EVALUATION OF EARLY STRENGTH REQUIREMENT OF CONCRETE FOR SLAB REPLACEMENT USING APT

PROBLEM STATEMENT

Full slab replacement is a common method for repairing badly deteriorated concrete pavement slabs in Florida. This type of repair work is typically performed at night, and the repaired slabs are opened to traffic by the following morning. To minimize interruptions to traffic flow, it is essential that this repair work be finished in a minimal amount of time. High early strength concrete is typically used in this application in order to have sufficient strength within a few hours after placement. The Florida Department of Transportation (FDOT) currently specifies the slab replacement concrete to have a minimum 6-hour compressive strength of 2200 psi (15.2 MPa) and a minimum 24-hour compressive strength of 3000 psi (20.7 MPa). However, there currently are uncertainties with regard to the optimum concrete mixtures to be used in this application. Moreover, there are unresolved questions regarding the required early-age properties of the concrete for this application.

OBJECTIVES

The goal of this project was to evaluate the early-age behavior and performance of typical concrete replacement slabs under Florida conditions using full-scale testing and employing a Heavy Vehicle Simulator (HVS). The main objectives of this study included the following:

1. To determine the relationship between the early-age concrete properties and the performance of concrete replacement slabs.
2. To determine the required concrete properties at the time of opening to traffic to ensure satisfactory performance of concrete replacement slabs under Florida conditions.

FINDINGS AND CONCLUSIONS

The results from this study show that the performance of a concrete replacement slab depends not just on the cement content of the concrete mix, as two concrete slabs with the same concrete mix design can have drastically different performance. The performance of a concrete replacement slab will depend on whether the concrete will have sufficient strength to resist the anticipated temperature-load induced stresses in the concrete slab. The strength development of a concrete depends not only on the mix design but also the condition under which the concrete is cured. The anticipated temperature-load induced stresses are a function of the slab thickness, effective modulus of subgrade reaction, modulus of the concrete, coefficient of thermal expansion of the concrete, anticipated loads, and anticipated temperature differentials in the concrete slab. The anticipated stress must be lower than the anticipated flexural strength of the concrete at all times to ensure good performance.

Based on the limited test results from this study, it appears that for a 9-inch slab placed on an adequately strong foundation and a maximum temperature differential of +10° F in the concrete slab, a minimum required compressive strength of 1100 to1600 psi for the concrete at the time of application of traffic loads may be adequate. It may be feasible to lower the minimum required compressive strength of 2200 psi at 6 hours, as specified by the current FDOT specifications, to 1600 psi at 6 hours, subject to further testing and verification.

Due to the limited scope of this study and the limited amount of testing that was performed, there is no recommendation for changes in FDOT specifications for concrete replacement slab.

BENEFITS

The findings from this study have improved the understanding of the relationship between concrete properties, pavement parameters, and the performance of concrete replacement slabs in Florida. With further testing and verification, the results of this research will lead to more effective specifications for concrete replacement slabs in Florida.

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