

SAP2000 v23.1.0 Release Notes

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This document lists changes made to SAP2000 since v23.0.0, released 15-January-2021. Items marked with an asterisk (*) in the first column are more significant.

Analysis

Enhancements Implemented

*	Ticket	Description
	3117	An incident was resolved where the "Check Surface" button used to check and correct the interaction (PMM) surface of interacting hinges (Define menu > Section Properties > Hinge Properties) was not able to identify non-convex surfaces. This issue did not affect analysis results because non-convex surfaces are automatically changed to be convex by the same process during analysis, and indicated as such in the analysis .LOG file. Now the correction to the surface can be viewed before running the analysis.
	5954	A change was made to nonlinear static analyses run with the solution scheme "Event-to-Event Only" so that results will be saved at the first event that occurs during the first step of the analysis. For analyses that start with zero or very small events, the results will be saved at the first event with a step size ratio that is equal to or exceeds the smaller of 0.0001 times the minimum number of saved states and 0.01. This change allows for a better representation of the initial stiffness of the structure for analyses with a small specified number of saved states. This change is not expected to affect existing results, but may slightly change the load factor of each saved step and may result in the number of saved states being one more than the minimum number of saved states specified in the Results Saved for Nonlinear Static Load Cases form. Code-based pushover plots may be affected if the initial stiffness changes and the generated curve is sensitive to that. The new results should be improved compared to previous results.

API

Enhancements Implemented

*	Ticket	Description
	5979	A new Python API example has been added. This new example does not rely on COM as an intermediate layer to connect to the API, instead communicating directly with the underlying .NET objects. Use of .NET rather than COM is generally more reliable and more efficient, and is recommended whenever possible.
	5992	The utility that unregisters the Application Programming Interface (API) library types has been enhanced. Previously, not all references to the API were removed from the Windows Registry upon uninstallation of the software. This could cause difficulties using the API with later versions of SAP2000. Uninstalling the new version will now fully clean the registry of references to the SAP2000 API.
	6082	The SAP2000 API is now limited to start and/or connect to a running instance of SAP2000 on a remote computer that is using a Network or Cloud license.

Design – Steel Frame
Enhancements Implemented

*	Ticket	Description
	6210	An enhancement has been made in the steel frame design codes Eurocode 3-2005, Italian NTC 2018, and Italian NTC 2008 in which the end moments M1 and M2 for a braced segment are now calculated more accurately by using interpolation. Previously, M1 and M2 were taken from the nearest output stations within the segment. This modification affects the C_{my} , C_{mz} , and $C_{m,LTB}$ calculation. In most cases, this will not affect results as the segment lengths often fall on the output stations. In other cases, the changes in the results are minor.

Installation and Licensing
Enhancements Implemented

*	Ticket	Description
*	5876	The version number has been changed to v23.1.0 for a new intermediate release.

Loading
Enhancements Implemented

*	Ticket	Description
	6044	An enhancement was implemented for the Chinese 2010 response spectrum function, reducing the period step from 0.2 seconds to 0.05 seconds.
	6074	An enhancement was added for the ASCE 7-16 auto seismic load pattern to now consider the exception in ASCE 7-16 section 11.4.8. The value of C_s must be set to 1.5 times the value computed from equations 12.8.3 and 12.8.4, for structures on Site Class D, with $S_1 \geq 0.20$ and with period $> 1.5T_s$.

Structural Model
Enhancements Implemented

*	Ticket	Description
	4358	An enhancement has been implemented to compute the values of any section properties that are imported as zero during import of steel sections from the section libraries.
	6260	An enhancement has been made to include the shear center of cold-formed C and Hat sections in the analysis.

User Interface
Enhancements Implemented

*	Ticket	Description
	6100	An enhancement has been implemented to allow users to specify the width of a single angle or single channel when defining a double-angle or double-channel section respectively. Previously, the user was expected to specify the overall width of the section (i.e. twice the width of a single angle or channel plus the back-to-back distance).

