ENGINEERING POLICY BALLOT

Effective: July 1, 2021

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: July 1, 2021

Issue 1: Big Block Unbonded Concrete Overlay

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

Sponsor: John Donahue – CM
Richard Prosser - DE

Summary: Concrete overlays have been a pavement rehabilitation option for several years, however there are no standard plan details for design teams, construction inspectors, or contractors. New Standard Plan 506.20 was developed to incorporate big block concrete overlay into the Standard Plans.

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

Publication: Standard Plan 506.20

Issue 2: Crashworthy End Terminals with Curb

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

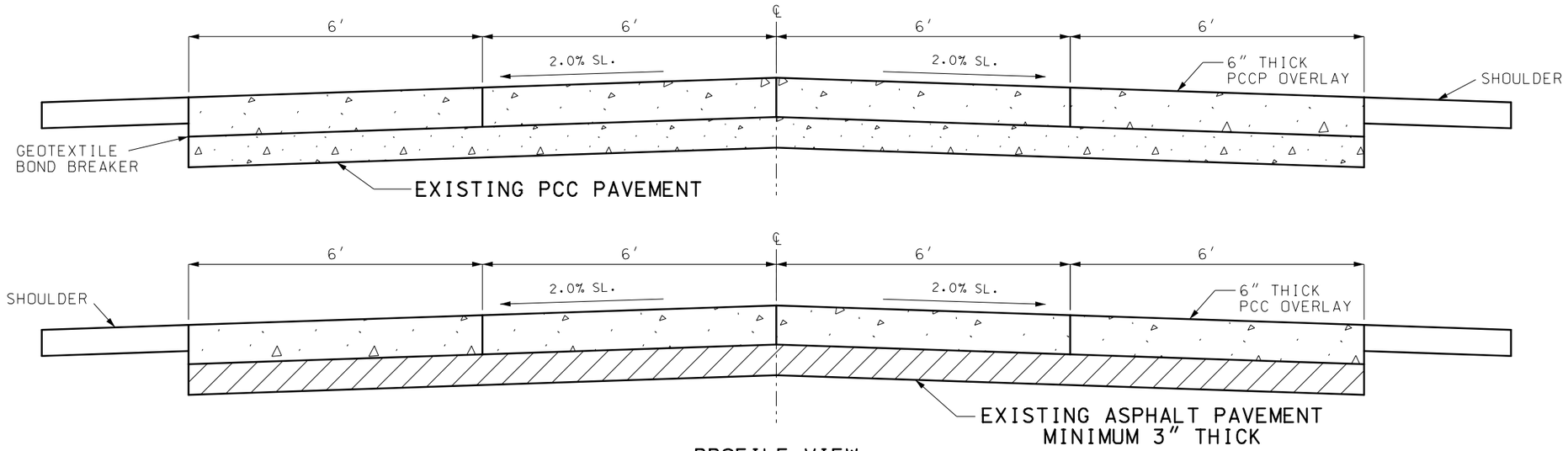
Sponsor: Sarah Kleinschmit - DE
Nickolas Voltenburg - DE

Summary: EPG 606.1 is being updated to reduce or eliminate curb heights in the vicinity of crashworthy end treatments (CETs). There is potential of ramping situations at CETs when curb heights exceed 4". Until full-scale crash testing can be performed, the EPG guidance will be to reduce curbs to 4" or less where drainage and embankment are not adversely affected. In addition to the curb height revisions, grammatical and clarification revisions are also included.

