

CONCRETE PAVEMENT RECONSTRUCTION ON THE INTERSTATE SYSTEM

E. J. Renier, National Director, Highway
Reconstruction, Portland Cement Assn.

Experts are estimating that 65 to 70% of future highway expenditures will be made for pavement Rehabilitation and Reconstruction. The 1982 Surface Transportation Assistance Act established a 4R (Resurfacing, Restoration, Rehabilitation, Reconstruction) Interstate fund that will generate \$10.3-billion for 4R work through fiscal 1986. The level of funding to 4R Interstate projects is expected to continue at a minimum level of \$3-billion per year. Funding for these projects is available to the states on a 90% Federal-10% State basis. This paper reviews and discusses design and reconstruction aspects of some portland cement concrete reconstruction projects (the 4th R) built on the Interstate System to date. Projects included represent: complete removal of existing concrete pavement and replacement with new concrete pavement; full-depth unbonded concrete overlays on existing concrete and asphalt pavements; concrete pavement inlays into existing asphalt pavements; partial depth bonded concrete overlays; and recycling of old concrete pavements for use as aggregate in new concrete pavement. Projects reviewed are located in all parts of the United States and in various climatic areas. The establishment of the 4R Interstate fund has initiated research, design and manufacture of new construction equipment that relates directly to the new construction techniques being used. Application of this new equipment (and some of its limitations) will be discussed in conjunction with review of known construction techniques. Effect of increasingly heavy commercial Interstate traffic on design requirements for the future is reviewed. Reasons for making the reconstruction decision are discussed. They include: life-cycle costing, economic factors, material supplies, future traffic levels, etc.

The Interstate Highway System represents a large portion of our highway dollar spent to build a single system which today carries some 20% of the nation's traffic. Each added year of use is rapidly increasing the mileage requiring rehabilitation or reconstruction. The rate of increase has been accelerated by recent legislation allowing increases in legal axle loading.

Highway planners are presently estimating that up to 65% of future expenditures on major highways will be made for pavement rehabilitation or reconstruction. This prediction is based on the premise that the majority of our major highway systems are now in existence and that strong environmental, public official and general public opposition to new construction and/or relocation can be expected to continue.

The most difficult decision for today's highway engineer to make is whether or not an existing pavement structure can be economically rehabilitated to a level where it will provide additional service life under the ever-increasing loading or whether reconstruction is required.

With present highway monitoring systems indicating that over 6,000-miles of the 41,000+ miles of pavement now in existence on the Interstate System have a pavement serviceability rating of less than 2.5 on a scale of 0 to 5 and that over 2,000+ miles have a rating of less than 2.0, the necessity for increased use of a decision that favors the reconstruction option, has become apparent.

Congress recognized this need by the addition of the 4th "R" -- Reconstruction to the 1982 Surface Transportation Assistance Act. It designated some \$10.3-billion for 4R Interstate projects through fiscal 1986(1) and highway administrators expect that funding for 4R Interstate work will continue at a high level in the future. The funding for 4R Interstate projects was made available to the states on a 90% Federal - 10% State basis (95% Federal

- 5% State on recycling projects). The establishment of the 4th R initiated research and design that has resulted in numerous concrete reconstruction projects being built on the Interstate in states throughout the country and in various climatic areas.

These have included projects requiring: complete removal of the existing concrete and its replacement with an all new concrete pavement; partial-depth bonded concrete overlay over existing concrete pavement; full-depth unbonded concrete overlay over existing concrete pavement; full-depth concrete overlay of existing asphalt pavement; full-depth concrete inlays of existing asphalt pavement; recycling of old concrete pavements as aggregates for the new concrete pavement; and use of tied concrete shoulder concept.

In addition, highway engineers have been making more extensive use of life-cycle costing analyses and giving greater consideration to the re-use of materials in satisfying the demands of future traffic and loading.

The following discusses some of the advances that have been made in portland cement concrete pavement Interstate highway reconstruction in the past few years.

Removal and Replacement with All New Concrete

Projects have been built in Nebraska, Minnesota, Wyoming, Illinois and Iowa where determination was made that the old pavement was not suitable for recycling and was completely removed and replaced with a new concrete pavement. In these cases the pavement was first broken into large pieces for removal.

Figure 1. Note large size of concrete pieces being removed for disposal.



On two projects on I-90 in Minnesota where wide right-of-way existed the old pavement was buried in the back slope and covered within the right-of-way. On a Nebraska project it was stockpiled in a nearby area and contracts later awarded for recycling the material for use as riprap and for shoulder maintenance. In Wyoming, Illinois and Iowa it was recycled and

used as subbase material under the new concrete pavement. All three of these procedures worked very well.

Figure 2. On I-80 in Nebraska the old concrete unsuitable for recycling was temporarily stored. Later recycled for use as riprap or shoulder maintenance material.



Figure 3. Recycled 3" coarse material used as subbase material on Eden's Expressway in Illinois.



Partial-Depth Bonded Concrete Overlays Over Existing Concrete Pavements

The bonding of concrete overlays to old concrete pavements is not a new idea. For years highway engineers have recognized that bonding a partial-depth overlay to an existing concrete slab would increase its structural capacity, salvage the existing pavement, and improve safety.

