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• Multi-Processor / Multi-Thread Analysis Solvers; Fast, fast, fast analysis times and unmatched solution capacity
• Very large models
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• Reinforced Concrete, Steel and Aluminum Frame Design, Shell R.Concrete Design, Cold Rolled Steel Design
• Modal Analysis, Response Spectrum, Time History, Linear and Nonlinear Analysis, Pushover Analysis, Base Isolators, Viscous Dampers, Power Spectral Density, Staged Construction, Explosion Analysis, Time dependent Creep and Shrinkage
• MODEL-ALIVE™ Option in SAPFIRE: The Model-Alive feature provides continuous updating of the model during development and editing, automatically re-running the analysis for every revision so that model changes are easily evaluated.

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**Multi-Processor / Multi-Threading Analysis Solvers:** Fast, fast, fast analysis times and unmatched solution capacity • Very large models • Nonsymmetrical and Symmetrical Structures • Design of Bridges, Industrial Structures, Transmission Towers, Machine Foundations, Piled Foundations, Stacks, Cooling Towers, Water Dams, Power Facilities, Cable Structures, Sports Facilities, Performance Venues and other Special Structures • Reinforced Concrete, Steel and Aluminum Frame Design, Shell R. Concrete Design, Cold Rolled Steel Design • Modal Analysis, Response Spectrum, Time History, Linear and Nonlinear Analysis, Pushover Analysis, Base Isolators, Viscous Dampers, Power Spectral Density, Staged Construction, Explosion Analysis, Time dependent Creep and Shrinkage • **MODEL-ALIVE™ Option in SAPFIRE**; The Model-Alive feature provides continuous updating of the model during development and editing, automatically re-running the analysis for every revision so that model changes are easily evaluated.

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SAP2000 represents the most sophisticated and user-friendly release of the SAP series of computer programs. When initially released in 1996, SAP2000 was the first version of SAP to be completely integrated within Microsoft Windows. It features a powerful graphical user interface that is unmatched in terms of ease-of-use and productivity. Creation and modification of the model, execution of the analysis, and checking and optimization of the design, and production of the output are all accomplished using this single interface. A single structural model can be used for a wide variety of different types of analysis and design.

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**Program Levels and Features**

The latest release of SAP2000 is available in three different analytical levels that all share the same graphical user interface: **SAP2000 Basic, SAP2000 PLUS and SAP2000 Advanced**. All of these programs feature sophisticated capabilities, such as fast equation solvers, force and displacement loading, non-prismatic frame elements, tension-only braces, line and area springs, post-tensioning tendons, highly accurate layered shell elements, Eigen and Ritz modal analysis, multiple coordinate systems for skewed geometry, many different constraint options, the ability to merge independently defined meshes, a fully-coupled 6-by-6 spring stiffness, and the option to combine or envelope multiple dynamic analyses in the same run.
The SAP2000 PLUS (P) program adds unlimited capacity, bridge live-load analysis capabilities, a complete range of finite elements, frequency-domain analysis (both steady-state and power-spectral-density types) and time-history and buckling analysis options. Ground motion effects with multiple base excitations can be included.

The SAP2000 Advanced (A) level extends the PLUS capabilities by adding a 64-bit based analysis engine (requires a 64-bit processor), a nonlinear link element (gaps, hooks, isolators, dampers, and multi-linear plasticity), a multi-linear plastic hinge for use in frame elements, a fiber hinge, a catenary cable element, a nonlinear shell element, and geometric nonlinearity. Analysis capabilities include static nonlinear analysis for material and geometric effects, including pushover analysis; and nonlinear time-history analysis by modal superposition or direct integration.

In general, the Advanced program is required to perform nonlinear analyses, with the exception being that a nonlinear analysis may be run in any of the three program levels for p-delta analysis, and when using tension/compression only frame members.

All of the above programs feature powerful and completely integrated design for steel, concrete, aluminum, and cold-formed steel, all available from within the same interface used to create and analyze the model. The design of steel and aluminum frame members features initial member sizing and iterative optimization. The design of concrete frame members includes the calculation of the amount of reinforcing steel required. Design stresses and tension reinforcing for concrete shells may also be displayed, calculated from the resolved tension-compression couple. Members can be grouped for design purposes, and a single mouse click on an element accesses the detailed design calculations. A wide variety of the latest national and international design codes are supported, and more are being added all the time.

Additional add-on modules, which integrate completely within the SAP2000 interface, are available for the following: Object-based bridge design (BrIM – Bridge Information Modeling) (BR), Staged construction, with time-dependent effects, Offshore/wave loading.

All SAP2000 data, including model information, analysis results, and design results, can be accessed using a tabular data structure. Tabular data can be edited and displayed in the interface, or exported to a Microsoft Access database file, a Microsoft Excel spreadsheet file, or a simple text file. Data can be exported to create reports or to perform specialized calculations. This same tabular data can be imported into SAP2000, enabling models to be generated or modified outside SAP2000. Import and export capabilities also exist for other popular drafting and design programs.
An Open Application Programming Interface (OAPI) is available for SAP2000. The OAPI provides developers of products for CADD and 3D modeling seamless and efficient access to all of the sophisticated analysis and design technology of SAP2000. Third-party developers can now create rich and tight two-way links with SAP2000, allowing for accurate transfer of models into SAP2000, complete control of SAP2000 execution, and extraction of analysis and design information from SAP2000, all from within their applications. The OAPI is compatible with most major programming languages, including Visual Basic Applications (VBA). Anyone familiar with Visual Basic programming should find the SAP2000 OAPI syntax easy and intuitive.

The SAP name has been synonymous with state-of-the-art analytical solutions since the introduction of SAP, SOLIDSAP, and SAP IV more than thirty years ago, followed by its implementation on the PC with SAP80 and SAP90. To those sophisticated numerical techniques, SAP2000 adds a tremendously easy and complete graphical user interface linked with powerful design capabilities. The result is an analysis and design program unequaled in efficiency and productivity that is used by thousands of engineering firms in more than one hundred countries.

From its 3D object based graphical modeling environment to the wide variety of analysis and design options completely integrated across one powerful user interface, SAP2000 has proven to be the most integrated, productive and practical general purpose structural program on the market today.

This intuitive interface allows you to create structural models rapidly and intuitively without long learning curve delays. Now you can harness the power of SAP2000 for all of your analysis and design tasks, including small day-to-day problems. Complex Models can be generated and meshed with powerful Templates built into the interface.


SAP2000 is for everyone! SAP2000 is for every project! From a simple small 2D static frame analysis to a large complex 3D nonlinear dynamic analysis, SAP2000 is the answer to all structural analysis and design needs.
SAP2000 ANALYSIS

- Static Analysis with Frame, Shell and Solid Objects
- Response Spectrum Analysis with Eigen or Ritz Vectors
- P-Delta + Large displacement Analysis • Joint Constraints including Rigid Bodies & Diaphragms • Applied Force and Displacement Loading • Gravity, Pressure and Thermal Loading • Layered Shell Element • Plane, Asolid and Solid Objects (A, P) • Time History Analysis, including Multiple Base Excitation (A, P) • Post Tensioning in Frame, Area and Solid Objects • Relaxation & Anchorage Slip Losses in Tendons (A, SC) • Frequency Domain Analysis – Power Spectral Density (A, P) • Moving Loads (A, P, BR) • Time Dependent Concrete Creep & Shrinkage Effects (A, SC) • Frame Hinges for Axial, Flexural, Shear & Torsional Behavior (A) • Nonlinear Static Pushover Analysis (A) • Viscous Dampers (A) • Fiber Hinges (A) • Base Isolators (A) • Gap Object for Structural Pounding (A) • Dynamic Effects of Moving Loads (A, P, BR) • Segmental Construction Analysis (A, SC) • Time History with Wilson FNA or Direct Integration Methods (A) • API Simplified Fatigue Analysis (A, OS) • New deformation loads for Frame and Cable elements • Automatic iteration for target forces in Frame and Cable elements

