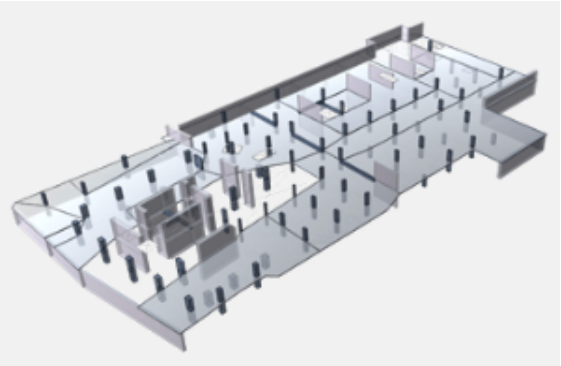
Home

This space is devoted to **SAFE**. Please visit the Technical Knowledge Base for documentation on topics common to all CSI Software.

SAFE is a software tailored for the engineering of elevated floor and foundation slab systems. Slab modeling, analysis, and design procedures feature a suite of sophisticated tools and applications, couple with post-tensioning, punching-shear, and beam detailing, and integrate the influence of soils, ramps, columns, braces, walls (rectilinear or curvilinear), and other interfacial elements. Interoperability with SAP2000 and ETABS allows users to import models, loading, and displacement fields into SAFE for more advanced local assessment of slab systems within larger structures.



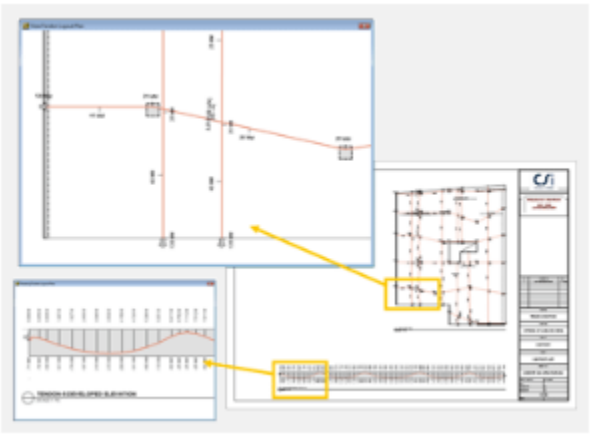
A 3D-object-based model may originate in SAFE or import from SAP2000, ETABS, or CAD. Templates quickly initiate a model. Grid, snap, chamfer/fillet, trim/extend, circular- and spline-curve controls allow direct drawing of any slab shape. Replication tools streamline modeling for a series of unique slab systems, as was done with Studio Gang's Aqua in Chicago, Illinois (Reid, Robert L. *Chicago Tower's 'Wavelike' Design Features Different Shapes For Every Floor*. Civil Engineering Apr. 2007: 22). Up to four simultaneous display windows present the model. Interactive database editing presents definition tables in SAFE and Excel.

On this page:

- Post-tensioning
- Support conditions and loading
- Analysis
- Output

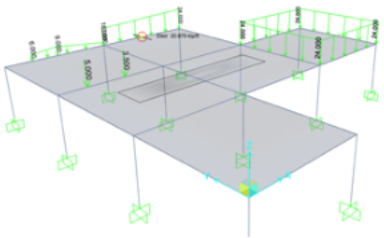
Post-tensioning

SAFE is ideal for designing traditional and post-tensioned (PT) reinforced-concrete slab systems. The PT process is intuitive and comprehensive. Design strips (per grid-line or support conditions), banded and distributed tendon layout, tendon profiles, and jacking options (per force percentage, stress value, or hyperstatic analysis) may all be user-defined or automated (with interactive editing features) according to the following 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, Singapore CP-65-99. Transfer, final, and long-term PT checks ensure design adequacy. SAFE also provides for beam design with post-tensioning capability.



PT design for slabs of complex geometry, in which design strip location is uncertain, is best served by a finite-element application. FEM techniques also provide 2D or 3D contour plots of various performance measures, indicating *hot spots* for possible redesign.

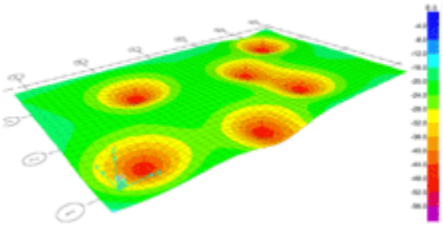
Support conditions and loading



Punching-shear and drop-panel checks are automatic. If necessary, SAFE designs tie and shear-stud punching reinforcement. Moment-release and rigid-zone options define kinematic relations where vertical and slab systems interconnect. Point-displacement load assignment is available for support conditions. Point, line, area, tension-only, and compression-only spring supports may also be modeled. Point loading with load-size assignment may be superimposed on punching shear locations. At the foundation level, checks are run for punching shear from piers and piles. Nonlinear uplift can be implemented through soil-spring modeling. Manual and automatic point, line, and uniform loads, enveloped and applied per user-defined or building-code specification, are presented in clear and detailed 3D views.

Analysis

The SAPFire ® Analysis Engine translates the object-based model into an optimal finite-element model by coordinating the tessellation process with object orientation, observing bounds to establish effective aspect ratios, and connecting mismatched mesh seams where area objects connect. A sophisticated slab analysis can then proceed with realistic contribution from adjoining systems. SAFE enables the following analyses: nonlinear, cracked-section, long-term cracked-section (capturing creep and shrinkage behavior), dynamic, Ritz or Eigen modal-frequency, floor-vibration, and foundation-level nonlinear-cracked-slab, among others. Measures may be implemented for deflection control and import of parameters from dynamic analysis using ETABS. Accurate nonlinear simulation of combined vertical, lateral, and secondary response enables effective slab design and detailing.



Output

Output and display features are equally comprehensive. The Report Generator compiles images and input, analysis, and design data in organized and customizable reports that may be printed or exported in a variety of file formats. Diagrams, contour plots, and animations, available in 2D and 3D views, display deformed configuration, component response, and min/max values of response data. The mouse-over feature displays values at any point. Bearing-pressure contours and vertical-system reactions are also depicted.



SAFE automatically generates drawing sheets for plan, elevation, and section views that detail and dimension framing, reinforcement, and tendon layout. Options for title block, drawing scale, font, and line type, color, and thickness are available, along with rebar tables and schedules. Tendon views present anchor and stressing-end indicators. Manual changes in these drawings coordinate with the analytical model. Rendered 3D views present exceptional visuals of the structure and reinforcement layout. SAFE provides useful image- and animation-capture tools for additional graphics. Export to DXF or DWG format is available for integration with CAD documentation.

