CHAPTER 670 – TAPERS AND SHOULDER BACKING

Topic 671 – Pavement Tapers

Index 671.1 – Background and Purpose

Pavement tapers are a common design detail for asphalt layer overlays and other projects where new pavement surface has a higher profile than existing pavement surface or curbs. The goal of tapers is to provide a smooth unnoticeable transition from pavement to pavement. Tapers are intended to provide a reasonable cost alternative to engineering a profile for every transition. However, in some cases, an engineered profile may be more cost-effective than a taper.

This section provides information on the best design practices for transition tapers that meet geometric, operational, constructability, as well as other pavement surface and drainage standard practices. The tapers presented in this index meet the Caltrans standards and requirements for grade breaks in Index 204.4. The pavement tapers discussed herein do not address every possible situation that can be encountered on projects throughout the State. Good engineering judgment should still be exercised when developing transition taper details for a specific project. This index only addresses permanent pavement transition tapers used on overlay and other pavement projects.

671.2 Engineering Requirements and Considerations

(1) *Minimum Thickness Requirement.* In order for tapers to be constructable, maintainable and meet performance requirements:

(a) The minimum thickness for an asphalt pavement taper should be no less than 3 times the maximum aggregate size (example 0.15’ for ½” aggregate and 0.20’ for ¾” aggregate.)

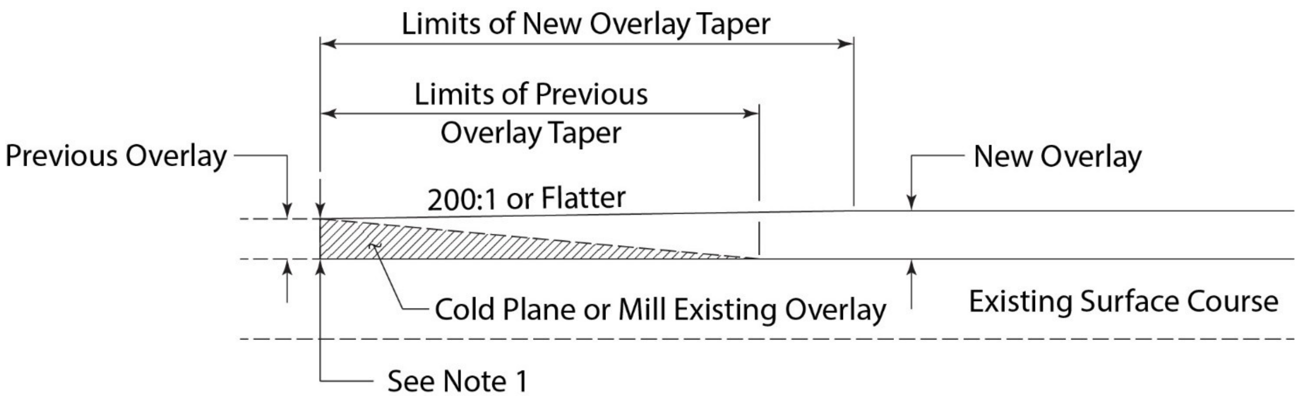
(b) The minimum thickness of the overall surface course layer (existing and new) in the taper should be no less than that of the adjoining existing pavement.

(c) When tapering into an existing pavement that was previously overlaid (pavement preservation or rehabilitation), the new taper should overlap the taper of the previous overlay to avoid creating a “dip” or “weak spot” in the pavement (see Figure 671.2A).

(2) *Transition Taper Slopes.* The taper slope should be 200:1 or flatter, with taper slope of 400:1 being preferred in highways with design speeds of 65 mph or higher. At locations where taper slopes flatter than 400:1 are desired, engineered profiles should be used because they are often shorter, less expensive, and easier to construct than the pavement taper.

Figure 671.2A

Tapering Into a Previously Overlaid Pavement



NOTES:

(1) Minimum thickness should match thickness of previous overlay.

(2) No Scale.

