SCIA ENGINEER

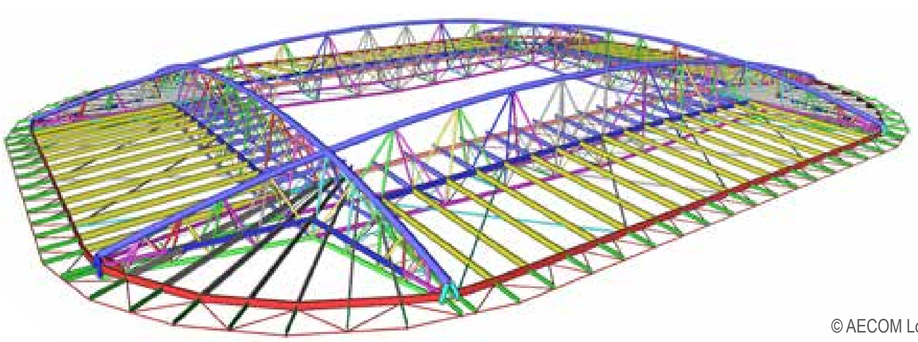
TOP 10 Modeling Workarounds

EVERY CIVIL ENGINEER NEEDS TO KNOW

and How to Avoid Them

More and more structural and civil engineers are being asked to participate in collaborative model-based workflows. However, migrating to these workflows can be difficult with today's traditional engineering software programs, which were not designed to support these workflows.

Based on discussions with engineers and software consultants, we documented the top 10 workarounds for engineers working in a 3D environment and how they can be avoided using SCIA Engineer.



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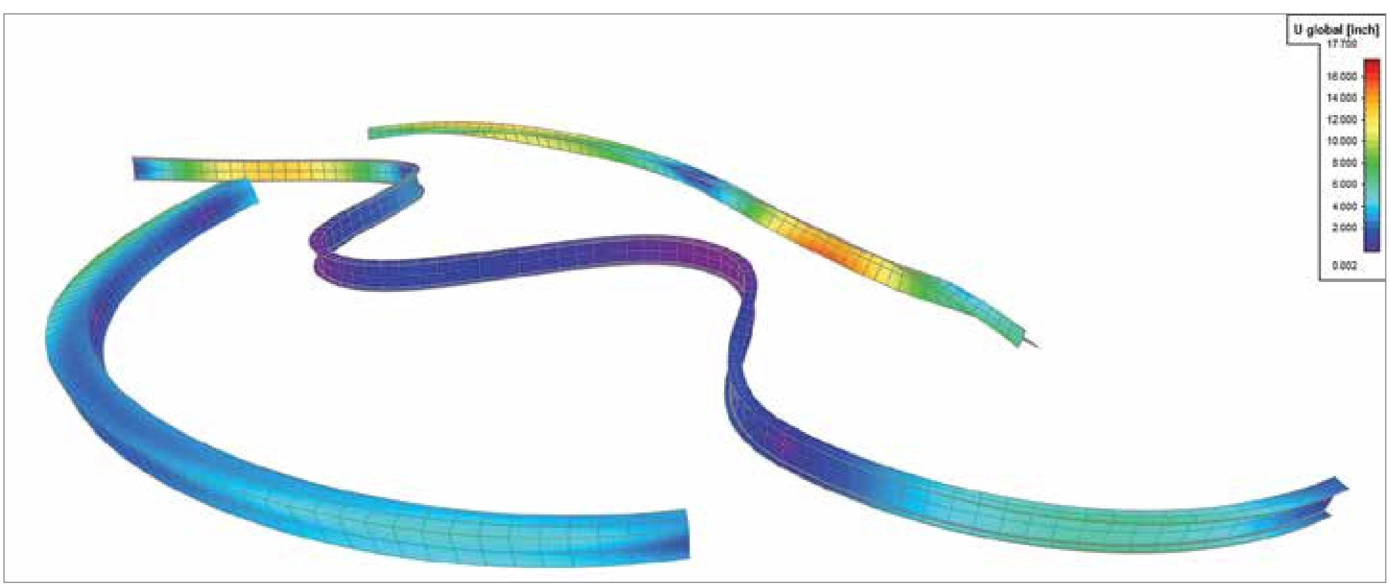
SCIA ENGINEER Workaround #1

Modeling Curved Members as Linear Segments

Without a doubt modeling many small, linear segments to create a curved member is time consuming, but the true issues arise in the inaccurate analysis and design results. Bending and compression checks based on unbraced lengths will not be calculated on the member length but rather the small, segmented lengths. Additionally, this creates issues in terms of proper BIM integration as the members are not mapped correctly.

SCIA Engineer offers modeling of virtually any shape for beams, columns, walls or plates. These include curved shapes, splines, parabolas and bèziers. No segmenting is needed; therefore the actual member length is used for the analysis and design, including torsional moments and stresses. These complex geometries can easily be moved back and forth between various BIM programs for seamless integration.



