CSiXRevit 2020

SAP2000®, ETABS®, SAFE® and Revit® 2020 Data Exchange Documentation

ISO XRV061419M1 Rev. 0 July 2019
Proudly developed in the United States of America

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Computers and Structures, Inc.
www.csiamerica.com

info@csiamerica.com (for general information)

support@csiamerica.com (for technical support)

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Contents

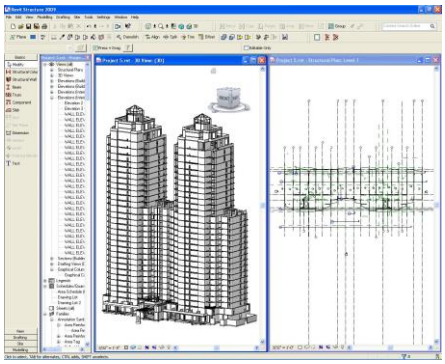
1 Introduction

This manual describes the exchange of Building Information Modeling (BIM) data between Revit 2020 and ETABS v18 or greater, SAP2000 v20 or greater, and SAFE 2016 or later.

Data can be repeatedly exchanged between Revit and ETABS, between Revit and SAP2000, and between Revit and SAFE along the following paths:

- Exporting from a Revit project to create a new ETABS, SAP2000, or SAFE model.
- Exporting from a Revit project to update a previously exported or previously imported ETABS, SAP2000, or SAFE model.
- Importing from an ETABS, SAP2000, or SAFE model to create a new Revit project.
- Importing from an ETABS, SAP2000, or SAFE model to update a previously imported or previously exported Revit project. In this case, you may choose to update locations, designs, or both.

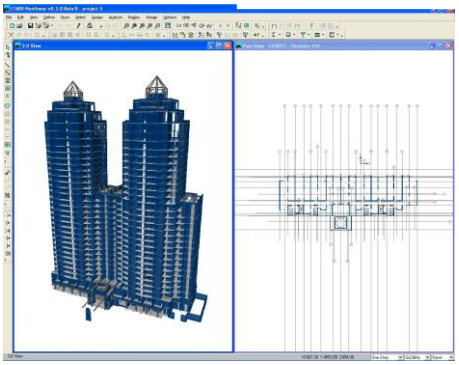
The flow of data in these exchanges is illustrated below:



Export from Revit to create a new ETABS, SAP2000 or SAFE model, or update an existing one.

ETABS®, SAP2000® or SAFE®

Revit®



Import from ETABS, SAP2000 or SAFE to create a new Revit project or update an existing Revit project.

The remainder of this manual is organized in three chapters:

- Chapter 2 presents the exchange of data between Revit and ETABS.
- Chapter 3 presents the exchange of data between Revit and SAP2000.
- Chapter 4 presents the exchange of data between Revit and SAFE.

2 Revit and ETABS Data Exchange

Data can be exchanged between Revit and ETABS along the following paths:

- Exporting from a Revit project to create a new ETABS model.
- Exporting from a Revit project to update a previously imported or previously exported ETABS model.
- Importing from an ETABS model to create a new Revit project.
- Importing from an ETABS model to update a previously exported or previously imported Revit project.

The actual data transferred varies in each of these cases.

2.1 Data Exported from Revit when Creating a New ETABS model

The table below provides an overview of the data imported into ETABS when exporting from a Revit project to create a new ETABS model:

Action	Project Element	Supported	Notes
Creation of…			
	Grid Lines		
	Story Levels		
	Materials		
	Structural Columns and Structural Framing		Transfers geometry, offsets, end releases, and beam and brace y and z justifications into ETABS. Imports columns based on splice information in ETABS.

	Steel Column and Framing Family Section Geometry		Creates and maps equivalent ETABS frame sections. Makes Auto-Select Lists in ETABS for all families used in the Revit project.
	Concrete Column and Framing Family Types		Creates and maps equivalent ETABS frame sections.
	Walls		Slanted or warped walls not imported.
	Wall Section Geometry		Creates and maps equivalent ETABS wall sections.
	Wall Openings		
	Floors		Sloped floors with more than four outer corners are projected on a horizontal plane.
	Floor Section Geometry		Creates and maps equivalent ETABS slab and deck sections.
	Floor Openings		
	Footings		Creates fixed joint restraints in ETABS wherever a footing occurs in Revit.
	Point Loads		
	Line Loads		
	Area Loads		Non-uniform area loads not imported.
	Load Cases		Creates both an ETABS load pattern and load case for each Revit load case.
	Load Combos		

2.1.1 Grid Lines

The following Revit grid line attributes are imported in ETABS:

- Grid Line Name: The same grid name is used in the ETABS grid bubble.
- Grid Line Points: The start and end points are used to define the general grid line in ETABS.
- Curved Grid Line: The center point, radius, start angle and aperture are used to define the circular grid line in ETABS.

