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AECbytes Product Review (October 7, 2010)

Scia Engineer

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To date, AECbytes has reviewed several structural BIM applications including Revit Structure, Tekla Structures, and Bentley Structural (now called Structural Modeler). We also looked at BIM technology for structural engineers in general in the overview of the "BIM Fundamentals Seminar for Structural Engineers" in 2007, which provided an opportunity to understand the BIM phenomenon from a structural engineering point of view. At that time, Nemetschek's Scia Engineer was not mentioned at all, and even today, it is largely unknown in the US, despite being an established 3D structural design and analysis tool in Europe, where it originated. However, it is now starting to be marketed in the US. For example, at the AIA 2010 convention, sister company Nemetschek Vectorworks demonstrated how Vectorworks Architect could be used by architects to collaborate with structural engineers using Scia Engineer. Also, in the recent review of ArchiCAD 14, we saw that it has a dedicated IFC translator to export the model to Scia Engineer in addition to translators for other engineering applications.

It is certainly worthwhile for structural engineering firms to look into Scia Engineer, as it includes both modeling and analysis capabilities in contrast to other structural BIM applications which are focused primarily on modeling and require the analysis to be done using other tools. This review explores the capabilities of Scia Engineer in more detail, starting with the background

Product Summary

Scia Engineer is a structural design tool that includes both sophisticated modeling and advanced analysis capabilities in one application, in contrast to other structural tools that only do either modeling or analysis.

Pros: Modern and sophisticated interface that allows for fast and easy modeling; includes ability to create as well as analyze complex freeform geometry; supports both steel and concrete design along with other materials such as timber and membrane; includes a wide range of analysis capabilities along with optimization and auto-design; is flexible enough to be applied to a diverse range of structures; includes bidirectional links with leading structural BIM and analysis tools as well as IFC support for participating in a multi-tool, multi-disciplinary workflow; includes clash detection capabilities for model coordination; allows good quality renderings to be created directly from the application.

Cons: 2D documentation capabilities are not as comprehensive as CAD or structural BIM applications; limited detailing and shop drawing capabilities for fabrication; slowdown in performance for large models as 64 bit memory and multi-processing are currently limited to analysis tasks only.

Price: US annual subscription prices are: Basic Edition, $3,232; Professional Edition, $6,122; Expert Edition, $10,073. There are discounts for multiple seats and competitive cross grade pricing for firms who switch from another A&D application.

NEMETSCHEK Scia

and overview of the application. It focuses on the application as a whole rather than on the specifics of the current 2010 release of the application.

Product Background and Overview

Scia was founded all the way back in 1974 in Belgium, where it still maintains its corporate headquarters. It started off by developing a structural analysis tool called ESA 2D for on WANG and HP mini-computers, and continued to develop and enhance the software's capabilities, expanding its operations to several European countries, over the next three decades. In 2006, it went more global, partnering with CSI to enter the Indian market. In 2007, it was acquired by the Germany-based Nemetschek AG and added to its extensive portfolio of AEC solutions, including the Allplan product line (see the review of Allplan Architecture 2008). The company started operations in Brazil and North America last year in cooperation with Nemetschek Vectorworks (formerly known as Nemetschek North America). Scia Engineer is currently translated in 8 languages and distributed in more than 50 countries; it has localized building codes for 16 countries, including the US.

The undivided focus of Scia on continually developing and refining its structural engineering application over 35 years has resulted in a mature and sophisticated product with powerful capabilities that is flexible enough to be applied to a diverse range of structures including buildings, bridges, tunnels, industrial facilities, towers, and so on, and even temporary structures such as scaffolding, pavilions, etc. In the buildings sector, it is used extensively for institutional projects such as schools and campuses, commercial buildings, skyscrapers, stadiums, transportation facilities, and many other building types, including those with non-traditional forms. A few examples of building projects done around the world with Scia Engineer are shown in Figure 1. Additional examples can be seen at: http://www.scia-online.com/en/customer-examples.html. Another excellent resource is the book showing all the participants and the winners of the biannual Nemetschek Engineering User Contest (last held in 2009), which can be browsed online at: http://www.scia-online.com/ebook/uc2009/.

The most unique aspect of Scia Engineer is that it combines design and analysis into one application, as opposed to other structural engineering tools that are either focused only on design and modeling (such as the structural BIM applications mentioned earlier) or only on analysis (such as RAM, Staad, Risa, Robot, ETabs, and so on). Other noteworthy aspects of Scia Engineer are that it is capable of modeling as well as analyzing complex freeform geometry in addition to more traditional structures, supports both steel and concrete design along with other materials such as timber and membrane, includes a wide range of analysis capabilities along with optimization and auto-design, and allows good quality renderings to be created directly from the application. It has bidirectional links to several applications, including Revit Structure and Tekla Structures, enabling it to be used to complement their modeling capabilities with its analysis tools, if required. It includes IFC support and can thus also be used as the main structural engineering application in a BIM workflow, allowing the engineer to exchange models with the architect and other disciplinary professionals by importing and exporting IFC files.

