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Revit® Structure: Documents, Linking to Third-Party Structural Analysis Programs (Yes, You Can), and Beyond!

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SE214-1L A brief overview of documentation in Revit Structure followed by an introduction to 3rd party analysis for internal electronic data interchange and formats for taking the models down stream into construction.

About the Speaker:

Mr. Ikerd directs INTERTECH Design, Inc.'s, department of Advanced Building Design, which focuses on structural engineering using interoperable data for multidimensional modeling beyond 3D and constructible solutions for project scheduling requirements. Mr. Ikerd is on the National ASCE Structural Engineering Institute committee for BIM, chairs the national sub-committee of SEI on BIM Developments, Software & Training, participates in the National BIM Standards committee, and chairs the Structural Engineers Association of Texas's State Committee on BIM in design, construction, and facility management. He is a speaker, author, and a member of the advisory board for the University of North Texas' Construction Engineering Department where he teaches one of the first classes in the country to incorporate BIM into undergraduate structural design and construction curriculum using Revit Structure.

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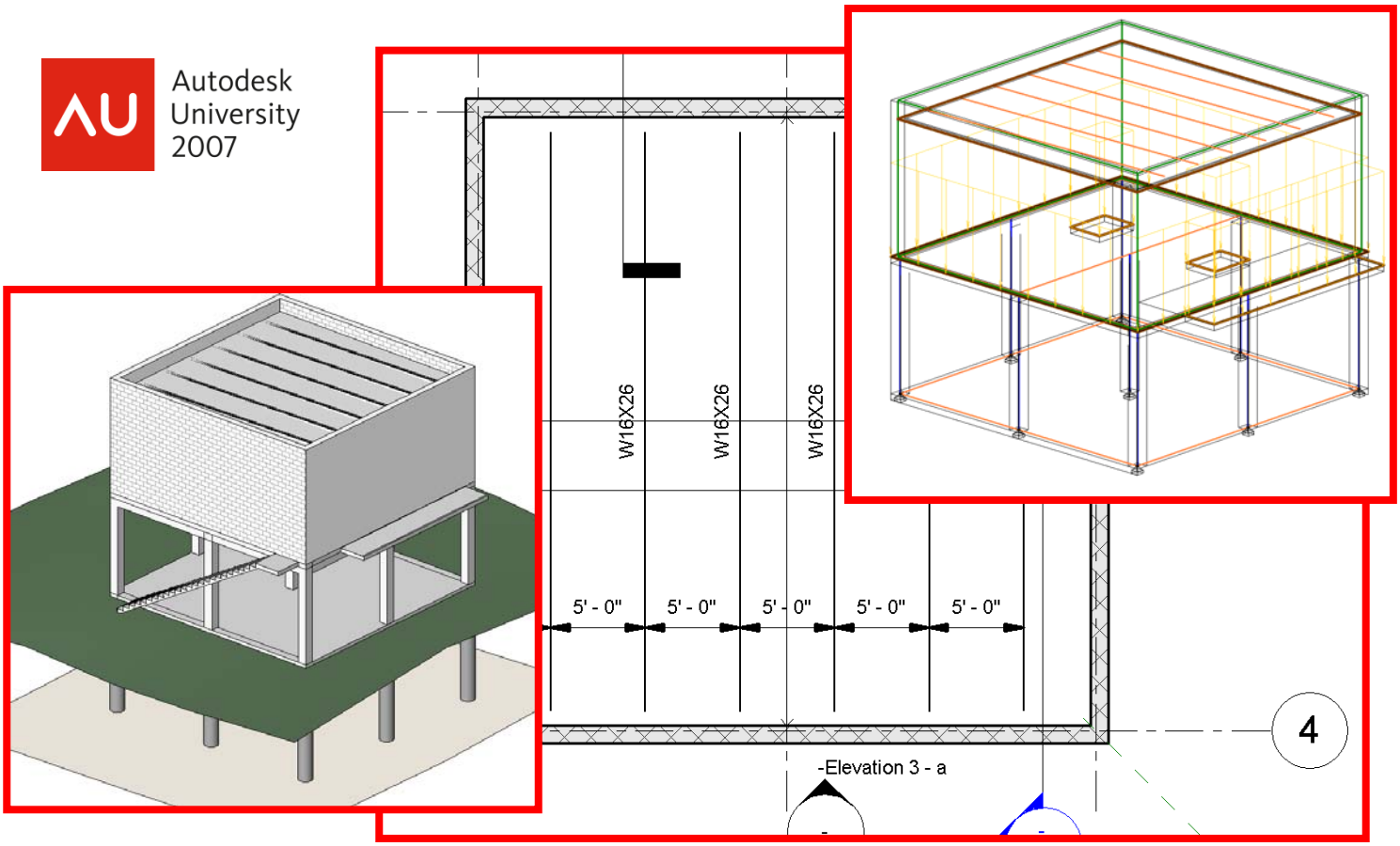

