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Micromechanical Origins of Basic Creep in Mature Slag-Based CEM II Concretes Applied to Large-Scale Railway Tunnels

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Abstract

The frontier of engineering material mechanics is often defined by new technological demands and challenges, as will shown in the following at the crossroads of the material mechanics of cement and concrete, and the structural mechanics of large-scale railway tunnels: As the construction industry increasingly adopts eco-efficient materials, accurate characterization of slag-based CEM II concretes has become essential. In this study, the basic creep behavior of slag-based CEM II concretes is attributed to mixture invariant properties of their hydration products. An experimentally validated three-step micro-viscoelastic model originally developed for CEM I/OPC concretes is therefore extended by incorporating a Powers–Acker-type hydration model for CEM II, along with long-term creep, temperature activation, and moisture sensitivity. The resulting framework is applied in a strain-rate-based aging viscoelastic analysis of two creep tests on compositionally distinct CEM II concretes. The results reveal that the shear creep modulus of CEM II hydrates is approximately half that of ordinary Portland cement hydrates [1]. This reduced modulus renders slag-based CEM II concretes particularly advantageous for applications such as precast

segmental tunnel linings, currently employed for major railway tunnels connecting the Baltic to the Adriatic Sea [2], where rapid stress relaxation under displacement-controlled conditions is desirable.

Keywords:

viscoelasticity micromechanics CEM II cement concrete tunnel engineering

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