

SAP2000 v24.0.0 Release Notes

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This document lists changes made to SAP2000 since v23.3.1, released 24-September-2021. Items marked with an asterisk (*) in the first column are more significant.

Analysis

Enhancements Implemented

*	Ticket	Description
*	7077	An enhancement was made to allow the disabling of the coupling between major bending, shear V2, and torsion for Channel and General sections, including the cold-formed C and Hat sections. The new option to control this coupling effect of the shear center is available in the affected section-property definitions. Consideration of the shear center is enabled by default.
*	7783	The meshing of frame objects that contain tendons has been changed to generally improve accuracy but also to reduce the size of the analysis model. Previously, any frame object that contained one or more tendon mesh points was discretized based on the minimum discretization anywhere along the length of any tendon that contained a point in that frame. That could lead to over-meshing of frames, yet did not necessarily mesh the frames at the tendon points. It also affected adjacent frame objects if a tendon point was at the end of the frame object, even if the tendon did not pass through that frame. Now, frames are meshed only at the contained tendon points, regardless of the discretization elsewhere in the tendon. Only interior points are considered, so adjacent frame objects are not affected. Note that frame objects containing a tendon point will only be meshed if the frame is a member of the group loaded by that tendon, as specified in the tendon definition. Area and solid objects are not meshed at tendon points and are not affected by this change. Tendon points that affect frame meshing are the control points used to define the tendon geometry, as well as additional points created to satisfy the minimum discretization specified for the tendon. Frame discretization due to tendons will not create elements smaller than 1/8 of the smaller cross-sectional dimension (t2 or t3) of the frame object, subject to an absolute minimum of 10 times the Auto Merge Tolerance (File > Settings > Dimensions). Affected models run in the new version may exhibit a very small effect upon the results, generally of no engineering significance, unless the model is unstable or ill-conditioned. Verification Example 1-009 has been updated to reflect the new results, which are now approximately 50% closer to the benchmark values.
*	8082	A change has been made to how equilibrium errors are checked for convergence in nonlinear static load cases. Previously, the relative contributions of force unbalance to moment unbalance were dependent upon database length units. This tended to over-emphasize moments for small length units (mm, inch), which are the default database units. In certain cases, this could lead to larger force equilibrium errors than expected based on the relative convergence tolerance specified for a load case (the default is 0.0001). Now these equilibrium measures are independent of length units, and they are better balanced between force and moment for typical structural dimensions. Because of this change, the results of nonlinear static load cases may differ when run in the new version compared to the previous version. Generally any change will be small, but it may be more significant for sensitive or ill-conditioned models. Note that nonlinear static analysis is an approximate, iterative process. Results should be confirmed by engineering judgment, and re-running certain load cases using progressively smaller convergence tolerances may be necessary to get the expected equilibrium for some models. Results for non-iterative, event-to-event load cases should not be affected, except that the reported error at the end may differ.

API

Enhancements Implemented

*	Ticket	Description
	6852	An enhancement has been implemented for the Application Programming Interface (API) to add a new function, SectCut.Delete, to allow deleting a section cut.

Data Files

Enhancements Implemented

*	Ticket	Description
	7906	The following changes have been made to the Chinese materials library: (1.) Tendon materials in accordance with the JTG D62 and TB codes have had their yield and tensile stress values adjusted. (2.) New tendon material grade JTGD62 fpk1960 was added. (3.) Tendon materials in accordance with GB 50010 have been added.
	8168	The Russian material library has been updated to add materials from the latest standards SP 63.13330.2018 (concrete, rebar, tendon) and SP 63.13330.2017 (steel). The materials from the older standards, available previously, are still present in the updated library.
	8173	Two new Russian frame section libraries have been added to conform to the latest standards. These files are Russian2020_en.XML and Russian2020_ru.XML. The former contains the frame sections with names in the English language, and the later contains the same frame section with names in the Russian language, where applicable.
	8190	The handling of functions (time history, response spectrum, steadystate, and power spectral density) defined in external data files has been enhanced to: (1.) Significantly speed up reading of function data files with many data points, and (2.) Allow users to suppress error messages caused by multiple missing function data files when running the analysis.

Database Tables

Enhancements Implemented

*	Ticket	Description
	7482	An enhancement has been made to the aluminum frame design codes AA 2015, AA 2020, EN 1999:2007 and cold-formed frame design codes AISI-16 and Eurocode 3 1-3 2006 to include the description for field names of the associated design display tables.

Design – Aluminum Frame

Enhancements Implemented

*	Ticket	Description
	7660	An enhancement has been made to provide clarification for the location of load application in the aluminum frame design overwrites for the AA 2015/2020 and EN 1999:2007 codes, and in the cold-formed frame design overwrites for EN 1993-1-3:2006 code. The item descriptions in the respective design overwrites forms have been updated for this purpose.

Design – Cold Formed Frame

Enhancements Implemented

*	Ticket	Description
	7324	An enhancement has been made to the EC3 1-3 2006 cold-formed frame design to offer design preference and design overwrite options to select different sets of combination equations to be considered for member buckling. In addition, all the demand-capacity ratio and combination equations are now displayed in the right-click design report.

