



# MATES

## MATERIALS AND TECHNOLOGY ENGINEERING AND SCIENCE

Published by the Materials and Technology Division of the Michigan Department of Transportation

Issue No. 5

March 1987

### NOTES ON CONCRETE RECYCLING AND ASSOCIATED SPECIFICATION CHANGES

One of the things we try to do at M&T is to keep tabs on the more complex or unusual projects. For example, this past summer we monitored large portland cement concrete recycling projects; two on I 96 west of Portland, and two on I 94, one just west of Marshall and the other at Paw Paw. As we observed these projects some common problems came to light.

In all cases, the broken pavement was picked up from the grade by front-end loaders or back-hoes, hauled to the contractor's yard by trucks, and end-dumped in long piles. In picking up the concrete rubble from the grade, a considerable quantity of select subbase often was included. So much, in fact, that in three of the four long piles (four projects) there were zones where select subbase almost completely covered and obscured the broken concrete rubble.

All of the materials, the broken concrete and select subbase, were run through the crushing and screening operations and ended up in either the modified 6A stockpile or the crushed fine aggregate stockpile. This meant that a significant quantity of stone, No. 4 to 3/4 in., from the select subbase ended up in the modified 6A stockpiles. The problem with this procedure is that we have no information as to the quality of this stone, but do know that it would require heavy media separation to make it into 6A quality. Enough fines found their way into the 6A modified stockpiles on two projects that brown colored, vertical faces were observed when the stockpiled material was being excavated for concrete operations.

Prior to placing the broken concrete in stockpiles, the ground in each contractor's yard was stripped bare and the rubble placed directly on the ground. The bare soil at the I 96 projects was till clay, some of which was picked up and incorporated into the material going through the aggregate plants. Clay balls were found in the 6A modified stockpile on one project. One project had a haul road on top of the concrete rubble pile with end-dumping at the end. A significant quantity of clay from the truck tires or stacking dozers was deposited with the salvage concrete and later incorporated into the produced aggregate piles.

Because of these common problems, the "Supplemental Specification for Producing Crushed Concrete Aggregates for Use in Portland Cement Concrete and Open-Graded Drainage Course" is being revised. The supplemental will require a 3/4-in. grizzly or scalping screen to be placed ahead of the primary crusher or between the primary and secondary crushers to eliminate the select subbase material from being incorporated into the 6A modified or crushed concrete fine aggregate. This was done on one project and worked very well.

On soils capable of producing clay balls, a 12-in. layer of either fine aggregate 2NS or crushed concrete fine aggregate is to be maintained beneath and 20 ft around the concrete rubble pile.

There have been some requests to use the crushed concrete fine aggregates for Granular Materials Class II. We took samples from all four projects and measured their permeability. The results indicate that drainage through these materials, when they are compacted, ranged from very poor to nearly zero. It is recommended that the crushed concrete fine aggregate not be used for applications where good drainage is required.

Future concrete recycling projects will be monitored to see how the new specifications work. Construction methods and practices will be observed and specifications will be altered if necessary.

-Don Malott

### WHY ADD CHEMICALS TO CONCRETE?

Chemicals added to concrete mixes are called admixtures. Those we are concerned with are water reducers, set retarders, and set accelerators, either used individually or in combination. A more recent form of water reducer is known as a 'superplasticizer,' or 'super water reducer,' but officially called a 'high range water reducer.'

Water reducers lower the water requirement in concrete by about 5 to 10 percent. Strength is increased somewhat more than can be attributed to the water reduction alone because water-reducers disperse the cement grains more effectively. Water reducers can be used to provide increased strength, to provide higher slump concrete, or to reduce the cement requirement while maintaining the strength and slump. The Department permits the latter option, and most contractors adopt this procedure since the water reducer costs less than the cement it replaces.

High range water reducers (superplasticizers) reduce the water requirement in concrete by about 15 to 25 percent due to much more efficient dispersion of the cement grains. Possible benefits are similar to ordinary water reducers. MDOT does not generally specify use of superplasticizers, but permits their use. Contractors are electing to use them (at their expense) due to higher permitted slump of concrete for difficult placements (around heavy reinforcement in small columns, for example). Prestressed beam manufacturers use superplasticizers for higher strengths and more rapid strength gain. Superplasticizers have been used for modified Iowa method (low-slump high-density) bridge deck overlays, in a few cases, in place of latex modified concrete. Superplasticizers cost significantly more than normal water reducers, so with regard to materials costs they are not cost-effective in relation to cement reduction permitted by the Department. Earlier formulations increased slump for only a very short time, so they had to be added at the jobsite. Newer formulations, however, have been modified to retain the increased slump for a longer time, so they can be added at the batch plant and still be effective when the load arrives at the site.

Retarders delay the set of concrete, although they do not delay the loss of slump. Retarders are required in bridge

Testing Laboratory  
U of M 1913

Research Laboratory  
MSU 1939

Investigation and Research Division  
1924

✱

Testing and Research Division  
1933

✱

Materials and Technology Division  
1985

"Committed to superior transportation services and facilities"

deck construction, so that full deflection of a span due to the weight of the concrete, takes place before the concrete sets. Since the setting of concrete is naturally slower in cool temperatures, the specifications permit the use of plain water reducers when temperatures are low and a retarder would cause excessive delays in setting. MDOT approves only retarders that are also water reducers, officially named 'water-reducing retarders.'

