



# ENGINEERING POLICY BALLOT

Effective: January 1, 2019

## Level 2

Level two revisions require the approval of the **Assistant Chief Engineer** and the **Federal Highway Administration** only. The **Senior Management Team** is encouraged to review the content and provide comment to the appropriate director. For all other parties, these revisions are posted for information only.

# ENGINEERING POLICY BALLOT

Effective: January 1, 2019

## Issue 1: Coordinate System for Referenced and Coordinate Point Sheets

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** William Politte - DE

**Summary:** These changes will ensure all the districts are using the same coordinate system. The Professional Land Surveyor of Record will be the district's point of contact/reference for the coordinate information.

**Fiscal Impact:** There is no anticipated fiscal impact associated with this revision.

**Publication:** EPG 237.4.8 & 237.4.9

**Actions:**

- ☐ Approve
- ☐ Reject
- ☐ Discuss Further

## Issue 2: Early Strength Concrete

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Boyd Denson – BR  
Rhonda Luck - BR

**Summary:** Revising latex modified high early strength concrete to latex modified very early strength concrete to correlate with type of cement used in the concrete and the purpose of the concrete. Clarify the type of cement required for this concrete and what cement will not be permitted.

**Fiscal Impact:** There is no anticipated fiscal impact associated with this revision.

**Publication:** Sec 505 and EPG 751.6.1

**Actions:**

- ☐ Approve
- ☐ Reject
- ☐ Discuss Further

### **Issue 3: MGS Guardrail**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Sarah Kleinschmit - DE

**Summary:** The revisions included in the standard plans will update and clarify the current practices for guardrail installations.

**Fiscal Impact:** There is potential for increased costs due to required grading for guardrail installation. The potential costs will vary dependent on the grading method used (i.e. linear grading, embankment, etc.) The full cost impact is yet to be determined.

**Publication:** Std. Plan 606.50

**Actions:**

- ☐ Approve
- ☐ Reject
- ☐ Discuss Further

### **Issue 4: Rebound Hammer Allowance for Determining Opening Strength of Full Depth Concrete Pavement Repairs**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** John Donahue - CM

**Summary:** This revision consists of a new MoDOT test method, TM-7, for using rebound hammers to determine opening strength for full depth concrete pavement repairs, and the corresponding specification change in Sec 613.10.2.4.3 that allows this alternate test method.

**Fiscal Impact:** There is no anticipated fiscal impact associated with this revision

**Publication:** Sec 613, and EPG 106.3.2.7

**Actions:**

- ☐ Approve
- ☐ Reject
- ☐ Discuss Further

**Issue 5: Rumble Strips**

**Approval:** Level 2 – Assistant Chief Engineer

**Sponsor:** Jon Nelson – TS

**Summary:** This revision clarifies the location of the rumbles strips and pavement markings for differing shoulder and pavement conditions. It also revises the minimum pavement thickness from 1 3/4" to 1".

**Fiscal Impact:** There is no anticipated fiscal impact associated with this revision

**Publication:** EPG 626

**Actions:**

- ☐ Approve
- ☐ Reject
- ☐ Discuss Further

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*Signature*

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*Date*

### 237.4.8 Referenced Points Sheet

-The referenced points for the surveyed alignment are indicated on a separate sheet for use by Construction and Materials in re-establishing the location. Referenced points sheets are available on CADD. The referenced points are shown on a single sheet, if possible, ~~and shown using Grid to Ground~~ “Modified” Project Coordinates.

~~It is common for MoDOT Modified Coordinates to be placed on the Referenced Points Sheet but it is to be indicated on the sheet if they are Grid to Ground MoDOT “Modified” Project Coordinates or Missouri State Plane Coordinates along with the projection factor for the project. This factor is furnished by the Professional Land Surveyor of Record.~~

### 237.4.9 Coordinate Points Sheet

In order to aid in the re-establishment of the alignment for a project, a listing of significant alignment and control points with their ~~1983 Missouri State Plane~~ Grid to Ground “Modified” Project Coordinates are included in the plans on the Missouri Coordinate Sheet. A blank form is available as a MicroStation seed file. This listing includes the sheet number, station, location, offset, point ID, northing coordinate, easting coordinate, elevation, and description of the significant points. The coordinates for the points are shown in feet to two decimal places ~~(three decimal places for metric projects)~~, but may be shown with up to ~~five~~ three decimal places.

The points listed include the following:

- Beginning and ending station coordinates of project.
- Alignment points (POTs, PIs, Curves [PC, CC, PT], and Spiral Curves [TS, SC, Overall PI, CS, ST]).
- Major centerline intersections (e.g. state routes, major side road approaches, ramp intersections, outer roads, etc.).
- Survey Control Points used by the Professional Land Surveyor of Record ~~Survey Crews.~~
- Other significant points unique to the project.

This sheet is used on all projects that have state plane coordinates. This sheet is not used on projects that have independent grid coordinates.

The coordinates listed are Grid to Ground “Modified” Project ~~state-plane~~ Coordinates. The average projection factor used for the computation of the coordinates for the project is included on the sheet. This factor is furnished by the Professional Land Surveyor of Record ~~Photogrammetry~~. It is shown in the form of a multiplier of the state plane distances to obtain ground distances. The station and offset distances shown on this sheet are ground distances. The point ID is the point number or name used in the computations.

The coordinate point sheet contains the historical data for the alignment information for the project and is a permanent part of the plans.

**505.30.13 Basis of Payment.** Payment for silica fume concrete will be made in accordance with [Sec 505.10.13](#).

#### **SECTION 505.40 LATEX MODIFIED ~~HIGH~~VERY EARLY STRENGTH CONCRETE.**

**505.40.1 Description.** This work shall consist of a wearing surface of latex modified ~~high~~very early strength concrete constructed on a prepared surface in accordance with this specification and in accordance with lines, grades, thickness and typical cross sections shown on the plans or as directed by the engineer.

**505.40.2 Material.** All material shall be in accordance with [Sec 505.10](#), [Division 1000](#), Materials Details and specifically as follows:

| Item                     | Section              |
|--------------------------|----------------------|
| Latex Emulsion Admixture | <a href="#">1054</a> |
| Polyethylene Sheeting    | <a href="#">1058</a> |
| Water                    | <a href="#">1070</a> |

~~505.40.2.1 Hydraulic cement shall be in accordance with ASTM C 1600, Type VRH. Type HE (ASTM C 1157) or 1 Unless restricted on the plans, Type HE (high-early strength) cement in accordance with ASTM C 1157 may be used with approval of mixture by the Engineer. Type III cement will not be permitted.~~

~~505.40.2.2 Unless restricted on the plans, Type VRH (very rapid hardening) cement in accordance with ASTM C 1600 may be used with approval of mixture by the Engineer. Type III cement will not be permitted.~~

**505.40.2.23** Coarse aggregate shall be an approved crushed limestone, crushed quartzite, flint chat from the Joplin area, or porphyry in accordance with [Sec 1005](#), Gradation E or Gradation F, except the percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances shall not exceed one percent.

| Item                   | Percent by Weight (Mass) |
|------------------------|--------------------------|
| Deleterious Rock       | 1.0                      |
| Shale and Pyrite       | 0.2                      |
| Chert in Limestone     | 0.5                      |
| Other Foreign Material | 0.1                      |

**505.40.2.34** Fine aggregate shall be in accordance with [Sec 1005](#) and shall be Class A sand in accordance with [Sec 501](#).

**505.40.2.45** With approval of the engineer, other gradations of coarse or fine aggregate may be used, however all quality requirements, including a maximum of 2.0 percent passing the No. 200 for fine and coarse aggregate, shall apply and the maximum aggregate size shall not exceed that of [Sec 1005](#), Grade E aggregate.

**505.40.2.56** Pozzoloanic material or Portland pozzolan cements shall not be used.

**505.40.2.67** Latex admixture shall be kept in suitable enclosures which will protect it from freezing and from exposure to temperatures in excess of 85 F.

#### **505.40.3 Concrete Mixture.**

**505.40.5 Testing.** Testing will be done in accordance with [Sec 505.10](#), except that the slump test will be conducted 4 to 5 minutes after discharge from the mixer. During the waiting period, concrete shall be deposited on the deck and shall not be disturbed.

**505.40.6 Mixing.**

**505.40.6.1** The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with [Sec 501](#). In addition to other requirements, the mixer shall provide positive control of the latex emulsion into the mixing chamber, and the latex emulsion shall calibrate to within  $\pm 2$  percent of that required. The mixer shall be capable of continuously circulating the latex emulsion and have a flow-through screen between the storage tank and the discharge.

**505.40.6.2** The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace. Final finishing shall be completed before the formation of a plastic surface film on the surface.

**505.40.6.3** The moisture content of aggregates at the time of proportioning shall be such that water will not drain or drip from a sample. Coarse and fine aggregate shall be furnished and handled to avoid variations in the moisture content affecting the uniform consistency of the concrete.

