PRESTRESS LOSSES IN CAST-IN-PLACE POST-TENSIONED BRIDGES: ANALYSIS AND COMPARISONS WITH DESIGN CODES

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ABSTRACT

Long-term prestress losses in concrete structures are caused by creep and shrinkage of concrete and relaxation of prestressing steel. Reasonably accurate prediction of these losses is important to ensure satisfactory performance of the concrete member under service loads. If prestress losses are underestimated, the tensile strength of concrete can be exceeded under full service loads, causing cracking and unexpected excessive deflection. On the other hand, overestimating prestress losses can lead to excessive camber and uneconomic design.

An analytical method is presented to predict the long-term prestress losses and the associated change in concrete stresses in cast-in-place post-tensioned bridges. It is assumed that prestress loading and bridge self weight are applied at the same time instant, and a single concrete type (same creep, shrinkage and modulus of elasticity properties) is used for the entire cross section. The long-term effects of concrete creep and shrinkage and relaxation of prestressing steel start gradually from the time of post-tensioning; shrinkage occurring before post-tensioning is ignored.

It is shown that long-term prestress losses calculated using the current provisions of bridge codes can be underestimated or overestimated, depending on the concrete creep and shrinkage properties as well as the non-prestressed steel ratio. On the other hand, the remaining concrete compressive stresses after long-term losses have occurred are normally overestimated when using current codes; this could result in unexpected cracking under additional live loads.

Keywords: creep; long-term; prestress loss; relaxation; serviceability; shrinkage