SAP2000® Version 21.0.0
Release Notes

Notice Date: 2018-12-20

This file lists all changes made to SAP2000 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)

Drafting
Enhancements Implemented

*	Incident	Description
	223383	An enhancement has been implemented to allow specifying the local axis rotation angle in the Properties of Object box when drawing line objects.

Graphics
Enhancements Implemented

*	Incident	Description
*	70198	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.

Modeling
Enhancements Implemented

*	Incident	Description
	225502	An enhancement has been implemented to allow adding a copy of a load pattern.

Loading
Enhancements Implemented

*	Incident	Description
*	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.

*	Incident	Description
*	212208	An enhancement has been implemented to add auto wind loading according to the SP 20.13330.2011 code, using the static methodology.
	224515 224960	An enhancement was made to distribute the user defined seismic loads on diaphragms to the joints in the diaphragms in proportion to the mass at each joint. Previously the seismic load was distributed to only a few joints of the diaphragm. This does not affect overall structure behavior, but will affect diaphragm behavior when the diaphragm is declared as semi-rigid.
	225200	An enhancement was implemented to incorporate Amendment 1 to NZS 1170.5-2004 for the response spectrum function and the equivalent static seismic loading.

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.
*	46539	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.

*	Incident	Description
*	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.
*	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.

Frame Design

Enhancements Implemented

*	Incident	Description
	94546	An enhancement has been made to expand the design details reporting for concrete frame design according to the Russian SP 63.13330.2012 code.
	212165	An enhancement has been made to the Russian steel frame design code SP 16.133330.2011 in which the program now allows additional input parameters for the slenderness limit check for compression and tension members per SP 16.13330.2011 section 10.4.1 and Tables 32 and 33. For compression members, the limit for slenderness ratio KL/i (or Lambda = lef/i) is taken as follows: Lambda < KLoverRLimitC - KLoverRLimitSlope * Alpha, where Alpha = max {N/(Phi*A*Ry*Gamma_c), N/(Phi_e*A*Ry*Gamma_c), 0.5}. The program allows input for KLoverRLimitC and KLoverRLimitSlope in the overwrites. By default, the program takes the value of KLoverRLimitC as 180 for columns, 210 for braces, and 150 for beams; and takes the value of KLoverRLimitSlope as 60 for columns, 60 for braces, and 0 for beams. For tension members, the limit for slenderness ratio l/i (or Lambda) can be assigned one value in the overwrites. The default value for the limit for slenderness ratio l/i is taken as 300 for columns, 400 for braces, and 300 for beams.
*	219676	An enhancement has implemented to add the new Turkish TS 500-2000(R2018) concrete frame design code, including seismic design requirements.
*	224700	An enhancement has been implemented to add concrete frame design for the Mexican Building Code (Mexico RCDF 2017).
	224989	An enhancement has been made to the Russian steel frame design code SP 16.133330.2011 in which the program now considers an additional parameter for seismic factor, m_tr, per Table 6 of SP 14.13330.2014 only when the design load combination contains an earthquake load case. For strength design/check, its value is taken as 1.3. For buckling design/check, it is taken as 1.0 for steel frame members with slenderness more than 100, 1.2 for steel frame members with slenderness less than 20 and interpolated between 1.2 and 1.0 for steel frame members with slenderness ratio between 20 to 100. This value cannot be modified by the user using the preferences or overwrites.
	224990	An enhancement has been made to the Russian steel frame design code SP 16.133330.2011 in which the program now allows additional input parameter for the criticality safety factor, Gamma_n, in the Preferences form. Its default value is taken as 1.0. However, the users can change it to any positive value they want. By increasing the criticality safety factor Gamma_n, the design force values are practically increased. The PMM interaction ratios are directly related to this factor.
	224992	An enhancement has been made to the Russian steel frame design code SP 16.133330.2011 in which several preference and overwrite items have been removed from the Preferences and Overwrites forms. These include “Framing Type”, “Section Class”, and “Live Load Limit, L/” from the Steel Frame Design Preferences form. These also include “Framing Type”, “Section Class”, “Live Load Limit, L/”, “Live Load Limit, Abs”, “Effective Length Factor Braced (K1) Major”, and “Effective Length Factor Braced (K1) Minor” from the Steel Frame Design Overwrites form. All of these parameters were not used in the design. The corresponding items have been removed from the API and Database.
*	225852	An enhancement was implemented to add the new Australian AS 3600-2018 concrete frame design code.
*	225853	An enhancement was implemented to add the new Korean KBC 2016 concrete frame design code, including seismic design requirements.
*	225854	An enhancement was implemented to add the new Korean KBC 2016 steel frame design code, including seismic design requirements.

