

# SAP2000® Version 19.0.0 Release Notes

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**Notice Date: 2016-11-16**

This file lists all changes made to SAP2000 since the previous version. **Most changes do not affect most users.** Incidents marked with an asterisk (\*) in the first column of the tables below are more significant.

## **Changes from v18.2.0 (Released 2016-08-19)**

### **User Interface**

#### **Enhancements Implemented**

*	Incident	Description
	13537	A change was made to the terminology for certain steel material properties, changing from "effective" to "expected" stress values. This is only a change of wording in the user interface and documentation to be more consistent with current codes and standards.
	95060	An enhancement was implemented to enhance several of the edit menu forms to allow them to remain open for repetitive use with a new apply button.
	95728	An enhancement was implemented to improve the speed of the Set 2D View form for large models. A feature was also added to determine the plane from a single click on the drawing form.
	97401	The Edit > Show Duplicates command has been changed to Select Duplicates. Previously, the Show Duplicates command highlighted objects of the same type that had the same connectivity by displaying them in a magenta color, but this color would disappear upon moving the mouse. The new command will highlight the duplicated objects by selecting them instead. This has the added advantage that they can be shown alone without the rest of the model (command Show Selection Only), displayed in a table, or otherwise manipulated. Another change was made to the "Merge Duplicates" command in that it will no longer merge joints in the same location that have different merge numbers. This is different from the "Select Duplicates" command which will select joints in the same location irrespective of the merge numbers.

### **Modeling**

#### **Enhancements Implemented**

*	Incident	Description
*	18878 37418 45772	An enhancement has been implemented to expand and enhance the hysteresis models for nonlinear energy dissipation. This enhancement applies to the nonlinear materials used in fiber hinges and the layered shell, to single degree-of-freedom (non-interacting) frame hinges, and to the multi-linear plastic link. These hysteresis models include: (1) Isotropic model, which dissipates the most energy; this was previously available only for frame hinges. (2) Kinematic model, typically suitable for metals; this was previously available. (3) Takeda model for simple degradation; this was previously available. (4) Pivot model, typically for reinforced concrete; this was previously available for hinges and links but not materials; the reloading behavior has been slightly modified so as to load from the pivot point to the backbone curve along the secant line, rather than along the backbone curve as done previously. (5) Concrete model, representing compression and tension behavior differently; this is new and similar to the model in Perform-3D; it can also be used in reverse to represent tension-only behavior. (6) Degrading model, capturing energy and stiffness degradation with kinematic behavior; this is new and similar to the model in Perform-3D. (7) BRB Hardening model, for representing buckling-restrained braces; this is new and similar to the model

*	Incident	Description
		in Perform3D. The behavior of the existing models has been improved for the cyclic behavior during strength loss.
	58601	An enhancement has been implemented to add A500 Grade C steel to the United States material library.
	67569	An enhancement has been made to update the frame hinge definitions to follow ASCE 41-13 guidelines. Older files with automated FEMA hinges will now follow the new guidelines. Also the performance point calculations for pushover curves have been updated to ASCE 41-13.
*	86202	A new parametric P-M2-M3 frame hinge has been implemented for use with performance-based design and other types of nonlinear analysis. This hinge can be used for double-symmetric steel and reinforced-concrete frame sections. The axial capacity can be different in tension and compression. The P-M2-M3 interaction surface is assumed to be smooth and is represented by a few simple parameters. Strength loss and energy degradation can be captured. Deformation capacities can be defined and reported as part of the performance checks. Parametric P-M2-M3 hinge properties can be user-defined or automatically created from frame sections.

## Section Designer

### *Enhancements Implemented*

*	Incident	Description
	94580	An enhancement has been implemented to import sections from DXF files into Section Designer. A list of importable entity types and the layers they are on in the DXF file is presented to the user. The user can specify the layers and the entity types from those layers to be imported and what Section Designer entities they should be mapped onto. As necessary, based on entity mapping, other parameters such as material, thickness, rebar designation, spacing, etc. can also be specified.

