

TECHNIQUES FOR REPAIRING PAVEMENTS

Repair and resurfacing jobs on concrete pavements are occasionally unavoidable. It is not the intention in this article to discuss the whys and wherefores of resurfacing but simply to cover the approved techniques for providing a new surface of maximum durability. With a little care such surfaces can be achieved relatively easily.

The first point to recognize with resurfacing work of this kind is the importance of having the base surface in the proper condition to receive the topping. Mix design, placing, compacting, finishing and curing techniques also play their part; but unless the base surface is clean and has a strong, rough-textured outer skin, it is most unlikely that a good bond will be obtained. By far the majority of failures on resurfacing jobs can be traced to insufficient attention to surface preparation.

SURFACE PREPARATION

Scarify or abrade all areas that show any signs of scaling, lamination, crumbling or excessive laitance. All material that is suspected of being weak should be removed to expose sound clean concrete. Debris created in this way should be carefully removed, and dust and fine particles should be blown away with compressed air.

It should be emphasized that an extremely rough surface is not essential. The slightly roughened surface produced by acid etching is entirely adequate to insure good bond.

Remove all bituminous and other organic material from the surface and from joints, paying particular attention to cracks. Such contamination includes oil and grease, sealers, hydraulic fluids and paints.

On large jobs joints can be plowed free of sealer using an improvised foot mounted on the front of a light tractor. Hand-operated spud bars should also be used to insure absolute freedom from sealer at points inaccessible to the plow. After removing joint sealer in this way it is advisable to make two or more passes, either side of the line of the joint, with a scarifier to insure complete cleanliness of the shoulders. Sandblasting is also highly recommended as a means for final cleaning of the joint itself and of the shoulders.

Where the area to be resurfaced has been scarified this will normally remove any contamination. For paint markings, bituminous contamination and large grease spillings, spot scarification is still the easiest and most effective method of cleaning. It is also usually the most economical.



For light contamination the surface can often be scrubbed clean with a water-soluble commercial detergent such as sodium metasilicate with resin soap. This detergent should be applied at the rate of 1 to 2 pounds per 100 square feet. Over large areas it can be distributed evenly with a hand-operated device similar to a seeder. The moistened detergent must be thoroughly scrubbed into the surface, preferably with a motor-driven scrubber. Treatment should continue until there is no doubt that the contamination has been removed. It is most important after scrubbing an area clean in this way to flush the surface thoroughly with clean water. Such flushing should continue until the last trace of detergent has been removed and the water shows a neutral reaction when tested with pH paper. Thorough flushing is necessary because the alkaline detergent, if left on the surface, would tend to neutralize the acid used for etching.

Immediately prior to the acid etching it is worthwhile to make a final check to see that the surface is thoroughly clean. If leaking equipment has dripped oil on to the prepared surface, the resulting stains must be removed.

Commercial muriatic acid (about 28 percent hydrochloric acid) should be used for etching. It must be applied at the rate of 1 gallon per 60 square feet of pavement. The area should previously have been wetted. On large jobs the acid can be sprayed over the wet surface directly from a tank delivery truck through a trailing spray bar. Such trucks are equipped with force pumps to give the necessary pressure, and the rate of distribution can be regulated according to the forward speed of the truck.



Note that in preparing this pavement for repair the damaged area has been completely removed. This is sometimes preferable to resurfacing. Relatively sharp vertical faces have been created by cutting around the damaged area with a concrete saw before attempting to break up the concrete.

For small jobs acid will normally be purchased in glass carboys. Even distribution is then somewhat more difficult to achieve, but it can be managed by hand pumping the acid through a plastic garden hose. The end of the hose should be perforated and mounted on a square of plywood equipped with a carrying handle to form an improvised dispenser. Three perforated loops of hose coiled around the board are sufficient. One man can then carry the board forward and play the acid over the wet area, while another operates the hand pump. If necessary the glass carboys can be set on the back of a pick-up truck.