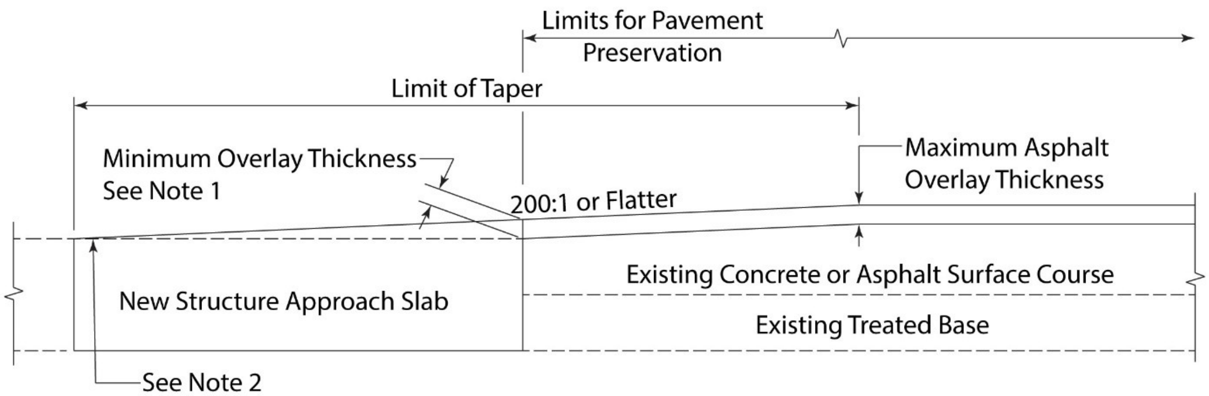
(3) *Design Life Requirements for Tapers.* For new construction, widening, and rehabilitation/reconstruction projects, the minimum thickness of the pavement structure (existing plus surface course overlay) for pavement tapers must meet the minimum pavement design life requirements for the project as discussed in Topic 612. This is intended to prevent creating isolated “weak spots” in the pavement that may require additional maintenance and repair in the future. On rehabilitation and reconstruction projects, where the pavement structure of the taper does not meet the pavement design life requirements, the pavement structure or part of it will need to be removed and replaced. Deviations from this requirement or decision not to reconstruct the pavement sections underneath bridges will require a design standard decision document from Headquarters Pavement Program for pavement design life (see Index 612.2 and 612.5). Since pavement preservation projects (preventive maintenance and CAPM projects) are not designed for structural capacity, the minimum thickness of the pavement structure for the pavement taper needs only to match or exceed the existing pavement structure. See Figure 671.2B for further details.

671.3 Tapers into Existing Pavement or Structure

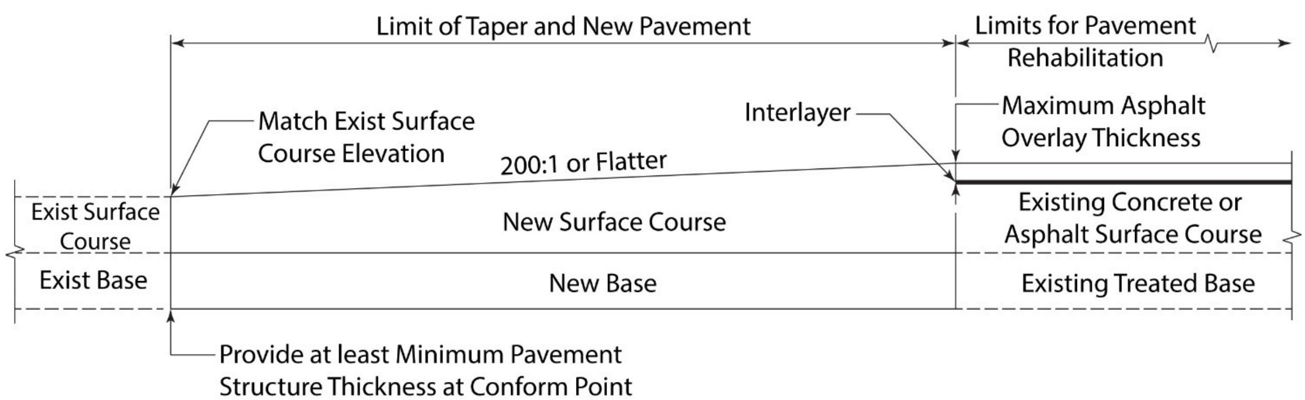
Figures 671.3A to 671.3C provide details on how to construct pavement tapers.

Figure 671.2B

New Structure Approach Pavement Transition Details



Pavement Preservation



Pavement Rehabilitation

NOTES:

(1) Use Maximum Overlay Thickness or 3x maximum aggregate size, whichever is less.

(2) Cold plane as needed to conform overlay with existing pavement.

(3) No Scale.

(1) *Tapers into an Existing Asphalt Pavement.* Where a new pavement structure or an overlay is tapering into an existing asphalt pavement that is not part of the project, the following apply:

(a) For preventive maintenance projects (thin asphalt overlays of 0.10' or less), the Design Engineer should follow the taper details in Figure 671.3A.

(b) For CAPM projects, taper the overlay using the same details used for OGFC taper to existing OGFC or HMA pavement surface course (See Figure 671.3A)

(c) For rehabilitation projects, taper the overlay using the taper details shown in Figure 671.3A for HMA taper to existing HMA surface course.

(2) *Tapers into an Existing Concrete Pavement.* Where a new pavement structure or an overlay is tapering into an existing pavement that is not part of the project or into/under a structure, grinding existing concrete pavement to create a taper is not recommended because it shortens the life of the concrete pavement. Because it is not always practical to remove and replace concrete pavement for every overlay, the following guidance should be followed regarding tapers for concrete pavement.