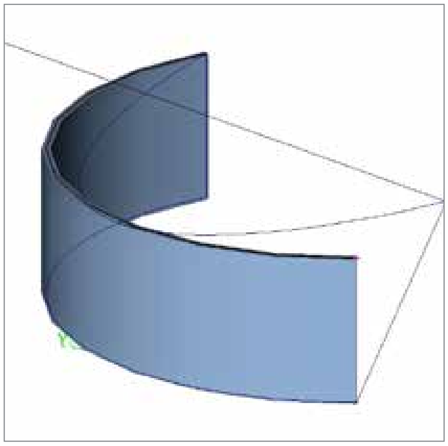
SCIA ENGINEER Workaround #2

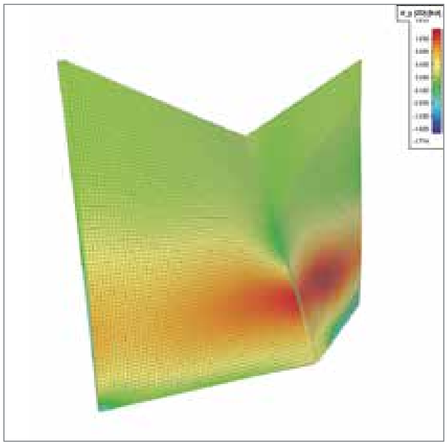
Modeling Walls with Nodes, Lines, and Shell Elements

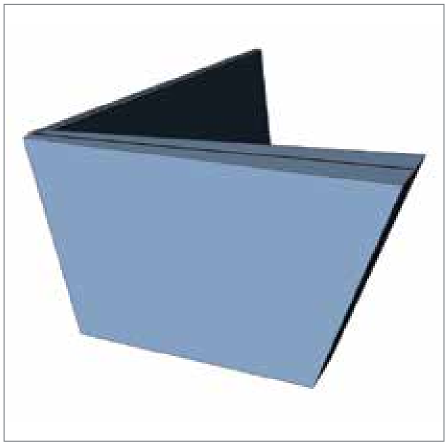
Modeling a simple wall is time-consuming in most analysis & design software programs, while modeling curved, sloped, or variable thickness walls can be nearly impossible. Modeling this fundamental building element requires extra creativity on the part of the structural engineer. In many cases, engineers are modeling walls using coordinate input (X, Y, Z) and lines. Once the walls are drawn, the properties of the shell elements must be defined and then applied to the walls. If using a design program that is rooted in 2D space, walls can be drawn at each level of the structure, but making changes translates into editing at each level, individually. As most engineers know, moving, resizing and editing walls is a favorite pastime of architects, so not being able to model walls easily is a real problem.

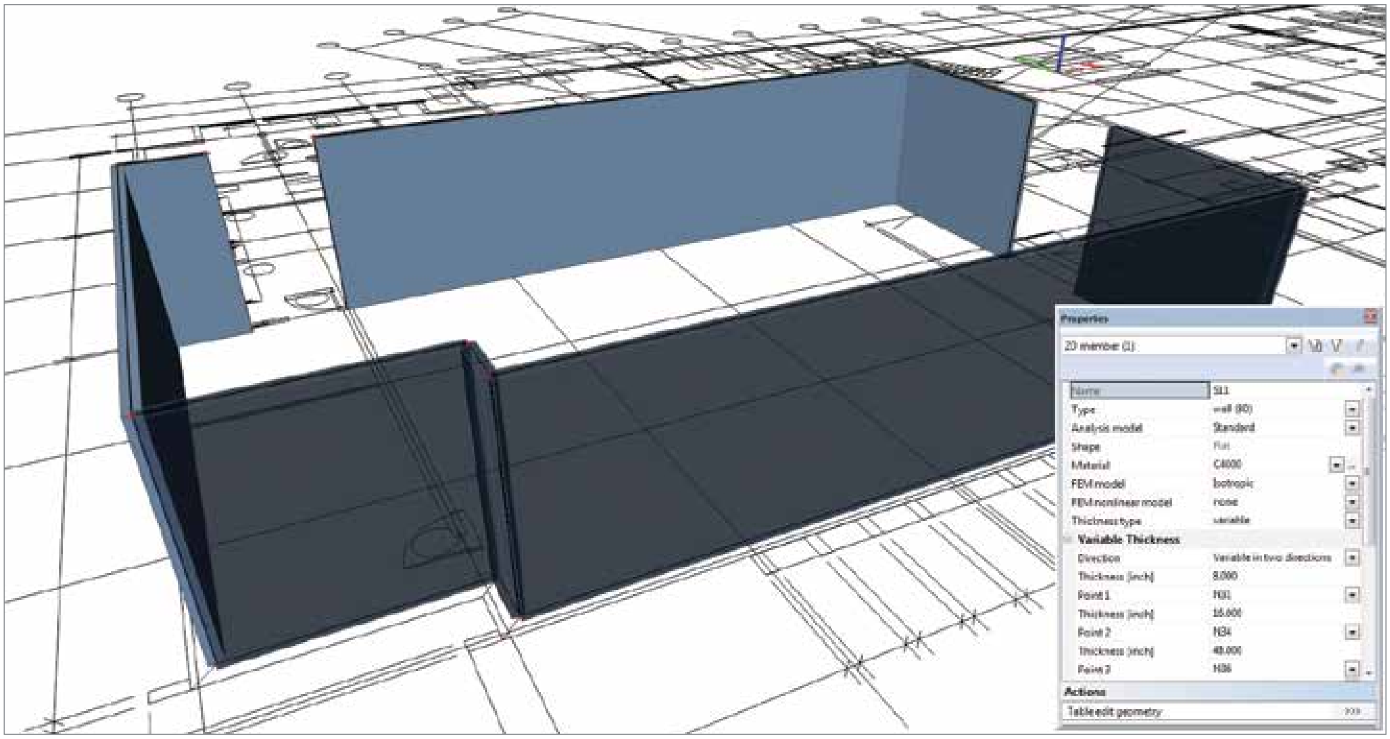
The solution to this traditional engineering workflow is to model in a true 3D environment. Modeling and editing a structure in a CAD or 3D modeling program offers flexibility as well as ease of input. With SCIA Engineer you get BIM and freeform wall modeling, integrated with advanced analysis and design.