The etching action is marked by the occurrence of foaming. As soon as this foaming stops the surface should be scrubbed vigorously with handbrooms or a mechanical scrubber, and flushed copiously with clean water. It is important that the scrubbing and flushing begin immediately upon the cessation of foaming, since otherwise the products of the etching reaction will form a jell which is difficult to remove. Flushing should continue until there is a neutral indication with pH paper.

Remember that in any work involving the use of acid, goggles and protective clothing are necessary for the safety of work crews.

CONCRETING

Forms. On some resurfacing jobs adjacent sound paving may provide the boundary for the work and give the desired grade and elevation for the finished resurfacing. Where the entire area is being raised, steel or wood forms must be used. A wooden form to give the desired thickness can be fabricated fairly easily from dressed lumber. The planks should be reasonably wide

(6 to 8 inches) for good rigidity. It is necessary to bolt steel flanges into the bottom of the form about every 3 feet. These flanges should be countersunk into the form so that the surface remains flush, and should extend about 3 inches beyond the outer edge of the form. The extensions should be drilled so that they can be bolted into holes drilled in the old pavement, by means of lag screws and lead expansion sleeves.

Wooden forms may not be entirely satisfactory, since they will inevitably show some degree of flexibility. In this case steel channel or angle iron, in a size that will conform to the thickness of topping desired, should be used.

At the outside edge of a slab it is often possible to use conventional steel sidewalk or pavement forms, installed to the correct level for the thickness of surfacing desired.

Joints. In bonded concrete resurfacing it is essential to match exactly the joints in the old pavement, both in location and kind. Longitudinal and transverse expansion joints can be readily formed in place using wood or fiberboard strips inserted in the joint crevice of the old pavement. These strips can serve both to mark the location of expansion joints during paving and to act as a filler in the finished resurfacing. Alternatively they can be sawn out and the joint sealed with a non-extruding filler. Transverse joints have also been made by vibrating paper inserts into the plastic concrete over the old joint locations. These inserts provide positive crack control until they can be sawn out later prior to sealing the joints.

Transverse contraction joints should also be sawn with abrasive-type blades. To saw through the resurfacing directly over the joint in the old pavement it is necessary to mark the location of the joints accurately and carefully on the side forms or on adjacent pavement. A line can then be snapped over the finished surface of the plastic concrete to mark the exact location for the saw cut. Sawing must be done early to avoid pre-cracking over the old joint. In general it should be done from 5 to 12 hours after paving, depending on temperature and relative humidity. During cool weather it is possible to saw joints dry, which permits earlier sawing with a minimum of raveling along the cut. A depth of cut 1 inch greater than the thickness of the topping is recommended; this insures that the joint opening in the basic concrete will be cleared of both grout and topping mix.

When longitudinal side forms are used these will normally be installed over the longitudinal construction joint in the old pavement. It is then good practice to tack a thin steel strip to the edge of the form, so that it can be inserted within the joint and thus prevent grout and concrete from flowing under the form.

Grouting. Just prior to placing of the topping mix, a 1 to 1 sand-cement grout, to the consistency of heavy paint, should be scrubbed over the damp (but not wet) surface using ordinary rattan stable brooms. The sand

should be screened to remove any particles over 1/8 inch. A paddle-type mixer is suitable for mixing the grout, which can be carried to the desired location on the surface in buckets and spread initially by pouring. Brushing out of the grout should leave a layer about 1/16 inch thick. Excess grout in transverse and longitudinal joints can be redistributed with a warehouse broom.