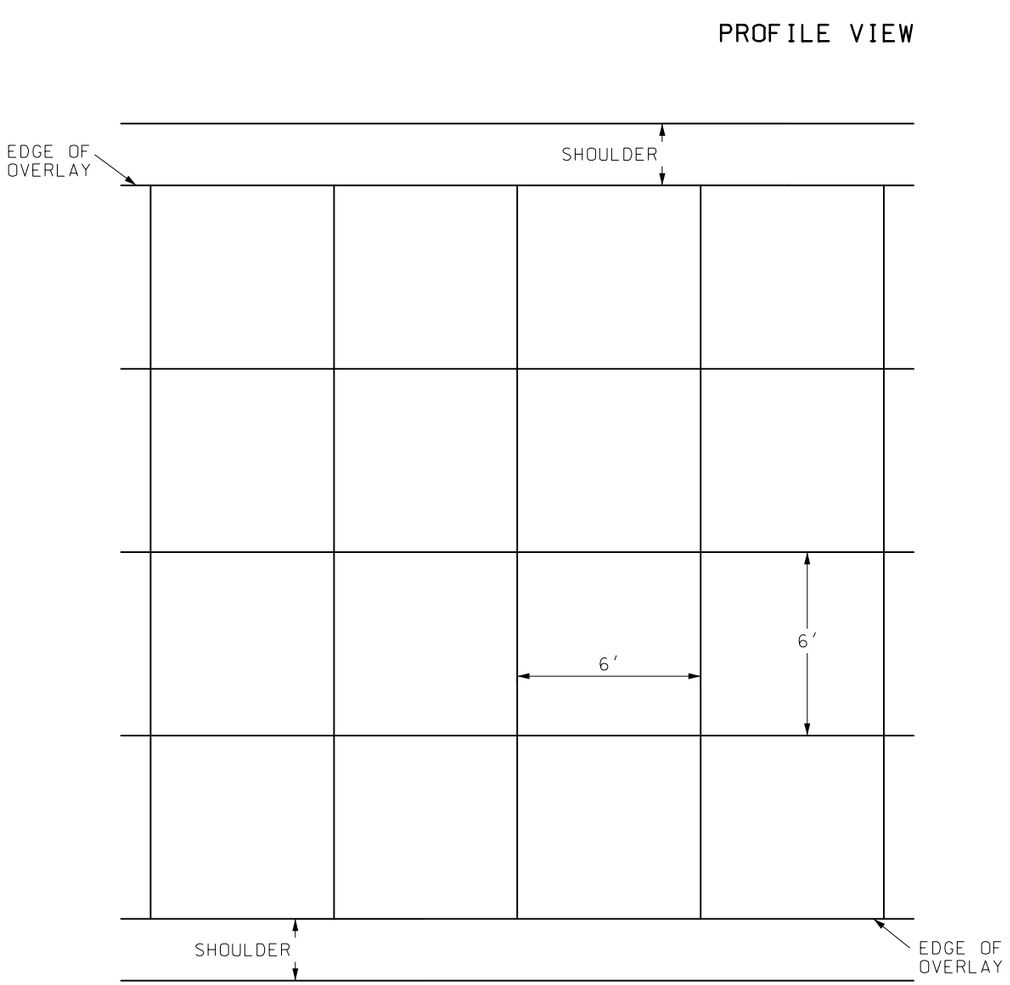
Fiscal Impact: There is no anticipated fiscal impact associated with this revision.

Publication: EPG 606.1

Level 2 - Issue 1 (1 of 1)



PROFILE VIEW



JOINT LAYOUT

GENERAL NOTES:

CONCRETE OVERLAY DESIGN THICKNESS WILL VARY BASED ON TRAFFIC VOLUMES, BUT WILL TYPICALLY RANGE FROM $5\frac{1}{2}$" TO 6". THE CONSTRUCTION AND MATERIALS PAVEMENT SECTION WILL DETERMINE THE DESIGN THICKNESS.

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
105 WEST CAPITOL
JEFFERSON CITY, MO 65102
1-888-ASK-MODOT (1-888-275-6636)

New Standard Plan

BIG BLOCK UNBONDED CONCRETE OVERLAY

DATE EFFECTIVE: 07/01/2021
DATE PREPARED: 1/27/2021

506.20

SHEET NO.
1 OF 1

Crashworthy End Terminals and Crash Cushions

If an embedded terminal or rock face anchor cannot be installed, consider installing a crashworthy end terminal and/or crash cushions. Crashworthy end terminals and crash cushions are devices used to provide an acceptable level of safety to the end of a roadside barrier or fixed object. Such treatment is required because of the serious consequences that may result from a vehicle impacting an untreated unprotected barrier or object. An untreatedprotected barrier or object end can cause an impacting vehicle to abruptly stop, become unstable or roll; it can even penetrate the passenger compartment, all of which increase the risk of injury to the vehicle's occupants.