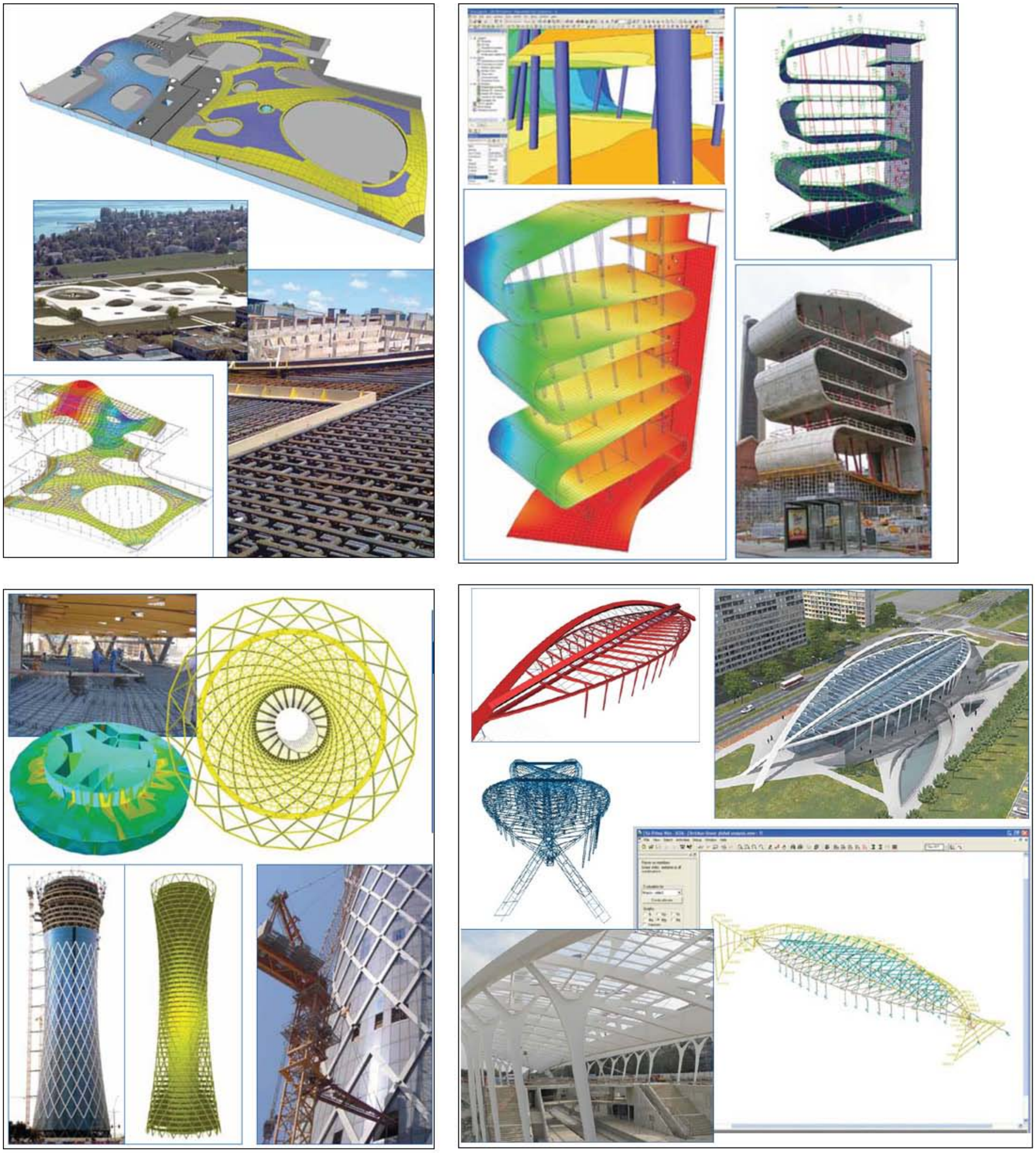

Figure 1. Some examples of building structures designed with Scia Engineer, including the Rolex Learning Center in Switzerland (top left), Qipco Office Tower in Doha (lower left), Umicore office building extension in Brussels (top right), and Metro Station in Prague (lower right).

While Scia Engineer does include some basic documentation capabilities which allow engineers to automatically generate drawings from the model, place them on sheets, and add additional dimensions and annotations, it lacks full-featured documentation capabilities like CAD applications such as AutoCAD or even BIM applications such as Revit Structure. Thus, if it were being used as the main structural engineering application by a firm, the additional use of a CAD application for converting the basic drawings from Scia into more detailed documentation would be required. Another aspect that Scia is not that strong on, especially in comparison to an application like Tekla Structures, is in the level of detailing required for fabrication and the creation of shop drawings.

Scia Engineer is available in three editions. The Concept Edition is a basic version aimed at engineers who are modeling and analyzing common structures made of steel, concrete, or another material. The Professional Edition is for engineers dealing with more complex projects that require nonlinear, dynamic or stability calculation; it also includes tools for collaborating with other disciplines. The most high-end version is the Expert Edition, which is aimed at experts who design the most challenging structures and engineers who work with prestressed concrete; it also includes 4D analysis for construction staging.

Interface and Modeling

The user interface of Scia Engineer is shown in Figure 2. In addition to common components found in most design applications such as the Title bar, Menu bar, Status bar, and graphical window, a unique aspect about Scia is the Tree menu window that is docked to the left of the graphics window by default. This contains a tree-like menu that is used to access the individual program functions, making for a more compact and user-friendly interface. For example, double-clicking on the Structure option in the Main tree opens up all the Structure related commands in the same window, as shown in Figure 2. You can still access the Main tree by clicking on its tab, and the opened Structure command sub-tree can be closed at any time to open another function sub-tree, for example, Loads. Thus, most of the functionality of the application can be accessed from one location, if required. There are also toolbars that provide quick access to the most common functions, and it is possible to change from a full toolbar display (which is the one shown in Figure 2) to a lighter layout or a custom one. The other main components of the Scia interface are a Properties window, which provides detailed information about the different attributes of selected elements and allows their values to be modified, and a Command line, which can be used to type commands to operate the program and also displays brief instructions about what to do when running a specific command.

You can start in Scia Engineer by creating a new model from scratch. But more typically, you would import a 2D drawing or a 3D model as a reference for creating the structural model. Drawings can be imported in DWG or DXF formats. There are several import options including which layers and entity types to import, as well as the ability to convert specific elements to beams or slabs upon import. Alternately, you could just import the drawing and then convert its lines and polylines to structural elements as required. Another possible workflow is where the architectural model is imported instead of 2D drawings. This would typically be done using the IFC import option, which provides the ability to import the objects in the IFC files as structural members or as general solids. Here again, you could choose the "general solids" option and subsequently convert specific solids into structural members as required. Scia uses layers as a means to organize and separate out parts of the model, so you would typically put the imported architectural model in a separate layer and turn on its visibility only when required. Similar to ArchiCAD 14, Scia keeps track of model versions, allowing the engineer to see the deleted, added, and modified elements in a new version of an imported model.

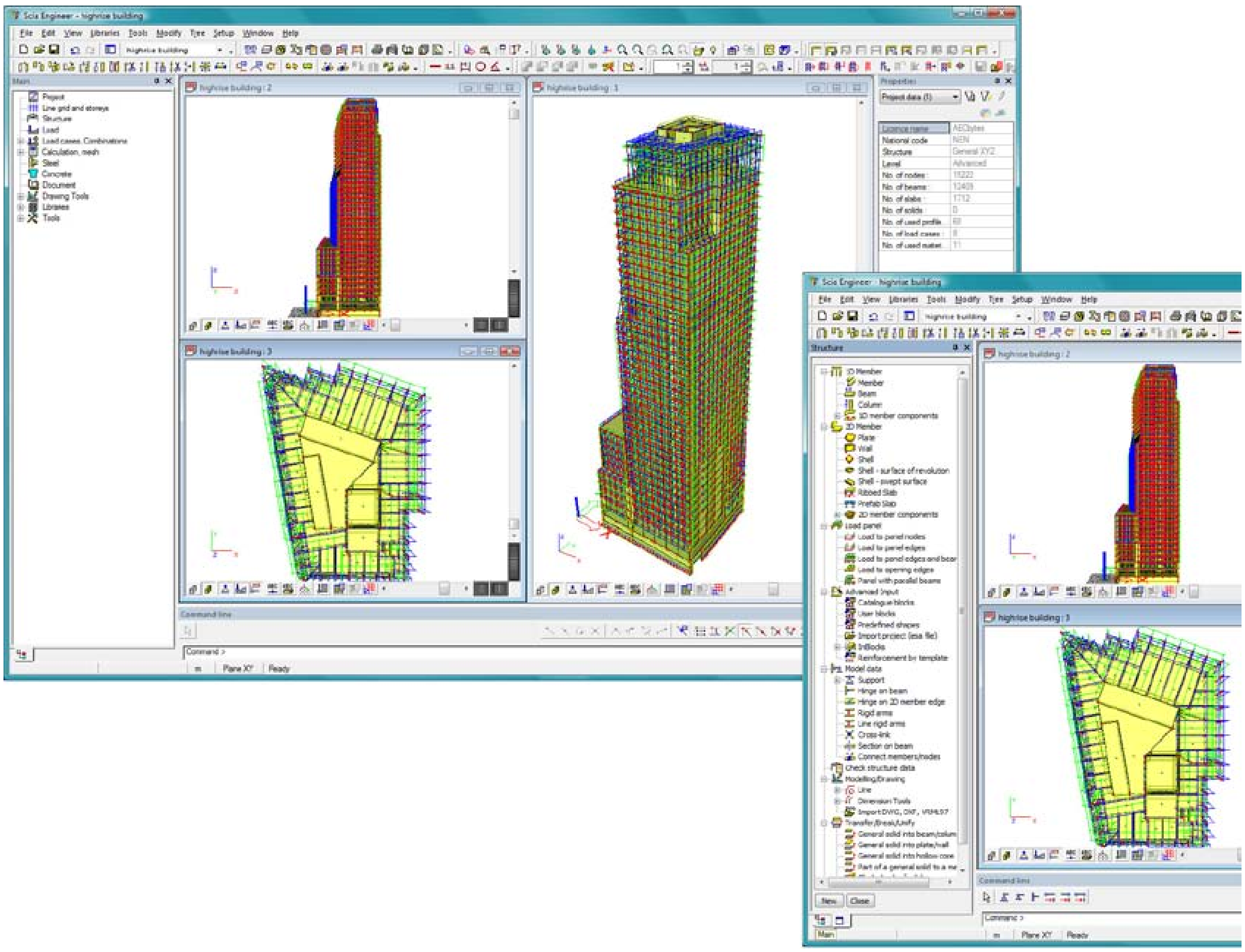

Figure 2. The user interface of Scia Engineer, which also shows how both the Main command tree and the Structure sub-tree occupy the same tree menu window on the left.