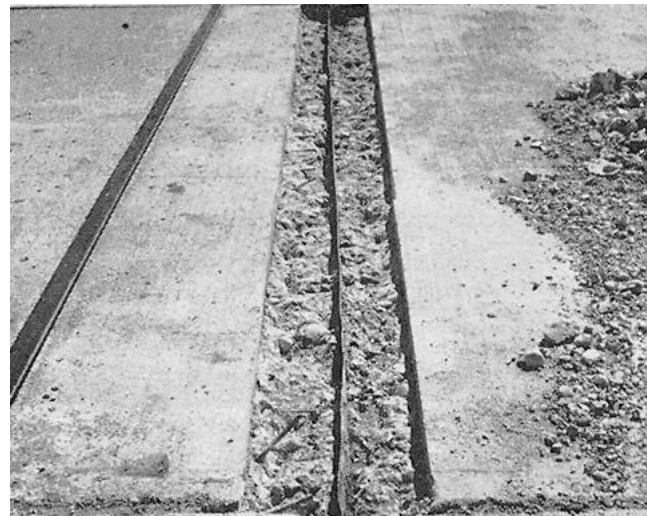
Bonding grout can also be applied successfully by pneumatic spraying. This method requires expert operation to control rebound and prevent the accumulation of coarser sand particles along the form lines. If such particles are then present in sufficient concentration, they are likely to prevent good bonding.

Mixes. The mixes in the accompanying table are recommended for thin bonded resurfacing. They were established by the Highway Research Board and have proved their worth on paving jobs of all types, including airplane runways subject to the 50,000-pound individual wheel loads of jet bombers.

Placing and Finishing. The mix can usually be placed by preliminary hand spreading followed by two passes of a two-screed self-propelled finishing machine. The first pass will complete the spreading and the second will strike off and consolidate the concrete to final grade. If wooden forms are being used it is preferable for the finishing machine to be fitted with offset rubber tire wheels that will travel on the old pavement outside the forms. When this is done the forms need only support the weight of the screeds. For a low slump mix it may be found of advantage to drag a conventional hand-type vibrator through the plastic concrete in a longitudinal direction ahead of the finishing machine. Spud vibrators mounted on the front screed offer another possibility. On smaller jobs a hand-operated vibrating screed will usually be adequate to strike off and consolidate the mix.

Final finishing can be with mechanical floats, hand floats and scraping straightedges. A burlap drag or hand broom will provide the desired surface texture.

Curing. Use of a white-pigmented curing compound is recommended for curing resurfacing. This method has two advantages: it can be applied early to prevent the rapid loss of water, and it greatly simplifies any sub-



An example of a well prepared patch area in a pavement joint. Here the spalled concrete has been cut away with a power saw to a depth of about 3/4 inch and approximately 6 inches back from the joint. The surfaces are ready for etching and grouting after which the repair is completed by tamping into place a concrete of dry consistency. It is important that the joint be continued up through the patch.

sequent joint-sawing operations. Otherwise curing by any of the conventional methods is possible, bearing in mind the need to begin curing as soon as possible after final finishing.

RAMPS

When a resurfaced area is higher than an adjacent slab it is advisable to provide a ramp to avoid subjecting the edge of the surfacing to undue wheel impact loads. The ramp should never be less than about 3 feet long. The surface must be prepared and the mix placed in the same way as that for other resurfacing.

PATCHING

Placing of thin bonded patches of any size requires essentially the same surface preparation and concreting procedures as those given for resurfacing. In general the

Recommended Bonding Mixes

Resurf. Thickness	Cement Content	Total Water ¹	Fine Agg. ²	Coarse Agg.		Air Content	Cement Factor ³	Slump
				Max. Size (in.)	Amt. ² (lb)			
(in.)	(lb)	(lb)	(lb)	(in.)	(lb)	(%/°)	(s/cy)	(in.)
1/2	94	42	190	3/8	115	9 to 11	8.5	1 to 4
1	94	42	170	1/2	170	6 to 8	7.5	1 to 4
2	94	42	190	1	230	5 to 7	7.0	1 to 4
3 (or more)	94	42	180	1 1/2	305	4 to 6	6.3	1 to 4

