SAFE® 2014

Integrated Design Of Flat Slabs, Foundation Mats and Footings

Version: 14.0.0

Overview:

SAFE is the ultimate tool for designing concrete floor and foundation systems. From framing layout all the way through to detail drawing production, SAFE integrates every aspect of the engineering design process in one easy and intuitive environment. SAFE provides unmatched benefits to the engineer with its truly unique combination of power, comprehensive capabilities, and ease-of-use.

Laying out models is quick and efficient with the sophisticated drawing tools, or use one of the import options to bring in data from CAD, spreadsheet, or database programs. Slabs or
Foundations can be of any shape, and can include edges shaped with circular and spline curves.

Post-tensioning may be included in both slabs and beams to balance a percentage of the self-weight. Suspended slabs can include flat, two-way, waffle, and ribbed framing systems. Models can have columns, braces, walls, and ramps connected from the floors above and below. Walls can be modeled as either straight or curved.

Mats and foundations can include nonlinear uplift from the soil springs, and a nonlinear cracked analysis is available for slabs. Generating pattern surface loads is easily done by SAFE with an automated option. Design strips can be generated by SAFE or drawn in a completely arbitrary manner by the user, with complete control provided for locating and sizing the calculated reinforcement. Finite element design without strips is also available and useful for slabs with complex geometries.

Comprehensive and customizable reports are available for all analysis and design results. Detailed plans, sections, elevations, schedules, and tables may be generated, viewed, and printed from within SAFE or exported to CAD packages.

SAFE provides an immensely capable yet easy-to-use program for structural designers, providing the only tool necessary for the modeling, analysis, design, and detailing of concrete slab systems and foundations.

**SAFE Technical Features:**

**Features-SAFE User Interface**
SAFE offers a single user interface to perform: Modeling, Analysis, Design, Detailing and Reporting. A model explorer is available for quick access to objects, properties and forms. Users can have up to 4 simultaneous display windows open.

**Model Explorer**

- Define, duplicate, and modify properties
- Drag and drop assignment to model
- Display and set default displays
- Save and recover user-defined displays
- Review detailing views and drawings
- Print and export drawings and views
Horizon Graph Paper

- Graph paper horizon aids drawing model
- Graph is to scale
- Graph scale adjusts to optimal scale when zooming
- Horizon can be switched off after drawing

User Coordinate System

- UCS acts like a new coordinate system
- Intelligent snaps based on UCS
- Coordinates based on UCS when UCS is active
- Toggle between UCS and other coordinate systems
Extruded Views

- Smooth shading
- Clear display of wall junctions
- Allows review of insertion points, local axes rotations, and geometry

Dimension Lines

- Architectural or decimal units
Features-SAFE Modeling

Templates

- Variety of templates for quickly starting a new model
  - Flat slabs
  - Two-way slabs
  - Base mats
  - Waffle slabs
  - Ribbed Slabs
  - Single and Combined Footings
Intelligent Snaps

- Set multiple snap increments
- Intelligent detection of intersections, extensions, parallels, perpendicualrs, etc.
- Toggle between snaps with ‘N’ key
Architectural Tracing

- Import an architectural DXF/DWG into the background
- Layer colors imported
- Trace the drawing to generate SAFE structural objects
- Right button click to convert tracing line to SAFE structural object
- Drafting snaps work on imported background
Grid Systems

- Rectangular, cylindrical, and general grids
- Direct drawing of grid lines

Foundations, Basemats, and Footings

- Easy modeling of soil supports
- Zero tension soil model with uplift analysis
- Area assignment of soil supports based on subgrade modulus. Soil supports adjust automatically whenever mesh changes. Variable soil property assignments, irregular geometry, and/or openings are no problem with SAFE.
- Soil supports can be analyzed as nonlinear compression-only in order to account for load redistribution.
- Piles can be explicitly modeled with elements including automatic punching shear checks based on pile section.
- Basemat foundation models can include pedestals, walls, columns, beams, and/or piles in addition to the foundation area. Loads can be assigned at the ends of pedestals, walls and other elements in order to automatically determine moments transferred into the foundation/slab.
- Single or combined footings can be easily modeled, analyzed and designed.
**Walls and Ramps**