**505.40.6.4** Each drum of latex admixture shall be mechanically agitated or hand rolled until thoroughly mixed prior to being introduced into the mixer storage compartment. Latex admixture that is stored in the mixer storage compartment overnight or during delays in mixing of four hours or more shall be agitated by at least two complete cycles in a continuous circulating pump or by mechanical means in the storage compartment. The flow through screen shall be cleaned immediately prior to beginning proportioning and as often as necessary thereafter. Latex admixtures of different brands shall not be combined together in any manner.

**505.40.6.5** The water/cement ratio shall be within 0.02 of that specified in the approved mix design. If adjustments for water content beyond that are necessary, a previously tested and approved mixture shall be used.

**505.40.6.6** Prior to placement of concrete in the work, the contractor shall be required to prepare trial batches of concrete for testing. Trial batches shall comply with the limits specified in this provision.

**505.40.7 Surface Preparation.** Surface preparation shall be in accordance with [Sec 505.10](#) except as specified herein.

**505.40.7.1** Prior to scarifying or chipping on concrete adjacent to latex modified ~~high~~-[very](#) early strength concrete, 24 hours of curing shall elapse. If practical, or unless otherwise shown on the plans, all scarifying by mechanical units shall be completed prior to placing any latex modified ~~high~~-[very](#) early strength concrete. Areas from which unsound concrete and patches have been removed shall be kept free of slurry produced by wet sawing or wet scarifying by planning the work such that this slurry will drain away from the completed areas of preparation.

**505.40.7.2** On both old and new decks within 24 hours before latex modified ~~high~~-[very](#) early strength concrete placement begins, the entire surface shall be thoroughly cleaned by hydro blasting followed by an air blast in accordance with [Sec 505.10](#).

**505.40.8.0 Finishing Equipment.**



**505.40.8.1** The finishing machine shall be self-propelled with one or more rollers, augers and vibratory pans capable of 1,500 to 2,500 vpm. It shall also be capable of forward and reverse movement under positive control, with a provision for raising all screeds to clear the screeded surface for traveling in reverse. A drag float may be necessary. Any modifications shall be subject to approval from the engineer.

**505.40.8.2** Support rails shall be in accordance with [Sec 505.10](#).

**505.40.9 Placing and Finishing Concrete.** Placing and finishing shall be in accordance with [Sec 505.10](#) except as specified herein.

**505.40.9.1** Prior to placement of latex modified ~~high~~-very early strength concrete, the cleaned surface shall be thoroughly wetted for a minimum of one hour, then covered with polyethylene sheeting until time of concrete placement. The surface shall be damp at the time the overlay is placed. Any standing water in depressions, holes or areas of concrete removal shall be blown out with compressed air. No free water or puddles of standing water shall exist at the time of placement.

**505.40.9.2** Expansion joints and dams shall be formed in the concrete overlay. Formation of the joint by sawing through the overlay will not be allowed.

**505.40.9.3** Water shall not be added to the surface of the concrete during finishing. A commercially available evaporation retardant may be used judiciously with a misting device during the finishing process until the wet burlap is applied only to prevent the surface of the concrete from drying out. The evaporation retardant shall not be used to increase surface workability.

**505.40.9.4** Texturing shall occur immediately after finishing and before the plastic film forms on the surface. Texturing shall be performed in a manner to prevent pulling the concrete away from an existing vertical face. Care shall be taken not to texture too deep and not to tear the surface.

**505.40.9.5** Screed rails and headers shall be separated from the newly placed material by passing a pointing trowel along their inside face. Metal expansion dams shall not be separated from the new overlay. The trowel cut shall be made for the entire depth and length of rails or headers after the mixture has stiffened sufficiently and shall prevent the concrete from flowing back into the cut.

**505.40.9.6** During placement of the overlay, all joints with adjacent concrete shall be sealed with a mortar paste of equal parts cement and fine aggregate, using latex emulsion in lieu of mixing water.

**505.40.9.7** The overlay concrete shall be moist cured from the time placed until opened to traffic.

**505.40.9.8** The wet cure shall be applied promptly after the concrete has been placed on the deck without deforming the finished surface.

**505.40.9.9** Within one hour of covering with wet burlap, a layer of white polyethylene sheeting shall be placed on the wet burlap. The surface shall receive a wet cure until the latex modified ~~high~~-very early strength concrete has attained a compressive strength of at least 3,200 psi.

**505.40.9.10** The thickness of the overlay shall not exceed 3 inches, unless otherwise approved by the engineer.

**505.40.9.11** The finished deck will be examined for cracking. If cracking is found, the engineer will determine whether cracking is detrimental, whether remedial surface repairs are needed or whether the overlay in the cracked area should be removed and replaced. All remedial surface repairs, removal or replacement shall be done by the contractor at the contractor's expense.

**505.40.9.12** After placement and curing of the latex modified ~~high~~-very early strength concrete, the finished deck will be tested to detect unbonded areas.

**505.40.9.13** No surface sealing shall be applied to the latex modified ~~high~~-very early strength concrete wearing surface.

**505.40.10 Limitations of Operations.**

**505.40.10.1** No latex modified ~~high~~-very early strength concrete shall be placed when the ambient or deck surface temperature is above 85 F. Deck temperature shall be determined in accordance with MoDOT Test Method T20.

**505.40.10.2** Since latex modified ~~high~~-very early strength concrete may not exhibit bleed water, the probability of plastic shrinkage cracking is increased. At surface evaporation rates above 0.1 pounds per square foot per hour plastic shrinkage cracking is probable and the contractor should take precautions such as erecting windbreaks, lowering the mix temperature or delaying operations until ambient temperatures are lower. Fogging the concrete surface will only be allowed, as provided for in this specification. Surface evaporation rates can be predicted from mix temperature, air temperature, relative humidity and wind velocity using Figure 1 of ACI 308-81 (revised 1986) "Standard Practice for Curing Concrete".

**505.40.10.3** A fogging system shall be in-place prior to concrete placement. The fogging system shall consist of pressurized equipment that distributes water at minimum rate of 0.10 gallon per hour per square foot. The fogging system shall apply the fog uniformly over the entire surface of the bridge deck. The fogging system shall produce atomized water that has a droplet with a maximum diameter of 0.003 inches and which keeps the finished deck surface saturated without producing standing water. The contractor shall submit a letter certifying that their fogging system is in accordance with this provision.

**505.40.10.4** The fogging system shall be started progressively along the length of the deck, during or immediately after floating.

**505.40.10.5** No latex modified ~~high~~-very early strength concrete shall be placed at ambient or deck surface temperatures below 45 F. Latex modified ~~high~~-very early strength concrete shall be protected to maintain a minimum specified curing temperature of 45 F. The contractor shall provide a method, meeting the approval of the engineer, of monitoring the concrete that demonstrates that the concrete has been maintained above the minimum curing temperature and has been protected from freezing. Any concrete damaged by freezing or which is exposed to a temperature of less than 45 F during the first 8 hours after placement shall be removed and replaced at the contractor's expense.

**505.40.10.6** The temperature of the latex modified ~~high~~-very early strength concrete at time of placement shall be between 45 F and 90 F. If either the aggregate or water is heated, the maximum temperature for each shall be 100 F at the time of addition to the mix. Any method of heating during the mixing of concrete may be used provided the heating apparatus will heat the mass uniformly and avoid hot spots which will burn the material. Cement or aggregate containing lumps or crusts of hardened material or frost shall not be used.

**505.40.10.7** No vehicle traffic shall be permitted on the latex modified ~~high~~-very early strength concrete surface until the latex modified ~~high~~-very early strength concrete has attained a minimum compressive strength of 3,200 psi. Compressive strength will be determined by tests conducted in accordance with MoDOT test methods.

**505.40.10.8** Concrete shall not be placed adjacent to a parallel surface course which is less than 24 hours old; however, this restriction will not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

**505.40.10.9** Preparation of the area, except scarifying, may be started in a lane or strip adjacent to newly placed surface the day following the surface placement. If this work is started before the end of the curing period, the work will be restricted such that any interference with the curing process is held to the minimum practical time only.

**505.40.10.10** Longitudinal construction joints shall be placed between designated traffic lanes. The location of the longitudinal joints shall be subject to the approval from the engineer.

**505.40.10.11** Transverse joints in the overlay may be permitted if approval by the engineer. Transverse joints shall be located a minimum of 10 feet from the centerline of bent.

**505.40.10.12** A header shall be installed in case of delay in the placement operations exceeding one-half hour in duration. During minor delays of one-half hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

**505.40.10.13** Adequate precautions shall be taken to protect freshly placed concrete from rain. All placing operations shall stop when rain begins. The engineer may order removal of any material damaged by rainfall and such material shall be replaced in accordance with this specification at the contractor's expense.

