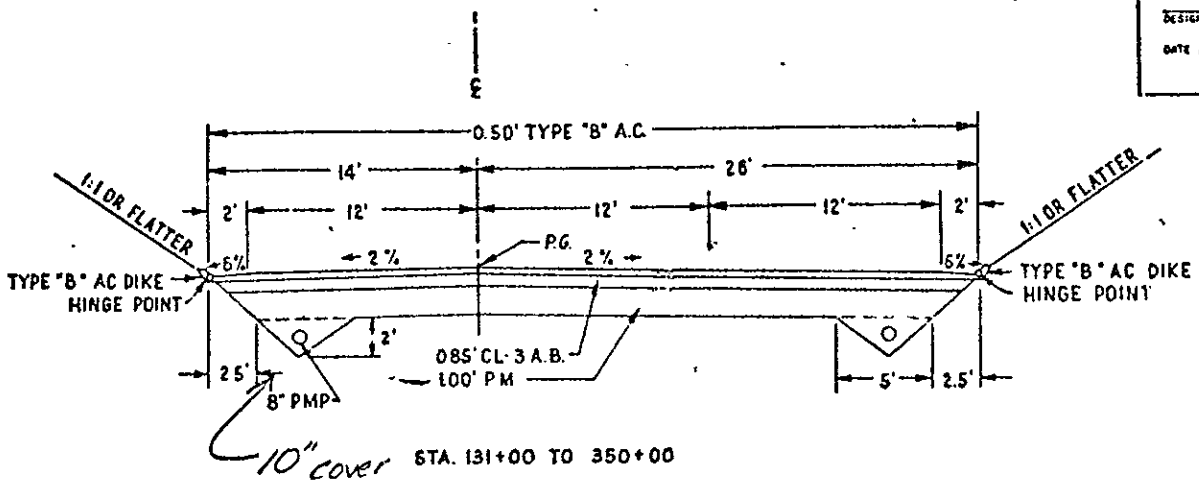
DIST	COUNTY	ROUTE	PM	SHEET	TOTAL SHEETS
01	HUM	299	R24.5/R29.3	2	31

B.D. Van Zandt
DESIGN ENGINEER REGISTERED CIVIL ENGINEER NO.
DATE APPROVED March 3, 1969

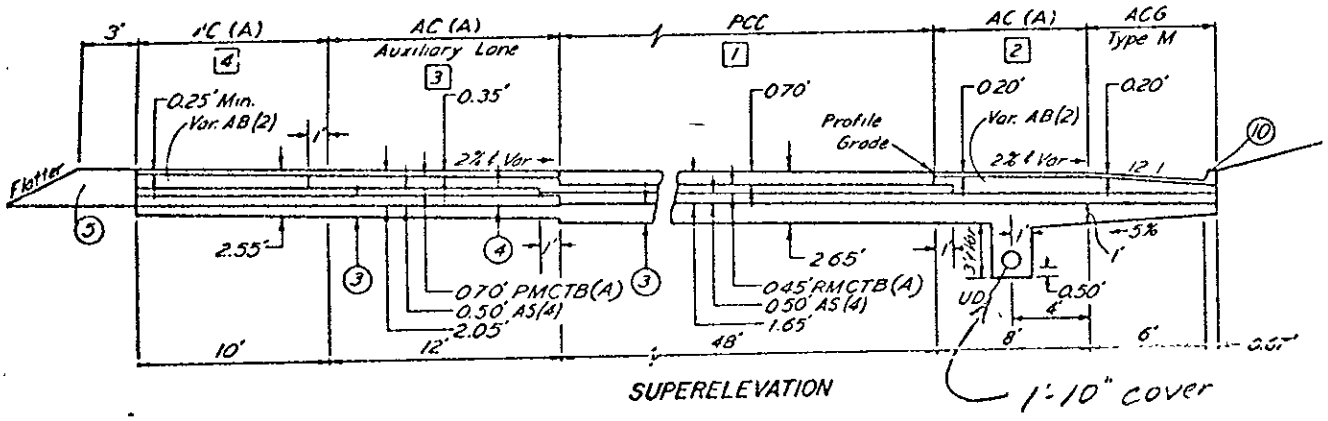


Notes. 1. Dimensions shown are subject to tolerances in the Standard Specifications

2. Superelevation as directed by the Engineer.

TYPICAL CROSS SECTIONS

Scale: 1" = 5'



