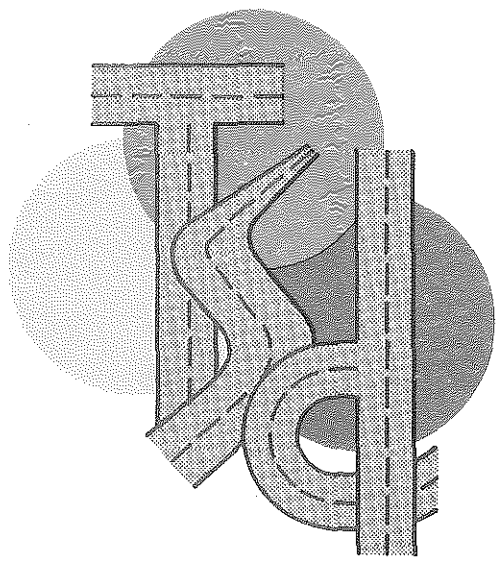


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DESIGN GUIDES
FOR
ROADSIDE SAFETY IMPROVEMENT PROGRAM
TASK 1



**TRAFFIC and
SAFETY
DIVISION**

**DEPARTMENT OF STATE HIGHWAYS
STATE OF MICHIGAN**

MICHIGAN DEPARTMENT
OF
STATE HIGHWAYS AND TRANSPORTATION

DESIGN GUIDES
FOR
ROADSIDE SAFETY IMPROVEMENT PROGRAM
TASK 1

by

Geometric Standards and Development Unit
Traffic Research and Development Section
Traffic and Safety Division

STATE HIGHWAY COMMISSION

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January 1975

Michigan Department of State Highways and Transportation
Roadside Safety Improvement Program
Task 1

Design Guides

General

The sole objective of Task 1 is to replace existing exposed steel beam guardrail endings on the state trunkline system with the buffer end-section, and to do this as rapidly as resources allow. It is understood that at many guardrail installations there is other work that ought to be done, but increasing the amount of work at one installation will delay the removing of exposed endings at others. So the work to be done under Task 1 is strictly limited; the balance of the work needed will be undertaken in Tasks 2 and 3.

Task 2 will be the improving of structure approach guardrail and, as necessary, the reconstruction of the structure railing to meet current standards.

Task 3 will be a complete improvement of the roadside to current standards, considering all items, not just guardrail. Most of the work done under Task 1 will be negated by the work done under Task 3. A guardrail installation treated under Task 1 cannot be considered to have necessarily been brought up to "Yellow Book" standards.

In applying these Design Guides for Task 1, it is important to keep in mind the objective of Task 1. Since these guides are to be used to determine the proper treatment for thousands of existing guardrail installations, there will be situations in which strict

adherence to the guides will be detrimental to the objective. In such situations, the investigator must adjust the guides, using his engineering judgement, as necessary to best achieve the objectives.

END SECTIONS

All exposed guardrail endings on two-way roadways and on the approach end of one-way roadways will be replaced with a buffer end-section and, if necessary, a curved guardrail section, in accordance with Standard Plan (Special Detail) ____.

An "exposed guardrail ending" is an ending which has the potential of penetrating the vehicle on an end-on impact and that is a position where an end-on impact is possible.

The most common types of endings that have the potential of penetrating the vehicle are flared or curved end sections and blunt endings. Neither buried end-section nor the lower rail of Type C or CD guardrail are considered "exposed guardrail endings."

An ending is not in "a position where an end-on impact is possible" if there is an obstruction in the vehicle's path that will prevent it from hitting the guardrail ending head-on, or if the guardrail is turned so that the ending does not face oncoming drivers on the trunkline, or if some other situation exists such that an end-on impact is improbable. See sheet 7. On divided highways, the trailing end of a median guardrail installation should be treated under Task 1 if the existing ending is 30 ft or less from the inside edge of the opposing roadway.

OTHER WORK

In addition to treating the guardrail endings, the investigator should recommend that a minor amount of additional work be done, when such work is expected to greatly improve the protection provided to the motoring public. The types of additional work the investigator may recommend are discussed below.

1. Guardrail Removal. All unwarranted guardrail installations shall be removed; some of the other work described below may be recommended so as to eliminate the guardrail warrant. Guardrail is not warranted when the roadside is cleared, within the limits set below, of all obstacles from which the motorist needs protection for these slopes:

- a) Foreslope of 1 on 4 or flatter: Clear roadside for 30 ft from the edge of pavement.
- b) Foreslope of 1 on 4 to 1 on 3; maximum height of fill of 20 ft: Clear roadside on the slope and the first 10 ft of the backslope and within 30 ft from the edge of pavement.

However, the guardrail may still be warranted if an overly-hazardous situation exists at the toe of the slope, such as a V-ditch, water, trees, or a backslope of 1 on 2 or steeper.

2. Guardrail Extensions. Occasionally existing guardrail installations may be extended under the three conditions listed below. If the existing guardrail is Type A or Type B, the extension shall be Type B. If the existing guardrail is Type C the extension shall be Type C. Structure approach guardrail will be treated under Task 2, and so will not be extended under Task 1.

- a) A guardrail installation may be extended up to 100 ft on either end if necessary to provide adequate protection from an obstacle. The guardrail should extend at least 50 ft from either side of the obstacle.
- b) A guardrail installation less than 100 ft in length should be lengthened to 100 ft, 50 ft on either side of the obstacle. If the installation to be lengthened is less than 21 in. high, measured to the top of the rail, the entire installation should be replaced.
- c) If the opening between two successive guardrail installations would be less than 150 ft after the Task 1 treatment is applied, the guardrail should be extended to close the gap. In doing so, however, the access rights of the abutting property owner must be protected; driveways, field entrances, cattle crossings, and in some cases pedestrian openings, generally cannot be closed.

The dimensions given above do not include the buffer end section. It will often be necessary to adjust those dimensions as existing conditions dictate.

3. Minor Grading. Minor grading to eliminate the warrant for guardrail can occasionally be done, depending on the capabilities of the agency doing the work. Such work could include flattening slopes to 1 on 3 or flatter (1 on 4 desirable) up to 100 cubic yards of fill. (Sheet 8). Subbase and roadside drainage and erosion control must be maintained or restored.
4. Culvert Endings. Occasionally a guardrail installation can be eliminated by replacing a culvert headwall with a culvert end section. For Task 1, culverts up to 36 in. diameter may be so treated (Standard Plans IV-86A and IV-88A). For culverts of 24 in. diameter or greater, a grate shall also be required unless the culvert end section is 20 ft or more from the edge of pavement. Culverts that must be extended as a result of minor grading shall have a culvert end section.
5. Inlet Covers. Any Inlet Cover E that is found in a driveable area shall be replaced with an Inlet Cover G (Standard Plan I-12A).