**Analysis
Incidents Resolved**

*	Ticket	Description
*	5276	An incident was resolved where restraint-displacement loading applied in a nonlinear direct-integration time-history load case using the Hilber-Hughes-Taylor (HHT) integration method was being scaled by the factor one minus alpha ($1 - \alpha$), where the HHT alpha value can range from $-1/3 \leq \alpha \leq 0$. The default and most common value is zero, corresponding to the Newmark method, for which there was no error. In the worst case with $\alpha = -1/3$, the applied load could be 33% too large. Displacement loads applied through springs and one-joint link elements were not affected, only loads applied through restraints. No other type of loading was affected. No other type of load case was affected. In particular, FNA and linear direct-integration load cases were not affected.
*	6022	An incident was resolved where, when a Parametric PMM hinge underwent a strain reversal between points C and D of the backbone curve, the final strength of the hinge was fixed at the level where the reversal occurred and did not drop further to the force/moment defined for point E of the backbone curve. This issue affected both the steel and concrete type Parametric PMM hinge, but did not affect other hinge types. This behavior was not common because load reversal when losing strength is not common in most practical models.
*	6035	An incident was resolved where an analysis could inadvertently get canceled while performing a license check. This issue was not common. It was timing-dependent and was most likely to occur when running long, multi-stepped load cases. Running such load cases in parallel and/or network connectivity issues that interfered with the license check increased the prevalence. When the issue occurred, full results for completed load cases were available, as well as partial results for load cases that were already running. No results were available for load cases that had not started when the cancellation occurred.
*	6054	An incident was resolved where creep effects may not have been correctly accounted for when an iterative time-dependent load step converged in a single step. When the issue occurred, the joint displacement would not change between the affected time-dependent load steps even though time-dependent behavior was enabled in the model. To resolve the issue, the behavior of iterative time-dependent analyses has been improved so at least one iteration is taken for each load step. This error did not affect load cases run non-iteratively with the event-to-event only solution scheme and did not affect models that were already taking multiple iterations in each time-dependent load step. This error was not common.
	6258	An incident was resolved where the acceleration loads generated for thin or thick shells with joint offsets were inconsistent with the mass used for analysis. By way of explanation, mass is always created at the joints. Previously, acceleration loads for shells were computed for the mass at the mid-surface of the shell, then transformed to the joints, creating small moment acceleration loads. This inconsistency between the location of the mass and the associated acceleration load led to errors in the calculation of the participating-mass ratios. It also could generate a warning message during Ritz-vector generation for acceleration loads stating that loads were applied to massless degrees of freedom. Now acceleration loads will be computed at the shell joints, consistent with the location of the mass. Changes in results for acceleration loading and mass-participation factors can be expected for models with shell joint offsets, limited by the size and associated mass of the joint offsets relative to the overall dimensions and mass of the structure.

**API
Incidents Resolved**

*	Ticket	Description
	4914	An incident was resolved for the Application Programming Interface (API) where the function <code>cSelect.CoordinateRange</code> was always considering the passed-in coordinates to be in database units instead of the present units, which can be set with the <code>SetPresentUnits</code> function.
	5670	An incident was resolved for the Application Programming Interface (API) where the function <code>cPropFrame.GetTypeOAPI</code> did not support all frame property types. The missing types have been added.