**Design – Concrete Frame
Enhancements Implemented**

*	Ticket	Description
	7061	An enhancement has been made to the EC 2-2004 concrete frame design to calculate the extra longitudinal reinforcement required due to shear according to equation 6.18 in Section 6.2.3(7) of the EN 1992-1-1:2004.
	7379	An enhancement has been made to the concrete frame design codes in which IgnoreBeneficialPuInBeamDesign, ConsiderTorsion, and TanTheta are now available to the Preferences and the Overwrites forms. Previously IgnoreBeneficialPuInBeamDesign was available in the Preferences forms, and ConsiderTorsion and TanTheta were available through the Overwrites form for specific codes. IgnoreBeneficialPuInBeamDesign applies to beams, while ConsiderTorsion and TanTheta apply to both beams and columns. These parameters are code-specific.
	7380	An enhancement was made to the concrete frame design code "Eurocode 2-2004" where now the optimized Theta value is used for shear design even when the minimum governs. Previously optimized Theta was only used for design when the minimum did not govern. Now the computed value of VRd,s and VRd,max are always based on the optimized Tan(Theta).
	7407	An enhancement has been made to the concrete frame design code "ACI 318-19" to allow control of either including or excluding axial compression in the flexural design of beams if the axial compression reduces the required reinforcement. Axial tension and axial compression that increase the required flexural reinforcement are always considered. This option to exclude beneficial compression is accessed through the concrete preferences and overwrites for the "ACI 318-19" code.
	7503	A change has been made to ACI 318-19 concrete frame design where the factored design torsion (T_u) is no longer increased to $\phi \cdot T_{cr}$ if it is greater than $\phi \cdot T_{th}$. The previous implementation was too conservative for determinate structures and for structures where torsion redistribution was not done. If redistribution is desired, torsional stiffness modifiers can be applied to obtain the desired T_u .
*	8061	Concrete frame design has been added per the Canadian CSA A23.3-19 code.

**Design – Slab
Enhancements Implemented**

*	Ticket	Description
*	1007	Several enhancements have been made to the Concrete Shell Design in accordance with Eurocode 1992-1-1:2004: (1.) Concrete shell design has been moved to the Design menu. (2.) Design Preferences can be used to specify several design parameters, including the national annex. (3.) The design now includes iteration to calculate the design thickness of the outer layers and to determine the optimum amount of reinforcement. (4.) Design can now be performed for a single layer of reinforcement, assumed to be at mid-thickness, as well as for two layers (top and bottom reinforcement). (5.) Design is available for shells with variable thickness under the assumption that the cover remains constant within each element. (6.) Graphical display of the design results has been enhanced to provide more detailed information. (7.) Design results are now available in the database tables. Tabular results can be presented as envelopes, step-by-step, or with correspondence, depending upon the types of load cases and load combinations selected.

**Design – Steel Frame
Enhancements Implemented**

*	Ticket	Description
	7231	An incident was resolved where frame element forces used for frame design and reported in the "Design Force Data" tables did not account for all of the load cases referenced in selected design load combinations when such design load combinations included modal or buckling load cases. Now any modal or buckling load cases included in load combinations used for design will simply be ignored and the effects of other load cases will be correctly considered; previously the effects for other load cases could be affected by the presence of the modal and buckling load cases in the load combinations. Analysis results for frame forces and stresses as plotted and tabulated were not affected.
*	7460	An enhancement has been made to reconcile the design axis notations to the Eurocode 3-2005, Italian NTC 2008, and Italian NTC 2018 steel design codes, EN 1999:2007 aluminum design code, and Eurocode 3 1-3 2006 cold-formed design code. Previously, major and minor axis notations were used. They are now changed to Y-Y and Z-Z. Changes have been made to affected column headings the following database tables: (1.) For Eurocode 3-2005, Italian NTC 2008, and Italian NTC 2018 steel design codes: "Overwrites - Steel Design", "Steel Design 1 - Summary Data", "Steel Design 2 - NMM Details", "Steel Design 3 - Shear Details", and "Steel Design 7 - Beam Shear Forces". (2.) For the EN 1999:2007 aluminum design code: "Overwrites - Aluminum Design", "Aluminum Design 1 - Summary Data", "Aluminum Design 2 - Axial Details", "Aluminum Design 3 - Flexural Details", Aluminum Design 3 - Shear Details". (3.) For the Eurocode 3 1-3 2006 cold-formed design code: "Overwrites - Cold Formed Design", "Cold Formed Design 1 - Summary Data", "Cold Formed Design 2 - Axial Details", "Cold Formed Design 3a - Major Flexural Details", "Cold Formed Design 3b - Minor Flexural Details", "Cold Formed Design 4 - Shear Details". In addition, the tables "Cold Formed Design 3a - Major Flexural Details" and "Cold Formed Design 3b - Minor Flexural Details" have been renamed to "Cold Formed Design 3a - Flexural Details Y-Y" and "Cold Formed Design 3b - Flexural Detail Z-Z", respectively.
	7842	For steel frame design per the Eurocode 3:2005, Italian NTC 2008, and NTC 2018 codes, and for aluminum frame design per the Eurocode 9:2007 code, the values of the geometrical moments of inertia I22, I33, I23 are reported for angle sections in addition to the principal moments of inertia Iy, Iz, and Iyz (= 0). For all other sections, only Iy, Iz, and Iyz are shown.
*	8129	An enhancement was made to add Steel frame design based on Canadian code CSA S16-19.

**Documentation
Enhancements Implemented**

*	Ticket	Description
	7012	Design manuals shipped with the software have had chapters or sections that document the design preferences and overwrites removed in favor of the documentation that is already provided directly inside the software on the design preferences and overwrites forms themselves. Note that this had already been done for some of the manuals in previous releases.
	7288	The steel frame design manual for the Russian steel frame design code "SP 16.13330.2017" has been updated to clarify the use of the Reliability factor (γ_n) and the Working conditions factor (m_{tr}). These factors were already used for design calculations, and only the documentation has been updated.