2.1.2 Story Levels

The following Revit material attributes are imported in ETABS:

- Level Name: The same name is used in ETABS.
- Elevation: The elevation retrieved relative to the project origin is the elevation of the imported story level.

2.1.3 Materials

The following Revit material attributes are imported in ETABS:

- Material Name: The same name is used in ETABS.
- Material Type: The Revit material type is used to identify the ETABS material type, namely Concrete, Steel or Other.
- Young's Modulus: The Young's modulus values from Revit set the ETABS material Young's modulus (E). These three values (for the three different directions) cannot be zero in ETABS. If the first value is zero, then the default ETABS value is used. If any of the remaining two are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.
- Poisson's Ratio: Poisson's Ratio values from Revit set the ETABS material Poisson's Ratio (u). These three values (for the three different directions) cannot be zero in ETABS. If the first value is zero, then the default ETABS value is used. If any of the remaining two are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.
- Shear Modulus: Shear Modulus value from Revit set the ETABS material Shear Modulus (G). If the Revit material is defined as isotropic, then ETABS calculates this value on the basis of the Young's Modulus and the Poisson's Ratio. In the case of an orthotropic material, these three values (for the three different directions) cannot be zero in ETABS. If the first value is zero, then the default ETABS value is used. If any of the remaining two are zero, then the first non-zero value is used.
- Thermal Expansion Coefficient: The thermal expansion coefficient from Revit sets the ETABS material thermal expansion coefficient (Alpha). These three values (for the three different directions) cannot be zero in ETABS. If the first value is zero, then the default ETABS value is used. If any of the remaining two values are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.
- Weight Density and Mass Density: The unit weight value from Revit sets the ETABS material weight density (w) and mass density (m). In ETABS, the mass density is calculated by dividing the weight density by the gravitational constant (g). The weight density cannot be zero in ETABS. If the unit weight is zero in Revit, then the default ETABS densities are used.

- Damping Ratio: This value is not in used in the current version of ETABS.
- Bending Reinforcement: The bending reinforcement value from Revit sets the ETABS material main reinforcement F_y if the type is concrete. If this value is zero in Revit, then the default ETABS value is used.
- Shear Reinforcement: The shear reinforcement value from Revit sets the ETABS material shear reinforcement F_y if the type is concrete. If this value is zero in Revit, then the default ETABS value is used.
- Resistance Calculation Strength: The resistance calculation strength from Revit sets the ETABS material f'_c factor. If this value is zero in Revit, then the default ETABS value is used.
- Behavior: The Revit behavior tag is used to identify the isotropic or orthotropic materials in ETABS.
- Concrete Compression: The concrete compression value from Revit sets the ETABS material f'_c if the type is concrete.
- Lightweight: The Revit lightweight tag is used to identify the lightweight concrete material in ETABS.
- Shear Strength Reduction: This value is not in used in the current version of ETABS.
- Yield Stress: The yield stress value from Revit sets the ETABS material yielding stress F_y if the type is steel. If this value is zero in Revit, then the default ETABS value is used.
- Tensile Strength: The tensile stress value from Revit sets the ETABS material ultimate stress F_u if the type is steel. If this value is zero in Revit, then the default ETABS value is used.
- Steel Reduction Factor: This value is not in used in the current version of ETABS.

Only those materials assigned to floor, wall, or frame elements in the Revit project are imported into ETABS.

ETABS writes a warning in the .wrn file it writes when a default value is used while importing materials from the Revit project.

2.1.4 Structural Column and Framing Elements

The following Revit structural column and framing element attributes are imported into ETABS:

- End Points: For straight column and framing elements and curved framing elements other than arc shaped, the coordinates of the end points of the lines defining the analytical model of the element are retrieved and ETABS point objects with identical coordinates are created. When the analytical model of an element includes rigid links, the ETABS joint objects are created at the ends of the rigid links with ETABS joints offsets created to model the link. For arc shaped framing elements, the coordinates of the end points of the elements themselves are imported instead of the end points of their analytical models because these analytical models consist of

series of short straight segments and such a tessellation is not required in ETABS 2013 and later. Columns are imported with the Local Axis 1 always pointing up, and beams and braces with their Local Axis 1 always in the first quadrant, which means that the end joints may have been switched compared to the Revit end points. Multi-story columns and braces are automatically broken into several single story ETABS frame objects. This is required for reporting and design.