(a) For preventive maintenance projects (thin asphalt overlays of 0.10' or less), the taper should follow the taper details for OGFC overlay over asphalt pavement found in Figure 671.3A or reduce the thickness of overlay to 0.08' at end of taper and roll down edge to minimize raveling. For under structures, existing concrete surface may remain.

(b) For CAPM projects, either taper the overlay down using the same details used for OGFC (See Figure 671.3A) or replace the concrete pavement slab. For under structures, the existing concrete surface may remain but should be repaired and ground or rebuilt as needed in accordance with CAPM strategies for concrete pavement in Index 624.2.

(c) For rehabilitation projects, do not grind the concrete pavement to accommodate a taper. Instead, remove concrete pavement within the taper section and replace with a new pavement structure that will meet the design life requirements for the project as defined in Topic 612.

(d) When grinding concrete pavement, meet the following two conditions:

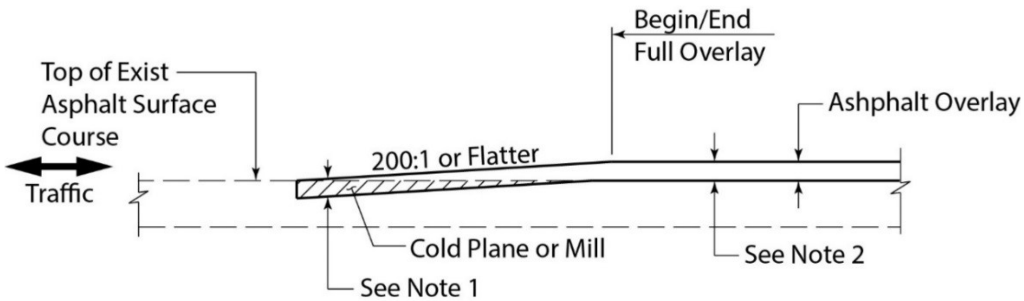
- Use a diamond grinder, not a planing machine.
- Never grind more than 1 inch or reduce the thickness of the concrete pavement slab to less than 0.65 foot.

If neither of these conditions can be attained with the taper detail, then remove and replace the concrete pavement slabs and the underlying base as needed for the transition taper section to match the existing pavement surface.

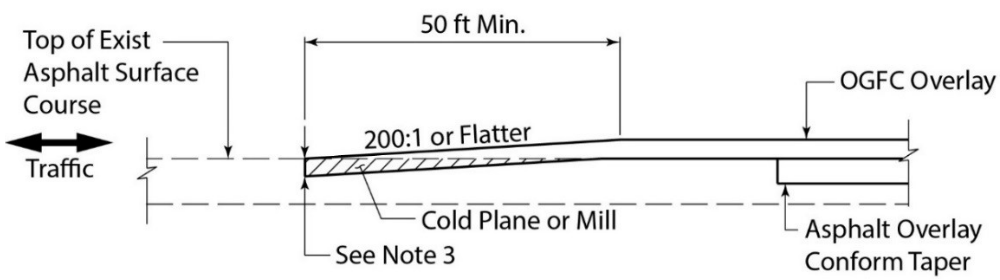
(3) *Longitudinal Tapers at Shoulders, Curbs, Dikes, Inlets, and Guardrail.* Detailed drawings and information on the best design practices for longitudinal tapers at shoulders, curbs, dikes, inlets, and guardrail are shown in Figure 671.3B.

Figure 671.3A

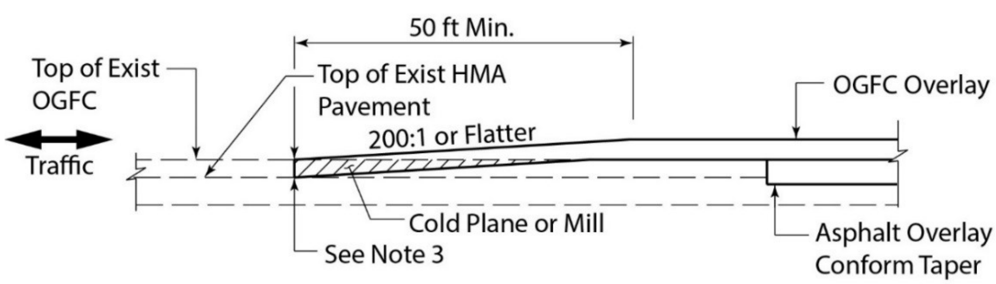
Transverse Transition Tapers for Pavement Preservation Projects



Transverse Asphalt Taper to Existing Asphalt Pavement



Transverse OGFC Taper to Existing Asphalt Pavement



Transverse OGFC Taper to Existing OGFC Pavement

NOTES:

(1) Minimum thickness should match thickness of the top lift.