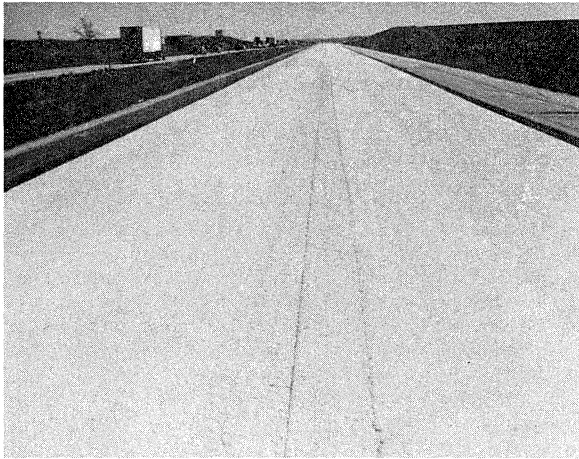
Partial-depth concrete overlays have been bonded successfully to existing concrete in the past. Procedures used required several steps in surface preparation and bonding material application. Early grouts were successfully applied to acid-etched pre-wetted concrete surfaces.

Recently, however, a considerable amount of research has been conducted on improving bonded concrete resurfacing

procedures. The most economical as well as the most successful bonding agents have been sand-cement-water grouts and cement-water grouts applied in a thin layer to dry, properly prepared concrete surfaces.

Preparation of the surface for bonding has been specified in several ways with the most common being the use of cold-milling equipment to remove a minimum of 1/4" (2) of concrete from the surface of the old concrete pavement in order to eliminate the effect of dirt, laitance, loose concrete, paint, or any other foreign material from the surface that might affect bond.

Figure 4. Prepared surface of I-80 in Iowa after cold-milling and sandblasting. Surface is ready to receive cement-grout.



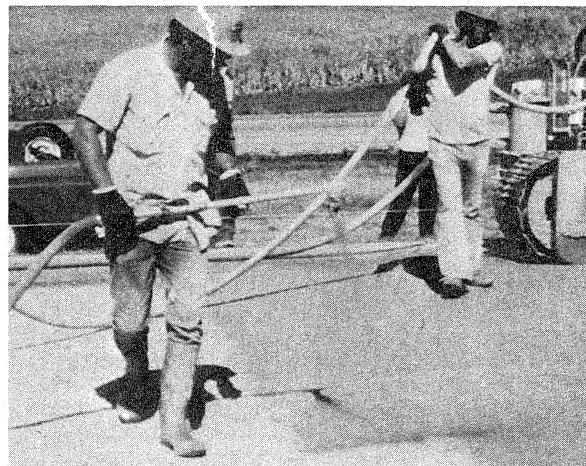
Following scarification by cold-milling equipment sandblasting is usually required to eliminate fractured concrete particles resulting from the cold-milling of the pavement. Grout is applied directly to the dry surface so it will be absorbed into the old pavement. Coverage should be completed without ponding in any areas and the grout covered immediately by the new concrete.

If full-depth patches are required in areas where the existing pavement is no longer structurally secure, they should be completed prior to resurfacing. The extent of the patch area to be removed is usually designated on the plans or by the engineer. If the existing pavement is plain or mesh-dowel reinforced, diamond or carborundum blades are used to saw through the slab in a transverse direction prior to removal of the concrete from the patch area. This results in the faces around the patch area being neat vertical planes. Experience has shown that either tiebars or dowels should be installed at each end of the patch area

to provide adequate load transfer in the old slab. When the existing pavement to be patched is continuously reinforced (CRCP) existing concrete should be removed and the full-depth patches placed so that the reinforcing steel will act continuously through the patch area.

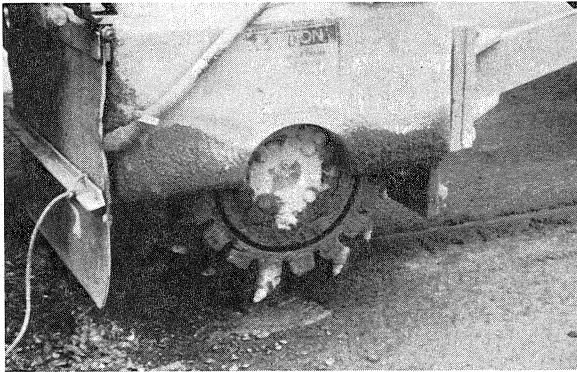
If the base or subgrade material is disturbed during the removal operation, or if additional fill material is required within the patch area, it must be recompacted to grade prior to concrete placement.

Figure 5. Mechanical spreading of cement-water grout to prepared surface. Note how close grout application is kept to slip-form paver.



Areas that have excessive deterioration are usually removed through the use of other types of scarification equipment. Deterioration at joints of existing mesh-dowel pavements is sometimes removed by scarification to a depth of 3" to 4" directly over the joint. This provides 6" to 8" of new concrete at the old joint. Where joints exist in an old pavement they must be matched by joints in the new overlay. These joints must be constructed entirely through the new overlay and be of equal width to those in the old pavement.

Figure 6. Galion cold-milling to extra depth in area of deep surface deterioration.