**505.40.11 Removal.** Material removal and disposal shall be in accordance with [Sec 505.10](#).

**505.40.12 Repair.** Repair shall be in accordance with [Sec 505.10](#).

**505.40.13 Method of Measurement.** Measurement will be in accordance with [Sec 505.10](#).

**505.40.14 Basis of Payment.** The basis for payment will be in accordance with [Sec 505.10](#).

## MISSOURI DEPARTMENT OF TRANSPORTATION

22

| ITEM NO. | UNIT | TYPE | ITEM DESCRIPTION                                                         | LAST UPDATED 08/01/2018 |
|----------|------|------|--------------------------------------------------------------------------|-------------------------|
| 5021334  | SQYD | 0.10 | CONCRETE PAVEMENT (10 1/2 IN. NON-REINFORCED, 15 FT. JOINTS)             |                         |
| 5021335  | SQYD | 0.10 | CONCRETE PAVEMENT (11 1/2 IN. NON-REINFORCED, 15 FT. JOINTS)             |                         |
| 5021340  | SQYD | 0.10 | TYPE A2 SHOULDER                                                         |                         |
| 5021341  | SQYD | 0.10 | TYPE A3 SHOULDER                                                         |                         |
| 5022000  | LF   | 1.00 | CONCRETE PAVEMENT NEOPRENE JOINT SEAL                                    |                         |
| 5024006  | SQYD | 0.10 | CONCRETE BASE ( 6 IN. NON-REINF)                                         |                         |
| 5024007  | SQYD | 0.10 | CONCRETE BASE ( 7 IN. NON-REINF)                                         |                         |
| 5024008  | SQYD | 0.10 | CONCRETE BASE ( 8 IN. NON-REINF)                                         |                         |
| 5024009  | SQYD | 0.10 | CONCRETE BASE ( 9 IN. NON-REINF)                                         |                         |
| 5024010  | SQYD | 0.10 | CONCRETE BASE ( 10 IN. NON-REINF)                                        |                         |
| 5029902  | EA   | 1.00 | MISC.                                                                    |                         |
| 5029903  | LF   | 1.00 | MISC.                                                                    |                         |
| 5029905  | SQYD | 0.10 | MISC.                                                                    |                         |
| 5029907  | CUYD | 1.00 | MISC.                                                                    |                         |
| 5031010A | SQYD | 1.00 | BRIDGE APPROACH SLAB (MAJOR ROAD)                                        |                         |
| 5031011A | SQYD | 1.00 | BRIDGE APPROACH SLAB (MINOR ROAD)                                        |                         |
| 5039904  | SQFT | 1.00 | MISC.                                                                    |                         |
| 5039905  | SQYD | 0.10 | MISC.                                                                    |                         |
| 5041000  | SQYD | 0.10 | CONCRETE APPROACH PAVEMENT                                               |                         |
| 5049905  | SQYD | 0.10 | MISC.                                                                    |                         |
| 5050001  | SQYD | 1.00 | ALTERNATE CONCRETE WEARING SURFACE                                       |                         |
| 5051000  | SQYD | 1.00 | LOW SLUMP CONCRETE WEARING SURFACE                                       |                         |
| 5052000  | SQYD | 1.00 | LATEX MODIFIED CONCRETE WEARING SURFACE                                  |                         |
| 5052001  | SQYD | 1.00 | LATEX MODIFIED <del>HIGH</del> - <del>VERY</del> EARLY STRENGTH CONCRETE | SURFACE                 |
| 5053000  | SQYD | 1.00 | SILICA FUME CONCRETE WEARING SURFACE                                     |                         |

|         |      |      |                                                                         |
|---------|------|------|-------------------------------------------------------------------------|
| 7040118 | CUYD | 1.00 | <del>HIGH</del> - <del>VERY</del> EARLY STRENGTH MONOLITHIC DECK REPAIR |
| 7040161 | EA   | 1.00 | DECK GIRDER END REPAIR                                                  |
| 7040163 | SQYD | 1.00 | CONCRETE CRACK FILLER                                                   |
| 7040164 | SF   | 1.00 | FIBER REINFORCED POLYMER REINFORCEMENT                                  |
| 7049901 | LS   | 1.00 | MISC.                                                                   |
| 7049902 | EA   | 1.00 | MISC.                                                                   |
| 7049903 | LF   | 1.00 | MISC.                                                                   |
| 7049904 | SQFT | 1.00 | MISC.                                                                   |
| 7049905 | SQYD | 1.00 | MISC.                                                                   |
| 7049907 | CUYD | 0.10 | MISC.                                                                   |
| 7056000 | LF   | 1.00 | TYPE 2 (32 IN.), PRESTRESSED CONCRETE I-GIRDER                          |
| 7056001 | LF   | 1.00 | TYPE 3 (39 IN.), PRESTRESSED CONCRETE I-GIRDER                          |
| 7056002 | LF   | 1.00 | TYPE 4 (45 IN.), PRESTRESSED CONCRETE I-GIRDER                          |
| 7056003 | LF   | 1.00 | TYPE 6 (54 IN.), PRESTRESSED CONCRETE I-GIRDER                          |
| 7056010 | LF   | 1.00 | TYPE 8 (63 IN.), PRESTRESSED CONCRETE BULB TEE                          |
| 7056011 | LF   | 1.00 | TYPE 7 (72 IN.), PRESTRESSED CONCRETE BULB TEE                          |
| 7056020 | LF   | 1.00 | NU 29, PRESTRESSED CONCRETE NU-GIRDER                                   |
| 7056021 | LF   | 1.00 | NU 35, PRESTRESSED CONCRETE NU-GIRDER                                   |
| 7056022 | LF   | 1.00 | NU 43, PRESTRESSED CONCRETE NU-GIRDER                                   |
| 7056023 | LF   | 1.00 | NU 53, PRESTRESSED CONCRETE NU-GIRDER                                   |

751.6.1 Index of Quantities

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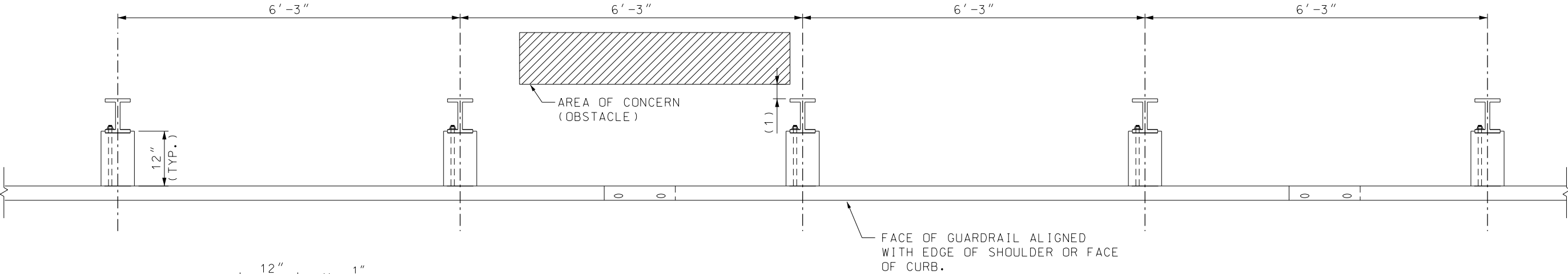
| Item Number | Plan Reporting Accuracy | Units | Item Description |
|-------------|-------------------------|-------|------------------|
|-------------|-------------------------|-------|------------------|

...

|           |   |          |                                                                                    |
|-----------|---|----------|------------------------------------------------------------------------------------|
| 505-20.01 | 1 | sq. yard | Latex Modified <del>High</del> <u>Very</u> Early Strength Concrete Wearing Surface |
|-----------|---|----------|------------------------------------------------------------------------------------|

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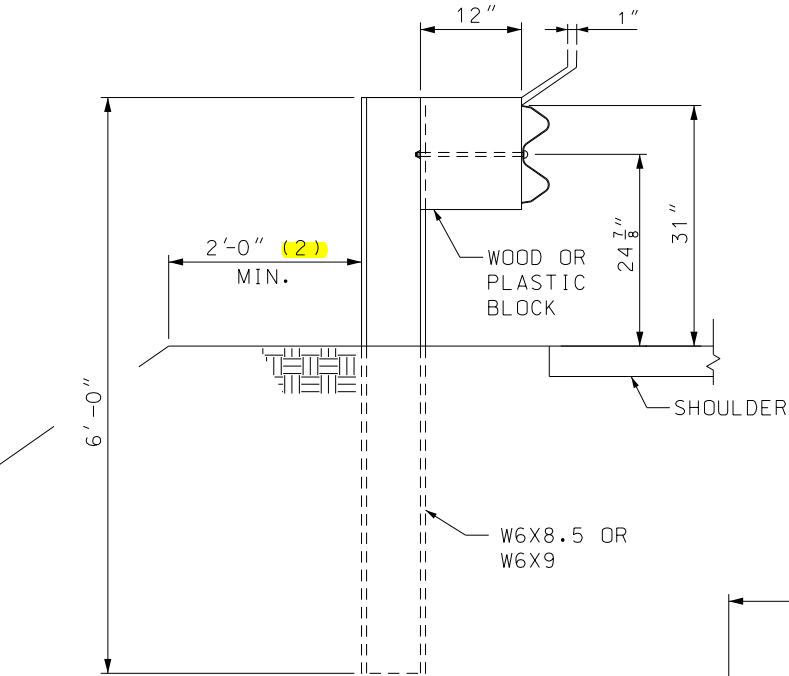
|           |   |          |                                                                                                                                                                                                                                          |
|-----------|---|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 704-01.17 | 1 | cu. yard | Monolithic Deck Repair<br>Note: Use with latex modified or silica fume concrete wearing surfaces.<br>Don't use with polyester polymer, low slump or latex modified <del>high</del> <u>very</u> early strength concrete wearing surfaces. |
| 704-01.18 | 1 | cu. yard | <del>High</del> <u>Very</u> Early Strength Monolithic Deck Repair<br>Note: Only use with latex modified <del>high</del> <u>very</u> early strength concrete wearing surfaces.                                                            |