Scia uses the centralized model approach, which means that the entire project, including the structural model, calculation reports, drawings, and any other information are all contained in one file. This makes it more similar to Revit Structure rather than Tekla Structures or Bentley Structural Modeler. The file sizes of projects that contain only the structural model are relatively small, for example, the size of the file with the high-rise structural model shown in Figure 2 is less than 3 MB. The file sizes tend to get a lot bigger if additional building geometry, say the imported architectural model, is also stored in the same file. It should be noted that large models, even those with relatively small file sizes such as the one in Figure 2, have a noticeable slowdown in performance compared to smaller models.

Another aspect to note about Scia Engineer is that it integrates both the physical and analytical model of a structure. While this is true for all present-day structural BIM applications, what makes Scia different is that you actually create the analytical model rather than the physical model—it is the physical model that is automatically generated from the analytical model based on settings for individual element types (which can be modified, if required). This is an important distinction between Scia and other structural BIM applications, as it makes Scia more in tune with the engineer's workflow—structural engineers think more in terms of an analytical model when they design rather than physical models. The capability to generate an accurate physical model from an analytical model also sets Scia apart from other analysis tools, which work primarily with analytical models and can, at the most, display the structural volumes for each analytical structural element, which are helpful but do not accurately represent the actual physical structure. Scia also has this volumetric display capability; in fact, all new elements are created in this mode until the command to generate the structural model is executed. Figure 3 shows an analytical model of a structure that displays only the axes, then the same model displaying the volumes of the analytical model, and finally the physical model that is generated from the analytical model.

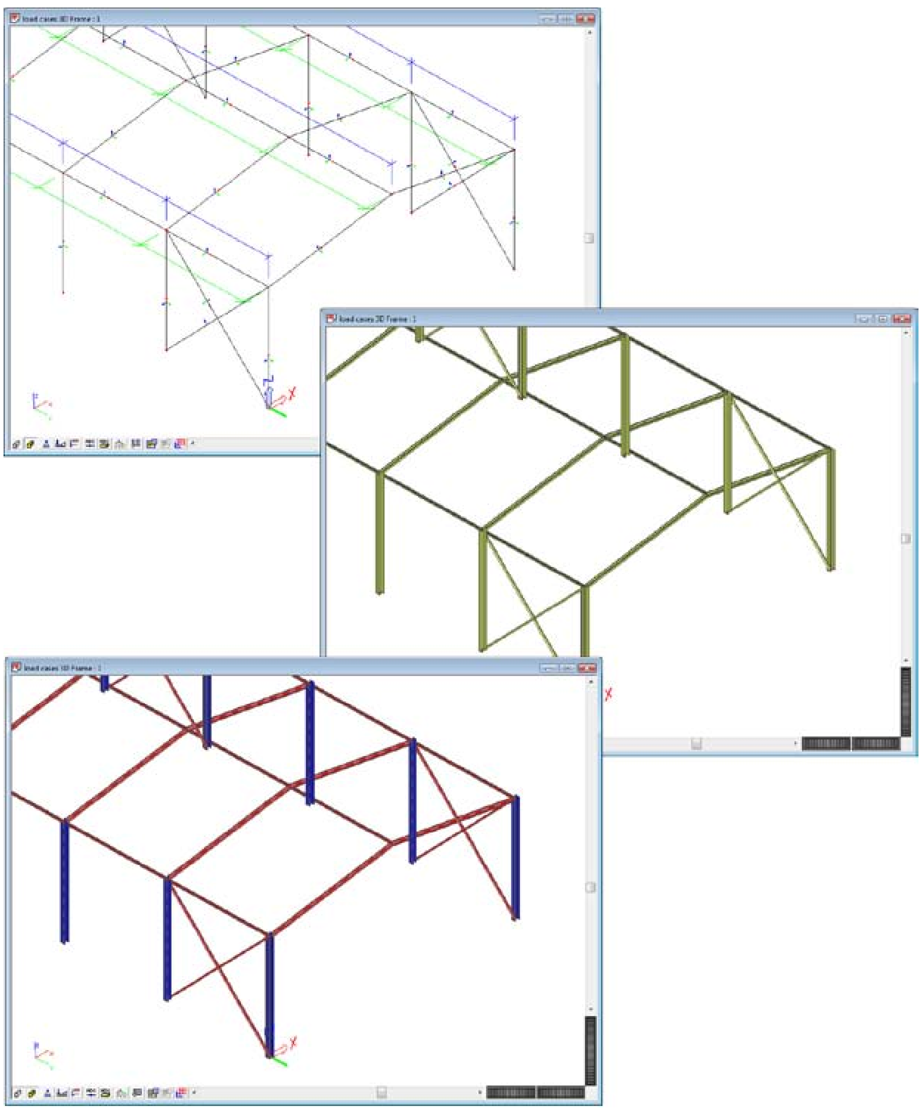

Figure 3. Three display modes for the same structural model. (Top) Analysis model showing only the axes. (Middle) Analysis model showing element volumes. (Bottom) Physical model created after running the command to generate the structural model.

For the actual modeling of the structure, the application has a wide array of tools for creating different structural elements, as shown earlier in the Structure menu in Figure 2. When a tool is selected, users can select from a large number of options that will define the structural properties of the element including its material and cross-sectional profile. The application comes with an extensive library of cross-sections for different materials and construction types; users can also define their own cross-sections. As an alternative to modeling the individual structural elements, Scia also includes "catalogue blocks" representing many commonly used structural systems such as 2D and 3D frames, trusses, towers, and so on. These are parametric, as shown in Figure 4, and can be adjusted to different modeling scenarios. Just like blocks in AutoCAD or families in Revit, they can be very effective to speed up the modeling of the structure.