* Ticket	Description
6013	An incident was resolved for the Application Programming Interface (API) where attaching to a running instance of the software and executing methods to create a new template model (e.g. New2DFrame, NewBlank) sometimes resulted in the application becoming non-responsive.
6068	An incident was resolved for the Application Programming Interface (API) where the SapModel.DatabaseTables property was not available in the SAP2000v1 API library under certain conditions. This issue would affect COM clients (e.g., Excel) using cHelper methods to create the SapObject.
6088	An incident was resolved where the API function cDatabaseTables.GetTableForDisplayArray did not return results if the FieldKeyList parameter was empty.
* 6096	An incident was resolved in the Application Programming Interface (API) where following changes broke compatibility with earlier API versions: (1) In SAP2000 v22.2.0 (SAP2000v1.dll version 1.9 and CSiAPIv1.dll version 1.9), the eMatTypeSteel_Chinese_Q345 enumeration got renamed to eMatTypeSteel_Chinese_Q355. (a)Affected programs: SAP2000 v22.2.0, v22.2.1, v23.0.0 (b) Affected API clients: (i) Compiled COM clients (e.g. VB6, Delphi) failed to start. (ii) Interpreted COM clients (e.g. VBA) failed to compile/run if the affected enumeration was used. (c) Fix: eMatTypeSteel_Chinese_Q345 enumeration got reinstated. (2) In SAP2000 v23.0.0 (SAP2000v1.dll version 1.13 and CSiAPIv1.dll version 1.13), the cDAIAA_ASD_2000 & cDAIAA_LRFD_2000 interfaces got removed. (a) Affected programs: SAP2000 v23.0.0 (b) Affected API clients: (i) Compiled COM clients (e.g. VB6, Delphi) started but gave an automation error if affected interfaces were used. (ii) Interpreted COM clients (e.g. VBA) failed to compile/run if affected interfaces were used. (iii) Compiled .NET clients started but gave an error if affected interfaces were used. (c) Fix: cDAIAA_ASD_2000 & cDAIAA_LRFD_2000 interfaces got reinstated. SAP2000 versions 22.2.0, 22.2.1, and 23.0.0 and corresponding SAP2000v1.dll versions 1.9 and 1.13 & CSiAPIv1.dll versions between 1.9 and 1.13 should not to be used for developing plug-ins and/or API scripts to ensure full compatibility with past and future API versions. The cOAPI.GetOAPIVersionNumber() method can be used to check for incompatible API versions before using affected interfaces to prevent run-time errors.
6104	An incident was resolved where the database tables obtained through the API were always for Group All regardless of what group was specified.
6166	An incident was resolved where the API function GetTableForEditingArray returned tables in database units. Similarly the import function, DoAPIIDBInteractivelyImport, assumed the imported tables were in database units. Both have been modified to work in present units.
6177	An incident was resolved for the Application Programming Interface (API) where, in SAP2000 v23.0.0, the function PropFrame.ImportProp was unable to import properties and would always return 1 (error). This issue has been resolved and PropFrame.ImportProp now works as intended.
6397	An incident was resolved for the Application Programming Interface (API) where the function cLineElm.GetInsertionPoint did not return insertion-point offsets in the present units, but instead always returned them in the internal database units (the consistent units in effect when the model was created or imported).
6419	An incident was resolved for the Application Programming Interface (API) where COM clients sometimes could not launch or attach to instances of the software on a remote computer running the CSiAPIService.exe. This was generally not a problem if the client first launched a local instance of the software before attempting to work with a remote instance.

Database Tables Incidents Resolved

* Ticket	Description
4603	An incident was resolved where projected distributed loads on cables were not supported in the database tables.

*	Ticket	Description
	4752	An incident was resolved where the Database Table "Load Case Definitions" did not show a modal load case for linear or nonlinear direct-integration time-history load-case records. When using Interactive Database Editing (Edit menu > Interactive Database Editing) to add a linear or nonlinear direct-integration time-history load-case record with an invalid modal case or no specified modal case, the time-history load case would not use the specified modal damping during analysis until the modal damping parameters were edited in the Load Case Data form (Define menu > Load Cases). This issue could be resolved by modifying the modal damping parameters in the Load Case Data form (Define menu > Load Cases). This issue did not occur for linear or nonlinear direct-integration time-history load cases that were added through the Load Cases form (Define menu > Load Cases). The modal load case associated with a linear or nonlinear direct-integration time-history load case that has modal damping enabled is now shown in the Database Table "Load Case Definitions". The behavior of the Interactive Database Editing (Edit menu > Interactive Database Editing) has been changed so that, when modal damping is specified in a linear or nonlinear direct-integration time-history load case, the modal case will be set to the default modal case if one is not present.
	6172	An incident has been resolved in Eurocode 3-2005, Italian NTC 2008, and Italian NTC 2018 steel design where the design overwrites Zs and Mcr were not imported into the model through importing of the .s2k text file.