Want to model a wall in SCIA Engineer? Simply sketch out a wall. Need to make a change? Easily reshape it, slope it, vary its thickness, move it, duplicate it, or make any other edits. It's fast and easy.









SCIA ENGINEER Workaround #3

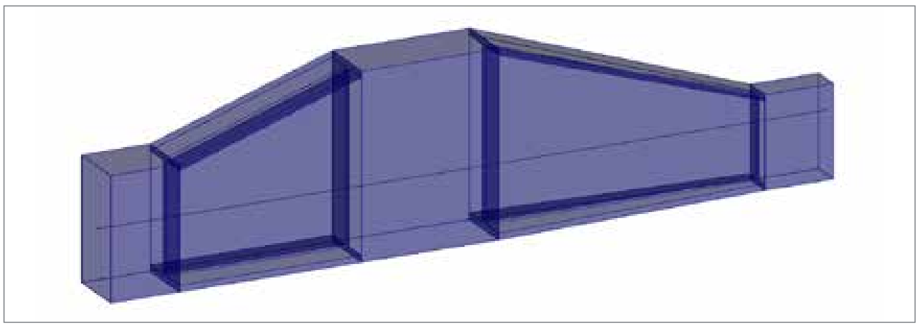
Modeling Non-Prismatic Members Using Multiple Sections

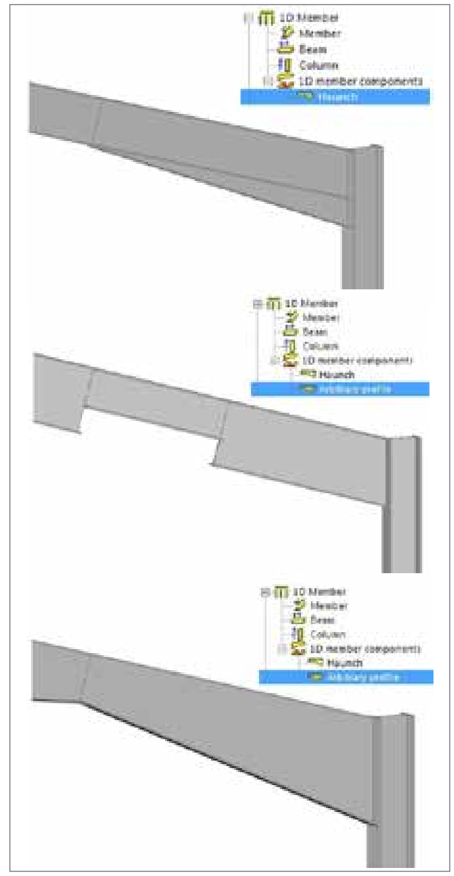
Many analysis & design software programs do not offer modeling of non-prismatic members. In this situation, you must input members using segments of varying section sizes and properties. This can be a big pain. Trial and error is used to determine the member sizes, and the designs may be too conservative as there is no easy way to optimize the members. Having these segmented member sizes also creates issues with BIM integration.

In SCIA Engineer, the user can easily define a member whose cross-section varies arbitrarily along the member length. Multiple sizes, shapes and even materials can be used in the same span.

