CONCRETE PAVEMENT GUIDE

PART 4: REHABILITATION STRATEGIES

CHAPTER 410– CRACK, SEAT, AND (HMA) OVERLAY

Chapter 410 provides guidelines and criteria for the pavement engineer to design cracked-and-seated JPCP pavement with a flexible pavement overlay to improve poor ride quality and reduce overlay cracking and related distress.

410.1 INTRODUCTION

When overlaying JPCP with flexible pavement, reflection cracking in the overlay is a common problem. Reflective cracking is induced by horizontal strains from thermal expansion and contraction and vertical strains from repeated heavy wheel loads above joints and other discontinuities in the underlying concrete. Cracking and seating the existing concrete reduces both horizontal and vertical JPCP movement, which reduces strain and cracking in the flexible overlay.

Crack, seat, and HMA overlay (CSOL) is a pavement rehabilitation strategy that consists of cracking existing JPCP slabs into segments from 3’ to 5’ long by 6’ wide (see Figure 410-1) and overlaying with a flexible pavement layer. Cracking the slabs is commonly performed using a heavy spring arm drop hammer machine (see Figure 410-2).

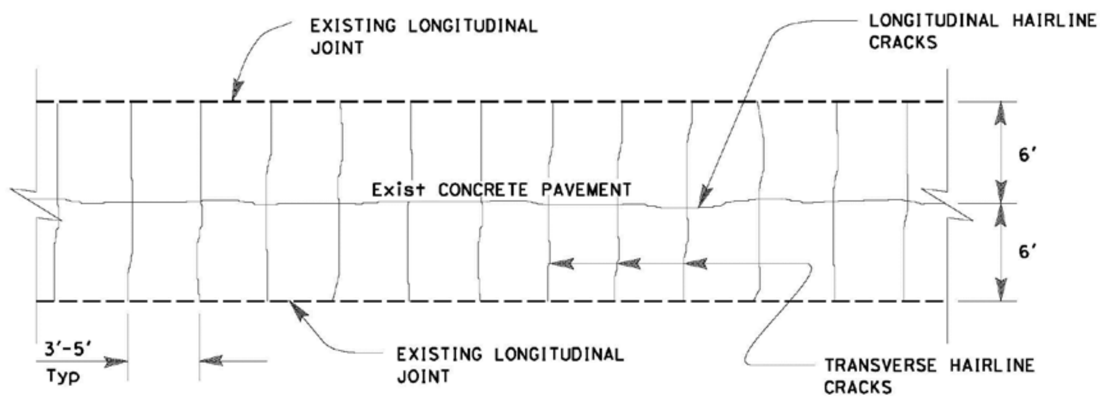

Figure 410-1: Typical cracking patterns and dimensions

The CSOL treatment produces concrete “mini-slabs” with reduced vertical and horizontal movement, while maintaining aggregate interlock and structural integrity between the cracked segments. Care must be taken in cracking the existing slab to ensure that the structural integrity of the interlocking slab sections remains high to provide the best foundation for the flexible overlay. If excessive force is exerted during the cracking process, aggregate interlock will be damaged and the effectiveness of the CSOL technique will diminish.

Figure 410-2: Spring arm drop hammer

After cracking, the cracked concrete segments are seated into the existing base layer using pneumatic-tired or pad-foot rollers to provide firm contact and limit vertical movement. Any joints, spalls, and cracks > ¾” are filled with a fine No. 4 graded HMA mix to provide a uniform support surface for the overlay.

Next, an overlay system comprised of an HMA leveling course, a geosynthetic pavement interlayer (GPI) or a stress absorbing membrane interlayer (SAMI), and additional flexible pavement layers are placed. Standard 20-year CSOL pavement structure designs are described in Section 410.4.2 and HDM Index 625.1.

410.2 PROJECT SELECTION

CSOL is typically used where multiple concrete pavement lanes have an unacceptable ride quality (ride score > 170 inches/mile), extensive 3rd stage cracking > 10% (see Figure 410-3), or stage construction alternatives do not allow for lane replacement strategies.