## Loading

### *Enhancements Implemented*

*	Incident	Description
	94048	An enhancement has been implemented to add automated wind load, seismic load, and response-spectrum function according to the NBCC 2015 code.
	95555	An enhancement was implemented to ignore marine growth when calculating buoyancy forces and also assume buoyancy forces to be zero for flooded objects.

## Frame Design

### *Enhancements Implemented*

*	Incident	Description
	31923	An enhancement was implemented for "Eurocode 2-2004" and "Italian NTC 2008" codes concrete frame design to provide a new overwrite for the value of $\tan(\theta)$ ( $\theta$ =angle between the concrete compression strut and the beam axis perpendicular to the shear force) which is used in the shear reinforcement calculation.
	96435	The automatic calculation of K-factors during frame design now accounts for the effect of frame property modifiers, whether assigned to frame objects or defined in frame section properties, or both. The K-factors computed for the frame object being designed can be affected by the relative stiffness of connected elements, and this is what has changed under this enhancement. Frame design results may be different in the present release compared to previous versions due to this change. No other results are affected.
	96699	An enhancement was implemented to reinstate the Italian UNI 10011 steel frame design. This was previously removed in v18.0.0.

## Analysis

### ***Enhancements Implemented***

<b>*</b>	<b>Incident</b>	<b>Description</b>
	45404 76493	An enhancement has been implemented that provides two alternatives to how frame nonlinear hinges are represented in the analysis model. Previously the hinge was internal to the frame element, but now the hinges may be modeled instead as a zero-length link elements connecting multiple frame elements that represent the full length of the member. The main reason for doing this is to allow nonlinear modal time-history analysis (Fast Nonlinear Analysis, FNA) to account for nonlinearities in frame hinges, as well as to provide more damping control for nonlinear direct-integration time-history analysis. This new feature are available only with the Ultimate license level. This change has several implications: (1) When performing FNA for such a model, it is important to use Ritz modal analysis to capture the modes that represent the link nonlinear deformations. (2) This approach introduces a very small amount of elastic flexibility at the hinge locations, which may cause slight differences in both linear and nonlinear behavior compared to a frame member without hinges. For the same reason, slight differences in results for all load cases may be expected from previous versions of SAP2000 in models having frame hinges. Isotropic hinges will now be slightly more flexible (previously they were rigid before yield), fiber and non-isotropic hinges will be slightly less flexible (these previously had some flexibility before yield). (3) Additional rotational mass degrees of freedom may be present at the hinge locations. (4) Convergence behavior should generally be improved for nonlinear static and direct-integration time-history load cases, particularly for cases where multiple hinges in the same frame object were dropping load at the same time. (5) For hinges modeled as links, the stiffness-proportional damping used for direct-integration time-history analyses may now be specified by the user to be proportional to the initial stiffness of the hinge (the current behavior), the tangent stiffness, or a mixture of the two. Tangent-stiffness damping is generally more realistic, but may increase computation time. Initial-stiffness damping generally leads to faster convergence during analysis, but may overestimate damping and hence be unconservative.
*	95529	The size of the saved analysis results files has been reduced for multi-step nonlinear static and nonlinear direct-integration time-history load cases. This will reduce the amount of disk space required for these types of load cases in models using non-isotropic single degree of freedom frame hinges, fiber P-M-M frame hinges, directional layered shell elements, and/or nonlinear link elements. Linear elastic shell and solid elements will also exhibit some reduction in disk-space requirements. This may also result in some speed increase when running the analysis and displaying results, particularly for load cases with many steps. The amount of data saved will be reduced for other types of elements in subsequent releases of the product.