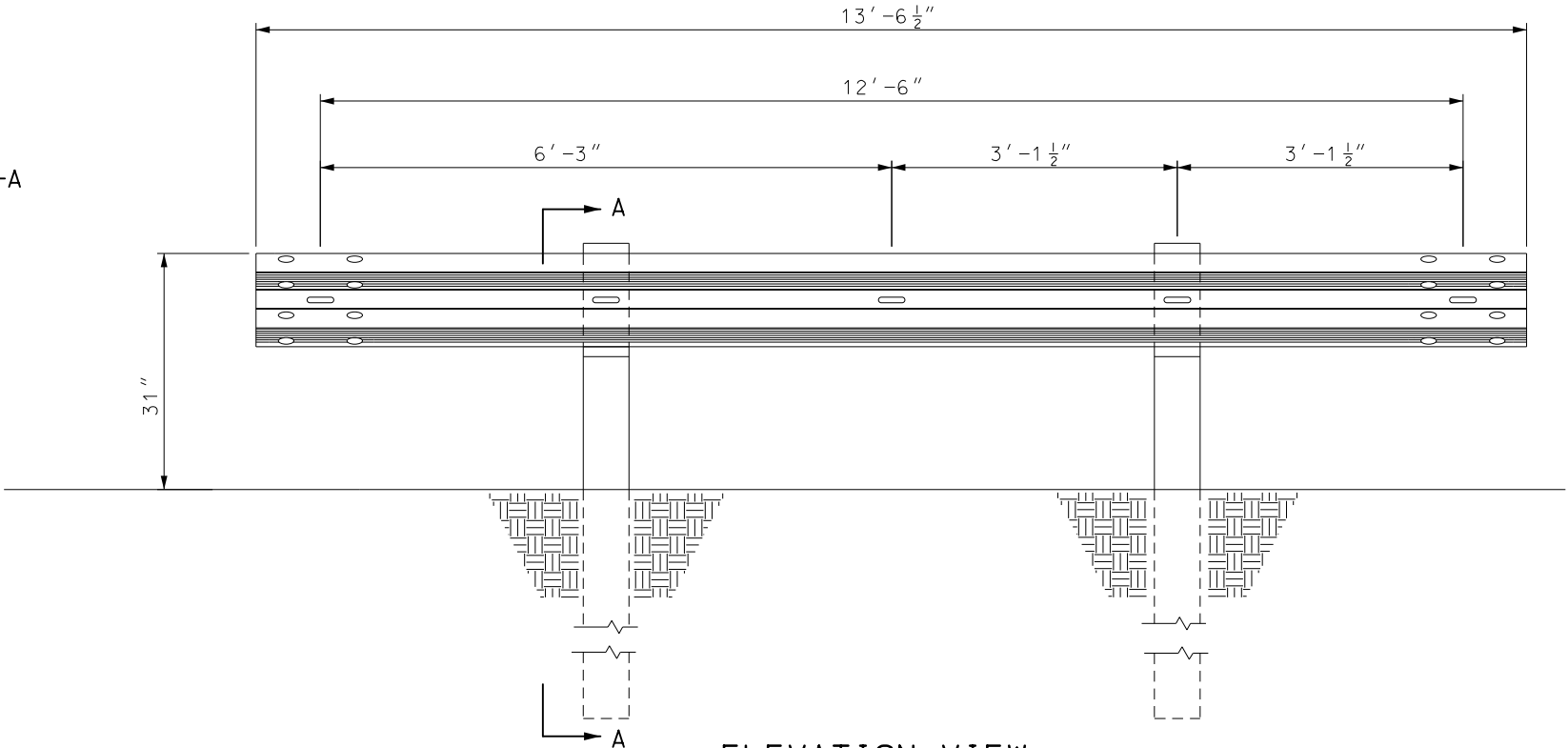
PLAN VIEW

(1) 2'-6" MINIMUM CLEARANCE TO THE FACE OF OBSTACLE WITH 6'-3" POST SPACINGS, 2'-0" MINIMUM CLEARANCE TO THE FACE OF OBSTACLE WITH 3'-1 1/2" POST SPACINGS, OR 1'-6" MINIMUM CLEARANCE TO THE FACE OF OBSTACLE WITH 1'-6 3/4" POST SPACINGS. SEE SHEET 4 OF 8 FOR POST SPACING DETAILS.

(2) WHEN SITE CONSTRAINTS PROHIBIT OR EMBANKMENT CANNOT BE CONSTRUCTED TO PROVIDE A MINIMUM OF 2 FEET BETWEEN THE BACK OF THE GUARDRAIL POST AND SLOPE BREAK POINT, 8 FOOT POSTS SHALL BE USED (SEE SHEET 6 OF 8). THE SUBSTITUTION OF 8 FOOT POSTS FOR REQUIRED GRADING SHALL NOT BE ALLOWED.



SECTION A-A



ELEVATION VIEW

GENERAL NOTES:

FOR INITIAL INSTALLATION, CONSTRUCT THE GUARDRAIL WITHIN 1" OF THE STANDARD 31" HEIGHT TO THE TOP OF W-BEAM RAIL. WHEN SUBSEQUENT PROJECTS, SUCH AS RESURFACINGS, AFFECT THE HEIGHT OF EXISTING GUARDRAIL, ADJUSTMENT IS NOT REQUIRED IF THE FINISHED HEIGHT IS WITHIN 3" OF THE STANDARD HEIGHT.

THE STANDARD POST LENGTH IS 6'-0" (+3", -0" TOLERANCE).

~~WHERE SITE CONSTRAINTS PROHIBIT THE POST FROM BEING PLACED AT LEAST TWO FEET IN FRONT OF THE SLOPE BREAK POINT, USE 8 FOOT POSTS AS SHOWN ON SHEET 6 OF 8.~~

REFER TO AASHTO M 180 FOR DIMENSIONAL DETAILS OF W-BEAM, RELATED BUFFER AND END SECTIONS, BEAM SPLICES, POST AND SPLICE BOLTS, NUTS, AND TYPE 1 W-BEAM TO THRIE BEAM TRANSITION SECTIONS.

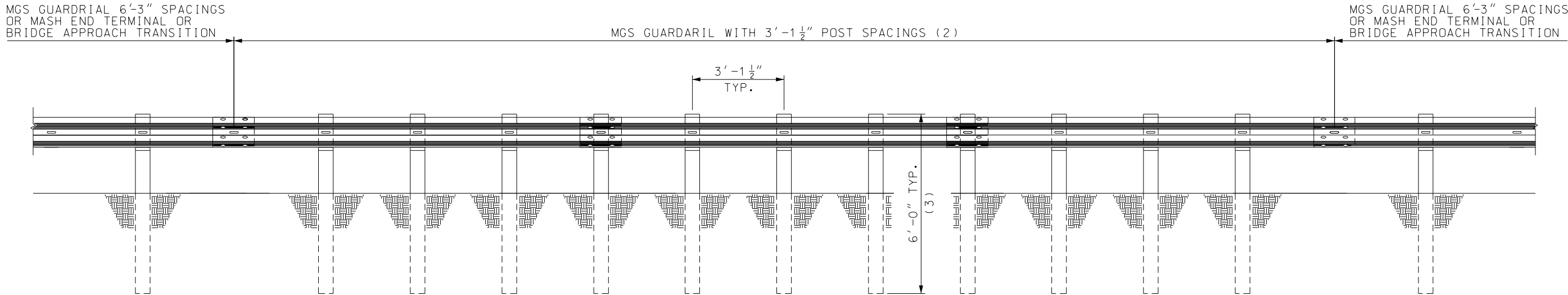
BEAM WASHERS ARE NOT TO BE USED. BOLT GRADE SHALL BE ASTM A307.

UNLESS OTHERWISE SPECIFIED, W-BEAM RAIL IS 12 GAUGE STEEL WITH AN EFFECTIVE LENGTH OF 12'-6" OR 25'-0", WITH 29 3/32" X 1 1/8" SPLICE BOLT SLOTS, AND 3/4" X 1/2" POST BOLT SLOTS ON 3'-1 1/2" CENTERS REGARDLESS OF POST SPACING.