- Multi-Processor /Multi-Threading Analysis Solvers- Lightening fast analysis times and solution capacity 64 bit and multi-processor/multi-threading algorithms. Numerous enhancements have been made in the analysis to increase efficiency and minimize memory usage. New analysis features include: New Solver - Added alternate solver for extremely efficient runtimes and storage utilization • New Eigen Solver - Added alternate Eigen solver for efficient solution of systems with large variations in stiffness and mass properties • Static and/or dynamic response spectrum analysis • Blocked active column equation solver • Automated fast profile optimization • Generalized joint constraint options including rigid bodies, diaphragms, rods and welds • Applied force and applied displacement loading • Gravity, pressure and thermal loading • Eigen analysis with an accelerated subspace iteration algorithm • Ritz analysis for fast predominant mode evaluation for earthquake loads • Multi-directional response spectrum analysis • Multiple response spectrum cases in single run • Modal combination by the SRSS, the CQC or the GMC (Gupta) method • Directional combinations by the ABS or the SRSS method • Static and dynamic response combinations and envelopes • Control over selective execution of analysis cases • Automatic multiple run batch capability from inside GUI • Variety of built in response spectrum input functions • Hyperstatic analysis for secondary effects of prestressing forces • Soil (area) springs can now be tension-only or compression-only springs • Improved automated load combinations for design • Enhanced display of failure modes for steel-frame design

BUCKLING ANALYSIS: Buckling Analysis Around Any Nonlinear State (A) • Element-Based P-Delta Effects for Local Buckling Instabilities (A)

P-DELTA + LARGE DISPLACEMENTS ANALYSIS: Large Displacement/Small Strain Analysis (A) • Nonlinear Large Rotations Cable Analysis (A)


DYNAMIC TIME HISTORY ANALYSIS: Ground acceleration excitation • Multiple base excitations • Load forcing functions • Transient or steady-state • Multiple Time History Cases • Time history Windows
AVI file • Graphic displays of nodal and element time history records • Functions vs time or function vs function displays • Generation of response spectrum curves for any joint acceleration component • Results can be combined with other loads for enveloping or step by step steel and concrete design • Variety of built in input functions for time history analysis

MOVING LOADS ANALYSIS: Vehicles can load frames, shells or solids • Three dimensional influence surfaces • Vehicle width effects included • Live-load analysis includes transverse positioning of the vehicles • Alternate Moving-load analysis using Multi-step loading (static or dynamic) • Support for AASHTO-LRFD and BS 5400-2 • Moving-load response available for section cuts • AASHTO, User-defined truck, lane and train loads • Determination of maximum and minimum displacements and reactions • Capable of handing complex lane geometries • Automatically calculates all possible permutations of traffic loads • Results can be combined with other loads for enveloping or corresponding components for steel and concrete design

NONLINEAR MATERIAL BEHAVIOR ANALYSIS:
Pushover Analysis Using Fiber Models (A) • Viscous Damper with Nonlinear Exponent on Velocity Term (A) • Base Isolator with Biaxial Plasticity Behavior (A) • Hinges offer P-M-M Interaction with Moment-Curvature (A) • Section Designer – Mander Model for Confined Concrete (A) • Pivot-Hysteresis and Takeda Models for Plastic Link Behavior (A) • Double-Acting Friction Pendulum Isolators (A)
MODELING and USER FRIENDLY GRAPHICAL INTERFACE (GUI):

More responsive graphical user interface • Enhanced OpenGL graphics • External tools developed by third parties can be accessed in SAP2000 • Open API functionality is complete and available without additional license • Users can add their own documents to be accessed through the SAP2000 Help menu • Export of geometry and element connectivity to CSI Perform-3D • Enhanced import of legacy program models • Powerful and completely integrated design modules for steel, Aluminum, cold formed steel and concrete, all available from within the same interface used to create and analyze the model • The design of steel frame members features initial member sizing and iterative optimization • The design of concrete frame and shell members includes the calculation of the amount of reinforcing steel required • Members can be grouped for design purposes, and a single mouse click on an element brings up the detailed design calculations • On-the-fly working plane for modeling at arbitrary orientations • Numerous new selection methods added, including parallel to object, polygon fence and poly-line intersection, and by supports and constraints • "Fly" through models using user-defined paths • Selection by any combination of input or output values using database tables • Right-button information forms now allow easy editing of all items • Materials and Frame Sections redone to improve usability • User notes can be added to all properties • Fireproofing assignment added to frame objects • Automated undeformed geometry modifications using displaced shape • User created documents now can be accessed through the SAP2000 Help menu • Export of geometry and element connectivity to CSI Perform-3D • Enhanced import of input files from STAAD.Pro, GTSTRUDL, NASTRAN, etc. • DXF export for finite element stress contour arrows for 2D and 3D views • Export structural model data for use with soil-structure interaction product, SASSI • Faster graphical user interface and enhanced OpenGL graphics

PARAMETRIC STAIRS TEMPLATES

MODELING: MODEL-ALIVE Option - True to our tradition, we are, once again, advancing the state-of-the-art of numerical analysis with the introduction of the Model-Alive™ feature in SAPFIRE™ ~ CSI’s Analytical Engine. Taking advantage of current advances in numerical methods and hardware technology this option provides instantaneous re-analysis and updating of the current displays following any change made to the model by the user • The Model-Alive feature provides continuous updating of the model during development and editing, automatically re-running the analysis for every revision so that model changes are easily evaluated • Object Based Graphical Interface • Model Templates with Auto Meshing • Frame, Cable and Tendon Members • Area (Shell) and Solid Objects with Internal Meshing • Integrated Graphical Section Designer for Complex Frame Shapes • Bridge Wizard for Bridge Modeling (A, P, BR) • Editing with Move, Merge, Mirror and Replicate • Accurate Dimensioning with Guidelines and Snapping • Auto Edge Constraints for Mismatched Shell Meshes • Quick Draw Options for Object Creation • Tendons in Frame, Shell and Solid Objects • Parametric Bridge Cross Sections (A, P, BR) • Support for Multiple Coordinate Systems • Powerful Grouping and Selection Options • Definition of Highway Layout Lines (A, P, BR) • Automatic Generation of Code Lateral Wind and Seismic Loads • Wind Loads on Open Structures • Transfer of Loads from Area Objects to Framing Systems •
Application of Lane Loads to Bridge (A, P, BR) • Cracked Properties – Property Modification Factors • Gravity, Pressure and Thermal Loading • Line and Surface Multi-Linear Springs (A) • Staged Construction Analysis (A, SC) • Wave Generator (A, OS) • Parametric Tendon Layout for Box Girders (A, P, BR)

DISPLAY: • 3D Perspective Graphical Displays • Static Deformed and Mode Shapes • Display of User Defined and Automated Loads • Animation of Model • Force Diagrams and Stress Contours • Tabular Display of Model Input & Output • Graphical Section Cut Definitions for Forces and Stresses • OpenGL Viewer • Analysis Case Tree Display • Display of Displacement and Force Time History Records (A, P) • Time History AVI Files (A, P) • Lane Loads, Influence Surface Plots (A, P, BR) • Nonlinear Force-Deformation Plots (A).