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.
	94320	An enhancement has been made to expand the design details reporting for concrete frame design according to the Russian SP 63.13330.2012 code.
	221241 223573 225141	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.
	226345	An enhancement was implemented to improve the capacity and speed of the import and export of CIS/2 STEP files.

Data Files
Enhancements Implemented

*	Incident	Description
	226914	An enhancement has been implemented to update the New Zealand material library for the latest material standards. The library now also contains aluminum, cold-formed, and tendon materials.

Application Programming Interface
Enhancements Implemented

*	Incident	Description
*	221919	The Application Programming Interface (API) has been updated in two significant ways. Starting with Version 21 of SAP2000, the API library no longer has the program version as part of its name. So, while the name of the API library for SAP2000 version 20 was SAP2000v20.DLL, the name of the API library for SAP2000 version 21 is SAP2000v1.DLL. The name of the API library will remain SAP2000v1.DLL , even as new major versions of SAP2000 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 SAP2000v1.DLL. Once users reference the new SAP2000v1.DLL in their client applications, they will no longer need to update with every major release. The SAP2000v1.DLL reference in their client application will automatically use the latest edition of SAP2000v1 that is registered with each product installation. 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.

Documentation
Enhancements Implemented

*	Incident	Description
	97495	Concrete and steel frame design manuals have been updated for CSA A23.3-04, CSA A23.3-14, CSA S16-09, and CSA S16-14 codes to incorporate snow loading within auto-generated load combinations. These combinations were already implemented in the software. This is a documentation change only and no design results are affected.

Installation and Licensing
Enhancements Implemented

*	Incident	Description
*	222643	The version number has been changed to v21.0.0 for a new major version release.

User Interface

Incidents Resolved

*	Incident	Description
	100606	An incident was resolved where the user specified maximum and minimum contour range values were either not saved or saved inconsistently when the form was closed by clicking the OK button, resulting in unexpected values in these input fields when opening the form subsequent times. This was a user interface issue only and did not affect results.
	222100	An incident was resolved in which the joint restraints and springs options on the Display Options form were always checked when the form was opened, even if they were previously unchecked and the OK or Apply buttons were clicked. This was a user interface issue only and did not affect results.
	222774	An incident was resolved where when viewing the deformed shape, the animation button was not visible when links with zero property assignments were present. In some cases, this also affected the display of the deformed shape itself.
	223421	An incident was resolved where the notes on tendon and cable property definitions were not recovered when the property definition was reviewed using the modify/show option. This was a user interface issue only.

Graphics

Incidents Resolved

*	Incident	Description
	85441 101864 216359 217554 224223	An incident was resolved where several minor issues with area displacement contours in DirectX graphics mode were resolved. These related to animation, contour legend, point of view after zooming, diagram scaling and speed of results. These were all display issues and no results were affected.
	203602	An incident was resolved to automatically resize symbols (axes, links, restraints) when zooming in DirectX graphics mode.

Loading

Incidents Resolved

*	Incident	Description
	222347 223083	An incident was resolved for the ASCE 7-16 response spectrum function where the coefficients Fa and Fv were not interpolated correctly for Site Class D and E.