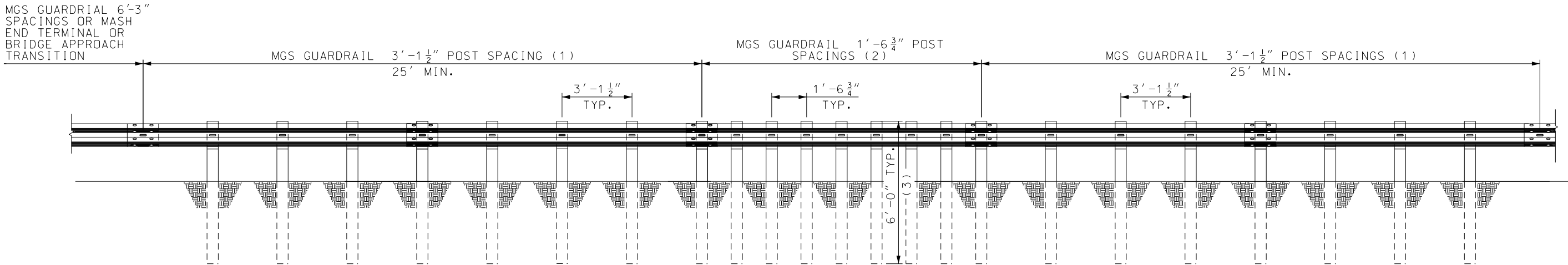
FOR PROTECTIVE COATING AND MATERIAL REQUIREMENTS, SEE SEC 1040 OF THE STANDARD SPECIFICATIONS.

LAP SPLICES BETWEEN TWO RAILS OR BETWEEN A RAIL AND TERMINAL CONNECTOR IN THE DIRECTION OF TRAFFIC. LAP THE FLARED END SECTIONS IN THE DIRECTION OF TRAFFIC.

|                                                                                                                                                                                                                                  |                                                        |                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---------------------------------------|
|  <b>MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION</b><br>105 WEST CAPITOL<br>JEFFERSON CITY, MO 65102<br>1-888-ASK-MODOT (1-888-275-6636) |                                                        |                                       |
| "THIS MEDIA SHOULD NOT BE CONSIDERED A CERTIFIED DOCUMENT."                                                                                                                                                                      | <b>MIDWEST GUARDRAIL SYSTEM (MGS) GUARDRAIL</b>        |                                       |
|                                                                                                                                                                                                                                  | DATE EFFECTIVE: 01/01/2019<br>DATE PREPARED: 9/28/2018 | SHEET NO.<br><b>606.50D</b><br>1 OF 8 |



MGS GUARDRAIL WITH 3'-1 1/2" POST SPACING



MGS GUARDRAIL WITH 1'-6 3/4" POST SPACING

- (1) 25 FEET OF MGS 3'-1 1/2" POST SPACING GUARDRAIL IS REQUIRED ON APPROACH AND DEPARTURE ENDS OF 1'-6 3/4" POST SPACING MGS GUARDRAIL.
- (2) USE AS MANY SEGMENTS AS NECESSARY TO SHIELD THE AREA OF CONCERN.
- (3) REDUCED POST SPACING SHALL USE 6'-0" POSTS MAX. ANY DEVIATION OF 6'-0" POSTS WILL ONLY BE ALLOWED IN ACCORDANCE WITH SPECIAL INSTALLATIONS AS SHOWN ON SHEET 5 OF 8.
- (4) 8' POSTS CANNOT BE USED WHEN:
- POST SPACING IS LESS THAN 6'-3"
  - WITHIN CRASHWORTHY END TERMINALS (SEE MANUFACTURERS DRAWINGS)
  - WITHIN VERTICAL BARRIER TRANSITIONS (606.60)
  - WITHIN BRIDGE APPROACH TRANSITIONS (606.70).



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MIDWEST GUARDRAIL SYSTEM (MGS)  
REDUCED POST SPACINGS

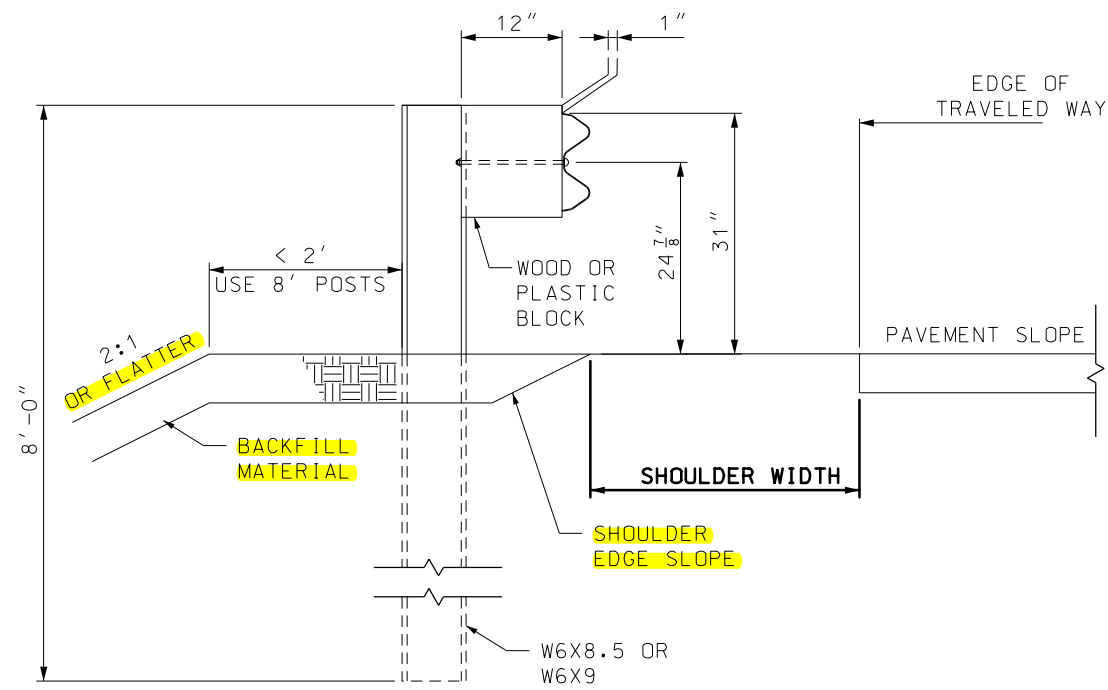
DATE EFFECTIVE: 01/01/2019  
DATE PREPARED: 9/27/2018

606.50D

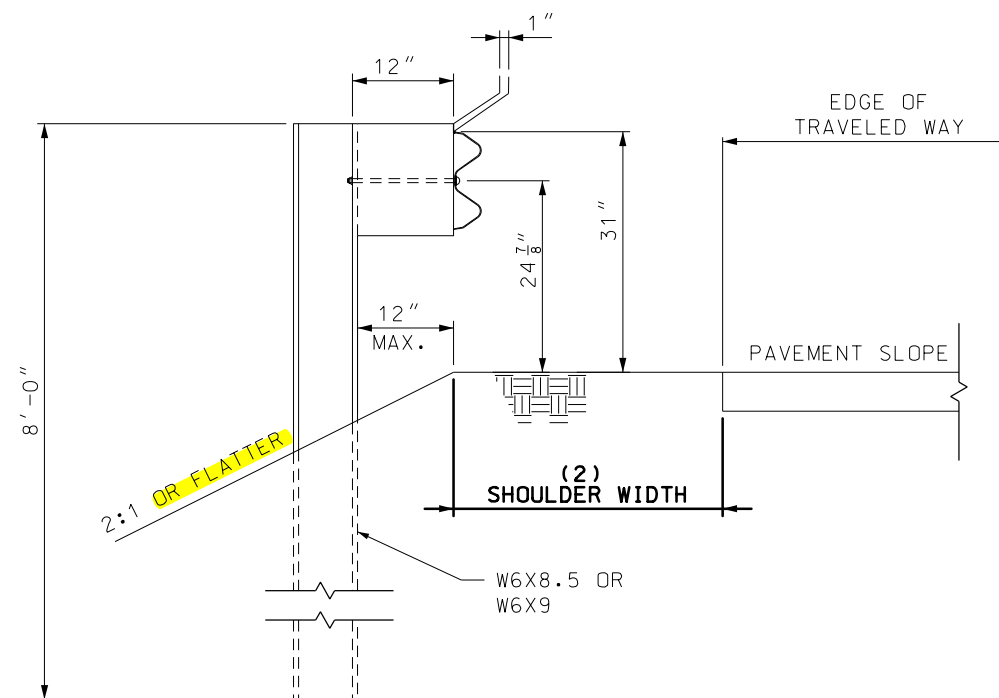
SHEET NO.