Easily model, analyze and design any non-prismatic member:

- Prismatic members where the cross-section of the span is changes
- A parametric haunch where a standard haunch is inserted into the span
- An arbitrary cross section using two cross-sections to vary the shape linearly along the member length





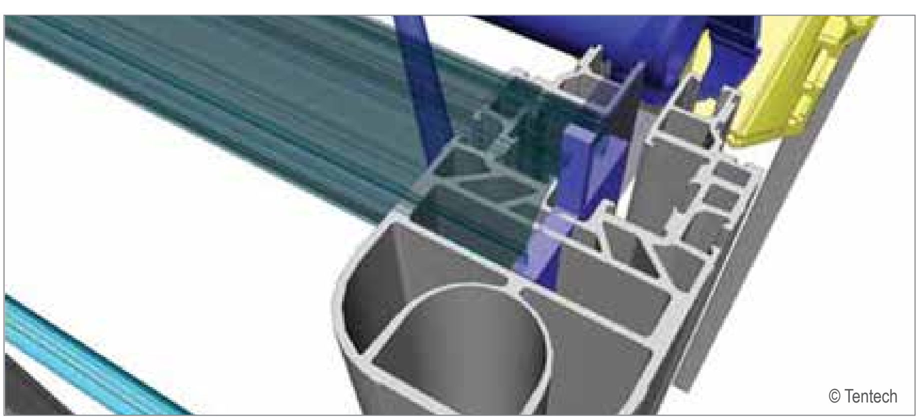
SCIA ENGINEER Workaround #4

Designing Custom Cross Sections by Self-calculating Member Properties and Checking Designs Manually

Some projects require more than standard structural shapes. In some of the most popular structural analysis and design software programs, engineers are unable to handle with custom shapes. In other programs, generic shapes can be defined by inputting self-calculated member properties to perform an analysis. Designs must then be carried out manually.

SCIA Engineer's integrated General Cross Section editor allows users to quickly create any cross section, including mixed material sections. New cross sections can be created by combining standard shapes, sketching new shapes, or importing shapes from a CAD file.

Once a cross section is defined, parameters can be used to create various dimensions for the defined profile, allowing an entire library of cross sections to be created. With the custom profile defined, SCIA Engineer's 2D FEM analysis engine automatically calculates all the section properties, which can be used for design in the 3D FEA model.



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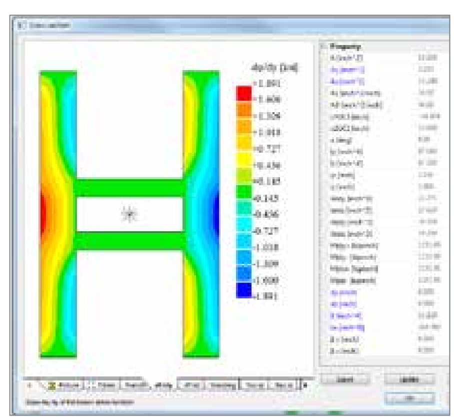
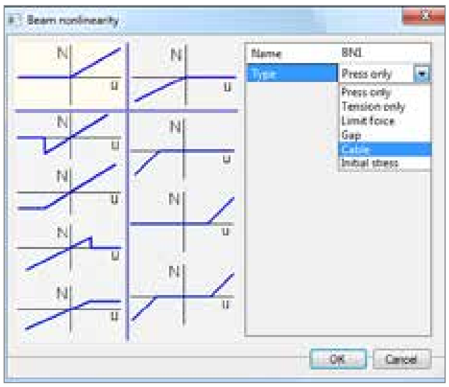


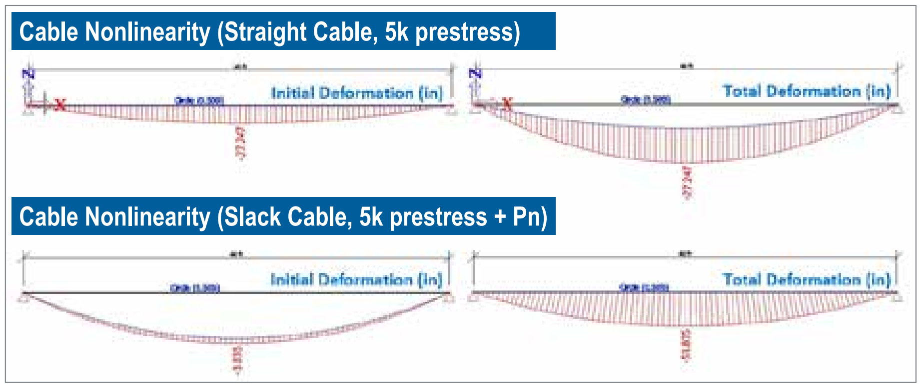
SCIA ENGINEER Workaround #5

Modeling Non-Linear Elements Using Trial and Error

Most structural design now requires non-linear analysis and handling these types of advanced analysis in some software, can require trial and error for member sizes and deflections. More importantly, traditional workarounds for certain types of non-linear elements do not reflect the true structural behavior. As an example, a cable may be modeled using a tension-only member with reduced section properties. The member is then created with multiple nodes, allowing only a rough estimation of the cable deflection. Additionally, a thermal load may be used to mimic pre-stressing in the cable. Not only is this inefficient, but the results are inaccurate.