Design – Aluminum Frame

Incidents Resolved

*	Ticket	Description
	6171	An incident has been resolved in which the K factors calculated for aluminum and cold-formed steel design were over-conservative for columns with one end fixed on the base level. As a result, the designs could have been too conservative.

**Design – Cold Formed Frame
Incidents Resolved**

*	Ticket	Description
	6007	<p>Several incidents have been resolved for the Eurocode 3 1-3 2006 Cold-formed steel design including: (1) A term in calculation of C3 for the case of linear bending moment diagram and $-1.0 < \psi < 0.75$ is correctly fixed in the program to $+2.200 \cdot \psi$ instead of $-2.200 \cdot \psi$. (2) The location of restraints that define the segment of the member over which the shape of the bending moment diagram is considered to determine the factors C1, C2, and C3 used in calculation of the elastic critical moment M_{cr} has been corrected to use the location of restraints for lateral-torsional buckling. Previously, the location of restraint for buckling about the major axis was used. (3) The end moments of the lateral-torsional buckling unbraced segment are interpolated between output stations instead of being taken as the moment of the output station whose location is between the braced points. (4) The limits of applicability check for the Effective Width Method: a) the thickness of the web in the ratio of the web height over the thickness is taken as twice the flange thickness for I and T sections, b) the limit of flange width over thickness ratio is increased to 60 rather than 50 previously. These are only for display/warning of the method applicability in the design result display. Actual design results are not affected. (5) The eccentricity of the centroid of the tee section due to the shift of the neutral axis of the effective section under uniform compression is corrected. Previous calculation of eccentricity was not correct. (6) The effective moment of inertia and section modulus of the angle sections are now correctly calculated for bending about principal axes. Previous implementation in several cases resulted in a negative value of effective moment of inertia and section modulus. (7) The effective width portion b_{e2} is correctly calculated for angle sections with lips bending about major principal axis. Previously, in some rare cases, the sum of calculated b_{e2} and b_{e1} was larger than the compression portion of the flange. (8) The monosymmetry coefficient (z_j) of angle sections used in calculation of M_{cr} for bending about principal axis was not zero previously. It is now corrected to be zero as angle sections are symmetric about major principal axis. (9) The shear center of angle sections for bending about geometric axes were reported incorrectly for y_0 and zero for z_0 in the design report previously. The value of y_0 is now shown correctly as projected on geometric axis and z_0 is corrected to be equal to y_0. (10) Display of the slenderness and effective thickness factor of the bottom stiffener for Z sections under minor axis bending was incorrectly shown as $10e-6$ in the right-click design report. These values are appropriately displayed in the report now. (11) The 'Shear area in 3 direction' in the frame section Property Data form for cold-formed tee sections was previously not calculated accurately. It is now corrected. (12) The Z_a overwrite was not assigned and the Z_a value input by the user was not exported to and imported from the .s2k text file previously. They are now assigned, exported, and imported properly. (13) The monosymmetry coefficient (z_j) used in calculation of M_{cr} is corrected to be zero for sections that are symmetric about the major y-y axis, such as C, Hat, and Box sections. Previously, it was incorrectly non-zero.</p>

**Design – Concrete Frame
Incidents Resolved**

*	Ticket	Description
	5311	<p>An incident was resolved for TS 500-2000(R2018) and TS 500-2000 concrete frame design codes where column design showed a warning message regarding the "Column factored axial load exceeds maximum limit" for columns when column axial load was less than maximum limit. This was a reporting error and design was not affected.</p>