SAP2000 DATA EXCHANGE: Interactive Database Editing for Model Creation/Editing • Import/Export Model to Access Database (.mdb) • Import/Export Model to Excel Spreadsheet (.xls) • Cut & Paste Portions of Model to Excel Spreadsheet for Editing • Import/Export Model in CIS/2 STEP File Format • Data Exchange Using IFC Standard • Steel Buildings Detailed in ProSteel 3D using an Import/Export link • Export Steel Models in the Steel Detailing Neutral File Format, TEKLA (OAPI <> • Import Files in the following program formats: AutoCAD (.dxf), FrameWorks Plus, IGES (.igs), Nastran.dat, Strudi/Staad (.std/.gti), Prosteel, • Export Files in the following program formats: AutoCAD (.dxf), FrameWorks Plus, IGES (.igs), Prosteel, Capture graphics of any SAP2000 Window. Export slab to SAFE
SAP2000 DESIGN

NEW AUTOMATED LATERAL LOADS: Automatic generation of lateral National loads for design • IBC 2006 Seismic load and response spectrum function • IBC 2006 Wind load

STEEL, CONCRETE, ALUMINUM and COLD FORMED SECTION DESIGN

MODELING & DESIGNING STEEL FRAMES: Integrated Object Based Steel Frame Models
- Lateral Displacement & Period Control • Automatic Generation of Code Lateral Wind and Seismic Loads • Automatic Transfer of Vertical Loads from Floor Decks to Frames • Steel Frames Interacting with Complex 2D and 3D Shear Walls

STEEL FRAME DESIGN FEATURES: Fully Integrated Steel Frame Design • Automatic Member Sizing – No Preliminary Design Required • Virtual Work Based Optimization for Lateral Deflections • Grouping of Members for Member Sizing • Structural Steel Design Codes: AISC 360-05/IBC2006 with seismic provisions • Direct Analysis Method of AISC 360-05 code - Includes small P-delta effect • Automated inclusion of stiffness modification factors, with user control - Design-decision guidance on when Direct Analysis Method is needed • CAN/CSA-S16-01 with seismic provisions, Canadian NBCC 2005 with wind loads, seismic loads, and response-spectrum functions • Enhanced design of eccentrically braced frames for AISC 360-05/IBC 2006 AISC-ASD & LRFD, UBC, AASHTO Steel 04, AISC-ASD01, AISC ASD89, AISC-LRFD99, AISC-LRFD93, API RP2A-LRFD97, API RP2A-WSD2000, ASCE 10-97, BS5950 90, BS5950 2000, CISC95, EUROCODE 3, Indian IS 800-1998, Italian UNI 10011, UBC97-ASD, UBC97-LRFD, IBC 2003 Wind and Seismic loads, Design of power transmission towers and similar structures (ASCE-10-97 2000), API Tank Design, Open Structure wind loading for the API 4F 2000 code • International Building Codes, British, Canadian, Italian, Indian and Eurocodes • Code Dependent or User Defined Loading Combinations • Interactive Options for Design and Review • Design for Effects of Torsion • Includes small P-delta effect • Automated inclusion of stiffness modification factors, with user control • Design-decision guidance on when Direct Analysis Method is needed • Load combinations can be converted to nonlinear load cases for advanced design • Improved automated load combinations for design • Enhanced display of failure modes for steel-frame design • Hyperstatic analysis for secondary prestress forces • Steel Frame Design Offers Automatic Member Selection • API Punching Shear Checks • Automated Effects of Panel-Zone Deformations on Lateral Drift • Design for Static and Dynamic Loads • Straight & Curved Girder Design (A, P, BR) • Automatic Calculation of Moment Magnification Factors • Automatic Calculation of K-Factors & P-Delta Effects • Virtual Work Based Optimization for Lateral
Deflections • Fully interactive and graphical steel and concrete frame member design • Design for static, moving and dynamic (response spectrum and time history) loads • Ductile and non-ductile design • Member grouping for design envelopes • Detailed onscreen design information with right button click • Steel member selection and optimization • Graphical section builder for built-up sections and concrete rebar location • Biaxial moment-axial load column interaction diagrams.

**STEEL SEISMIC FRAME DESIGN FEATURES:** Response Spectrum and Time History Based Structural Dynamics • Seismic Requirements for Special Moment-Resisting Frames • Design of Intermediate/Special Moment-Resisting Frames • Interactive Evaluation of Floor Diaphragm Shears Using Section Cuts.

**STEEL FRAME DESIGN OUTPUT FEATURES:** Controlling Steel Member Sizes • Color Coded Controlling Steel Stress Ratios

**STEEL DETAILING DATA FEATURES:** IFC • CIS/2 • TEKLA • ProSteel 3D • Steel Detailing Neutral File (SDNF) • FrameWorks Plus

**ADVANCED FEATURES FOR STEEL STRUCTURES:** Effects of Construction Sequence Loading (A) • Effects of Panel-Zone Deformations on Lateral Displacement • Eccentricities Due to Changes in Member Dimensions • Analytical Effects of Member Centerline Offsets In 3D • Effects of Beam-Column Partial Fixity • Three-Dimensional Pushover Analysis (A) • Buildings/Bridges with Base Isolation and Dampers (A) • Element-Based P-Delta Effects for Local Buckling Instabilities (A)

**SAP2000 COLD-FORMED STEEL DESIGN CAPABILITIES**

**MODELING & DESIGNING COLD-FORMED STEEL FRAMES:** Integrated Object Based Cold-Formed Steel Frame Models • Lateral Displacement & Period Control • Automatic Generation of Code Lateral Wind and Seismic Loads • Transfer of Vertical Loads from Area Objects to Framing Systems • Cold-Formed Steel Frames Interacting with 2D and 3D Shear Walls

**COLD-FORMED STEEL AND ALUMINUM FRAME DESIGN FEATURES:** Fully Integrated Cold-Formed Steel Frame Design • Virtual Work Based Optimization for Lateral Deflections • U.S.A. Alum. Assoc. AISI – ASD 1996 (Add. 1999), AISI – LRFD 1996 (Add. 1999) ASD 2000, LRFD 2000 • Design for Static and Dynamic Loads • Code Dependent or User Defined Loading Combinations • Automatic Calculation of K-Factors & P-Delta Effects • Integrated Section Designer for Composite & Built-Up Sections • Interactive Options for Design and Review • Design for Effects of Torsion

**COLD-FORMED STEEL SEISMIC FRAME DESIGN FEATURES:** Response Spectrum and Time History Based Structural Dynamics

**COLD-FORMED STEEL FRAME DESIGN OUTPUT FEATURES:** Color Coded Controlling Cold-Formed Steel Stress Ratios
COLD FORMED RACKING ANALYSIS AND DESIGN

COLD-FORMED STEEL DETAILING FEATURES: IFC • CIS/2

POWER FEATURES FOR COLD-FORMED STEEL STRUCTURES: Eccentricities Due to Changes in Member Dimensions • Analytical Effects of Member Centerline Offsets In 3D • Effects of Beam-Column Partial Fixity • Element-Based P-Delta Effects for Local Buckling Instabilities

SAP2000 CONCRETE FRAME AND SHELL DESIGN

MODELING & DESIGNING CONCRETE FRAMES:
• Integrated Object Based Concrete Models
• Special Modeling of Concrete Frame Systems
• Cracked Properties – Property Modification Factors
• Automatic Generation of Code Lateral Wind and Seismic Loads
• Automatic Transfer of Vertical Loads to Framing Systems

CONCRETE FRAME DESIGN FEATURES: Fully Integrated Concrete Frame Design • Concrete Design Codes: AASHTO Concrete 97, ACI 2005/IBC 2006, ACI 318-05/IBC 2003, ACI 318-02, ACI 318-99, BS 8110 89, BS 8110 97, Canadian 2004, CSA CSA-A23.3-94, EUROCODE 2, Indian IS 456-2000, Italian DM 14-2-92, KCI-1999, Mexican RCFD 2001, NZS 3101-95, UBC 97, Chinese • Seismic Check of Beam/Column Joints in Concrete Frames • P/T Concrete Box Girder Design (A, P, BR) • Strength & drift controlled optimization • Concrete Shell Design - Display showing required rebar intensity and maximum concrete stress • Layered Shell Element • Design for Static and Dynamic Loads • Grouping for Design Envelopes • Automatic and User Defined Loading Combinations • Designed for Biaxial-Moment/Axial-Load Interaction & Shear • Automatic Calculation of Moment Magnification Factors • Magnification Override Option with the Evaluation of P-Delta Effects • Integrated Section Designer for Complex Concrete Sections • Generation of Biaxial-Moment/Axial-Load Interaction Diagrams • Interactive Options for Design and Review • Design for Effects of Torsion
CONCRETE SEISMIC FRAME DESIGN FEATURE: Dynamic Analysis – Response Spectrum and Time History • Design of Intermediate/Special Moment-Resisting Frames • Seismic Check of Beam/Column Joints • Seismic Check for Strong-Column/Weak-Beam Design • Evaluation of Concrete Floor Diaphragm Shears Using Section Cuts

