DESIGN AND CONSTRUCTION OF CONCRETE RESURFACING OF CONCRETE PAVEMENTS

Ross Martin, Portland Cement Association

Abridgment

In the last decade, great progress has been made in the design and construction of concrete pavements. Central-mix batch plants, slip-form paving, and electronically controlled fine grading allow very smooth, economical pavements to be built at average rates, exceeding a mile of 2-lane pavement per day. Developments such as these should be exploited in the design and construction of concrete resurfacing.

Concrete pavements have been successfully resurfaced by the following methods: partially bonded resurfacing placed directly on the existing pavement, unbonded resurfacing placed over a leveling or separation course or both laid on the existing pavement, and bounded resurfacing placed on an existing pavement after the surface is completely cleaned. The following discussion pertains to design and construction of partially bonded and unbounded concrete resurfacing of highways.

An appraisal of the performance of partially bonded and unbonded concrete resurfacing indicates the following:

1. Thickness must be adequate for the service conditions.
2. Joints, both longitudinal and transverse, and cracks must have the capacity to transfer applied loads without loss of surface smoothness. The joint and crack system should minimize the migration of moisture and fine solids through the resurfacing as well as between it and the underlying pavement. To this end, shoulders should preferably be of concrete tied to the resurfacing or of another material stabilized for the full depth of the overlay.
3. Reinforcement must have adequate cover for the exposure conditions and should be of such a size and spacing that adequate load transfer is obtained across all cracks.
4. Suitable concrete, for the service conditions, is mandatory.

Apart from defects related to concrete quality and construction procedures, such as surface scaling, concrete resurfacings may lose smoothness because of faulting and cracking. Faulting is the differential vertical displacement of slabs at joints or cracks (indicating inadequate load transfer) and can be prevented by appropriate designs. Aside from aesthetic considerations, cracks that do not affect pavement smoothness or required maintenance are not detrimental.

Formulas for determining the thickness of partially bonded and unbonded resurfacing have existed for some years. These formulas, indicating that partially bonded resurfacing may be of less thickness than unbonded resurfacing, have been used successfully in the design of resurfacings for strengthening airport pavements. However, there seems to be a lack of data verifying the accuracy of these formulas for determining the resurfacing thickness of highways. Further, in highway applications bond is rarely obtained

Sponsored by Committee on Pavement Maintenance.

between a partially bonded overlay and the existing pavement; therefore, it is difficult to justify different thicknesses for partially bonded and unbonded resurfacing. Minimum thicknesses for various conditions, considering construction feasibility as well as performance, are as follows:

Traffic	E18 Single Axles in Millions on Design Lane in 20 Years	Thickness in In. With No Free Joints or Edges	Thickness in In. With Free Joints or Edges
Moderate	<1	5	6
Heavy	1 to 10	6	7
Very heavy	>10	7	8

Continuously reinforced concrete (CRC) resurfacing may be 1 in. less than the thickness shown in the tabulation. For the unbonded resurfacing, the separation course should be of high-quality, hot-mixed bituminous concrete. Free joints are those without adequate deformed tie bars, dowels, or other means of positive load transfer. Free edges are those without an adjacent tied concrete lane, shoulder, or thickened widening to reduce edge deflection. Partially bonded and unbonded resurfacing may have a load transfer system of plain concrete with undoweled joints, mesh reinforced concrete with doweled joints, or continuously reinforced concrete.

PLAIN CONCRETE RESURFACING

This type of resurfacing has undoweled transverse joints, but all longitudinal joints should be keyed and tied with deformed tie bars. It should not be used if the number of equivalent 18-kip single-axle loads in 20 years on the most heavily traveled lane exceeds 10 million in nonfrost areas or 1 million in frost areas. If traffic exceeds these limits and a plain resurfacing is contemplated, dowels should be used across all transverse joints.

Any moving slabs in the existing pavement should be stabilized. (This may require badly damaged sections to be replaced with concrete patches.) A separating course of bituminous concrete should then be placed over the existing pavement, and an unbonded resurfacing should be constructed before cracks from the existing pavement develop in in the leveling course.

Transverse joints in the resurfacing should preferably not be placed over joints in the existing pavement and should be skewed and randomized (maximum joint spacing should not exceed 20 ft). Construction joints should be keyed and tied by deformed tie bars. All joints should be sealed.

MESH-DOWEL CONCRETE RESURFACING

This type of resurfacing has distributed steel in the slab panels, dowels across all transverse joints, and all longitudinal joints keyed and tied by deformed tie bars. It may be used under any conditions of traffic and environment.