TASK 2 INVENTORY

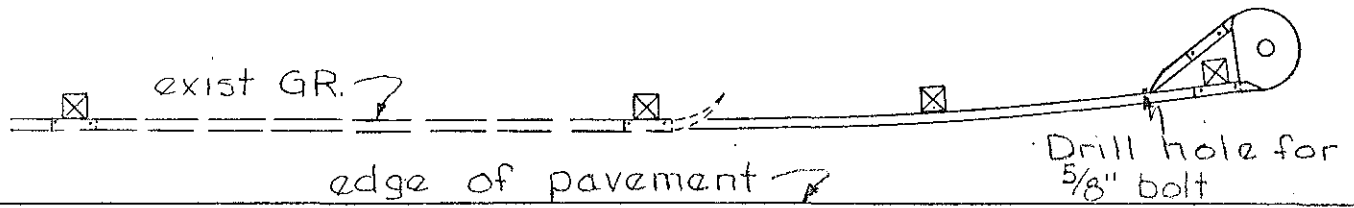
When the information required for Task 1 is gathered in the field, the inventory required for Task 2 will also be obtained.

This inventory must include enough information about each structure and box culvert so that the proper approach guardrail and structure railing system can be designed: the type of existing structure railing; the length of existing guardrail; structure, pavement, and shoulder widths; the foreslope for each quadrant, to the point where it is 1 on 3 or flatter; culverts in the vicinity of the structures; and railroad grade crossings, driveways, or other items that would restrict the length of guardrail that can be installed.

The normal lengths of guardrail to be installed at structure approaches are shown on sheet 12. A sample of the type of data needed on this inventory is shown on sheets 10 & 11. The structure

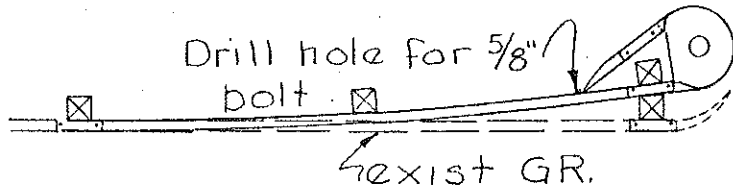
approach guardrail system, including structural anchorages, revised structure railing, and impact attenuators, if any, will be designed in the office.

Rem. End Shoe
 Place 12.5' Curved Beam GR.
 (50' R. type B)
 1-Buffer End Section



EXIST GR. IS STRAIGHT WITH AN END SHOE

Rem. 12.5' GR. & End Shoe
 Place 12.5' Curved Beam GR.
 (50' R. type B)
 1-Buffer End Section