Texturing of the bonded overlay is usually produced by using burlap or astro-turf drags to create microtexture. Transverse tining is usually specified to produce macrotexture. White pigmented curing compounds are then applied to the plastic concrete on both surface and edges of the pavement at a rate of 1½-times normally specified coverage.⁽⁴⁾ Retention of mixing water in the new overlay is especially critical due to the thinness of the bonded overlays (3" - 4"). Curing compounds are often placed in two courses to minimize run-off. The curing operation should be kept as close to the texturing operation as possible.

In June of 1979 the Iowa DOT took bids for the construction of a minimum 3" thick portland cement concrete bonded overlay on a section of I-80 near Avoca. The original pavement had been built in 1966. This project was really a milestone-type project and on September 25, 1979 over 500 transportation officials, contractors, and allied industry personnel inspected the project. The project incorporated partial and full-depth patching. Cement-water grout was spread mechanically. Preparation of the existing surface required scarification to depths of 1" followed by sandblasting and the installation of edge drains.

A 3" minimum thickness overlay was placed over the existing continuously reinforced concrete pavement that was deteriorating due to "D"-cracking conditions that related to limestone aggregates produced from a Winterset formation.

Inspection of this project in the Spring of 1984 indicated very good performance and resulted in the Iowa DOT awarding and constructing two more partial-depth bonded concrete overlays on I-80 in 1984. Since that time bonded overlays have been successfully constructed on the Interstate System in a number of states.

Full-Depth Unbonded Concrete Overlays Over Existing Concrete Pavement

Where unbonded overlays over existing concrete pavements have been used the overlays have been built full-depth and placed with some sort of bituminous stress relief course between the old and the new pavement.⁽⁵⁾

The unbonded overlay has been used primarily where the existing pavement is no longer structurally secure, where "D"-cracking or alkali reactivity eliminates the recycling option, or disposal of the old pavement would be difficult because of environmental or other reasons. Unbonded overlays have been successfully in use since 1916.

The use of an unbonding medium which has the ability to act as a stress relief course and not transmit shear allows the designer to use jointing systems in the new pavement that may or may not match the existing joint pattern. The unbonding medium will greatly reduce and/or eliminate reflective cracking and act as a leveling course on which to place the new pavement. The unbonding medium should eliminate the possibility of the new pavement keying into any surface irregularities of the existing pavement.

Figure 7. 10" thick mesh-dowel unbonded overlay being placed on I-70 in Ohio in 1984. Existing pavement was 10" thick showing "D"-cracking distress. A 1" asphalt stress relief course was used. Full-depth tied concrete shoulder was placed later.

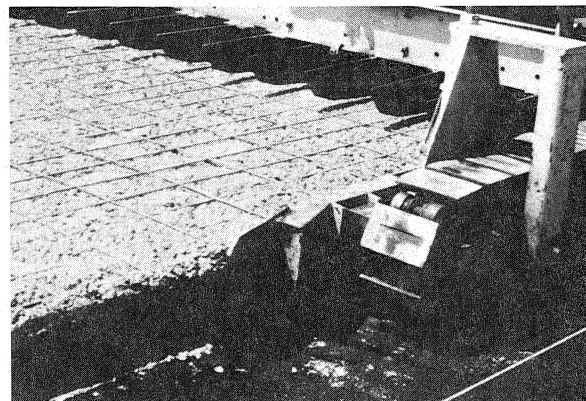
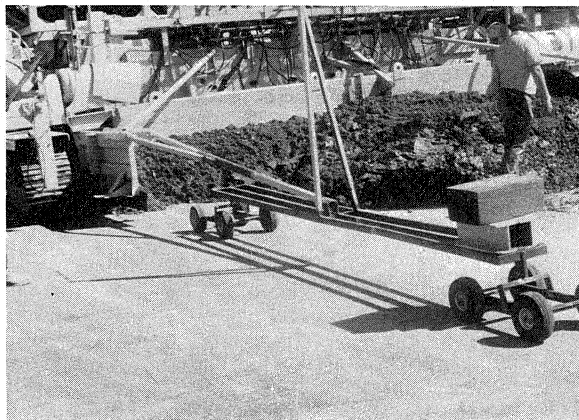


Figure 8. 7-3/4" plain concrete unbonded overlay being placed on I-25 in Colorado in 1984. Note use of asphalt stress relief course and ski assembly to improve smoothness of new pavement.



Full-Depth Concrete Overlays of Existing Asphalt Pavement

The construction of a new full-depth concrete pavement over or inlaid into an existing asphalt surface was being used as a reconstruction option on county roads for several years (6) and now in more and more cases as legal loadings have increased states are using this method of increasing the load-carrying capacity of existing highways.

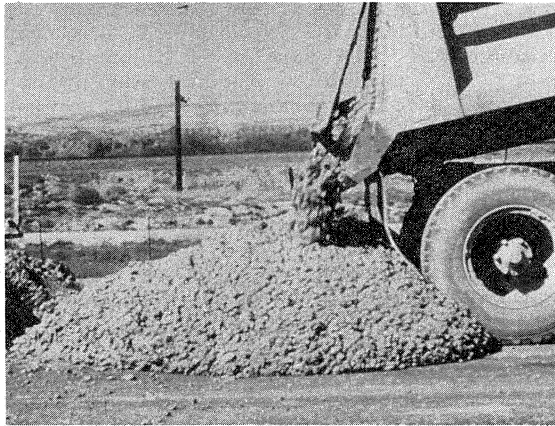
Figure 9. Asphalt surface after cold-milling and ready for concrete overlay on 1979-80 project in Utah.



