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PERFORMANCE HIGHLIGHTS
ALLPLAN BRIDGE MODELER

Allplan Bridge Modeler is the powerful solution for four-dimensional parametric modeling of bridges. The software supports engineers in all planning phases, from the initial concept to the execution plan. The parametric description of the bridge model takes usability to a new level and allows engineers to work flexibly and quickly.

MODEL CREATION WITHOUT COMPROMISE

Allplan Bridge Modeler has been developed by recognized bridge experts – the Allplan Infrastructure team at Graz – and to the requirements of bridge engineers. The 3D parametric model description considers the road layout, bridge alignment and required cross-sections, making model configuration quick and efficient. Complex geometries including double curved alignment and variable cross-sections can be created easily with the help of alphanumeric entries and formulas. For example, the user only needs to define one typical cross-section and Allplan Bridge Modeler will accurately calculate all cross-section variants in accordance with the defined table(s) or/and formula(s). A complete 3D bridge model cannot be generated more easily or quickly.

CHANGES MADE IN NO TIME AT ALL

Allplan Bridge Modeler helps you to manage the inevitable changes that occur during the design process. The parametric model description is an ideal base for adapting design changes. The modifications are incorporated only at their origin and all other linked members are automatically updated. For example, if the road axis changes the complete bridge geometry will be adjusted. If only a certain structural member is modified only directly linked elements will be recalculated.

SAVE TIME WITH PARAMETRIC OBJECT PLACEMENT

Objects from the Allplan Engineering library can be referenced in Allplan Bridge Modeler to add further details such as lamp posts or anchor devices of tendons to the bridge model. To do this, reference points are defined in Allplan Bridge Modeler, using variables along the bridge. These points are linked to the object in the Allplan library using the respective name. When the parametric model is transferred to Allplan Engineering, the corresponding objects are positioned at these reference points. The position of these objects is automatically adjusted whenever the model is updated.

SMOOTH DATA EXCHANGE

Integrating road data used for road/bridge alignment is easily achieved via ALLPLAN's open BIM platform Allplan Bimplus. The bridge engineer must only take over the road data and can immediately start with the bridge design. To assist the engineer even further, the bridge model can easily be transferred to analysis software (such as RM Bridge by Bentley®) for structural calculations. Once the design is completed, the parametric model can be transferred in Allplan Engineering for completion of pre-stressing and reinforcement drawings.

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CONVENIENT OPERATION

Compared to mechanical engineering CAD software or traditional 2D drafting, working with Allplan Bridge Modeler is very convenient and specifically tailored to the requirements of bridge engineering. This leads to an essential optimization of the working speed. Furthermore, you can use Allplan Bridge Modeler on multiple monitors at the same time. Allplan Bridge Modeler automatically adapts its user interface to the screen size and resolution and is ideal for the use in powerful high-resolution monitors (4D/UHD with 3840x2160 pixels and more).

INTELLIGENT DATABASE

Allplan Bridge Modeler benefits from a built-in database that is continuously logging modifications as the project progresses. This will benefit projects that have a long design period by ensuring project data is securely available for the duration of the project.

INTEGRATION OF THE FOURTH DIMENSION

In Allplan Bridge Modeler it's possible to map the construction process in a 4D model. The construction plan is first divided into several construction phases and then into individual tasks such as concrete hardening, tendon stressing or activating the self-weight. The corresponding components are interactively assigned to the tasks. In this way, the temporal dimension is linked to the structure. With this information, the construction process can be graphically visualized. Thus, complex construction processes can be made transparent for all parties involved. It's also possible to create several different construction plans for the same bridge for a variant comparison. The result is a reliable parametric 4D bridge model. Once the construction is completed in Allplan Bridge Modeler, the model is transferred to Allplan Engineering, where further steps such as detailing, reinforcement and plan creation are carried out.

