CHAPTER 680 – PAVEMENT DESIGN FOR WIDENING PROJECTS

Topic 681 – Pavement Widening Overview

Index 681.1 – Background

(1) Purpose - Pavement widening involves the construction of additional width to improve traffic flow and increase capacity on an existing highway facility or to improve existing features such as the inclusion of shoulders, turn lanes, and passing lanes. Pavement widening projects create unique issues for pavement engineers such as what is the best structure to build for the widening and how to make the widened pavement or new lanes compatible with existing pavement. This Chapter provides basic instructions and guidance for selecting pavement type, design standards, and details for pavement widening projects.

(2) Types of Pavement Widening Projects - Pavement widening may involve the following types of pavement projects:

- Adding travel lanes (including bus or bicycle lanes), auxiliary lanes, climbing or passing lanes
- Adding shoulders, pullouts for maintenance/transit traffic
- Widening existing lanes, shoulders or pullouts

When planning widening projects such as lane or shoulder additions, the existing adjacent pavement condition should be investigated to determine if the measures discussed in Index 682.3 are needed to combine rehabilitation or pavement preservation work with widening.

Topic 682 – Design Considerations

682.1 Standards

Besides pavement engineering discussed in Chapter 610, pavement widening presents additional challenges in pavement design. These include achieving the following standards:

- Provide a uniform foundation across the new and existing pavement structure to accommodate both pavement drainage and fatigue performance.
- Ensure that existing pavement is adequate to sustain traffic loads expected during the design life of the new pavement widening structure. Existing pavements may have been designed decades earlier for less traffic, and those thicknesses may not only be less than those of the newly widened pavements but may also have worn surfaces and in some cases exhibit minor or major structural distress.

- Maintain functionality of the existing pavement structure drainage system.

These issues can affect the service life and drainage of both the existing and new pavement structures. To ensure both drainage and design life standards are met, the drainage conditions and structural capacity of both the existing and new pavement structures should be evaluated and the results of the evaluation should be taken into account during the planning and scoping phases of a widening project.

682.2 Pre-Design Evaluation

The following pre-design evaluations are recommended to ensure that pavement widening projects are designed and constructed to meet the performance standards described in Item 682.1.

- Perform an official investigation following the Site Investigation Guide, including:
  - Review as-built records of the existing pavement structure such as material types and layer thicknesses, and where available the as-built material properties and mix designs. Look for material types and layer thicknesses from historical cores in iCore and the Ground Penetrating Radar (GPR) data.
  - Review the current pavement condition survey data and history of past maintenance and rehabilitation treatments of adjacent lanes
- Conduct a site investigation following the Site Investigation Guide. The investigation will produce information needed for mechanistic-empirical design for flexible pavement alternatives and for selection of rigid pavement design alternatives from the catalog in Chapter 620, including:
  - Existing subgrade type and condition and pavement layer types, thicknesses, and conditions.
  - Drainage and moisture conditions in the existing pavement and areas to be widened, and condition of any drainage layers in the existing pavement that must be considered in the widening. Note that widening may cover existing drainage systems, especially side drains, and new systems will need to be designed and constructed to accommodate the additional water catchment of the wider road surface.
  - Condition, pavement structure, and subgrade stiffness in the adjacent lanes, if this information will be used in the design of the new lanes, or if the adjacent lanes will be rehabilitated as part of the widening.

682.3 Pre-Design Considerations

The following pre-design considerations are recommended when designing a pavement widening project.

(1) *Consistent and Cost-effective Overall Pavement Structure.* The engineer needs to consider what characteristics are important for both the new and existing pavement to provide a consistent, cost-effective, and functioning structure for the overall pavement. This includes considering how the new pavement will perform as well as doing a life-cycle cost analysis that considers initial cost, maintenance and rehabilitation schedules, and costs for different alternatives. The life-cycle cost analysis is to follow the Life Cycle Cost Analysis Procedures Manual (*https://dot.ca.gov/programs/maintenance/pavement/concrete-pavement-and-pavement-foundations/life-cycle-cost-analysis*).