In 1979 Utah (7) awarded a contract to construct a 10-inch thick plain concrete pavement over the existing asphalt on I-80. Concrete was supplied from a central-mix plant to meet design strengths of 5200 psi at 28 days. It was transported to the slip-form paver in dump trucks and dumped directly on the old asphalt surface. The concrete was paid for by the cubic yard in order to take into account any unevenness in the old surface. This new pavement was built 38' wide and was slip-formed monolithically. Longitudinal joints were sawn at centerline and at the shoulder point both sides of the centerline. The longitudinal joints were sawn to one-third the depth of the pavement. Rumble strips were produced in a 10' wide monolithic shoulder next to the truck lane. Skewed transverse joints were sawn with a random spacing averaging 15'.

Polyethylene tape was used for longitudinal joints. It was unrolled from a spool and inserted vertically just below the pavement surface. Any disturbance of the surface during the process was corrected by the use of a narrow trailing float. Surface microtexture was obtained by use of an astroturf drag. Macrotexture was produced with a transverse tining machine. The tining operation greatly increases skid-resistance and reduces potential for hydroplaning. In recent projects Utah has substituted sawing of the longitudinal joints in place of using tape in order to insure proper joint depth.

Figure 10. Concrete is usually transported by dump truck and dumped directly on old asphalt surface ahead of paver. I-80 project - Utah.



The Kansas DOT has made extensive successful use of full-depth plain concrete overlays over existing asphalt on I-80 east of the Colorado border and in 1983 the Texas State Department of Highways and Transportation resurfaced the existing asphalt on I-30 in Rockwell County with 10" of plain dowelled concrete 38' wide with 15' joint spacing.

Figure 11. Tooling rumble strip in 10' tied shoulder of 10" thick 38' wide plain pavement over existing asphalt on I-84 in Utah.

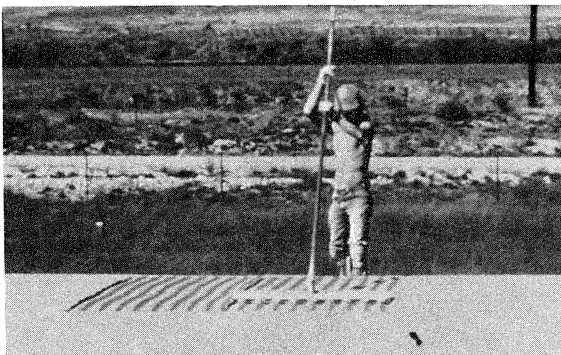
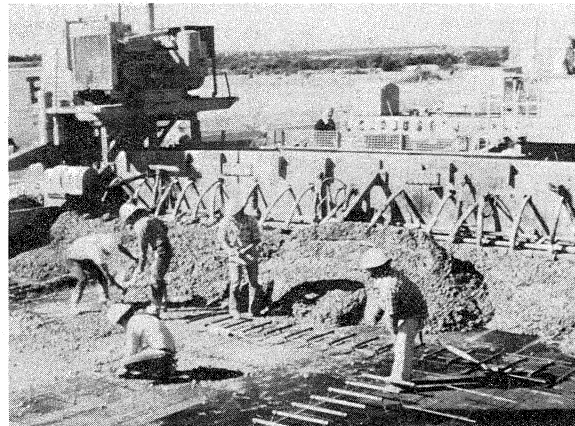


Figure 12. Placing 38' wide plain pavement over existing asphalt I-30 in Texas. A thin asphalt levelling course was used between pavements.



Full-Depth Concrete Inlays of Existing Asphalt Pavement

Successful concrete inlays have been built into existing asphalt surfaces in Iowa (8), Idaho (9) and Oregon. In the construction of all these projects a trench was first constructed into the existing asphalt with cold-milling equipment to a pre-determined depth to provide space for the new portland cement concrete inlay. In Iowa, 9" of an existing 13" thick asphalt pavement on I-80 was removed and a 10" plain portland cement concrete pavement was then slipformed into the trench. In Idaho, the existing asphalt was removed to the top of an old cement-treated base and the new plain concrete pavement then slipped into the trench. In both of these cases the removed asphalt was used to bring the existing asphalt shoulders up to meet the edge of the new concrete pavement. Iowa built a 12'6" wide, 10" thick inlay in the truck lane of I-80 in Adair County in 1981.

Figure 13. Removing existing asphalt to create trench for new concrete on I-84 - Idaho. Cold-milling equipment can remove 3" or more in single pass.

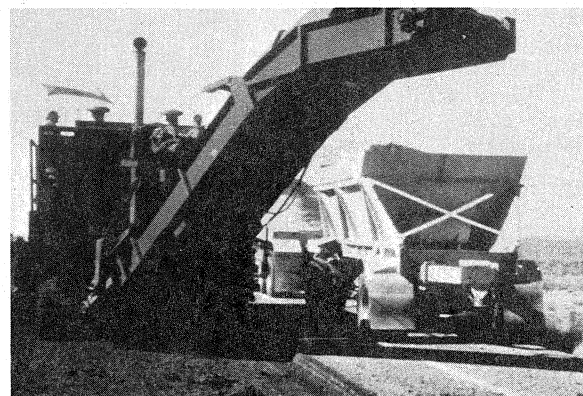


Figure 14. Cross section of 10" plain dowelled pavement placed in 9" asphalt trench. Note location of edge drain under edge of slab.