- Wall/ramps can be modeled as line loads, line supports, or explicitly modeled with wall elements
- Option to release wall out of plane moments
- Rigid zone option prevents slab deformation at wall/ramp locations
- Wall openings can be assigned
Curved Lines & Area Edges

- 3-point arc
- Center and 2-point arc
- Multilinear
- Spline curve
Column Shapes

- Rectangular, T-shaped, L-shaped, Circular, General with user-defined properties
- Rigid zone option prevents slab deformation at column location
- Options for column moment releases
- Automatic drop panel and column capital options
Insertion Points

- Define offsets for beams and columns
- Define based on quick cardinal points
- Define based on user-defined dimensions
Spring Supports

- Point, line, or area (soil) spring supports
- Tension only
- Compression only

General Design Strips

- Non-orthogonal strip definition
- Multi-segmented strips
- Varying width within each segment
Auto Strip Widths

Design strip widths can be determined automatically by SAFE, or they can be manually defined by the user for more complex designs.
P/T Layout

- Banded and distributed tendons
- Automated tendon layout based on strips
- Interactive editing of tendon profiles
- P/T layout drawing
- Vertical profile shown in 3-D

Autostrip and P/T Layout

- Quick tendon layout using flat slab template
- Quick tendon layout based on strips
- Automated profiles for specified precompression and balancing ratio
- Automated design strips based on gridlines or structural supports
Editing Tools

- Linear, radial, and mirror replication
- Chamfer/fillet slab corners
- Move a specified distance
- Trim and extend
- Align points
- Subdivide lines and areas
Developed Elevations

- Elevations along gridlines
- Developed elevations along strips
- Editing and assignments in elevation view
Interactive Database Editing

- Choose model definition tables to edit Interactively edit, delete, or add new data to tables
- Take tables to Excel for editing and directly back into SAFE with changes
- Multiple changes to the model all at once
Features-SAFE Loading

**Loading Diagrams**

Show the loads in both 2D and 3D views of your SAFE model. Display color contoured area loading diagrams with loading values, or mouse over various parts of your model to get instantaneous loading values.

**Load Cases and Combinations**

- Unlimited number of load cases and combinations
- Automated design combinations based on selected design code
- Strength and service combinations
- User-defined load combinations
- Linear add, envelope, absolute add, SRSS, and range combinations
- Load combinations can be comprised of other load combinations
Area, Line and Point Loads

- Uniform or non-uniform gravity surface loads
- Point loads on lines
- Uniform or trapezoidal loads on lines
- Point load including load size for punching shear
- Point (support) displacement loads
Auto Pattern Live Loads

- Automatically generated patterns based on grid created by design strips
- Results from each “single panel” are combined with the Range Add load Combination
- User-defined pattern live load patterns can be input
Tendon Loads and Losses

- Jack from start, end, or both ends of tendon
- Specified jacking stress is converted to loads
- Specify loads at transfer and final in one operation
- Losses based on force percentage
- Losses based on user-defined stress values
- Losses based on detailed calculations
- Hyperstatic analysis
Loading Diagrams

- Display loads on 2-D or 3-D views
- Show analysis model loads
- Mouse over diagram for instantaneous values
- Display loading values
- Color contoured area loading diagrams

Features-SAFE Analysis

SAPFire Analysis Engine

- Blazing SAPFire analysis engine
- Three solver options
- Multi-processor, multi-threading support
- Supports 64-bit machines
3D Analysis Model

- Full 3-D model
- Stiffness of columns, walls, braces, and ramps included
- Columns, walls, and braces above and below the slab
- Beams with flexural, shear, and torsional deformations
- Orthotropic slab properties
- Thick plate behavior with shear deformation
Deflection Control

