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Patching of Continuously Reinforced Concrete Pavements

MICHAEL I. DARTER

This paper presents recommendations for the permanent repair of localized distress in continuously reinforced concrete pavements in Illinois. Recommendations for cost-effective patching are provided for selection of patch boundaries, sawing of the concrete, removal of concrete, replacing and splicing the reinforcing steel, preparing the patch area, placement of concrete, and curing of the patch until the area is reopened to traffic. These procedures have been validated through extensive field testing. The procedures reduce costs and lane-closure time by (a) adapting the patch size and type to fit the distress, (b) reducing reinforcement embedment length into the patch, (c) using mechanized equipment for construction, and (d) using concrete additives and curing techniques to facilitate early reopening to traffic.

The increasing amount of patching of continuously reinforced concrete pavement (CRCP) in Illinois has led to the need for procedures that are more cost-effective. Existing procedures evolved from the expensive repairs of CRCP sometimes required by the contractor to remedy errors made during new construction. CRCP is perhaps the most difficult and costly type of pavement to patch because of the unique design characteristics (e.g., continuous steel and closely spaced cracks). For these reasons, a cooperative research project was initiated in 1976 between the Illinois Department of Transportation and the University of Illinois. One major objective of the project was to develop improved patching procedures for the permanent repair of localized distress, which is briefly summarized here (1-5). The complete patching procedures are included in the report by Simonsen (6).

TYPES OF DISTRESS THAT REQUIRE PATCHING

The various types of CRCP distress that may require permanent patching are edge punchout, wide crack (ruptured steel), longitudinal joint fault, localized breakup, construction-joint failure, blowup, D-crack, and ramp-joint forced crack (steel rupture). Most of these distress types are unique to CRCP, so traditional methods used for identifying and diagnosing distress in plain or reinforced jointed concrete pavements may not be applied to CRCP. It is important that the various distress types be properly identified and diagnosed. To make a good diagnosis of the distress, the mechanisms of development must be understood. Maintenance personnel should know whether the distress is primarily a result of traffic loads, environmental conditions, or a construction defect. It is especially important that they be aware of the extent of the distress and how it has affected the slab, the reinforcing steel, the subbase, and the subgrade.

SELECTION OF PATCH BOUNDARIES

Permanent concrete patches have three distinct sections, simply referred to as the center section and the end sections (Figure 1). The correct determination of these section boundaries will increase the life of the finished patch and minimize overall annual patching costs.

For example, in most cases the subbase material beneath an edge punchout has disintegrated for some distance on either side of the distress. Signs of edge pumping or longitudinal joint faulting (settlement) will prove to be a good guide in determining how far from the edge of the visible distress the subbase has been damaged (typically 2-3 ft). Consequently, the overall length of the patch must reflect this deteriorated subbase material. Careful attention must be given to these warning signs around the distresed area and appropriate steps must be taken to ensure that the deteriorated areas are contained within the patch boundaries.

Broken reinforcement can be verified by running a thin ruler down through the crack, or any crack that has faulted 0.10 in or more can be assumed to contain broken or corroded steel or both. The patch boundaries cannot be moved too close to the distressed portion because then the possibility exists that all the deteriorated subbase may not be included, and future failure of the adjacent slab or patch or both will occur.

In order to minimize patch size and cost and at the same time provide adequate lap length and allow for cleanout of the center section, the following minimum values for overall patch length should be observed: (a) for a patch that contains tied steel, 4.5-ft minimum length; and (b) for a patch that contains welded steel, 3-ft minimum length.

A patch that contains tied steel can be placed for any distress type:

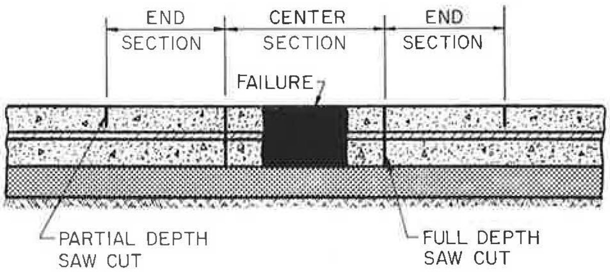
1. The distressed portions of the continuously reinforced concrete (CRC) slab and base should be incorporated within the center section of the patch, and
2. The end sections and the center section of the patch should be a minimum of 18 in long. Field and laboratory testing has shown these end and center section lengths to be adequate for typical reinforcement used in Illinois (no. 5 bars and welded deformed wire fabric).