Any moving slabs in the existing pavement should be stabilized. (This may require badly damaged sections to be replaced with concrete patches.) A separating course of bituminous concrete should then be placed over the existing pavement, and an unbonded resurfacing should be constructed.

Transverse joints in the resurfacing should preferably not be placed over joints in the existing pavement and should have a spacing not exceeding 25 to 30 ft. Construction joints should be keyed and tied by deformed tie bars or doweled, whichever is appropriate. All joints should be sealed.

It is mandatory that distributed steel hold intermediate panel cracks tightly closed. A satisfactory mesh style is 6 × 12 - 00/4 (78 lb/100 sq ft). Cover on all steel should be at least 2 in.

To ensure accurate dowel alignment and obtain proper consolidation of concrete around the dowel, it is recommended that dowels be placed mechanically. Dowel spacing should be 12 in. and of a size compatible with the resurfacing thickness. Dowels should be manufactured with an appropriate coating and have sawed ends.

CONTINUOUSLY REINFORCED CONCRETE RESURFACING

This type of resurfacing depends on continuous steel to cause tight, closely spaced, transverse cracks. The crack spacing should ideally be 6 to 10 ft so that sufficient continuity across cracks, with respect to shear transfer, is obtained. It may be used under any conditions of traffic and environment.

Any moving slabs in the existing pavement should be stabilized. (This may require badly damaged sections to be replaced with concrete patches.) Partially bonded resurfacing is not recommended over existing pavements having joint spacings greater than 60 ft because of the large movements that may occur at these joints. Regardless of the joint spacing, if joints and cracks in the existing pavement have faults generally greater than ⅜ in., a leveling course of bituminous concrete should be placed over the existing pavement and an unbonded resurfacing constructed.

Past performance appears to indicate that the longitudinal steel area in CRC pavement generally should not be less than 0.6 percent; if the pavement will be subjected to large drops in temperature, a higher percentage is probably desirable. Transverse steel areas of between 0.05 and 0.1 percent have been used in the past with CRC resurfacing. Recently, transverse steel has been omitted from CRC pavements (having thicknesses of 8 in.) with no apparent ill effects. The omission of transverse steel in unbonded CRC resurfacing should be tried on an experimental basis. Cover on all steel should be at least 2 in.

Longitudinal joints should be keyed and tied with deformed tie bars. Transverse construction joints and terminal treatment should follow the practices used in CRC pavement construction.

DESIGN INNOVATIONS IN CRC RESURFACING

Attempts have been made to improve the performance of conventional CRC pavement that exhibits random cracking. The designs use weakened plane joints with continuous steel crossing the joints (here called elastic joints) to form transverse hinges across the pavement. The weakened plane joints may be formed by crack starters (inserts or saw cuts) above the continuous steel.

An initial highway installation indicated that 0.2 percent continous steel with elastic joints could be used; continuous steel (plain) was treated with asphalt to prevent bond for a short distance across the joints (1). Because the steel near the elastic joint is treated to prevent bond with the concrete, overstressing of the steel at low temperatures is avoided and the steel serves as an elastic tie across the joint.

The initial cost of CRC pavement with elastic joints may be less than that of conventional CRC pavement because the reduction in steel requirement should more than compensate for the cost of constructing elastic joints. The performance should be superior, particularly in locations where there is possibility of steel corrosion in the vicinity of cracks because the bond breaker could also be a protection against corrosion. If deformed bars are used, a plastic sleeve may be utilized to prevent bond. Plastic tape inserts might be considered for forming weakened planes at appropriate spacings. Because all the elastic joints should have similar and very small movement, joint maintenance will be eliminated.

This concept can be applied to resurfacing and should be investigated on an experimental basis.

SUMMARY

Partially bonded and unbonded concrete resurfacing may be plain, mesh-dowel, or continuously reinforced. Field projects to determine the full potential of CRC resurfacing with random cracking and controlled cracking by elastic joints are needed. There is a need to document the performance history of concrete resurfacing types by relating smoothness of ride to both the traffic carried and the age of the resurfacing (with due regard to the type and condition of the underlying pavement). Only by this means can the performance and cost of resurfacing types be compared.

REFERENCE

1. Persson, B. O. E., and Friberg, B. F. Concrete Pavements With Continuous Reinforcement and Elastic Joints. Highway Research Record 291, 1969, pp. 48-56.