- Curvature: Straight elements are imported as straight ETABS frame objects. Curved framing elements that are not arc shaped are imported as series of short ETABS objects based on the lines defining their analytical models. Arc shaped framing elements are imported as arc shaped ETABS line objects.

- Family Types: The family type assigned to the Revit element is imported along with the whole family. ETABS converts the Revit family to an ETABS auto selection list.

- End Releases: End releases defined in the element analytical models are imported into ETABS. ETABS restricts releases that would cause an analytical instability, such as for example torsion released at both ends. When that happens, ETABS writes a warning in the .wrn file it writes. When ETABS joints have been switched compared to Revit end points, end releases are also switched.

- Insertion Points: In Revit, the beam or brace insertion point is defined by the following two parameters:

  - Z-Direction Justification

  - Lateral Justification

  ETABS calculates the corresponding insertion point based on these two parameters. If these parameters are not defined then the default cardinal point, Top Center, is chosen. Columns in Revit have no parameters corresponding to the ETABS insertion point and they are imported with a Middle Center insertion point.

- Rigid Links: When the analytical model of an element includes rigid links, these are imported as end offsets. You can visualize them by looking at the ETABS model in extruded view. In addition, when a beam has its z-Direction Justification parameter set to Other, an additional vertical offset is created at both ends of the ETABS frame object based on the value of the z-Direction Offset parameter. Other beam offset parameters such as Start Level Offset and End Level Offset are not taken into consideration because, except for arc shaped members, end joints are located based on the end points of the analytical model which already reflects the values of these parameters. When ETABS joints have been switched compared to Revit end points, end offsets are also switched.

- Orientation Angles: The ETABS Local Axis 2 Angle of columns is computed based on their rotation as internally stored in Revit. The ETABS Local Axis 2 Angle of beams and braces is computed based on the value of their Cross-Section Rotation parameter. When ETABS joints have been switched compared to Revit end points, rotations are adjusted accordingly.

2.1.5 Structural Column and Framing Element Sections

This section explains how ETABS maps the sections specified by various Revit family types of structural columns or framing elements to ETABS frame sections.

- If the ETABS model into which the Revit project is being imported already contains an ETABS frame section with the same name as a Revit family type, the Revit structural column or framing elements with that family type are imported with that ETABS section. The name comparison is not case-sensitive, and the prefixes UB and UC are considered equivalent to, respectively, UKB and UKC. Note that if you import a Revit project into ETABS, and later redefine a given Revit family type and then re-import the Revit project, ETABS will not redefine the ETABS frame section.

- If the ETABS model does not contain any frame section with the same name as a Revit family type, but does contain a frame section whose name matches part of the name of a Revit family type, the Revit structural column or framing elements with that family type are imported with that ETABS section.

- If a Revit family type is an instance of one of the pre-defined concrete or wood structural column or structural framing families listed in Table 1, or the steel plate or steel round bar families, ETABS creates a frame section with the same name, shape, and dimensions as the family type and the Revit structural column or framing elements with that family type are imported with that ETABS section.

- If the above did not apply, ETABS looks for a frame section with the same name as the Revit family type in its .xml catalogs of section properties. If it can find a namesake frame section, it loads it into the ETABS model, and the Revit structural column or framing elements with that family type are imported with the namesake ETABS section. You can interactively add or remove .xml catalogs and you can change their search order when you import the Revit project into ETABS.

- If ETABS cannot find any frame section with the same name as a Revit family type in its .xml catalogs, but does find a frame section whose name matches part of the name of a Revit family type, it loads it into the ETABS model, and the Revit structural column or framing elements with that family type are imported with the ETABS section with the abbreviated name.

