Evaluation of HPC Pavement in Nelsonville, Ohio

Problem

One of the major causes of distress in Portland Cement Concrete (PCC) highways is loss of support under slabs. A new mix for High Performance Concrete (HPC) pavement appears to promise an enhancement of pavement lifetime. This new mix includes blast furnace slag, a by-product of manufacturing processes.

The Ohio Research Institute for Transportation and the Environment (ORITE) evaluated the structural performance of three sections of PCC pavement installed on the reconstructed US Route 33 in Nelsonville using new and standard mixes to see if the new mixes do provide better performance. The project also involved comparing two different curing methods, the traditional method using wet burlap and a new method using a spray-on membrane.

Objectives

The objectives of this study were to test the performance of three different mixes of concrete, two new and one standard mix. This testing included monitoring the curing process, measuring the shape of the slabs after curing, conducting non-destructive testing on the finished road, and conducting laboratory tests to determine the mechanical properties and maturity curves of these mixes.

Description

Three different mixes were compared: Mix A had 30% blast furnace slag and used #57; Mix B had 30% blast furnace slag and used #357 aggregate; and Mix C was a standard ODOT mix with no slag and #57 aggregate. Sections of 1000 ft (305 m) were constructed using each mix. Half of each section was cured using wet burlap and the other half was cured using a spray-on membrane. with no slag and #57 aggregate. Sections of 1000 ft (305 m) were constructed using each mix. Half of each section was cured...
predicted strength ratios \((S/S_{28})\) using this model to measured strength ratios of field and lab samples. Again, the strength of Mix A was overpredicted by about 30%. The fits in general were not as good for each of the mixes. Some of this may be attributable to the possible differences between the small lab batch and the much larger field batch; the Arrhenius method may work better if samples were obtained from a larger batch of concrete at the mixing plant. Another possible source of discrepancy was the possible mixing of some of the Mix C with the quick set concrete used in the previous batch of concrete in the field.

Using the profilometer, the average warps seen in slabs made of Mix A were 0.020 inches (0.51 mm) for membrane cured concrete and 0.022 in (0.56 mm) for water cured concrete. The average warps seen in the slabs of Mix B are 0.019 inches (0.48 mm) for membrane cured concrete and 0.016 inches (0.40 mm) for water cured concrete. The average warps seen in the slabs of Mix C are 0.027 inches (0.69 mm) for membrane cured and 0.023 inches (0.58 mm) for water cured concrete. The FWD was used to measure pavement deflections and load transfers at the joints. On all sections, approaching and leaving measurements of deflection at each joint agreed very closely, except for the afternoon run with membrane cured Mix C. In both the morning and afternoon runs, membrane cured Mix B had the lowest deflection, 0.34 mils/kip \((1.94\times 10^{-6} \text{ mm/N})\) and 0.315 mils/kip \((1.80\times 10^{-6} \text{ mm/N})\) respectively, using an average of approaching and leaving values in each case. Water cured mix B had deflections that were almost as low, while water cured Mix A had the highest deflection, at 0.545 mils/kip \((3.11\times 10^{-6}\text{ mm/N})\) in the morning and 0.445 mils/kip \((2.54\times 10^{-6}\text{ mm/N})\) in the afternoon, followed by membrane cured Mix C. In all sections, the average deflection in the afternoon was less than that in the morning by 10-20%.

Water cured mix B had the highest load transfer across the joint at 94.5% in the morning and 94.95% in the afternoon, again using the average of approaching and leaving values. Water cured Mix A had the lowest load transfer at 87.5% in the morning and 89.0% in the afternoon. Load transfer measured in the afternoon was about the same as that measured in the morning for each section.

As seen in the preceding discussion, Mix B had both the least deflection as measured by the falling weight deflectometer and the least warping as measured by the profiler. The water curing produced a lower maximum warp, but the membrane cured section had a slightly lower deflection. In both tests, the other curing method for mix B produced the second best result. Thus it appears that Mix B experienced the least loss of support. Either method of curing seems to work equally well with Mix B.

**Implementation Potential**

It appears that Mix B, which uses 30% blast furnace slag and #357 aggregate, performed the best. It is expected that use of blast furnace slag in highway concrete will not only recycle waste material, but will enhance the lifetime of PCC pavements in the future.