How does SCIA Engineer handle this? It provides non-linear elements including cables (both straight and slack), compression-only, tension-only, limit force, gap elements, and initial stress. SCIA Engineer models the true structural behavior. No more guessing; it will analyze, design, and optimize.





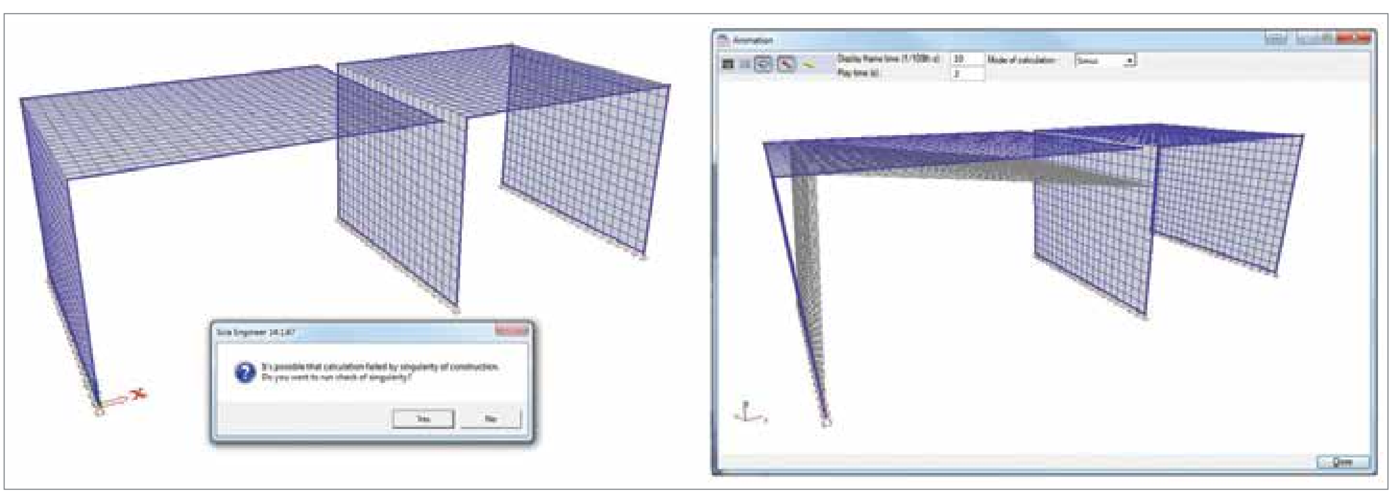
SCIA ENGINEER Workaround #6

Manually Finding Analysis Instabilities Using Nodal Output

A familiar error in FEA software looks something like this, "Singularity in node N153, Calculation Aborted." What then? Weeding through pages of output to locate the problem, only to make a change to have the re-run analysis show an instability in a different node? Or simplify the model and deal with potentially inaccurate results.

Here's what one engineer told us: "Modeling a hip roof takes 4–5 hours in our current software program so we just don't do it."

In SCIA Engineer, the singularity check provides a graphical animation of model instabilities, showing translations and rotations. Duplicate and unconnected members are also detected. The interactive singularity check makes identifying model errors simple, allowing for a better understanding of how the model is performing.



SCIAENGINEER Workaround #7

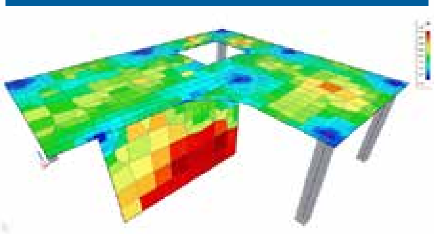
Manually Defining and Modifying Meshing

The question of necessary mesh size needs to be asked at the beginning of every finite element analysis. Too coarse and the results may be inaccurate. Too fine and the project takes forever to solve. Additionally, manually setting and refining a mesh is tedious and time consuming. Engineers know the painful process: estimate a global mesh size, create a mesh, run an analysis, determine areas of refinement (lines, nodes, and 2D surfaces) and repeat until errors are within acceptable limits.