An approved cErashworthy end terminals or crash cushions is a device or system that hasve met the safety requirements contained in MASH are deemed crashworthy and has beenmust be listed as eligible for use on the NHS by FHWA. MoDOT then reviews these items and makes a determination of their use on Missouri's state-owned roadways. Refer to MoDOT's End Terminals, Crash Cushions and Barrier Systems website for more information on qualified approved crashworthy end terminals.

While crashworthy end terminals do not need to haverequire an offset at the end, a flare is recommended so that the end piece does not protrude into the shoulder. These terminals may have a 2 ft. offset to the first post. Four feet of widening is needed at the end posts to properly anchor the system. When widening includes an embankment, fill material will be necessary for optimum terminal performance. (See Standard Plan 606.30 for widening details.) When the entire barrier run is located farther than 12 ft. beyond the shoulder break point and the slopes are greater than 1V:10H (10:1) and 1V:6H (6:1) or flatter, additional embankment at the terminal is not needed. Crashworthy end terminals located within 10 ft. of the edgeline will be marked delineated with a Type 3 Modified Object Marker.

There is cCurrently, there is not a MASH eligibleapproved flared--end terminal system. However, if a flared-end terminal is needed, there are NCRHP 350 systems available. These designs include an anchor for developing the tensile strength of the guardrail. The length of need begins at the third post for two approved both flared terminals. When a flared terminal is specified, it is critical that the embankment quantity also be specified so that the area around the terminal can be constructed as shown in the standard plans.

There are five distinct types of end terminals and crash cushions; Type labeled A, B, C, D and E. This sort of classification aids in the designers' selection of the appropriate treatment for a given context. It is important to note that each of these treatments reduces driver risk to equally acceptable levels and that the classifications are based merely on the benefit/cost associated with replacementing or repairing them after a crash.

Additional information on crashworthy end terminals and internet links to approved terminals

MoDOT's end terminal website

EPG 1040.4 Crashworthy End Terminal and Qualified Plastic Guardrail Block

~~The definitions of e~~Each type is classified as follows:

End Terminals

Type A. ~~A~~ Type A end terminals ~~is an~~are ~~end~~ treatments used for one-sided barriers such as roadside guardrail or roadside concrete barrier. These devices can also be used on one-sided barriers in the median, provided sufficient clear space is available behind the system to allow opposite direction traffic to recover from an errant path.

Crash Cushions

Type B. ~~A~~ Type B crash cushions ~~is an~~are end treatments used for double-sided barriers, most often in the median. ~~Such a~~ These devices can safely be impacted from several angles including~~, in most cases,~~ the ~~entirely~~ opposite direction. Type B crash cushions cannot be installed in paved surface locations unless the installation is temporary and the paved area ~~is to~~will be resurfaced after the system's removal.

A Type C ~~Crashworthy End Treatment~~Crash Cushion

Type C. ~~A~~ Type C crash cushions ~~is~~are an end treatment used for double-sided barriers, in gore areas and in the median. Like the Type B, this device can ~~be~~ safely be impacted from several angles usually ranging from head-on to the ~~entirely~~ opposite direction. Type C crash cushions, however, may be installed in both paved and unpaved surface locations, but must be installed on an asphalt or concrete pad in non-paved areas. ~~In a design~~After impact, these crash cushions are usually damaged beyond repair and as such, should be used only in areas where low, annual- impact frequencies are expected.

Type D. ~~A~~ Type D crash cushions ha~~s~~ve all of the installation and performance parameters of the Type C, but must be at least 80% reusable and have the ability to be reset manually with a moderate amount of repair. Type D crash cushions should be used in gore areas or medians with moderate traffic volumes and where high- impact frequencies are expected.

