

SUBJECT: Guidelines for Portland Cement Concrete Inlay or Overlay

DATE: January 1, 2005

### **Applicability**

These guidelines are to be followed to: (a) review the existing pavement structure, (b) identify design considerations, and (c) prepare a request for review and approval of a portland cement concrete (PCC) inlay / overlay system. This alternative rehabilitation strategy shall apply only to Class II, III, and IV pavements.

### **Background**

The stopping, starting, standing, and turning actions of vehicles at intersections can be very rigorous on pavement structures with hot mix asphalt (HMA) surfaces. The resulting pavement will rut and allow standing water to create a hydroplaning hazard during rain events. In addition, the ruts collect snow and ice and create potential hazards to snowplows during snow events. These scenarios are very hazardous to the traveling public. The use of a portland cement concrete (PCC) inlay / overlay at these intersections may reduce the pavement distress and reduce the hazards to the motorist.

A PCC inlay / overlay consists of placing a thin, synthetic fiber reinforced, concrete on an existing HMA pavement structure. Placement at urbanized intersections generally includes milling some of the existing rutted HMA to create an inlay versus overlay situation. Placement on rural roadways may include milling to correct profile irregularities and provide a scarified surface for bonding of the overlay. A PCC inlay / overlay should be considered as an alternative at intersections where HMA overlays frequently rut and have short performance lives. A PCC inlay / overlay may also be considered on rural roadways where rutting and profile corrections are a concern and an extended performance life is desired.

The benefits of a PCC inlay / overlay are: elimination of the pavement rutting, reduced standing water and hydroplaning, increased visibility, increased skid resistance, and a longer performance life compared to a hot mix asphalt overlay.

These guidelines may be used in the evaluation of an existing intersection or pavement to determine if the use of a PCC inlay / overlay is feasible and constructible. These guidelines also contain the design steps needed to successfully complete this option. The use of a PCC inlay / overlay should follow a thorough review of the existing pavement structure, as well as close attention to utility, profile, and elevation adjustments. This technique requires a bonding action to the underlying pavement and multiple relief joints at an early age to control cracking and curling stresses within the inlay / overlay.

### **Limitations**

The performance of PCC overlay sections can be variable. Many times, the pavement cross section contains an old slab of concrete or brick pavement. The designer is strongly cautioned to maintain a reasonably sound bituminous overlay of 3.0 inches or more over these types of slabs. Past projects which required the placement of the concrete overlay directly on an existing concrete or brick pavement have resulted in a high degree of surface distress.

Concrete inlays and overlays less than 5.0 inches should be viewed as a rehabilitation, and a reasonable performance life of 15 years can be expected. An inlay or overlay thickness of 5.0 inches or more is likely to provide good service over a longer period. The designer shall use a design period of 20 years in this case due to the small thickness increase to provide increased service life.

## **Procedures**

The selection of a PCC inlay / overlay should be the result of a thorough review of the existing pavement structure, existing and proposed ADT, design considerations, construction sequencing and feasibility, and an examination of other alternatives.

### **(a) Review of the Existing Pavement Structure**

A thorough investigation of the existing pavement structure should be conducted. The purpose of this investigation is to determine if the section in question is suitable for a PCC inlay / overlay. It is essential that only appropriate sections be selected for this rehabilitation option.

#### **(1) Preliminary Pavement Investigation**

Prior to requesting a detailed pavement investigation, the designer should research the past rehabilitation attempts as well as the future plans for the area that surrounds the intersection / roadway. Research of the past rehabilitation attempts will provide information on why the past rehabilitation methods have not performed as desired. Insight into the future plans for the pavement and area surrounding the project may influence the design of the rehabilitation.

The designer should also consider the general constructability of a PCC inlay / overlay at the selected location. The existing HMA pavement that is to remain in place must be a minimum of 3.0 inches thick. If a portion of the PCC inlay / overlay will be bonded directly to bare concrete, this rehabilitation method should not be used. Construction is also hindered by complicated geometrics, utility obstructions, traffic demand, and the condition of the existing pavement.