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TECHNICAL PREVIEW TO ANALYSIS: CALCULATION OF CROSS-SECTION VALUES

The calculation of cross-sectional values is an essential step in the generation of an analysis model. All cross-section values as well as the shear forces for the defined cross-sections are calculated automatically as soon as the corresponding calculation option is activated. This function is currently available as Technical Preview. All types and any geometries of cross-sections are supported. The stiffness matrix of the individual beam elements is automatically created considering the calculated cross-section values, beam geometry and material properties.

MODELING OF COMPOSITE AND STEEL BRIDGES

When defining the cross-section, standardized and repetitive profiles such as longitudinal stiffeners for steel and composite cross-sections can be easily positioned parametrically. The profile is first defined parametrically in a separate section or imported from the user library. The position and number of elements are then defined and automatically placed along a cross-section edge.

TECHNICAL SUPPORT FROM BRIDGE EXPERTS

ALLPLAN's bridge design experts have over 30 years' experience supporting engineers worldwide. ALLPLAN's clients can benefit from our technical experts providing comprehensive consultancy, training and support.

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PERFORMANCE HIGHLIGHTS
ALLPLAN BRIDGE PRESTRESSING

Allplan Bridge Prestressing is the powerful solution for four-dimensional parametric modeling of bridges. The software supports engineers in all planning phases, from the initial concept to the execution plan. The parametric description of the bridge model with the prestressing cables takes usability to a new level and allows engineers to work flexibly and quickly.

PRESTRESSING MADE SIMPLE

Allplan Bridge Prestressing makes it easy to model a wide range of types of pre-stressing: with immediate or later bond, internal and external, longitudinal, transverse and vertical, as well as with non-standard geometry. Based on user-defined 3D points, the program automatically generates the geometry of a tendon along the bridge structure. Each 3D Tendon point is specified by the position along the axis, and the position in the cross-section in relation to a reference point. In addition, direction angle and curvature radius of the tendon can be specified in each point. Selective parameters can be defined as variable. When calculating the detailed tendon geometry, the program determines these values automatically, using an intelligent algorithm minimizing the friction losses in the stressing process. A special point grid is available in the cross-section to ease the specification of the tendon position in the cross-section plane. This point grid facilitates copying and mirroring of the tendon in longitudinal and transverse direction.

CHANGES MADE IN NO TIME AT ALL

Allplan Bridge Prestressing helps you to manage the inevitable changes that occur during the design process. The parametric model description is an ideal base for adapting design changes. The modifications are incorporated only at their origin and all other linked members are automatically updated. For example, if the road axis changes the prestressing tendon geometry will be adjusted. If only a certain structural member is modified only directly linked elements will be recalculated.

PLANNING STRESSING SEQUENCES IN ALLPLAN BRIDGE

A stressing sequence can be defined for each tendon specified in the model. Stressing, wedge slip, and releasing are available actions. These actions are carried out at the begin of the tendon, at the end, or at both sides simultaneously. To optimize the management of tendon stressing, the sequences of stressing actions are stored as named "stress groups". The tendons are assigned to the corresponding group via Drag&Drop, and automatically stressed in accordance with the group definition. In addition, the values can be adjusted individually for each tendon.

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PERFORMANCE HIGHLIGHTS
ALLPLAN BRIDGE LINEAR ANALYSIS

Allplan Bridge Linear Analysis is the ideal complement to the Allplan Bridge Modeler. The parametric 4D model serves as the basis for the static calculation. The analytical model is automatically derived from the geometrical model. The automation accelerates the workflows enormously. Nevertheless, the engineer retains always full control. Furthermore, also loads are automatically assembled from the 4D model.

MATERIAL CATALOGUE (EURO NORM) IN ALLPLAN BIMPLUS

Allplan Bimplus is the open BIM platform for all disciplines to collaborate efficiently. In order to improve the collaboration a material catalogue is available. There are several different types of material at hand such as concrete, reinforcement steel, prestressing steel, etc. Each material contains the parameters required for structural analysis and several additional parameters. This allows the user to easily load the materials into the project, assign it to corresponding bridge part and perform the analysis.