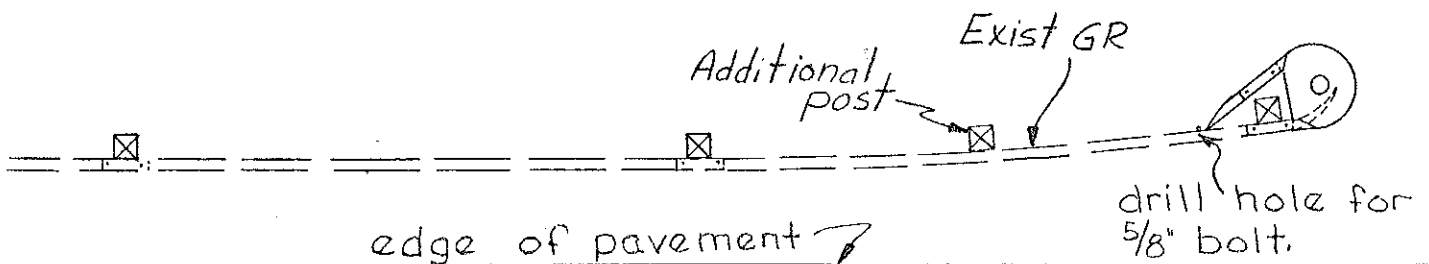


Driveway
 Crossroad
 Culvert
 etc.
 Any Obstruction

↘ edge of pavement

EXIST GR. IS STRAIGHT WITH AN END SHOE
 NO ROOM FOR EXTENDING

Rem. End Shoe
 Place 1-Buffer End Section

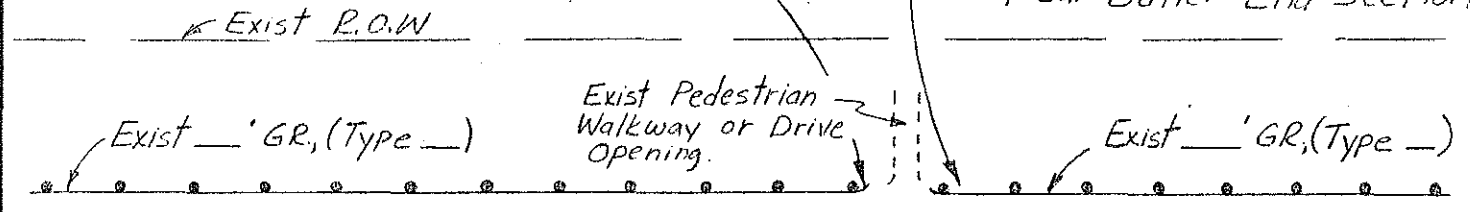


EXIST GR. IS CURVED WITH AN END SHOE

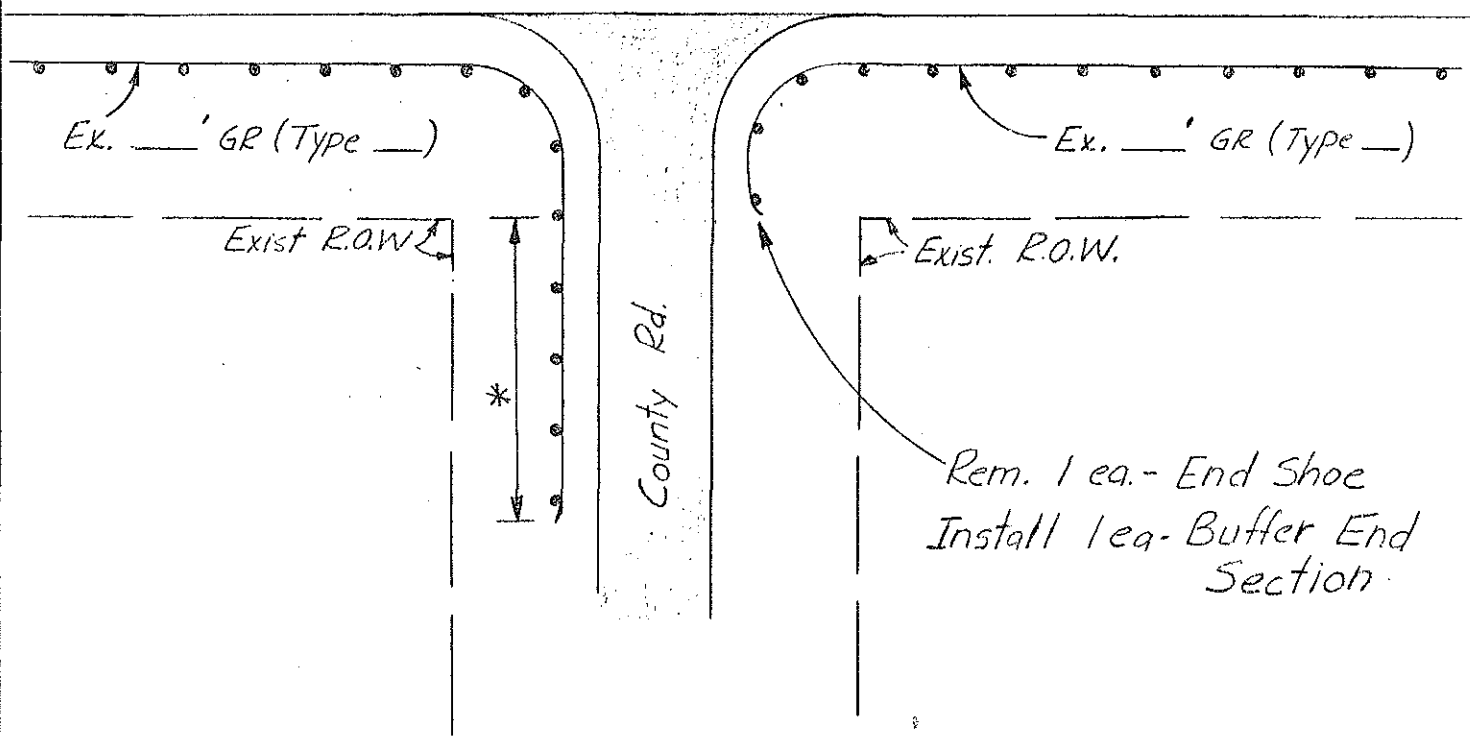
STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN <i>Pearson</i>
	CONT. SEC.	DATE <i>10-15-74</i>
	REF.	SCALE <i>None</i>
	SHEET <i>6</i> OF	PLAN

Rem 1 ea. - End Shoe
 12.5 ft. - Beam GR
 Install 12.5 ft. - Galv. Curved Beam
 GR, Type B (50' R)
 1 ea. - Buffered End Section

Rem. 1 ea. - End Shoe
 12.5 ft. - Beam GR.
 Install 12.5 ft. - Galv. Curved Beam
 GR, Type B (50' R)
 1 ea. - Buffer End Section

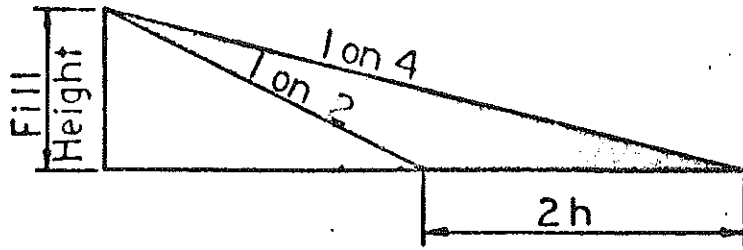


Trunkline



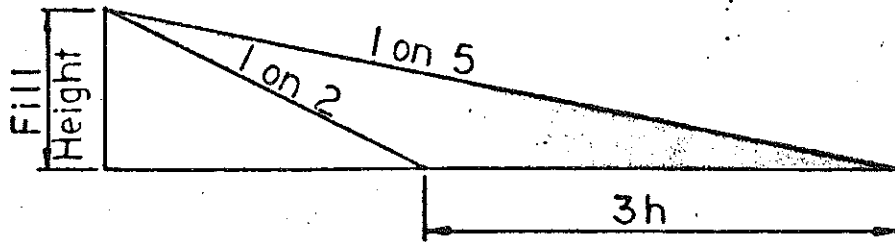
* If the distance from the state-owned R.O.W is less than 50', replace existing end shoe with buffer end section.

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN
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	REF.	SCALE
	SHEET 7 OF	PLAN



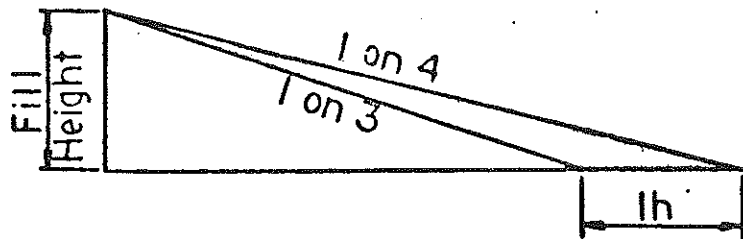
$$V_{100} = \frac{1}{2} (2h)(h)(100) \frac{1}{27} = \left(\frac{100}{27}\right) h^2$$

Fill Hgt.	Emb. (Cyds/100')
2'	15
4'	59
6'	133
8'	237
10'	370
12'	533
14'	726
16'	948