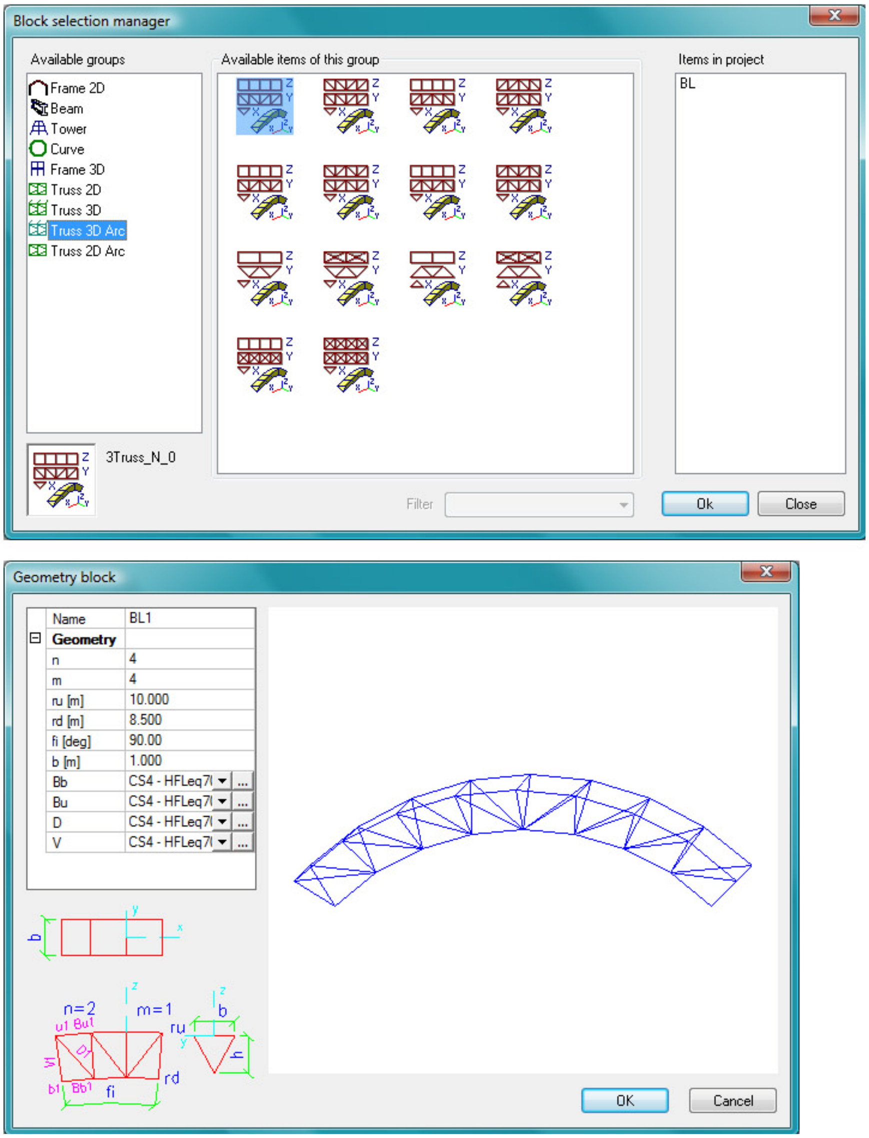

Figure 4. The parametric catalogue blocks available for the quick modeling of common structural systems.

The graphical modeling interface of Scia has a sophisticated feel that is comparable to any modern-day design application and is much more intuitive compared to say, Tekla Structures, which still relies heavily on numeric input in dialogs for many operations. There is no forced division of the model into horizontal levels (corresponding to the building's floors) as in Revit Structure. Instead, the engineer creates the model as a whole, using layers to segregate different parts of it for convenience, if required. The modeling can be done in reference to the global coordinate system, or any user-defined coordinate system. Workplanes can be created in any orientation and used as the basis for modeling. In addition to traditional linear structural elements, members can be modeled using arcs, parabolic arcs, Bezier curves, and splines. These can, in turn, be used to generate surface elements such as slabs and panels, making it easy to design freeform building structures that can not only be modeled physically but also analyzed (see Figure 5). Additionally, all structural members, including freeform ones, can have varying thicknesses if required. Advanced modification tools such as Booleans, Extend, Trim, and others, and a large array of snapping options, including the ability to detect extended intersections (typically found only in sophisticated CAD applications) allow even complex structures to be modeled quickly and easily.

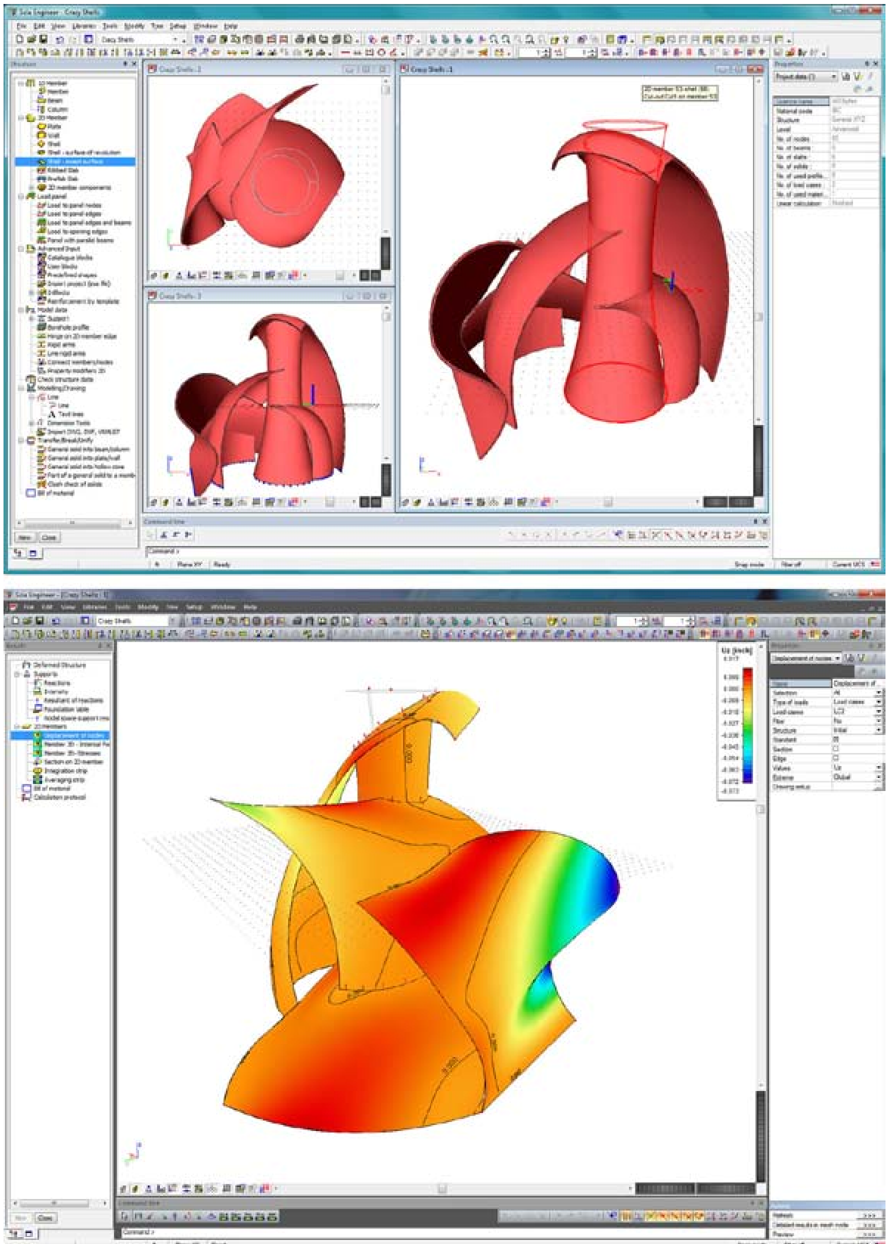

Figure 5. Modeling and analyzing a freeform structure in Scia.