4 OF 8

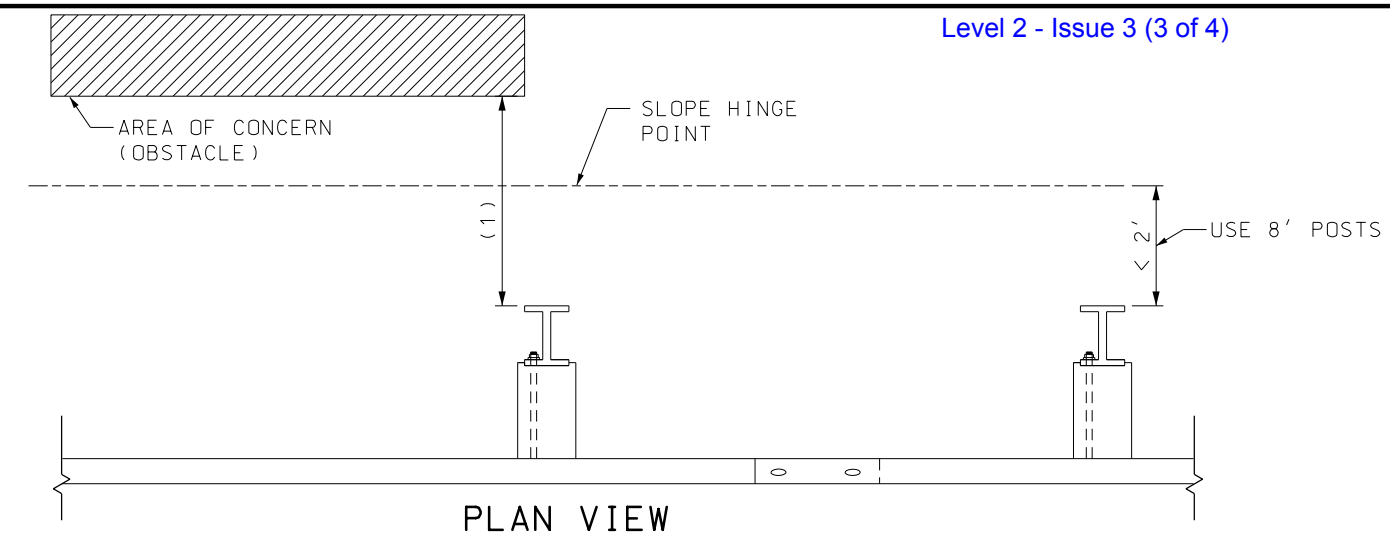
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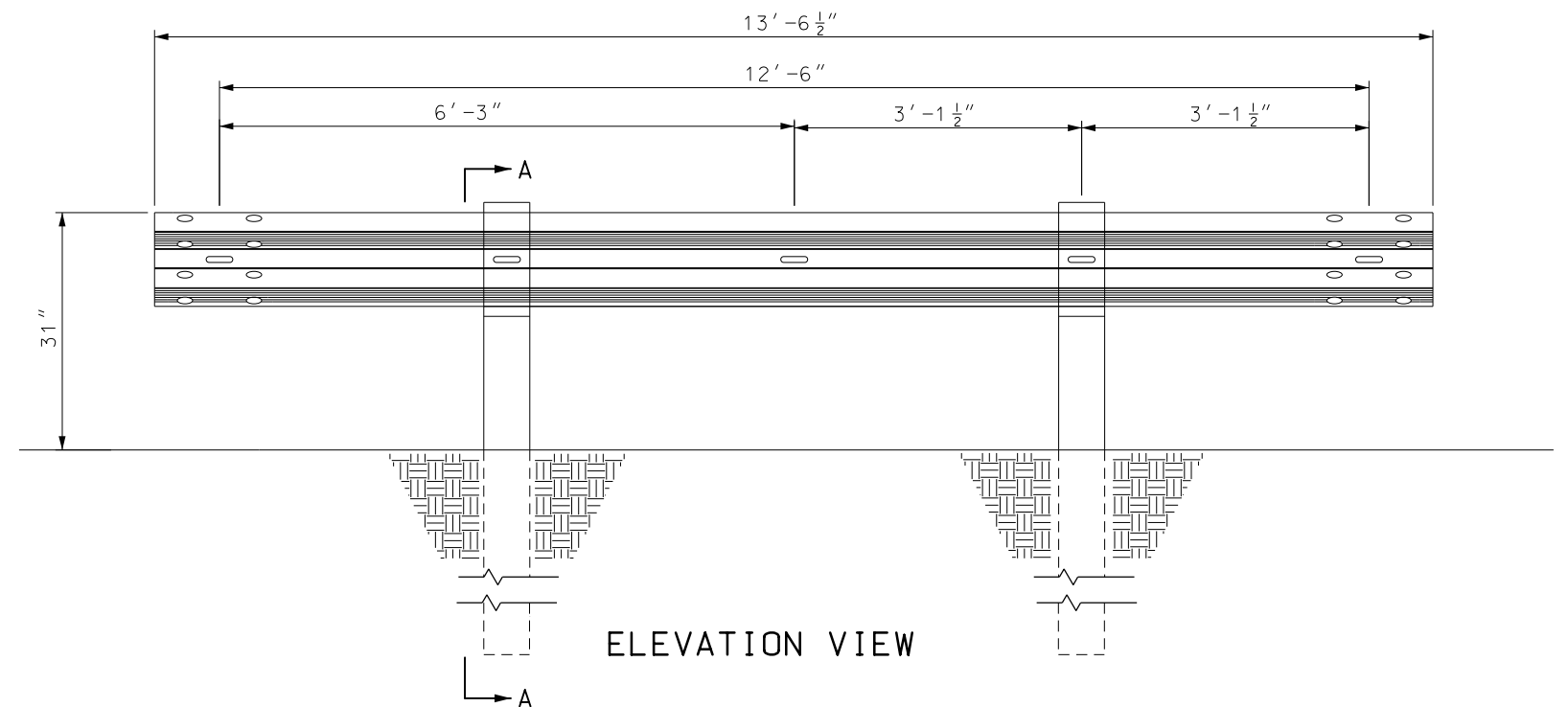
SECTION A-A  
8' STEEL POST



ALTERNATE SECTION A-A  
MAXIMUM LATERAL PLACEMENT OF  
8' STEEL POSTS ADJACENT TO  
SLOPES



PLAN VIEW



ELEVATION VIEW

NOTES:  
SEE STD. PLAN 606.81 FOR SITE GRADING REQUIREMENTS  
FOR CRASHWORTHY END TERMINALS.

8 FOOT POSTS SHALL BE USED ONLY WHEN LESS THAN 2 FEET OF EMBANKMENT IS PRESENT BETWEEN THE BACK OF THE GUARDRAIL POST AND THE SLOPE BREAK POINT.

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MIDWEST GUARDRAIL SYSTEM  
(MGS)  
8 FT. POST

DATE EFFECTIVE: 01/01/2019  
DATE PREPARED: 9/28/2018

606.50D

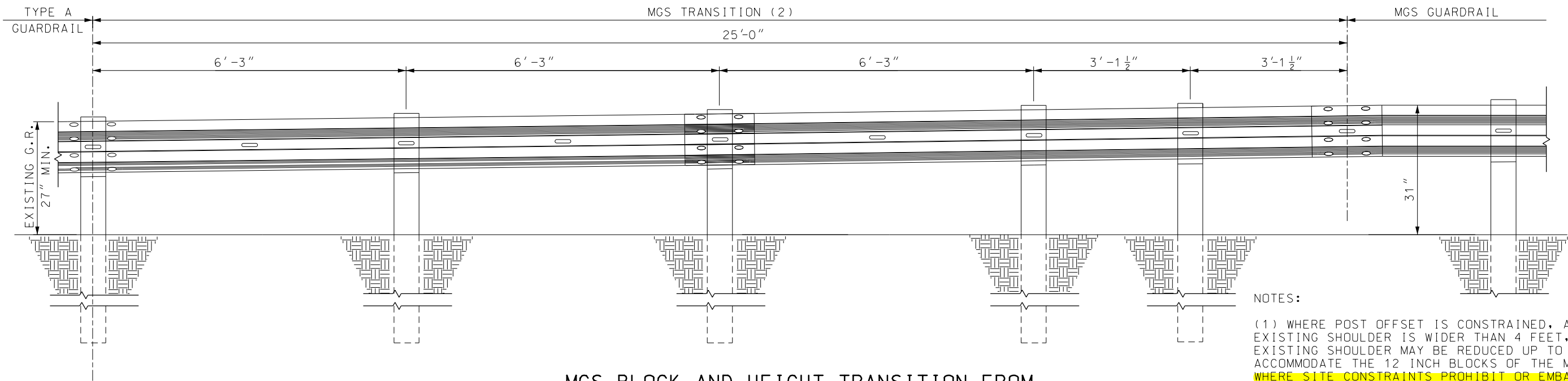
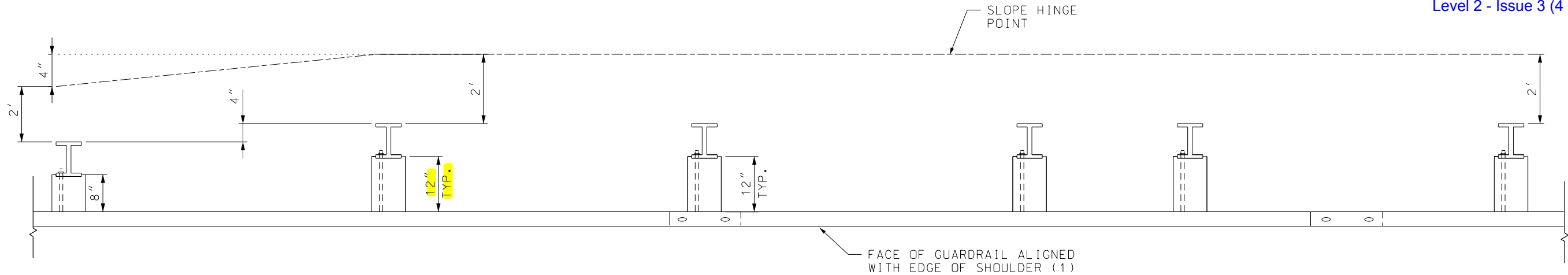
SHEET NO.  
6 OF 8

(1) 3'-6" MINIMUM CLEARANCE TO THE FACE OF OBSTACLE WITH 8' POSTS ADJACENT TO A 2:1 SLOPE.