**External Import and Export
Enhancements Implemented**

*	Ticket	Description
	5690	An enhancement has been made to the export of models with curved frames to .DXF files. Frame objects curved along a circular arc, which were exported as AutoCAD line objects in previous versions of SAP2000, are now exported as AutoCAD arc objects. In addition, each extruded frame object is now exported as a single CAD object, instead of one object for each face, as was the case in previous versions.
	7626	An enhancement to the export of models as CIS/2 Step files has been implemented. Labels and names of exported objects and definitions containing non-ASCII characters are now exported with the ISO 10303-21 and ISO 10646 encoding of the non-ASCII characters. Previously, such label and names were exported with the non-ASCII characters replaced with their closest ASCII equivalents.

**Graphics
Enhancements Implemented**

*	Ticket	Description
	1523	The extruded view of the undeformed shape now supports nonprismatic Section Designer (SD) sections under the following conditions. These conditions, and the resulting plot, apply on a segment-by-segment basis along the non-prismatic section: (1.) For the segment, the beginning and end sections must both be SD sections; (2.) The SD sections at both ends of the segment must contain the same number of shapes, defined in the same order; (3.) Corresponding shapes must be of the same type; and (4.) Corresponding polygon shapes must contain the same number of points. Previously, nonprismatic SD Sections were represented with rectangular extruded shapes based on the bounding dimensions of the section at each end of each segment. This will still apply to those segments of nonprismatic sections containing SD sections that do not meet the conditions stated above.
	7115	An enhancement was done to allow specifying grid bubbles to be shown on both ends of the grid line at the same time.
	8100	An enhancement was made to add an option to turn ON/OFF showing of frame-section thicknesses in extruded views of thin-walled sections. Turning this OFF can speed up the display and reduce the size of printed files. In addition, an option has been added to control the frame edge color for extruded views, which can be adjusted as needed for clarity.
	8104	An enhancement was made to remove internal shading when printing frame extruded views in DirectX graphics mode. This speeds up printing and reduces file size when printing to PDF.
	8146	An enhancement was made to change the printing resolution from from 100 to 300 DPI. This should especially improve print quality on PDF printers, with limited effect on file size.

**Installation and Licensing
Enhancements Implemented**

*	Ticket	Description
*	7222	The version number has been changed to v24.0.0 for a new major release.

Loading

Enhancements Implemented

*	Ticket	Description
	7782	An enhancement has been made for the default loading combinations for Chinese Design codes based on changes in the "General Specification for Seismic Resistance of Buildings and Municipal Works", GB55002-2021, Section 4.3.2. The gravity load factors, when combined with seismic loads, have been changed from 1.2 to 1.3, and the seismic load factors have been changed from 1.3 to 1.4. Additionally, in accordance to "General Specification for Steel Structures", GB55006-2021, Section 5.2.3, a factor of 0.5 is applied to notional loads in load combinations that include seismic loads.

Results Display and Output

Enhancements Implemented

*	Ticket	Description
	7811	An enhancement was made to speed up recovery of frame forces for tables and the API (Application Programming Interface).
	7840	Steel frame design has been enhanced to display multiple D/C ratios along with consistent colors. Previously, the color displayed was always based on the P-M ratio, even when showing the numerical value for a different D/C ratio. Now the color is consistent with the displayed ratio. A new display of Max Ratio has been added to envelope all the D/C ratios for a given member. The following D/C ratios can now be displayed: (a) Max Ratio Colors & Values (absolute maximum DC ratios over all checks), (b) Max Ratio Colors/No Values, (c) P-M Ratio Colors & Values (maximum from strength and buckling P-M checks), (d) Shear (or Average Shear) Ratio Colors & Values, (e) Max Shear Ratio Colors & Values, (f) Equivalent Ratio Colors & Values, (g) Identify all Failures. All items except (e) and (f) apply to all steel frame design codes, whereas the items (e) and (f) apply to only the "SP 16.13330.2017" and "Indian IS:800-1998" codes. No design results have changed.

Structural Model

Enhancements Implemented

*	Ticket	Description
	1524	An enhancement was implemented to report the shear center location for certain frame-section properties. This value may be reported even in cases where it is not used for analysis. The shear center is only used for shear V2; only for Channel, General, cold-formed C and cold-formed Hat sections; and only if the option to consider the shear center is selected (see Ticket 7077 for this release).
*	7566	AS3600-2018 is added to the types of time-dependent material properties available for concrete materials, supporting creep, shrinkage, and age-dependent stiffness behavior.

User Interface

Enhancements Implemented

*	Ticket	Description
	2482	An enhancement has been made for steel, concrete, cold-formed steel, and aluminum frame design where now the Design Overwrites forms offer an additional choice for decision-type (Yes/No) overwrite items. The previous choices were "Yes" and "No". The new choices are now "Yes", "No", and "Program Determined". The new "Program Determined" option allows easily returning to the default value after the overwrites have been changed. Design results for existing models are not affected unless the design overwrites are changed.
	7238	An enhancement was made to the display of frame property data to additionally show the location of the centroid and section moduli both on the positive and negative sides, as well as the warping constant when it has been computed.

*	Ticket	Description
	7282	The analysis log can now be displayed using the Show Log button on the Analysis Message form which appears after running an analysis that generates warning or error messages, or later using the command Analyze > Show Analysis Messages. This is the same analysis log that can be displayed directly using the command Analyze > Show Last Run Details.