CONCRETE FRAME DESIGN OUTPUT FEATURES: Biaxial-Moment/Axial-Load Interaction Diagrams • Longitudinal Reinforcing Requirements at User Defined Stations • Shear Reinforcing Requirements at User Defined Stations • Graphical Displays of Reinforcing Layouts • Design for Static and Dynamic Loads • Automatic and User Defined Loading Combinations • Reinforcing Steel Intensity Diagrams for Concrete Shells

POST TENSIONING: Tendons in frame, shell, solid elements • Creep, shrinkage, relaxation, anchorage slip, elastic shortening losses • Tendons can be placed with arbitrary geometry

ADVANCED FEATURES FOR CONCRETE STRUCTURES: Effects of Construction Sequence Loading (A) • Effects of Time Dependent Creep & Shrinkage (A) • Automated Effects of Panel-Zone Deformations on Lateral Drift • Meshing Techniques for Shear Walls and Floors • Models Using Edge Constraints • Eccentricities Due to Changes in Member Dimensions • Analytical Effects of Member Centerline Offsets In 3D • Three-Dimensional Pushover Analysis (A) • Buildings/Bridges with Base Isolation and Dampers (A) • Element-Based P-Delta Effects for Local Instabilities (A)

SHELL REINF. DESIGN:

COOLING TOWER ANALYSIS AND DESIGN H=135 m

Shell reinforcement at all directions considering concrete cover, section forces (F11, F22, F12, M11, M22, M12). Display of reinforcement contours for both sides, both directions, layered nonlinear Shell element.
SECTION DESIGNER: Integrated generation of arbitrary and complex steel and concrete cross sections • Parametric shape generation • Section property calculations • Three dimensional axial force and biaxial interaction diagrams • Moment-curvature relationships • Frame element fiber hinges for arbitrary sections can be defined using Section designer • More control over material properties, including Mander model for all sections • Powerful Graphical Interface for Locating Reinforcement • Calculates Section Properties, Biaxial Moment & Interaction Curves • Moment curvature curve and PMM interaction surface for arbitrary fiber sections • Enhanced control over material properties, including Mander model for all sections • GUI now allows for overlapping shapes and improved Boolean operations • Properties for concrete only sections, steel encased sections and steel only sections • Properties for CALTRANS bridge sections, with or without prestressing tendons • Enhanced performance and efficiency

AUTOMATED and CUSTOMIZED REPORT GENERATION: Quick and easy generation of final printed reports • Cover sheet • Formatted tables of model definition, analysis and design results • Graphical displays • Detailed design sheets • Can use predefined report, or customize with complete control • Generation of analysis and design reports in customizable format • Output to Word (RTF), Internet Explorer (HTML), text editor and printer • Any input or output table may be added to report • Information in the tables may be filtered and sorted • Display units may be user specified for any numerical field in a table • Quick and easy generation of final printed reports with complete user control • Cover sheet identifying project, user and company • Formatted tables of model definition, analysis and design results • Typical graphical displays of the model • Output sheets of detailed design information
SAP2000 ELEMENTS / OBJECTS:

LINE OBJECTS: The 2D and 3D Beam and Truss Element: Curved beam element • Multiple non-prismatic segments over element length • Point, uniform and trapezoidal loading in any direction • Temperature and thermal gradient loading • Prestress loading • Automated end offset evaluation • Moment and shear releases • Built-in steel sections • Frame member cardinal points and joint offsets.

AREA OBJECTS: The 3D Shell Element: General double curved quadrilateral or triangular element • Layered Shell Element • Orthotropic materials • Six degrees of freedom per joint • Shell, plate or membrane action • Gravity, uniform, pressure, temperature and thermal gradient loading

ANALYTICAL MODEL: Spring assignments to Line, Area and Solid objects can now be distributed, nonlinear links • Null property assignments to Line and Area and Solid objects are now allowed • Analysis model (element level) displays, including loads and assignments • Analysis model information available for any element with a right-button click

POINT OBJECTS: The Spring Element: Joint to ground (support) spring with gap element• Automatic spring calculation from foundation surface • Global and skewed springs • Coupled 6x6 user defined spring stiffness option (for foundation modeling) • Fully-coupled 6x6 linear spring and dashpot • Link degrees of freedom can be rigid to act as constraints or restraints

ASOLID ELEMENT: 3 to 9 nodes axisymmetric element • Orthotropic material properties • Gravity, thermal, surface pressure and pressure gradient loading options

SOLID Element: Three dimensional 8 node brick element • Anisotropic material properties • Gravity, thermal, surface pressure and pressure gradient loading options.
SAP2000 ADVANCED and NONLINEAR ELEMENTS

SAP2000 Advanced extends the capabilities of the PLUS version to include following nonlinear analysis options.

The Frame Plastic Hinge Element for use with Static Pushover Analysis: Axial, flexural, shear and torsional hinge • Axial load - biaxial moment interaction • Multilinear behavior including softening • P-Delta options

Pushover Analysis Options: Static Pushover Analysis starting from gravity loads • Force or displacement control • User defined lateral load patterns • Effective damping computations • Capacity Spectrum computation • Demand-Spectrum computation • FEMA 356 Hinges • Force Controlled Hinges • Caltrans Column Section Hinges • Fiber Hinges • Improved Pushover Hinge Results Display • ATC 55/FEMA 440 support

The SAP2000 Nonlinear Link Element for use with the dynamic time history analysis option: Link may be placed between any two joints or from joint to ground • Viscous damper with nonlinear exponent on velocity term • Gap (compression only) and Hook (tension only) • Uniaxial plasticity (all 6 degrees of freedom) • Base isolator with biaxial plasticity behavior • Base isolator with friction and/or pendulum behavior • AVI file option for creating real time displays of nonlinear deformation behavior • Force versus Deformation plots of nonlinear systems for energy dissipation studies.