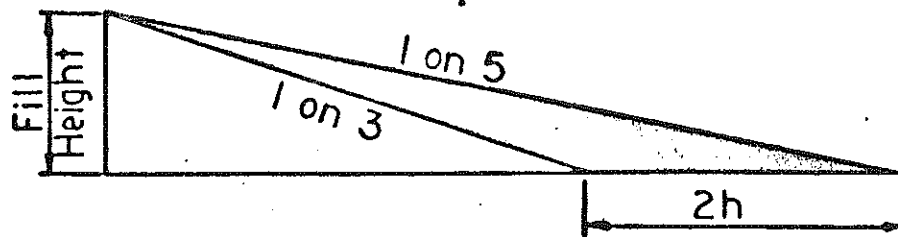
$$V_{100} = \frac{1}{2} (3h)(h)(100) \frac{1}{27} = \left(\frac{3}{2}\right) \left(\frac{100}{27}\right) h^2 = \left(\frac{50}{9}\right) h^2$$

2'	22
4'	89
6'	200
8'	356
10'	556
12'	800
14'	1089
16'	1422



$$V_{100} = \frac{1}{2} (h^2)(100) \frac{1}{27} = \left(\frac{50}{27}\right) h^2$$

2'	7
4'	30
6'	67
8'	119
10'	185
12'	267
14'	363
16'	474



Same as 1 on 2 to 1 on 4	
--------------------------------	--

GUARDRAIL REMOVAL AS RELATED TO CULVERTS

TASK 1

CULVERTS UP TO 36 INCH DIAMETER:

REMOVE HEADWALL, EXTEND AND ADD CULVERT
END SECTION.

FOR CULVERTS OF 24 INCHES DIAMETER OR
GREATER, A GRATE SHALL BE ADDED UNLESS
20 FEET OR MORE FROM EDGE OF PAVEMENT.

Rem. 1 ea. End Shoe
 Install 12.5 ft. Galv. Curved
 Beam GR, Type B (50'R)
 1 ea Buffer End Sect.

Ex. ___' of GR, (Type ___)

lon3 | lon2

lon3 | lon4

Ex. ___' of GR, (Type ___)

River, Stream
 or X-Road Name

Rem 1 ea - End Shoe
 Install 1 ea - Buffer End
 Section

Exist Drive

B.E.

Ex. ___' of GR, (Type ___)
 w/ Buried End

Ex. ___' of GR, (Type ___)

lon2 | lon3

lon3 | lon2

Rem. 1 ea. End Shoe
 Install 1 ea - Buffer End Section

S # of Control Section No

or

Reference No. if Struc # not assigned.

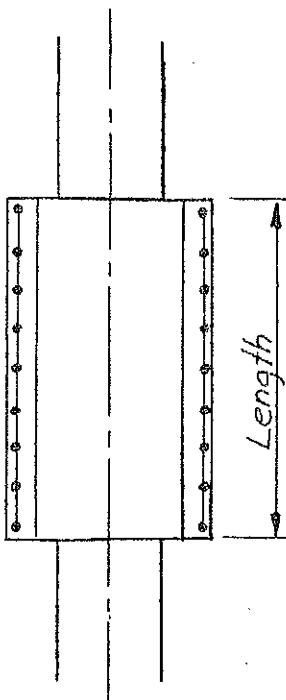
Provide information shown on
 supplemental sheet

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN
	CONT. SEC.	DATE
	REF.	SCALE
	SHEET 10 OF	PLAN

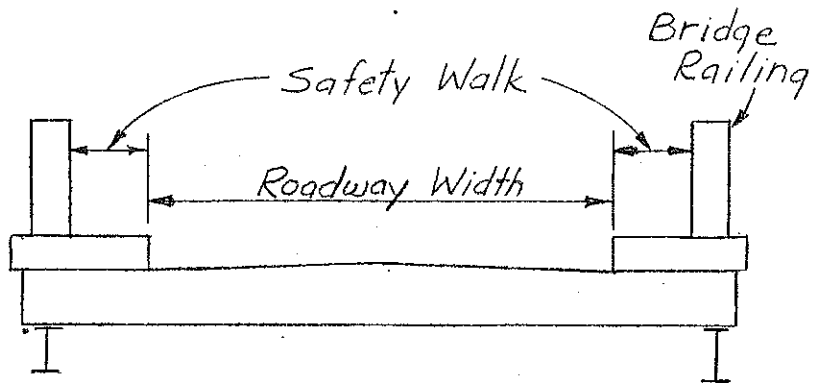
Item or Structure No. _____

Control Section _____

Route No. _____



PLAN



CROSS-SECTION

1. Structure Length ----- ft.
2. Roadway Width ----- ft.
3. Width of Safety Walk ----- ft. ----- in. (North or East side)
----- ft. ----- in. (South or West side)
4. Type of Bridge Railing
 - a. Parapet -----
 - b. 2 or 3 Tube -----
 - c. Conc. Posts w/ Fabricated Railing -----
 - d. Steel " " " " -----
 - e. Concrete Wall -----
 - f. Other (include sketch or photo) -----

