CSiBridge® Version 21.0.0
Release Notes

Notice Date: 2018-12-20

This file lists all changes made to CSiBridge since the previous version. **Most changes do not affect most users.** Incidents marked with an asterisk (*****) in the first column of the tables below are more significant.

Changes from v20.2.0 (Released 2018-09-19)

Installation and Licensing
Enhancements Implemented

*	Incident	Description
*	222644	The version number has been changed to v21.0.0 for a new major release.
*	226703	Two changes have been made to the license levels available for CSiBridge v21: (1.) Staged construction load cases may now consider multiple stages and may also be sequenced in the "Plus" license level, whereas previously staged construction in the "Plus" level was limited to a single stage starting from zero. All other features remain unchanged as to their availability in the various license levels. (2.) The "Plus w/Rating" license level has been removed in favor of the three remaining levels: "Plus", "Advanced", and "Advanced w/Rating". Users with the "Plus w/Rating" level for CSiBridge v20 and older should contact the CSI Sales department for options to upgrade to CSiBridge v21.

Graphics
Enhancements Implemented

*	Incident	Description
*	30182	DirectX graphics mode has been enhanced for speed and functionality in drafting and display operations. DirectX is now the default graphics mode when the product is installed. Classical GDI+ graphics mode is still available for machines that do not adequately support DirectX. For capable machines, DirectX mode is faster than GDI+, particularly for 3-D operations.

Bridge Modeler
Enhancements Implemented

*	Incident	Description
	50909	The speed of creating the analysis model from a bridge object has been improved for the operation that creates the bridge and tendon loads. While the speed has been improved, this process can still be time-consuming. Results are not affected.
	204580	An enhancement has been implemented in Bridge Modeler in which the steel beam type and brace type cross diaphragms are now able to be assigned to a precast concrete I girder bridge.
	212187	An enhancement has been implemented to add an option to the Bridge Modeler to specify whether or not to offset solid-type bridge diaphragms at the abutments. Previously, solid-type diaphragms were always offset inward (longitudinally away from the ends of the bridge object) by half the thickness of the solid diaphragm, so that the edge of the diaphragm was located over the bearings at the abutments. Now the option is available to center the diaphragm over the bearings.

*	Incident	Description
	223298	The Bridge Modeler has been enhanced to allow bridge diaphragms to be located using the bridge layout line or any girder distance. Previously, staggered diaphragm locations could only be specified using the distance along one of the two adjacent girders. The new option makes it easier to align multiple staggered diaphragms consistently.
	223303	An enhancement was made to the Bridge Modeler for steel brace-type cross-frames (diaphragms) used in steel-girder bridge models where the diagonal and horizontal cross-frame members are now directly connected to the specified locations on the frame object that represents the connection plate when the specified elevation changes for the brace work points are not zero. Previously the cross-frame members were always connected to the top and bottom web-flange juncture points of the steel girder, and the elevation changes for the brace work points were accounted for using insertion points assigned to the cross-frame members. The new approach provides more realistic force and moment values in the cross-frame members, although the difference is usually small. Note that when connection plates are not included in the cross-frame definition, the previous modeling method will still be used. This enhancement only affects steel I-girder bridges updated as area-object models when the steel I-girders are modeled as area objects or mixed area/frame objects.
*	223914	The Bridge Modeler has been enhanced for more detailed modeling of brace-type steel cross-frames (diaphragms) to account for eccentric members, such as angles, channels, tees, and double-angles. Now an optional gusset plate thickness and location (before, after, or centered on the connection plate) can be specified, as well as the orientation and location of the horizontal and diagonal members. The orientation determines whether the long or short leg is vertical for angle sections, and whether the vertical leg points up or down for angles and double-angles. All members are assumed to be connected to the gusset plates, if present, else to the connection plates. Insertion points are calculated automatically for the horizontal offset due to the thickness of the connection and gusset plates, which can induce bending out of the plane of the diaphragm due to axial forces in the members. Vertically, the members are assumed to be located at their centroids, so that axial force does not induce bending in the vertical plane. Gusset plates are not explicitly modeled but are used only to determine the horizontal offsets.
*	226658	The Bridge Modeler has been enhanced so that all support-bearing properties (command Components > Substructure > Bearings) created by the modeler will be defined so that P-delta moments are carried as two equal moments at the top and bottom of the bearing. Previously the P-delta moment was carried as a shear couple across the height of the bearing. Using a shear couple sometimes produces unrealistic instability for buckling load cases and for nonlinear load cases that consider P-delta. Using two equal moments is more realistic for typical bearings and isolators that act like sliding surfaces. On the other hand, using a shear couple is more representative for tall, narrow bearings that can fail by tipping over. For support bearings where P-delta should be modeled as a shear couple, or as a mix of moments and a shear couple, you can define a link property with custom P-delta parameters and then reference that link property in the definition of the bridge support bearing. Models created in previous versions will not be changed when opened in the new version.

