SAP2000 v23.0.0 Release Notes

© 2021 Computers and Structures, Inc.

Notice Date: 20-January-2021

This document lists changes made to SAP2000 since v22.2.0, released 20-October-2020. Items marked with an asterisk (*) in the first column are more significant.

Analysis
Enhancements Implemented

*	Ticket	Description
*	5433	An enhancement has been made to speed-up the recovery of the 'Element Nonlinear Energy By Group' and step-by-step 'Base Reactions' response tables for load cases with a large number of output steps.
*	5615	An enhancement has been made to speed-up the stiffness solution by parallelizing the global stiffness assembly phase when using the Advanced or Multi-threaded Solver options. This should increase the speed of nonlinear static, nonlinear multi-step static, and nonlinear direct-integration time-history load cases for medium-sized models, especially when using Newton-Raphson iteration and/or event-to-event stepping.
	5637	An enhancement has been made to speed-up nonlinear stiffness formation, event determination, and state update operations for small to moderate sized models where the number of frame and/or link elements are less than 10 times the number of requested analysis threads.
	5638	An enhancement has been made to speed up initialization and finalization of the analysis process when running cases in parallel. This should significantly reduce the time between the completion of a parallel load case and the start of the next parallel load case in the queue, especially for models with multiple nonlinear cases having many saved steps.
	5784	A new Summary tab has been added to the Analysis Monitor form that displays the status for all cases that are set to be run in parallel. The status can be running, scheduled, or completed.

API
Enhancements Implemented

*	Ticket	Description
*	4146	An enhancement has been implemented to add access to the database tables through the API.

Data Files
Enhancements Implemented

*	Ticket	Description
*	5482	An enhancement was made whereby frame section libraries in XML format were added to the program for importing sections. The enhancement is intended to allow users to customize and/or create their own section database(s) without relying on any external utilities. The capability to read the section libraries in binary format (.PRO files), although still available, will be phased out in the near future. For users who have created their own PRO libraries, a utility is available that can be used to convert the PRO libraries to XML format. API functions have also been revised to allow users to import frame section from XML libraries.
*	5862	Starting with SAP2000 v23, the components necessary to open v16 and older models are no longer shipped with the installation in order to adhere to requirements set out by Microsoft for app certification. The necessary components are now provided in the CSI Knowledgebase with instructions on how to install them.

Database Tables
Enhancements Implemented

*	Ticket	Description
	5436	An enhancement has been made to the design result data table for AISI 2016 cold-formed steel design to display design results for minor-axis bending of pipe sections, consistent with the major-axis bending.

Design – Aluminum Frame
Enhancements Implemented

*	Ticket	Description
	4863	An enhancement has been made to remove the old aluminum frame design codes AA LRFD 2000 and AA ASD 2000. Old models opened in v23 will be updated to use the new AA 2015 code.
	5410	An enhancement has been made to utilize the lateral bracing option in the design menu for the design of aluminum frames according to AA-2015. This affects the design results of axial compression and moment strengths due to the limit states of flexural-torsional and lateral-torsional buckling, respectively, as the parameters such as Cb, Fex, Fey, and Fez depend on the unbraced lengths.

Design – Cold Formed Frame
Enhancements Implemented

*	Ticket	Description
*	932	An enhancement has been implemented to include cold-formed steel frame design in accordance with Eurocode EN 1993 1-3 2006.

Design – Concrete Frame
Enhancements Implemented

*	Ticket	Description
*	2125	An enhancement was made to concrete frame design involving seismic design in which the columns are designed for enhanced moments and the factored axial force (in addition to the factored moments and axial force) at the two end stations so that beam/column capacity ratios satisfy the code mandated limit. In doing so, the enhanced moment is calculated as half of the sum of beam probable moment capacities taking the components of the moment capacities of all beams connecting at the top of the columns along either major or minor direction of the column axes. If the column belongs to the topmost story, the enhanced moment is calculated as the sum of full-beam moments rather than just half of that. If the column is only to be checked, this procedure has no effect. All columns are checked for beam/column capacity ratios at the end and the results are reported as before. The affected codes are ACI 318-14, ACI 318-11, ACI 318-08, AS 3600-09, TS 500-2000, KBC 2009, CSA A23.3-14, CSA A23.3-04, Mexican RCDF 2004, Mexican RCDF 2017, and IS 456:2000.
	4656	A change has been implemented for the Chinese 2010 concrete frame design code, in which the MMF and SMF factors for columns were not matching for top and bottom columns when all the column lines did not have the same height. The program has now been updated to pick up the factors based on Table 5.3.2.1 (GB 50011-2010 6.2.2, 6.2.5, JGJ 3-2010 3.10.2-2) correctly.
*	5217	An enhancement has been made to include the new design code ACI 318-19 for designing concrete frames.