(2) *Rehabilitation or Pavement Preservation of Existing Pavement with the Widening Project.* It is often not cost-effective nor desirable to widen a highway without correcting ride quality and structural distress in the adjacent pavement structures when that work is needed. During planning and scoping of widening projects, it is necessary to thoroughly evaluate the existing adjacent pavement structure to determine if rehabilitation or pavement preservation is needed in conjunction with the widening. This involves a review of the current pavement condition survey data, future projections of distress and roughness condition, and the information from the site investigation of the existing roadway. The review should be done during the project initiation phase and updated during the design phase because the pavement condition may have deteriorated during the intervening time. If rehabilitation or pavement preservation is warranted, combining rehabilitation or pavement preservation work with widening is strongly encouraged.

(3) *Future Traffic Delay and Long-Term Costs.* Combining widening with rehabilitation or pavement preservation work on existing pavement can minimize future traffic delay and long-term costs, and reduce overhead costs of managing two separate projects. If the adjacent existing lane warrants rehabilitation, the lane should be rehabilitated in conjunction with the widening and brought up to the same life expectancy as the new widened portion of the roadway (see Index 612.3. In certain circumstances, the District may defer the pavement rehabilitation work and program it as a separate project, but this should be done in coordination with Headquarters Pavement Reviewers and the Project Delivery Coordinators (for non-delegated projects per the District Design delegation Agreement). If the adjacent lane does not need to be rehabilitated, an appropriate pavement preservation treatment should be applied to provide a uniform surface for existing and widened sections and synchronization of future preservation of the existing and new pavement.

Pavement preservation and rehabilitation work that should be included with widening projects for concrete and asphalt pavements are discussed in Index 682.5(2) and 682.5(3) respectively.

682.4 Design Considerations

Design of the widened lanes should follow the same procedure as new pavements. See Index 633 for design of new flexible pavements. See Chapter 620 for design of new rigid pavements. The inputs needed for new flexible and rigid pavements should be developed following the Site Investigation Guide.

682.5 Scoping, Estimating, and Detailing

The following design criteria are provided to aid in scoping, estimating, and detailing pavement widening projects. As per Index 682.1, these requirements should be viewed as minimum criteria for determining how much work to do on existing pavements. Because each widening project has different pavement engineering and performance issues, early and frequent involvement of Headquarters Pavement Designer or Reviewers is recommended to appropriately address what features to include and how to ensure the following design criteria are met.

(1) Pavement Structure Requirements. The following minimum requirements should apply when designing pavement structures for widening projects:

(a) If a widening project will result in any traffic lanes to be placed partially on existing pavement and partially on new pavement, then the engineer should ensure that the pavement type and structure are consistent across the lane. Avoid creating lanes that are partially asphalt, concrete, or composite because they will develop distresses at different rates and will have different distresses which will increase future maintenance costs and worker exposure to traffic. Longitudinal joints between different pavement types in the lane can also lead to more rapid deterioration of the pavement. The partial existing lane can be removed and replaced with a complete lane of new pavement, or new pavement of the same type can be added to the partial lane.

(b) Criteria for leaving the existing structure to serve as part of the new lane are:

(1) The structural capacity of the existing pavement is assessed using the future design truck traffic plus the truck traffic that has been applied to it since initial construction or the last rehabilitation using CalME or the rigid pavement design catalog (or Pavement ME), and the structure is found to be able to carry more than 90 percent of the predicted need of the combined past and future traffic,

(2) The existing pavement is in good condition as identified in the pavement condition survey, and

(3) The widening project is adding less than 2 lanes and the width of existing pavement to remain in the proposed lane is 3 feet or more.