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AUTH. NO. _____

CONT. SEC. _____

REF. _____

SHEET // OF

PLAN

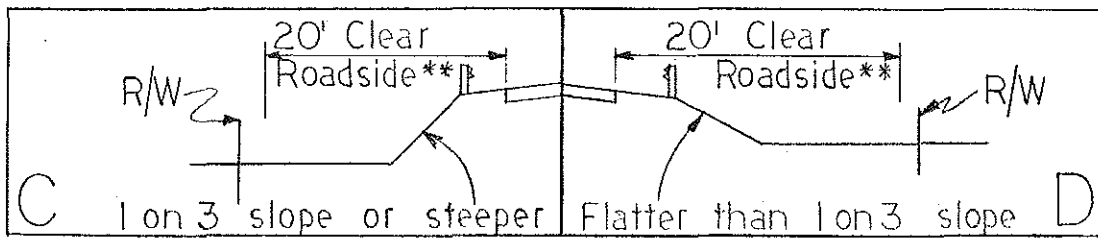
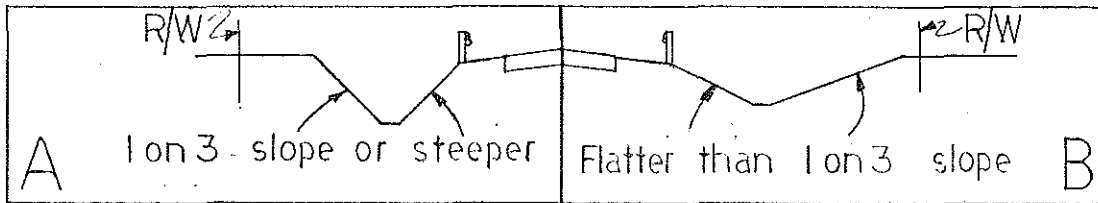
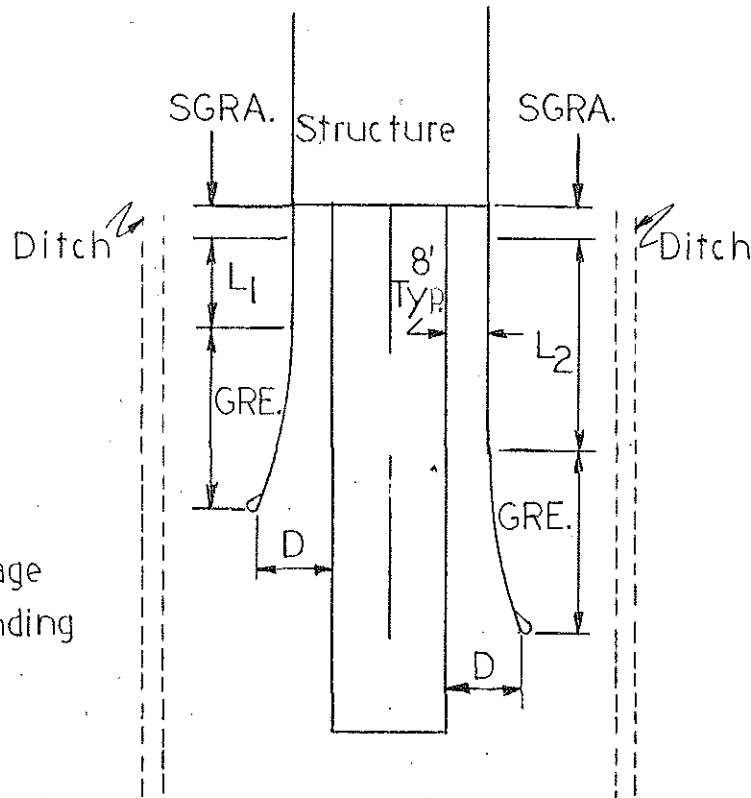
DRAWN _____

DATE _____

SCALE _____

Supplemental Sheet
for
Structures

SGRA - Structure
 Guardrail Anchorage
 GRE - Guardrail Ending
 Det. 1 or 2



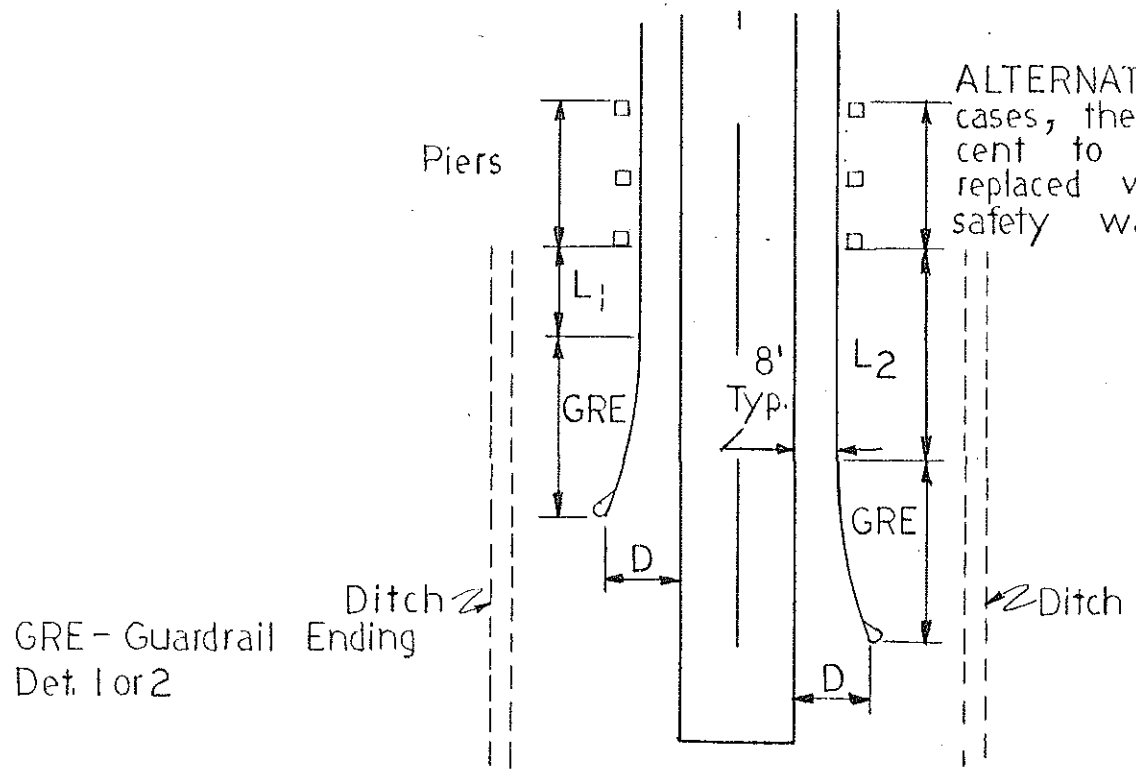
D (ft.)	Length of Guardrail according to Roadside Features							
	A		B		C		D	
	L ₁	L ₂	L ₁	L ₂	L ₁	L ₂	L ₁	L ₂
12 or <	25'	50'	50'	75'	50'	75'	75'	100'
13' 14'	25'	37.5'	37.5'	62.5'	37.5'	62.5'	62.5'	87.5'
15' or >	25'	25'	25'	50'	25'	50'	50'	75'

*Edge of pav't. to face of guardrail is less than typical

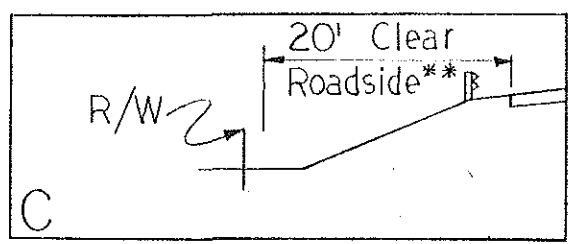
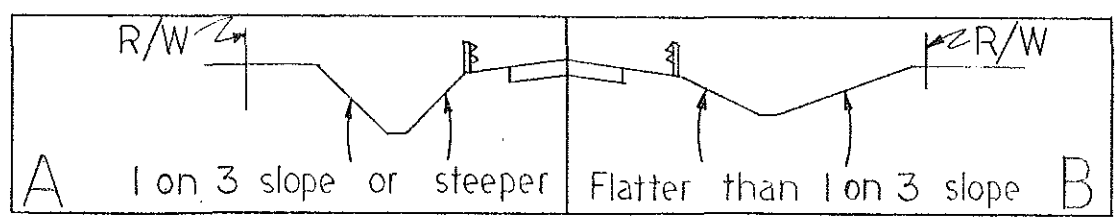
**If clear roadside is < 20' use lengths shown for A & B for C & D respectively

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	SHEET 13 OF	PLAN

ALTERNATE - In some cases, the guardrail adjacent to the pier could be replaced with a concrete safety wall.