Loading

Enhancements Implemented

*	Incident	Description
^	71437 91559 92045 94251	Automated wind loading on bridge objects has been implemented for the following codes: AASHTO 2018, CSA S6-14, and Eurocode EN 1991-1-4. Wind load is calculated on the substructure (bent caps and columns), the superstructure, and on live load. Code-specific parameters are specified that describe wind forces as a function of height and exposed area. For the substructure, wind forces are calculated acting on the plane of the bent and along the bent. For the superstructure, wind forces are calculated on the projected length of the bridge object and its average depth, including barriers. Vertical wind forces are considered according to the chosen code. For the live load, wind forces are calculated on the projected length of the bridge object and a specified height above the superstructure. Wind forces on the substructure are applied directly to the bent caps and columns. Wind loads on the superstructure and on live load are applied as line loads on the top slab of the deck, with torques applied as necessary to account for the centroid of the bridge section and the height of the live load. Wind load is applied at a series of angles to the transverse direction of the bridge. These different angles are contained in a single load pattern and analyzed in a multi-step load case, which can be linear or nonlinear. Each step in the load case is independent of the others. The multi-step load cases can be included in load combinations for design.
*	76545	An enhancement has been implemented to generate spectrum-compatible time history functions by performing spectral matching in the frequency domain. The implementation adjusts the Fourier amplitude spectrum of the reference time history based on the ratio of the target response spectrum to the response spectrum of the reference history while keeping the Fourier phase of the reference time history fixed. Generated functions can be saved and recalled in the model file; exported functions cannot be imported but need to be re-created unless converted to user-defined before export.
*	76546	An enhancement has been implemented to generate spectrum-compatible time history functions by performing spectral matching in the time domain. The implementation adds wavelets to the reference time function such that its computed response spectrum matches the target spectrum across the whole frequency range while maintaining realistic velocity and displacement time series as well as preserving the non-stationary character of the reference time function. Generated functions can be saved and recalled in the model file; exported functions cannot be imported but need to be re-created unless converted to user-defined before export.
	223632	An enhancement has been implemented in the Bridge Modeler to allow user-defined concrete haunch loads to be specified as part of the bridge section definition for composite sections. The option for automatic (program-determined) haunch loads is still the default.