A patch that contains welded steel can be placed whenever the proper equipment is available. This type reduces the length of the end sections and consequently saves a considerable amount of breakout time:

1. The distressed portion of the CRC slab and base should be incorporated within the center section of the patch, and
2. The end sections of the patch should be a minimum of 8 in long.

Because of the potential failure of the CRC slab between the edge of a patch and the nearest transverse crack in CRCP, the outer patch boundaries should be located at least 18 in from the nearest

Figure 1. Identification of center and end sections.



transverse crack. However, sometimes the spacing between cracks is very small, and in these cases it might be necessary to place the boundary closer to the nearest transverse crack than 18 in but not closer than 6 in. If this is necessary, one must make sure that the cracks are tightly closed and not faulted (to determine faulting one simply runs a hand over the crack in the direction opposite to that of the traffic). If a crack that is not tight or is faulted is within 18 in, the patch should be extended to include this crack. Also, the outer patch boundaries should not cross a transverse crack, since this may lead to spalling in the slab at the intersection.

In most instances the patch will be equal to a full lane's width, but this can be reduced under some circumstances:

1. Distress types such as wide cracks, large edge punchouts, blowups, and other distresses that occur over more than one-half of the lane should be patched over a full lane's width (12 ft); and
2. In some cases, such as a small edge punchout or spalling in the outer wheel path, the width of the patch need not be a full 12 ft. In these cases, a longitudinal boundary must be established. A minimum patch width of 6 ft should be used, however, to assure that the longitudinal boundary is placed between the longitudinal reinforcement bars and that the joint is not in the center of a wheel path.

Whenever a failure occurs across all tied traffic lanes, a special patching sequence is required to avoid rapid deterioration of the first patch placed. The typical situation is that in which a steel rupture or blowup has occurred across two lanes of four-lane divided Interstate highway. There is typically a large amount of movement across this crack during a given 24-h period. This movement has often badly cracked the first lane patched (normally the truck lane), and heavy truckloads during the next few weeks cause these cracks to spall and deteriorate until the patch breaks up. The patch placed in the other lane normally does not crack badly because slab movement is restrained.

The following procedure has been found to increase the likelihood of obtaining two good patches: (a) patching the passing lane (or the lane that has the lightest truck traffic) first and (b) patching the heavier truck lane(s) last. Cracks formed in the passing-lane patch from the daily temperature changes will not be likely to break down because of reduced truck traffic.

SAWING OF PATCH

Sawing of all outer boundaries of the patch is highly recommended. Experience has shown that the outer boundaries of a patch will undergo spalling if they are created by jackhammers or other breakout equipment or if they follow an existing crack. Consequently, the proper sawing equipment should be used.

The outer boundary of each end section should be a partial-depth saw cut 1.5-2 in deep that does not cut the reinforcing steel (Figure 2, step 1).

The boundary between the center section and each end section should be a full-depth saw cut through the reinforcement, unless the alternative method presented next is used (Figure 2, step 1).

The following alternative to the full-depth saw cut generally results in a saving of time and cost. The partial-depth saw cuts are placed as usual (Figure 3, step 1). Jackhammers are used to break up the concrete down to the steel, at which point it is cut by using a handsaw or a torch; this eliminates the full-depth saw cut at the boundary between the center and each end section (Figure 3, step 2).

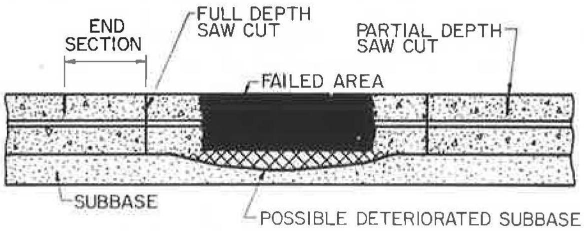
If pins or chains are to be used to lift out the center section of the patch, the saw cuts must be extended through the CRC slab. If full-depth sawing is not possible, an area approximately 5 in wide can be broken up by using a jackhammer along all edges (note that the saw cut must be deep enough to cut the steel). This will enable the slab to be lifted out without experiencing severe binding. This may be needed in hot weather even if full-depth saw cutting is available.