If it appears that a PCC inlay / overlay can be constructed at the intersection / roadway, then a detailed pavement investigation is necessary to verify the constructability of the inlay / overlay.

#### **(2) Detailed Pavement Investigation**

Upon completion of the preliminary investigation, the District may request Falling Weight Deflectometer (FWD) testing from the Bureau of Materials and Physical Research for determination of substructure support ratings. In addition, a detailed pavement coring plan should be developed and administered by the District. In general, cores will be taken to represent all pavement cross sections and all locations within the project. A document with guidelines for material sampling entitled "Guidelines for Material Sampling and Testing of Existing Bituminous Concrete Pavements and Overlays" is available through the Central Bureau of Materials and Physical Research. The coring plan should be completed to specifically address the following points.

- HMA overlay total thickness and thickness for each layer detected
- Condition and tensile strength of the HMA overlay for each layer detected
- Presence of stripping within the HMA overlay
- Underlying pavement thickness and type
- Compressive strength (if concrete) and tensile strength (if HMA) of the underlying pavement
- Presence of D-cracking (if concrete) or stripping (if HMA) within the underlying pavement
- Identification of locations where patching or alternative rehabilitation methods are recommended.

In addition to the coring plan, a general inspection of the project limits should be completed. In general, the inspection will address items such as geometrics, drainage, utilities, and surface abnormalities. More specifically, the inspection should address the following points.

- Intersection of pavement crowns (Multi-leg intersections)
- Location of drop inlets
- Location of loop detectors for traffic signals
- Location of sewer manholes, water valves, and all other utility obstructions
- Location of existing surface patches
- Location of high severity distress cracks
- Clearances for overheads

(3) Existing and Projected Annual Daily Traffic

An accurate count of the existing Annual Daily Traffic (ADT) with a breakdown of percentages for passenger vehicles, single unit, and multiple unit trucks should be performed. In addition, estimates for the projected ADT and classification breakdown should be developed for the design period.

Upon completion of the coring and inspection procedures, and the collection of traffic data, a report should be created to document this information.

**(b) Identify Design Considerations**

There are several design issues that must be considered before a PCC inlay / overlay project can be submitted for review and approval. A list of issues that may be resolved prior to the submittal of a design is as follows:

(1) Design Period

The design period to be used for this rehabilitation strategy is 15 years. If the resulting inlay or overlay thickness is 5.0 inches or greater, the designer shall use a 20 year design period.

(2) Cost Alternatives

Consideration should be given to the cost analysis of several different rehabilitation options. Cost analyses include items such as the initial

construction cost, annual maintenance costs, and the expected lifespan of the rehabilitation option. Cost alternatives may also be warranted for various options within the same rehabilitation technique.

(3) Drainage Considerations

Maintaining proper drainage through design and during construction is very important. Design of the PCC inlay / overlay must include a crowned section to ensure proper drainage to the edge of the roadway. During construction, maintaining drainage is especially critical for projects that include an inlay.

(4) Pavement Patching

Severely deteriorated areas of the existing pavement that are present before, or after, the milling operation must be repaired. Such areas include large potholes, raveled areas, and severe cracks. Large repairs generally will include additional milling and placement of an HMA patch. The finished surface of any patch placed after the initial milling operation is complete must be milled or the surface given a rough texture. The rough surface produced by the milling operation provides increased bonding surface area for the PCC inlay or overlay.

(5) Thickness Design and Relief Joint Spacing

The PCC inlay / overlay thickness design is based on a unique combination of variables including design traffic, underlying pavement structural support, and the final panel dimensions of the inlay or overlay. The minimum thickness allowed is 2.0 inches, and the maximum thickness should not exceed 6.0 inches. Designs greater than 6.0 inches should consider the addition of reinforcement steel and follow the guidelines of an unbonded concrete overlay or be reconstructed.

The traffic factor should be determined according to the appropriate class of roadway and type of facility. Based on the traffic factor and the known amount of bituminous material that will remain in place under the inlay / overlay, the PCC thickness and relief joint spacing may be determined from the appropriate table below. Interpolation between thickness values in the following tables should always result in the use of the smaller relief joint spacing option.