Analysis

Enhancements Implemented

*	Incident	Description
*	46215	The stiffness to be used for the nonlinear degrees of freedom (DOF) of link elements when running linear load cases can now be specified with more control. Previously the linear effective stiffness was always used for linear load cases starting from zero initial conditions, and the actual nonlinear stiffness existing at the end of a nonlinear load case was always used for linear load cases continuing from that load case. Now the following stiffness options are available for each nonlinear link property: (1.) "Effective stiffness", (2.) "Nonlinear stiffness", or (3.) "Effective stiffness from zero, else Nonlinear". The first option is most suitable for isolators where mode shapes and damping are to be calculated based on a specified secant stiffness, regardless of any preceding load case. The second or third options are more appropriate for gaps and other link properties where previous conditions do affect mode shapes, damping, and other linear behavior. When "Nonlinear stiffness" is chosen, the initial nonlinear stiffness is used rather than the effective stiffness for linear load cases starting from zero. This value is taken as zero for viscous dampers. To maintain the same behavior as previous versions of the software, use "Effective stiffness from zero, else Nonlinear", which is still the default. Note that geometric nonlinearity effects (P-delta and large deflections) are always included from a preceding nonlinear load case regardless of the option chosen. Linear link properties and linear DOF of nonlinear link properties are not affected by this enhancement.
*	46540	A new nonlinear multi-step static load case type has been added, similar to linear multi-step static load case. Multi-step load patterns, such as wave and vehicle loading, may be applied. The load case produces one or more output steps for each step in the applied load patterns. Any load patterns applied that are not multi-stepped are included in every output step. Each applied load step is independent and does not represent a continuation from the previous step. A nonlinear multi-step static load case may be continued from any nonlinear static, staged-construction, or nonlinear direct-integration time-history load case. Nonlinear multi-step static load cases may be used as the previous case for other nonlinear load cases or used as the stiffness case for linear load cases, although this may not have much usefulness since it uses the state corresponding to the final output step. In addition, linear multi-step static load cases have been enhanced to allow application of more than one simultaneous multi-step load pattern, selection of which load-pattern steps to apply, and control over how to synchronize multiple load patterns. These same features are available for the new nonlinear multi-step static load case.
*	66306	A modification factor for stiffness-proportional viscous damping to be used in direct-integration time-history analysis can be specified in the Link Properties Definition form. This modification factor is multiplied with the stiffness-proportional damping coefficient defined in the Time-History load case to compute the net stiffness-proportional damping coefficient to be used by the link element. This can be used to reduce or eliminate stiffness-proportional damping in a link element. In addition, the reference stiffness value to be used for stiffness-proportional viscous damping in nonlinear direct-integration time-history analyses can be specified for link properties with nonlinear degrees of freedom (DOFs). The stiffness options are: the initial stiffness, the tangent stiffness, or the effective stiffness of the nonlinear DOFs. To maintain the same behavior as in previous versions of the software, set the modification factor to unity and use the initial stiffness for stiffness-proportional viscous damping. This is still the default.

*	Incident	Description
*	222882	The behavior has been changed for time-history load cases that have one or more loads applied with non-zero time-history function values at the start of the load case. The behavior of such load cases has been made consistent to the following: (1) When a time-history load case starts from zero initial conditions or from a previous state that does not include any time-history load cases in its history, then any non-zero function values are ignored at the start of the load case. This includes all linear time history load cases. Note that pulse-type loads should always start at zero to avoid loss of load. (2) When a time-history load case starts from a previous state that includes a time-history load case in its history, then model is assumed to be in equilibrium with any non-zero time-history function values at the start of analysis. This allows a single time history to be split into multiple load cases, using different arrival times, without having to alter the time-history function. Because of these changes, results in the new version are expected to change for the following load cases when non-zero time-history function values are present at the start of the load case: (A) Nonlinear modal time-history (FNA) load cases when continuing from another FNA load case. (B) Nonlinear direct-integration time-history load cases starting from zero initial conditions or from a previous state that does not include a time history load case in its history (all ETABS, SAP2000/CSiBridge v20.1.0 and earlier). (C) Nonlinear direct-integration time-history load cases starting from a previous state that includes a time history load case in its history (SAP2000/CSiBridge v20.2.0 only).
*	223129	Several changes have been made to the iteration procedures for nonlinear static and staged-construction load cases to improve the consistency for measuring convergence. Most models will not be affected. A few models may run faster or slower, exhibit different convergence behavior, and/or may produce different results. These will primarily be models that are numerically sensitive. Changes described below that affect the absolute tolerance refer to the relative tolerance multiplied by the magnitude of the external applied load or the internal resisting load, whichever is larger. (1) The rate at which the absolute convergence tolerance can grow with increased substep size has been severely limited. Previously, when the substep size was greatly reduced to achieve convergence and then increased again during the remainder of the load case or stage, the convergence tolerance could grow large enough to allow significant equilibrium errors. This was not common. (2) The rate at which the absolute convergence tolerance can shrink with multiple steps or iterations has been severely limited for the case of small or negligible loads. Previously, the convergence tolerance could shrink with multiple steps, causing convergence failure in the absence of applied load. The converge tolerance can still shrink as needed during iteration under significant loading. (3) Iteration may be curtailed before the iteration limit is reached, and the step-size reduced, when the relative unbalance is not reducing fast enough. This effect becomes more pronounced as the number of iterations approaches the iteration limit for each step.