- Nonlinear analysis
- Cracked analysis
- Long-term cracked analysis considering creep and shrinkage
- Initial conditions based on previous nonlinear load case
Dynamic Analysis

- Modal frequency analysis using Ritz or Eigen vectors
- Floor vibration analysis
- Response spectrum loads and modes imported from ETABS®

Object Based Meshing

- Automated based on maximum element size
- Meshes parallel and perpendicular to longest edge, grid system, or area local axes
- Aims to maintains good element aspect ratios
- Edge constraint connects mismatched slab meshes
Features-SAFE Design
Strip Based Design

SAFE will calculate the minimum reinforcement requirements of area, intensity, or number of bars. Design will be performed at multiple stations. Design strips can be non-orthogonal and of varying width.

FEM Based Slab Design

- Finite element based design does not require design strips
- Ideal for complex geometry where defining strips is difficult
- Contour plots of rebar intensity
- Averaging of peaks over user-defined width
- Identifies “hot spots” for reinforcing design
Beam Design

- Design of conventional and post-tensioned concrete beams
- Design done at multiple stations per span
- Code minimum reinforcement requirements considered
- Flexure, shear, and torsion design
Punching Shear Check/Design

- Considers column location
- Considers openings and slab edges
- Additional drop panel check
- User over-writeable perimeter and openings
- Design punching reinforcement ties or shear studs if required
P/T Stress Checks

- Checks done for transfer, final, and long-term
- Stress limits in design preferences
- Top and bottom stress contours
- Demand capacity ratio contours
- Mouse over for instantaneous values

RC and P/T Design Codes

- Traditional reinforced concrete design
- Post-tensioned concrete design
- Considers lateral loads and secondary
- PT stresses Design to 10 current international codes:
  - ACI 318-08
  - AS 3600-01
  - BS 8110-97
  - CSA A23.3-04
  - Eurocode 2-2004
  - Hong Kong CP-04
  - IS 456-2000
  - NZS 3101-06
**Features-SAFE Output & Display**

### Deformed Shapes

- Mouse over diagram for instantaneous values
- Animate deformed shapes and capture to AVI
- Filled or line contour plots
- Full 3-D deformed shape including walls, columns, braces, and ramps
- Automatically displays min/max values

### Beam Force Diagrams

- Axial force, shear, moment, torsion, and stress diagrams
- 2-D and 3-D views of diagram
- Mouse over diagram for instantaneous values
- Results for load case or combination
- Automatically displays min/max values
Strip Force Diagrams

- Moment, shear, axial force, and torsion diagrams
- 2-D and 3-D views of diagram
- Mouse over diagram for instantaneous values
- Results for load case or combination
- Automatically displays min/max values
Shell Contour Diagrams

- Force, moment, shear, and stress contour plots
- Load flow arrows
- 2-D and 3-D views of diagram
- Mouse over diagram for instantaneous values
- Results for load case or combination
- Automatically displays min/max values
Bearing Pressure Contours

- Force, moment, shear, and stress contour plots
- 2-D and 3-D views of diagram
- Mouse over diagram for instantaneous values
- Results for load case or combination
Reaction Diagrams

- Display selected reaction components
- Display as arrows
- Display as tables that can be user-positioned
- Results for load combinations and cases
Tabular Output

- Tables for all input data, analysis results, and design results
- Filter, sort, and query table data
- Customize column data format
- Hide unnecessary columns
- Print or save tabular data to Access, Excel, Word, HTML, or TXT
Display Output

- Capture images to Enhanced Metafile (EMF)
- Capture images to standard image formats (BMP, JPG, TIF, GIF, PNG)
- Capture video animations to AVI
- Print graphics directly to printer with ability to add text and pictures
Output Tables

- Output tables can be sorted, edited and/or exported to Excel or Access for easier, more efficient review of results. Sort by ascending or descending min and max values for any field in any direction in seconds.
- Exported SAP2000 tables can be merged within Microsoft Access to create a single table containing fields from multiple SAP2000 tables to further customize output.