Class Timeline: After a brief introduction you will examine and work on a model in progress. A short tour of the model creation process will follow using Autodesk Revit Structure 2008, allowing each student to gain experience and “get a feel” for how the modeling process evolves during the production of a structural model, as well as how its various elements are created and relate to each other.

Questions and Answers: Questions and answers will be encouraged at the end of each exercise. The last ten minutes will be dedicated to Q&A.

Objective: After you have completed this lab class you will have taken a quick spin through different portions of the modeling process utilizing Revit Structure software so that you can gain a better understanding of its capabilities. Our objective is to give you a first hand look at various aspects of the Revit Structure and the Building Information Modeling process by leading you through a hands on demonstration of its powerful features with a focus on linking to 3rd party structural applications (3PSA). Beyond structural analysis, we will also highlight ways to take the structural engineering models vertically down stream into construction.

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Overview: Revit Structure is a Building Information Modeling application. All elements of the structural model are controlled by one unifying, underlying database that controls the entire project. Bi-directional associativity of the various building objects means that a change to an object in one view changes the object in all views, vastly improving the integrity of your overall project. With Building Information Modeling we endeavor to capture, preserve, and reuse information for downstream applications. The benefit of this approach is higher quality output, with greater productivity, at a lower cost. Revit Structure elements are controlled through parametric relationships. By this we mean that families are constructed through a series of parameters that define various component sizes and characteristics in order to create multiple types of the same object. This allows a maximum of flexibility in its ability to define, change, and update parts of the model.

Using the latest links available form many of these analysis programs, new models can be created in either REVIT Structure or your analysis software using the information available in the other program. In many cases, all geometric and design information including materials, family instances, walls, slabs, openings, grid lines, boundary conditions, footings, loads and load combinations can be created / updated / deleted in either of the two programs using the information available in the other program.

Analysis Partners

The following is a list of Autodesk 3rd Party Structural Analysis (3PSA) Partners at the time of printing. This information has been copied here to give you background and information on the analysis linking options currently available for Revit Structure users.

ADAPT
Concrete Design Software

http://www.adaptsoft.com/revitstructure/

ADAPT Corporation
ADAPT-Builder Suite—structural concrete design software

ADAPT-Builder concrete design suite offers a complete bidirectional link with Revit® Structure. Users can seamlessly transfer concrete slab and mat 3D models with all relevant information to ADAPT-Builder for detailed analysis and design. ADAPT-Builder software's unique, true 3D finite element analysis (FEM) engine translates physical model information imported from Revit Structure into an accurate analytical model. Use models originally created in ADAPT-Builder to generate Revit Structure models. ADAPT-Builder Suite programs include ADAPT-Floor Pro and ADAPT-MAT.

CSC
software and solutions
for structural engineers

http://services.cscworld.com/registration.php?id=1

Fastrak Building Designer
Dedicated Steelwork Building Design

CSC's Fastrak Building Designer is a comprehensive, easy-to-use, dedicated software solution for the structural design of steel and composite buildings. Using Fastrak Building Designer's intuitive interface and full model validation, users can create and easily change a complete physical design model incorporating timber and concrete members, as well as steel.

Integration with Revit® Structure enables engineers to pass their design model directly into Revit Structure. Any changes in the Revit Structure model can be exported back to Fastrak to complete the seamless two-way information exchange. This will ensure that users avoid duplicated effort in the design and drafting process.

http://www.csiberkeley.com/Revit/index.html

Computers and Structures Inc.
ETABS—integrated analysis and design of building structures

The ETABS and Revit Structure integration provides a smooth path for information exchange between important aspects of the structural engineering workflow. The model can be prepared in the Revit Structure environment with the model information then made directly available to ETABS for analysis, design, and optimization. The Revit Structure model is automatically updated with the latest design information produced by ETABS.