## Results Display and Output

### ***Enhancements Implemented***

<b>*</b>	<b>Incident</b>	<b>Description</b>
*	40433 43668 47298 55092	Step-by-step energy plots are now available for nonlinear direct-integration time-history load cases and for nonlinear static/staged-construction load cases. Previously they were only available for linear and nonlinear modal time-history cases. In addition, plots of the input ground accelerations and/or load function are now available for nonlinear direct-integration time-history and nonlinear static load cases.

## Application Programming Interface

### ***Enhancements Implemented***

<b>*</b>	<b>Incident</b>	<b>Description</b>
	97339	An enhancement has been implemented to provide v18 API compatibility in v19. Tools built against the v18 API should continue to work in v19 without the need to change references or recompile.

*	Incident	Description
	97377	An enhancement has been implemented to add API functions for concrete frame design preferences and overwrites for the Hong Kong 2013 and TS 500-2000 codes.

**External Import/Export**

***Enhancements Implemented***

*	Incident	Description
	91404	An enhancement has been implemented to export curved frame members to the EXR file used by CSiXRevit.

**Miscellaneous**

***Enhancements Implemented***

*	Incident	Description
	95226	The version number has been changed to v19.0.0 for a new major update.

## User Interface and Display Incidents Resolved

*	Incident	Description
	93725	An incident has been resolved in which an abnormal termination could occur when trying to manipulate data in the table for an advanced extrusion path (command Edit > Extrude > Extrude {Objects} to {Objects} > Advanced > Define/Modify Path). This was a user interface error and did not affect analysis or design results.
	94548	An incident was resolved in which an abnormal error would occur on the staged construction load case definition form if a stage was defined with no stage data and the Modify button for the stage data was clicked. This was a user interface issue only and did not affect results.
	95197	An incident was resolved when area or line springs were assigned to the model, and no link objects were assigned to the model, then when creating the analysis model the visibility of the link elements that were created to model the line or area springs from the Display Options form could not be controlled because the appropriate checkbox was not enabled.
	95864 96680	An incident was resolved in which the program would terminate if a minimum value was specified larger than a maximum value, or in certain cases when two windowed selections were made on the View > Set Limits form. This was a user interface issue only and did not affect results.
	95757	An incident has been resolved in which some of the preference and overwrite items were not conditionally activated or deactivated when changing other items on the form.

## Graphics Incidents Resolved

*	Incident	Description
	88656	An incident was resolved for models containing solid objects in which saving the model with the option to not show the solids in the view and then reopening it would result in an abnormal termination.
	93176	An incident was resolved in which the display of the uniform to frame resultant area loading was not correct on certain members. This was a display issue only. This was previously fixed in v18.2.0 but inadvertently excluded from the release notes.
	96016	An incident was resolved in which the graphical display of applied lateral loads was not working. This was a graphical issue only and did not affect results.
	96098	An incident was resolved in which the graphical display was not updated to show selected area objects when using the Select > Select > Labels command. This was a graphical issue only.
	96132	An incident was resolved where area surface pressure loads applied to the bottom face of an area object were not displayed correctly using the Display Load Assigns by Load Pattern – All Objects form. When surface pressure loads on the bottom face were specified to be displayed the program showed loads on the top face.

## Drafting Incidents Resolved

*	Incident	Description
	96895	An incident was resolved in which solid objects would get selected using on-screen selection tools even when they were set to not be in view. This was inconsistent with how other objects were working.

## Modeling Incidents Resolved

*	Incident	Description
	94231 96686	An incident was resolved in which an error was generated when assigning a joint pattern in certain models.

## Section Designer Incidents Resolved

*	Incident	Description
	94833	An incident was resolved for Section Designer where the stress units were not converted correctly in the Steel Model Form such that stress value displayed at the bottom left corner of the steel stress-strain plot was not correct if the units were changed from the database units. Database units are those in effect when the model is first created and in effect each time the model is opened. This was a display issue only for the plot in this form and did not affect analysis results or any other display.
	96094	An incident was resolved for section designer where the section properties and the geometry of a section designer section containing two or more box shapes could be calculated incorrectly if two of the box shapes were attached along one edge and aligned on another edge. This was not common.