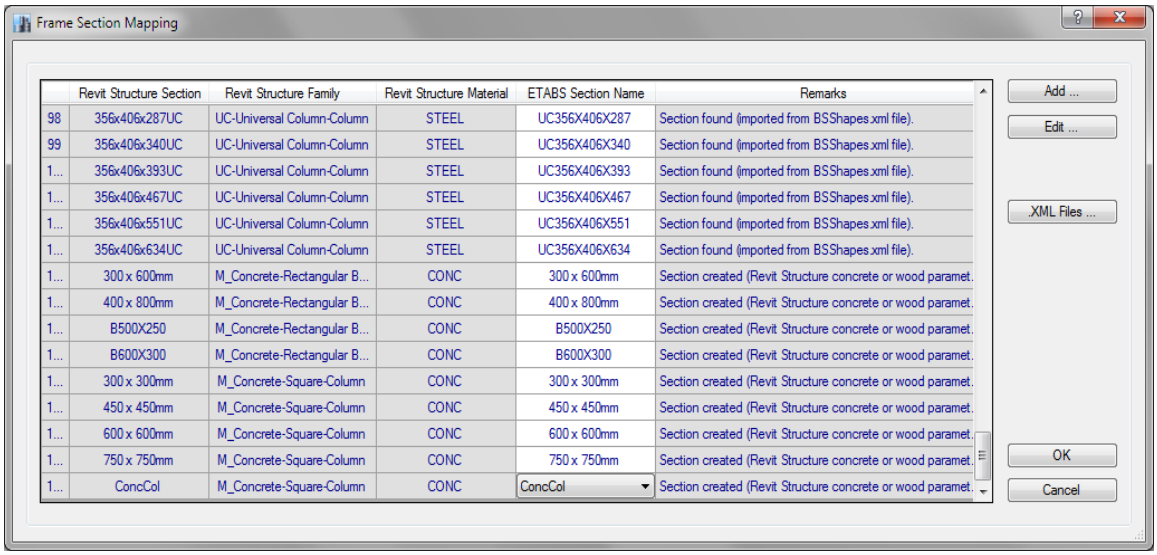


Figure 1: Import of Sections from Catalog (.xml) files

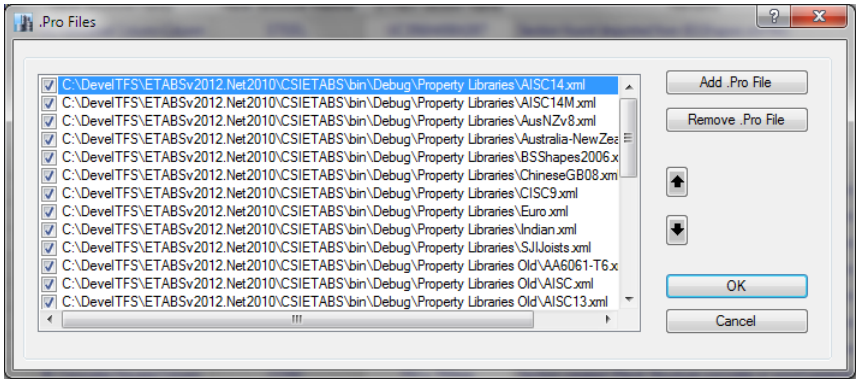


Figure 2: Adding and removing Catalog files when importing into ETABS

- If none of the above applied, the Revit structural column or framing elements with the unrecognized family type are assigned a default ETABS section. You can specify any ETABS section already in the model as a replacement, or you can explicitly define a new ETABS section and specify it as a replacement, or you can load a section from any of the ETABS .xml catalog, and specify it as a replacement.

You can save the ETABS frame section assignments you have made to a mapping file, and ETABS will reuse these assignments on subsequent imports.

Member Type	Family Name	Parameters
CONCRETE COLUMNS	CONCRETE-RECTANGULAR-COLUMN	B, H
	CONCRETE-ROUND-COLUMN	B
	CONCRETE-SQUARE-COLUMN	B
	PRECAST-RECTANGULAR COLUMN	B, H CHAMFER
CONCRETE FRAMING	PRECAST-DOUBLE TEE	WIDTH, TEE WIDTH, STEM WIDTH, SLAB DEPTH, DEPTH
	PRECAST-INVERTED TEE	H1, H, B, SEAT
	PRECAST-L SHAPED BEAM	H1, H, B, SEAT
	CONCRETE-RECTANGULAR BEAM, PRECAST-RECTANGULAR BEAM	B, H
	PRECAST-SINGLE TEE	WIDTH, STEM WIDTH, SLAB DEPTH, DEPTH
WOOD COLUMNS	DIMENSION LUMBER-COLUMN	B, D, SY, SX, IY, IX, A
	GLULAM-SOUTHERN PINE-COLUMN	B, D, SY, SX, IY, IX, A
	GLULAM-WESTERN SPECIES-COLUMN	B, D, SY, SX, IY, IX, A
	PSL-PARALLEL STRAND LUMBER-COLUMN	B, D, SY, SX, IY, IX, A
	TIMBER-COLUMN	B, D, SY, SX, IY, IX, A
WOOD FRAMING	DIMENSION LUMBER	B, D, SY, SX, IY, IX, A
	GLULAM-SOUTHERN PINE	B, D, SY, SX, IY, IX, A
	GLULAM-WESTERN SPECIES	B, D, SY, SX, IY, IX, A
	LVL-LAMINATED VENEER LUMBER	B, D, SY, SX, IY, IX, A
	TIMBER	B, D, SY, SX, IY, IX, A
	OPEN WEB JOIST	B, H
	PLYWOOD WEB JOIST	B, H

STEEL FRAMING	PLATE	B, D
	ROUND BAR	D

Table 1: Revit Family Names recognized by ETABS and associated Parameter Tags

2.1.6 In-place Family Members

Revit in-place family members are not imported into ETABS.