http://www.oasys-software.com/products/structural/gsa/revit.shtml

Oasys GSA
Structural analysis and design

Oasys GSA includes a bi-directional link between Revit® Structure and GSA. Oasys steel, concrete, and general standard sections can be loaded into Revit models and the model can be exported as a whole or as a selected subset. Referencing Oasys sections in the Revit model results in strong coordination between the Revit model and GSA sections during data transfer. GSA's comprehensive specification enables structural analysis and design requirements to be fulfilled within one program, whether you're working on a tall building, an iconic bridge, a deep foundation, or something unusual, like a sculpture.

http://www.risatech.com/partner/revit_structure.asp

RISA Technologies
RISAFloor and RISA-3D—building design and optimization software

As an Autodesk Authorized Developer, RISA Technologies has worked closely with Autodesk to help ensure compatibility between RISAFloor, RISA-3D, and Revit Structure software. RISAFloor and RISA-3D link with Revit Structure and each other to provide a robust, two-way exchange of information, enabling synchronization between the Revit Structure physical

model and the analytical model in RISAFloor and RISA-3D.

http://www.extensions4revit.com/n/e4r/

Robobat
ROBOT Millennium—structural analysis and design software

ROBOT Millennium is a feature-rich structural analysis and design software application capable of modeling and analyzing virtually any type of structure, no matter how advanced the geometry conditions. ROBOT Millennium is an ideal analysis companion for building information modeling (BIM) software, even with the most demanding structural models.

With ROBOT Millennium, Revit Structure users can directly analyze their models, without oversimplifying or interfering with the overall building information model in order to satisfy the restrictions of their chosen analysis solution.

Extensions for Revit
Extensions for Revit extend the capabilities of the Revit products in several key areas, including structural analysis and reinforced concrete drafting. Extensions for Revit provide immediate value to Revit users and are easy to download, install, and use.

Extensions for Revit are updated regularly, with one or more new modules posted monthly. Of particular interest is the availability of a variant of Robobat's structural analysis software ROBOT Millennium, which allows bidirectional integration with Revit Structure. Robobat currently makes this, and other select extensions to Revit users, available at no cost.

For more details information on Extensions for Revit, plus downloads, visit: www.extensions4revit.com.

http://www.sofistik.com/revit-to-sofistik

SOFiSTiK AG
SOFiSTiK Structural Desktop Suite—finite element analysis and design

With its brand-new Revit® Structure interface, SOFiSTiK adds high-performance finite element information modeling to building information modeling (BIM).

Using the SOFiSTiK Structural Desktop Suite, engineers can perform finite element analysis and design for virtually any structural system—buildings, bridges, tunnels or post-tensioned structures.

SOFTEK Services Ltd.
http://s-frame.com/index.htm

Softek
Softek Structural Office--advanced structural analysis and design software for professional engineers

Softek Structural Office 8.0 provides an integrated suite of products used for analysis and design of steel and concrete

structures. The flagship product, S-FRAME, offers:

4D/3D/2D modeling and analysis software features
State-of-the-art graphical interface with folder technology and dynamic grids
Staged construction analysis (4D)
MDB export/import
Inclined diaphragms
Automated area loads, notional loads, and story drift

The two-way integration of S-FRAME and Revit Structure allows the engineer to take advantage of S-FRAME's superior structural modeling, analytical, and design capabilities while simultaneously delivering the pertinent information required for managing building information in Revit Structure.

Autodesk cannot take responsibility for, and disclaims all liability in relation to, the use, implementation, reliability and performance of all of the third party products referred to above.

Many of the application have the following points to consider when working with 3rd Party Structural Analysis (3PSA). ALL OF THESE CAN BE SUMMED UP BY SAYING THAT **YOU MUST HAVE CLOSE COMMUNICATION WITH ALL OF THE MEMBERS OF THE TEAM WORKING ON THE PROJECT. In the following text 3rd Party Applications:**

1. **Tolerances:** The engineer can specify a **Tolerance** value. The Tolerance value is provided to take into account the discrepancies while modeling in Revit Structure. Any points/ elements/ loads defined within this tolerance limit will be snapped to the same location.

2. ***Boundary Conditions:*** Point Boundary conditions are supported. The X, Y, Z translation and rotation are supported. If the boundary condition is specified as a spring, then the spring modulus is also supported.

3. ***Point Loads:*** REVIT Structure point loads are translated into either 3PA joint loads or 3rd Party Analysis member point loads, depending on whether the REVIT Structure point load is placed on a joint or on a member. Point loads that are not located on either a joint or a member are typically not translated in many 3rd Party Applications.