Since all lanes must receive CSOL, it may not be a cost effective strategy if there is sufficient remaining service life in multiple adjacent lanes. If the only an outside truck lane needs rehabilitation, lane replacement may be more cost effective than a multilane CSOL strategy (see Ch. 400). A life-cycle cost analysis (LCCA) should be completed to determine whether CSOL composite pavement is more cost effective over the long term than flexible or concrete lane replacement alternatives. The Headquarters Division of Maintenance Pavement Program website provides information on performing LCCA: http://www.dot.ca.gov/hq/maint/Pavement/Offices/Pavement_Engineering/LCCA_index.html.

Figure 410-3: 3rd stage JPCP cracking

Due to the increase of pavement profile resulting from CSOL, candidate projects should have few structures or other overhead obstacles. Vertical clearance requirements at overhead structures often dictate localized pavement reconstruction and require tapers to lower the mainline profile grade. Tapers of the overlay approaching existing bridge decks are also required. Refer to the pavement tapers and transitions guidance on the HQ Pavement Program website for more information.

By nature, CSOL operations generate an excessive amount of vibration that can cause damage to surrounding structures in close proximity to the roadway, especially shallow culverts and buildings with eligibility for the National Register of Historic Places. Depending on the structure type and age, various damage potential thresholds apply that could limit CSOL applicability for certain locations or projects. Special mitigation and vibration monitoring measures may be required. Refer to the Division of Environmental Analysis website and coordinate with district environmental personnel early in the project development process so the project area can be analyzed for compliance.

Other project selection considerations include:

- availability of special equipment and materials
- traffic impacts from repeated lane closures and limitations on longitudinal lane drop-off during overlay construction (see Section 410.4.3)

410.3 MATERIALS

410.3.1 Flexible Pavement

CSOL flexible pavement materials may consist of HMA Type A, RHMA-G, or a combination of each. RHMA-G is recommended for the final surface layer because of its superior resistance to reflective cracking. For more information about flexible pavement materials, refer to the Asphalt Pavement Guide.

410.3.2 Interlayers

A pavement interlayer is included in all CSOL designs. GPI fabric and SAMI provide a continuous moisture barrier and additional resistance to reflection cracking in the pavement structure. Water intrusion can weaken underlying unbound layers and potentially unseat the cracked concrete. In drier climates where water intrusion is not a big concern, GPI paving grids may be preferable for superior reflective cracking resistance. Geocomposite strip membranes or "band-aids" are seldom used.

If RHMA-G is used as a flexible pavement surface layer, use a SAMI-R asphalt rubber binder seal coat or GPI paving mat in lieu of other GPI types, some of which can be susceptible to melting or loss of strength due to high RHMA-G placement temperatures.

GPI material requirements are in Section 88 of the Standard Specifications and placement provisions are in Section 39. SAMI requirements are in Section 37-2.06. Interlayer alternatives for crack, seat, and overlay strategies are summarized in Table 410-1.

Table 410-1: Interlayer Alternatives and Criteria for Application

Material	Description
GPI Paving Fabric	A geosynthetic used for paving fabric must be a lower stiffness (modulus), nonwoven material. It is used with a heavy asphalt tack coat and becomes saturated with asphalt cement prior to a flexible overlay or chip seal.
GPI Paving Mat	A geosynthetic used for paving mat must be a non-woven, higher stiffness (modulus) fiberglass or polyester hybrid material that is also used with a heavy tack coat and becomes saturated with asphalt. Placed prior to an asphalt overlay.
GPI Paving Grid	Geosynthetics used for paving grid must be a geopolymer material formed into a grid or open mesh with openings ≥ ½" to allow interlock with surrounding HMA materials. Applied with a self-adhesive or a lightweight scrim (nonwoven material <1.2 oz/yd^2 attached to the grid) and tack application before overlaying.
GPI Paving Geocomposite Grid	A paving grid laminated, bonded, or integrated with a paving fabric that is saturated with liquid asphalt binder before overlaying.
GPI Geocomposite Strip Membrane	12", 18", 24", or 36" width strips of rubberized or polymerized asphalt and geosynthetic materials. Applied with either a self-adhesive or asphalt tack before overlaying. Not recommended for CSOL.
SAMI-R	SAMI is an asphalt rubber binder seal coat under Section 37-2.05B. Heated asphalt rubber liquid binder is applied to the surface followed by precoated aggregate screenings. SAMI specifications are in Section 37-2.06.