Other features: Large deformation cable element • Tension only/compression only frame elements • Nonlinear dynamic direct integration time history analysis • Static and dynamic large displacement analysis across all element types • Stiffness and mass proportional damping • Nonlinear buckling analysis • Steady-State analysis with damping • Frame and shell property modifiers for cracking.
The Bridge Design Module adds capability to easily model complicated bridge geometry using Bridge Designer’s terminology. Specifically included are:  
- Bridge Wizard with Step by Step Guidance to Create a Bridge Model  
- Parametric Bridge Model Templates  
- Highway Layout Lines  
- Definition using Horizontal & Vertical Curves  
- Super Elevations and Skews  
- Parametric Cross Sections – Box Girders & Steel Composites  
- Cross Sections May Vary Along Bridge Length  
- Parametric Post Tensioning Tendon Layout for Box Girders  
- Abutments with User Defined Support Conditions  
- Bents with Single or Multiple Columns  
- Hinges  
- Layered Shell Element  
- Lane Definition Using Highway Layout or Frame Objects  
- Automatic Application of Lane Loads to Bridge  
- Predefined Vehicle and Train Loads  
- Parametric cross-section definitions  
- Cross-section parameters can vary along length of bridge  
- Bridge definition includes spans, abutments, hinges, bents and superelevation  
- Abutments, bents and hinges can be skewed  
- Post-tensioning layout  
- Automatically creates spine (frame), shell or solid-element models  
- Structural model can remain linked to Bridge objects for quick editing  
- Display of integrated forces and stresses along bridge  
- Detailed design checking has been implemented for multi-cell prestressed-concrete box-girder bridge superstructures according to the “AASHTO LRFD 2007” code using Live-Load Distribution Factors. This is in addition to the whole-section design previously released. Design checks are available for stress, flexural capacity, and shear capacity using MCFT (modified compression field theory)  
- Concrete frame design has been implemented using the AASHTO LRFD 2007” code  
- Significant speed improvements have been made to the generation of ASHTO/Caltrans frame hinges for pushover analysis  
- The concrete U-girder frame section can now also be used to model steel tubs in the Bridge Modeler. Each section can be supported by a single bearing at the center, or two bearings at the edges of the girder.
BRIDGE OBJECT DEFINITION: Quick definition of bridge geometry • Spans with section variations along length • Abutments with linear/nonlinear support conditions • Bents with single or multiple columns • Hinges with linear/nonlinear behavior • Abutments, bents, hinges can be skewed • Post-tensioning definitions • Auto generation of bridge structural model • Structural model remains linked to bridge objects for quick editing.

BrIM WIZARD - BRIDGE MODELLING WINDOW:
PARAMETRIC BRIDGE MODELING:

Parametric Bridge Model Templates • Model Auto-updates with Parameter Changes • Parametric Cross Section Variations • Parametric Bridge Layout Lines • Super-elevations, Curves and Skews • Lane Definitions Independent of Structure • Abutments, Bents and Hinges • Improved Bridge Modeler for Steel Bridges • Display Bridge Results on a Girder by Girder Basis • Additional AASHTO, Caltrans, and JTG vehicles are now available • BrIM allows temperature loading including nonlinear thermal gradients • Design for AASHTO LRFD 2007 for concrete box-girder bridges • Checks include, shear, flexure, and principal-stress • Enhanced BrIM wizard with more detail and guidance • Span definitions simplified • Templates now have a quick BrIM option for instantaneous bridge model generation • Improved abutments with separate bearings, abutment seat, and soil properties • Improved bents, allowing single or dual sets of bearings • Superstructure may be continuous or discontinuous over bents • More control of location, alignment, and properties of bearings • More control over restrainers at abutments, bents, and hinges
BRIDGE LAYOUT DEFINITION: Quick Definition of Highway Layout • Layout line definition for bridge components and lanes using bearings and stations • Layout line has horizontal and vertical curves and transitions • Super-elevation definitions

SECTION DESIGNER:
PARAMETRIC BRIDGE CROSS SECTIONS:

Quick definition of variety of bridge cross sections
• Concrete box girder sections • Concrete tee beam sections • Steel composite bridge sections
• Section parameters can vary along length of bridge • Automatic generation of frame (spine), shell or solid model from parametric section • Model automatically updates with change in parameters • Easily switch between different types of models

BRIDGE LANE DEFINITION:
Quick definition using bridge layout line or existing frames • Lane width effects • Auto application of lane loads to bridge structure • Lane influence lines and surfaces
BRIDGE POST TENSIONING:
Quick post-tensioning layout • Tendons in frame, shell, solid elements • Creep, shrinkage, relaxation, anchorage slip, elastic shortening and friction losses • Prestress tendons can be represented as loads or elements for analysis • Explicitly model time-dependent effects using tendons represented as elements

FOUNDATION MODELLING:
- Pile or spread footings
- P-Y multi-linear force deformation assignments
- Compression only soil springs
- Grade beams as line springs
- Soil springs properties may be linear or nonlinear
BRIDGE DESIGN OPTIONS:
Moving Loads with 3D Influence Surface • Moving Loads with Multi-Step Analysis • Lane Width Effects • P/T Concrete Box Girder Design • Composite Steel Deck Bridge Design • Straight & Curved Girder Design • AASHTO, LFD & LRFD and BS 5400-2 Codes • Dynamic Effects of Moving Loads

ADVANCED ANALYSIS OPTIONS (Requires Advanced)
Pushover analysis using fiber models • Isolators, dampers, plasticity, contact-friction • Pounding effects at skewed abutments • Buckling analysis • P-delta and large deflections • Nonlinear cables • Nonlinear dynamics by modal, implicit, or explicit methods • Frequency-domain analysis • All analyses use the same model • Segmental Construction (SC) • Include the Effects of Creep, Shrinkage Relaxation • Pushover Analysis using Fiber Models • Bridge Base Isolation and Dampers • Explicitly Model Contact Across Gaps • Nonlinear Large Displacement Cable Analysis • Line and Surface Multi-Linear Springs (P-y
curves) • High Frequency Blast Dynamics using Wilson FNA • Nonlinear Dynamic Analysis & Buckling Analysis • Multi-Support Seismic Excitation • Animated Views of Moving Loads

**SAP2000 STAGED CONSTRUCTION MODULE (Requires Advanced)**

The Staged Construction Module adds capability to consider staged construction sequencing for any model. Time dependent effects such as creep and shrinkage can be included in staged construction analyses. Specifically included are: Staged construction sequencing allowing Adding or Removing members • Staged construction sequencing allowing Adding or Removing loads • Staged construction sequencing allowing Adding or Removing supports • Time dependent concrete age effects (FIP-CEB) • Time dependent creep and shrinkage (FIP-CEB) Time dependent prestressing steel relaxation (FIP-CEB) • Explicitly model time-dependent effects using tendon elements • Staged-construction groups may be defined as part of bridge object • Construction scheduling using standard Gantt charts to generate staged-construction cases • Control by individual objects as well as by group • Frame end releases can be changed • Property modifiers for frames, tendons, and shells can be changed • Section properties for frames, tendons, and shells can be changed.
SAP2000 STAGED CONSTRUCTION ANALYSIS AND DESIGN CAPABILITIES:
Automatic generation of staged-construction stages using standard Gantt charts • Stage construction groups may now be defined as part of the bridge object • Control is now by individual objects as well as by groups • Frame end release assignments can be changed • Property modifiers for frames, tendons, and shells can be changed • Section properties for frames, tendons, and shells can be changed

STAGED CONSTRUCTION MODELING:
Integrated Object Based Bridge or Building Models • Model Templates with Auto Meshing • Frame, Cable, Tendon, Shell and Solid Object Libraries • Powerful Grouping and Selection Options • Gravity, Pressure and Thermal Loading • Automatic Generation of Code Defined Wind and Seismic Loads • Line and Surface Multi-Linear Springs (P-y curves) • Straight & Curved Girders (BR) • Combination of Static and Dynamic Analyses, including Time History • Post Tensioning

STAGED CONSTRUCTION ANALYSIS: Staged Construction Sequencing by Adding/Removing Objects • Staged Construction Sequencing by Adding/Removing Loads • Staged Construction Sequencing by Adding/Removing Supports • Time Dependent Concrete Age Effects • Time Dependent Creep and Shrinkage • Time Dependent Prestressing Steel Relaxation • Explicitly Model Time Dependent Effects using Tendon Objects • P-Delta Analysis • P/T Concrete Box Girder Design (BR) • Nonlinear Large Displacement Cable Analysis

STAGED CONSTRUCTION DESIGN: Integrated Steel and Concrete Frame Design • AASHTO, LFD & LRFD Codes • ACI, UBC, British, Canadian, New Zealand, Indian, Italian, Korean, Mexican and Euro Concrete Codes • AISC-ASD & LRFD, UBC, API, British, Canadian, Italian, Indian and Euro Steel Codes • Integrated Section Designer for Complex Concrete Sections