Bridge Design

Enhancements Implemented

*	Incident	Description
^	222581	An enhancement has been implemented that adds bridge superstructure rating according to the "AASHTO Manual for Bridge Evaluation (MBE) 3rd Edition". This is referenced in the software as "AASHTO Rating 2018", and is an update to the existing "AASHTO Rating 2010" with Interims for 2011, 2013, 2014, and 2015, which are all still available. AASHTO rating can be applied to bridge models using the following types of bridge sections: concrete box girder, precast-concrete I-girder and U-girder, concrete slab (service check), steel I-girder, and steel U-girder. Strength and service checks are available, depending on the section type.
^	222582	An enhancement has been implemented to add new service checks for AASHTO bridge rating for the concrete box girder, multi-cell concrete box girder, precast-concrete I and U-girder, and flat slab bridge sections.

*	Incident	Description
*	222584	Bridge superstructure design has been enhanced for all codes and design/rating requests that use live-load distribution factors (LLDF) for the following situation. Previously, when LLDF was used for area (shell) or solid models of composite bridge sections, and when nonlinear staged-construction analysis was performed that accurately captured the distribution of cast-in-place slab dead loads onto the beams (bare girders), the LLDF algorithm was still distributing all the non-live loads onto the full cross section, therefore losing any history of stresses accumulated in the beam throughout its non-composite and composite stages. In the new algorithm the non-live load stresses will be averaged separately on all the beams first and then on the slab only, thus preserving the history of the stresses accumulated in the beams and in the slab. This change affects all design and rating requests for precast-concrete I-girder and U-girder, steel I-girder and U-girder bridge sections for all codes that consider LLDF. Note that the most accurate stress values will be obtained by choosing to use actual stresses from analysis rather than using LLDF.
*	224884	An enhancement has been implemented to add a new bridge superstructure design request to check principal stresses for precast-concrete girder composite bridge sections according to the AASHTO code, all versions. Principal stresses are checked at the top and bottom of the web and at the neutral axis of the precast girder itself.

Results Display and Output
Enhancements Implemented

*	Incident	Description
*	12706 82048	An enhancement has been implemented to the response output for Generalized Displacements. Absolute and relative displacements, velocities, and accelerations will be available for all Generalized Displacements and results presented in the Tables.
^	100795	An enhancement has been implemented to allow defining and saving of the settings on the bridge response display form as named plots. This allows quick retrieval of saved options on the form for viewing results. The plots associated with these named settings can now also be included in reports.
	221241 223573	An enhancement was implemented to show only the active structure when creating multi-step animation videos of staged-construction load cases, which may change from stage to stage as objects are added and removed. Previously the video always showed the structure as displayed in the present model window when the command File > Create Video was invoked.
	226530	An enhancement has been implemented to allow animating the deformed-shape display of a multi-stepped load case or combination through a specified sequence of steps. The animation is performed directly in the model window, separate from the existing feature to create animation files.

External Import/Export
Enhancements Implemented

*	Incident	Description
*	98954	An enhancement was made to add functionality to export the model to a file in STL format. The settings for this file are taken from the current view window. The graphics mode must be set to DirectX, and the view must be in 3D. This file can then be used for 3D printing of the model.

Application Programming Interface (API)
Enhancements Implemented

*	Incident	Description
*	221919	The Application Programming Interface (API) has been updated in two significant ways. (1.) Starting with Version 21 of CSiBridge, the API library no longer has the program version as part of its name. So, while the name of the API library for CSiBridge version 20 was CSiBridge20.DLL, the name of the API library for CSiBridge version 21 is CSiBridge1.DLL. The name of the API library will remain CSiBridge1.DLL , even as new major versions of CSiBridge are released. Since improvements will continue to be added to the API, a new function, cHelper.GetOAPIVersionNumber, has been added. This API version number will increment as new API functions are added. However, the API library name will remain CSiBridge1.DLL. Once users reference the new CSiBridge1.DLL in their client applications, they will no longer need to update with every major release. The CSiBridge1.DLL reference in their client application will automatically use the latest edition of CSiBridge1 that is registered with each product installation. (2.) In addition, a new API library, CSiAPIv1.DLL, has been introduced. This library is compatible with SAP2000, CSiBridge, and ETABS. It will be available with all new versions of each product. Developers can now create API client applications that reference CSiAPIv1.DLL , and connect to either SAP2000, CSiBridge, or ETABS, without any code changes required.