REMOVAL OF CONCRETE

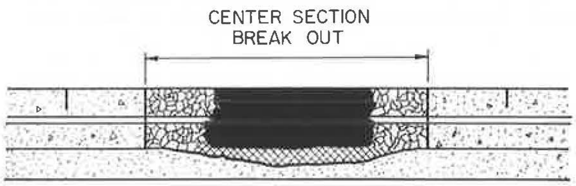
Removal of the concrete from the center section can be accomplished by several methods, depending on the equipment available (Figure 2, step 2; Figure 3, step 2; and Figure 4, step 2):

1. The most common procedure is to break up the concrete by using jackhammers and to shovel it out by using hand tools. The advantages of this method are that a minimum of equipment is needed and, if the work is done carefully, damage to the subbase and the adjacent slab is avoided. Unfortunately, this is the most time-consuming, manpower-intensive method and is thus relatively expensive.
2. The removal time can be shortened by using a pavement breaker and a backhoe. Breaking the concrete by means of a ball breaker should never be permitted, since the large shock waves will damage the adjacent concrete. The problem with this breakout method is that damage to the subbase material usually occurs.
3. A third method that has been used successfully is to lift the section out by using a front-end loader or a bulldozer. The usual procedure is to make a full-depth saw cut or to break up the concrete by using jackhammers on all sides of the center section. The front-end loader or bulldozer then lifts up one end of the slab. Chains are connected to the exposed steel at the other end of the slab and then secured to the bucket. The slab is lifted out and placed in a truck or, if it is very large, on a flatbed. This method can be accomplished in a very short time and it does not damage the subbase or the adjacent CRCP. One of the problems with this method is that the size of slab that can be lifted depends on the equipment available. Also, this method does not work very well in badly D-cracked material or where temporary bituminous patches are being replaced, and disposal of the slabs can be a problem.
4. A fourth method involves lifting the slab out by using pins or other mechanisms (Figure 4). This procedure requires two or more drilled holes, two or more lift-out pins, and some heavy equipment capable of lifting large loads, such as a large end loader. First a strip approximately 5 in wide of the CRC

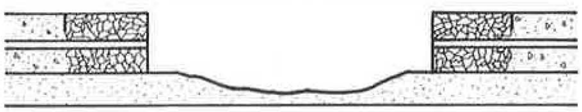
Figure 2. Standard breakout method: partial-depth and full-depth saw cuts (top, step 1); center-section breakout (middle, step 2); and end-section breakout (bottom, step 3).



Step 1: Make one partial depth saw cut at the ends of the patch and one full depth saw cut at the proper end section lengths from the edges (18 inches for tied steel patches 8 inches for welded steel patches).

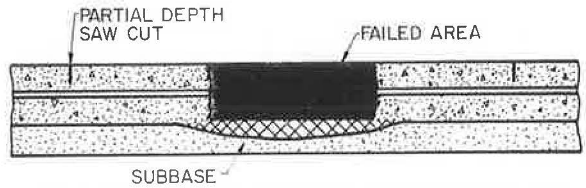


Step 2: Breakout concrete in the center section using jackhammers and remove debris by mechanical methods. Carefully remove the deteriorated subbase, if any exists, making sure not to damage the remaining subbase. The deteriorated area will be filled with portland cement concrete.

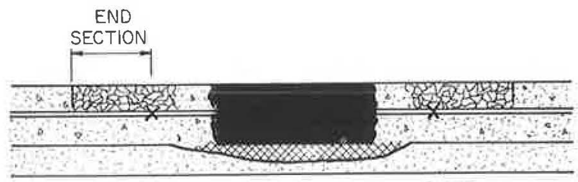


Step 3: **Break up and remove the remaining concrete in the end sections using hand methods being careful not to nick or bend the reinforcement and not to spall the existing CRC slab beneath the reinforcement. The rebar shall not be bent up for the removal of the remaining concrete.**

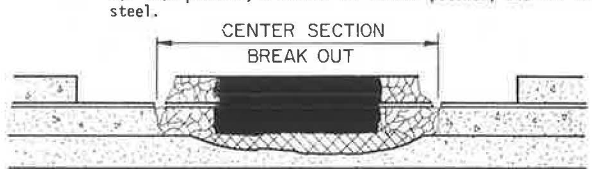
Figure 3. Alternative breakout method: partial-depth saw cut (top, step 1); end-section breakout (middle, step 2); center-section breakout (middle, step 3); removal of remaining concrete (bottom, step 4).