**Analysis
Incidents Resolved**

*	Ticket	Description
*	7502	An incident was resolved where nonlinear static and staged-construction load cases could converge with equilibrium errors that were larger than expected when large external loads were applied. When this occurred, the errors were typically in a direction or region of the model not significantly affected by the external load. For example, horizontal reactions in one portion of the model may be out of balance due to large vertical loading in a different region of the model. The effect of this error was negligible for most models. Now equilibrium convergence is measured using the relative convergence tolerance times the magnitude of the internal forces, rather than the previous approach of considering the larger of the internal and external forces. This change will have no impact on most models, and will tend to increase iteration and improve equilibrium for other models. A few models that previously converged may now fail to converge under the tightened equilibrium requirements; this can usually be resolved by improving the stability or conditioning of the model. Note that the behavior of the pure event-to-event solution strategy is not affected by this change, except that the reported equilibrium error could be larger; no other results will be affected.
	7936	An incident was resolved where the analysis failed to run on moderate- to large-sized models with a very large number (more than a thousand) of nonlinear static or staged construction load cases. When this occurred, results were not available.
*	8206	An incident was resolved where running a steady-state or power-spectral-density (PSD) load case with no effective applied loads caused a fatal analysis error. When this occurred, analysis results were not available.

**API
Incidents Resolved**

*	Ticket	Description
	7261	An incident was resolved for the Application Programming Interface (API) that addressed several issues: (1.) For the functions relating to concrete frame design overwrites, the moment coefficient C_m , and also moment factors D_{ns} and D_s for the Eurocode 2-2004 and NTC 2008 codes, were all available even though those factors were not used anywhere in the design. This has been resolved by returning 1 from the API functions indicating that the function did not successfully execute when these values are requested. (2.) The API function for effective length factor, β , has also been corrected to check whether or not the frame section is of column-design type. If the frame section is column design type, the API functions will be executed and the value of the effective length factor will be retrieved or assigned to the frame element, appropriately. Otherwise, the functions will return 1 indicating that they were not successfully executed. (3.) The frame type can be set to have a value ranging from 1 to 4 corresponding to DC High, DC Medium, DC Low, and Secondary for Eurocode 2-2004, and from 1 to 3 corresponding to DC High, DC Low, and Secondary for NTC 2008. Previously, it could only be set to Sway or Non-sway for both design codes.
	7598	An incident was resolved for the Application Programming Interface (API) where the value of the coordinates of load application (z_a) and shear center (z_s) were not properly set using the function <code>SetOverwrite</code> for Eurocode 3-2005, NTC2008, and NTC2018 steel-frame design codes. Similarly, the value of the coordinate of load application was not correctly set using the API function <code>SetOverwrite</code> for the AA 2015, AA 2020, and EC9 2007 aluminum-frame design codes and Eurocode 3 1-3 2006 cold-formed frame design codes. All these values are now properly set via the API function <code>SetOverwrite</code> and used for the design procedures.
	7647	An issue was resolved for the Application Programming Interface (API) where the functions <code>SapObject.SapModel.LoadCases.StaticNonlinearStaged.GetMassSource</code> and <code>SapObject.SapModel.LoadCases.StaticNonlinearStaged.SetMassSource</code> always returned 1 (error) when called, and did not perform their intended function. This issue has been resolved so that the API functions behave as intended.

* Ticket	Description
7849	An incident was resolved for the Application Programming Interface (API) where the function LinkObj.SetGroupAssign was not assigning the link object to a group when used in the cross-product API. This did not affect the implementation in the SAP2000 API.
8101	An incident was resolved for the Application Programming Interface (API) where frame section properties imported by using the function SapModel.PropFrame.ImportProp may produce a frame section with property modifiers set to zero (0). This behavior has been corrected and imported properties will have property modifiers set to the default value of one (1).

Data Files

Incidents Resolved

* Ticket	Description
* 7763	An incident was resolved where the depth and width of unequal angles imported from AISC15.xml, AISC15M.xml, AISC15.pro, and AISC15M.pro libraries were switched. Consequently, the program was showing the longer leg as horizontal but the section properties in the database were based on the longer leg being vertical. This was an issue in the section database itself and has now been addressed. No other section libraries were affected by this bug. Older files that use unequal angles from the AISC15 databases will have the error corrected when opened in the new version by reimporting the section. Older versions of the program can replace the AISC15 databases in their section libraries and reimport any unequal angles used in the models.
8130	An incident was resolved where the material data for the Spanish region was not available for versions 23.3.0 and 23.3.1. This was caused by an invalid character in the library file that has now been fixed. Note that the corrected library file also includes corrections to the thermal coefficients as previously reported for v23.3.0 under Ticket 7174.

Database Tables

Incidents Resolved

* Ticket	Description
7512	An incident was resolved where the load cases selected for tabular output may not be saved correctly in models that include response spectrum load cases with nonzero diaphragm eccentricity and at least one rigid diaphragm assignment.
* 7539	An incident has been resolved where the Eurocode 1999:2007 aluminum frame design tables exported to Excel and displayed or printed in Word was not working. For Excel, this was caused by the presence of a colon (:) in the sheet names, which has now been changed to a dash (-). For the Word RTF files, some of the tables had too many columns to fit on a page; now they will break into smaller tables as needed.
7653	An enhancement was made to improve the error messages displayed when the import of database table "Groups 2 - Assignments" fails due to invalid data. Previously the import was aborted with no useful information as to why. This change affects the direct import of database files and interactive database editing.
7893	An incident was resolved where the Between and Not Between commands for Text fields in the Quick and Basic filters were missing some single quotes. For example, the generated command would be {Joint > '2' And Joint < 4'} instead of {Joint > '2' And Joint < '4'}, where the {} characters are not included.