## Loading Incidents Resolved

*	Incident	Description
	87448	An incident was resolved for concrete frame design according to ACI 318-11 in which some of the automated load combinations that corresponded to dead + live + static earthquake were generated blank. The combinations were generated properly if the design code was changed to ACI 318-14. The blank combinations were producing zero forces. The error was inadvertently introduced in v18.0.0.
	94023	An incident was resolved where a combination that included seismic load as well as other lateral loads (wind or wave) may not get tagged as design type seismic and may not be considered for special seismic design requirements. This is not a common condition.
	96129 96592	An incident was resolved in which the area load to frames was applied in the opposite direction than expected when specified to be applied in the gravity projected direction.
	97248	An incident was resolved for the Peru NTE E.030 2014 response spectrum function where parameter $I_p$ was also used for parameter $R_0$ in the analysis instead of the specified $R_0$ value in the function form. The results were overly conservative. A work around was to convert the Peru NTE E.030 2014 response spectrum function to user defined.

## Analysis Incidents Resolved

*	Incident	Description
	40905	An incident was resolved where nonlinear static load cases using displacement control would sometimes fail to run when loads were applied only to solid, plane, or asolid objects. When this occurred the analysis log file (.LOG) would indicate that the monitored displacement was zero for that load case, and no results were available for the affected case.
	95495	An incident was resolved where the load assignment "Links - All" used for a modal load case (usually of type Ritz) was generating starting load vectors for all degrees of freedom (DOF) of link elements of type "Damper - Friction Spring", even when the DOF were linear or not selected. This had the effect of requiring more modes to achieve adequate static and dynamic load participation factors for the DOF that were actually nonlinear. Results were consistent with the modes calculated and the participation factors reported.
	96077	An incident was resolved where the reported stresses and element joint forces for plane and asolid types of area objects excluded the effects of temperature and strain loads when applied in a nonlinear static or direct-integration time-history load case. The error in the joint forces affected reactions at joints connected to plane/asolid objects, as well as section cuts through these types of objects. The effect of temperature and strain loads applied to plane/asolid objects upon the rest of the structure was correct, including all displacements and forces or stresses in all other elements. Only the stresses in the loaded plane/asolid objects themselves were

*	Incident	Description
		affected, as well as the connected joint reactions and section cuts. Results reported for linear load cases were not affected, nor were nonlinear modal time-history (FNA) load cases.
*	97759	An incident was resolved where incorrect results could be produced for iterative nonlinear direct-integration time-history load cases for models where all degrees of freedom were restrained. No other type of load case was affected. The joint displacements for these load cases did not necessarily match the applied ground displacements, or were not necessarily zero at joints without applied displacement load. Forces and stresses were consistent with the incorrect joint displacements. The incorrect displacement results were random and could vary from one run to the next. Only models where all degrees of freedom were restrained, whether explicitly or implicitly, were affected, which is not a common case. When this occurred, the error was obvious in that the joint displacements did not match the specified values, which could be zero.