2.1.7 Walls

The following wall attributes are imported into ETABS:

- Points: The coordinate of all the points in the wall analytical model are retrieved and ETABS joint objects with identical coordinates are created. Revit walls may be defined as having more than four corners, but ETABS walls can only have three or four. Revit walls with more than four corners are broken into several four corner ETABS walls, with a few three corner walls when some of the edges are sloped. Also, multi-story walls are broken into several single story ETABS walls. This is required for analysis results reporting and concrete reinforcement design.

- Wall Curve: Arc shaped curved walls with horizontal bases and tops are imported as ETABS curved walls. Straight wall edges are imported as such. Other edges are tessellated, with the degree of approximation defined internally by Revit, and the wall is imported as a series of walls. Note that when a Revit wall is arc shaped in plane but its top is not horizontal, its top curve is not an arc and will be tessellated.

- Wall Openings: Wall openings are imported based on their locations. Opening with more than four sides are broken into three and four node openings. Multi-story openings are broken into several single story openings.

- Wall Thickness: A Revit wall has different layers, each having different thickness and material properties. ETABS only considers the layer with the maximum thickness when importing the data from Revit.

- Wall Materials: All the materials assigned to the different layers of a Revit wall are imported into ETABS. However, only one material is assigned to the ETABS wall section property. The material of the wall layer with the maximum thickness is used.

Slanted or warped walls, with their top not lined up with the base when looked at from above, are not imported into ETABS.

2.1.8 Floors

The following floor attributes are imported into ETABS:

- Points: The coordinate of all points in the floor analytical model are retrieved and ETABS joint objects with identical coordinates are created.

- Floor Edge Curvature: Arc-shaped floor element edges are imported as arc-shaped floor edges in ETABS. Straight floor edges are imported as such. All other curved floor edges are tessellated, with the degree of approximation defined internally by Revit. Floors with more

than four outer corners are projected onto a horizontal plane at an elevation matching their average elevation.

- Number of Layers: Revit floor family types consist of one or several layers. ETABS reads the layer information and imports the floor element with a **slab** section if its floor type includes a single layer, and with a **filled deck** section otherwise.
- Layer Thickness: The overall thickness of the ETABS deck or slab section assigned to an imported floor element is the thickness of the thickest layer in the Revit floor family type.
- Material: The material of the thickest layer is assigned to the ETABS deck or slab section. A default material is used if no material is defined in Revit.
- Deck Profile: If the Revit floor family type assigned to the floor element references a deck profile family type, ETABS interprets the parameters of the deck profile type as follows:
  - The parameter labeled "HR" measures the deck depth
  - The parameter "SR" measures the deck rib spacing
  - The parameter "WR" measures the width of the top of the deck ribs
  - The parameter "RR" measures the width of the bottom of the deck ribs
  - The parameter "THICKNESS" measures the thickness of the metal
    - Note that the composite shear stud diameter is taken as equal to the bottom rib width, and its height, and its height is taken as the overall section depth minus the thickness of the metal.
- Floor Span Directions: The Revit span direction is imported for decks. A default direction is used if no span direction is defined in Revit.
- Floor Openings (Regular or Irregular): Openings defined in Revit by "Modeling>Opening> Vertical Opening" are imported into ETABS.
- Ramps: All inclined slabs with three or four sides are imported as floor objects in ETABS.

2.1.9 Openings

The following opening attributes are imported into ETABS:

- Horizontal Openings: These are imported as openings in the floors.
- Wall Openings: These are imported as openings in the walls (vertical planes).
- Shaft Openings: In Revit, a shaft opening element is defined as a vertical extrusion with upper and lower limits (or offset elevations from upper and lower story levels). In ETABS the shaft opening is imported as horizontal floor openings at all the story levels that lie between the

upper and lower limits of the 3D shaft.

2.1.10Footings

The following footing attributes are imported into ETABS:

- Width, Length: For rectangular footings, the width, length and thickness are imported. In this case, ETABS locates all the columns within the rectangular footing area and restrains them.