**Design – Cold Formed Frame
Incidents Resolved**

*	Ticket	Description
	7896	An incident was resolved for cold-formed steel frame design and aluminum frame design where explicit bracing points defined as point and/or uniform bracing (command Design > Lateral Bracing) were not being considered when unbraced length determined from connectivity and support for buckling about the minor (or Z-Z) axis or for lateral-torsional buckling was longer than the frame member itself. The bracing points were properly considered for the case where the program-determined unbraced length was less than or equal to the member length.
	8050	An incident has been resolved for Eurocode 3 1-3 2006 cold-formed frame design in which the demand-capacity ratio calculated by equation 6.26 was shown as a negative value. It is now displayed by its absolute value. The design results are not affected.

**Design – Concrete Frame
Incidents Resolved**

*	Ticket	Description
	6625	An incident was resolved in the Chinese 2010 concrete frame design to now report T/Wt correctly in the design details output. This was a reporting issue only and did not affect the design results.
	6903	An incident was resolved for concrete frame design codes "Eurocode 2-2004" and "Italian NTC 2008" where the beam/column capacity ratio was not being calculated for ductile moment-resisting frames ("DC High" and "DC Medium" for "Eurocode 2-2004" and "DC High" for "Italian NTC 2008"). This error only affected versions 23.2.0 to 23.3.1. The error was obvious since there was no output for the beam/column capacity ratio.
	7277	An incident was resolved in the concrete frame design manual for the Canadian concrete frame design code "CSA A23.3-14" where the factors in the expressions of the minimum shear rebar requirements were incorrect. Instead of using the expected factors of 0.06, no factor was used on page 3-24, and factor 0.6 was used on page 3-50. This was a documentation issue only. No results were affected.
	7545	An incident was resolved for "ACI 318-19" concrete frame design where the minimum top longitudinal rebar for flexural design was too conservative for all T-beams of all framing types if there was any negative moment. Previously, the minimum was enforced in these cases based on the assumption that bw was the smaller of 2*b and b_flange, per Section 9.6.1.2 of "ACI 318-19" code. But the use of this enlarged bw is actually only required for statically determinate T-beams where the flange is in tension, per Section 9.6.1.2. Now this enlarged bw is only used for cantilever T-beam where the flange is in tension.
	7816	An incident was resolved in the Russian concrete frame design code SP 63.13330.2011 where the "Snow Load Duration Factor" preference was not taken into account when doing a crack design check. The whole snow load was being considered as a short-term one. In addition, the phi3 factor is now taken to be 1.2 when an axial force is either zero or when axial compression is less than 0.01 * Rb,n * Ag.
	7995	An incident was resolved for the Indian concrete frame design code "Indian IS 456-2000" where the section depth for Section Designer (SD) sections was taken as 2 * sqrt(3) * r, where r is the radius of gyration in the respective direction. This approximation affected calculation of the slenderness limit per IS 25.1.2 and calculation of the additional moment per IS 39.7.1. Now the design will consider the depth as the full section dimension in the respective direction. Previously the behavior was correct for rectangular SD sections, conservative for I-shaped SD sections, and unconservative for diamond-shaped SD sections.
	8185	An incident was resolved for Russian SP 63.13330.2012 concrete design code where design tensile strength of concrete was computed incorrectly by not accounting for gamma_b5 factor for R_bt,long and R_bt,short.

**Design – Steel Frame
Incidents Resolved**

*	Ticket	Description
	5874	An incident was resolved for steel frame design code "Chinese 2018" in which some of the section numbers of relevant Chinese codes in the reported error messages were incorrect. This was a reporting error only. No other results were affected.
	5996	An incident was resolved in steel frame design codes "Eurocode 2-2005" and "Italian NTC 2018" in which the torsional strength for hollow box shapes was miscalculated. From elastic theory, the torsion strength of such sections is defined by the following equation: $T, R_d = \tau_{Rd} * (2 * A_o * t)$ where τ_{Rd} is the maximum allowable shear stress that, for steel members, is approximated by $\eta * (f_y / \gamma_{M0}) / \sqrt{3}$ for non-slender sections and $\chi * (f_y / \gamma_{M0}) / \sqrt{3}$ for other section (EN 1993-1-5:2006 Section 5.3, Table 5.1); A_o is the area enclosed by the centerline perimeter; and t is the thickness of the section. A_o was being taken as $A_o = (b_f - t_f) * (h - t_w)$. This has been corrected to $A_o = (b_f - t_w) * (h - t_f)$. There was no error for sections with constant wall thickness, and only a minor effect if the thickness of the webs (t_w) was different from that of the flanges (t_f).
	6393	An incident was resolved for steel frame design codes "Eurocode 2-2005" and "Italian NTC 2018" where the resultant stress ratio reported on the Steel Stress Check Information form did not match the sum of the component ratios reported. This happened when torsion was dominant as its component ratio was not reported. This has now been improved. Moreover, for the "Italian NTC 2018" code, the reported interaction equation name was incorrect in the detailed report when the governing equation was "EC3 6.2.7(1)-6.23". This was a reporting issue only. The actual calculations and design results were correct.
	7151	An incident was resolved for Russian steel frame design code "SP 16.13330.2017" in which the member color displayed in the "Steel Stress Check Information" window was based on the maximum stress ratios considering P-M interaction, maximum shear stress, and equivalent stress ratios. However, the reported text said that the color was based on the P-M interaction ratios. The "Steel Stress Check Information" form has been updated to include maximum shear stress and equivalent stress ratios. The "Display Steel Design Results" form has been updated to include the following items in the design output section: "Max Ratio Colors & Values", "Max Ratio Colors/No Values", "Max Ratio Colors/P-M Values", "Max Ratio Colors/Average Shear Ratio Values", "Max Ratio Colors/Max Shear Ratio Values", and "Max Ratio Colors/Equivalent Ratio Values". The calculated P-M ratios for the equations "SP 8.2.3 Eq. 51" and "SP 9.1.1 Eq.105" have also changed for the circular sections as the bending components are now subjected to the square root of the sum of squares.
*	7256	An incident has been resolved in which the warping constant C_w was computed incorrectly for double-channel and double-angle sections. It is now calculated appropriately with the assumption that it is the contribution of C_w from two single channels or two single angles for the double channel and double angle, respectively.
	7546	An incident was resolved where an error condition occurred designing an eccentrically braced frame if the design loading combination contained an enveloping load case or combination.
	7744	An incident was resolved for steel frame design where the warping constant (C_w or I_w) was not reported for the Tee, Angle, and Double Angle sections in the AISC 360-16, AISC 360-10, AISC 360-05, AS 4100-1998, CSA S16-14, CSA S16-09, Eurocode 3-2005, Indian IS 800:2007, Italian NTC 2018, Italian NTC 2008, KBC 2016, KBC 2009, NZS 3404:1997, SP 16.13330.2017, and SP 16.13330.2011 design codes. This was a reporting error only, and no design results were affected. Note that the value may be displayed as "Not Required" in cases where it is not used by the design code or has an insignificant effect for the section type.
	7774	An incident has been resolved for steel, aluminum, and cold-formed frame design in which the Make Auto Select Section Null command now assigns the design section to the analysis section for the next analysis run. Previously, the analysis section was not updated to be the same as the design section for the next analysis run after the design was run for the first time and the Make Auto Select Section Null command was selected.

