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Approximate Methods for Analysing the Effects of Creeping and Shrinkage of Reinforced and Prestressed Concrete Constructions

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Abstract

´Precise´ procedures of analysis of so - called slow deformations, based on absence of negligence, are not suitable for practical calculations, due to its characteristic to be in demand of sufficient analyses. For that reason, there is the need for applying the approximative procedures and methods of analyses which give acceptable results, and they are still based on simplified mathematical relations. There are three procedures of that kind included in the exposition : method of simplified differential equation, modified Trost procedure and method of the idealistic modulus of elasticity, as well as their applicability on the exact example of the reinforced and prestressed concrete element.

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Keywords: shrinkage, creep, relaxation, approximate methods, centrally loaded pillar, prestressed structural element.

1. Introduction

In order to understand the behavior of a construction in the stadium of exploitation and the limit equilibrium state likewise, as well as laying the premises for their analyses, there are two characteristic features of concrete as a structural material, essential for being taken into consideration, defined as strength and its ability of deformation. For accurate evaluation of joint work between concrete and iron in reinforced and prestressed concrete structural elements, it is essential to examine their deformations first, due to the fact that deformations of concrete have got a substantial impact on construction deformations and strains, as well as stability and safety of constructions [1-22].

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2. Rheological properties of concrete

In terms of its rheological properties, concrete is a complex structural material. Generally, there are three kinds of deformations prone to emerge in concrete: elastic, plastic and viscous (viscoelastic and viscoplastic). In addition, there is another remarkable feature of concrete. That is its inclination to get mature and change its rheological characteristics over time. In general, the rheological features (contracting, yielding, relaxation) should be observed as the function of its structure, time, thermo-hygrometric and other parameters in relation to the material itself and its surrounding environment. However, put into practice, there is the tendency of applying the procedure based on using the objective experimental data, freed from extensive preoccupation with the physical and chemical properties of the phenomena and their manifestations. In this case,it is most accurate for deformations to be regarded in relation to the state of the strains, humidity of the surrounding environment, and some other influential factors as well, taking the structure and its characteristics into consideration only partially as minimally required.

It is doubtless that shrinkage and creeping of concrete have large influence on behaviour of reinforced concrete constructions and constructions under long – term influence over time. As deformations of concrete could reach twice or three times its initial value of deformations, the effects of concrete shrinkage and creeping are especially significant for the behaviour of concrete in the domain of exploiting states, when the initial states of strains and dilatations are in the domain of elasticity, so the initial elastic and its correlating viscoplastic dilatations are small.

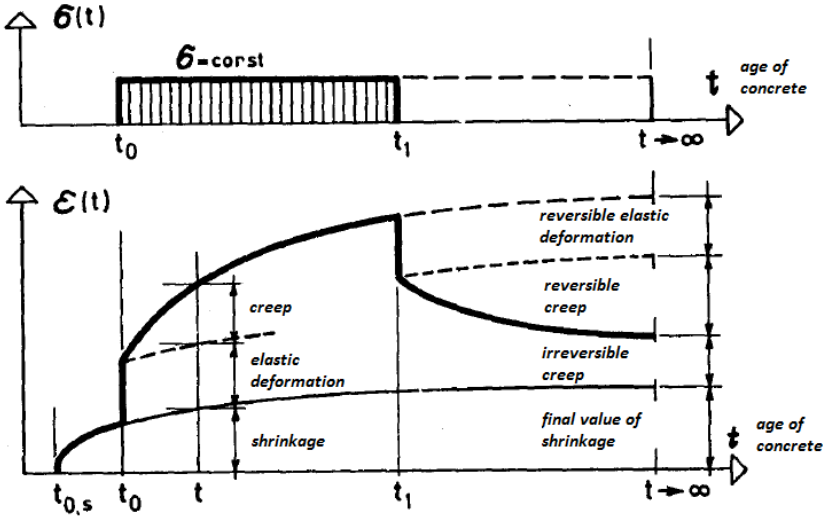

Fig. 1. Time – dependent deformations of concrete

The shrinkage of concrete represents downsizing of the volume of concrete due to the process of hydration of concrete. Deformation of concrete does not depend on the fact whether the concrete is under stress or not, but on the temperature of the surrounding environment, maturity and structure of concrete, as well as on the dimensions of the element (smaller dimensions - more extensive shrinkage). Deformation in total consists of shrinkage due to shrinkage of the products of hydration (hydrating shrinkage), shrinkage due to evaporation of water during the process of cement binding (plastic shrinkage) and shrinkage after the process of cement binding gets completed (hydraulic shrinkage).

The creep of concrete means enlargement of initial deformations during a period of time under the constant stress of pressure. This deformation depends on duration and size of deformation (long-term pressure in concrete), maturity of concrete at the moment of stress applicance, concrete composition (the features of cement - larger amount - increased creep), the characteristics of aggregate, the quantity of water in composition (higher water-cement ratio - increased creep), dimensions of the element (smaller dimensions - increased creep), humidity and temperature of the surrounding environment.

The chart (1) represents qualitatively expressed dilatations, where it could be noticed that shrinkage and creep of