Design – Steel Frame
Enhancements Implemented

*	Ticket	Description
	5900	An enhancement has been made to the steel frame design code Chinese 2018 in which the

*	Ticket	Description
		Chinese steel grade Q345 has been replaced with Q355. The yield strengths of the grades Q355, Q390, Q420, and Q460 have also been changed. Now the calculation of epsilon_k [epsilon_k = sqrt(235/fy)] uses the yield strength fy from the name of steel grade (355, 390, 420, and 460 MPa) and is not affected by plate thickness.

Installation and Licensing
Enhancements Implemented

*	Ticket	Description
*	5426	SAP2000 now utilizes cloud licensing by default, allowing access to the license by multiple users and/or from multiple machines. The number of simultaneous users corresponds to the number of licenses owned. Cloud licensing requires connection to the internet while using the software, either directly or through a proxy. Connection to a company network or VPN is not necessary. Licenses can be checked out for a limited time period to allow use while disconnected from the internet. Legacy licensing options (Standalone and Network) are still available upon request.
*	5463	The version number has been changed to v23.0.0 for a new major release.

Loading
Enhancements Implemented

*	Ticket	Description
*	3978	An enhancement has been made to add automated seismic loads and response spectrum functions for the Vietnamese Standard TCVN 9386:2012 code.
*	5548	An enhancement has been implemented to add auto lateral loading per the Korean KDS 41 17 00:2019 code. This includes auto-seismic loading and the response-spectrum function.
	5692	An enhancement was implemented to update the AS 1170.4-2007 auto seismic loading according to Amendment 1. The seismic base shear obtained using a Program Calculated period is now set to not be less than 70% of the base shear obtained using the approximate period.
*	5798	An enhancement was made for the NBCC 2015 auto wind load to add the exposure factor (Ce) for the dynamic procedure for open and rough terrain.

Structural Model
Enhancements Implemented

*	Ticket	Description
	4302	An enhancement was made to the frame section definition interface to show the fillet radii for the applicable section shapes. The fillet radius is shown for I, Channel, Double Channel, Angle, Double Angle, T, and Box/Tube sections. The fillet radius field on the form is not editable for imported sections. However, the field can be edited for user-defined sections subject to checks for a legal section. The fillet radius information has also been added to the database table for frame sections and can be edited interactively.
*	5471	Several enhancements were made to the acceptance criteria (IO, LS, CP) values and hinge status output: 1) Acceptance-criteria strain can now be specified in the Uniaxial Nonlinear Material Data form (Define menu > Materials) and will be used to calculate the hinge status for fiber hinges. 2) The acceptance criteria deformations for a hinge property are no longer restricted to occur between the B and C points on the backbone curve. The hinge status output (AtoIO, IOtoLS, LStoCP, and >CP) are changed so that they are independent of hinge state (AtoB, BtoC, CtoD, DtoE, and >E). This enhanced behavior is consistent with ETABS. 3) The status of fiber hinges and individual fibers are now reported in the Hinge Results form (Display menu > Show Hinge Results), the output tables 'Frame Fiber Hinge States 01 - Overall Hinge' and 'Frame Fiber Hinge States 02 - Individual Fibers', and in the deformed-shape plots. 4) The deformed-shape display has been changed to show colored dots based on either the hinge state or hinge status depending on the selected option in the Display Deformed Shape form (Display menu > Show Deformed Shape).

