Change in Mechanical Properties of Early-Age Concrete under Repetitive Compressive Stress

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Summary

This paper deals with the effect of repetitive compressive stress on the change in mechanical properties of early-age concrete. The concrete used was high strength and high flow type and the mix proportion was the same as the one which was employed in an actual repair construction for a bridge shoe. Concrete specimens were repetitively loaded from 18 to 72 hours after casted for 2 days with a fatigue testing machine. The maximum stress in the repetitive loading was 35 % and the minimum stress was 5 % to the compressive strength of concrete. The wave shape was sinusoidal and the frequency was 5 Hz. Under the test condition of this study, there observed no significant decrease in residual strength and residual elastic modulus of concrete, though there was a tendency that calcium ion elution from specimens was accelerated with repetitive loading started from 18 to 24 hours after casted.

Keywords: early-age concrete; repetitive compressive stress; pH measurement; ultrasonic propagation velocity; residual strength; residual elastic modulus

1. Introduction

In urbanized areas, there are an increasing number of damaged road bridges due to an increase in traffic load. Repair constructions for those damaged structures are carried out often with traffic closures. Considering economic losses, road repairing needs to be completed promptly to open the traffic; however, in this case concrete will be exposed under repetitive loading at its early age. Compared to aged concrete, early-age concrete is coarsely structured because of insufficient hydration reaction; thereby it may be vulnerable to external force. It is concerned that the repetitive loading negatively influences the strength and elastic modulus of early-age concrete.

A few studies relating to the above situation [1]-[3] have been reported. In summary, the residual strength of concrete, whether early-age or aged, does not decrease under repeated compressive stress, rather increases in many cases. Neville [4] illustrates by examples that cyclic loading below the fatigue limit improves the fatigue strength of concrete, i.e. concrete loaded a number of times below its fatigue limit will, when subsequently loaded above the limit, exhibit a higher fatigue strength than concrete which had never been subjected to the initial cycles, and states that this increase in strength is due to a "densification of concrete" caused by the initial low-stress level cycling, in a manner similar to improvement in strength under moderate sustained loading [5]. On the other hand, bond strength of patching repair materials hardening under vibration decreases [6].

These results were obtained from the experiments in which concrete specimens were tested in air. Hence, experimental data is insufficient on the effect of repetitive compressive stress on the mechanical properties of early-age concrete in wet condition. This knowledge will contribute to the case that early-age concrete is wetted by rainwater; or concrete is moist cured for durability improvement. In this study, we conducted experiments to clarify the change in mechanical properties of early-age concrete under repetitive compressive stress in water. The same experiments in air were also conducted for comparison.

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