(2) See HDM for minimum thickness.

(3) Same thickness as OGFC overlay or 0.10’, whichever is less.

(4) Do not use HMA to bring the shoulders up to grade when traveled way is OGFC.

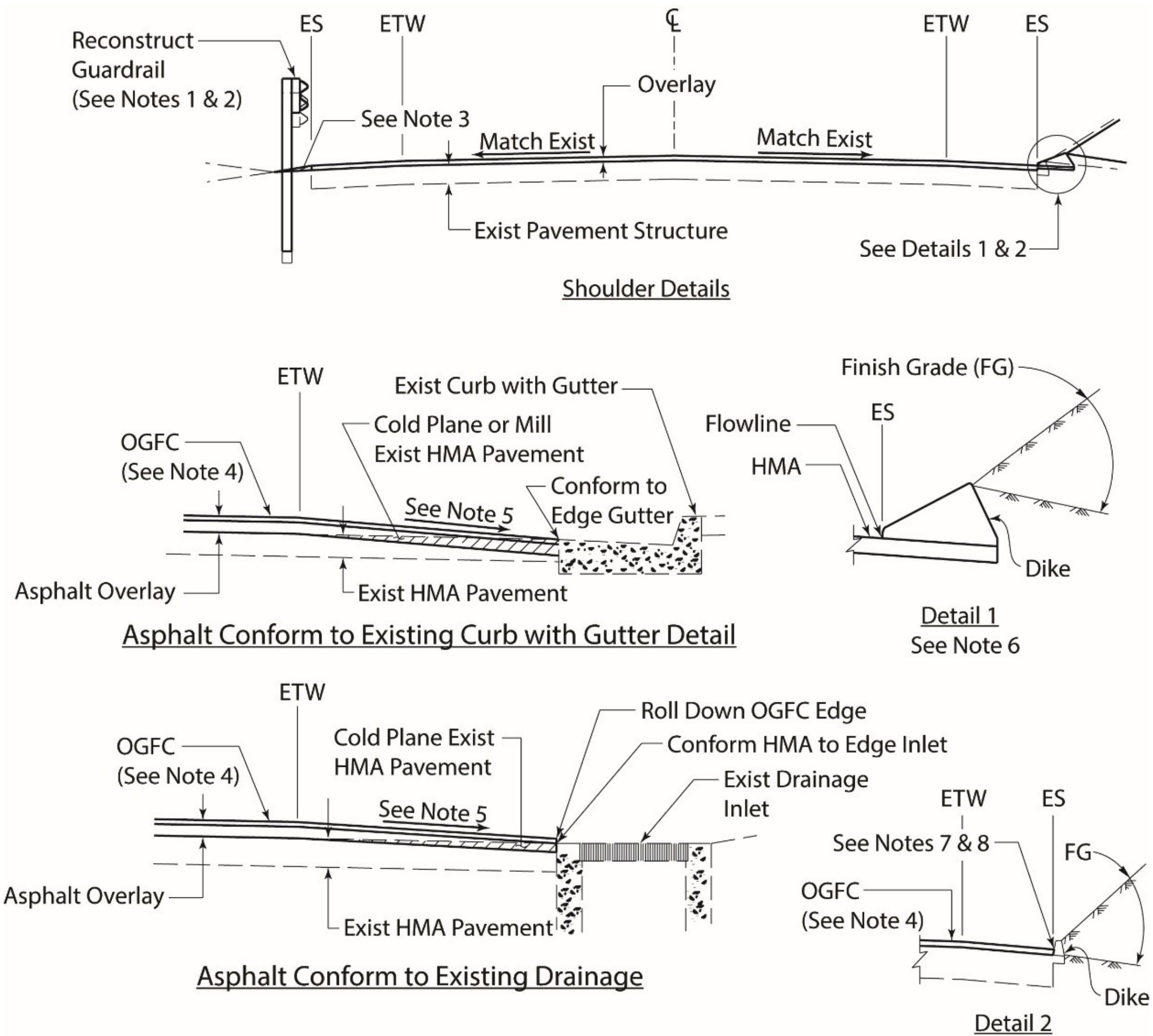
LEGEND:

HMA = Hot Mix Asphalt

OGFC = Open Graded Friction Course

Figure 671.3B

Longitudinal Tapers at Shoulders, Curbs, Dikes, Inlets, and Guardrail



NOTES:

(1) Additional design and safety criteria may apply for guardrail, for further info, see Traffic Safety Systems Guidance or District Traffic.

(2) When grinding or paving next to guardrail or obstacle, reconstructing guardrail will be necessary to accommodate grinding machines and compaction equipment.

(3) Contact District Landscape and Maintenance regarding the appropriate treatment for weed abatement.