**Design – Steel Frame
Incidents Resolved**

*	Ticket	Description
	5483	An incident has been resolved in the steel frame design codes "Eurocode 3-2005", "Italian NTC 2008", and "Italian NTC 2018" for which for the internally created special load combos, the stability interaction equations for columns in DCH-MRF and DCM-MRF frames were checked for the overall member by using the axial force from the special amplified load combo and the span moments from the original combos. Now for these internally created combinations, the span moments from the amplified combos are used. The strength interaction equations were and are checked at every station for the special amplified load combo forces correctly.
	6085	An incident has been resolved to appropriately calculate C1, C2, and C3 coefficients using the shape of the bending moment diagram over the length between lateral-torsional buckling restraints instead of major-axis buckling restraints for Eurocode 3 steel design. Additionally, a term in calculation of C3 for the case of linear bending moment diagram and $-1.0 < \psi < 0.75$ is correctly fixed in the program to $+2.200 \cdot \psi$ instead of $-2.200 \cdot \psi$ for Eurocode 3, Italian NTC 2008 and Italian NTC 2018. Previous design results should be reviewed.
	6148	An incident has been resolved in the Russian steel frame design code SP 16.13330.2017 for singly-symmetric sections when plastic strains are allowed, where now the minimum values of the section moduli $W_{x,min}$ and $W_{y,min}$ are used in the calculation of interaction ratios per Eqn. 105 of SP 16.13330.2017 section 9.1.1. Now the design is conservative. All singly symmetric sections (singly-symmetric I-shape, Channel, T-shape, and Double Angle) are affected.
	6211	An incident has been resolved in the steel frame design codes Eurocode 3-2005 and Italian NTC 2018 in which the Γ_{M0} was missing in the expression of $V_{pl,T,Rd}$. Now the Γ_{M0} parameter is included in the expression per EC3 6.2.7(9) Equations 6.26, 6.27, and 6.28.
	6425	An incident has been resolved in the Russian steel frame design code SP 16.13330.2017 in which the limit slenderness of steel axially compressed members was calculated using ϕ_e factor (cl.9.2.2, Table E.3) instead of the ϕ factor (cl.7.1.3, Table E.1). The limit slenderness of elements, subjected to axial compression, is now calculated using the ϕ factor. The limit slenderness of elements, subjected to axial compression with bending is now calculated using the ϕ_e factor.

**Documentation
Incidents Resolved**

*	Ticket	Description
	6395	An incident was resolved in the API (Application Programming Interface) documentation for the functions under DesignColdFormed.EuroCold06, in which the documentation was showing DesignSteel instead of DesignColdFormed. This was a documentation issue only.

**Drafting and Editing
Incidents Resolved**

*	Ticket	Description
	3934	An incident was resolved where moving the joint of an area using the reshaper tool would move the joint for all objects connected to the particular joint. This affected only standard graphics mode.
*	4713	An incident was resolved where using the command Quick Draw Areas would sometimes result in an error condition if a large number of areas were to be drawn in the same command.
	5343	An incident was resolved where the area object expand/shrink command may not work correctly when there are additional points defined on the area object edges and the Offset Selected Area Edges Only option is used.

**External Import and Export
Incidents Resolved**

*	Ticket	Description
*	4629	An incident was resolved where program was being abnormally terminated when converting restraint data read from a Nastran data file. This was an issue specific to the Nastran file provided by the user. A trap has been added whereby the translator will skip the invalid restraint data and complete the translation.