Analysis
Incidents Resolved

*	Ticket	Description
*	5664	An incident was resolved where very sudden strength loss in single degree-of-freedom nonlinear hinges, nonlinear materials used in fiber hinges, or multi-linear plastic links could result in a stress value that is below the residual stress specified on the backbone curve. This issue could occur in nonlinear static, nonlinear staged construction, nonlinear direct-integration time-history, and nonlinear modal time-history (FNA) load cases. The affected hysteresis types were kinematic, isotropic, degrading, or BRB-hardening. Other types of hysteresis, as well as the Interacting and Parametric P-M2-M3 hinges, were not affected. This issue would be most noticeable for a backbone curve with significant loss of strength and when the strength-loss branch of the backbone curve was traversed quickly in only a few analysis steps. Additionally, the behavior of the kinematic, isotropic, degrading, and BRB-hardening hysteresis types, when reloading from the strength-loss branch of the backbone curve, were adjusted to be consistent with the other hysteresis types and the Interacting and Parametric P-M2-M3 hinges. Models which experience strength loss in single degree-of-freedom nonlinear hinges, nonlinear materials used in fiber hinges, or multi-linear plastic type links for the affected hysteresis types may now produce somewhat different results due to this change. In particular, the new results will tend to dissipate more energy following strength loss. Most models will not be affected.
	5813	An incident was resolved where, when a non-isotropic single-degree-of-freedom hinge was modeled as a separate link element (Analyze menu > Analysis Model for Nonlinear Hinges) and assigned a hinge sub-divide length (Assign menu > Frame > Hinge Overwrites) such that the magnitude of elastic stiffness of the hinge length was comparable to or larger than that of the plastic deformation of point C of the hinge backbone curve, the hinge results would display a noticeably flexible initial stiffness and a backbone curve where point C did not account for the elastic part of the deformation. Additionally, when this issue occurred, the backbone curve displayed in the Hinge Property Data form for the generated hinge (Define menu > Section Properties > Frame Nonlinear Hinges) and Hinge Response display (Display menu > Hinge Results) would be incorrect and was not representative of the behavior of the hinge. This issue was uncommon and primarily affected hinges with limited ductility, such as shear hinges. This issue did not affect hinges modeled within elements and did not affect multi-degree-of-freedom hinges such as the fiber or interacting P-M2-M3 hinges.

Design – Cold Formed Frame
Incidents Resolved

*	Ticket	Description
	5883	An incident has been resolved for an uncommon cold-formed design case of a Z section with large holes in the web according to AISI 2016. With such large holes and the compression buckling about principal axes, the design produced unexpected results in compression capacity. For smaller hole size, the design would provide conservative results.

Design – Concrete Frame
Incidents Resolved

*	Ticket	Description
	4338	An incident has been resolved in the concrete frame design code Chinese 2010 and the steel frame design codes Chinese 2010 and Chinese 2018 in which the following issues have been resolved: (1) The descriptions of Gamma_0 have been fixed in the concrete frame design code and the steel frame design codes, (2) The reported value of Gamma_0 in the column design details for the concrete frame design code has been corrected, (3) The reported value of Gamma_RE in the beam design details for the concrete frame design code has been corrected. These were result display issues only. Actual calculations were not affected.

