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EFFECT OF VIBRATION ON CONCRETE STRENGTH DURING FOUNDATION CONSTRUCTION

PROBLEM STATEMENT

One of the pressing issues that concerns the Florida Department of Transportation (FDOT) is the effect of vibrations induced during deep foundation construction on the green concrete of drilled shafts. Green concrete (i.e., concrete less than 24 hours old**)** is particularly vulnerable to the weakening of its properties if it is subjected to intense vibrations that could disrupt the concrete matrix during the formative bond development process. To minimize the adverse effect of excessive construction vibrations on newly drilled shafts, FDOT requires that all construction activities cease around the green concrete for the period of time needed for the fresh concrete to harden. Specifically, the FDOT Roadway and Bridge Specifications (2000) require contractors to "stop driving piles within 200 ft of concrete less than two days old unless authorized by the engineer." In some major bridge construction projects, FDOT supplemental agreements require that within a distance of three times the shaft diameter vibrations be prohibited for a period of 12 hours to protect the green concrete. The time and no-vibration distance restrictions can significantly affect the project production.

OBJECTIVES

The main objective of this project was to specify more reliable halting times for concrete mixes based on initial and final setting times of the concrete rather than on fixed times. Additionally, the no vibration distance should be selected such that the damped vibration has no influence on the green concrete properties. To meet these objectives, laboratory testing was conducted on two sets of drilled shaft concrete samples. The main testing variables were (1) vibration amplitude and (2) duration of vibration. The setting time for both sets were recorded to correlate the variations of the concrete properties with time.

FINDINGS AND CONCLUSIONS

The findings of this study showed that vibrations induced during drilled shaft construction may produce large peak particle velocities in the ground as the driven case advances in the subsurface. The largest peak particle velocities, however, were rapidly damped within short distances from the driven casing. In this study, two correlations were obtained to estimate the peak particle velocities in a half space sandy soil. The surface peak particle velocity (ppv) correlation conformed to Bornitz's relationship. The recorded durations of the induced vibrations were very scattered, and it was not possible to define a suitable duration from the field testing. Therefore, the first set of concrete samples was subjected to vibrations that lasted for the duration of the final setting time. The second set of samples was subjected to vibrations for a length of time that equaled

the period between the initial and the final setting time. Results from the laboratory testing showed that the effect of the ppv was more severe for the second set of samples than for the first set. However, some samples from the first set experienced more bleeding and segregation than those from the second set.

As a result, it can be concluded that no vibration should be allowed within a distance equal to three times the shaft's diameter or for a duration equal to or greater than the final setting time of the concrete. During this time, the ppv limit suggested at the prescribed distance should not exceed 2in/sce.

Therefore, based on the outcomes of this study, it is recommended that green concrete be protected from excess construction vibrations to avoid any detrimental effects on the concrete properties. Although controlled concrete vibration is desirable to improve its physical and mechanical properties, construction vibrations can simply be categorized under uncontrolled vibrations that include both durations and amplitudes. Therefore, deterring any construction vibrations around the green concrete in drilled shafts would eliminate effects such as segregation, bleeding, and reduction in concrete stiffness and strength. The threshold values of the ppv of 2 in/sec and a distance of three shaft diameters should be used in the absence of the exact measurements of resonant frequency of the freshly cast concrete drilled shaft. This study showed that ppv 2 in/sec was the most critical velocity for the concrete samples used in the investigation. Increasing the ppv beyond 2 in/sec did not reduce the strength of the samples, which indicated that the concrete samples reached resonance where the vibration amplitudes in the concrete matrix were at the maximum and hence produced the most detrimental effect.

BENEFITS

The findings of this study will assist project managers and field engineers to determine when and where to stop vibration around drilled green concrete. The main advantage of this study is that other types of green concrete can also be investigated using a similar methodology. Therefore, time and distance restrictions can rationally be assessed rather than arbitrary values assigned.

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