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# PERFORMANCE HIGHLIGHTS
## ALLPLAN BRIDGE CODE-BASED DESIGN

The Allplan Bridge Code-Based Design module is a complement to the Allplan Bridge Modeler and Allplan Bridge Linear Analysis. The structural model is automatically derived from the architectural model and the results from the structural analysis are the base for code-based design and checks. Once the relevant envelopes of combinations have been created the user can use the code dependent design tasks to determine the required reinforcement area. ULS and SLS checks can be performed once the reinforcement area has been calculated or manually specified. Allplan Bridge enables, that the user always gets easy, fast and economical design for any prestressed concrete bridge structure.

### LINEAR STRESS CALCULATION

The design of prestressed concrete bridges is governed by the level of prestressing. It is therefore essential, to carefully tune tendon profile and prestressing force. As the code-based checks are too complex, it would be rather cumbersome to use them directly to identify necessary amount of prestressing. That is why Allplan Bridge provides the calculation of linear elastic stress. By keeping the stresses within certain limits, the user can finalize the tendon profile and prestressing force. Linear elastic stress is calculated in all relevant fibers of cross-sections and in user defined stress points. The minimal and maximal stresses are calculated with respect to the transformed cross-sectional characteristics and the results of construction stage analysis. The user can plot the result in any desired way such as overall minimum and maximum in whole section or minimum and maximum in specified stress point. This allows the user to understand the behavior of the bridge better, to design pre-stressing force and tendon geometry, which enables easier fine-tuning of the structure. Linear stress calculation is code independent, therefore it can be used both for Eurocode and for AASHTO.

### REINFORCEMENT DESIGN

After fine-tuning of prestressing, Allplan Bridge can also be used to design the reinforcement area, which is necessary to satisfy all Ultimate Limit State (ULS) and some Serviceability Limit State (SLS) code-based conditions. The design of longitudinal and shear reinforcement uses the pre-defined reinforcement position to calculate the necessary area with respect to the acting internal forces and certain detailing rules (maximal area and minimal clear spacing between bars). The procedure enables not only to optimize the reinforcement area for several envelopes but can also consider the minimum reinforcement area given by the user and add additional reinforcement where needed. The goal is to provide the user with a simple process to determine the necessary area of longitudinal, shear and torsional reinforcement that fits into the section, passing all ULS checks and SLS crack width check. Furthermore, it covers multiple stages and respects all changes in the structure. The output is one simple sheet, that can be used by rebar detailers.

### ULS & SLS CHECKS FOR VARIOUS CODES

Allplan Bridge contains a module for the checks of the ultimate limit state of prestressed and/or reinforced concrete sections loaded in flexure with and without axial force, in shear and torsion, as well as the check of interaction of internal forces. Serviceability limit state conditions for stress limitation, crack width and decompression (guarantee of compression reserve) are checked considering the sectional dimensions and reinforcement designed verified in preceding steps.

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Checks can be performed at any time, during the virtual construction process or in the final state, with no limits in section shape and considering the effects of creep, shrinkage, and relaxation. Complete ULS and SLS checks are available for Eurocode, and flexure check calculation for AASHTO.
The check procedures use non-linear material stress-strain relationships; so, the user can achieve the most economical results.
The results of all checks are very visual and therefore, provide all information necessary for the engineer to get a clear view on the structural behavior. 2nd order effects of slender piers are analyzed using the method based on nominal curvature considering geometric imperfections and the effects of creep. Subsequently, the combination of normal force and biaxial bending is evaluated through the 3D interaction surface intersected with the resulting bending moment vector.
EN design for shear is based on the variable-angle truss model. The torsional resistance of a section may be calculated based on an equivalent thin-walled closed section. The parts of cross-section effective for the resistance in shear and torsion are defined automatically based on linear elastic shear stress distribution caused by unit loads $Q_z$, $Q_y$ and $T_x$. The effects of all components of internal forces may be superimposed and the interaction of $N_x$, $M_y$, $M_z$, $V_y$, $V_z$, and $T_x$ can be checked.
As concerning the EN code assessments, the serviceability conditions are often governing the cross-section design. Normal stresses and crack width due to service effects are calculated with the concrete ineffective in tension. EN crack width approach is extended into an innovative general method suitable for real-life bridge cross-sections. Arbitrarily shaped reinforced cross—sections are converted into local cracking zones, in which the area of effective embedment is determined. At the same time bar strain calculation takes account of the full section geometry.

## AUTOMATIC REPORT GENERATION

All results of the design and check procedures can be seen in the automatically generated text snippets related to the selected cross-sections and can be merged in a MS Word document. The snippets contain all relevant information about the design and the check respectively: for which cross-section, at which time the code-based design was performed, and the position in the structure where it was evaluated. In this way, the engineer can check and understand all the details of the calculations and assumptions given by the code and prove the correctness of the results.

**Current system requirements can be found at allplan.com/info/sysinfo**

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