*	Ticket	Description
	4725	An incident was resolved where the following three issues were fixed for calculating PMM interaction surfaces per Eurocode 2-2004. Beams are not affected by these bugs. (1) A maximum concrete strain of 0.0020 was used for all concrete strengths when calculating PMM interaction surfaces and the whole section was under compression strain. This is the value of epsilon_c2 for fck of 50 MPa or less, and this limit was incorrect for concrete strengths higher than C50 where a larger value should be used as per Eurocode (Table 3.1 of BS EN 1992-1-1:2004). There was a problem with the consistency of using epsilon_c3 and epsilon_cu3 everywhere, as the program was using epsilon_c2 in this place only. This problem has been corrected. The compression strain is now limited by the epsilon_c3 when the whole section is under compression strain, and the strain distribution is governed by the code (Figure 6.1 of BS EN 1992-1-1:2004). Previously the depth of the neutral axis was limited by (1 - epsilon_c2/epsilon_cu2)*h, and now it is limited by (1 - epsilon_c3/epsilon_cu3)*h. Please see Figure 6.1 of BS EN 1992-1-1:2004 for details. This change affects the PMM interaction near the top where the compression governs and where the whole section is under compression strain irrespective of the value of fck. (2) The maximum concrete strain of epsilon_cu3 was used for all concrete strengths and for all normal and lightweight concrete when calculating PMM interaction surfaces. This limit is correct for normal weight concrete (EC2 Table 3.1, 3.1.7(2), 3.1.7(3), Fig. 3.5), but not correct for lightweight concrete. For lightweight concrete, the maximum concrete strain limit is epsilon_cu3 * eta1 and it can not be less than epsilon_cu2 (EC2 11.3.6(2), Table 11.3.1, Table 3.1, 3.1.7(2), 3.1.7(3), Fig. 3.5). This problem has been fixed. This change affects the PMM interaction for all lightweight concrete columns. (3) For lightweight concrete, the value of design concrete compressive strength is flcd = alpha_lcc * fck / Gamma_c. The program always used alpha_lcc as 1.0. The program now uses the correct value of alpha_lcc which can be set in the preferences. This change affects the PMM interaction for all lightweight concrete columns.
	5056	An incident has been resolved in concrete frame design codes in which the shear rebar display may be incorrect on the screen and the database tables when there were extra load combinations present for crack width check limit states among the design load combinations. However, the calculated values were correct, and they were displayed correctly in the details window.

Design – Steel Frame
Incidents Resolved

*	Ticket	Description
	3066	An incident was resolved in steel frame design codes AISC 360-10 and AISC 360-16 in which the program did not use B1 and B2 factors when the analysis method was set to Direct Analysis, the second-order method was set to Amplified 1st Order, and the stiffness reduction method was set to No Modification. The program was correct for every other combination of analysis method, the second-order method, and the stiffness reduction method.
	4363	An incident has been resolved in steel frame design codes Eurocode 3-2005 and Italian NTC 2018 in which the program calculated stress ratio for torsion check was infinity for some stations and some load combinations when the torsion check was considered, torsion was present, the major axis bending moment was significant, and the minor axis bending moment was identically zero for a doubly-symmetric I-shaped section. The program was displaying the wrong governing equation in the details window in this case and was causing an error condition.
	5031	An incident has been resolved in steel frame design codes AISC 360-16, AISC 360-10, and AISC360-05/IBC2006 where a member with a singly-symmetric section like a channel section or tee section was fully-braced, the program calculated the axial compression capacity for the torsional and flexural-torsional limit state as zero. This was due to a numerical sensitivity in the equation for Fe in the limiting case of Fez. Now for the limiting case the value of Fe is taken as either Fex (for channel) or Fey (for tee) based on the axis of

*	Ticket	Description
		symmetry of the section. The error was obvious as the D/C ratio became infinity.

External Import and Export
Incidents Resolved

*	Ticket	Description
	5571	An incident was resolved where the cardinal point of frame objects was not exported from SAP2000 v22 models for import into Revit 2021, and it was not exported from Revit 2021 projects for import into SAP2000 v22. The cardinal point of frame objects was instead set to its default value by the importing application. When this occurred, the error was visually obvious and the analysis results agreed with the model as imported. Choosing the 'Export to Revit 2019 or earlier' option when exporting from SAP2000, and choosing the 'Export to ETABS v17, SAP2000 v21, SAFE 2016 or earlier' option when exporting from Revit 2021 prevented this problem from happening, yet still created .EXR files that were compatible with Revit 2021 and SAP2000 v22.
	5767	An incident was resolved which affected the export of SAP2000 models with vertical rectangular area objects to Architectural Coordination View IFC files. These area objects were exported at an incorrect location, shifted from their correct locations by half the area object width. When this occurred, the error was visually obvious.

Loading
Incidents Resolved

*	Ticket	Description
	5800	An incident was resolved for NBCC 2010 and 2015 auto wind load patterns where user specified terrain type and corresponding values for Ce,windward and Ce,leeward were not saved in the text file.

Structural Model
Incidents Resolved

*	Ticket	Description
	5940	An incident was resolved in which the ultimate strain capacity value in the Italian material library for the B450C rebar material was incorrectly defined as 0.675 when it should actually be 0.0675. Models using this material and nonlinear analysis features that utilize this value should be reviewed.