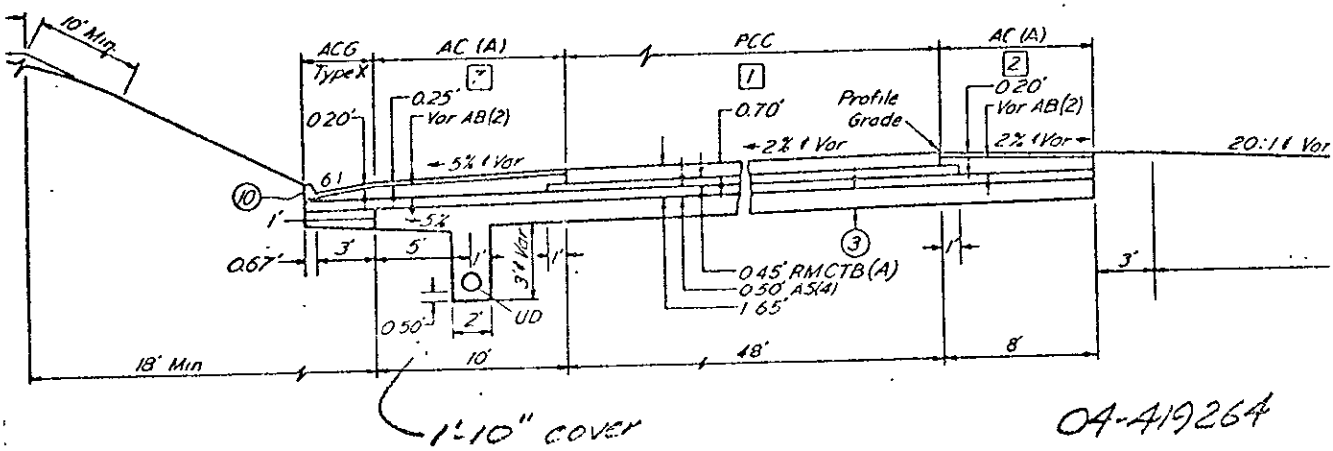


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Figure 4

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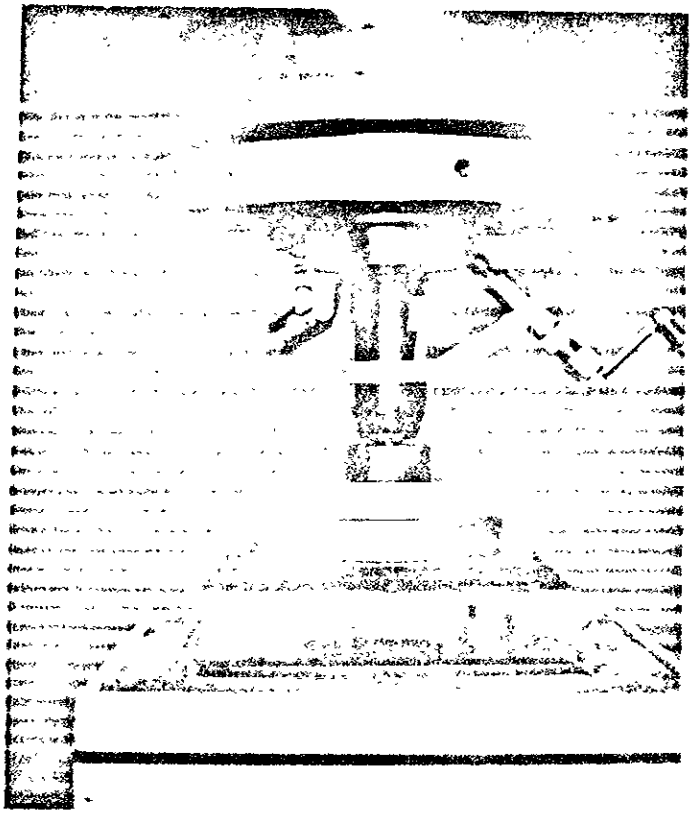
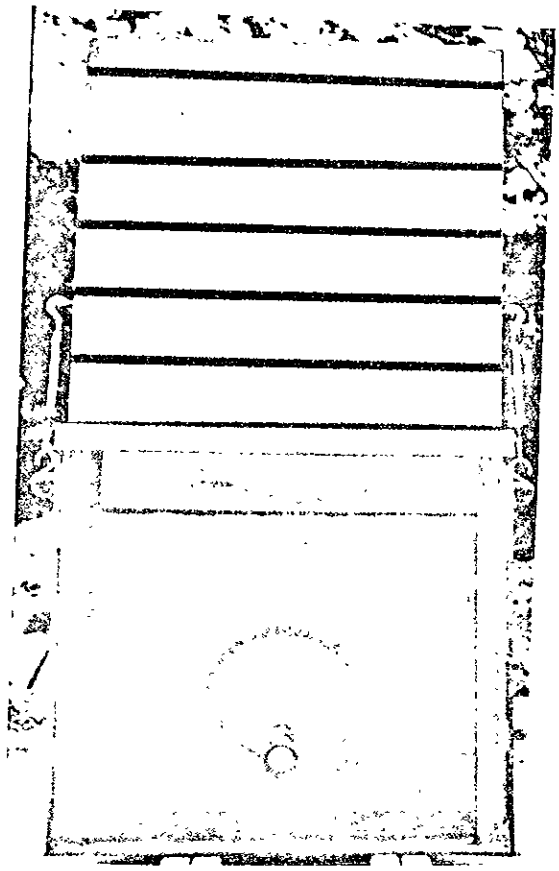
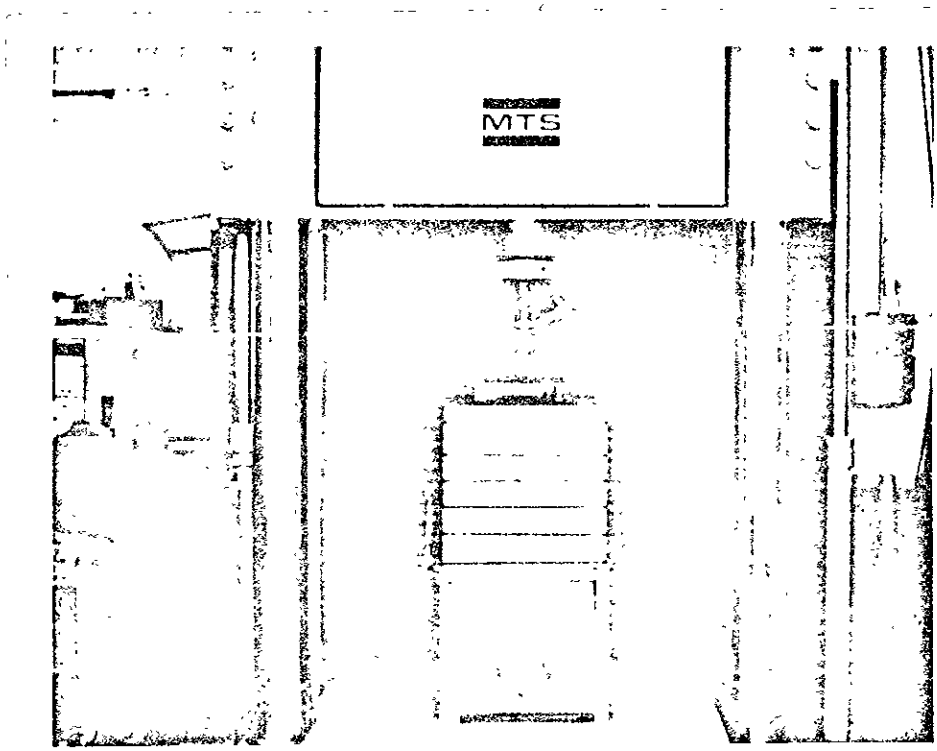