(4) OGFC applies only when used as a surface course, omit details for this course when OGFC is not used.

(5) See HDM Topic 302 for maximum allowable cross-slopes.

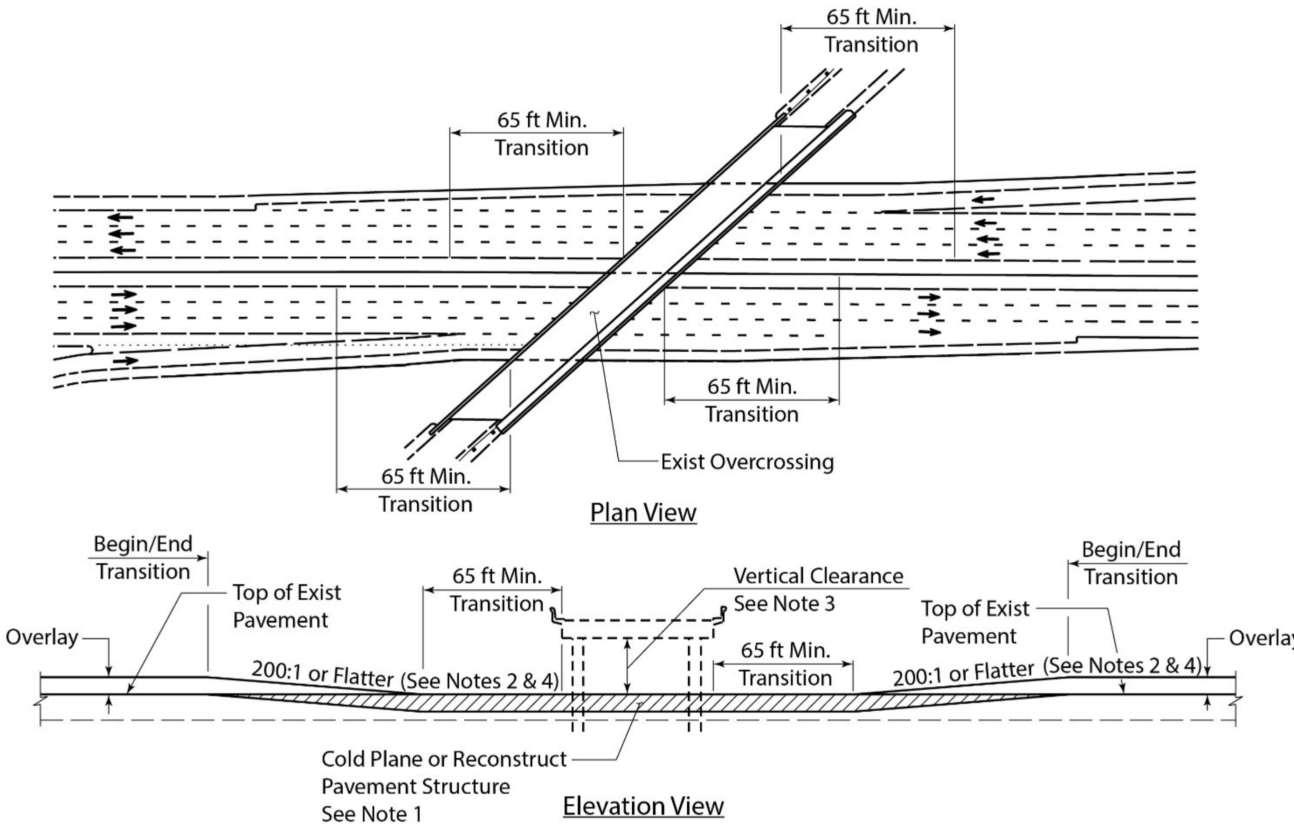
(6) For additional information on dikes, see HDM Topic 303, and Standard Plan A78B.

(7) Verify with Hydraulics to see if dike needs to be raised to maintain capacity of gutter.

(8) Verify with District Hydraulics if additional drainage is required at the conform on the shoulder or at bridge approach slabs in order to avoid ponding.

Figure 671.3C

Transition Taper Underneath Overcrossing/Bridge



NOTES:

(1) Pavement structure thickness needs to provide the proposed pavement design life. This may require that the pavement structure be removed and replaced.

(2) Verify that the existing drainage facilities will continue to function properly after transition is completed.

(3) For minimum vertical clearance requirements, see HDM Index 309.2

(4) Creation of a sag may require additional drainage features.

(4) Tapers Into or Under Structures. Figure 671.3C provides a layout and information for transition tapers under an existing structure. The following guidance should be followed when designing tapers underneath over-crossings or into bridges:

(a) Compare the cost and constructability of very flat tapers (400:1 or flatter) vs. engineered profiles to ensure that the less expensive and easier to construct alternative is used when replacing pavement underneath a structure.