If the existing lane meets all these criteria then the proposed widened pavement structure should match the existing pavement and, where needed, a preservation treatment applied as discussed in Index 682.5(2)(c) and (3)(b). If the existing pavement does not meet all these criteria, then it is preferable to construct new lane(s), or partially reconstruct the existing lane, to new construction standards and remove existing pavement or pavement layers to accommodate a structure that will carry the predicted future traffic. If the existing pavement is inadequate, remove the existing pavement to the lane line of the existing adjacent truck permitted lane and replace it with new pavement or partially reconstructed pavement.

(2) Details for Widening Next to Existing Concrete Lanes. The following design standards should apply when widening concrete roadways:

(a) Place longitudinal joints at the locations of proposed lane lines (or ultimate lane lines if project is an interim stage of an ultimate project) except as noted below:

(1) For new outside non-truck permitted lanes next to existing outer lanes and for new median lanes next to existing median lanes, place the longitudinal construction joint between the existing pavement and the new widened section at the lane line as shown in Figure 682.4A.

(2) Additional requirements and details for tying adjacent concrete slabs can be found in Index 622.4 and the Standard Plans.

(3) When existing longitudinal joints and proposed or ultimate lane lines do not align, it is preferable to construct longitudinal pavement joints between new and existing concrete (particularly isolation joints) in non-truck permitted lanes rather than truck permitted lanes.

(b) Do not place or leave slabs less than 8 feet wide in truck permitted lanes or joints within 2 feet of wheel paths. The reduced width of the slab will result in joints in the wheelpaths which will lead to early cracking of the pavement.

(c) When widening contiguous to the concrete pavement in good condition, a pavement preservation strategy in conjunction with widening is recommended if warranted, including grinding the existing rigid pavement where warranted by roughness. This provides a smooth riding surface and can eliminate old striping and pavement markings. Grinding the lane next to the proposed widening is required when the existing International Roughness Index (IRI) exceeds 90 inches per mile in order to provide a smooth platform for the paving machine to construct the adjacent pavement structure. Pavement preservation strategies are discussed in Index 603.3 and in the *Concrete Pavement Guide* (*https://dot.ca.gov/programs/maintenance/pavement/concrete-pavement-and-pavement-foundations/concrete-pavement-guide*). Additional information on procedures for concrete pavement preservation can also be found in Topic 624.

(d) Where existing concrete pavement will require rehabilitation within ten years, the widening project should consider future compatibility of the proposed structure in the widening project with the eventual concrete pavement rehabilitation strategy in the existing lanes. Pavement rehabilitation strategies are discussed in Index 603.4 and procedures for concrete pavement rehabilitation can be found in Index 625.1.

(e) Drainage continuity may require constructing the top of the subgrade for the widening at the same or lower elevation than the existing subgrade and extending underdrains from the edge of the existing pavement to an outlet beyond the new pavement structure.

(3) Details for Widening Next to Existing Flexible Lanes. The following design standards should apply when widening next to existing flexible pavement lanes. The following alternatives should be considered and evaluated in terms of life cycle cost, and other considerations:

(a) *Flexible Pavement Alternative*. Design the new pavement structure for the widening as a new flexible pavement. The final surface elevation of the new

structure should match the elevation of the existing pavement. If the existing adjacent lanes have a preservation treatment or rehabilitation in the widening project, then the new widening surface elevation should match the new surface in those lanes. When widening flexible pavement, continuity with the existing pavement should be provided whenever it is economically feasible. At a minimum, the design should use compatible materials and provide for adequate drainage underneath the existing pavement.

(b) When widening adjacent to existing asphalt pavement that is in good condition, a pavement preservation strategy in conjunction with widening such as placing a non-structural wearing course over the widening and existing pavement should be done. This provides a surface with a uniform appearance, a surface course with equivalent future maintenance requirements, a clean surface for new striping configurations, as well as elimination of pavement joints which are susceptible to water intrusion and early fatigue failure.

If the asphalt concrete surface course required for the new pavement structure is thicker than the surface course in the existing lanes, the existing shall be overlaid a minimum of 0.15 feet to match the top surface of the new asphalt concrete layer.

