Determination of the Slip-up Time for Slip-Form System using Surface Wave Velocity

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Summary

The early setting time of concrete is a factor determining the slip up velocity of the slip-form system. Accordingly, need is for a technique evaluating the early setting time in order to secure the safety of the slip-form system and the construction quality of concrete. The technique using surface wave velocity makes use of the characteristics of the surface wave propagating along the surface and can assess the setting degree of concrete through the changes of the surface wave velocity. This technique is suitable for thick concrete structures like the pylon. Therefore, this paper intends to estimate the early setting time by evaluating the setting degree of concrete using surface wave velocity so as to determine the slip up time of the slip-form system. Penetration resistance test and compressive strength test are performed first to clarify the relationship between the early setting time of concrete and the compressive strength. Then, compressive strength test and ultrasonic wave test are conducted to examine the relation between the compressive strength and the surface wave velocity. Continuous wavelet transform is adopted to measure the surface wave velocity. Numerical analysis is carried out to demonstrate the appropriateness of the application of continuous wavelet transform. Based on these results, the propagation velocity of the surface wave required for the slip up of slipform system is suggested. Finally, a reduced model test of the slip-form system is conducted to verify the feasibility of the proposed surface wave velocity for the determination of the slip up velocity.

Keywords: slip-up time; setting time; slip-form system; surface wave velocity; continuous wavelet transform.

1. Introduction

During the construction of a concrete cable-stayed bridge, the methods using moveable forms for the erection of the pylons or piers are mainly the Auto Climbing Form System (ACS) and the Slip-Form System. The slip-form system, also known to as the sliding technique, is a technique placing concrete continuously by lifting vertically the form-panel and yoke-leg by jacks attached to the rod embedded horizontally or vertically in the concrete mass. This technique presents the advantage of shortening significantly the construction time compared to other methods since the 5 tasks that are assemblage of form, assemblage of reinforcement, placing of concrete, curing and stripping are executed simultaneously.

The economic efficiency of the slip-form technique depends on the appropriate maintenance of the slip up velocity of the slip-form system so as to satisfy the required construction quality on site. The design slip up velocity of the slip-form system should be determined with sufficient consideration of the type of cement and admixture, the height of the slip-form, and the performance of the slip-form lifting equipment. The slip up velocity of the slip-form system during erection cannot be larger than the design slip up velocity, which must be imperatively determined to secure the safety and construction quality. However, even if the design slip up velocity of the slip-form system has been determined, the actual slip up velocity applied during erection shall be determined with respect to the eventual early setting of the cast-in-place concrete. If concrete is exposed

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