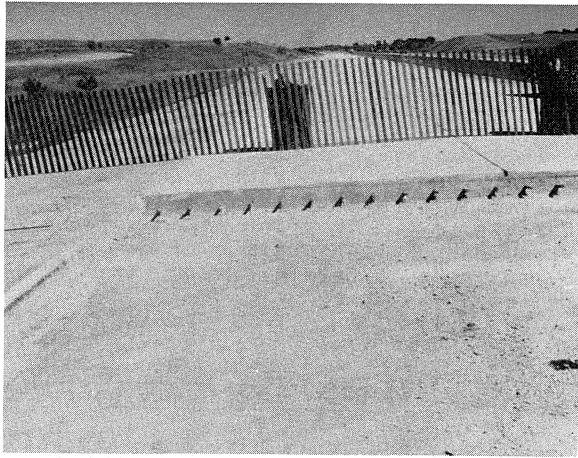


Figure 15. Concrete being dumped in asphalt trench in front of slipform paver on Interstate.

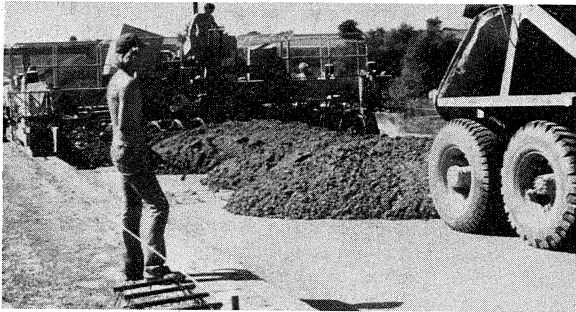
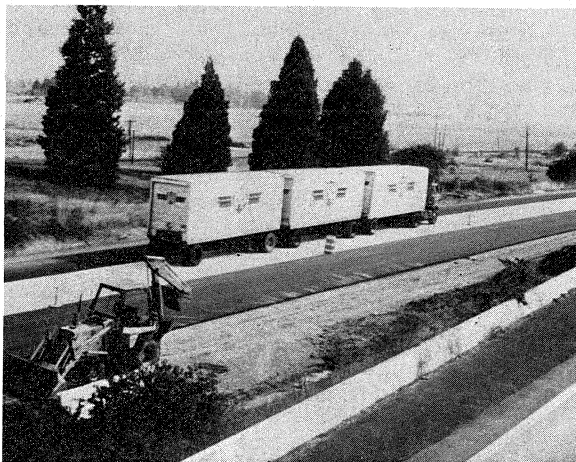


Figure 16. Completed concrete inlay on 13-miles of I-5 in Oregon. Inlay is 13' wide and 13" thick. Note new truck.



In 1983 Oregon built 13-miles of single-lane inlay on I-5. In both of these cases the trench was built into the right-hand lane only with cold-milling equipment. The single-lane inlays included the installation of keyways and bent deformed tiebars along the centerline between the newly constructed truck lane and the existing asphalt inner-lane in order to provide for future replacement of the asphalt passing lane with new concrete. These projects have all performed well to date.

Drainage is of special import whenever concrete inlays are placed into existing asphalt roadways. This drainage must provide for removal of water from the asphalt trench below the new concrete pavement to eliminate the so-called "bathtub" effect created by trenching into the impervious asphalt surface.

Figure 17. Edge drain has been placed 3' - 4' deep in existing asphalt surface prior to cold-milling the trench on this project on I-80.



Figure 18. Drains at sides of trench are outletted at low points of grade.

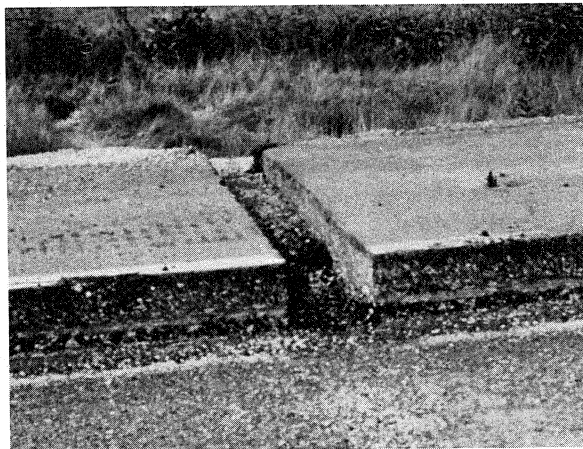


Figure 19. Spray wagon being used to cool asphalt surface prior to concrete placement on inlay project in Idaho.



Such drainage is usually provided by the construction of edge drains cut through the remaining asphalt and into the subgrade at depths of 3' to 4'. Perforated plastic tile drains are placed in the bottom of the edge drain and outletted at low points in the grade. The edge drain is then backfilled with open-graded porous material. On some projects filter cloth has been used.

When concrete is being placed in an asphalt trench care must be exercised in not allowing the temperature of the asphalt to get too high prior to concrete placement. The asphalt surface is cooled by spraying the surface with water just prior to paving.