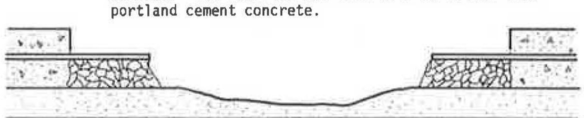
Step 1: Make one partial depth saw cut at the ends of the patch (do not cut steel reinforcement).



Step 2: Breakout concrete in end sections using jackhammers down to the steel at the proper end section length (18 inches for tied patches, 8 inches for welded patches) and cut the steel.



Step 3: Breakup center section using mechanical methods, remove debris in center using mechanical methods if the length allows. Carefully remove the deteriorated subbase, if any exists, making sure not to damage the remaining good subbase. The deteriorated area will be filled with portland cement concrete.



Step 4: Breakup and remove remaining concrete in the end sections using hand methods being careful not to spall existing CRC slab beneath reinforcement and not to nick or bend the reinforcement. The rebar shall not be bent up for removal of the remaining concrete.

center section across the lane must be broken up and removed down to the reinforcement. The steel must then be cut and taken away. The remainder of the strip down to the subbase must then be broken up and carefully removed by hand methods, care being taken not to damage the existing subbase. This may also be accomplished by making two full-depth saw cuts and then breaking out the strip of concrete by using hand methods. Simonsen (5) describes a reusable pin that has been used effectively by several states. However, some contractors have developed equipment that can lift out the slabs more rapidly. The lift-out of a given center section can be accomplished in less than a minute and normally leaves the base material and adjacent CRC slab undisturbed.

Removal of the concrete from the end sections is difficult and must be accomplished carefully (Figure 2, step 3, and Figure 3, step 4):

1. Concrete in the two end sections must be carefully removed so as not to damage the reinforcement in the lap area and to avoid spalling at the bottom of the joint (beneath the reinforcement). This task can be accomplished only by using jackhammers, prying bars, picks, shovels, or other hand tools.
2. Breaking around the reinforcing steel without nicking, bending, or in any way damaging it is difficult. However, the reinforcement must not be bent up during removal of the concrete since the bars cannot be properly straightened out afterwards. Bent reinforcement in the patch area will eventually result in spalling of the patch because of the large eccentric stresses carried by the reinforcement.
3. The use of a drop hammer or hydrahammer should not be allowed in the end sections because this equipment will typically damage the reinforcement and/or cause serious undercutting beneath the partial-depth sawed joint. It may be necessary to limit the size of the jackhammer operating at the joint to minimize undercutting beneath the reinforcement.
4. Any bent reinforcement should be carefully straightened after the breakout of the concrete. Any bends left in the reinforcement may eventually cause spalling in the completed patch.

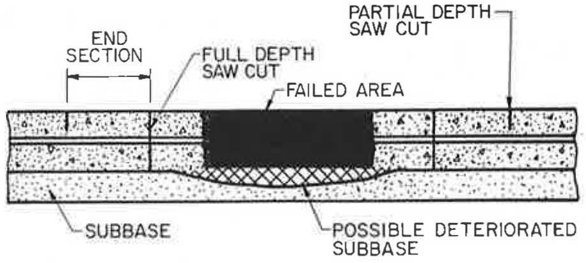
EVALUATING CONDITION OF SUBBASE AND SUBGRADE

All material that has been disturbed or that is loose should be removed and replaced with regular concrete during placement of the patch. If possible, all excessive free moisture should be removed or dried up before the placing of the concrete. If the subbase and subgrade are saturated and considerable water is present, a side French drain should be installed to facilitate drainage. This can be accomplished by cutting a narrow trench through the shoulder. The trench is then back-filled with crushed stone (no fines) and surfaced with asphalt concrete.