Accelerators speed up the setting and strength gain of concrete. They usually are used to offset the effect of low temperatures, but are also used for early strength development in fast-set pavement patching or other situations where early strength is required. The usual material is calcium chloride, but its use is restricted to plain concrete or in concrete without significant reinforcing steel. Non-chloride, non-corrosive accelerators have been developed recently but are not used generally because of their high cost.

Precaution on the use of admixtures. Use of excessive quantities of admixtures can produce unusual results: water reducers can cause retardation, retarders can delay set for days or cause very rapid setting. Refer to the "Admixtures Approval List" for minimum addition rates. Maximum addition rates generally should not be more than twice the minimum rates unless recommended by the admixture supplier or indicated satisfactory by test. While these chemical admixtures can be beneficial in providing improved concrete, they are not a substitute for normal care in maintaining moderate concrete placement temperatures, maintaining lowest practical water/cement ratio, control of rapid evaporation of water from slab surfaces, and providing for good early (and continued) curing of the concrete.

-Ralph Vogler

### GOODBYE TRICHLOR

In 1976, Congress passed the Resource Conservation and Recovery Act which directed the Environmental Protection Agency (EPA) to develop and implement a program to protect human health and the environment from improper hazardous waste management practices. This program was then designed to control hazardous waste from its generation to its ultimate disposal—from 'cradle to grave.' In 1984, amendments to the Act were signed into law requiring that small generators of hazardous waste (between 100 and 1,000 kilograms per month) be brought into the regulatory systems. For quantities smaller than 100 kg, the Michigan Department of Natural Resources has its own control procedures, that we must follow.

In order to minimize the problems associated with controlling and disposing of hazardous waste, MDOT has begun a vigorous campaign to reduce the use of such materials. One of the first to go is trichloroethylene as used in the field for extraction testing of bituminous paving mixes. Trichlor can continue to be used in the laboratory, because of the extensive air handling equipment and disposal facilities located there.

Once the decision was made to eliminate trichloroethylene from the field, a search was begun immediately for a substitute method of quality control. The Bituminous Technical Services Unit looked at alternate solvents (almost all of which are also considered to be hazardous materials), nuclear gages for measuring asphalt content, and other methods of carefully controlling the materials before they were mixed, in order to eliminate the need for field extractions.

Although development of all three of the preceding general methods are continuing, we were fortunate enough to find a substitute solvent that will not generate hazardous waste. The solvent, called BIOACT, has been used as a replacement for trichloroethylene as an industrial degreaser. BIOACT has been tested in the bituminous laboratory and found to work effectively in extraction testing; thus, field extraction testing can continue as a primary method of quality control. Daily samples and lab samples for verification of materials indicated by field tests to be out-of-specification, will continue to be tested in the laboratory by the Bituminous Technical Services Unit using trichloroethylene.

Although extraction test procedures using BIOACT are similar to those using trichloroethylene, there are some important differences. Therefore, our Bituminous Technical Services Unit is scheduling seminars to be given in each District to the persons involved with extraction testing. To get this information to our field personnel as quickly as possible, initial seminars will involve only MDOT employees; however, these seminars will be available also to local government, contractor, and consultant personnel, once our in-house needs are served.

Field Engineers will be receiving a letter listing dates for the schools and asking their cooperation in making this changeover a success. We were very fortunate to find such a relatively painless way to eliminate the use of a hazardous material. With the cooperation of everyone involved, it will work! Questions regarding the schools can be directed to Gary Chapman (517) 322-1216.

-Fred Cople

### TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

#### RUDY KETOLA

Rudy Ketola is retiring this month after more than 40 years of service with the Department. Rudy joined MDOT in 1946, working in the Construction Division. In 1951 he began his long career with the Materials & Technology (then Testing & Research) Division as the traveling bituminous mix technologist for the entire Upper Peninsula, and for 36 years thereafter Rudy represented the best interests of the Department, while maintaining a cooperative and helpful relationship with the contractors.

Rudy's career paralleled the State's use of hot-mix bituminous material; he started about the time that hot-mix plants and paving equipment were introduced (and in those days his job involved street, as well as plant inspection) and his technical expertise grew as the industry did. With such a long and pioneering career in the field, Rudy has many unique experiences to relate; however, the most challenging

was the paving of the Mackinac Bridge. Paving operations took place in November, and the Governor had promised that the bridge would be open in time for deer season; thus, conditions were less than ideal and time was of the essence. Further, paving over such a structure with its movements, its steel grid surface, etc., entailed special mix, equipment, and construction procedures. The job was a success, and Rudy's part in it was no small one.

Rudy has played an integral part in the technical advancements in bituminous paving throughout the State in his years as a traveling bituminous mix technologist, and he has literally overseen the design and quality assurance of thousands of miles of flexible pavements. Though the loss of his knowledge and experience is one that will be keenly felt, it's his presence on the job—as Rudy—that will be missed by his many friends in the Department and the industry. Thanks, Rudy, for all you've done, and best wishes for many happy retirement years ahead!

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

Technology Transfer Unit  
Materials and Technology Division  
Michigan DOT  
P.O. Box 30049  
Lansing, Michigan 48909  
Telephone (517) 322-1637