410.4 DESIGN

410.4.1 Preliminary Repairs

Existing pavement distresses should be repaired before overlaying the existing pavement according to the advisory design standard in HDM Index 625.1. A visual field survey is needed during preliminary and final project design to identify and evaluate existing pavement distresses and estimate repair quantities. Potential repairs and preparations include:

- Sealing cracks from ¼ to ¾" wide (requires using nSSP with approval of HQ Division of Maintenance Pavement Program).
- Replace slabs with cracks ≥ ¾" wide, rocking under traffic loads, or missing pavement. Individual slab replacement may use concrete, RSC, or full-depth HMA material (see Ch. 320).
- Repair spalls and loose pavement. Cracking and seating under Section 41-6 of the 2010 Standard Specifications includes filling joints, cracks, and spalls > ¾" wide and 1" deep with HMA.
- Remove existing thermoplastic and painted traffic markings, striping, and pavement markers (refer to the HQ Division of Maintenance Pavement Program website http://www.dot.ca.gov/hq/maint/Pavement/Offices/Pavement_Engineering/PDF/Pave-Over-Thermo-Paint.pdf).
- Remove previous AC overlays > 0.10' thick by milling before CSOL work begins.

Refer to Chapter 110 for more information about evaluating existing pavement conditions.

410.4.2 Pavement Structure Design

Crack, seat, and flexible overlay with a pavement interlayer is designed for a 20-year life without requiring significant pavement maintenance. The flexible pavement layer thickness and interlayer (GPI or SAMI) are critical design features of CSOL projects that delay reflective cracking. Following cracking, seating, and pre-overlay repair of the JPCP slabs, the flexible pavement overlay is placed, consisting of:

1. Tack coat
2. 0.10’ or 0.15’ HMA leveling course
3. SAMI-R or GPI pavement interlayer
4. Final HMA or RHMA-G flexible surface layers

Figure 410-4 shows 2 typical sections for crack-and-seat and flexible overlays. Section A is either HMA or RHMA-G above a pavement interlayer. Section B is a thicker combination of RHMA-G and HMA above the interlayer for Traffic Index (TI) ≥ 12.0.

The minimum standard thicknesses for a 20-year design life are found in Highway Design Manual (HDM) Index 625.1. The minimum layer thicknesses from Table 625.1 are given in Table 410-2.