**Graphics
Incidents Resolved**

*	Ticket	Description
	5462	An incident was resolved to adjust view limits in DirectX graphics mode. This affected viewing of models when the origin was far removed from the model.
*	5468	An incident was resolved where switching to a full screen view when the screen was showing an animation in DirectX mode may cause an error condition.
	5970	An incident was resolved in the DirectX graphics display to adjust the joint load text position which was overlapping frame elements.
*	6032	An incident was resolved where trying to show area object uniform loads to frames in a 2D elevation view would result in an error condition if the graphics mode was DirectX.

**Loading
Incidents Resolved**

*	Ticket	Description
	6026	An incident was resolved for NTC 2008 and NTC 2018 auto seismic load patterns where the topography factor was always used as 1.0.

**Results Display and Output
Incidents Resolved**

*	Ticket	Description
	4029	An incident was resolved where object loads were not shown when printing the display and the mode was set to standard graphics.
	4139	An incident was resolved where the potential and link-hysteresis energy may have been reported incorrectly in models with Damper - Friction Spring type link elements. This was a reporting issue for the energy associated with these elements only and did not affect other results.
	4576	An incident was resolved where the plot axes labels for the base-shear vs displacement type pushover plot were enhanced.
*	6107	An issue was resolved where the energy response output may be reported incorrectly, most often as zero or very large values. This issue only affected SAP2000 v23.0.0. This was a reporting issue that only affected energy output; no other results were affected. Load cases would need to be re-run in order to get the correct energy values, since they were not being correctly saved.
	6108	An incident was resolved where, when linear-type links with non-zero damping coefficients were used in a nonlinear modal time-history (FNA) load case, the link viscous damping energy for these links was incorrect reported as being zero. When this issue occurred, the missing linear-link viscous damping energy would be included in the energy error, so that the total energy and other energy components were not affected. No other results were affected. Only SAP2000 v23.0.0 was affected.

Structural Model
Incidents Resolved

*	Ticket	Description
*	4642	An incident was resolved where the steel and rebar uniaxial stress-strain curves were using minimum instead of expected strengths. Nonlinear results for models run in the new version that use these stress-strain curves, such as models with fiber hinges and/or directional materials in layered shells, can be expected to produce changed results consistent with an increase in the strengths. Materials with user-defined stress-strain curves are not affected.
	6043	An incident was resolved where the calculation of section properties was not accounting for the specified fillet radius for certain user-defined section shape types. This only affected v23.0.0 where the fillet radius was first implemented for steel sections.
	6045	An incident was resolved where the program was not accepting zero as the input for the fillet radius for section shapes that allow fillet radius specification. A fillet radius value greater than or equal to zero is now allowed.
	6053	An incident has been resolved to correct the calculation of moment of inertia about major axis of cold-formed wide flange section in accordance with AISI 2016 Volume 1 Part 1 Section 3.3.3 Page I-50 Bullet No. 6. Previously, the equation provided by AISI 2016 had a typo (the term 0.358^3 inside the curly bracket), which had been recognized by AISI. AISI will publish an errata to reflect this correction (the term 0.358^3 should be $0.358r^3$). This change affects the moment of inertia of the section used in analysis as well as AISI and Eurocode cold-formed design.

User Interface
Incidents Resolved

*	Ticket	Description
	4843	An incident was resolved for the Italian NTC 2008 and 2018 auto-seismic load patterns where a change to the nominal life input parameter was not retained. Results agreed with the value shown when the form was reopened.
	4957	An incident has been resolved where trying to assign a different aluminum (material) type, from Wrought to Mold Cast or Sand Cast, an illegal value error would occur and the change could not be made.
	5344	An incident was resolved where the drawing parameters for quick drawing braces were not correctly displayed in the object property form when the brace type was changed.
	6039	An incident was resolved where a unnecessary dimension field was present on the frame section definition form for multiple section shapes. Any value input in the field did not affect the frame section dimensions, section properties or the analysis/design results in any way.
	6055	An incident was resolved where the joint name was improperly displayed in the Response Spectrum Generation form.
	6194	An incident was resolved where a vehicle name could not be modified in the vehicle definition form.