Recycling Existing Concrete Pavement as Aggregates for New Concrete Pavement

Highway engineers have come to recognize the advantages of recycling old concrete pavements and their use as aggregate in the reconstruction of the new concrete pavement. When this technique was first suggested a few years ago as a viable reconstruction option, it was viewed with skepticism. However, the rapid development of new successful construction techniques and equipment has removed the doubts from the highway engineer's mind and proven that recycling of the old concrete pavements to provide aggregates for the new can oftentimes provide the best possible life-cycle answer. There are many reasons for their increasing use of the recycling option. These include: potential for both long and short-range savings is often increased; with ever-increasing haul costs recycling can represent considerable savings by providing the needed aggregates on-site; an ever-increasing population continues to create demands on existing aggregate supplies for structural and residential construction and our natural aggregates are being rapidly depleted in many areas as a result; protection of natural reserves is required in some areas and the recycling option provides the highway engineer with an aggregate substitute source while retaining the natural reserves for more critical future needs; growing concerns for landfill and environmental effects relating to rubble disposal and the dumping or burial of waste materials must be taken into consideration. This is especially true in urban areas where the movement alone of large quantities of waste materials can add considerably to traffic congestion and environmental problems; in addition, energy savings can usually be realized through the reduced haul distances and traffic restrictions.

Projects constructed throughout the country to date have not only shown that the recycling of old portland cement

concrete pavements is economically and technically feasible but in many cases represents the lowest life-cycle cost solution.

Plain concrete pavements, mesh-dowel concrete pavements and continuously reinforced concrete pavements have all been successfully recycled and at the present time any existing concrete pavement can be considered to represent a candidate for recycling.

There is probably no area in portland cement concrete pavement reconstruction technology where equipment manufacturers, contractors, and aggregate producers have developed or improved on existing techniques faster or to a greater extent than in the breaking, removing, crushing and handling of old concrete pavements to produce recycled concrete aggregates.

Figure 20. Usually existing asphalt overlays are removed from the old pavement prior to breaking to produce recycled aggregates that are as clean as possible.



Where the old concrete is being recycled for use as aggregate in the new concrete existing asphalt overlays, jointing material and patches are removed from the old pavement prior to breaking in order to provide a recycled aggregate that is as clean as possible.

Many procedures have been used for breaking up the old slab. These have included: pneumatic hammers mounted on backhoes (sometimes referred to as concrete chisels), which punch holes in the slab as part of the breaking up process; hydraulic and diesel-powered hammers usually towed by a prime mover of some type, and the resonant-powered pavement breaker which is one of the newer types developed and designed for high-speed crushing of concrete pavements for recycling.

In deciding on the type of breaker to use the contractor usually considers: whether the project is rural or urban; whether noise and/or dust generation are a factor; the desired size of the broken

Figure 21. Pneumatic punch (concrete chisel) used to punch holes in slab on Iowa project. Pattern used controls resulting size of broken concrete pieces.



Figure 22. Towed hydraulic hammer on project in Minnesota. 14" x 20" hammerhead moved forward approximately 20' per minute. Fuel injection control regulates force of blow and size of broken concrete.

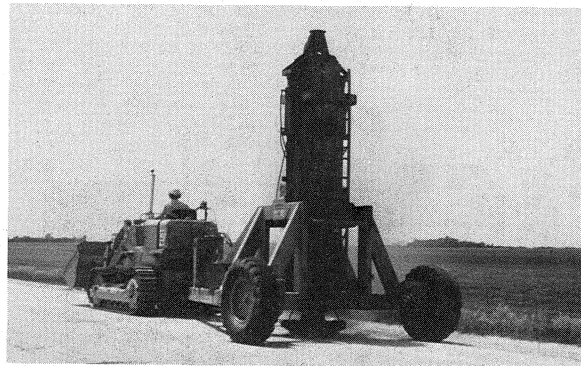
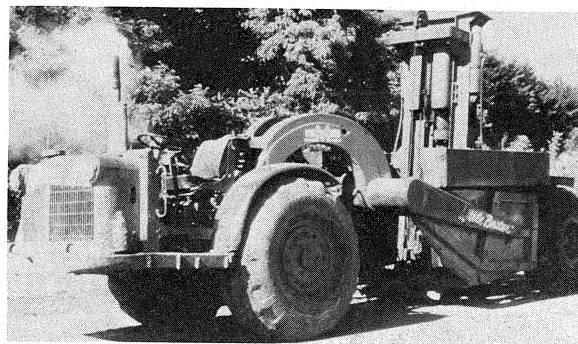


Figure 23. Diesel-driven hammer mounted in rubber-tired scraper to reduce vibrations on Michigan project. Production rate was about 1/2-mile of 24' wide pavement per day.



concrete particles on-grade; if the old pavement is reinforced or not, and type of reinforcement used.

In general, plain concrete pavements have recycled the easiest as the handling of reinforcing steel is not required during the removal or crushing stages.

Recycling of existing mesh-dowel pavements differs only in the techniques used to remove steel from the old pavement.

Figure 24. Resonant-powered pavement breaker on I-94 in North Dakota. Note small size of concrete particles.



In general, following breakup of the pavement in place, backhoes equipped with a rhinohorn are used to remove as much of the mesh from the old pavement as possible prior to removal of the broken concrete from grade. Remaining steel is removed by hand and by the use of electric magnets at the crushing site.