JACKING APPARATUS



SAND BOX



SAND BOX IN TESTING MACHINE

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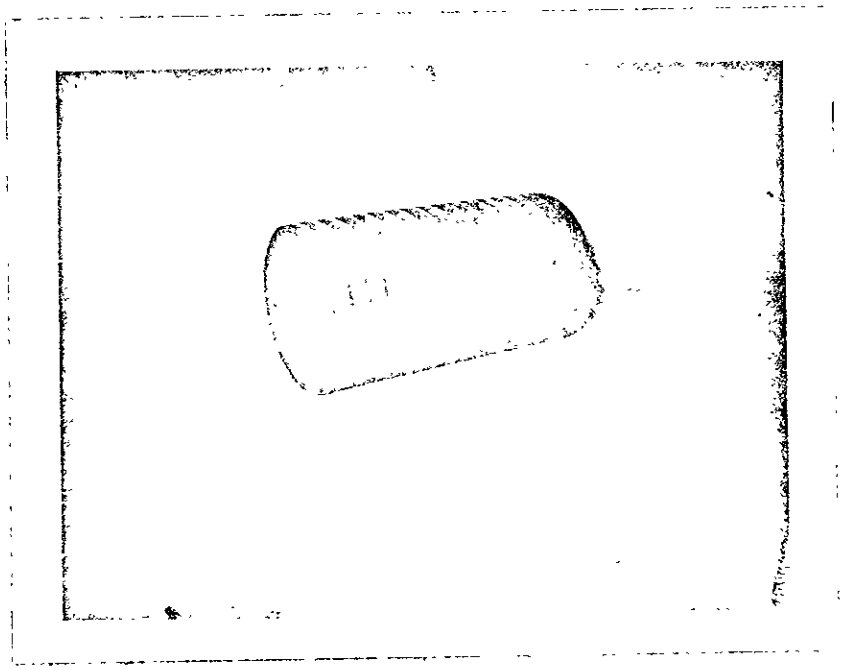

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