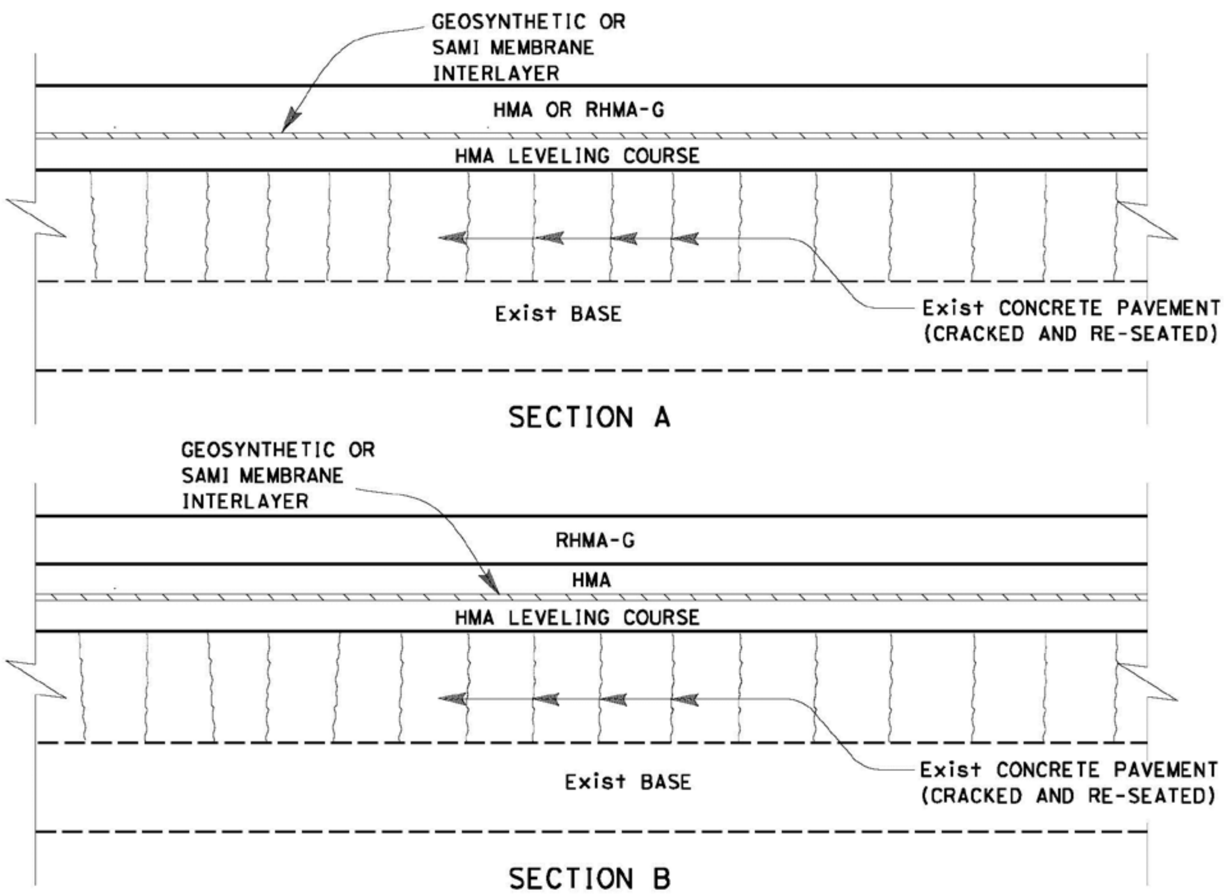

Figure 410-4: Typical crack, seat and HMA overlay sections

Table 410-2: Minimum Standard Pavement Structure Thicknesses (from HDM Table 625.1)

Traffic Index (TI)	Pavement Structure	Layer Thicknesses		
		Alternative 1	Alternative 2	Alternative 3
< 12	Surface Layer	0.35′ HMA	0.20′ RHMA-G	
	Interlayer	GPI or SAMI-R	SAMI-R	
	Leveling Course	0.10′ HMA	0.10′ HMA	
≥ 12	Surface Layer	0.40′ HMA	0.20′ RHMA-G	0.20′ RHMA-G 0.15′ HMA
	Interlayer	GPI or SAMI-R	SAMI-R	GPI or SAMI-R
	Leveling Course	0.15′ HMA	0.15′ HMA	0.10′ HMA

Where the slab deterioration is primarily limited to the outer lane for lanes on multilane facilities, an economic analysis should be made to compare the cost of lane replacement with the cost of crack, seating, and overlaying all lanes and shoulders. The District Materials Engineer should be consulted about CSOL rehabilitation strategies.

410.4.3 Traffic Handling and Safety

Safety and traffic handling must be considered when developing crack, seat and overlay strategies to obtain the required quality of work with minimal increases in project costs.

Traffic control is an important consideration for CSOL project design. Consider the repeat lane closures required for the different phases of construction work, the 0.15’ restriction on longitudinal lane drop-off during paving, and the need to minimize traffic on the partially completed pavement.

Traffic is permitted to use cracked and seated JPCP within 24 hours of seating until the initial HMA lift is placed. Exposure of the partially completed overlay to public traffic and heavy trucks is limited to 15 days to avoid unseating of the JPCP and incremental cracking.

For more information about traffic handling alternatives, refer to Section 120.3.4 and coordinate with the district traffic operations, traffic management, construction, and public information office.

410.4.4 Other Design Considerations

Transverse Transition Tapers

The preferred method of conforming an HMA overlay to existing concrete pavement is to replace the pavement structure with a concrete pavement transition taper under Section 41-7 of the 2010 Standard Specifications. Transition tapers can prevent HMA raveling at the conform location and should be designed to meet pavement design life standards in HDM Topic 612. If the existing JPCP was built with an end anchor (see Revised Standard Plan RSP P30) and the overlay is ≥ 0.25’ with an interlayer, the existing concrete may be diamond ground until the remaining thickness is at least 0.65’.