* Ticket	Description
7778	An incident was resolved for the Russian steel frame design code "SP 16.13330.2017" in which the ϕ_b factor was not being calculated correctly because the effective length L_{eff} was taken as $K_{LTB} * L_{22}$ instead of $K_{LTB} * L_{LTB}$. In the default case where L_{22} and L_{LTB} are determined automatically from the framing condition, they are equal and the results were not affected. However, for frame members for which point bracing or uniform bracing were specified, or whose unbraced lengths were overwritten, then the values L_{22} and L_{LTB} could be different, and the ϕ_b factor could have been incorrect.
7790	An incident has been resolved in steel frame design codes "AISC 360-16", "AISC 360-10", and "KBC 2016" in which the B1 factor was calculated based on the pure Euler buckling force P_{e1} with unmodified EI instead of EI^* when the Direct Analysis Method was used (AISC 360-16 Appendix 8.2.1, AISC 360-10 Appendix 8.2.1) with certain conditions. The results were affected when Direct Analysis Method was used with τ_b fixed or τ_b variable for either generalized second-order method or amplified first-order method of amplification. The results were not affected when Direct Analysis Method was not used or when Direct Analysis Method was used but no modification was assigned in the preferences. The resulting PMM ratio was slightly unconservative.
* 7895	An incident was resolved for steel frame design codes "Eurocode 3-2005" and "Italian NTC 2018" where the moment capacity reduction factor for shear, ρ , was being miscalculated as unity (1.0) for the case where $V_{Ed}/V_{pl,Rd} < 0.5$, but $V_{Ed}/V_{pl,T,Rd} > 0.5$. This affected the calculation of $M_{y,V,Rd}$. When $V_{Ed}/V_{pl,Rd} > 0.5$, or when $V_{Ed}/V_{pl,Rd} < 0.5$ and $V_{Ed}/V_{pl,T,Rd} < 0.5$, the calculated ρ factors were correct. However, the minor-direction ρ factor was incorrectly reported to be the same as the major direction ρ factor. In addition, and for the "Italian NTC 2018" code only, the value of η was always taken as 1.0 when calculating $V_{pl,Rd}$ and $V_{Ed}/V_{pl,T,Rd}$. Now η is taken as 1.2 for f_y less than or equal to 460 MPa and as 1.0 for f_y greater than 460 MPa. The calculation of η remains unchanged for the "Eurocode 3-2005" code. The result was on the unconservative side. The effect of these errors tended to be unconservative.
7930	An incident has been resolved for the steel frame design code "SP 16.13330.2017" where the ϕ_{iB} calculation was not correct for singly-symmetric I-shapes under certain conditions: (a) the shape was a singly-symmetric I-shape, (b) the narrower flange was under compression, (c) $n_{Coeff} = I_1 / (I_1 + I_2) < 0.7$, i.e., the flanges were not very different, (d) $L_{eff,LTB} > 5 * b_2$, where b_2 is the width of the narrower flange, and (e) bending moment was significant in the member. If all these conditions were met, then ϕ_2 calculated with equation SP 16.13330.2017 G.4 Eq. (G.7) should not be modified per section SP 16.13330.2017 Annex G.6. However, ϕ_2 was being modified per section SP 16.13330.2017 Annex G.6 for all cases. The effect was that ϕ_2 was being modified by a factor $(1.025 - 0.015 * L_{eff,LTB})$ when it should not have been, and eventually ϕ_{iB} was reduced per section SP 16.13330.2017 Table G.3. The results were slightly conservative for such a case.
8004	An incident was resolved for the steel frame design code "Chinese 2018" where the determination of β_t was not correct when there was a uniformly distributed lateral load on the span of the member. The value was correct when there was no lateral load on span or when there were one or more concentrated lateral loads on the span.