If the existing pavement exhibits oxidation, raveling, or minor cracking, it is recommended to mill 0.15 foot of the existing asphalt surface and overlay across the entire existing pavement and the new section as shown in Figure 682.4C.

Pavement preservation strategies are discussed in Topic 634 and in the Maintenance Technical Advisory Guide (MTAG) (*https://dot.ca.gov/programs/maintenance/pavement/mtag*). Additional information on procedures for asphalt pavement preservation can also be found in Index 603.3.

For existing asphalt pavement that needs rehabilitation work because of major distress, the widening project should include an appropriate pavement rehabilitation strategy for the existing pavement structure at least in the lane adjacent to the widening. In such cases, project scoping and other engineering decisions consider life cycle cost as well as other project considerations such as traffic safety to determine whether pavement rehabilitation of the existing roadway should be included with the pavement widening project. If the existing flexible pavement adjacent to the widening has extensive cracking, in-place recycling should be considered as one of the alternatives for the widening project and compared with other alternatives and considerations. See the In-Place Recycling Guidance for more details. Care must be taken that the site investigation considers both the existing pavement and the subgrade in the area to be widened. See the Site Investigation Guidance for more details. Pavement rehabilitation strategies and procedures for flexible pavement rehabilitation can be found in Index 603.4.

(c) When widening asphalt pavement, continuity with the existing pavement should be provided whenever it is economically feasible. At a minimum, the design should use compatible materials and provide for adequate drainage underneath the existing pavement. This may require constructing the top of the subgrade for the

widening at the same or lower elevation than the existing subgrade and extending underdrains from the edge of the existing pavement to an outlet beyond the new pavement structure.

To provide a new uniform surface for the widening and existing pavement, mill and replace 0.15 foot of the existing asphalt surface course. If the new asphalt concrete surface course required for the new pavement structure is thicker than the existing surface course in the existing lane, then the existing lane shall be overlaid with a minimum of 0.15 feet of the same material to be used in the widening so that the surfaces of the new and existing lanes match. Figure 682.4B shows a typical pavement widening structure adjacent to existing previously cracked, seated and asphalt overlaid concrete pavement.

(d) Widening of asphalt roadways with concrete lanes should not be done except if both are true:

(1) Concrete pavement will be placed across all the truck permitted lanes, or there is a funded project to replace or overlay the existing lanes with concrete within the next 10 years.

(2) The concrete pavement joint will be located at the proposed lane line (or ultimate lane line if the project is just an interim stage of an ultimate project.)

(4) Drainage of Pavement Widening Structure. Perpetuate pavement drainage in accordance with Chapter 650. The pavement structure of the widening should be designed where feasible to provide a path for subsurface water drainage to the edge of pavement. If it is not feasible to accomplish this, then consult with Headquarters Pavement Reviewers for other options.

682.6 Other Considerations

In addition to the foregoing design considerations, the following measures should be considered when constructing a pavement widening project.

(1) Geosynthetic Interlayer at Joint between Existing Pavement and Widening. Consideration should be given to using a geosynthetic pavement interlayer at the longitudinal joint between new and existing pavement prior to applying the full-width overlay to delay reflective cracking of the joint.

(2) Selection of the Base Material. Selection of the new base material should be based on laboratory evaluation of both new and existing materials to compare the moisture susceptibility and drainage characteristics of each. Preferably, the moisture susceptibility and permeability of the existing and new base materials should be similar. A lower permeability or more moisture susceptible material should not be used for base, subbase, or fill material where it would block the ability of water to drain to the edge of the pavement or draw water to itself. Consideration should be given to the potential for water ingress at longitudinal joints at the interface between widening pavements that are of a different type than the adjacent existing pavement.