STAGED CONSTRUCTION RESULTS & OUTPUT: 3D Perspective Graphical Displays • Multiple Views with Different Stages Displayed • Force Diagrams and Stress Contours • Displacement Plots • Tabular Display of Model Input & Output • Analysis Case Tree

ENHANCED FRAME HINGE MODEL: P-M-M interaction with load-dependent moment-curvature relationships • New Section Designer considers Mander model for confined concrete • Caltrans shapes and hinge behavior • Fiber model options • FEMA 356 recommendations

ADDITIONAL NONLINEAR LINK BEHAVIOR: Pivot-hysteresis and Takeda models for plasticity • Double-acting friction-pendulum isolators

CABLE STAYED BRIDGES
• Automatic cable shape finder • P-Delta plus large displacement geometric nonlinearity • Cable target force determination • Full 3D gravity, wind and seismic analysis capabilities • Multiple point excitation for time-history analysis
3-D INFLUENCE SURFACES: Influence surfaces can be plotted for all displacements, reactions, forces, and stresses • Multiple Display options are available • Tabular data can be exported • Influence surfaces are used for moving-load envelope calculation
BRIDGE ANALYSIS RESULTS & OUTPUT: Influence Lines and Surfaces • Forces and Stresses Along and Across Bridge • Displacement Plots • Graphical and Tabulated Outputs

BRIDGE ANIMATIONS

• Create real time movie files showing time-history and moving vehicle responses
• Include multiple vehicles
• Displays may include displacements and stresses
STEP-BY-STEP SEISMIC DESIGN OF BRIDGES
PER AASHTO SEISMIC GUIDE SPECIFICATION

8 SEAMLESS STEPS

1. Build bridge model rapidly using BrIM/SAP2000

2. Locate bridge geographically

3. Obtain seismic demand curve (response-spectrum) from built-in AASHTO/USGS maps

4. Analyze for dead load, live load, and linear dynamic seismic demand using automatic cracked properties

5. Generate column hinge properties automatically for nonlinear seismic capacity analysis

6. Execute nonlinear seismic capacity (pushover) analysis

7. Determine seismic displacement capacities and evaluate demand-capacity (D/C) ratios

8. Produce report

BrIM/SAP2000 provides automated seismic design integrated within a complete bridge modeling package. The AASHTO Seismic Guide Specification, hot off the press, is already built into the software. The parametric modeler allows the user to rapidly build simple or complex bridge models and to make changes readily while maintaining total control over the design process. The seismic design category, which indicates the level of risk, is determined from the location (latitude, longitude) and soil type. Once dead and live loads are defined, the program produces a fully automated seismic design, culminating in a design report.

BrIM/SAP2000 automatically sets the design procedures based upon the AASHTO seismic design category of the bridge. Cracked section properties for the columns are automatically calculated from the dead load analysis. Demand is computed from a linear dynamic response spectrum analysis. Capacity is determined either from the AASHTO Guide Specifications or from a full nonlinear static pushover analysis, as appropriate. Demand-capacity ratios are computed and reported along with other pertinent design information in a complete formatted design report.
SAP2000 OFFSHORE/WAVE MODULE (Requires Advanced)

SAP2000 OFFSHORE ANALYSIS AND DESIGN CAPABILITIES

OFFSHORE MODELING: Integrated Object Based Models • Wave Load Generator • Frame, Cable, Tendon, Shell and Solid Object Libraries • Auto Edge Constraints for Mismatched Shell Meshes • Wind Loading on Open Structures • Line and Surface Multi-Linear Springs (P-y curves) • Gravity, Pressure and Thermal Loading • Any Combination of Static and Dynamic Analyses

OFFSHORE ANALYSIS & DESIGN: API Simplified Fatigue Analysis • API Punching Shear Checks • Applied Displacement Loading • Multiple Base Excitation • Nonlinear Hinges • Nonlinear Time History Analysis • API Steel Frame Design • Integrated Graphical Section Designer for Built-Up Sections

OFFSHORE RESULTS & OUTPUT: 3D Perspective Graphical Displays • Graphical Wave Plots • Tabular Display of Wave Data • Force Diagrams and Stress Contours • Reinforcing Steel Intensity Diagrams for Concrete Shells • Displacement Plots
SAP2000’s sophisticated analytical methods and design algorithms directly address the Oil and Gas industry’s structural engineering requirements. Analytical features include the ability to easily capture rotational acceleration due to pitch, roll and yaw; perform simple linear or complete nonlinear snap-through buckling analyses; compute frequency-domain response for harmonic and non-harmonic periodic loading; calculate power-spectral density response; apply automated wave loading and API 4F wind loading; pushover analysis and much more. The implementation of the API 4F, API 2A (offshore structures) and Norsok N-004 (offshore structures) design codes allows the engineer to optimize designs with greater accuracy and speed, including punching shear checks. Structural models are very easily created through the integrated 3D SAP2000 environment where users can model all structural geometry, complex built-up sections, loading, and analytical components. Spreadsheet capability is integrated within the graphical environment for creating or modifying the model as well as viewing or processing the analysis and design results. Customizable reports can be produced that include graphical and tabular data. The Open Application Programming Interface (OAPI) can be used to develop special-purpose plug-in tools or to link with in-house programs.

- Rotational acceleration loads
- Cable elements with large displacement options
- API 4F
- Design code checks
- Import from TEKLA STRUCTURES and StruCAD 3D
- Buckling analysis
- P-Delta Analysis and large displacements
- Offshore Module
- Wave Loading
- Advanced dynamic analysis
- Section Designer
- Prestressed modal & eigen buckling analysis options
- Center of gravity
- 64 Bit and 32 Bit Win 7, Win XP
**Rotational Acceleration Loads**

- In addition to translational acceleration loads, SAP2000 allows users to apply rotational acceleration loads to easily capture pitch, roll, and yaw effects. These accelerations can be applied as static and/or dynamic loads.

**Cable Elements with Large Displacement Options**

- SAP2000 offers true nonlinear cable elements with catenary behavior and large displacement analysis. Coupling this with dynamic analysis enables engineers to capture true inertial effects along with the complex changes in behavior as members forces change from tension to compression and vice versa during various lift or launch stages.

*Click Here* to view SAP2000 video simulating the lowering of a subsea structure into the splash zone.

**API 4F**

- For offshore and drilling structures, SAP2000 offers automated API 4F wind load generation and comprehensive design code unity checks. Wind loads can be applied from any angle relative to the structure and local axis of the members. Loads are automatically modified to include the effects of shielding, cladding, and ice. The API 4F design code check accounts for the difference between shielded and unshielded wind loads on an element-by-element basis per the design specification.
Comprehensive design code checks for steel and/or concrete frames are available for a multitude of international design codes, including: API 4F, AISC, CSA S-16 Canadian, Eurocode, and more. Code-dependent lateral loads based upon code parameters can be conveniently generated for API 4F wind, ASCE 7-05 wind (open frame or building structures), IBC2006 seismic, NBCC 2005 wind and seismic, and other international standards.

- API 4F / RP2A WSD
- ASCE
- IBC
- ACI
- UBC
- Canadian CSA S-16 / NBCC / CSA A23 (concrete)
- Chinese
- India IS 800 / 1893
- Mexico RCDF (concrete)
- Australia/New Zealand 1170
- Eurocode 3-2005
- Italian UNI 10011

Input files for TEKLA STRUCTURES or StruCAD*3D can be imported directly into SAP2000 Version 14.

- SAP2000 offers linear Eigen buckling and nonlinear snap-through buckling analysis, either of which may be necessary when designing tall mast structures. Nonlinear buckling analysis also includes the effects of large displacements.
P-delta Analysis

- SAP2000 nonlinear P-delta analysis automatically includes both sway ("large Delta") and local ("small delta") member deformations, satisfying the requirements of the AISC Specifications (13th edition) and other design standards.

