Biot-Bažant Conference, June 1-3, 2021
Northwestern University, Evanston, IL

Tridimensional long-term finite element analysis of reinforced concrete structures

G. Di Luzio[a*], L. Cedolin[a] and Carlo Beltrami[b]

[a] Politecnico di Milano, Milan, Italy
[b] Lombardi-Reico srl, Milan, Italy
[*] corresponding author: giovanni.diluzio@polimi.it

Abstract:

Accurate simulation of creep and shrinkage behavior is necessary for certain types of structures such as prestressed concrete bridges. In this type of structures the long-term deflections arise as difference between the downward deflections due to dead load and the upward deflections due to prestress that are very sensitive to the creep and shrinkage properties of the material. The characterization of these properties as functions of the composition and mechanical properties of concrete, adopted by national building codes and research organizations, leads in general to wide discrepancies in the predicted deflection curves. This is shown here applying the ACI (North-American) and Euro-code2 (European) building codes and the the RILEM B3 recommendation, to the concrete used for the construction in Romania of a box girder bridge which crosses a wide artificial channel that connects the Danube river to the port of Constanta in the Black Sea. For this concrete a series of short term creep and shrinkage tests were performed in the design stage and the results of these tests used to calibrate the parameters of the B3 model, whose formulation contemplates this possibility, obtaining a significantly greater accuracy of its predictions.

The four creep and shrinkage models so obtained were then implemented in a three-dimensional finite element model of the box girder bridge deck using a general procedure for a rate-type creep analysis (based on the use of the continuous retardation spectrum) which avoids the need of recalculating the Kelvin chain stiffness elements at each time step. The 3D finite element approach is capable of (1) representing the different shrinkage and drying creep in the cross-section and (2) capturing the effects of the shear lag, which gives rise to diffusive patterns for the support reactions at the piers and for the concentrated forces at the tendon anchorages. The predictions of the various models are compared in terms of deflections, prestress loss and stress state in the upper and lower part of the cross-section, showing the relevance of the short term creep and shrinkage tests.

In the presentation the main results and findings of a recent manuscript[1] will be shown.

[1] G. Di Luzio, L. Cedolin, C. Beltrami. (2020) *Tridimensional Long-Term Finite Element Analysis of Reinforced Concrete Structures with Rate-Type Creep Approach.* Applied Sciences, 10(14):4772.