SEMI-AUTOMATICAL GENERATION OF ANALYSIS MODEL

Allplan Bridge automatically generates the analysis model from the geometrical model. This greatly reduces the amount of work and the susceptibility to errors. Hereby the engineer retains full control by specifying structural parts and those ones which contribute as load only. One of additional analysis-relevant definitions is the choice of generating a beam or a grillage model.

ASSEMBLING CONSTRUCTION SEQUENCE CALCULATION

Allplan Bridge analyses the defined construction schedule and sets up all necessary calculation definitions in an automated process, like load cases, element activations and calculation actions. This includes input data for calculating non-linear time effects, like creep, shrinkage and relaxation. Complete transparency is granted, the user keeps full control of the generated items and an overview of the results at any time of construction.

AUTOMATED TENDON LOAD APPLICATION

The Analysis model for placing the tendons in the beam elements is generated from their defined position in space. The product analyses the exact position of the tendon in relation to the girder and assigns it automatically the corresponding beam elements with the relevant eccentricity values. Once the user specifies the point in time when the tendon is stressed the product generates automatically the corresponding load cases and calculation action and applies the load on the structure.

NONLINEAR TIME DEPENDENT MATERIAL EFFECTS

Based on the assembled input parameters describing the creep and shrinkage behavior of the concrete and relaxation of the pre-stressing throughout the construction phases, respective creep load cases are calculated for every time interval between relevant changes of the active structural system and/or loading state. The calculation is based on the formulas specified in the selected standard. A final creep load case covers the long-term effects arising during life time.

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SUPERIMPOSED DEAD LOADS DERIVATED FROM GEOMETRICAL MODEL

The weight and the position of superimposed dead loads (like sidewalk, road pavement, etc.) are automatically retrieved from the geometrical model. The user needs to specify the point in time of the equipment installation, and consequently the load is applied. Additional loads, such as temperature change or wind loads, can be defined and applied easily as well.

TRAFFIC LOAD DEFINITION

Traffic loads can be defined and applied in a very comfortable way. On one side, the traffic load is automatically applied in accordance with the selected standard. On the other side, the generic approach of live load definition implemented in Allplan Bridge allows the user to consider any type of moving load.

CALCULATION AND EVALUATION OF INFLUENCE LINES

With Allplan Bridge, the most unfavorable effects due to traffic loads can be determined quickly and easily. In the first step, the influence lines are calculated for each element and for all degrees of freedom. In the second step, the influence lines are evaluated with the corresponding load train (vehicle) and the results are stored as an envelope.

EARTHQUAKE LOAD

Allplan Bridge uses the multi-mode Response Spectrum Method for evaluating the effects of seismic loading. The solution consists of 2 separate tasks in the calculation procedur.

CALCULATION OF EIGEN MODES

The natural modes of the structure are calculated on the undamped system by determining the roots of the homogeneous equation system $[K]*u - \omega^2*[M]*u = 0$. A subspace iteration scheme according to Bathe is used to find the eigenvalues of this equation system and thus the natural frequencies ω and relevant displacement directions for computing the mode shapes. The eigen modes are normalized to a maximum displacement value of 1. They are saved to the database in order to allow for visualization and further evaluation tasks. In addition to the stiffness matrix also the mass matrix is required as governing parameter of the Eigen value calculation. It represents the oscillating masses of the structure. In Allplan Bridge 2021, the self-weights and superimposed dead loads as defined for the static load-case are automatically considered for calculating a consistent mass matrix. This ensures accurate results even with coarse element subdivisions. Any additional relevant masses can be easily defined by the user with their position and possible moment of inertia.