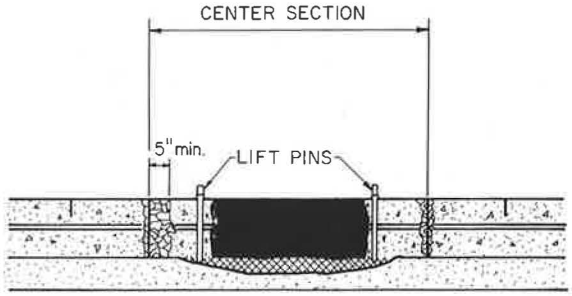
REPLACING AND SPLICING REINFORCING STEEL

The reinforcing steel at the patch ends should be inspected for damage. If more than 10 percent of

Figure 4. Center-section liftout method: partial-depth and full-depth saw cuts (top, step 1); removal of center section (bottom, step 2).



Step 1: Make one partial depth saw cut at the ends of the patch and one full depth saw cut at the proper end section lengths from the edges (18 ins. for tied steel patches, 8 inches for welded steel patches).



Step 2: Breakup concrete down to the steel in the center section at the full depth saw cuts and on one side extend the breakup at least 5 inches into the center section. Remove debris and cut the steel with a saw and remove. Breakup remaining concrete down to the subbase and remove. Drill the required number of holes and insert the lift pins. Carefully remove the deteriorated subbase, if any exists, making sure not to damage the remaining good subbase. The deteriorated area will be filled with portland cement concrete.

the steel is visibly damaged or corroded, the ends of the patch should be extended until this situation is rectified over the required lap length.

New reinforcement of similar size and strength is placed in the patch and spliced to the existing reinforcement at the patch ends by lapping. The required length of embedment of the existing reinforcement into the patch depends on the size and type of reinforcement. Illinois field tests have shown that an embedment length of 18 in is adequate for no. 5 deformed bars and welded deformed wire fabric (0.516-in diameter). This provides an embedment of 29 bar diameters for the no. 5 bar. A no. 4 bar then requires approximately 15 in and a no. 6 bar requires 22-in embedment for 29 bar diameters. This exceeds the American Concrete Institute 318 Code for basic development length. Further research may show that a shorter length is adequate. A minimum 2-in clearance should be provided between the ends of the new rebars and the existing CRCP slab face to allow for possible expansion. The number and spacing of the new reinforcement should match the existing reinforcement as closely as possible.

An alternative to splicing by means of tying the reinforcement as described above is to weld the new reinforcement in place. In some cases, however, the reinforcement in the patch will have been made from old rails, which cannot be easily welded. The origin of the reinforcement should be determined, and if it was old rails, welding should not be attempted. Welding guidelines are as follows:

1. Continuous welds for 0.25 in should be made;
2. The length of the welds should be 4 in (this length develops the full strength of no. 5 bars) and both sides of the bars should be welded; stacking the bars on top of each other is recommended;
3. American Welding Society A5.1 E70XX electrodes should be used;
4. Arc strikes outside the permanent weld area should be avoided and tack welding is expressly prohibited; and
5. To avoid potential buckling, the reinforcement should be lapped at the center of the patch (minimum lap length is 16 in).

The new reinforcing steel bars should be placed according to the following conditions:

1. Reinforcing steel is placed so that a minimum of 2.5 in of cover is provided (if existing steel is less than 2.5 in, the spliced bar is placed under the existing bar), and
2. Reinforcing steel is placed and supported by chairs or other means so that the reinforcement will not be permanently bent down during placement of the patch.

PREPARING PATCH FOR CONCRETE PLACEMENT

If the shoulder has settled below the surface of the slab or is in poor condition, wood side forms should be placed so that it will be possible to strike off the concrete.

It is important to achieve a strong bond between the new patch and the existing concrete. Since concrete bonds better to dry surfaces than to wet surfaces, the ends of the existing CRCP should not be wetted down before concrete placement. Just before placement of the concrete, a neat cement-water grout should be brushed onto the dry ends of the existing CRCP slab. The concrete must be placed before the neat cement-water grout has dried.

PLACING CONCRETE IN PATCH

The concrete should be obtained from a nearby approved ready-mix cement plant. A seven-bag mix of portland type 1 cement has been found to be adequate. The detrimental effects of increased shrinkage and the increase in cost outweigh the increase in strength that a higher cement factor or other types of cement provide. This of course may vary among plants.