User Interface
Incidents Resolved

*	Incident	Description
	224336	A change was made to hide the thermal properties input for material property definitions as the thermal properties are not currently used in the software.
*	224872	An incident was resolved where an abnormal termination of the software could occur in the Define Bridge Section Data form after performing the following two steps: (1) In the Loads tab, set the load pattern to be "None" for either Barriers or Sidewalks, and click OK to exit the form; (2) Go back to the Define Bridge Section Data form, Loads tab again and try to change all other load patterns (except Barrier and Sidewalk loads). This was an interface issue and did not affect results.

Graphics
Incidents Resolved

*	Incident	Description
	82562 207055	An Incident was resolved where the Named Views and Named Displays were not working correctly for DirectX graphics mode, producing different views than expected. This was a display issue only, and no results were affected. This issue did not affect Named Displays when working in GDI+ graphics mode.

Bridge Modeler

Incidents Resolved

*	Incident	Description
	214949	An incident was resolved for the Bridge Modeler where the operations available on the Move Prestress Tendon form were not working correctly, copying or moving the tendon to the same location without applying the specified offset. The Move Prestress Tendon form is called from the "Add Copy of Tendon" button on the Assign Prestress Tendon form, or from the "Move Tendon" button on the Bridge Tendon Data and the Tendon Vertical/Horizontal Layout Data forms. This error affected versions 19.2.0 to 20.2.0. Results were consistent with the model as generated.
	225598 225602	An incident was resolved in which tendons were included in girder, section, and mixed bridge groups when not desired. Now only tendons that are defined inside of precast I-girder frame section properties will be included in such groups.

Loading

Incidents Resolved

*	Incident	Description
	218216 221231	An incident was resolved where the tendon forces when the tendon is stressed from both ends could be incorrect. This happened in rare cases when the seating losses were high compared to the other instantaneous losses usually on short tendons. When this happened, the calculated forces were the same as if the tendon was stressed only from the start end.
*	214498	An incident was resolved for the Bridge Modeler where bridge loads (point, line, area) defined as part of the bridge object might not have been applied to the bridge slab if the bridge object had non-zero superelevation. In such cases, the load would act on a bridge girder or other bridge component, such that the total load acting on the structure was correct, even though the distribution was not as expected. For staged-construction load cases where the bridge load was in a load pattern applied to a group containing only top slab objects, a portion of the expected load could be missing. This error did not affect bridge objects with zero superelevation.
*	223556	An incident was resolved where the bracket loads used in the staged-construction “Pour Concrete” operation were calculated incorrectly for user-specified permanent and temporary concrete construction loads. They were too small by a factor of 0.5. The bracket loads due to the concrete slab itself were calculated correctly. The “Pour Concrete” operation is available for bridge object with steel I-girder, steel U-girder, and precast concrete I-girder bridge sections. Bracket loads only apply to the portion of the “Pour Concrete” load outside the exterior girders.

Analysis

Incidents Resolved

*	Incident	Description
	221172	An incident was resolved where nonlinear analysis of models containing triple-pendulum isolators could fail to converge if the isolators went into axial tension. This occurred because the locations of the internal components of the device become undefined when there is no compression to keep the multiple surfaces in contact. Now a small, fictional internal transverse stiffness is assumed to provide definiteness in the presence of tension so that convergence can be more readily achieved. However, analysis results can still be numerically sensitive when the isolators go into tension, depending upon the stiffness characteristics of the isolators themselves and the rest of the structure. Engineering judgment is required to determine if tension is acceptable for these devices.