410.5 CONSTRUCTION CONSIDERATIONS

Typical CSOL construction work includes:

- Replace distressed or unstable JPCP slabs
- Crack and seat existing concrete pavement
- Repair, patch, and sweep existing surface

- Place HMA leveling course
- Place GPI or SAMI interlayer
- Place additional HMA or RHMA-G flexible pavement layers

In addition to preliminary repairs and preparations described in Section 410.4.1, several other construction elements must be considered in the design phase to estimate work schedules, traffic controls, and working days, including:

- Sweeping and patching the pavement surface. Cracking the pavement can produce spalling, chipping, and surface deterioration. The contractor should fill joints, cracks, and spalls > ¾" wide and 1" deep with minor HMA according to requirements in Section 41-6 of the 2010 Standard Specifications. The surface also must be swept prior to public traffic use and HMA leveling course paving.

- Traffic closures. CSOL projects involve repeat closures of multiple lanes, creating significant traffic impacts. In many areas night work is required.

- Height differentials during construction. When planning project timelines and working day schedules, temporary vertical drop-offs from overlay lifts across multiple lanes must be considered together with safety issues for construction workers and motorists. The maximum temporary vertical drop-off is 0.15'.

- Traffic on cracked and seated pavement. Work sequencing for the project should reduce the exposure of cracked and seated pavement to truck traffic prior to full-depth overlay placement. Such exposure could cause unseating of the cracked pavement and expose traffic to loose gravel and debris.

  Section 41-6 of the 2010 Standard Specifications requires the initial overlay lift be placed within 24 hours of seating or the segment must be reseated. Similarly, intermediate overlay paving lifts should not be exposed to prolonged heavy truck traffic that could result in incremental cracking through each lift. The CSOL design should accommodate 24 hours of traffic between lift placements. Work should be scheduled so that the full overlay thickness will be in place quickly, or preferably before opening to traffic, to prevent incremental cracking of each lift. CSOL projects should not be considered candidates for stage construction.

For more details about CSOL construction, refer to the Construction Manual.

410.6 PLANS, SPECIFICATIONS, AND ESTIMATING

410.6.1 Plans

Crack, seat and flexible overlay details are usually shown in the following project plan sheets:

1. Title Sheet showing limits of project and pavement work.
2. Typical Section showing existing and proposed pavement widths and thicknesses.
3. Construction Details for unique items of work not addressed on the typical sections or standard plans.
4. Quantities Sheets specifying types and amounts of work. Locations and limits of CSOL should be tabulated in the quantity tables consistent to what is shown on the layout sheets.

410.6.2 Specifications

Crack and seat provisions are in Section 41-6 of the 2010 Standard Specifications. Flexible pavement overlay provisions for minor HMA, HMA, RHMA-G, and GPI are in Section 39. GPI material requirements are in Section 88 and SAMI-R provisions are in Section 37-2.06.

410.6.3 Cost Estimating

Crack, seat, and overlay related bid items for pavement work are shown in Table 410-3.

Table 410-3: Crack, Seat, and Overlay Related Bid Items

Item	Description	Unit	Notes
411105	Individual Slab Replacement (RSC)	CY	Replace slabs with cracks ≥ ¾" wide, rocking under traffic loads, or missing pavement (see Ch. 320)
413000	Crack and Seat	SQYD	Includes filling joints, cracks, and spalls > ¾" wide and 1" deep with HMA
390135	HMA (Leveling)	TON	Should be used for the initial paving lift to correct surface irregularities
390132	HMA (Type A)	TON	Includes GPI pavement fabric, paving mat, paving grid, paving geocomposite grid, or geocomposite strip membrane as shown
390137	RHMA (Gap Graded)	TON	Offers superior reflective cracking resistance
370120	Asphalt-Rubber Binder	TON	Use for SAMI-R
375035	Precoated Screenings	TON	Use for SAMI-R
Nonstandard	Crack Sealing (¼ to ¾")	LF	Use nSSP with approval of HQ Division of Maintenance Pavement Program

REFERENCES

1. Asphalt Overlays (MS-17), Asphalt Institute.
2. D. Jones, J. Harvey, and C. Monismith. Reflective Cracking Study: Summary Report. UCPRC-SR-2007-01.