Rendered Views

- Smooth rotation of model
- Multiple lighting options
- Texture options for concrete, rebar, tendons and other materials
- Shadows
Rebar Cages

- Display realistic rebar cages in 3D view that is based on the detailer's rebar layouts.
Report Generator

- Summary design report with a single button click
- Microsoft Word, HTML, or TXT format
- Fully customizable report content
- Reporting in user-defined units Text, tables, and figures
- Detailed design output
- Hyperlinked table of contents

Features-SAFE Detailing

Drawing Title Block

Give your drawing title blocks the look you want. Choose from standard, metric, and ANSI sheet size and engineering, metric, and architectural scales. Three predefined title block choices are built in to the SAFE Detailer that allow you to import your title block from a DXF.
Detailing Rules

- Control bar sizes and spacing
- Beam and slab curtailment rules
- Control information displayed in rebar calls
- Specify bars around openings
- Detail all or only bars above a typical quantity
Drawing Format & Styles

- Control scale of each view on a drawing
- Modify line type, color, and thickness
- Modify fill color and transparency
- Modify font type, size, color, alignment
- Modify dimension line styles

Detailed Section Cuts

- Cuts through slabs, beams, and mats
- User-defined orientation and length
- Instant section preview
- Adjustable section cut view range
Reinforcement Editing

- Edit rebar size, number, and length
- Automatic update of associated views
- Edit strip by strip
- Review provided versus required areas
Edit Text and Annotations

- Edit drawing component views
- Modify text size, font, and placement
- Add text annotations with leaders
- Add dimension lines

Drawing Component Views

- Drawing component views are the basic building blocks for drawings. Drag framing plans, reinforcement plans, section cuts, rebar tables and schedules, bill of quantities, reinforcement profiles, tendon layout plan, tendon profile elevations onto sheets to create your drawings.
Reinforcement Plans

- Show indicative bars or all bars
- Customize rebar calls (bar marks)
- Reinforcement follows strip directions
Tendon Layout Plans

- Show indicative tendons or all tendons
- High and low point dimensions
- Anchor and stressing end indicators
- Tendon profile elevations
Drawing Sheets

- Typical drawing sheets automatically generated
- Composed of drawing component views
- Add views from a list or with drag-and-drop from the Model Explorer
- Drawings synchronize with updates to the model and reinforcement
Print & Export Drawings

- Print drawings or view directly to a printer or plotter
- Export drawings and views to DXF or DWG format
- Open drawings in AutoCAD or other CAD software
Features-Import and Export Formats

- Import models from SAP2000 and ETABS.
  - Loads, geometry, section properties, and wall deformations can be imported.
- Import/export geometry and results plots from/to DXF or AutoCAD DWG files
  - Import architectural dwg/dxf file, then click or window to automatically fill with slab section, walls, columns and/or openings.
- Import or open old SAFE models
- Import/export models from/to Microsoft Access or Excel
SAFE System Requirements

Processor:

- Minimum: Intel Pentium 4 or AMD Athlon 64
- Recommended: Intel Core 2 Duo, AMD Athlon 64 X2, or better
- A CPU that has SSE2 support is required
- The SAPFire® Analytical Engine includes a multi-threaded solver that can take advantage of multi-core CPUs

Operating System:

- Microsoft® Windows XP with Service Pack 2 or later, Microsoft® Windows Vista, or Microsoft® Windows 7, 32- and 64-bit versions
- With a 64 bit operating system, the SAPFire® Analytical Engine can utilize more than 4 GB of RAM, making it possible to more efficiently solve larger problems
Memory:

- Minimum: 2 GB for XP O/S, 4 GB for Vista/Windows 7 O/S
- Recommended: 4 GB for 32-bit O/S, 8 GB or more for 64-bit O/S
- The problem size that can be solved & the solution speed increases considerably with more RAM
- Vista/Windows 7 requires more RAM than XP for the operating system itself

Disk Space:

- 6 GB to install the program.
- Recommended: 500GB or larger Hard Disk Drive (7200 rpm SATA)
- Additional space required for running and storing model files and analysis results, dependent upon the size of the models