Only rectangular footings are processed.

2.1.11 Point Loads

The following point load attributes are imported into ETABS:

- Load Case Name: It sets the corresponding load case name in ETABS.
- Location: It is used to define the point of application of the load.
- Fx, Fy, Fz, Mx, My, Mz: All forces and moments applied in the global direction, in Revit, are transferred in a similar manner into ETABS.

2.1.12 Line Loads

The following line load attributes are imported into ETABS from Revit:

- Load Case Name**:** It sets the corresponding load case name in ETABS.
- Start and End Point Locations: Used to define the start and end point of the line load. Line loads carrying the gravitational load and overlapping more than one beam are distributed to the corresponding beams in ETABS. In the case of a lateral line load, users must check no line load overlaps more than one beam; otherwise it is not processed in the ETABS analysis.
- Fx, Fy, Fz, Mx, My, Mz: All forces and moments applied in the global direction, in Revit, are transferred in a similar manner into ETABS. A Revit line load which includes more than one of these components is imported as several ETABS line loads because ETABS line loads are mono-directional.

2.1.13 Area Loads

The following area load attributes are imported into ETABS from Revit:

- Load Case Name: It sets the corresponding load case name in ETABS.
- Points: Points are used to define the geometry of the loading area. Curved edges that are arc shaped are imported as arcs. Straight edges are imported as such. Other edges are tessellated, with the degree of approximation defined internally by Revit.

- LoadX, LoadY, and LoadZ: All loads applied in the global direction in Revit are transferred in a similar manner into ETABS.

Non-uniform surface loads are not imported into ETABS.

2.1.14 Load Cases

The following load case attributes are imported into ETABS:

- Load Case Name: The same name is used for the ETABS load case.
- Load Case Category: It is used to define the load case type in ETABS. The mapping is shown in the following table:

Revit Load Case Category	ETABS Load Case Type
Dead	Dead
Live	Live
Wind	Wind
Snow	Snow
Roof Live	Live
Accidental	Other
Temperature	Other
Seismic	Quake

2.1.15 Load Combos

The following load combination attributes are imported into ETABS:

- Load Combination Name: The same name is used for the ETABS Load Combination Name.
- Load Cases: The same load cases list is used in ETABS to define the Load Combination.
- Load Case Factor: The same load case factors are used for the corresponding load cases in the ETABS load combination.

2.1.16 ETABS Auto Select Lists

ETABS automatically creates Auto-select lists based on the Revit family types that are loaded in the current Revit project and being exported into ETABS.

2.2 Data Exported from Revit when Updating an ETABS model

The table below provides an overview of the data imported in ETABS when exporting from Revit to update an existing ETABS model:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Story Levels		
	Materials		Creates equivalent ETABS materials.
	Frames		Transfers geometry, offsets, end releases, and beam and brace y and z justifications, into ETABS. Cuts all columns at story levels.
	Frame Sections		
	Steel Sections		Maps to ETABS database sections.
	Concrete Sections		Creates and maps equivalent ETABS sections.
	Walls		
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Deck Properties		
	Floor Openings		
	Footings		Creates fixed joint restraints in ETABS wherever a footing occurs in Revit.
	Joint Loads		
	Frame Loads		
	Shell Loads		
	Load Cases		
	Load Combos		
Update of…			
	Grids		

	Story Levels		
	Materials		
	Frames		
	Frame Sections		
	Steel Sections		
	Concrete Sections		
	Walls		Walls with changing number of sides are replaced.
	Wall Properties		
	Wall Openings		Wall openings with changing number of sides are replaced.
	Floors		
	Slabs Properties		
	Deck Properties		
	Floor Openings		Floor openings with changing number of sides are replaced.
	Point Loads		
	Line Loads		
	Area Loads		
	Load Cases		
	Load Combos		
Deletion of…			
	Grids		
	Story Levels		
	Frames		
	Walls		
	Wall Openings		
	Floors		

	Floor Openings		
	Footings		
	Point Loads		
	Line Loads		
	Area Loads		
	Load Cases		
	Load Combos		

NOTE: Deletion of ETABS objects when updating a model only works if you are exporting the entire Revit project. If the "selection only" update feature is used, no ETABS objects are deleted.