Calcium chloride is recommended as a set accelerator in the patching concrete according to the following conditions:

1. The calcium chloride should be added to the ready-mix concrete at the site when the ambient temperature is above 70°F. When the temperature is below 70°F, the calcium chloride can be added at the site or at the plant as long as the length of time from mixing to delivery is less than 15 min. When the calcium chloride is added at the site, a standard solution should be prepared in accordance with standard practice. The ready-mix truck should mix the concrete an additional 40 revolutions after the addition of the calcium chloride at the site.
2. At all times the percentage of calcium chloride by weight of cement is limited to a maximum of 2. It is recommended that no more than 1 percent be used when the ambient temperature is above 80°F because greater percentages can bring on a flash set. It must be noted that on warm days the initial set of the concrete can occur as soon as 30 min after the addition of calcium chloride. Consequently, the patch should be placed and finished as quickly as possible.

On some days, additional early strength could make the difference between opening the patched area to traffic at the end of the day or waiting until the next morning (Table 1). If the engineer fore-

Table 1. Recommended minimum times from placement of patch to opening of patched area to traffic.

Ambient Temperature at Placement (°F)	Minimum Time to Opening (h)			
		Regular Patch with Addition of		
	Regular Patch	Superplasticizer	Insulation	Superplasticizer and Insulation
40-42	54	35	26	22
43-45	49	33	23	20
46-48	44	31	21	18
49-51	39	29	19	16
52-54	35	27	16	13
55-57	32	25	14	11
58-60	29	23	11	8
61-63	26	21	9	7
64-66	23	19	9	6
67-69	21	17	8	5
70-72	18	15	7	5
73-75	15	13	6	5
76-78	13	10	5	5
79-81	10	8	5	5
82-84	9	7	5	5
85-87	8	6	5	5
88-90	7	5	5	5
91-93	6	5	5[a]	5[a]
Above 93	5	5	5[a]	5[a]

[a]Insulation should not be used when ambient temperature is <90°F.

sees this to be the case, an approved superplasticizer may be added to the concrete in order to gain the additional strength:

1. When a superplasticizer is to be used, the mix at the ready-mix plant should be altered to produce the following: (a) a 1-in slump concrete and (b) a concrete that has approximately 8 percent entrained air.
2. The superplasticizer should always be added at the site. If calcium chloride is to be added at the site also, the calcium chloride should be added according to the provisions of the previous section and before the addition of the superplasticizer. The superplasticizer should be added immediately after the calcium chloride has been thoroughly mixed.
3. The superplasticizer should be added in accordance with the instructions supplied by the manufacturer to provide a 7-in slump concrete for easy placement (never more than a 9-in slump, because segregation will occur). If the concrete begins to stiffen by the time the second or third patch is to be poured, an additional reduced dose of the superplasticizer may be added. (Note: This may be repeated as many times as is necessary but, except for the initial dose, no more should be added than the amount necessary to increase the slump 1 in at any one time.) It is recommended that a large plastic container that has volume markings along the outside be used to measure the superplasticizer. The ready-mix truck should mix for 2 min at high speed after every addition of the superplasticizer (including the initial dose).

Addition of water to the concrete at the site should be avoided unless absolutely necessary because of the detrimental effects this has on the strength development and increased shrinkage.

1. If calcium chloride is being added at the plant and the concrete is consistently too stiff on arrival at the site, the calcium chloride should be added at the site.
2. If, after the addition of calcium chloride at the site, the concrete is too stiff, the operator of the ready-mix plant should be notified to increase the slump by an appropriate amount.

The entire patch area should be consolidated by an appropriate-sized spud vibrator, particularly around the edges of the patch. The use of a vibrator not only consolidates the concrete but also helps in the finishing process, thus avoiding unnecessarily high slumps.

The casting of patches before noon is not recommended, especially during the summer, since expansion of the CRCP end sections leads to crushing of the weak concrete patch. However, experience in some localities may not show this to be a problem for CRCP.

CURING OF PATCH CONCRETE

A liquid membrane curing compound should be sprayed over the concrete in a uniform manner. On days when the wind speed is more than 10 mph, light-colored or clear polyethylene sheeting should be placed over the concrete to reduce the amount of moisture loss from the surface. It can be held down by means of reinforcing steel along the edges or by any other similar weight.