RESPONSE SPECTRUM ANALYSIS

In case of an earthquake, the actual extent of excitation of the different natural modes is dependent on the direction of the seismic waves (ground accelerations), the corresponding mass participation and on the damping behavior of the structure. The analytic solutions for typical structures and unit impacts are provided in the design codes as relevant response spectra, specifying the relevant proportionality factors for the individual eigenmodes dependent on the natural frequency. The calculated amplitudes related to the individual natural modes are superimposed using different methods described in literature. Allplan Bridge 2021 offers the ABS-method, the SRSS method, and the CQC method. Three separate calculations are provided to consider different possible earthquake directions, transverse, longitudinal and vertical directions. These different cases are combined to get finally the envelope of extreme values.

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COMBINATIONS

The table definition and visualization of the combination scheme allows for highest usability and perfect overview. The table form gives the user an overview not only of the defined load factors but also of different types of combinations. The combination type becomes an important attribute when the code-based design is performed. It allows specific design procedures for automatically using the corresponding combinations.

NEXT GENERATION SUPERPOSITION

The superposition in Allplan Bridge works very user-friendly . The schematic definition of the superposition combines maximum flexibility with optimal overview. It is possible to select several stress components in user-defined stress points and perform a stress leading superposition. Furthermore, the superposition allows for storing corresponding results for selected elements.

STRUCTURAL ANALYSIS

A global static analysis based on the Bernoulli beam theory is performed for all automatically and manually generated calculation actions defined previously in the construction sequence definition. The analysis is enhanced to accurately consider the cross-section variation. Furthermore, the non-linear calculation of time-dependent effects is performed, considering design code formulas.

ELEMENT & LOAD REMOVAL

Part of every construction process are temporary structures. In Allplan Bridge, the time as 4th dimension is considered when specifying the construction phases. New in this release is the possibility to consider these structures within the construction plan not only geometrically but also analytically. The product analyzes the defined construction schedule and assembles all necessary calculation tasks in an automated process, like load case definition, element deactivation, calculation actions and updating the summation load-cases.

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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.

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PERFORMANCE HIGHLIGHTS
ALLPLAN BRIDGE INTERNATIONAL

The Allplan Bridge International module is a complement to several local modules: Allplan Bridge Modeler, Allplan Bridge Pre-stressing, Allplan Bridge Linear Analysis and Allplan Bridge Code-based Design. The International module allows to use the product without any limitation in language and to use all standards for the code dependent calculations and load definitions. There are several code-dependent computations, like considering time dependent material behavior and all the design and check procedures. Furthermore, several templates for load application are available.

CREEP, SHRINKAGE AND RELAXATION ACCORDING TO JTG AND KOREAN STANDARD

Particularly important for the construction stage analysis of prestressed and reinforced concrete structures is the correct consideration of the time-dependent effects. In Allplan Bridge the calculation of creep and shrinkage of concrete and relaxation of prestressing steel is code-compliant and now also available for Chinese and Korean Standard.

CODE-BASED DESIGN

Allplan Bridge can be used to check prestressed and/or reinforced sections for resistance in flexure. Flexure checks are based on the calculated 3D interaction diagram (surface) intersected with the resulting bending moment vector based on the design normal force. Allplan Bridge can be also used to design the reinforcement content. The design of longitudinal reinforcement uses the defined reinforcement position to calculate the necessary area. Furthermore, the linear elastic stress in relevant fibers of used cross-sections can be also checked. All design procedures are code-based and with international module all future standards (currently only EN) are available.

LOADS

Additional loads, like temperature change, wind loads, settlement, loads due to braking and acceleration, traffic loads, etc. can be easily defined and applied at any time. These loads are code-dependent and in Allplan Bridge several templates are available. Currently there are templates for LM1, LM3 and centrifugal load according to EN. Especially centrifugal load is applied very comfortable; the user only needs to define the point of the load application and the sum of vertical loads. The product will automatically apply the correct load direction and final load intensity depending on the road curvature. Furthermore, the subdivision of the carriageway into notional lanes is also automized, the user needs to select only the parametric lines defining the carriageway.

LANGUAGES

Different GUI languages are available in Allplan Bridge: German, English, Russian, Chinese

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