Advancements

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Roller Compacted Concrete Project – Lessons Learned

Business Issue

Roller Compacted Concrete (RCC) uses less cement, less water and a higher percentage of aggregates to create a stiffer concrete mix that is compacted with vibratory rollers similar to those used in asphalt paving. According to the Portland Cement Association, "RCC is simple, fast, and economical." MODOT began allowing Roller Compacted Concrete on new shoulder construction in February 2008, but a specification for mainline paving has not been developed.

The RCC Project

Through the leadership of Central District Engineer Roger Schwartze and Glenn Robertson of Emery Sapp & Sons, RCC specialists were brought to Missouri to test this innovative overlay option. A.G. Peltz Company placed a RCC overlay on Ponderosa Road on October 29-30, 2008 with the help of local contractor Emery Sapp & Sons. The test overlay, in Boone County just south of Columbia, was placed on two, 10.5-foot lanes measuring approximately 2,000 feet in length. Unlike conventional concrete overlays, local traffic was allowed on the overlay within 24 hours of placement.

Results

MoDOT did not achieve the results with RCC that were anticipated. The pavement, which is less than six months old, is showing some deterioration in the form of surface raveling, and an overlay is being considered. However, MoDOT material engineers do not believe that the RCC paving product on Ponderosa Road is representative of typical end products. When test results were beginning to show serious concerns with the product durability, two construction companies with past RCC projects were contacted for comparison purposes. Table 1 shows the test results of both days of RCC paving on the Ponderosa project, as well as the test results obtained from the two construction companies.

Lessons Learned

MoDOT is still interested in pursuing RCC techniques and has been working to determine what went wrong with the project. MoDOT staff believes that the issues come down to three categories: mix optimization, surface curing, and proper compaction and placement.

Mix Optimization: The aggregates used in the Ponderosa RCC project consisted of gap graded crushed limestone and manufactured sand. RCC mix is very dry and care should be given to having a uniform graded course aggregate. The use of natural sand also would have provided a more workable mix.

Surface Curing: The Ponderosa pavement was not cured and no curing compound was applied. Due to the dry nature of the mix, any moisture loss will inhibit full hydration. Another problem occurred because the trucks delivering the mix were not tarped, which most likely compounded the issue of moisture loss. RCC must be near the optimal water content in order to be compacted properly.

Proper Compaction and Placement: It is obvious from the density testing and permeability tests, that the pavement did not get fully compacted. It is unknown at this time if the lack of compaction was due to equipment malfunction or mixture design or a combination of both. The Ponderosa project was delayed a day due to problems with the paving machine, it is possible the equipment was not performing adequately.

Table 1. Testing Results for RCC Pavement

Test	Ponderosa Rd Day 1	Ponderosa Rd Day 2	2002 RCC Project	2007 RCC Project	2008 RCC Project
Location	Roadway	Roadway	Entrance	Parking Lot	Temporary Shoulder
1-Day Compressive Strength	3450	2110	---	---	---
3-Day Compressive Strength	3910	3080	---	---	---
7-Day Compressive Strength	4360	3490	---	---	---
28-Day Compressive Strength	3480	2678	2232-day 11500	2232-day 7910	90-day 9424
28-Day Compressive Strength (Edge of Lane)	3525	2861	2232-day 9540	2232-day 11090	---
Core Density (#/ft^3) Center of Lane	144.1	139.5	155.9	156.5	151.5
Core Density (#/ft^3) Edge of Lane	131.4	134.7	148.4	141.6	---
Linear Traverse % Air	9.9	17.4	1.9	1.1	2.6
Linear Traverse S.F.	0.016	0.009	0.019	0.019	0.018
Linear Traverse S.S.	167	152	349	480	338
Permeability 28-Day (Coulombs)	Est. +10,000	Est. +10,000	645	698	---
Durability Factor	25 cycles 5.3	25 cycles 3.9	---	---	---
Flexural Strength (psi) (After F/T Tests)	95	197	---	---	---
Flexural Strength (psi) 35-Day	503	692	---	---	---
Permeable Voids (%) 28-Day	19.54	20.15	8.63	9.32	---

MoDOT is continuing to monitor this section of Ponderosa Road, as well as other RCC pavements, to identify an application range that will balance economy and durability in delivering a quality RCC pavement.