GRE - Guardrail Ending
Det. 1 or 2

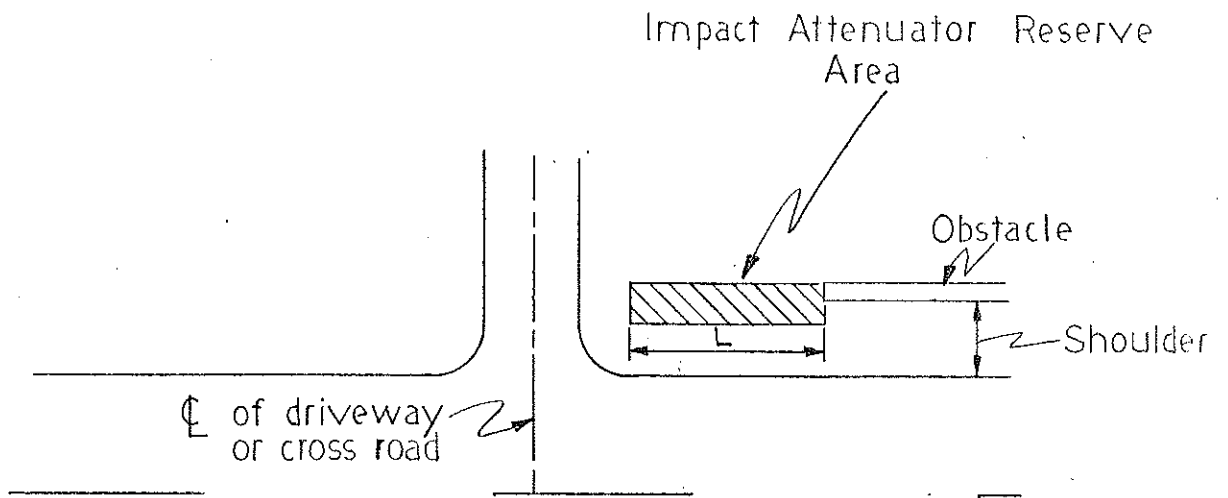


D (ft.)	Length of Guardrail according to Roadside Features			
	A		B & C	
	L ₁	L ₂	L ₁	L ₂
12 or <	37.5'	62.5'	62.5'	87.5'
13' - 14'	25'	50'	50'	75'
15' or >	25'	37.5'	37.5'	62.5'

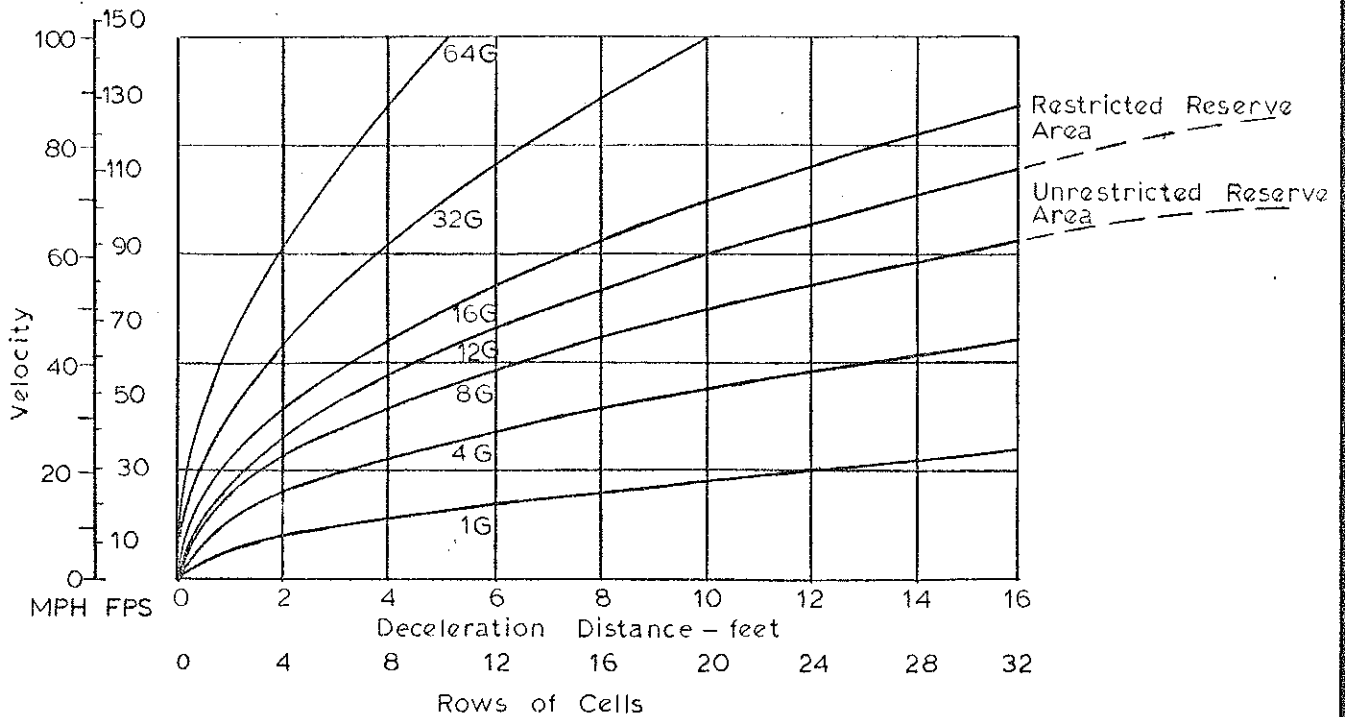
* Edge of pav't. to face of guardrail is less than typical.