(2) WHERE THERE IS NOT SUFFICIENT EMBANKMENT BEYOND THE SHOULDER TO PLACE THE GUARDRAIL POST, THE POSTS MAY BE PLACED A MAXIMUM OF 12" BEYOND THE SLOPE BREAK POINT OF A 2:1 OR FLATTER SLOPE. THE SUBSTITUTION OF 8 FOOT POSTS FOR REQUIRED GRADING SHALL NOT BE ALLOWED.

IF A SEAL IS PRESENT ON THIS SHEET IT HAS BEEN ELECTRONICALLY SEALED AND DATED:

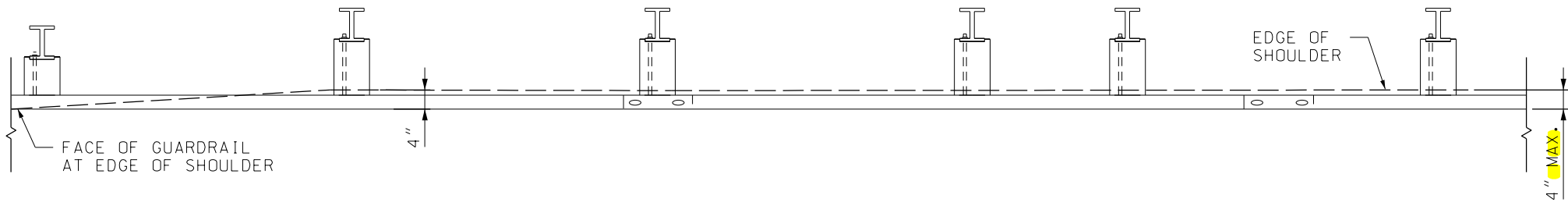




NOTES:

(1) WHERE POST OFFSET IS CONSTRAINED, AND WHEN THE EXISTING SHOULDER IS WIDER THAN 4 FEET, THE EXISTING SHOULDER MAY BE REDUCED UP TO 4 INCHES TO ACCOMMODATE THE 12 INCH BLOCKS OF THE MGS GUARDRAIL. WHERE SITE CONSTRAINTS PROHIBIT OR EMBANKMENT CANNOT BE CONSTRUCTED TO PROVIDE A MINIMUM OF 2 FEET BETWEEN THE BACK OF THE GUARDRAIL POST AND SLOPE BREAK POINT, 8 FOOT POSTS SHALL BE USED (SEE SHEET 6 OF 8). THE SUBSTITUTION OF 8 FOOT POSTS FOR REQUIRED GRADING SHALL NOT BE ALLOWED.

(2) MGS TRANSITION FROM TYPE A GUARDRAIL SHALL BE COMPLETED OUTSIDE THE 50' MGS END TERMINAL LIMITS.



SEE NOTE (1)

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**MIDWEST GUARDRAIL SYSTEM (MGS) BLOCK AND HEIGHT TRANSITION**

of full depth repair or at least once per project. The compressive strength shall be the average of the cylinder breaks.

**613.10.2.4.2** The concrete shall have an air content in accordance with Sec 501.10.2. The air content shall be measured once for every day's production.

**613.10.2.4.3** The concrete opening strength to all traffic shall be 2000 psi. The opening strength shall be verified by either compressive strength testing of cylinders in accordance with [Sec 613.10.2.4.1](#) ~~or~~ the maturity method in accordance with [Sec 507](#), or in accordance with MoDOT TM-7 using a rebound hammer. If MoDOT TM-7 is used, the minimum rebound ratio number (RNN) for opening strength shall be 60.

**613.10.2.5** If the concrete pavement has been previously resurfaced, the repair area shall be filled with Portland cement concrete to the surface of the existing bituminous overlay, even when the existing surface is to be removed by milling, unless contract provisions allow the milling to occur prior to the pavement repair operation.

**613.10.2.6** When the concrete pavement requires all milled areas to be resurfaced in the same work day prior to opening the pavement to traffic, pavement repairs identified after milling will be marked for future repair, and the area shall be resurfaced as planned for that work day. No additional lifts of hot-mix asphalt will be allowed until the marked pavement is repaired. The pavement repair shall be performed in accordance with [Sec 613.10.2.5](#).

**613.10.2.7** Immediately after finishing and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods.

**613.10.2.7.1** If the existing pavement has been or is to be resurfaced, an asphalt emulsion shall be applied at a rate of 0.1 gallon per square yard, or as directed by the engineer.

**613.10.2.7.2** If the existing pavement surface is concrete and will not be resurfaced, curing shall be in accordance with [Sec 502](#).

**613.10.2.7.3** When the ambient air temperature is below 50 F, insulated curing mats, approved by the engineer, shall be used throughout the curing period. Curing compound or asphalt emulsion shall be applied prior to placing the insulated blankets. The insulated curing mats shall not be applied until the curing material has dried sufficiently to prevent adhesion.

**613.10.2.8** Sawing of internal transverse and longitudinal joints and mitigation of uncontrolled cracking shall be in accordance with [Sec 502.5.3](#).

### **613.10.3 Method of Measurement.**

**613.10.3.1** Measurement for full depth sawing will be made to the nearest linear foot for the combined length of perimeter diamond saw cuts and of internal transverse saw cuts at 6 foot or greater intervals.

**613.10.3.2** Measurement for drilling dowel or tie bar holes and furnishing and installing dowels or tie bars will be made per dowel or tie bar.

**613.10.3.3** Measurement for furnishing and placing Portland cement concrete will be made to the nearest 1/10 square yard.

**613.10.3.4** Measurement of subgrade compaction will be made to the nearest square yard.

## 106.3.2.7 TM-7, Rebound Hammer for Opening Strength of Full Depth Concrete Pavement Repairs

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This method describes a procedure for using the rebound hammer to determine the opening strength of full depth concrete pavement repairs.

### Contents

106.3.2.7.1 Apparatus

106.3.2.7.2 Verification

106.3.2.7.3 Procedure

### 106.3.2.7.1 Apparatus

Rebound Hammer



The apparatus shall consist of the following:

(a) Rebound hammer, consisting of a spring-loaded steel hammer which when released strikes a steel plunger in contact with the concrete surface. The spring-loaded hammer must travel with a consistent and reproducible velocity. The rebound distance of the steel hammer from the steel plunger is measured on a linear scale attached to the frame of the instrument.

(b) Abrasive stone, consisting of medium-grain texture silicon carbide or equivalent material.

(c) Verification anvil, used to check the operation of the rebound hammer. An instrument guide is provided to center the rebound hammer over impact area and keep the instrument perpendicular to the anvil surface. The anvil shall be constructed so that it will result in a rebound number of at least 75 for a properly operating instrument.

**Abrasive Stone**



**Verification Anvil**

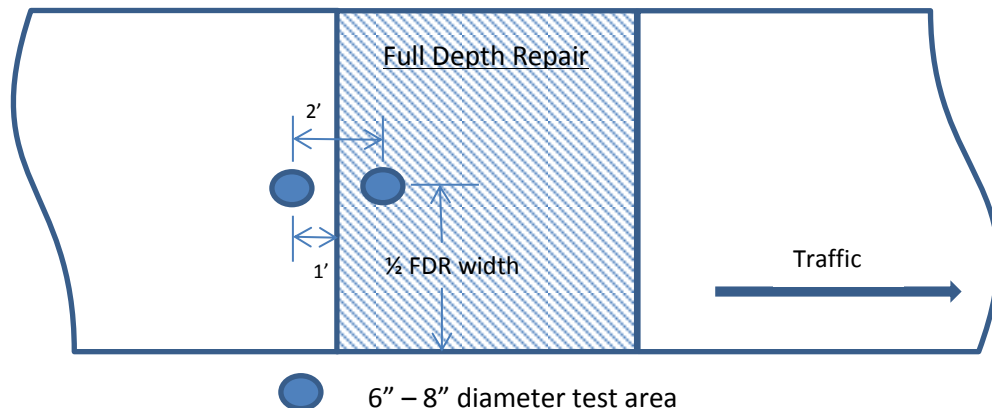


### 106.3.2.7.2 Verification

Rebound hammers shall be serviced and verified annually and whenever there is reason to question their proper operation. The functional operation shall be verified on the test anvil. Typically, a properly operating rebound hammer will result in a rebound number of  $80 \pm 2$  when tested on the anvil. The test anvil must be supported on a rigid base to obtain reliable rebound numbers.