Successful recycling and removal of steel from CRCP pavement has only differed from mesh-dowel removal techniques in the type and amount of steel to be removed. In most cases the reinforcing steel is brought to the surface by the breaking process and practically all of it can be removed on-grade. Cutting torches or heavy shears are sometimes employed to remove and reduce rebar lengths for easier handling.

Figure 25. Backhoe equipment with rhinohorn removing steel from broken concrete on I-35 project in Iowa.



Figure 26. Magnet removing any residual from crushed concrete on I-90-94 project in Wisconsin.

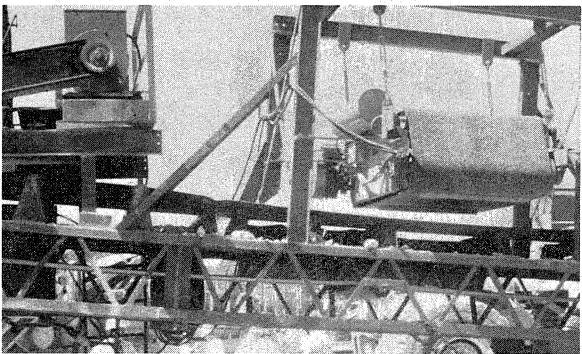
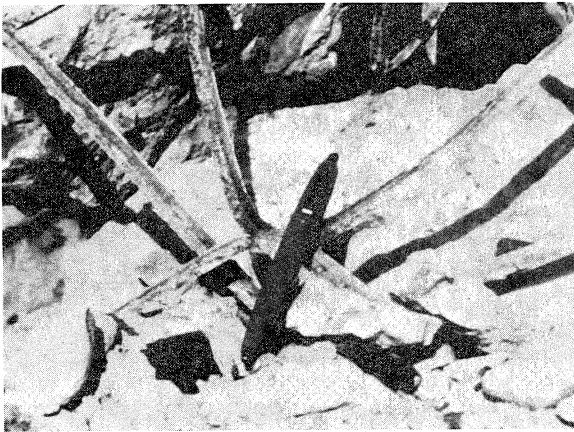
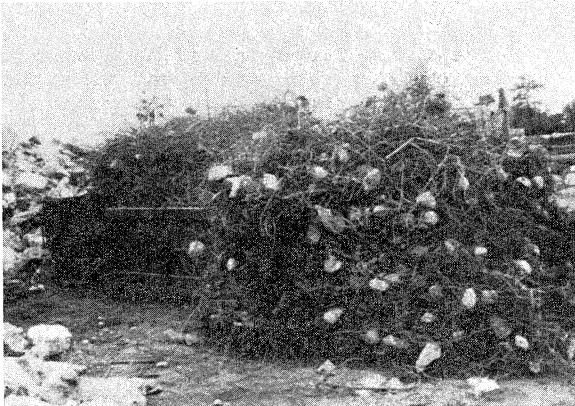


Figure 27. Close-up taken on Michigan project shows how concrete separates from mesh on old mesh-dowel project.



Crushing plants and concrete mix plants are usually located on or near the middle of a project -- either in a cloverleaf or near an interchange. This has the advantage of reducing construction interference with local traffic and can provide major savings.

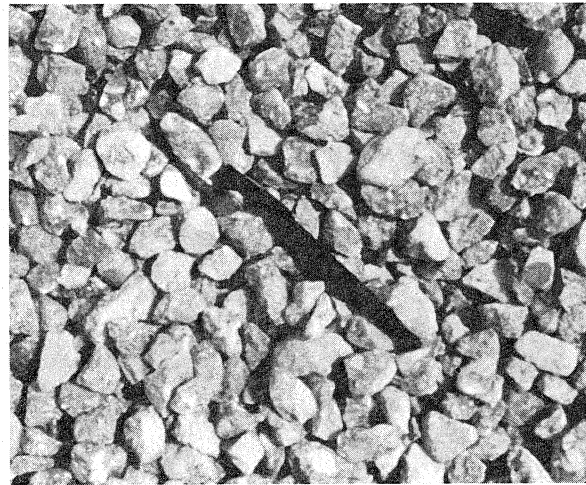
Figure 28. Stockpiling mesh removed from old mesh-dowel project in Illinois.



In general, primary crushers reduce the broken concrete to a maximum size of 4". The material is then conveyed to secondary crushers for additional reduction as required by the concrete mix design. The crushed material is usually separated into two or three size fractions at that stage. On projects that incorporate old pavements having "D"-cracked distress a maximum recycled coarse aggregate size of 3/4" is specified in order to beneficiate the new concrete.

Recycled coarse aggregates do not generally contain excessive amounts of elongated or flat particles but rather the most common resulting particle has a desirable pyramidal shape.

Figure 29. Typical example of recycled coarse aggregate. Note pyramidal particle shape.



On some projects the portion of the recycled material passing the No.4 sieve is used as fine aggregate in the new mix. On most projects, however, it is replaced by natural sands.

It is recommended that all recycled concrete mix designs be based on trial mixes made from concrete taken from the roadway being considered for recycling. Normally this means removal of a representative sample of the old pavement for evaluation and crushing to aggregate sizes being specified for use in the new mix.