The sophisticated modeling tools are nicely complemented by powerful viewing and display capabilities. An extremely unique and handy feature are the three slider bars on the lower right corner of the graphical window that let you quickly manipulate the zoom level, horizontal rotation, and vertical rotation of the model display in the window (see Figure 6). Another great feature is the ability to view only a part of the model using a clipping box, and while this concept is not unique, what is impressive about Scia is how nicely it has been implemented, making it very easy to place the clipping box where required and quickly resize or rotate it graphically to see different parts of the model (see Figure 7). There are also varied options for the actual display of the model, as shown earlier in Figure 3. It is even possible to adjust the direction of the lighting that illuminates the surfaces of the model when it is displayed in a rendered mode. This enables a decent quality of rendered images of the structural model to be generated directly within the application, without requiring the model to be exported to an external visualization tool. While most of the structural BIM applications have this capability, analysis tools typically do not, and this is one additional area where Scia Engineer stands out in comparison to other analysis tools

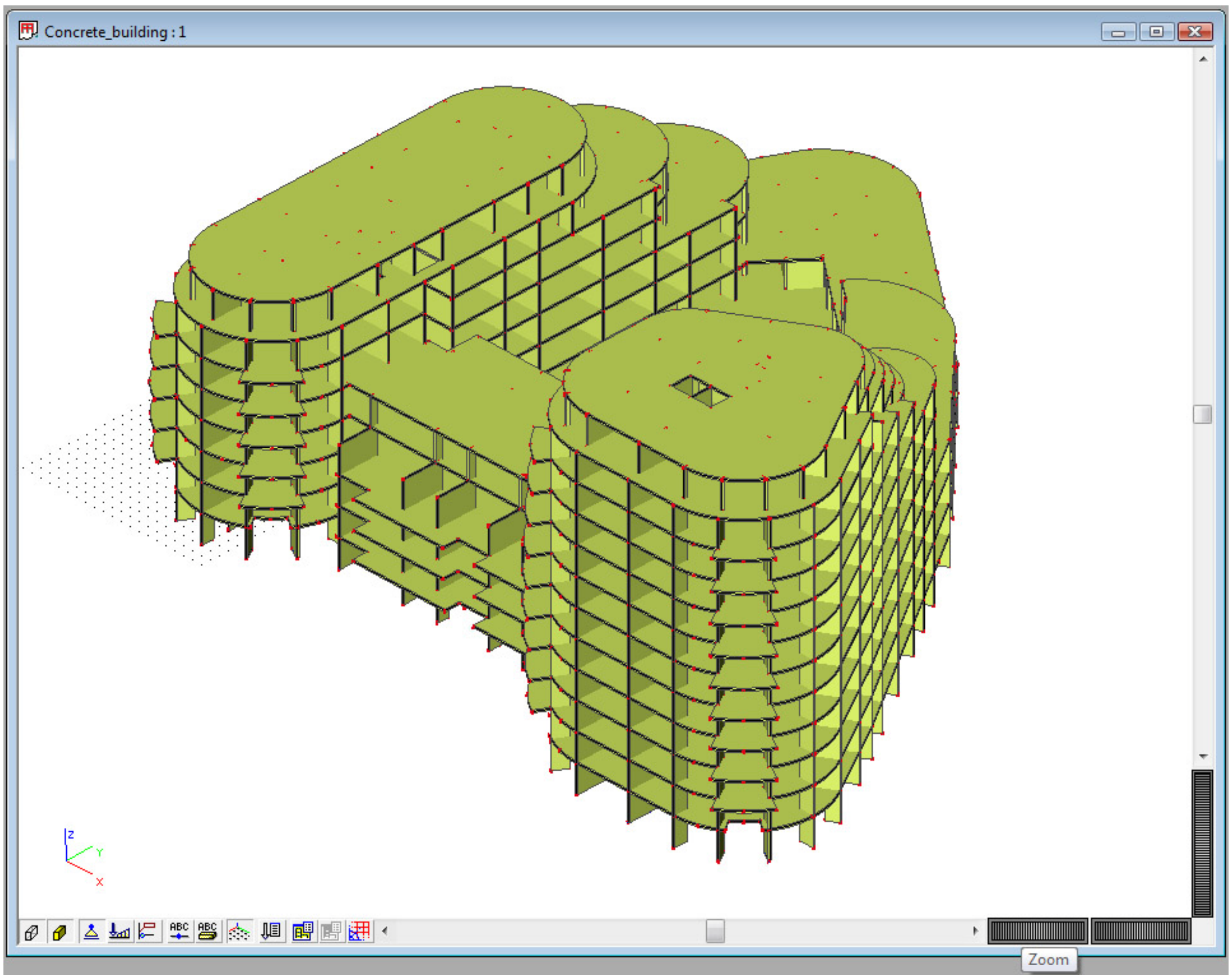

Figure 6. Using slider bars to quickly and conveniently zoom and rotate the view.

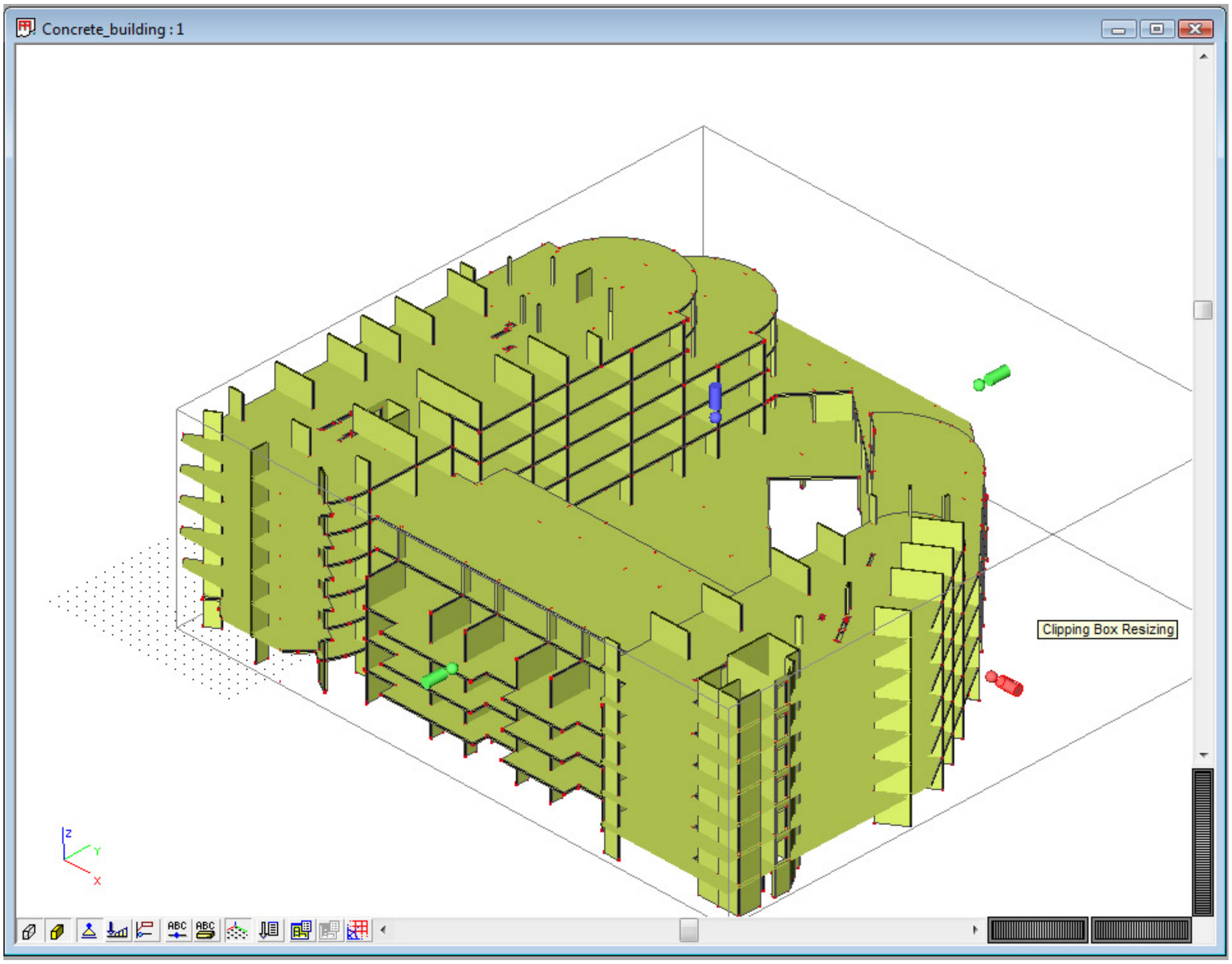

Figure 7. Using a clipping box to see only a portion of the model shown in Figure 6.