(b) The minimum thickness of the pavement structure for transition tapers into or under bridges must meet the minimum design life requirements discussed in Index 671.2(4) for new construction, widening, rehabilitation, and reconstruction projects.

Topic 672 – Shoulder Backing

672.1 Background and Purpose

(1) *Purpose.* Shoulder backing is a thin course of granular material that is used to provide support to the pavement edge by preventing edge cracking and pavement edge loss. Shoulder backing also minimizes pavement edge drop-off heights for overlays.

(2) *Standards and Requirements.* The placement of shoulder backing requires proper compaction of the shoulder backing material.

(3) *Application*: Shoulder backing is designed to provide edge support for thin overlays placed on existing pavements. Do not use shoulder backing as embankment material in the following cases:

- To repair erosion or subsidence in existing slopes (See Figure 672.3C).
- For side slope reconstruction (See Figure 672.3C).
- In locations where the overlay thickness is greater than 0.50 ft (See Figure 672.3C).
- For backfill behind dikes (See Figure 672.3D).
- To construct the required minimum hinge width (HW) for guardrails, dikes, and barriers.
- In roadside ditches or gutters (See Figure 672.3E). Since the material used for shoulder backing can be erodible, use non-erodible materials or stabilized base material in roadside ditches or gutters.

Shoulder backing is not be used in the above cases because the material and/or compaction specifications requirements in the Standard Specifications will not provide the desired results. Alternative engineering solutions should be utilized in these situations. Alternative engineering solutions include slope reconstruction, compacted fill, or use of stabilized material. Some alternatives to shoulder backing may require developing a nonstandard special provision.

672.2 Alternate Materials and Admixtures

(1) *Alternate Materials.* Alternate materials for shoulder backing include imported borrow and asphalt grindings.

(a) Imported Borrow: If native material does not meet the specifications for shoulder backing material, utilize imported borrow which meets the specifications for shoulder backing material.

(b) Asphalt Grindings: The Deputy Directive on Recycling Asphalt Concrete allows the use of asphalt grindings for shoulder backing; however, there are some limitations to where asphalt grindings can be used. For information on where asphalt grindings cannot be used consult the District Environmental unit. As stated in the Project Development Procedures Manual (PDPM), a Memorandum of Understanding (MOU) dated January 12, 1993 between the Department of Fish and Game (DFG) and Caltrans, allows Caltrans to use asphalt grindings for shoulder backing where these materials will not enter the water system.

(2) *Admixtures.* Admixtures may be used if recommended by the District Materials Engineer and their use is permitted in the environmental document and regulatory permits. District Environmental can assist in determining if and where admixtures can be used. Three types of admixtures (lime, cement, and seal coat with an asphaltic emulsion) are approved for use with shoulder backing.

(a) Lime and Cement Admixtures: Lime and cement are uniformly mixed into the shoulder backing material prior to application.

(b) Seal Coats: Seal coats with an asphaltic emulsion are applied in situ on top of shoulder backing material. When seal coats are specified, the appropriate seal coat special provisions should be included into the project special provisions. Seal coats are paid for separately from shoulder backing material.

672.3 Design

The limits, slopes, and other design details for shoulder backing need to be documented on the plans. The following design standards apply when designing shoulder backing details:

(1) Place shoulder backing from the edge of pavement (EP) to hinge point (HP). However, where the horizontal distance from EP to HP is greater than 3 feet, shoulder backing should be placed on a width of at least 2 feet from EP (See Figures 672.3A and 672.3B). The Design Engineer should consult with the District Materials Engineer for conditions where the distance from EP to HP is less than 2 feet and there are minimum hinge width requirements for dike, guardrail and barriers.

(2) Shoulder backing cross slope should be 10:1 or flatter where possible. Where there is insufficient width for a 10:1 slope, a steeper cross slope can be used but should not be steeper than 6:1 (See Figure 672.3A).

(3) The minimum hinge width (HW) from EP to new HP should be 2 feet (See Figure 672.3B). Where the existing HW is less than 2 feet, slope reconstruction (See Figure 672.3C) or some other strategy should be used instead of shoulder backing.

(4) Do not place shoulder backing on existing side slopes where shoulder backing cross slope will be steeper than 6:1 and/or the HW will be less than 2 feet (See Figures 672.3A & 672.3B).

(5) The maximum thickness for shoulder backing is 0.50 foot (See Figure 672.3B). Where the thickness will exceed 0.50 foot, use alternative strategies that have a combination of more stringent material and compaction requirements

(6) Where the combined distance for HW and side slope will exceed 5 feet in order to comply with the slope requirement specified in this document, side slope reconstruction is recommended in lieu of shoulder backing (See Figure 672.3C).

(7) At the option of the District, shoulder backing can be placed up to a thickness of 0.50 foot to cap new construction or reconstructions (See Figures 672.3B & 672.3C).