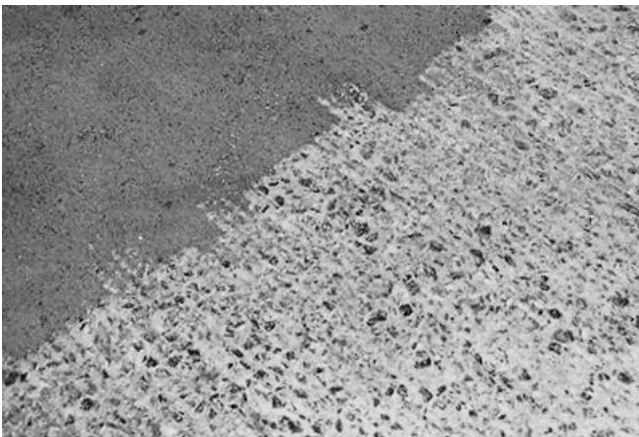
¹ Including free moisture in the aggregates.

² Based on saturated surface-dry aggregate, s. g. 2.65.

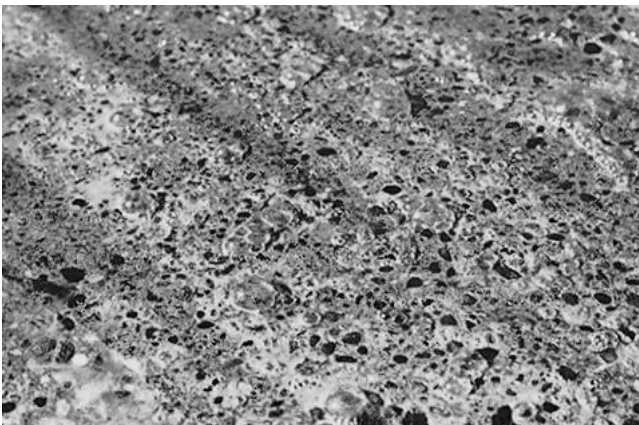
³ Approximate, sacks per cubic yard.



Regardless of the depth or type of repair being made, it is essential that portland cement grout be scrubbed into all of the adjacent concrete to which it is desired to effect a bond. The type of spall shown here is most likely to occur at a joint and it is usually the result of some form of poor construction practice.



Two of the important steps in almost any pavement resurfacing job consist of scarifying (i. e., scratching or cutting) the old surface in some fashion and then etching it with a 25 percent solution of muriatic acid. The lower portion of the photo above shows the effect of mechanical scarifying on a pavement surface. The photo below shows the foaming action that takes place as concrete is etched with muriatic acid.



area to be patched will be sawn and defective concrete removed by pneumatic paving breaker. The area to be removed must be extended as necessary until it is certain that all concrete exposed is sound. It is especially important that horizontal laminations do not extend back into the sound concrete behind the saw cut. Such laminations occur when steel inserts for forming joints have not been removed early enough.

Surface preparation then continues as before. The exposed area will however be considerably rougher after use of the pneumatic breaker. It is impractical to saw cut a patch much less than 2 inches deep, and the breaker will usually extend this to nearer 3 inches. Acid brooming and application then becomes progressively more difficult. A rate of 2 gallons per 100 square feet is recommended. The acid should be broomed over the patch to insure adequate coverage. It is best to use brushes with fiber bristles to apply acid to the vertical faces of the concrete.

Acid removal and neutralization are also somewhat more difficult. It is advisable to first fill the depression with water. Then use a high pressure jet to blow the water out and clean the surface.

A hand vibrator is the best means of consolidating. Strike-off can be by means of a 2 by 4 followed by hand-floating.

When patching in the region of joints, do not attempt to keep the joint open; instead reform the joint by sawing some 7 or 8 hours after final finishing. Patches of this type should be allowed to cure two weeks before being exposed to traffic.

STRENGTH

If there is adequate bond between old and new concrete, a thin resurfacing layer can perform as well as a thicker slab. Laboratory studies and extensive tests of cores taken from resurfacing jobs have proved that a bond strength of 200 psi is generally adequate to give satisfactory performance. Good workmanship, high-grade materials and full attention to preparing a clean sound base surface can insure that the desired bond is obtained.