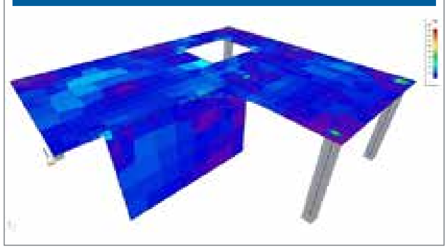
Adaptive Mesh Refinement technology in SCIA Engineer solves this trial and error process by letting the software improve the mesh and add local refinements where necessary. This tool allows engineers to input an acceptable error tolerance and a choose which load cases determine the refinement. Then, SCIA Engineer does all the heavy lifting.

For more information, check out this article publish by Engineering.com:
http://bit.ly/AdaptiveMesh.

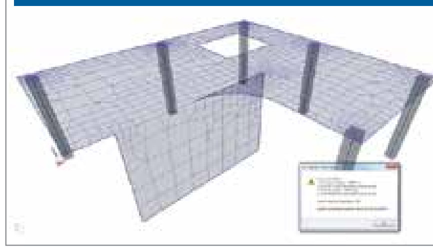
Mesh Refinement Result



Global Mesh Error



Mesh Refinement Result

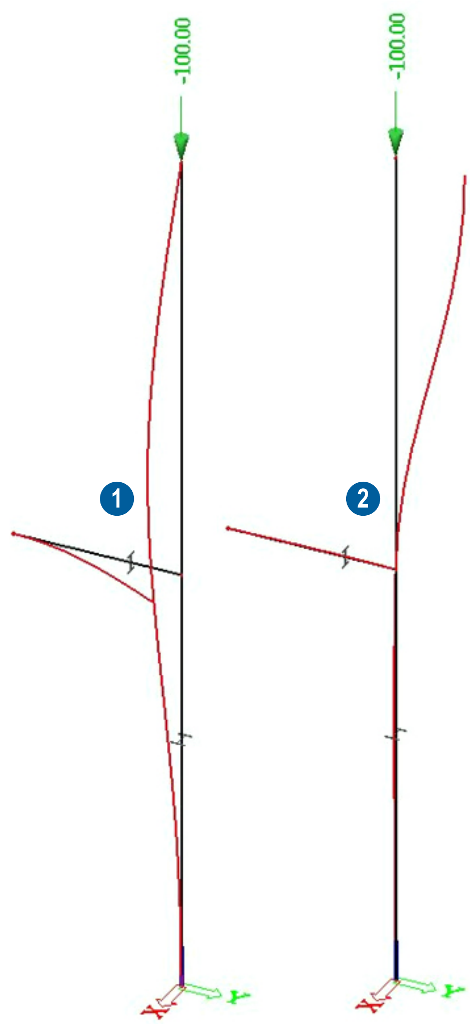


SCIAENGINEER Workaround #8

Using Approximations to Calculate Buckling

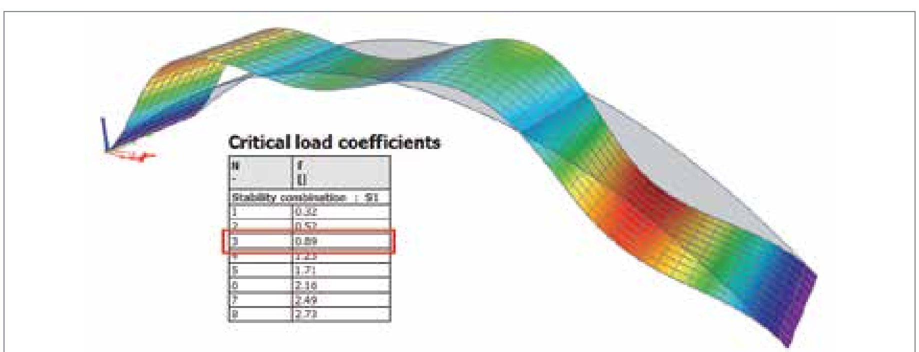
Structural engineers are being asked to design more complicated structures and to be competitive with their designs to keep project costs down. What's needed is an analysis and design software that provides accurate results to support these demands. When it comes to buckling, many software programs utilize simplified AISC approximations, which in many cases are too conservative.

Using stability analysis, SCIA Engineer calculates the true buckled shape of members. With critical load analysis, the software determines locations of member buckling and points of failure under certain loads. The calculated K factors are then applied to the steel design. With this accurate analysis, structural engineers can feel confident that their designs are precise and competitive.



