AAEM versus numerical rheology investigation of composite steel concrete beams

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Abstract

- The paper presents analysis of the stress changes due to creep in statically determinate composite steel-concrete beam according to (AAEM) method of Bažant in comparison with numerical solution using Volterra integral equations based on EC2 provisions for creep of concrete. The mathematical model involves the equation of equilibrium, compatibility and constitutive relationship, i.e. an elastic law for the steel part and an integral-type creep law of Boltzmann – Volterra and algebraic-type creep law of Trost - Bažant for the concrete part considering the above mentioned models. It is analyzed the migration of stresses from concrete plate to steel beam using two independent Volterra integral equations of the second kind and two independent algebraic equations. The closeness of the results obtained by the two methods is shown with an example from the bridge practice.

Keywords: steel-concrete section, integral equations, rheology, EC2 model, AAEM method.

1 Introduction

Steel-concrete composite beams are wide spread form of construction in both buildings and bridges. A reinforced concrete slab is mechanically connected to the top flange of a rolled or fabricated steel beam, thereby forming a composite member that is considerably stronger and stiffer than the steel beam acting on its own. The time-varying behaviour of composite steel-concrete members under sustained service loads drawn the attention of engineers who were dealing with the problems of their design more than 60 years [10, 14]. The solution of structural problems involving creep and shrinkage phenomena in composite steel-concrete beams has been an important task for engineers since the first formulation of the mathematical model of linear viscoelasticity. From an historical point of view the evolution of the research on this topic, as in many other research fields, has been dramatically influenced by the diffusion of computer technology, starting from the early seventies of past century. Before this event the research was mainly oriented on finding closed form solutions of simple analytic formulations of the creep models [6, 7, 13]. The theory of heritage and the theory of aging, the use of exponential formulations of creep have developed and largely adopted because of their capability to generate closed form solutions of structural problems. Creep and shrinkage have a considerable impact upon the performance of composite beams, causing increased deflection as well as affecting stress distribution. In general, time-dependent deformation of concrete may severely affect the serviceability, durability and stability of structures [5, 14].

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