Strength assessment of prestressed concrete sections under the combined action of internal forces

Jaroslav Navrátil, Libor Michalčík, Filip Svoboda

ALLPLAN Česko s.r.o., Infrastructure Team, Brno, Czech Republic

Andreas Domaingo

ALLPLAN Software Engineering GmbH, Competence Center Allplan Infrastructure, Graz, Austria

Contact: jnavratil@allplan.com

Abstract

Nowadays a bridge design tool has to integrate all operations in the design process, such as architectural modeling, construction planning and management, structural analysis, member design, and detailing. An essential part of the member design is the assessment and proof of the safety of prestressed concrete sections based on national standards. Prestressed and reinforced concrete elements resist tensile and shear forces, bending, and torsional moments. The actions are coupled, and cracks occur due to tensile stresses. This results in a non-linear response of cross-sections. The complexity of the problem is multiplied by the arbitrary shape of the bridge sections. The objective of the paper is to describe a general method for the assessment of the resistance of reinforced and prestressed concrete cross-sections subjected to a coupled action of internal forces. The assumptions of the models adopted in the currently valid EN and AASHTO codes are analyzed, appropriate numerical methods are developed, and the resulting values of strength and response of the sections are compared for several examples.

Keywords: bridge; concrete; prestressing; reinforcement; cross-section; design; check; standard.

1 Introduction

The design process of a bridge can be divided into four basic stages. It starts from the first sketches and hand-calculations in the conceptual design stage, followed by the preliminary design stage to confirm the feasibility of the selected concept and the detailed design stage, in which static and dynamic analyses are performed, and it ends with the construction design stage, which provides step-by-step procedures, and the design of details with respect to the technology and experience of the contractor.

Design steps are more or less the same for all design stages. The engineer has to create a numerical model to design the geometry of prestressing tendons, perform the structural analysis, and produce production drawings. Preferably this model is based on a parametric description of the geometry to allow for easy modifications throughout the whole process.

All operations of the bridge design process must nowadays be provided in one design tool. An essential part of the member design is the assessment and proof of the safety of prestressed concrete sections based on national standards.