(8) Place shoulder backing to match the pavement surface, even when the surface course layer is open graded friction course (OGFC). This reduces future maintenance needs to replace the shoulder backing as it subsides.

Figures 672.3A through 672.3E show some examples of what should and should not be done when using shoulder backing.

Figure 672.3A

Typical Application of Shoulder Backing

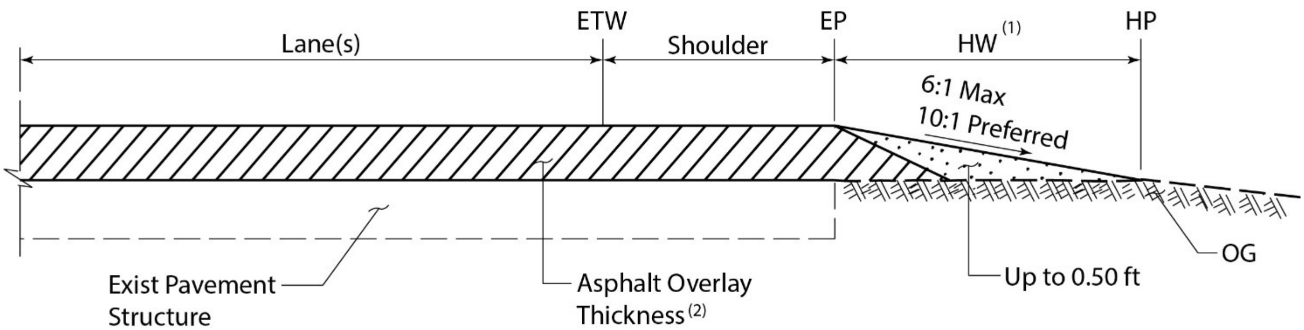
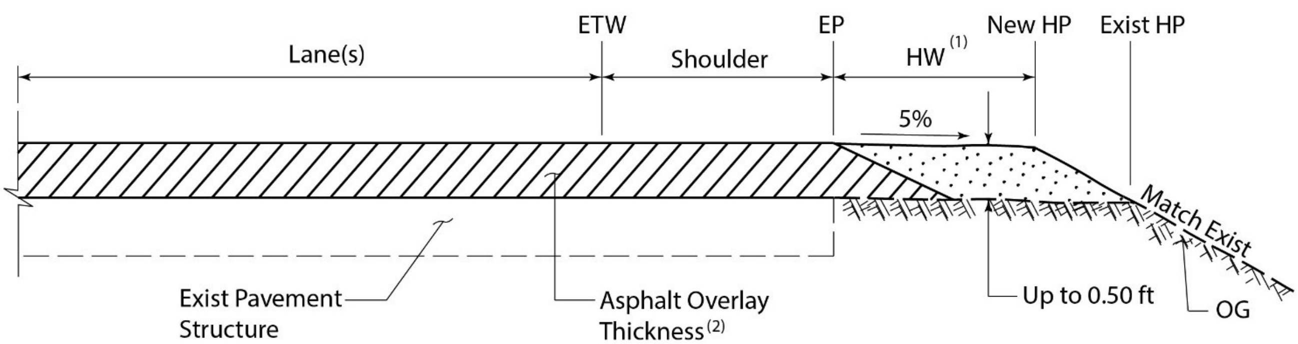


Figure 672.3B

Alternative Placement for Existing Slopes Steeper than 6:1



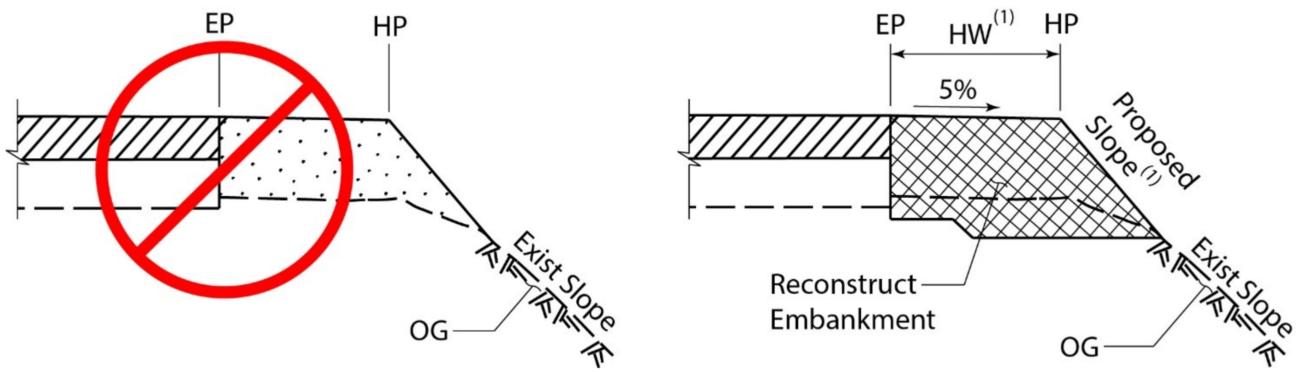
NOTES:

(1)Minimum Hinge Width (HW) is 2 feet. When HW is less than 3 feet, District Materials Engineer should be consulted regarding structural stability due to width reduction.