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.

Frame Design
Incidents Resolved

*	Incident	Description
	90321	An enhancement has been made to the Russian steel frame design code SP 16.133330.2011 in which the interaction equation as stated in equation (44) of section 8.2.1 is now checked as a PMM interaction equation. This involves the determination of elastic normal and shear stresses, calculation of von-Mises stress, and then checking the von-Mises stress with (Ry*Gamma_C)/0.87. The results are now reported in the details window as a separate page for "Equivalent Stress Check Details".
	224986	A change was made in concrete frame design per the "SP 63.13320.2012" code on how load combinations are to be tagged as long-term loading. Previously all load combinations which had lateral loads (seismic or wind) were tagged as short-term, and all the remaining combinations were tagged as long term. Now those load combinations that contain only sustained load are called long-term load combinations. All dead load and superimposed dead load cases are considered sustained. All wind load and earthquake dead load cases are considered short-term. All live load cases will be considered as sustained if the “Live Load Duration Factor” is 1.0. If the “Live Load Duration Factor” is less than 1.0, any combination involving live load will not be considered as long-term. Similarly, all snow load cases will be considered as sustained if the “Snow Load Duration Factor” is 1.0. If the “Snow Load Duration Factor” is less than 1.0, any combination involving snow load will not be considered as long-term. These two parameters can be modified in the Preference. Tagging a load combination as short-term or long-term effects the factor Gamma_b1, which in turn affects the design values of the compressive and tensile resistance of concrete, Rb and Rbt. In addition to this change, the “Gamma_b1 Short Term” parameter is deactivated from the preferences menu as this value must always be 1.0 (unity). The Gamma_b1 is now reported in the details correctly.
	224987	An incident was resolved in the Russian concrete frame design code SP 63.13330.2012 in which the limiting strain epsilon_b2 was not reported correctly. The short-term limit concrete strain was determined using p.6.1.20 SP63 which was correct for both concrete beams and columns. This was a display problem only.
	224988	An incident has been resolved in the Russian concrete frame design code SP 63.13330.2012 in which the Qb seemed too large compared to Qsw.

Results Display and Output
Incidents Resolved

*	Incident	Description
	223640	An incident was resolved where the Display Frame Forces/Stresses form did not allow selection of stress points 9 thru 16 when displaying stress on frame elements. This was a user interface issue only and did not affect results. All stress point results were available via the database tables.
	223826	An incident was resolved in which joint reactions were not able to be displayed when only the joints were in view. This was a display issue only and did not affect results.

Database Tables
Incidents Resolved

*	Incident	Description
	221821	An incident was resolved where modifying a linear or nonlinear modal time history load case using the interactive database could result in an error when trying to apply changes.

External Import/Export
Incidents Resolved

*	Incident	Description
	221710	An incident was resolved which affected the export to CIS/2 files of models with edge constraints. Models with edge constraints could not be exported at all. Deleting all edge constraints from the model made it possible to export the model and did not change the resulting CIS/2 file since edge constraints are not exported to CIS/2 files. Models with edge constraints can now be exported.

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 shown in the frame section definitions. The effect was generally small.
	226336	An incident was resolved where an auto select section assigned to a line object during certain import/editing/drafting operations may have been incorrectly identified internally, causing problems with the model. This was a rare occurrence. Auto select sections assigned after a line object had been added were not a problem.

Application Programming Interface
Incidents Resolved

*	Incident	Description
	222706	An incident was resolved in the API function cAreaObj.GetSpring in which an error would occur and properties were not retrieved when the area had a spring assignment in which the spring direction was defined with a user specified direction vector based on the area object local axis.

Documentation
Incidents Resolved

*	Incident	Description
	222682	An incident was resolved in which the API documentation did not have a complete list of the response spectrum function codes.
	225126	An incident was resolved in the API documentation where the name for the New Zealand steel design code used NSZ instead of NZS. This was a documentation error only.