## Frame Design Incidents Resolved

*	Incident	Description
	67836	An incident was resolved where analysis cases with loads that combined load patterns of different design types were not being tagged as "seismic" if seismic loads were present. They were being tagged as design type "other". This resulted in combinations including these analysis cases not being tagged as "seismic" in turn resulting in special seismic conditions in design not being triggered. This is not a common condition and would normally occur for nonlinear static cases which included load patterns of multiple design types.
	72147	An incident was resolved for concrete frame design according to the Italian NTC 2008 code in which the minimum flexural tensile steel reinforcement of a beam section was incorrect for seismic cases.
	87481	An incident was resolved where for steel, concrete, aluminum, and cold-formed steel frame design the framing type may not be reported correctly in the design details under certain conditions. This was a reporting issue only. The design was unaffected.
	89740	An incident was resolved for steel frame design according to AISC 360-10 in which the automated load combination that included roof live load was not correct. The load combination that includes dead, live, roof live, and wind should have been 1.2DL+1.6RL+/-0.5WL, but the program was assigning correct scale factors to DL and RL, and incorrect scale factors of 1.0 to the WL and 1.2 to the live load.
	90063	An incident was resolved for steel frame design according to the Italian NTC 2008 and Eurocode 3-2005 codes. The following three issues have been corrected: (1) For Italian NTC 2008 code only: The Nb,Rd for the angle sections for buckling about major and minor principle axes were based on purely $K_{33} * L_{33} / r_{max}$ and $K_{22} * L_{22} / r_{min}$ . They are now based on $Max(K_{33} * L_{33} \text{ and } K_{22} * L_{22}) / r_{max}$ and $Max(K_{33} * L_{33} \text{ and } K_{22} * L_{22}) / r_{min}$ . (2) For both codes: The reporting of the major and minor directions were reversed for the Double Angle sections while reporting the basic factors like K and L factors and Nb,Rd forces in the design details. (3) For Italian NTC 2008 code only: There was an error in the calculation of Weff. This has been fixed. It affected the calculation of Mc,Rd, Mv,Rd, Mn,Rd, and Mb,Rd for Class 4 sections.
	91360	An incident was resolved where the design overwrites for the shear capacities in AISC 360-10 and AISC 360-05 were not working. The program was always calculating these values.
	91929	An incident was resolved for steel frame design according to Eurocode 3-2005 in which the seismic provision related to the design of joints was incorrectly checked even for DCL structures. These special checks are needed only for DCH and DCM structures.
	94175 94940	An incident has been resolved for steel design based on the Chinese 2010 steel frame code. The following issues have been corrected/enhanced: (a) The error message "Section is slender" referred to several sections of the codes (GB50017 4.3.8, 5.4, GB50011 8.3.2, Table 8.4.1) for different types of structural forms and different types of shapes. Another section number (GB 50011-2010 section 8.4.1.2, Table 8.4.1) has been added to the list. (b) For concentrically braced frame, the program was reporting the axial force and the bending moments as zeros in

*	Incident	Description
		the detailed display even though they were non-zero. The error was limited to display only, and only for concentric braced frames. (c) The code has a limiting value of $100 \cdot (235/F_y)$ (GB 50017 5.4.5) for $D/t$ . Whereas the program was using the limit as $100 \cdot \sqrt{235/F_y}$ . The square root has been removed.
	95512	An incident was resolved for Eurocode 3-2005 and Italian NTC 2008 steel frame design codes where the reported shear areas were switched between major and minor axes. This was just a reporting issue and design was not affected.

## Results Display and Output

### Incidents Resolved

*	Incident	Description
	87991 95918	An incident was resolved where the soil pressure on-screen display was incorrect whenever multiple area springs were assigned to an area object. The display was correct only for the last spring assigned. All other results accounted for all the springs assigned and were not affected with this soil pressure display error.
	90124	An incident was resolved in which the shell design results did not display if other shell results were previously displayed with the option to show as arrows. This was a display issue only and did not affect results. This was previously corrected in v18.2.0 but inadvertently omitted from the release notes.
	91438	An incident was resolved where shell thickness overwrites using joint patterns incorrectly switched the thickness values assigned to the third and fourth joints of each quadrilateral element. For shell objects that were meshed into multiple elements, this error affected each individual element. Thickness overwrites specified directly for each node (joint) of the shell object were not affected, only those specified by reference to a joint pattern. Triangular elements were not affected. Other shell assignments using joint patterns were not affected, including joint offsets, temperature loads, and pressure loads.
	91746	An incident was resolved for steel frame design according to Eurocode 3-2005 in which the Shear Details table "Steel Details 3 - Shear Details - Eurocode 3-2005" always showed the design shears $V_{sdMajDsgn}$ and $V_{sdMinDesign}$ as equal to one. This was a display problem only and design calculations were not affected.
	95407	An incident was resolved in which the display of shell and solid stresses was not displaying arrows for $S_{Max}$ and $S_{Min}$ when requested. This was a display issue only and did not affect results.
	95158 95451 95816	An incident was resolved where the multi-value parameters in the Display Shell Stress form were not correctly enabled for enveloping load combinations. This was a user interface issue only and did not affect results.
	95861	An incident was resolved where errors would occur in the advanced report writer if a table defined in a saved report was not available or if there was a space at the end of the name of the saved report.
	95918	An incident was resolved where the soil pressure on-screen display was incorrect whenever multiple area springs were assigned to an area object. The display was correct only for the last spring assigned. All other results accounted for all the springs assigned and were not affected with this soil pressure display error.