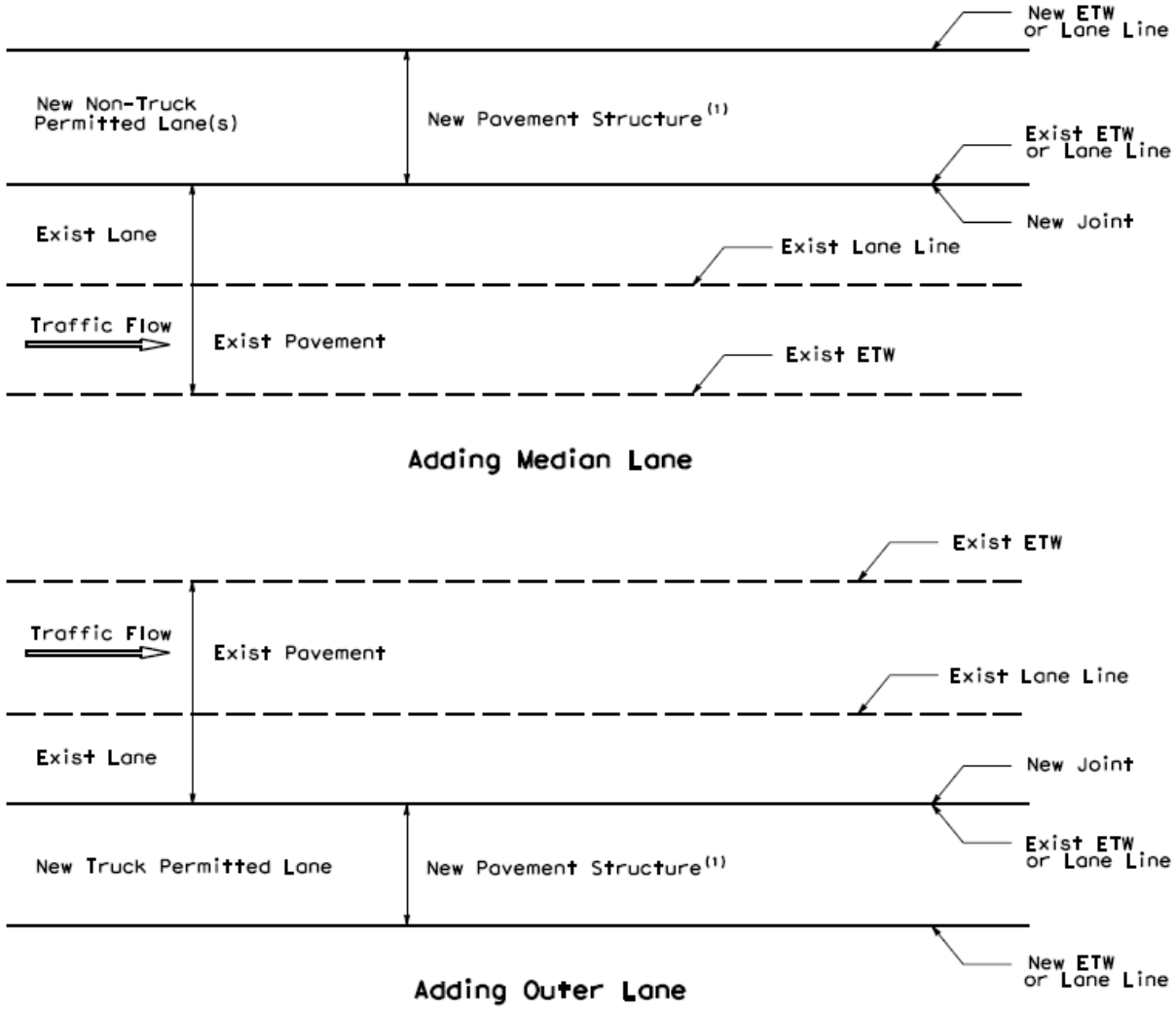
(3) Treated Base Sections. Other considerations will closely parallel those discussed in Index 662.2 for treated base materials. There are cases where it may be desirable to use full-depth HMA for the widening to expedite construction, even though the base for the existing pavement was cement-treated material. This strategy should not cause subsurface moisture flow problems ("bath tub" effect) provided that the cement treated base is not moisture susceptible. Laboratory evaluation of core samples will determine the degree of moisture susceptibility of the existing base.