### 106.3.2.7.3 Procedure

- (a) **Test Areas** - Two areas will be tested – one on the full depth concrete patch and one on the adjacent existing concrete slab. Each test location will be centered transversely along the repair and centered longitudinally approximately one foot from the repair joint and two feet from each other. Each test area will be between 6 and 8 inches in diameter.



- (b) **Surface Prep.** Heavily textured test areas shall be ground smooth with the abrasive stone. Each test area should have similar smooth textures. Any loose mortar or other detritus shall be thoroughly brushed away. Any free surface water shall be removed.

- (c) **Testing.** Testing temperatures shall be 40°F or higher. The rebound hammer shall be held firmly so that the plunger is perpendicular to the test area surface. The device shall be gradually pushed toward the test surface until the hammer impacts. After impact, constant pressure shall be maintained on the device and, if necessary, the button on the side to lock the plunger in its retracted position shall be depressed. The rebound number on the scale shall be recorded to the nearest whole number. Ten readings shall be taken in each test area with no impact points closer than one inch of each other. If the impact crushes or breaks through a near-surface void, the reading shall be disregarded and another impact location shall be tested. The same rebound hammer shall be used for both test areas.

#### Depressing the Plunger



### Reading the Scale



- (d) **Calculation.** The ten readings shall be averaged. If any reading differs by more than 6 units from the average, it shall be discarded and the average of the remaining readings shall be calculated. If more than two readings differ from the average, the entire set of readings shall be discarded and rebound numbers shall be determined at ten new locations within the test area.

The ratio of the average rebound in the full depth patch test area over the average rebound in the full depth patch test area (RNN) shall be calculated.

$$\text{Rebound Ratio Number (RNN)} = \frac{\text{Full depth repair rebound number average}}{\text{Adjacent concrete slab rebound number average}} (100)$$

## **Category: 626 Rumble Strips**

Rumble strips are a grooved pattern in the pavement that ~~make road travel safer for motorized vehicles~~improves safety by alerting drivers as they unintentionally stray from the roadway. The grooves alert drivers by causing the vehicle's wheels to noisily and suddenly vibrate when it leaves the driving lane.

This article deals with both edgeline and centerline rumble strips as well as the construction inspection guidelines that must be considered to achieve a high-quality product. Guidance is also presented for transverse rumble strips, warning devices placed ~~in~~horizontally across the driving lane.

For information on Temporary Rumble Strips for use in work zones, refer to EPG 616.6.87 Temporary Rumble Strips (MUTCD 6F.87).

District Responsibility. ~~A higher level of collaboration~~Collaboration with the Highway Safety and Traffic Division and ~~the Design Divisions of Central Office~~Division is necessary prior to a ~~District Engineer's~~ approval of a design exception to omit or modify ~~systemwide~~these system-wide safety improvements (such as rumble strips) on a project.

It is the district's responsibility to re-install obliterated or deteriorated rumble strips.

### **626.1 Edgeline Rumble Strips**

Edgeline rumble strips are used to enhance safety on every paved shoulder at least 2 ft. ~~wide in~~width, unless the shoulder has a curbed section or is intended to be used as a future travel lane. Rumble strips are omitted where the posted speed is less than 50 mph. All major roads will have edgeline rumble strips unless the posted speed is less than 50 mph.

In most situations, edgeline pavement marking material is sprayed over the milled rumble strip, creating what is referred to as a "rumble stripe." This is standard practice (see Standard Plan 620.00) and the preferred application. Any deviation from this typical application shall be submitted as a design exception.

Where full depth pavement extends beyond the travel lane and into the shoulder area at least 12 inches (e.g., pavement widths 13 ft. or greater), the rumble stripe should be placed in the full depth section of widened pavement (see Standard Plan 626.00).

In any case, when resurfacing and milling rumbles, the roadway surface course asphalt mix used for the travel lanes should extend a minimum of 18 inches beyond the edge of the travel lane and onto the shoulder so that the rumble strip is milled into the roadway surface course mix. For divided highways with 4 ft. inside shoulders, the roadway surface course mix should extend the full width of the inside shoulder.

Where the width of full depth pavement does not extend at least one (1) foot onto the shoulder, and the rumble strip must be placed on, or partially on, a shoulder with less than full depth



pavement, as indicated on Std. Plan 626.00 ( $\leq 12'$  Pavement Structure), the condition and depth of the shoulder structure should be evaluated prior to determining the location of the edgeline. If the shoulder condition and depth is deemed adequate to support routine off-tracking of traffic onto the rumble strip, the edgeline stripe should be placed over the rumble strip as shown in the Standard Plans (i.e., rumble stripe). If evidence suggests the shoulder condition or depth is inadequate to support routine off-tracking of traffic onto the rumble strip, placement of the edgeline stripe and rumble strip may be considered as follows:

- For major roads, the edgeline stripe should be placed in the travel lane with the rumble strip placed 4 inches beyond the edgeline stripe. The rumble strip should not be moved further out from the centerline. The goal is to leave as much shoulder width as feasible beyond the rumble strip. A design exception shall be submitted when separating the edgeline stripe from the rumble strip. See EPG 231.4 for recommended shoulder widths. A separate design exception may be necessary for insufficient shoulder width.
- For minor roads, a mini rumble strip (6 inches wide) should be placed along the edge of the travel lane structure provided sufficient driving width remains. The edgeline stripe (4 inches) should be placed over the inside edge of the mini rumble strip (i.e., mini rumble stripe).

In urban areas, where the rumble noise has been identified as a significant issue, the preferred method of mitigation is to ~~offset~~place the edgeline stripe on the edge of the travel lane and the rumble strip 1 ft. onto the shoulder pavement. In areas where this ~~offset would be~~is insufficient to mitigate noise concerns, rumble strips may be omitted for short sections, by ~~design exception only~~.

~~Edgeline rumble strips may be used on minor roadways as a specific safety countermeasure with a paved shoulder. Where several sections of edgeline rumble strips are installed in close proximity, continuity should be maintained.~~design exception only.

Edgeline rumble strips are to be milled into bituminous and portland cement concrete. ~~Milling has little or no effect on the integrity of the pavement structure and milled rumble strips produce greater noise and vibration than rolled or formed rumble strips. Refer to Standard Plan 626.00 for details.~~ Edgeline rumble strips are omitted ~~between the radius points for~~ through side road approaches, entrances, and median crossovers as shown in Standard Plan 626.00. Edgeline rumble strips should be omitted on bridges and on ramps for diamond, single point, partial cloverleaf, and similar types of interchanges, but may be considered on longer ramps for directional or other large interchanges. The length of edgeline rumble strip installation is to be estimated and pay items provided.

~~Edgeline pavement marking material is sprayed over the rumble strip, creating what is often called a "rumble stripe."~~

## **626.2 Centerline Rumble Strips**

All two-lane major roads with new pavement will have centerline rumble strips (see figure at right) unless the posted [speed](#) is less than 50 mph. Centerline rumble strips are provided on all major two-lane roads, and on minor roads with a cross-centerline accident history. Rumble strips on a centerline have been shown to reduce head-on crashes by alerting drivers that they are leaving their lane of travel. On roadways with a travelway width of 20 ft., [or less](#), centerline rumble strips become obtrusive and are not recommended.

As with edgeline rumble strips, pavement marking material is sprayed over the centerline rumble strip, creating what is often called a “rumble stripe.”

Rumble strips in the median of typical passing lane roadways (see Passing Lanes Special Sheet) vary somewhat from centerline rumble strips on typical two-lane roadways (see figure, [at left below](#)). Passing lanes can operate effectively with no separation between opposing lanes of travel. While no separation is required, AASHTO guidance recommends that some separation, however small, between the lanes in opposite directions of travel is desirable. Therefore, a flush separation of 4 ft. ~~(1.2 m)~~ between the opposing directions of travel is preferred (see typical section), if at all possible.

In order to maintain the integrity of the rumble strip and the pavement, the pavement material must be either concrete or the final lift of bituminous material must be least 1 ~~3/4 in. thick, and the pavement must have a final asphalt thickness of at least 3 3/4 in.~~ [inch thick](#). Centerline rumble strips are not to be placed on bridges or within the limits of an intersection with left turn lanes. The limits of the intersection are defined by the beginning of the tapers for the left turn lanes. The length of centerline rumble strip installation should be estimated and pay items provided.