TEMPERATURE VARIATION IN DRILLED SHAFT CONCRETE AND ITS EFFECT ON SLUMP LOSS

PROBLEM STATEMENT

A concrete delivered within the specified slump range ("slump" is a measure of concrete consistency) is easier to place and consolidate, and it results in a better end product or a more durable structure. Florida Department of Transportation (FDOT) specification 346-3.2 requires that the concrete used for the construction of drilled shaft should have a slump between 7 and 9 inches (180 and 230 mm) when placed and should maintain a slump of 4 inches (25 mm) or more throughout the concrete placement time. Furthermore, it requires that the mix for the slump loss test should be prepared at a temperature consistent with the highest ambient or initial concrete temperature (whichever is greater) expected during actual concrete placement. There is a prevalent feeling among many FDOT contractors that this requirement is not realistic and that it is too stringent. They feel that the temperature of concrete inside the drilled shaft is likely to be lower than the ambient or initial concrete temperature and hence slump loss would be less than the loss determined at the highest ambient or initial concrete temperature.

OBJECTIVES

This research study was undertaken with the objective of determining temperature profiles of concrete in time from placement to hardening. A clear answer as to whether the temperature in the drilled shaft is lower than the ambient or initial concrete temperature was provided by this investigation. For this purpose, three 4 ft (1.22 m) diameter, 25 ft (7.62 m) deep drilled shafts were constructed. Temperature probes connected with automatic data recorders were used to record concrete temperature inside the drilled shafts. Based on the collected data, temperature profiles were plotted and analyzed. The research study was conducted in two phases between February 2001 and March 2002. The objective of the first phase was to investigate the ground temperature variation along depth. The purpose of the second phase was to determine temperature variation in concrete with time. The temperature data were collected across the width (along the cross section) as well as along the depth of the drilled shafts.

FINDINGS AND CONCLUSIONS

Based on the results of this study, the following conclusions can be drawn:

1. The ground temperature stabilizes 1-2 ft below the water table and is independent of the atmospheric conditions. In this study, conducted in Miami, the average temperature below the water table was found to be 75-77°F. Hence, researchers have concluded that the slump loss in concrete would be same at all depths below the water table.

2. The temperature within the drilled shaft is same as the initial concrete temperature at the time of concrete placement despite the fact that prior to concrete placement, the temperature within the drilled shaft was lower than the ambient temperature. There was no indication that the concrete temperature within the drilled shaft was lower than the initial concrete temperature due to the presence of ground water.

3. There is no significant increase in concrete temperature within the first 2 hours of placement. Hence, it may be concluded that the slump loss would be minimal if the placement of concrete is completed within 2 hours from the start of operation.

4. No significant temperature differential exists along the depth and across the width of the drilled shafts during the initial setting of concrete. Hence, the slump loss in drilled shaft concrete would be same at all locations within the shaft.

5. Since the initial concrete temperature inside the drilled shaft was same as the initial concrete temperature before placing, the rate and amount of slump loss inside the shaft would be same as on the ground surface.

The investigators recommend that the FDOT specification 346-3.2 should be amended as follows in light of new findings: "*The concrete mix for the slump loss test shall be prepared at a temperature consistent with the highest initial concrete temperature expected during actual concrete placement.*"

BENEFITS

A revision to the FDOT specifications could be beneficial for hot weather concreting (common in Florida during the most months of the year) when the ambient temperature is much higher than the actual initial concrete temperature. It would allow more time to place the concrete in the drilled shafts before the slump is dropped to a minimum level of 4 inches. Since no published research is available on the topic of the temperature variation in drilled shaft concrete, this research could be considered as an initial effort in this area. It also provides a reliable set of temperature profiles data. These data can serve as a basis for any future investigation, which would be necessary, particularly considering the fact that controlling concrete temperatures is a more difficult process than evaluating and setting concrete admix dosages based on expected ambient temperatures.

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