Documentation Incidents Resolved

* Ticket	Description
7581	An incident was resolved where the Help topics for the Advanced Foundation property incorrectly indicated that the soil springs created along the lengths of piles, pile piers, and shafts were of the type compression-only, when in fact they are linear springs that support tension and compression. Compression-only springs are only generated at the bottom and edges of footings and pile caps.

**External Import and Export
Incidents Resolved**

*	Ticket	Description
	7558	An incident was resolved that addressed several issues affecting the import of CIS/2 Step files: (1.) CIS/2 Step files containing print-control directives or character strings containing escape sequences specifying non-ASCII characters encoded per the ISO 10646 standard could not be imported into SAP2000. When this occurred, no imported model could be created. (2.) Character strings containing escape sequences specifying non-ASCII characters encoded per the ISO 8859 were imported without any conversion of the escape sequences into the characters they specified. When this occurred, the error had no impact on the results. Only the labels of imported entities were affected. (3.) As an enhancement, the error messages reporting fatal errors encountered while SAP2000 first parses a CIS/2 Step file now include the line number of the problematic line. Note that these error messages are distinct from other error messages reporting incomplete or otherwise incorrect entity definitions in the CIS/2 Step files, which already include the problematic entity number.
	7637	An incident affecting the export of models to CIS/2 Step files was resolved. SAP2000 exported all model point objects and frame objects, even when the Export Selected Objects option in the Create CIS/2 STEP File form was chosen. This affected all versions of SAP2000 capable of exporting models to CIS/2 Step files. SAP2000 now exports only the selected point and frame objects, plus their connected point objects, when the Export Selected Objects Only option is chosen.
	7666	An incident affecting the import of IFC files was resolved. IFC files with comments containing forward slashes could not be imported. This affected all versions of SAP2000 capable of importing IFC files. When the problem occurred, nothing was imported and the issue was obvious. Editing out the problematic comments from the IFC file in a text editor made it possible to import the file. IFC files with comments containing forward slashes are now correctly imported.

**Graphics
Incidents Resolved**

*	Ticket	Description
	7206	An incident was resolved where displaying the cable applied loads using the "Display > Show Object Load Assigns > Cable" menu command could result in an error when the loads were shown in certain coordinate systems, including the "Current Display System".
	7716	An Incident was resolved that corrected several issues affecting the display of curved members. These were display issues only, and no results were affected: (1.) Curved frame objects with non-prismatic sections were displayed with a jagged section profile that repeated the full non-prismatic variation multiple times along their lengths. They are now displayed with the correct section variation along their lengths. (2.) In views for which the Shrink Objects option had been selected, curved frame objects were each displayed as series of shrunken disjointed lines instead of a single continuous curve. They are now displayed as continuous curves. (3.) In views displaying frame-object end-offset assignments, curved frame objects were displayed as straight lines when the graphics mode was DirectX. They are now displayed as curves in such views, irrespective of the graphics mode.
	7904	An incident was resolved where when displaying frame releases in DirectX graphics mode all frames would be shown shrunken instead of only those with releases.
	8125	An incident was resolved that addressed the following issues related to the display of deformed shape when viewing the model in a user-defined coordinate system that was not parallel to the Global system: 1. For both DirectX and GDIPlus graphics modes, the extruded thickness direction was wrong for area (shell) objects. 2. For both DirectX and GDIPlus graphics modes, frame joint offsets were plotted in the wrong direction. 3. For both DirectX and GDIPlus graphics modes, the joint displacements were plotted in the wrong direction. 4. For DirectX graphics mode, the snap location at the deformed joints was wrong, making it difficult to view the displacement values under the mouse cursor. 5. For DirectX graphics mode, the axes at the origin were drawn in the were wrong direction.

**Loading
Incidents Resolved**

*	Ticket	Description
	7078	An incident was resolved where torsional load assigned to a frame member that was modeled as a truss element was not transmitted to the rest of the model for linear load cases, and hence the assigned load was effectively lost. By way of background, any frame element is automatically treated as a truss element if all the following conditions are met: (1) Both moments M2 and M3 are released at both ends, (2) torsion T is released at either end, (3) there are no end offsets, and (4) the insertion points are at the centroid of the frame section. Truss elements only have 6 force degrees-of-freedom, whereas regular frame elements have 12 degrees-of-freedom: 6 forces and 6 moments. Now an additional check has been added: if the load assigned to a frame element generates any torsional moment at the unreleased end, then that element will not be treated as a truss member and all 12 degrees-of-freedom will be included in the model. In this case the unreleased end must connect to other members with rotational stiffness in order to provide a stable structure and load path. This error affected linear load cases and both linear and nonlinear modal time-history load cases. Nonlinear static, staged-construction, and nonlinear direct-integration time-history load cases were not affected. Frame objects that meet the truss conditions but then are auto-meshed will create frame elements for analysis that do not meet these conditions due to moment continuity within the object, and hence auto-meshed frame objects were not affected by this error. This error affected versions v20.2.0 to v23.3.0. This error was not common.
	7170	An incident was resolved where, in very flexible diaphragms, the assumed distribution of wind load based on a semi-rigid diaphragm could excite local behavior, appearing as if a small eccentricity had been introduced. A better distribution that includes the extreme points is now implemented. Equilibrium was always satisfied.
	7876	An incident was resolved where an error was generated when attempting to run a multi-step load case containing an auto-wind load pattern that only had one wind angle (step).
	8099	An incident was resolved where the NBCC 2015 auto wind load based on the dynamic procedure was incorrect. The calculated pressure on leeward side was using the windward height instead of one-half of the distance from the input bottom story or minimum level to the input top story or maximum level.
*	8134	An incident was resolved where the behavior of an area element with a nonlinear layered-shell section property subjected to temperature loads was incorrect: (1.) In linear analyses, temperature loads were applied in both in-plane translational degrees of freedom in membrane- and shell-type layers even if the degrees of freedom were set as inactive. This behavior has been corrected so temperature loads only affect the active degrees of freedom of each layer. (2.) For a linear analysis where the stiffness of the layer was significantly different from the elastic stiffness of the material property assigned to the layer, the behavior of the layer under temperature load could be incorrect. This could occur if the layer had inactive or nonlinear degrees of freedom and the material had a non-zero Poisson's ratio, or if the linear analysis used the stiffness from the end of a nonlinear analysis. The magnitude of the error was proportional to the difference between the stiffness of the layer and the elastic stiffness of the material property assigned to the layer and, in most cases, was small. This issue has been corrected. (3.) Nonlinear static load cases with an Event-to-event only solution scheme could have additional equilibrium errors when temperature loads were applied. This only occurred for nonlinear layered shells and has been resolved. The behavior of other types of shells, such as the thin and thick shell, were not affected by this issue.
	8158	An incident was resolved for the Eurocode 8-2004 vertical elastic response-spectrum function where expressions 3.8, 3.9, 3.10, 3.11 were using a multiplier of 2.5 instead of 3.0.