** If clear roadside is < 20' use lengths shown for A

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DECELERATION CHART



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DEPARTMENT OF STATE HIGHWAYS

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CONT. SEC.

REF.

SHEET 14 OF

PLAN

DRAWN

Pearson

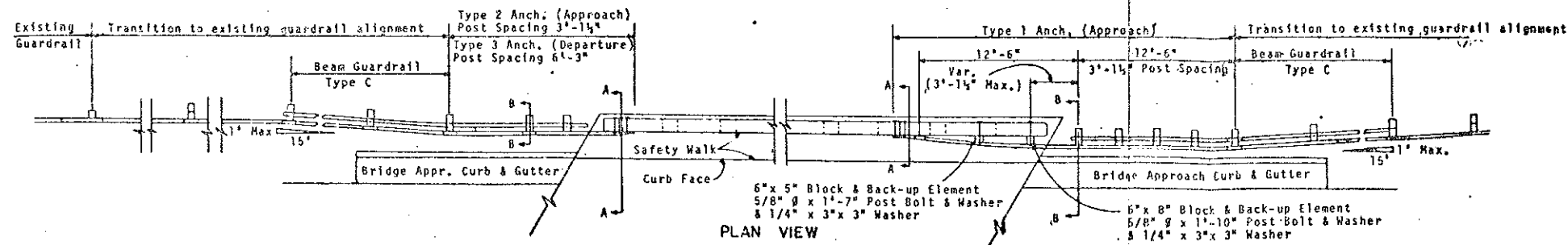
DATE

1-27-75

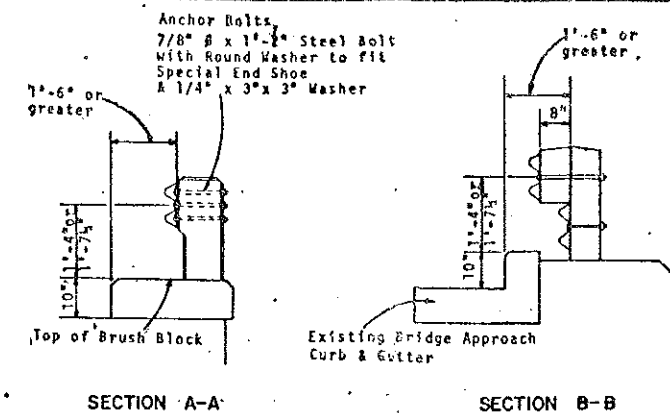
SCALE

Area needed for Impact
Attenuator (Hydro-Cell)

STRUCTURE GUARDRAIL ANCHORAGE TYPES 1, 2 AND 3



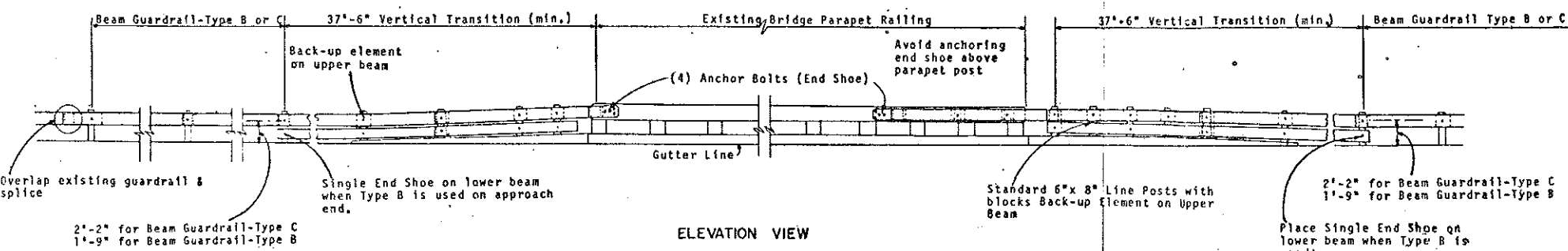
PLAN VIEW



SECTION A-A

SECTION B-B

- Notes:
1. Structure Guardrail Anch.-Type 1 shall be used when safety walk is 1'-6" or greater.
 2. Structure Guardrail Anchorage-Type 2 shall be used when safety walk is less than 1'-6".
 3. Installation of Anchor Bolts: To prevent spalling drill from both sides of parapet railing.
 4. Hardware shall be galvanized in accordance with ASTM-A153.
 5. The location of the Special End Shoe may be repositioned if reinforcing steel prevents drilling through parapet railing. If necessary, an additional hole may be drilled in the end shoe to provide the required 4 anchor bolts.

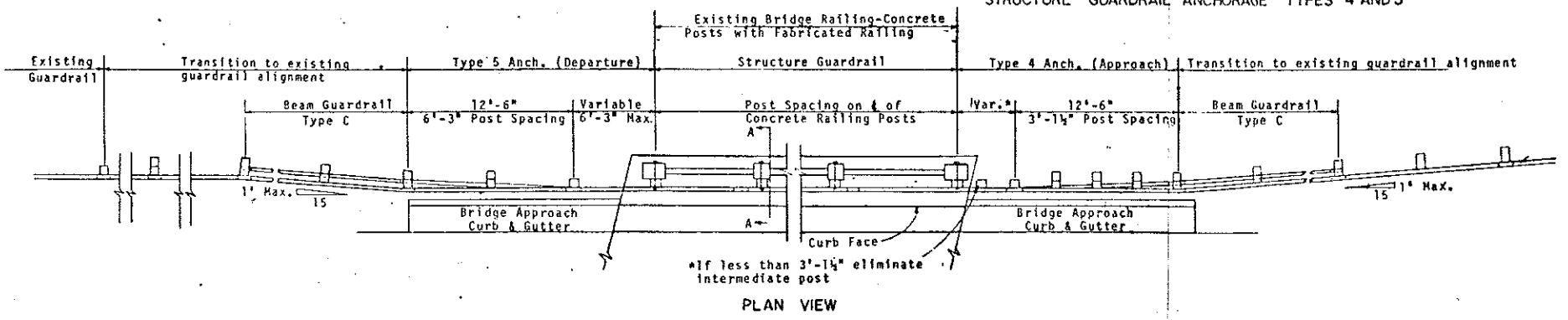


ELEVATION VIEW

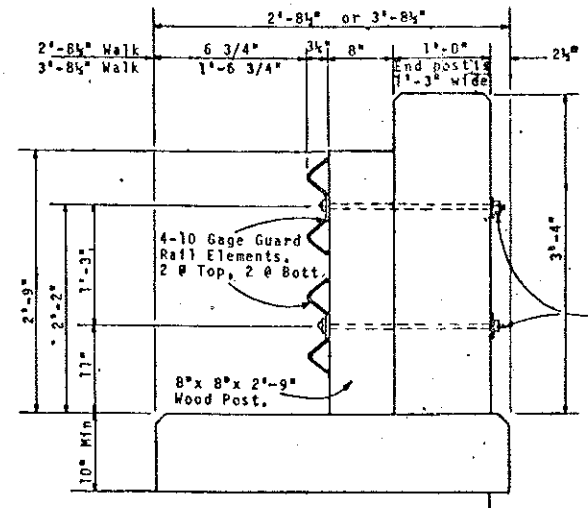
INSTALLATION AT STRUCTURE (FOR TYPES 2&3)