682.7 Life-Cycle Cost Analysis for Widening Projects

In addition to selecting the type of pavement for the widening project, as discussed in Topic 619, life-cycle cost analysis is a key component in determining how best to maintain both new and existing pavements over time and whether it is better to design the widening to match the life of the existing pavement or plan for the upgrading of the existing pavement to match the design life of the new pavement. When doing a life-cycle cost analysis for pavement widening, it is often best to evaluate the best alternative for upgrading the structural capacity of the existing pavement to meet current design life standards first, since the type and condition of the existing pavement will often influence the engineering of the new pavement. Life-cycle cost analysis is discussed further in Topic 619 and the Life-Cycle Cost Analysis Procedures Manual (*https://dot.ca.gov/programs/maintenance/pavement/concrete-pavement-and-pavement-foundations/life-cycle-cost-analysis*).

Figure 682.4A

Typical Concrete Pavement Widening Median Lane and Outer Lane

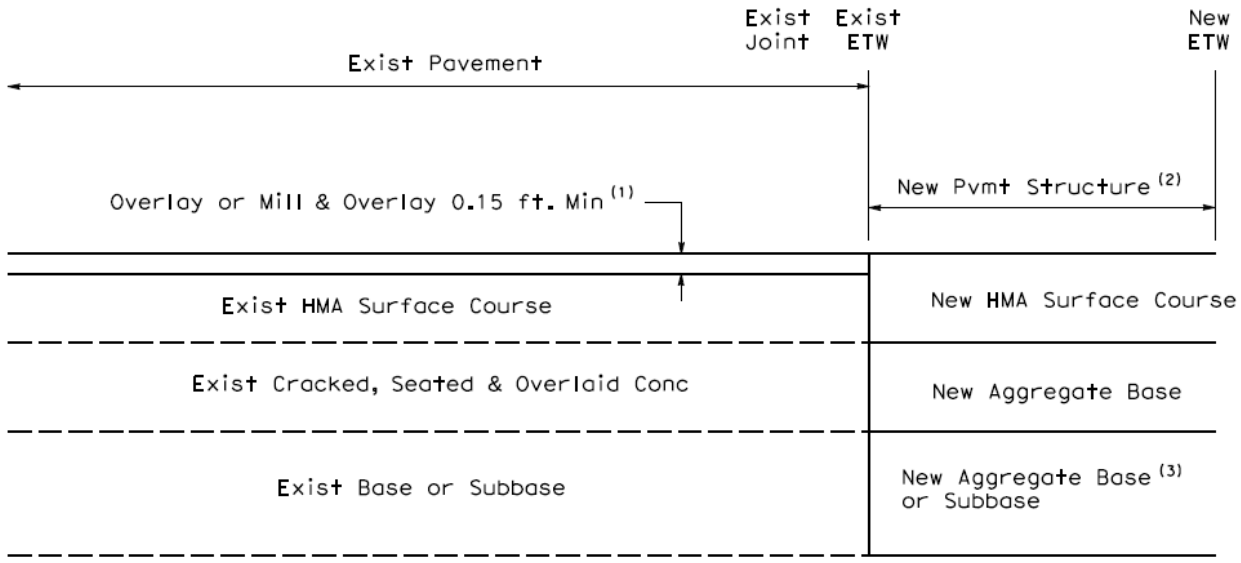


NOTES:

(1) See Index 623.1 and Tables 623.1B – M for details on concrete pavement structure design.

Figure 682.4B

Widening Previously Cracked, Seated, and Overlay Concrete Pavement in Good Condition



NOTES:

(1) See Figures 682.4A for additional details.

(2) Match the structural layers of the existing pavement for situations described in section 682.4 (1)(a).

(3) When matching existing treated base, granular base/sub base, or adding structural capacity.

Figure 682.4C

Widening Asphalt Pavement in Good Condition