Freeze-thaw cycle tests are conducted to determine any loss of quality in the new product. A minimum of 300 cycles is usually run. Most recycled concrete mix designs have required the use of water-reducing admixtures to lower water demands and the cement content. Washing of the recycled aggregates prior to their incorporation in the new concrete has not been required on projects built to date. Coarse aggregate sizes used have ranged from 1 1/2" to 3/4".

Concretes made from recycled portland cement concrete aggregates have in general exhibited excellent flexural strength properties.

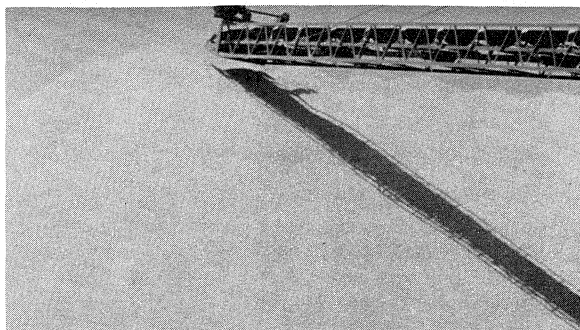
Tests have shown that recycled concrete mixes can improve the quality characteristics of the original concrete. This has been especially true in cases where "D"-cracked concretes have been recycled to provide aggregates for the new mix.

Central-mix concrete plants are located immediately adjacent to the crushing operation to reduce material hauling. The following mixes have been successfully used: mixes designed to use both recycled coarse and fine aggregates; mixes designed to use recycled coarse aggregates along with various percentages of natural sands and recycled fines; mixes designed to use recycled coarse aggregates and all natural sand; Mixes using "D"-

cracked concrete as coarse aggregate and the substitution of natural sands for the recycled fine aggregates. These mixes have substituted 20% fly ash for 15% of the required cement in the mix; mixes incorporating two sizes of coarse aggregate, natural sands, and with fly ash prohibited.

The construction techniques used in placing, finishing and curing the recycled concrete mixes have been identical to those used on new concrete paving projects and the recycled concrete has handled and finished like regular concrete.

Figure 30. Recycled concrete aggregate being stockpiled for use in new concrete.



USE OF TIED CONCRETE SHOULDER CONCEPT

Research conducted in Minnesota in 1976 showed that tied concrete shoulders were effective in reducing the level of measured strains and deflections at unsupported pavement corners and edges. In addition, the tied concrete shoulder provided the benefit of carrying run-off water farther from the wheel paths of traffic. Studies by the FHWA have determined that water in the joint between the existing asphalt shoulder and the concrete pavement can be a major factor in reducing pavement performance. Edge deflections decreased rapidly as loads were moved away from the unsupported edge and deflections always increased as the total load was increased. Under conditions of the research, tied butt, tied and key joint construction were equally effective in reducing loads, induced pavement stress, and deterioration.

An alternate to resurfacing has been the use of a widened lane or a tied concrete shoulder. This solution has been used not only to strengthen existing pavements but to add load-carrying capacity to new pavements.

The monolithic and tied concrete shoulder concept has now been made part of standard practice in many states.

Figure 31. Tied concrete shoulder being added to existing pavement under traffic on I-81 in Pennsylvania.

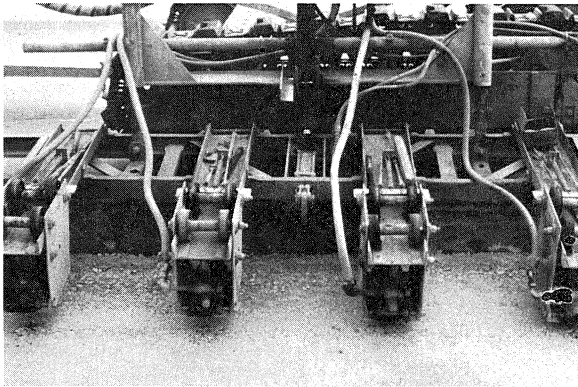


The technique used in adding a concrete shoulder to an existing pavement is rather simple. It requires, first, the removal of the existing shoulder material to a predetermined depth (minimum of 6") below the existing pavement edge, the drilling of holes into the edge of the existing slab, usually at 30" centers, and the grouting of reinforcing bars or the installation of tiebars into the holes. The new tied concrete shoulder is then placed by the use of belt spreaders and slipform pavers. Most of the tied concrete shoulders built to date have been designed as plain pavements with joint spacings of approximately 15-feet.

Plain concrete shoulders have been added to existing CRCP, mesh-dowel and plain pavements. The surface textures used have been burlap drag, astroturf drag, broom finish and tining. Curing of the concrete shoulder has been done by use of white pigmented curing membrane.

Most of the reconstructed concrete pavement designs used on the Interstate to date have incorporated the use of monolithic or tied concrete shoulders.

Figure 32. Drilling four holes at a time in the side of the existing pavement.



The 1982 Surface Transportation Assistance Act formalized the 4R (Resurfacing, Restoration, Rehabilitation, and Reconstruction) Interstate Fund. This fund is expected to continue at a high level of expenditure in the future.

In designing for the reconstruction of the Interstate, engineers are taking into consideration the demands of ever-increasing heavy commercial loading, life-cycle costing, material availability, and increased traffic. (10) (11)

As the 4th R - reconstruction option - takes on more importance, the use of portland cement concrete as the reconstruction material is providing the highway engineer with answers that will meet the challenge ahead.

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