Video Card:

- Minimum: Supporting 1024 by 768 resolution and 16 bits colors for standard (GDI+) graphics mode
- Recommended: Discrete video card with NVIDIA GPU or equivalent and dedicated graphics RAM (512 Mb or larger) for DirectX graphics mode. The card must be DirectX 9.0c compatible (DirectX SDK Aug 2009 - Build 9.27.1734.0).
- DirectX graphics mode fully utilizes the hardware acceleration provided by a GPU and dedicated graphics RAM.
- For better graphics quality in terms of anti-aliasing and line thickness, the device raster drawing capabilities should support legacy depth bias.
# SAFE Levels and Features

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<tr>
<th>Modeling Features</th>
<th>Standard</th>
<th>w/ PT</th>
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<tr>
<td>Model joint size limit</td>
<td>Unlimited</td>
<td>Unlimited</td>
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<tr>
<td>All drafting and model generation features</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>3D line and area objects</td>
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<tr>
<td>Model Explorer</td>
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<tr>
<td>Templates</td>
<td>✔</td>
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<tr>
<td>Converting architectural object to SAFE objects</td>
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<tr>
<td>Architectural Tracing</td>
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<tr>
<td>User Coordinate Systems</td>
<td>✔</td>
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<tr>
<td>Intelligent Snaps</td>
<td>✔</td>
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<tr>
<td>Architectural Units</td>
<td>✔</td>
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<tr>
<td>Dimension Lines</td>
<td>✔</td>
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<tr>
<td>Developed Elevations</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Section Designer for specialized sections</td>
<td>✔</td>
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<tr>
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<tr>
<td>Meshing tools</td>
<td>✔</td>
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<tr>
<td>Object-based mesh generation</td>
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<tr>
<td>Automatic edge constraint technology for unmatched meshes</td>
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<tr>
<td>2D and 3D</td>
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<tr>
<td>Shell element</td>
<td>✔</td>
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<tr>
<td>Shear walls and ramps</td>
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<tr>
<td>Tendons</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Tendon Loads and Losses</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
Coupled spring element
- No-tension soil modeling
- Design Strips
- Non-orthogonal, multi-segmental, varying width design strips

<table>
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<tr>
<th>Loading Features</th>
<th>Standard</th>
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<tr>
<td>Point, line, trapezoidal, and area loads</td>
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<tr>
<td>Tributary area load distribution to frames</td>
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<tr>
<td>Automatic code-based wind loading</td>
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<tr>
<td>Automatic code-based seismic loading</td>
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<tr>
<td>Pattern loading</td>
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<td>Auto-pattern live loads</td>
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<td>Applied displacement loading</td>
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<td>SAPFire Analysis Engine</td>
<td>✓</td>
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<tr>
<td>Eigen analysis with auto-shifting for ill-conditioned problems</td>
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<tr>
<td>Ritz analysis for fast predominant mode evaluation with missing mass</td>
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<tr>
<td>Multiple response spectrum cases in single run</td>
<td>✓</td>
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<tr>
<td>Modal combination by the CQC, SRSS, GMC or double sum methods</td>
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<tr>
<td>Directional combination by the ABS, SRSS, or CQC3 methods</td>
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<tr>
<td>Static and dynamic load combos - linear, envelope, absolute, SRSS, range</td>
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<td>Response spectrum curves from time history response</td>
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<td>Video of animations and time varying results displays</td>
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</table>
Rebar cages

Capture of graphics to .emf, .jpg, .bmp, .tif

Quick generation of final printed reports with complete user control

Cover sheet identifying client, project, user and company

Formatted tables of model definition, analysis and design results

Graphical displays of the model

<table>
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<tr>
<th>All Import &amp; Export Formats</th>
<th>Standard</th>
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<tr>
<td>Interactive Database Editing</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Microsoft Access</td>
<td>✔</td>
<td>✔</td>
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<td>Microsoft Excel</td>
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<tr>
<td>SAFE text file (.f2k)</td>
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<td>ETABS Stories</td>
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<td>AutoCAD (.dx/.dwg)</td>
<td>✔</td>
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<td>IGES</td>
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**SAFE Watch and Learn**