1. Strong Axis Buckling (Critical load Coefficient, f=9.81)

2. Strong Axis Buckling (Critical load Coefficient, f=9.81)



SCIA ENGINEER Workaround #9

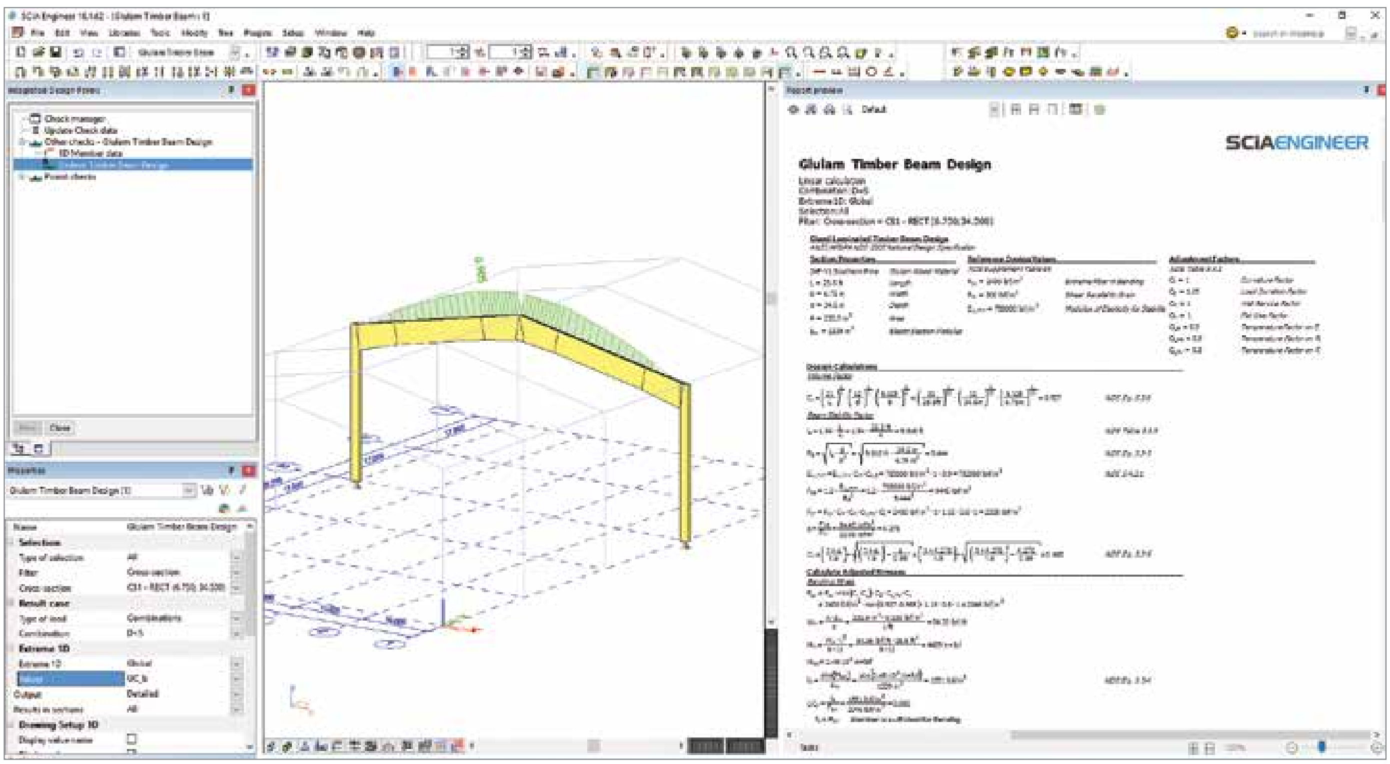
Creating, Managing, and Coordinating Checks Across Multiple Analysis Models

No software program can do everything. Engineers sometimes need the flexibility to go beyond what a software program provides out of the box. Workarounds applied in practice vary from using simple spreadsheets to purchasing a separate design program dedicated to one specific type of design.

But the time spent switching back and forth between a 3D FEA program and other disparate programs is not efficient. It can lead to errors, as results must be manually coordinated. In addition, most of these separate design modules, or simple design programs, are limited in scope and are completely “black box.” Keeping all results and output coordinated then becomes incredibly difficult.

With SCIA Engineer’s Open Check technology (a.k.a. Design Forms), users can easily script their own calculations. These custom checks can be used as stand-alone or integrated into SCIA Engineer’s FEA modeling environment.

With Design Forms, users can see and verify the calculation formulas, references to the code (articles), and all numerical (and graphical) output. In this workflow, nothing is black box and everything is completely transparent, editable and extensible. Easily enhance your FEA workflow by scripting custom checks to create a seamless analysis and design workflow.



SCIAENGINEER Workaround #10

Manually Coordinating Changes Between BIM and Structural Analysis and Design

Many engineering offices struggle to integrate BIM and structural analysis and design. The main problem is that the traditional engineering software was not designed to support today's BIM workflows. In many cases the 3D modeling is poor or non-existent. Additionally, if links exist to BIM software, they are often fragile, and do not support iterative design.

