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# Time-dependent Response of Composite Structures

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**Summary**

The paper deals with the procedure of numerical computational analysis of time-dependent response and redistribution of internal forces of a composite plane beam structure due to the rheology of material. Concrete creep is taken into account according to the linear theory of creep. The influence of concrete ageing and shrinkage is, similarly to the influence of concrete creep, considered by the adequate constitutive law of material.

## 1. Introduction

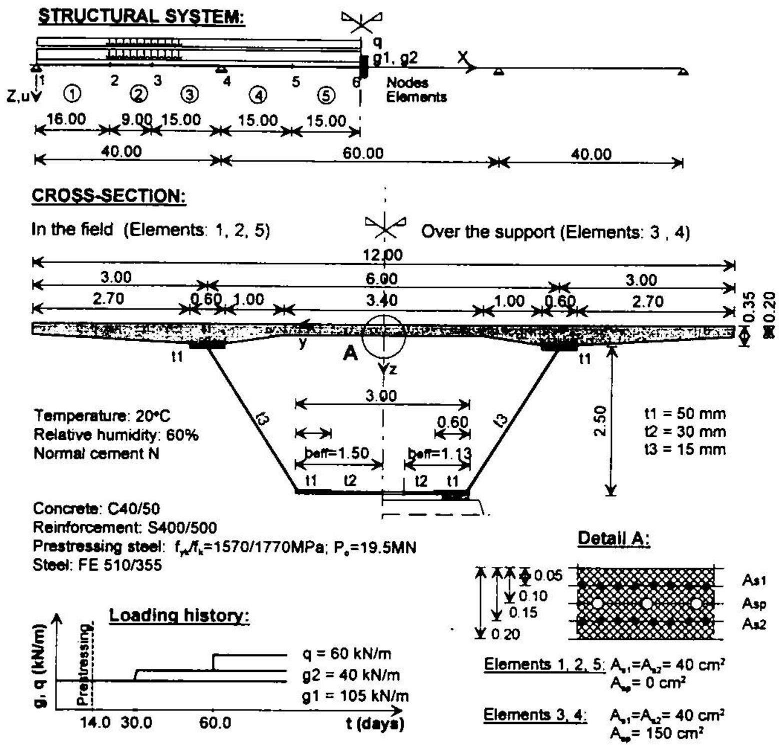
In order to make an adequate computational simulation of the behaviour of composite structures within time, it is necessary to consider also the influence of the rheology of material as well as the influence of cracks on the time-dependent response of the structure. Due to the rheology of material some extreme stresses appearing in the structure during the construction can decrease significantly after a certain time, but their influence on the strains or displacements of the structure often remains to a large extent the same. For this reason also the influence of gradual construction and the building technology have to be considered in the numerical simulation of the time dependent stress-strain relationship of structures.

## 2. Response of the Structure to the External Load

The time dependent response of the composite structure is simulated on a computer by using the finite element method. The geometrical nonlinearity of the structure is considered with adequate kinematic equations of the structure [1]. Physical nonlinearity and the rheology of material are taken into account using the adequate constitutive laws of materials. The influence of cracks on the behaviour of composite structures is taken into account by way of the constitutive equations of cross-sections [2, 3]. The time-dependent behaviour of the concrete according to the linear theory of concrete creep is modelled in the accordance with the well known constitutive law of concrete in its integral form. For the reinforcing steel, prestressing steel and profile steel of composed structures, a bilinear stress-strain diagram is taken into account.

The constitutive equations of the cross-section as the relationships between the internal forces, the elongation and the curvature of the element axis are obtained by the integration of the stresses through the whole composite cross-section consisting of concrete, reinforcing steel, prestressing steel and profile steel [2]. Bernoulli-Navier hypothesis is considered.

## 3. Computational Example




A composite bridge presented in Fig. 1 with spans of 40.0 + 60.0 + 40.0 m was analysed with the prepared software for the prediction of the behaviour of structures. The analysis takes into account concrete ageing, shrinkage and creep, relaxation of the prestressed steel and the influence of gradual construction. A part of the obtained results is presented on figures 2 and 3.

*Fig. 1: Computational example - composite box girder*

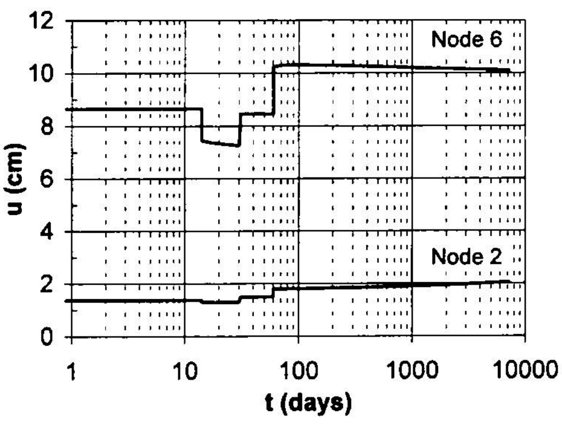



*Fig. 2: Deflections time-history*

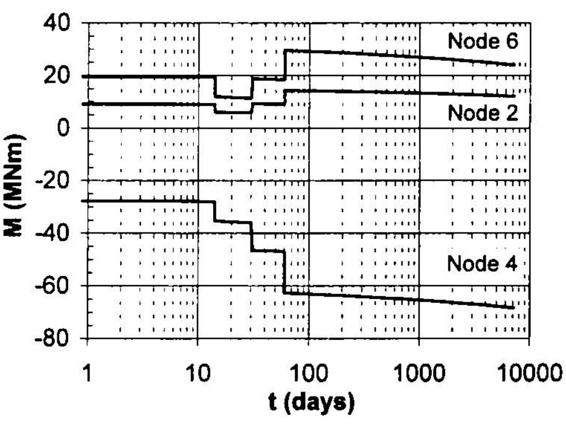



*Fig. 3: Bending moment time-history*

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