Analysis, Reporting, and Additional Capabilities

In addition to the structural attributes of an element such as its material, cross-section, and other properties visible and editable in the Properties window when the element is selected, Scia allows additional model data to be defined in detail including supports, foundations, and hinges. These additional entities are as important for the analysis and design of the structure as its physical geometry. In addition, there is a whole set of tools dedicated to defining the loads the different parts of the structure will be subjected to, which are critical to the analysis. There are tools for different load types such as concentrated force, linear moment load, wind load, etc., as well as the ability to manage the loads through load cases, load groups, load case combinations, and result classes. There are also load generators that allow for the transformation of a load from a specified load area into a given planar section of the structure, as well as for determining wind or snow load on a given vertical section of the structure. Figure 8 shows a structure for which additional model data and loads have been defined.

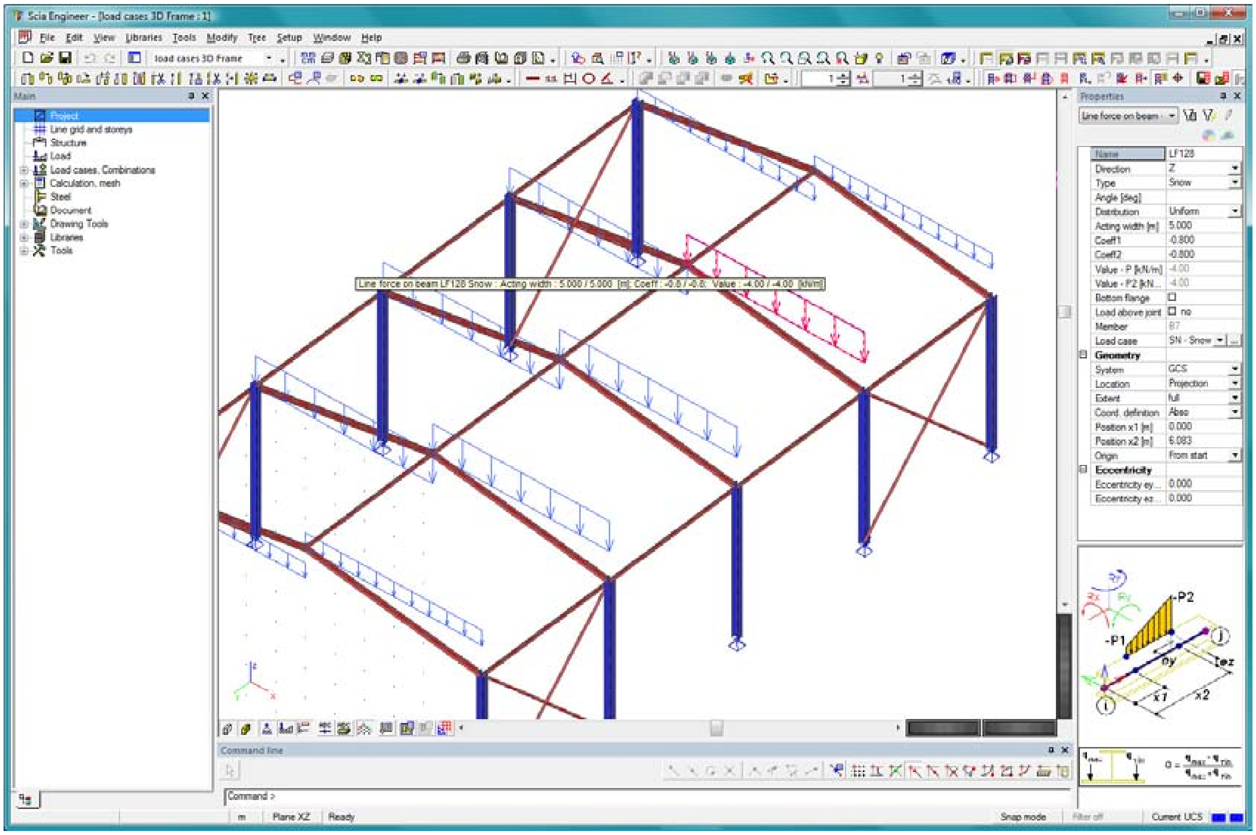

Figure 8. Adding model data and loads to a structure for analysis.

Once a model has been defined with all the needed structural attributes and loads, there is an option to check the model data before proceeding to the analysis, so that if there is any invalid or obsolete data, it can be removed from the model. This is done by an easy-to-use wizard that automatically searches the project and reveals improper or invalid data. After this optional step, the user can proceed to analyze the structure. Scia Engineer provides many different types of calculation options based on the type of material and construction as well as the building code that has been selected for the project (see Figure 9). These allow for both basic and advanced analysis, including linear and non-linear static analysis; geometrical and material based non-linear analysis; advanced non-linearity analysis with springs, gaps, and pressure only slabs; different types of dynamic analysis including free vibration, harmonic load, general dynamic load, and seismic analysis, time dependent analysis for construction staging, and pre-stressed structures; stability analysis; soil-structure interaction; analysis of membrane elements and friction supports; and other specialized analysis involving mobile loads, pipeline systems, absences, steel-concrete composites, etc. Scia Engineer also includes an auto-design capability, which enables optimization of the whole structure or of a selected part. This optimization can be run for steel and timber structures or for steel or timber parts of multi-material projects.