(2)Edge treatment shown are for asphalt overlay thickness of 0.45 foot or less. For asphalt thickness of more than 0.45 foot, see Standard Plans for edge treatment details.

Figure 672.3C

Placement of Shoulder Backing Thickness Greater Than 0.50 foot for Slope Repair



NOTES:

(1)See HDM Topic 304 for additional information on side slopes. See Standard Specifications for additional information on side slope construction. See District Materials Engineer for material recommendations. (Roadway Geotechnical also needs to be consulted for slopes steeper than 2:1.).

Figure 672.3D

Placement of Shoulder Backing Behind Dikes

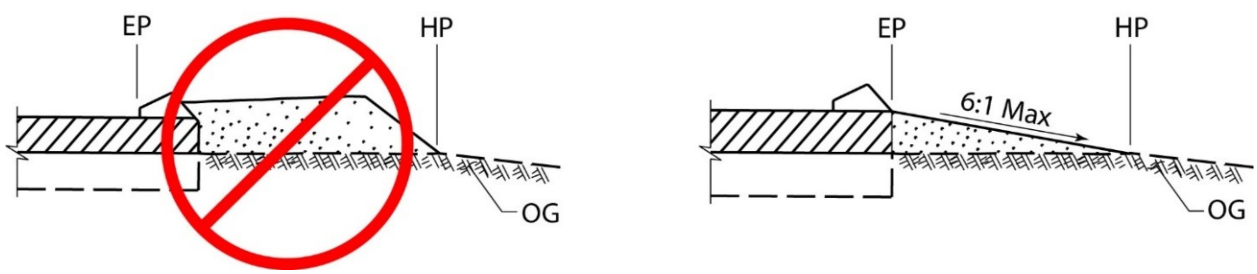
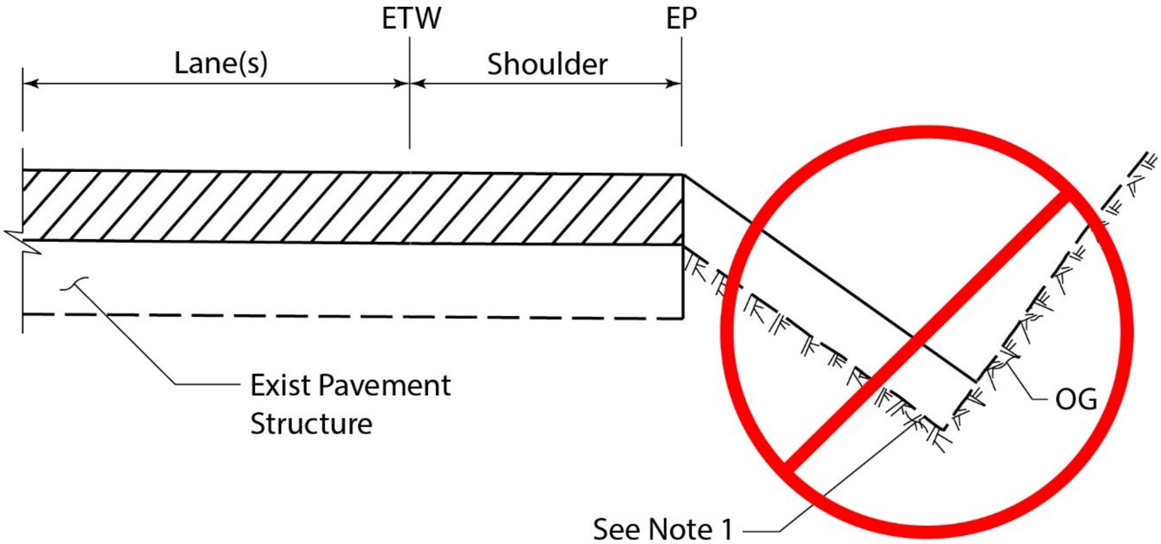


Figure 672.3E

Longitudinal Drainage (Roadside Ditches/Gutters)



NOTES:

(1) Consult with area Maintenance personnel and District Materials Engineer regarding erodability of ditch, alternative materials to shoulder backing, slope sloughing, and rockfall catchment in ditch.

Consult with District Hydraulics Engineer regarding acceptable change in ditch capacity.

Consult with District Stormwater Coordinator regarding water quality issues.