4. ***Line Loads:*** REVIT Structure line loads are brought over as member distributed loads in most applications. Any part of a REVIT Structure line load that is co-incident with a member will be translated. REVIT Structure loads do NOT have to start and end on the member's ends, and can be fully within or outside the member's start and end points for most applications. Line loads that span multiple members will have the appropriate part of the load applied to each member.

5. ***Area Loads:*** REVIT Structure area loads are translated into either 3 or 4 point 3rd Party Analysis member area loads. Any area loads with more than 4 points are not currently considered by some 3PSA.

6. **Type Sets**: ***Columns, Beams, and Braces (not all the same):*** Members with 'Type' set to Column, Beam or Brace are supported. These elements are created if they are not

existent in the current REVIT Structure project. If an existing element is found, its geometry and properties are updated. If an element was deleted in the 3PSA, it would be automatically removed from the REVIT Structure project. The geometry, location, shape name, rotation, material information and function of family instances can be updated from 3PSA to REVIT Structure in most cases.

3PSA shape names are mapped to families corresponding to shapes in REVIT Structure via a shape mapping file. If a family corresponding to a particular shape is not already existent in the current project and the 3PSA link supports an auto-load option, then the link will run through all available REVIT Structure families. If a match is found for the newly imported shape, then the corresponding family would be automatically loaded in the project.

If a shape name is in both a Column and Beam family in the REVIT Structure project, then it would be distinguished by the presence of the “Column” keyword in the Column family and “Framing” keyword in the Framing Family.

7. **Materials**: Most steel, concrete and wood materials available in 3PSA are translated to REVIT Structure Materials; however engineers need to pay close attention to this definition between the applications.

8. **Load Cases**: 3PSA Basic Load Cases are brought over as REVIT Structure Load Cases. The BLC label in 3PSA is used as the Name of Load Cases in REVIT Structure.

9. **Cantilever Beams**: If either the “Moment Connection Start” or “Moment Connection End” fields of a beam are set to “Cantilever Moment”, then the beam would be brought in as a Cantilever in the 3PSA. If both are specified as “Cantilever Moment”, then the beam would not be brought into RISA Floor, as this case is practically impossible. The Cantilever beam must have a co-linear beam attached to its cantilever end. Also, the properties of the Cantilever beam should be identical to those of the co-linear beam. This is to be consistent with the default procedure of creating cantilevers in RISA Floor.

10. **Multi-Level Columns**: Watch these as there definitions may vary between Revit and the 3PSA products.

11. **Deck Definitions**: Each individually defined deck/slab will have its own definition under “Deck Definitions” in most of the 3PSA. At present REVIT Structure provides the name of the **deck, its thickness, deck direction, concrete strength, weight of concrete and Elastic modulus**. All other properties are being defaulted to those of standard Composite Decks in the 3PSA.

LAB EX. 1 : WHERE IS ZERO – ZERO & MAKING THE TEMPLATE (NOTE, FULLY DETAILED TUTORIALS OF THIS EXERCISE CAN BE FOUND AT www.IKERD.com\AU07)

On of the most important aspects of interoperability between software applications are the location definitions between applications. We will work with two examples, on the first one we

will export a simple model to a 3PSA application and look & discuss the results. We will then close that application and start a new Revit model by importing a model begun in a 3PSA. We will then talk about how to form your own Revit template files tailored to meet the needs of your 3PSA.

LAB EX. 2 : Documentation & Linking to 3rd Party Analysis Applications (NOTE, FULLY DETAILED TUTORIALS OF THIS EXERCISE CAN BE FOUND AT www.IKERD.com\AU07)

This example will show a very simple model with steel and concrete construction. (This model is purposely small so that it is easy to work with on laptops.) We will highlight how the model is used for documentation with live sections, hybrid sections, and referenced 2D sections. We will then show how the model was set up in analysis to update and change the design of the Revit Structure model. Strategies for working with much bigger projects will also be discussed.

LAB EX. 3 : And Beyond! (Useful tools & taking the model downstream) (NOTE, FULLY DETAILED TUTORIALS OF THIS EXERCISE CAN BE FOUND AT www.IKERD.com\AU07)

In this part of the lab, as time permits, we will show the use of some very useful 3PSA for working with the model and for taking the model down stream into construction.

Thank you very much for your time in participating in this presentation. If you have any questions or suggestions for improvement please do not hesitate to contact me at Will@Ikerd.com.