Offshore Module

- The Offshore module offers the API 2A and Norsok N-004 design checks, which include checks for joint-can punching shear. The module also includes Airy, Stokes 5th-order, and cnoidal wave theory options. Water currents can simultaneously load the portions of the structure below the water line with automated corrections for marine growth as a function of depth, drag and inertia effects, and buoyancy.

- The user can view resultant wave velocities and accelerations graphically with color coded plots or produce output tables of the values that can be exported to Excel.

Wave Loading

- View resultant wave velocity and acceleration graphically with color coded plots, or through output tables which can be brought into Excel.
Automatic generation of sinusoidal time-history functions is available for modeling unbalanced rotating loads. Transient and steady-state response can be calculated for the displacements, velocities, accelerations, forces, and stresses, including step-by-step and max/min values.

SAP2000 can perform periodic time-history analysis for non-harmonic loading, such as reciprocating machinery, operating at any frequency.

Arbitrary load assignments can automatically be converted to mass.

SAP2000 steady-state harmonic analysis considers the entire “sweep” of machine-speed frequencies all in one load case. Loading may be specified with different phase angles. Supports and links may be given frequency-dependent properties, enabling consideration of radiation damping and complex support systems. Frequency plots of displacement, velocity, acceleration, force, and stress response can be produced at any phase angle, or for the resultant magnitude.

Dynamic time-history analysis can include the effects of linear or nonlinear soil boundary conditions. Soil conditions can be modeled using compression-only springs, gap-friction behavior, and/or multi-linear plastic behavior specified by P-Y and T-Z curves.
Section Designer

- SAP2000 has an integrated Section Designer makes it easy to define composite and built-up section properties.

- The user can see details of complex built-up section geometries using the rendered extruded view option of SAP2000.

- Using the concepts of insertion point and cardinal point, frame members may be modeled using centerline, top of steel, bottom of steel, or any other arbitrary reference lines. This allows the convenient alignment of members with a known datum. The effect of the eccentricity upon the connections is automatically accounted for. Shell elements may also be offset from the reference surface. Combining frames and shells offset from a common set of connection nodes is an effective way to model composite behavior.

- A layered shell is available to model composite materials. Each layer may have different isotropy and orientation, so that fiber-wrapped and other built-up constructions can be represented.
Modal analysis and Eigen buckling analysis can be based on a prestressed condition, such as due to thermal, gravity, pressure, and or other loads. P-delta and tension-stiffening, as well as other nonlinear effects, may change the modal or Eigen buckling behavior, and the effect of both prestressed and unstressed conditions can be considered simultaneously in the same model. ASCE 41 and other design standards have codified the practice of analyzing seismic loads based on prestressed modal analysis.

SAP2000 can automatically determine the center of gravity (CG) of the structure based on selfweight and user selected assigned loads. If piping, cladding, equipment or other gravity loads were applied as assigned loads, users have the option to include those assigned loads in the CG calculation and report.
SAP2000 OPEN APPLICATION PROGRAMMING INTERFACE MODULE (OAPI)

Free With Every SAP2000 Licence. The SAP2000 Open Application Programming Interface (OAPI) is a powerful tool that allows users to automate many of the processes required to build, analyze and design models and to obtain customized analysis and design results. It also allows users to link Sap2000 with third-party software providing a path for two-way exchange of model information with other programs. You can use most major programming languages to access SAP2000 through the OAPI. This includes Visual Basic for Applications (VBA) that is included in programs such as Microsoft Excel.

The OAPI for SAP2000 provides developers of products for CADD and 3D modeling seamless and efficient access to all of the sophisticated analysis and design technology of SAP2000. The OAPI can now be used in two different ways. First, OAPI tools developed by third parties can be accessed by the SAP2000 GUI as external plug-ins. Second, using the OAPI, third-party developers can transfer model information to and from SAP2000, trigger the SAP2000 execution and extract analysis and design information from SAP2000, all from within their application. The license for this functionality is now free with every SAP2000 license.

SAP2000 – V14.1 – Features & Enhancements List

- The capability to export a slab model to SAFE V12 has been implemented. This will be supported by SAFE V12.2 when it is released.
- Detailed design checking has been implemented for multi-cell prestressed-concrete box-girder bridge superstructures according to the “AASHTO LRFD 2007” code using Live-Load Distribution Factors. This is in addition to the whole-section design previously released. Design checks are available for stress, flexural capacity, and shear capacity using MCFT (modified compression field theory).
- Concrete frame design has been implemented using the AASHTO LRFD 2007” code.
- Significant speed improvements have been made to the generation of AASHTO/Caltrans frame hinges for pushover analysis.
- General improvements have been made to the automated bridge seismic design feature.
- The concrete U-girder frame section can now also be used to model steel tubs in the Bridge Modeler. Each section can be supported by a single bearing at the center, or two bearings at the edges of the girder.
- The modeling of steel-girder diaphragms for steel girder bridges has been improved to provide better support for the lower flange.
- Automated wind lateral loading for Australia and New Zealand has been implemented according to the 2002 AS/NZS 1170.2 code.
- The Norwegian national parameters have been implemented for auto seismic loading according to the “Eurocode 8” code.
The API 4F automated wind load has been enhanced to include a shielding factor.

Steel frame design for the “NORSOK N-004” code, including punching checks, has been added to the Offshore module. The design of non-tubular sections is in accordance with Eurocode 3-2005 with the Norwegian National Annex.

The Norwegian national parameters have been implemented for concrete frame design using the Eurocode 2-2004” code and steel frame design using the “Eurocode 3-2005” code.

The 3-D rotation command in the graphical user interface has been improved for working in zoomed-in regions.

SAP2000 – V14 – Features & Enhancements List

Computers & Structures, Inc. and Computers & Engineering are proud to announce the release of SAP2000 V14. The innovative enhancements in this version are categorized below. This fully integrated product for the modeling, analysis and design of structures continues to be available in three levels: Basic, Plus and Advanced.

Nonlinear and Pushover

- A nonlinear, layered shell element using a directional material model has been added for pushover analysis of shear-wall structures and similar applications. A Quick-Start option is provided for easy modeling of reinforced concrete sections.
- Plot functions have been added for shell layer stresses.
- Frame hinges for Section Designer sections "To be Designed" have been enhanced to use the designed amount of rebar when available.
- Section Designer has been enhanced for the display of fiber-model PMM surface.
- The default material properties for concrete have been modified to improve convergence behavior.
- The tangent stiffness used for the iteration of fiber hinges and multi-linear links has been changed to improve convergence.

Dynamics

- Material-based damping is now available for linear and nonlinear direct-integration time-history analysis.
- Material-based damping is now available for steady-state and PSD analysis.
- Stiffness-proportional damping now uses initial stiffness instead of tangent stiffness to improve the consistency of results and convergence behavior.
- The rigid-response calculation in response-spectrum analysis has been enhanced for NRC and general use.
- Base reactions for response-spectrum and modal time-history analysis have been improved for springs and grounded link supports to better capture missing-mass effects.
- Base reactions no longer include constraint forces at restraints, for consistency.

Bridge Modeling and Design

- AASHTO LRFD 2007 superstructure design for precast concrete composite sections has been implemented. Checks include: stress, flexure, and shear (using MCFT).
- Fully automated bridge design check per AASHTO Guide Specifications for LRFD Seismic Bridge Design 2009 has been implemented, including pushover analysis when required.
- Automated handling of secondary prestress force has been implemented for the AASHTO LRFD 2007 superstructure flexural design check for prestressed concrete box girder sections.
- The AASTHO/USGS 2007 response-spectrum function has been added.
- Variable girder spacing along the length of the bridge superstructure is now available.
- Variable reference-point location along the length of the bridge superstructure is now available.
- Alignment of shell local axes in generated bridge models has been enhanced.
- The longitudinal discretization of bridge models is now more uniform in complex models.
- Tendons modeled as elements now allow elastic, creep, shrinkage, and steel-relaxation losses to be directly specified.
- The displacements for constrained joints in staged construction are no longer updated for deflection until they are actually added to the model.