2.3 Data Imported from ETABS when Creating a New Revit Project

The table below provides an overview of the data imported into Revit when creating a new Revit project:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Story Levels		
	Materials		Imports Concrete and Steel materials into Revit from ETABS. Limitation is the Revit project should have one default concrete and one default steel material for duplication, otherwise the material will be created in Revit but its parameters will not be updated, and the properties of the new materials are identical to those of the template materials.
	Columns, Beams, Braces		Imports steel columns based on splice locations in ETABS.
	Frame Sections		Column cardinal points are not exported to Revit because the concept is not supported in Revit.
	Steel Sections		
	Concrete Sections		Creates and maps equivalent Revit sections. See Frame Sections below.
	Walls		Slanted walls not imported.
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Deck Properties		
	Footings		
	Load Cases		
	Joint Loads		
	Frame object Loads		Creates equivalent Revit point line loads and trapezoidal line loads.

	Shell Member Loads		Creates equivalent Revit area loads.
	Load Combos		

2.3.1 Frame Sections

This section explains how CSiXRevit maps ETABS frame sections to Revit structural column and framing element family types:

- If the Revit project into which the ETABS model is being imported already contains a Revit family type with the same name as an ETABS frame section, the ETABS columns, beams and braces with that frame section are imported with that Revit family type. The name comparison is not case-sensitive. Note that if you import an ETABS model into Revit, and later redefine a given ETABS frame section and then re-import the ETABS model, CSiXRevit will not redefine the corresponding Revit family type.

- If the type of the frame section is one of the section shape types listed in Table 2 or Table 3, CSiXRevit creates a new type of the corresponding Revit family in the Revit project based on the original ETABS section dimensions, and the ETABS columns, beams and braces with that frame section are imported with that Revit family type.

- If the above did not apply, CSiXRevit looks for a pre-defined family type with a matching name in the active Revit content libraries, and if it finds one, loads that family type in the Revit project and the ETABS columns, beams and braces with that frame section are imported with that Revit family type.

- If the above still did not work, CSiXRevit looks for a pre-defined family type whose name includes the name of the frame section in the active Revit content libraries, loads that family type in the Revit project and the ETABS columns, beams and braces with that frame section are imported with that Revit family type.

- If none of the above applied, the ETABS columns, beams and braces are assigned a default Revit family type. You can specify any family type already in the project or any pre-defined family type listed in the active Revit content libraries as a replacement.

Note that you can specify which Revit content libraries are active with the File->Options command, under the File Locations tab and Places… button.

ETABS Section Shape	Revit Family
Concrete rectangular	Concrete-Rectangular-Column.rfa, M_Concrete-Rectangular-Column.rfa
Concrete square	Concrete-Square-Column.rfa,M_Concrete-Square-Column.rfa
Concrete circular	Concrete-Round-Column.rfa, M_Concrete-Round-Column.rfa

Table 2: ETABS Column Section Shapes with preset Revit equivalent Families

ETABS Section Shape	Revit Family
Concrete rectangular	Concrete-Rectangular Beam.rfa, M_Concrete-Rectangular Beam.rfa
Concrete angle	Precast-L Shaped Beam.rfa, M_Precast-L Shaped Beam.rfa
Concrete tee	Precast-Single Tee.rfa, M_Precast-Single Tee.rfa
Steel Plate	Plate.rfa, M_Plate.rfa
Steel Rod	Round Bar.rfa, M_Round Bar.rfa

Table 3: ETABS Beam and Brace Section Shapes with preset Revit equivalent Families

2.4 Data Exported from ETABS when Updating a Revit Project

The table below provides an overview of the data imported into Revit when updating an existing Revit project:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Story Levels		
	Materials		
	Frames		
	Frame Sections		
	Steel Sections		
	Concrete Sections		Creates and maps equivalent Revit sections. See Frame Sections above.
	Walls		
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Deck Properties		
	Floor Openings		
	Footings		
	Load Cases		
	Joint Loads		
	Line Loads		
	Area Loads		
	Load Combos		
Update of…			
	Grids		
	Story Levels		
	Materials		
	Frames		Updates changes to column locations only for