Table 1  
PCC Thickness and Relief Joint Spacing  
**Remaining Bituminous Material, 3.0 in. ≤ X < 5.0 in.**

Traffic Factor	PCC Thickness (in.)	Relief Joint Spacing (in.)
< 0.05	2	24
< 0.1	3	36
< 0.3	4	48
< 0.6	5	72
< 1.7	6	72

Table 2  
PCC Thickness and Relief Joint Spacing  
**Remaining Bituminous Material,  $X \geq 5.0$  in.**

Traffic Factor	PCC Thickness (in.)	Relief Joint Spacing (in.)
< 0.3	2	24
< 0.6	3	36
< 1.0	4	48
< 1.6	5	72
< 4.0	6	72

A key to the success of a PCC inlay / overlay is the longitudinal and transverse relief joints. These joints are hand tooled into the plastic concrete or sawed into the hardened concrete to provide stress relief induced by drying shrinkage and curling of the concrete. These joints should be laid out on a regular pattern for both the longitudinal and transverse directions based on the spacing from the appropriate table above. No skewed joints will be allowed.

Transverse and longitudinal relief joints should be laid out to match joints, utility obstructions, and geometrics of the existing pavement as much as possible. The longitudinal relief joints should be laid out to avoid the wheelpath areas of the traveling lanes. The layout of all transverse and longitudinal relief joints should be detailed on the plan sheets.

There is a direct trade off in cost for saw cutting and inlay / overlay thickness. For example, the cost per square yard of a 2.0 inch concrete overlay with a 24.0 inch panel size may be similar to a 6.0 inch concrete overlay with a 72.0 inch panel size. The thicker inlay or overlay is preferred for long term performance.

(6) Profile Correction

Large profile corrections to the existing pavement should be a part of the initial milling operation. A hot mix asphalt overlay or repair may be needed in some cases to correct a sag vertical curve or insufficient pavement crown. The finished surface of any hot mix asphalt overlays placed after the initial milling operation is complete must be milled or have the surface roughed up

The PCC inlay / overlay may also include a variable thickness for profile correction of the existing pavement surface. If this occurs, the design thickness and relief joint spacing for each portion of the project should be based upon the thinnest section that is anticipated for that portion of the project.

(7) Final Finish

A Type B final finish followed by a rough broom finish struck perpendicular to the direction of traffic flow shall be used at all locations with a posted speed limit of 45 mph or less. The rough broom finish shall be used across the entire surface area of the inlay or overlay including any hand tooled joints.

The “Special Provision for Type A Final Finish of Portland Cement Concrete Pavement with Variably Spaced Tining (BMPPR)” shall apply at all other locations.

(8) Traffic Control

The control of traffic through the project must be considered and well established prior to the time of construction. The best alternative for traffic control is to completely close the project to traffic. This alternative may be difficult for urban projects; however, somewhat easier for rural projects. If closure to traffic is not possible, traffic control must be established that will effectively move traffic through the project with minimal disruption to construction operations and traffic flow. Traffic control that can be left unattended overnight must be anticipated for each stage of construction.

(9) Construction Staging

Construction staging for a PCC inlay / overlay project must be considered with respect to the construction timeframe and traffic flow through the project. The project must be staged in such a way that continuous traffic flow will be maintained. Construction staging must also consider the geometrics of the project and any lane to lane drop off restrictions that may be present with the overlay thickness.

The concrete mixture design for these inlays or overlays is designed to reach a predetermined compressive or flexural strength within 14 days. Normally, these mixture designs will acquire the strength requirements in 3 days. The completed inlay or overlay may not be opened to traffic until these strength requirements are met. If the inlay or overlay must be opened to traffic in less than 3 days, consult the District materials office for an acceptable concrete mixture.

**(c) Request for Review and Approval**

All proposed PCC inlay / overlay projects must be submitted for approval to the Bureau of Design and Environment. At a minimum, this submittal should include the following: 1) a report of the preliminary and detailed pavement inspections, 2) existing and proposed cross sections, 3) existing and projected traffic information, 4) construction sequencing and proposed traffic control, and 5) a summary on why a PCC inlay / overlay is the preferred method of rehabilitation over other alternatives.