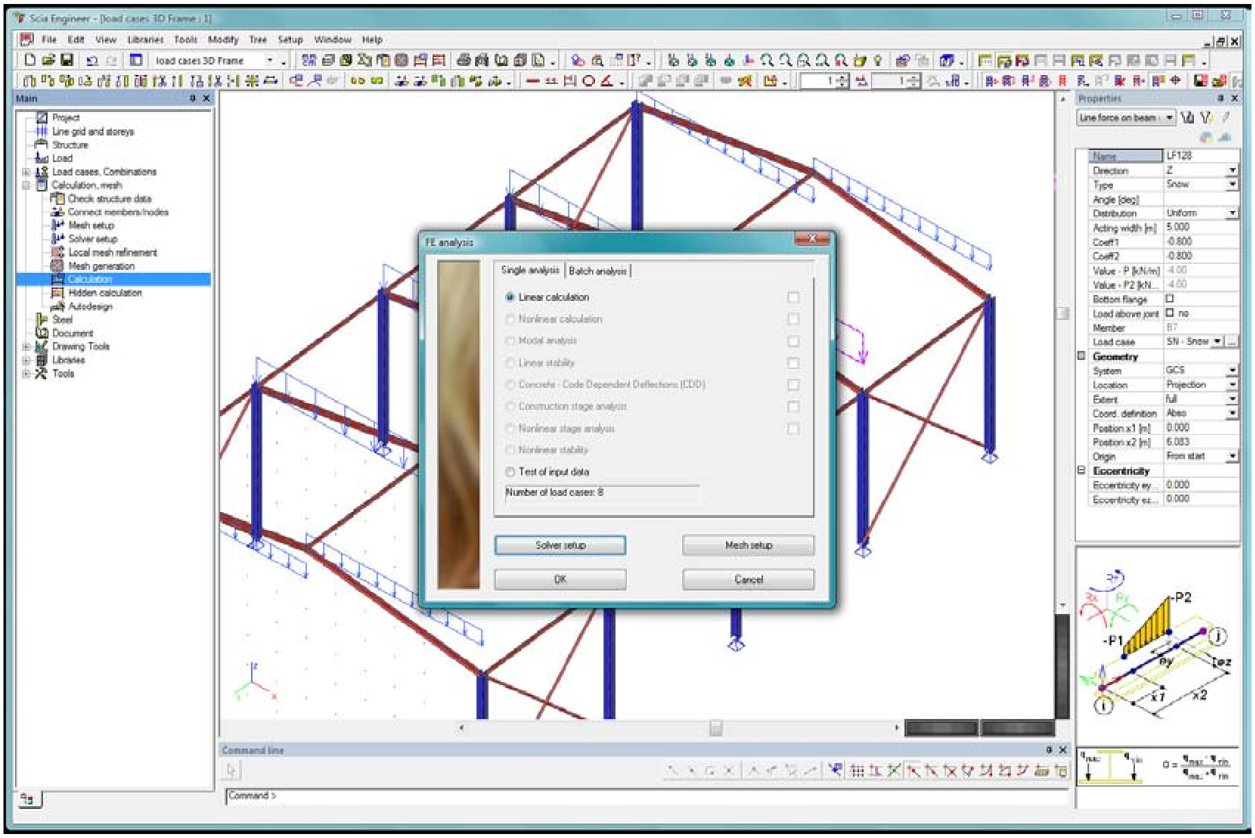

Figure 9. The different types of calculation options for a structure in Scia. Only those calculations relevant to the current structure will be activated.

While a detailed discussion of Scia's analysis capabilities is beyond the scope of this review, it is clear that these are wide-ranging and sophisticated, which makes Scia Engineer also a compelling option for its analysis capabilities alone. For example, Scia includes advanced foundation analysis capabilities, which has made the application very popular in the Netherlands, as most of the land there is below sea level leading to a lot of settlement issues. The use of Scia allows engineers there to study the interaction of buildings and soil and apply it to foundation design. The bidirectional links that Scia has with many structural BIM applications such as Revit Structure Tekla Structure, Allplan, and others, enables users of these applications to take advantage of its advanced analysis capabilities, even if they are not using it for structural modeling.

After the analysis has been performed, the results can be viewed within the application in the form of diagrams, tables, and even animations. It is also possible to generate a detailed calculation report showing the analysis results for each element and the structure as a whole (see Figure 10). This calculation report is bi-directional, so changes can also be made conveniently in the report that will then be applied to the model.

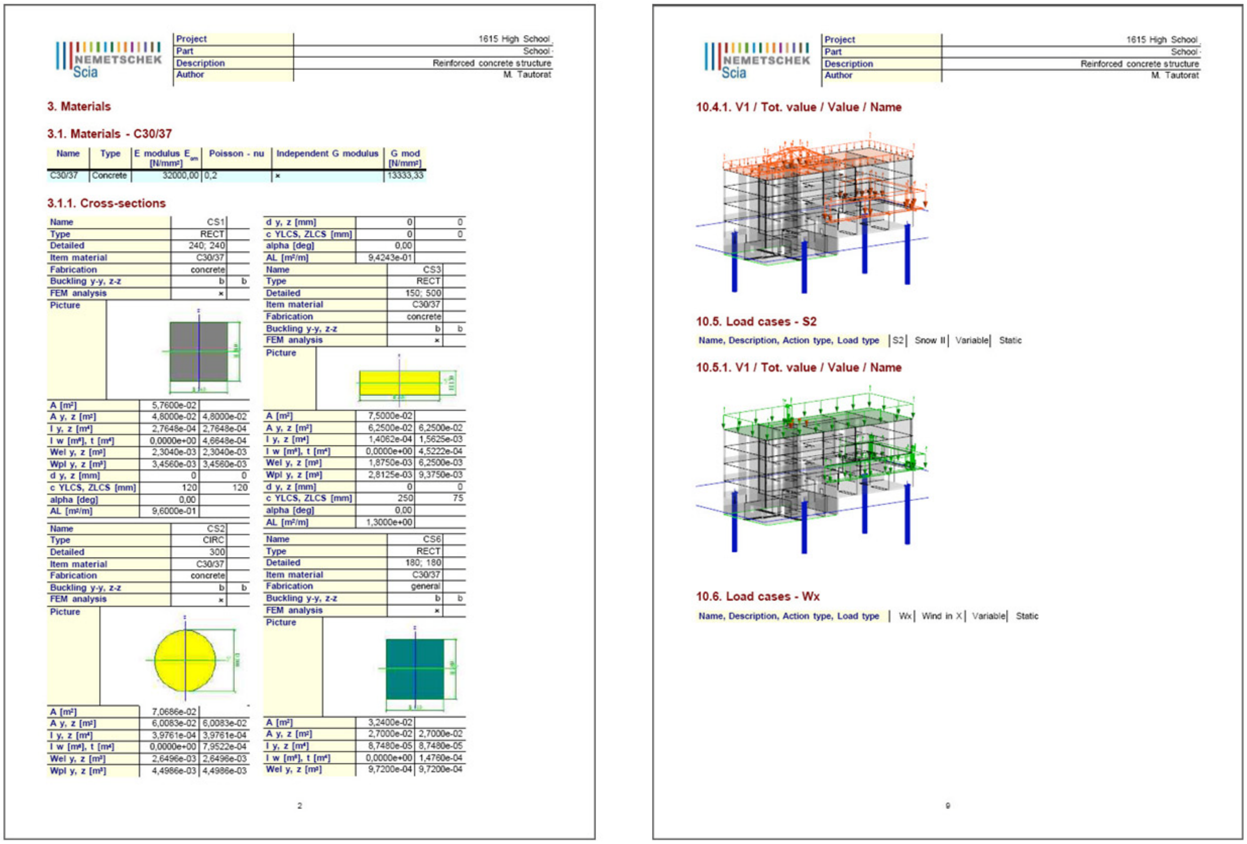

Figure 10. Two pages of a calculation report showing the detailed analysis of a structural design.

The application has many more additional capabilities including the design of frame connections of steel structures, reinforcement design and detailing of concrete structures, code checking for all kinds of structures, and the design of post-tensioned tendons as well as prestress checking for prestressed concrete structures. Scia has also special capabilities for pre-engineered metal buildings, allowing their integrated design to be driven by parametric modeling that covers all building details and all stages, from price estimation to production. The IFC support, along with direct integration with several other structural modeling and analysis tools, allows Scia to fit well into a multi-tool workflow. It also includes clash detection capabilities that enable it to be used for multi-disciplinary model coordination. While the 2D documentation capabilities of Scia Engineer are not as extensive as other CAD or BIM applications, as mentioned earlier, they are adequate for automatically generating different annotated views of the model and placing them on drawing sheets along with a title block, as shown in Figure 11. And finally, mention must be made of the excellent learning resources available for the application, including a comprehensive eLearning module that uses movies and slide shows to show how the application works (see Figure 12) and also lets you download the sample files as well as PDF versions of the lessons, if required.