The placement of insulation 4 in thick over the patch is highly recommended to maintain a high temperature for curing and permit early opening of the patched area. However, insulation should not be placed when the ambient temperature is more than 90°F.

1. Polyethylene sheeting should be placed on the concrete before the insulation is laid down, and
2. The insulation should be held down by reinforcing steel or a similar weight.

OPENING PATCH TO TRAFFIC

There are many factors that influence the length of time necessary for concrete to develop strength sufficient to safely resist traffic loads. As a result of a comprehensive study (5), the ambient temperature at placement has been found to be by far the most influential factor on the strength development of concrete patches. Consequently, Table 1 gives the minimum number of hours that the concrete must be allowed to cure before the patched area is opened to traffic, and this time is solely dependent on the ambient temperature at placement. Included in the table are reduced curing times when a superplasticizer or insulation or both are used according to the provisions set forth in this paper. The minimum times before the opening to traffic are based on achieving a modulus of rupture of at least 300 psi within the patch, which was found through field tests to be adequate (5).

SUMMARY

Based on many laboratory and field tests and analyses, new cost-effective permanent patching procedures have been developed. The procedures reduce costs and lane-closure time by (a) adapting the patch size and type to fit the several different distress types and extent, (b) reducing reinforcement embedment length into the patch, (c) using mechanized equipment for construction wherever possible, and (d) using concrete additives and curing techniques so that there can be an early opening to traffic. Practical field-tested procedures were developed for the efficient and long-lasting patching of CRCP.

ACKNOWLEDGMENT

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The contents of this paper reflect my views and I am responsible for the facts and the accuracy of the data presented here. The contents do not necessarily reflect the official views or policies of the Illinois Department of Transportation or the Federal Highway Administration. This paper does not constitute a standard, specification, or regulation.

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Evaluation of Several Maintenance Methods for Continuously Reinforced Concrete Pavement

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Research on continuously reinforced concrete pavement (CRCP) has been going on at Purdue University for the Indiana State Highway Commission since 1971. The primary objective of the overall research program has been to evaluate the performance of CRCP in Indiana and to make recommendations relative to design and construction techniques that might improve the performance of this type of pavement. Primary factors found to contribute to performance of CRCP in Indiana have been subbase type, method of construction, and traffic. The usual method of maintaining CRCP has been to patch failures by using reinforced concrete. This research has been done to evaluate other techniques for maintaining CRCP to determine the most cost-effective method. A test pavement on Interstate-65 south of Indianapolis was used. Maintenance methods investigated included normal concrete patching, bituminous patching, overlay by using asphalt concrete with and without prior undersealing and with and without installation of edge drains, undersealing by using asphalt only, drainage, and concrete shoulders. The results show that overlaying the pavements by using asphalt concrete completely stopped the progression of failures within the time frame of this research. Undersealing by using asphalt was also effective. The edge drains and concrete shoulders were not effective. The performance data were also analyzed in light of the cost of maintenance.

The use of continuously reinforced concrete pavement (CRCP) in Indiana dates back to 1938, when an experimental project was first built on US-40 near Stilesville, Indiana. The mileage of CRCP increased until the end of 1971, when 1120 km (696 miles) of equivalent two-lane CRCP were in service in the state.

In 1973, a continuing study of the performance of CRCP was initiated by the Joint Highway Research Project at Purdue University. The objective of the study was to evaluate performance and to recommend design and construction techniques.

HISTORY OF RESEARCH ON CRCP IN INDIANA

Primary emphasis was placed on construction of CRCP from 1967 to 1971. By the spring of 1972 it became apparent that distress was occurring on some of the pavements. Purdue University was first contacted in July 1972 regarding the problem; at that time, plans were made for a long-range research project.

The procedure below briefly summarizes the process of the research.

1. Detailed study of performance on Interstate-65, a major Interstate between Indianapolis and Chicago;
2. Statewide performance survey of all CRCP in Indiana;
3. Detailed study of selected pavements, including field measurements;
4. Laboratory evaluation of materials obtained in step 3;
5. Analysis of factors that influence performance;
6. Construction of test sections of several types of maintenance in the fall of 1975 on I-65 south of Indianapolis; and