SPECIAL END SHOE

STRUCTURE GUARDRAIL ANCHORAGE TYPES 4 AND 5

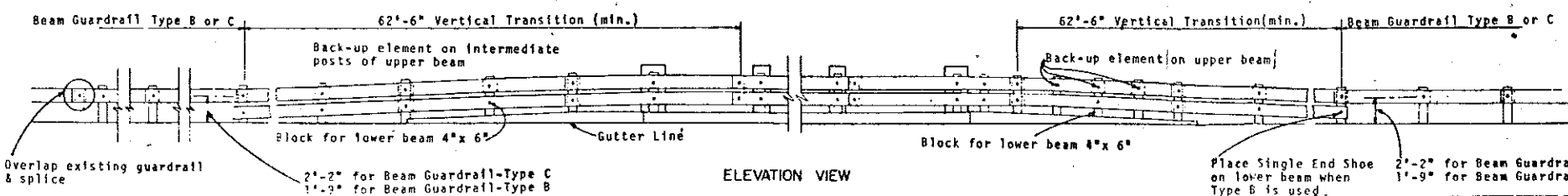


PLAN VIEW



DETAIL FOR STRUCTURE GUARDRAIL (SECTION A-A)

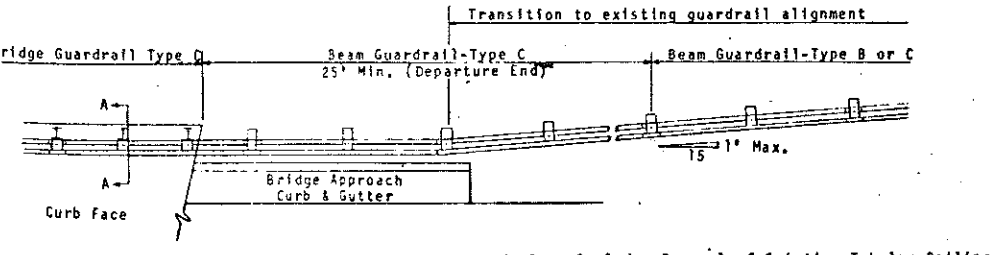
- Note:
- Hardware shall be galvanized in accordance with ASTM-A153



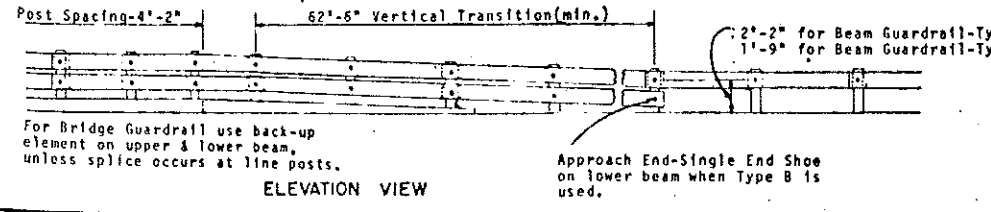
ELEVATION VIEW

DETAIL FOR STRUCTURE GUARDRAIL (SECTION A-A)

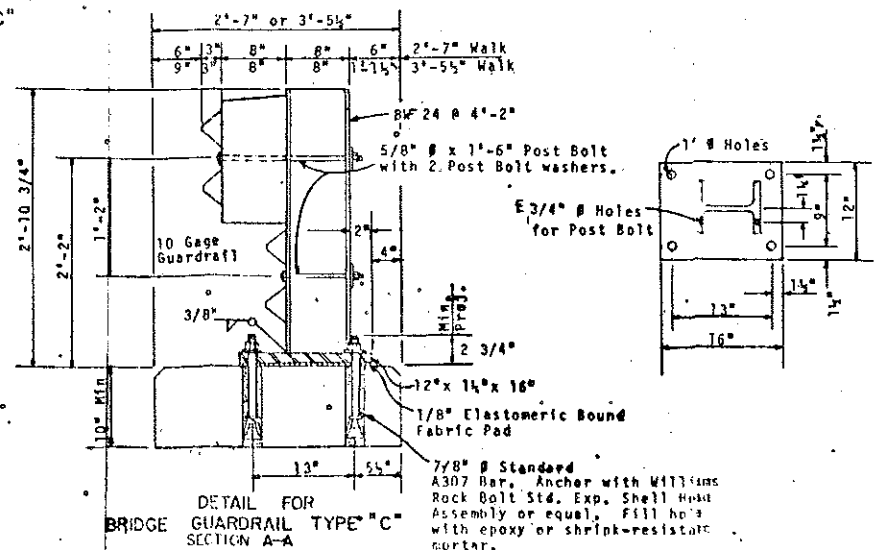
BRIDGE GUARDRAIL TYPE "C" (REPLACING TUBULAR RAILING)



PLAN VIEW



ELEVATION VIEW



DETAIL FOR BRIDGE GUARDRAIL TYPE "C" SECTION A-A

- Notes:
1. Hardware shall be galvanized in accordance with ASTM-A153
 2. Steel posts and plates shall be galvanized after fabrication in accordance with ASTM-A123

Rev. 5-13-74 Note 5 added for SGRA Type 1,2,4,5

STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS	AUTH. NO. FORM SEC.	DATE 3-19-73	DESIGN KLS
TRAFFIC AND SAFETY DIVISION	SHEET NO. OF	SCALE NONE	ANCHORAGES TO BRIDGE RAILINGS AND GUARDRAIL ACROSS STRUCTURES