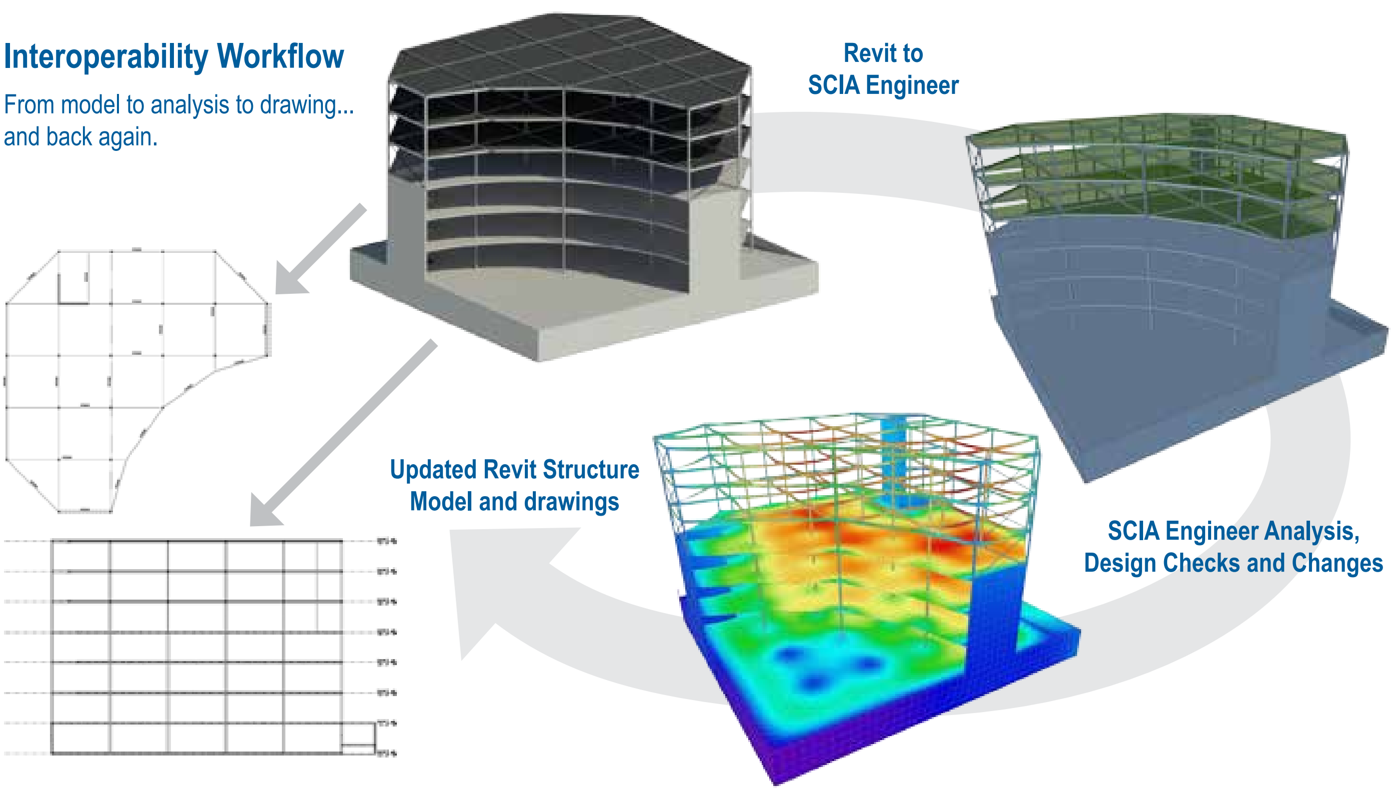
SCIA Engineer is part of a new breed of 3D structural design software that is helping firms plug analysis and design into today's collaborative 3D workflows. From its inception, it has been developed with 3D in mind.

In addition to having direct bi-directional links to Revit, Tekla Structures, Rhino and other popular modeling software, SCIA Engineer also is the only analysis software that offers certified support for IFC (or "Open BIM"). Supporting both bi-directional links and Open BIM provides engineering firms unique BIM workflow flexibility and compatibility with over 150 different BIM authoring, viewing and analysis programs; programs like ArchiCAD, Vectorworks and SDS/2 to name a few.

Within this workflow, projects can be initiated in SCIA Engineer to quickly explore different concepts, optimize the design and then send optimized models to a BIM program for final documentation. Another option is to start a project by linking the BIM model with SCIA Engineer. Once in SCIA Engineer, the model is analyzed and designed; changes are then pushed back to the BIM model, making iterative design easy. It is even possible to utilize a project workflow with an architect's model and from it, process the structural design in SCIA Engineer and push changes back to the architect directly. In SCIA Engineer, workflow is not limited. Create a BIM process that works for your firm and for a specific project.

Interoperability Workflow

From model to analysis to drawing... and back again.



These are just some of the ways that SCIA Engineer has been helping firms be more productive. Looking to migrate to, or improve your 3D workflows? – SCIA Engineer can help.

For more information – visit www.scia.net/en/top10 – or contact Ben Follett; b.follett@scia.net +1 443-393-3616