## Database Tables

### Incidents Resolved

*	Incident	Description
	96565	An incident was resolved where printing tables to a text file from the table display form left off the first row of each table and had incorrect values in the units name row.

## Data Files

### Incidents Resolved

*	Incident	Description
	97180	An incident was resolved where the BSShapes2006.PRO file was defined in incorrect units. Imported sections were in millimeters instead of centimeters.

## Application Programming Interface

### Incidents Resolved

*	Incident	Description
	91975	An incident was resolved in the ExternalAnalysisResults.SetFrameForceMultiple API function in which an error was returned in certain cases.
	95470	An incident was resolved in which the API functions New3DFrame, NewBeam, NewSolidBlock, and NewWall were not available in the SapModel.File class, although they were documented. The functions are now available in the API.
	97279	An incident was resolved for the Application Programming Interface (API) where the argument "Duration" for functions GetStageDefinitions_1 and SetStageDefinitions was declared as Integer instead of Double. Similarly, the argument "Age" for functions GetStageData_1 and SetStageData_1 was declared as Integer instead of Double. These functions are members of SapModel.LoadCases.StaticNonlinear. Values that are set or returned by these functions are rounded to the nearest integer. This has been corrected in the newly provided functions GetStageDefinitions_2, SetStageDefinitions_1, GetStageData_2, and SetStageData_2 where arguments "Duration" and "Age" are declared as Double. The old functions are retained for backward compatibility, but use of the new functions is recommended to correct this issue. "Duration" and "Age" are specified as days, and the error could be significant for shorter time periods using non-integral numbers of days. Analysis results using the old functions will agree with the integer number of days actually set and visible in the load case definitions.

## External Import/Export

### Incidents Resolved

*	Incident	Description
	75203	An incident was resolved where exporting a level to SAFE was not working properly. Two issues have been corrected. (1) Area springs were not being exported and the user had to manually assign them in SAFE. Now area springs of type "Simple" applied to the top or bottom face of the area in the normal direction are exported. (2) An error was corrected in the export of loads if both a floor and a wall area were being exported with the export option "Floor load and Loads from Above" and the floor was internally meshed.
	94372	An incident affecting the import of Revit projects into SAP2000 was resolved. When a Revit project included curved walls, these walls were not imported. When this occurred, the error was obvious and the results agreed with the model. Revit curved walls are now imported as a tessellated series of plane area objects which approximate the original curved wall geometry.
	94228	An incident affecting the export of SAP2000 models to Revit was resolved. When a model containing line or area objects with a material of a symmetry type other than isotropic was exported, SAP2000 wrote an .exr file which CSiXRevit was unable to read. This affected all versions of SAP2000 supporting data exchange with Revit. When this occurred, the results were unaffected. Line and area objects with a material of a symmetry type other than isotropic are now omitted from the .exr files SAP2000 writes, and warnings notifying the user are included in the .exr log file SAP2000 also writes.

**Documentation**  
***Incidents Resolved***

*	Incident	Description
	94544	The Eurocode 2-2004 concrete frame design manual has been updated to document that the beam-column joint capacity check is also performed for ductility class medium moment resisting frames (DCM-MRF).