New Design Code Related Enhancements

- Eurocode-2 2004 concrete frame design added, without seismic provisions.
- Eurocode-3 2005 steel frame design added, without seismic provisions.
- Australian concrete frame design per code AS 3600-2001 added, including seismic provisions.
- Multiple enhancements made for Indian concrete frame design per code IS 456-2000.
- Multiple enhancements made for Chinese 2002 concrete frame design.
- Multiple enhancements made for Chinese 2002 steel frame design.
- Auto-lateral loads added for Australia: Seismic and Response-spectrum.
- Auto-lateral loads added for New Zealand: Seismic and Response-spectrum.
- Other Enhancements to the Graphical User Interface (GUI) Multiple enhancements have been made to the graphical display for clarity and speed.
- Multi-stepped static analysis of Bridge Live loads acting on frame elements is now available in Plus/Advanced levels.
without the Bridge license for modeling crane loads, footfall, etc.

- Single-stage construction cases starting from zero are now available in Plus/Advanced levels without the Staged-construction license for modeling separate gravity and lateral configurations, different support conditions, etc.
- The import of StruCAD*3D data files is now available.
- New and updated API functions have been implemented.

**Minimum and Recommended System Requirements**

- **Processor**: Minimum: Intel Pentium 4 or AMD Athlon 64. Recommended: Intel Core 2 Duo, AMD Athlon 64 X2, or better (see notes 1 and 2 below)
- **Operating System**: Microsoft® Windows XP with Service Pack 2 or Microsoft® Windows Vista, 32- and 64-bit versions. (see notes 3 and 4 below)
- **Memory**: Minimum: 1 GB for XP O/S, 2 GB for Vista O/S. Recommended: 2 to 4 GB for 32-bit O/S, 4 GB or more for 64-bit O/S. (see note 5 below)
- **Disk Space**: 6 GB to install the program, additional space required for running and storing model files and analysis results.
- **Video Card**: Supporting 1024 by 768 resolution and 16 bits colors. Recommended: discrete video card with ATI / NVIDIA GPU & dedicated graphics RAM. (see note 6 below)

**Notes:**

1) To be able to take advantage of the features of the newer CPU's, SAP2000 V14 will not run on some of the older CPU's from Intel and AMD. A CPU that has SSE2 support is now required.
2) SAPfire® Analytical Engine now includes a multi-threaded solver that can take advantage of the newer multi-core CPUs.
3) Support for Microsoft® Windows 2000 and Microsoft® Windows NT has been discontinued. Microsoft® Windows XP without Service Pack 2 may cause unexpected problems when running SAP2000 V14.
4) With a 64 bit operating system, SAPfire® Analytical Engine can utilize more than 4 GB of RAM, making it possible to more efficiently solve larger problems.
5) The problem size that can be solved & the solution speed increases considerably with more RAM. Vista requires more RAM than XP for the operating system itself.
6) OpenGL graphics mode fully utilizes the hardware acceleration provided by a GPU & dedicated graphics RAM.

**SAP2000 – V12 – Features & Enhancements List**

Computers & Structures, Inc. and Computers & Engineering (distributor) is proud to announce the release of SAP2000, version 12. The new and innovative enhancements associated with various aspects of this version are categorized below.

This fully integrated product for the modeling, analysis, and design of structures continues to be available in three levels: Basic, Plus and Advanced. Please contact baser@comp-engineering.com for more information.

**MODEL-ALIVE™ Option in SAPFIRE™**

- True to our tradition, we are, once again, advancing the state-of-the-art of numerical analysis with the introduction of the Model-Alive™ feature in SAPFIRE™ ~ CSI's Analytical Engine. Taking advantage of current advances in numerical methods and hardware technology this option provides instantaneous re-analysis and updating of the current displays following any change made to the model by the user.
- The Model-Alive feature provides continuous updating of the model during development and editing, automatically re-running the analysis for every revision so that model changes are easily evaluated.

**Multi-Processor / Multi-Threading Analysis Solvers**

- Fast, fast, fast analysis times and unmatched solution capacity
- New 64 bit - multi-processing/multi-threading algorithms

**BrIM (Bridge Information Modeler) Enhancements**

- Design for AASHTO LRFD 2007 added for concrete box-girder bridges - Checks include, shear, flexure, and principal-stress
- Additional AASHTO, Caltrans, and JTG vehicles are now available
- BrIM allows temperature loading including nonlinear thermal gradients
- Enhanced BrIM wizard with more detail and guidance
- Templates now have a quick BrIM option for instantaneous bridge model generation
- Enhanced and simplified span definitions
- Improved abutments with separate bearings, abutment seat and soil properties
- Improved bents, allowing single or dual sets of bearings
- Superstructure may be continuous or discontinuous over bents
- Enhanced control of location, alignment, and properties of bearings
- Enhanced control over restrainers at abutments, bents, and hinges

**Staged Construction Enhancements**

- Automatic generation of staged-construction stages using standard Gantt charts
- Stage construction groups may now be defined as part of the bridge object
- Control is now by individual objects as well as by groups
- Frame end release assignments can be changed
- Property modifiers for frames, tendons, and shells can be changed
- Section properties for frames, tendons, and shells can be changed
Section Designer Enhancements

- Moment curvature curve and PMM interaction surface for arbitrary fiber sections
- Enhanced control over material properties, including Mander model for all sections
- GUI now allows for overlapping shapes and improved Boolean operations
- Properties for concrete only sections, steel encased sections and steel only sections
- Properties for CALTRANS bridge sections, with or without prestressing tendons
- Enhanced performance and efficiency

New Analysis and Design Code Related Enhancements

- Hyperstatic analysis for secondary effects of prestressing forces
- Soil (area) springs can now be tension-only or compression-only springs
- AISC 360-05/IBC2006 steel-frame design code, with seismic provisions
- Direct Analysis Method of AISC 360-05 code - Includes small P-delta effect - Automated inclusion of stiffness modification factors, with user control
- Design-decision guidance on when Direct Analysis Method is needed
- CAN/CSA-S16-01 steel-frame design code, including seismic provisions
- Enhanced design of eccentrically braced frames for AISC 360-05/IBC 2006
- Canadian NBCC 2005 wind loads, seismic loads, and response-spectrum functions
- Load combinations can be converted to nonlinear load cases for advanced design
- Improved automated load combinations for design
- Enhanced display of failure modes for steel-frame design
- Open structure wind loading for the API 4F 2000 code

Automated, Predefined and Customized Report Generation

- Quick and easy generation of final printed reports with complete user control
- Cover sheet identifying project, user and company
- Formatted tables of model definition, analysis and design results
- Typical graphical displays of the model
- Output sheets of detailed design information

Other Enhancements to the Graphical User Interface (GUI)

- User created documents now can be accessed through the SAP2000 Help menu
- Export of geometry and element connectivity to CSI Perform-3D
- Enhanced import of input files from STAAD.Pro, GTSTRUDL, NASTRAN, etc.
- DXF export for finite element stress contour arrows for 2D and 3D views
- Export structural model data for use with soil-structure interaction product, SASSI
- Faster graphical user interface and enhanced OpenGL graphics

Enhanced Open Application Programming Interface (OAPI) is now Free

- The OAPI for SAP2000 provides developers of products for CADD and 3D modeling seamless and efficient access to all of the sophisticated analysis and design technology of SAP2000. The OAPI can now be used in two different ways. First, OAPI tools developed by third parties can be accessed by the SAP2000 GUI as external plug-ins. Second, using the OAPI, third-party developers can transfer model information to and from SAP2000, trigger the SAP2000 execution and extract analysis and design information from SAP2000, all from within their application. The license for this functionality is now free with every SAP2000 license.

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