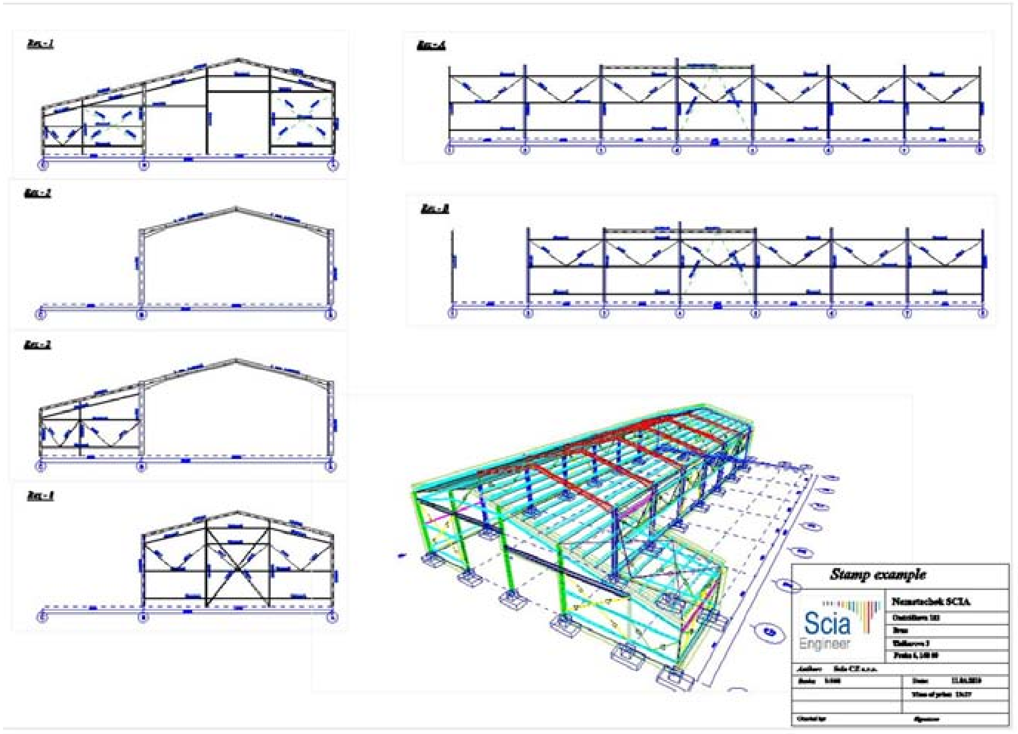

Figure 11. An example of a drawing sheet with annotated views that were generated directly from the model.

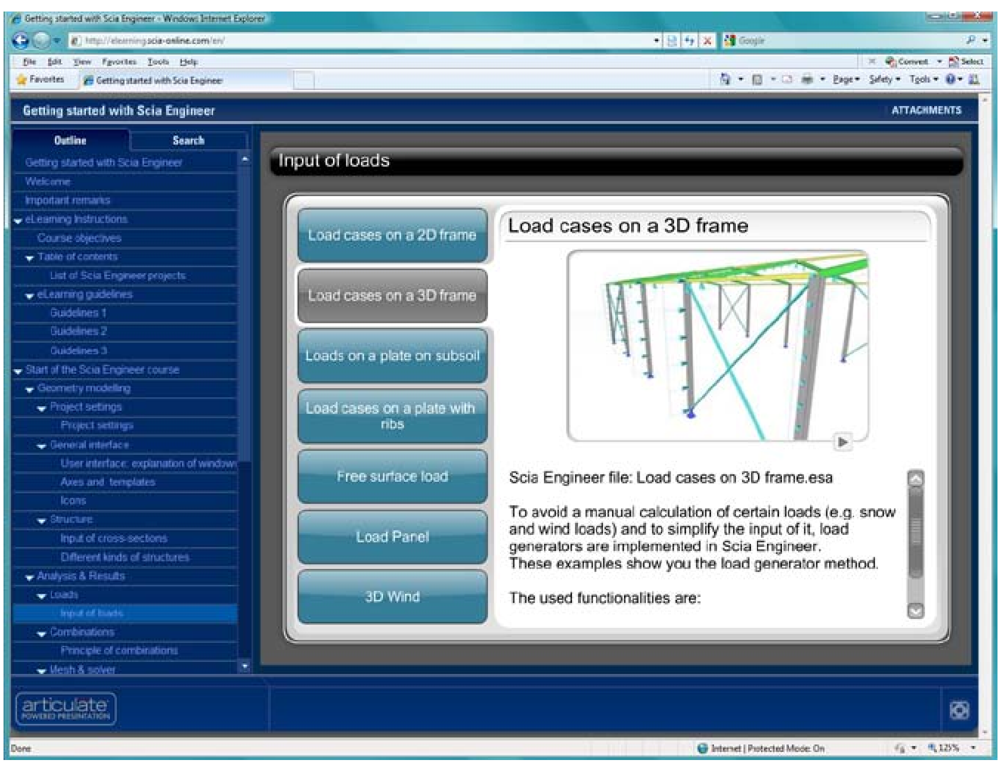

Figure 12. The online eLearning module of Scia Engineer provides an interactive way to learn the basics of the application.

Analysis and Conclusions

Since it combines both design and analysis capabilities, Scia Engineer is much more than a structural BIM application. Thus, for those engineering firms that haven't embarked on the BIM path yet, it can be a compelling option to consider, since it avoids the need for them to use separate analysis tools as they would have to do if they were using structural BIM applications such as Revit Structure, Tekla Structures, and Bentley Structural Modeler. For those firms already using these applications, Scia Engineer can also work well as a complementary application to them for analysis, since it combines the analysis capabilities—both basic and advanced—that would typically be found in several different analysis tools and supports multiple materials, structure types, and construction techniques. This workflow is facilitated by the bidirectional links Scia has with many of the structural BIM applications as well as with several other structural analysis and design tools. Scia's IFC support also enables the application to be used by the structural engineer as part of a multi-disciplinary BIM workflow. Other key strengths of the application are its modern and sophisticated modeling interface that allows for fast and easy modeling, and its ability for freeform modeling that is comparable to 3D modeling tools like Rhino and form.Z, except that that you are actually creating structural elements in Scia and not just 3D geometry. It far exceeds the freeform capabilities of any other structural modeling or analysis tool.

Overall, I was extremely impressed with Scia Engineer and found it eye-opening that a BIM application can include both design and analysis capabilities—we are so used to them being separately available in different applications. From this perspective, Scia seems more advanced than even many architectural BIM applications. It has relatively few limitations despite the wide repertoire of tasks that it handles—the main one seems to be the slowdown in performance for large models. The application currently uses 64 bit memory and multi-processing only for the analysis calculations; once these are implemented for all tasks, the application should be able to take full advantage of the latest computer hardware and be significantly faster. The lack of full-fledged documentation capabilities may seem a limitation at this point, but given that most firms still have legacy CAD applications with which they can complete the documentation tasks, I don't see this as a critical limitation of Scia. In fact, I would prefer to see the application focus more on supporting 64 bit and multi-processing, as well as advancing capabilities such as optimization and automated design, rather than trying to improve its documentation capabilities—eventually, the traditional requirement to create drawings for construction will go away and the model will suffice.

Given the growing interest in and adoption of 3D, BIM, and IPD in the AEC industry, the time seems right for the introduction of Scia in the US market. While the challenging economy at the moment may limit the actual sales of the software, the general slow-down can also provide engineers with some more time to explore new applications like Scia which they may otherwise not have.

About the Author

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About AECbytes

AECbytes (http://www.aecbytes.com) is an online publication launched by Dr. Lachmi Khemlani in Nov 2003. It is focused on researching, analyzing, and reviewing technology products and services for the building industry. Every month, it publishes various articles covering conferences and shows, reviews of products, feature articles profiling case studies of firms and projects that showcase the use of technology, viewpoint articles featuring contributions from industry leaders, and tips and tricks authored by experts in individual AEC applications. Subscription to AECbytes is free.