Bridge Design
Incidents Resolved

*	Incident	Description
*	223361	An incident was resolved for bridge superstructure design for the Eurocode where evaluation of LambdaW used in shear resistance per EN 1993-1-5 Section 5.3 incorrectly used fy,d in the formula for epsilon. In the revised algorithm the fy value is used instead. Typically this corrected algorithm results in higher values of LambdaW and lower values of Vbw,Rd. This affects Eurocode superstructure design "Steel I Comp - Ultimate" and "Steel U Comp - Ultimate" design requests.
*	224009	An incident was resolved for the superstructure design of steel I-girder bridges per the AASHTO code where the controlling value of the flange lateral bending stress, fl, within the unbraced panel length could have been underestimated. Previously, the combined effects of flange lateral bending stress and vertical bending stress were limited to cases where both were maxima or both were minima within the unbraced length. Now all possible combinations of maximum and minimum of both flange lateral bending stress and vertical bending stress are considered within the panel, leading to selection of highest absolute value of fl within the unbraced panel length that is later used for combination with flange vertical bending stresses. This change was made to comply with AASHTO LRFD requirement to effectively handle the flanges as equivalent beam-columns. The results for the new version may result in a reduced capacity of the section for certain models. This change affects the "Steel I Comp Service" design check for the AASHTO LRFD code, all versions. Models that could be affected should be re-verified.
	224115	An incident was resolved where the unbraced length calculated for a steel I-girder bridge could be incorrect for design if the steel I-girder being designed was non-prismatic, with a stepped section transition, and a section cut due to all-space (full width) diaphragm was near but not right at the stepped transition. In this scenario the all-space diaphragm could be incorrectly ignored when determining the girder unbraced length. Bridge design results for flexural and shear design requests could be affected by this error. Results were conservative since the unbraced length calculated and reported was too long. Analysis results were not affected.
	225377	An incident was resolved for the design and rating of steel U-girder bridge sections in which the U-girder interior diaphragms were incorrectly being ignored when calculating the girder unbraced length. This could cause the results to be overly conservative for constructability checks when the status of the slab was non-composite. This error affected the "Steel U Comp - Constructability" design and rating requests for all codes.

Results Display and Output
Incidents Resolved

*	Incident	Description
	219865	An incident was resolved where in rare cases the maximum value of displacement reported in the status bar when viewing displacement contours would be higher than the real value. This happened when there were no frames in the model, cubic curves were turned on and edge constraints were used to join irregular meshing. This was a display issue only. No results were affected.
	222312	An incident was resolved where the Bridge Object Response Display form would sometimes produce a blank response plot for concrete box-girder bridges modeled as solid objects. This could occur when the bridge section had one or more zero-length fillet dimensions. This was a rare case, and no results were affected.

*	Incident	Description
	224117	An incident was resolved where the section-cut objects could be incorrectly shown when selected from the Bridge Object Response Display form when there were staggered diaphragms, splices, or section transitions in a steel I-girder bridge model and the model was updated using the option “Mesh Slab at Critical Steel I-Girder Locations” to have local girder section cuts. In this case, the wrong section cuts could be displayed using the the “Show Cut” feature when the results were displayed for the Entire Bridge Section. This error did not affect the section cut displayed for individual girders. Note that this was a display issue for showing the section cut in the model window and did not affect any analysis results.
	224889	An incident was resolved where an error could occur when generating a report using a report contents XML file that contained table items that were not populated when generating the report. This was a report generation issue and did not affect results.
	226323	An incident was resolved for bridge superstructure design and rating of steel U-girder bridge sections using the AASHTO code where a reference to AASHTO Section 6.11.2.2 has been corrected when checking top flange section proportions for steel U-girder sections. The algorithm was using the correct AASHTO code section for U-girders, only the reference in the output table listed the incorrect AASHTO code section (6.10.2.2 for I-girders). This had no impact on the design or rating results. No results have changed. This affected all versions of AASHTO LRFD design and rating requests for steel U-girder bridge sections.

Database Tables
Incidents Resolved

*	Incident	Description
	222738	An incident was resolved where the database tables defining the input parameters for AASHTO bridge design requests were sometimes not displayed or exported when two or more design requests were defined, depending on the types of design requests present in the model. This error did not affect analysis or design results. However, in cases when these tables were not being exported, re-importing the model would reset the input parameters of the affected design requests to their default values.

Data Files
Incidents Resolved

*	Incident	Description
	223888	An incident was resolved where importing a model via text, XLS, or MDB file that contained a direct integration time history load case definition would enable additional modal damping in the load case if not previously defined. This could cause a change in results, but the results were consistent with the load case definition.
*	225233	An incident was resolved where the shear area for pipe sections imported from .PRO files was incorrect for the following section libraries: AISC13, AISC13M, AISC14, AISC14M, AISC15, AISC15M, AISCLRFD2, APSCLRFD3, ASTM A1085, AusNZ8, CISC9, CISC10, Euro, Nordic. Analysis results were based on the imported shear areas as shown in the frame section definitions. The effect was generally small.