<table>
<thead>
<tr>
<th>Title</th>
<th>Length</th>
<th>Click to Play</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFE - 01 Introductory Tutorial</td>
<td>24 min</td>
<td><a href="http://www.youtube.com/watch?v=SUPcREpni9Q">http://www.youtube.com/watch?v=SUPcREpni9Q</a></td>
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<tr>
<td>SAFE - 02 PT for Slabs</td>
<td>25 min</td>
<td><a href="http://www.youtube.com/watch?v=N6EEMRvXeYY">http://www.youtube.com/watch?v=N6EEMRvXeYY</a></td>
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<tr>
<td>SAFE - 03 Drawing &amp; Drafting</td>
<td><a href="http://www.youtube.com/watch?v=C111BgZ7A8A">http://www.youtube.com/watch?v=C111BgZ7A8A</a></td>
<td>16 min</td>
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<td>SAFE - 04 Import from CAD</td>
<td><a href="http://www.youtube.com/watch?v=ZMO_A6jnJqc">http://www.youtube.com/watch?v=ZMO_A6jnJqc</a></td>
<td>9 min</td>
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<tr>
<td>SAFE - 05 Drawing Tendons</td>
<td><a href="http://www.youtube.com/watch?v=MnjZl-iYeIq">http://www.youtube.com/watch?v=MnjZl-iYeIq</a></td>
<td>10 min</td>
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<td>SAFE - 06 Editing Geometry</td>
<td><a href="http://www.youtube.com/watch?v=fqxHNWJ1dLA">http://www.youtube.com/watch?v=fqxHNWJ1dLA</a></td>
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<tr>
<td>SAFE - 07 Pattern Live Loads</td>
<td><a href="http://www.youtube.com/watch?v=xNMYjgqO3t8">http://www.youtube.com/watch?v=xNMYjgqO3t8</a></td>
<td>11 min</td>
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<tr>
<td>SAFE - 08 Cracked Section Analysis</td>
<td><a href="http://www.youtube.com/watch?v=GZt_yHCBvts">http://www.youtube.com/watch?v=GZt_yHCBvts</a></td>
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<tr>
<td>SAFE - 09 Mat Foundations</td>
<td><a href="http://www.youtube.com/watch?v=B0-3XiqvQ38">http://www.youtube.com/watch?v=B0-3XiqvQ38</a></td>
<td>11 min</td>
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<tr>
<td>SAFE - 10 Foundation Uplift</td>
<td><a href="http://www.youtube.com/watch?v=fzqzjJaeQVg">http://www.youtube.com/watch?v=fzqzjJaeQVg</a></td>
<td>7 min</td>
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NEWS-SAFE 2014 Enhancements

SAFE 2014 V14.0.0 Enhancements

Significant enhancements included in SAFE 2014 (v14.0.0):

- Reinforced and Prestressed concrete design have been added for the ACI 318-11 code.
- Reinforced and Prestressed concrete design have been added for the Italian NTC 2008 code.
- Reinforced and Prestressed concrete design has been added for the Turkish TS 500-2000 and TS 3233-1979 codes.
- Reinforced and Prestressed concrete design have been added for the Hong Kong CP 2013 code.
- The specified concrete strength as used for Chinese materials and design codes has been comprehensively changed for SAFE 2014 to refer to the characteristic strength, whereas in SAFE v12 the concrete strength referred to the grade.
- Design-strip widths can now be imported from DXF/DWG files.
- The import and export of AutoCAD 2013 and 2014 *.DWG files is now supported.
- Import from and export to Revit Structure 2014 is now available using CSiXRevit 2014. Models can be created in SAFE or Revit Structure, and incremental import and export are supported.
- Licensing has been upgraded to provide support for virtual servers and to allow more flexibility for using commuter licenses.