Results Display and Output
Incidents Resolved

*	Ticket	Description
	1056	An incident was resolved where the stresses and strains reported in a degenerate solid element (one with two or more corners connected to the same joint) could be different at different element corners connected to the same joint. This was a reporting error only due to the extrapolation used from the 2 x 2 x 2 internal Gauss integration points. This does not otherwise affect the accuracy of the element or the results for the rest of the model. Note that the tetrahedron (four unique joints) produces constant stresses and strains, and hence was not affected. The pyramid (five joints), wedge (six joints), and transition (seven-joint) elements were affected.
	7254	An incident was resolved where specifying two or more quadrilaterals in a section-cut definition would not give any results. Section cuts defined with a single cutting quadrilateral were not affected by this issue.
	7511	An incident was resolved where the legend in the Response Spectrum Curves form incorrectly included a percent sign on the damping value.
*	7578	An incident was resolved in which an abnormal termination could occur when attempting to display the Tendon Response Form for a tendon with no assigned loads. This was not common.
	7841	An incident was resolved where certain quantities, such as section properties, were reported in the frame design details as zeroes when using larger length units because of a coarser zero tolerance for display. This was a display issue only, and design results were not affected. Changing to smaller length units for display would usually resolve the issue, and the values were correctly displayed in the tables.

Structural Model
Incidents Resolved

*	Ticket	Description
	6914	An incident was resolved for where a only a single frame-section property was being created for all the piles of all advanced-foundation properties, even if the pile-section dimensions were not the same in the different advanced foundations. Results agreed with the model as generated using the single frame-section property for all the piles. Models opened in the new version can be corrected by reassigning the advanced foundation properties to the connected joints. This process is not necessary if all advanced foundation properties use the same pile section.
	7534	An incident was resolved where (1) if auto select frame sections were assigned to steel members, and (2) an analysis and design were run that caused the design sections to be different from the analysis sections, and then (3) the analysis was rerun without unlocking the model, the software would give a message "There are no Load Cases to run." However, the analysis sections were already changed to reflect the design. This has now been corrected. Rerunning the model with or without unlocking the model will now cause any existing results to be deleted first if the analysis section changes require load cases to be run.
	7559	An incident was resolved where the shrinkage strain calculated using the Eurocode 2-2004 type time-dependent material property was larger than expected. This issue occurred due to an extra square root in the calculation for the beta_ds factor. Analysis results were consistent with the documentation, which was also incorrect. Both the shrinkage behavior in analysis and the documentation has been corrected to be consistent with Eurocode 2-2004.
	7672	An incident was resolved where section moduli imported from xml property files for double-channel sections were read in as zero and shown as such on the section properties form. This did not affect any analysis result, including frame stresses shown in the display, as the section moduli were recomputed. It was, however, substituted with a very small value in design and resulted in an overstress condition error. No other type of section was affected by this issue. This error got inadvertently introduced in v23.0.0 and did not affect earlier versions. Also any model containing this error will have the section moduli automatically recalculated and fixed when opened in v23.4.0. Affected versions are v23.0.0 to v23.3.1.

*	Ticket	Description
	7944	An incident was resolved where pipe section properties imported from library files were being overwritten by properties calculated using nominal dimensions. This only occurred if the pipe section was imported from a library in SAP2000 v23.1.0 to v23.3.1. Previous models with pipe sections were not affected. Pipe sections in affected models will now have their properties re-imported to be consistent with the library.

User Interface
Incidents Resolved

*	Ticket	Description
	7149	An incident was resolved where an abnormal termination could occur when trying to change the type of a load case from Modal to Response Spectrum or Time History if it was the only Modal load case defined. Now this operation is prevented and a message is presented indicating that it is not allowed. Because Response Spectrum and Time History load cases depend on a Modal case, this operation requires more than one Modal load case to be present in the model before one can be changed.
	7786	An incident was resolved where the "First Relabel Order" and "Second Relabel Order" items in the Interactive Name Change form (accessed through the Edit menu > Change Labels command) were not available when using any language other than English.
	7954	An incident was resolved where the font information for some of the items in the advanced report setup was not being displayed and saved correctly.