FHWA Eligibility Letters for Roadside Safety Devices
Barrier, Guardrails and Longitudinal Barriers
Breakaway Signs/Lighting Supports
Work Zone Devices

Type E. ~~A~~ Type E crash cushions ha~~s~~ve all of the installation and performance parameters of the Type ~~C, but~~C but must have the ability to ~~be~~ reset with little or no manual intervention and have an average cost of repair under $250 per event. Type E crash cushions should be used in gore areas or medians with high traffic volumes and where high~~-~~-impact frequencies are expected.

Use ~~T~~the following decision matrix ~~is intended~~ to help determine the appropriate end treatment for a given context, not to determine whether or not a ~~n end~~barrier or object should be ~~trea~~protected. The expected crashes per year are on an average basis:~~:~~

End Treatment Decision Matrix							
One-Sided Protection Required		**Two-Sided Protection Required**					
Non-~~traversible~~traversable Terrain Beyond the Terminal	~~Traversible~~Traversable Terrain Beyond the Terminal	Fewer than 0.5 Crashes Per Year Expected		0.5 or More Crashes Per Year Expected			
		Unpaved	Paved or Unpaved	Major ADT <75,000	Minor ADT <30,000	Major ADT ≥75,000	Minor ADT ≥30,000
Type A (energy absorbing)	Type A (non-energy absorbing)	Type B	Type C	Type D		Type E	

Sand barrels are a crash cushioning system most often used to shield fixed objects that cannot be removed or relocated. Sand barrels are recommended for temporary usage such as in work zones. Conduct a~~A~~ benefit/cost analysis ~~is to be conducted~~ before sand barrels are ~~us~~installed in a permanent application and consult with Maintenance staff. For more information, refer to EPG 612.2 Sand-Filled Impact Attenuators (Sand Barrels).

Other Anchor Applications

~~Use e~~End anchors are used to develop the tensile strength of the guardrail ~~o~~at~~n~~ the end of guardrail runs where a crashworthy end terminal is not needed.

606.1.3.2.1 Crashworthy End Terminals with Curb

When curb is present in front of and ~~along~~parallel to a crashworthy end terminal (CET), the~~re is~~ potential exists the CET will not perform as ~~intend~~designed (i.e. will not redirect the vehicle). When installing ~~runs of guardrail with crashworthy end terminals (~~CETs~~)~~, for ~~both~~ new construction and roadway up~~date~~grades, ~~some locations may include existing or new curb. If curb is installed along the run of guardrail with the CET,~~ the need for the curb and the curb height ~~in~~at the location of the CET shall be considered. See EPG 749 Hydrologic Analysis and EPG 640.1 Pavement Drainage to calculate the drainage needs in and around CETs.~~should be determined using the HYDROLOGY CALCULATOR.~~ Gutters might be able to be spread out or curb heights reduced in the vicinity of the CET while still accommodating drainage needs and the installation of the CET. Drainage calculations shall be documented in eProjects.

When curb is ~~located~~present in front of and parallel to ~~the area of~~ the CET, ~~these treatments should have documentation created for the project file regarding the design selected for the location and should be considered in the following priority~~the project file should have documentation regarding the design selected and considered in the following priority order:

1. Eliminate the curb or do not install new curb for the entire length of the CET with an additional 30'-50' of curb removed upstream of the CET.
2. Reduce the curb or install new curb ~~at~~to a height of two (2) inches for the entire length of the CET with an additional 30'-50' upstream of the CET.
3. Reduce the curb or install new curb ~~at~~to a height of four (4) inches for the entire length of the CET with an additional 30'-50' upstream of the CET.

If a two (2) inch curb ~~cannot~~is not adequate ~~control~~for the drainage needs~~flow determined in the HYDROLOGY CALCULAR~~, a four (4) inch curb may be installed but ~~this~~ is the maximum curb height allowed when installing a CET~~crashworthy end terminal~~.