			columns not meshed in ETABS and with a 1:1 correspondence between Revit and ETABS. You can choose between leaving columns meshed in ETABS in their original Revit locations or replacing them with the ETABS meshed columns.
	Frame Sections		
	Steel Sections		
	Concrete Sections		Updates Beam, Column and Brace section assignments; however section parameters themselves do not update. If you would like to bring in the changes to the parameters from ETABS, create a new section with the desired parameters in ETABS and assign the new section to the frame.
	Walls		Updates changes in wall location only for walls not meshed in ETABS and with a 1:1 correspondence between Revit and ETABS. You can choose between leaving walls meshed in ETABS in their original Revit locations or replacing them with the ETABS meshed walls.
	Wall Properties		Updates wall type assignments; however wall types themselves do not update. If a wall section is changed in ETABS, it is imported under a new name in Revit.
	Wall Openings		Non-rectangular wall openings are not updated.
	Floors		Replaces floors which moved, were not meshed when brought in from ETABS, and with a 1:1 correspondence between Revit and ETABS. You can choose between leaving floors meshed in ETABS in their original Revit locations or replacing them with the ETABS meshed floors.
	Slabs Properties		Updates floor type assignments; however floor types themselves do not update. If a floor section is changed in ETABS, it is imported under a new name in Revit.
	Deck Properties		
	Floor Openings		Floor openings moved in ETABS are replaced.
	Load Cases		
	Point Loads		
	Line Loads		
	Area Loads		Area loads moved in ETABS are replaced.

	Load Combos		
Deletion of…			
	Grids		
	Story Levels		
	Materials		
	Frames		
	Walls		
	Wall Openings		Non-rectangular wall openings are not deleted.
	Floors		
	Floor Openings		Floor openings imported as a floor shaft and deleted in ETABS are not deleted.
	Load Cases		
	Point Loads		
	Line Loads		
	Area Loads		
	Load Combos		

NOTE: Deletion of elements when updating a project only works if you are sending the entire model. If the "selection only" update feature is used, items are not deleted.

2.5 Procedures

2.5.1 Exporting from Revit to Create/Update a New/Existing ETABS Model

NOTE: CSiXRevit only exports the analytical models of Revit elements. All the analytical models of all the Revit elements must be correctly connected to each other to ensure the stability of the ETABS model generated.

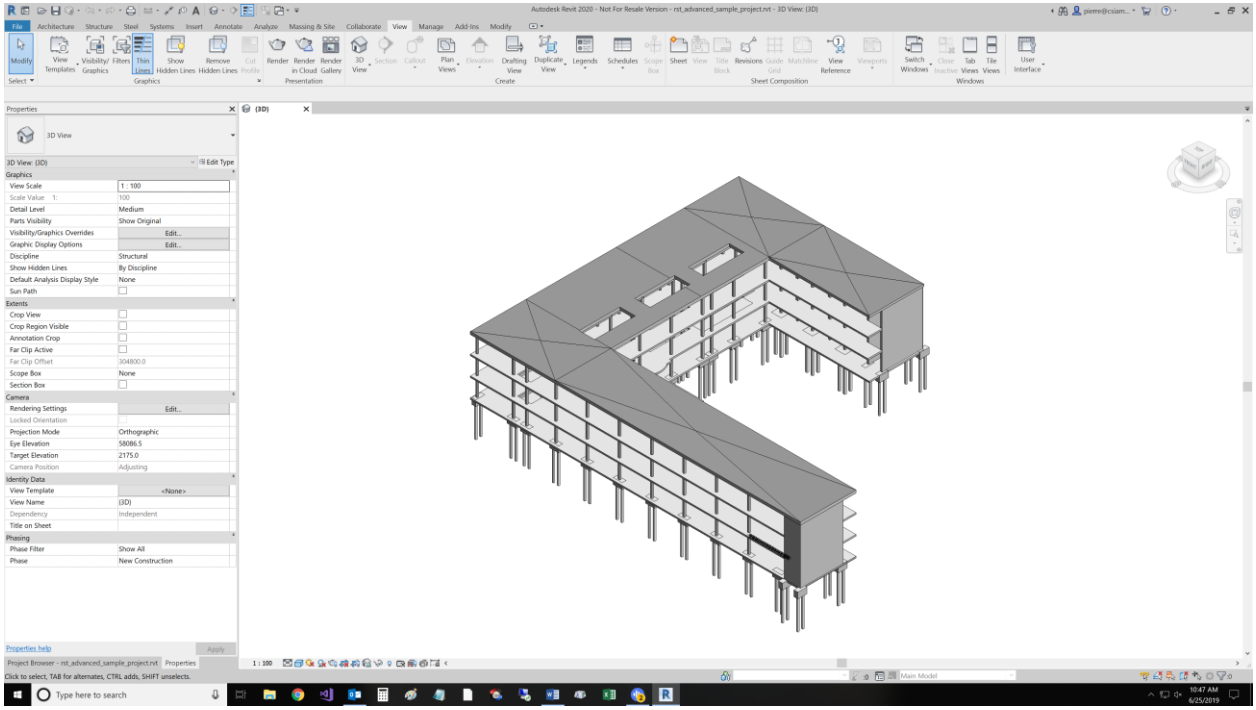


Figure 3: Revit Model View

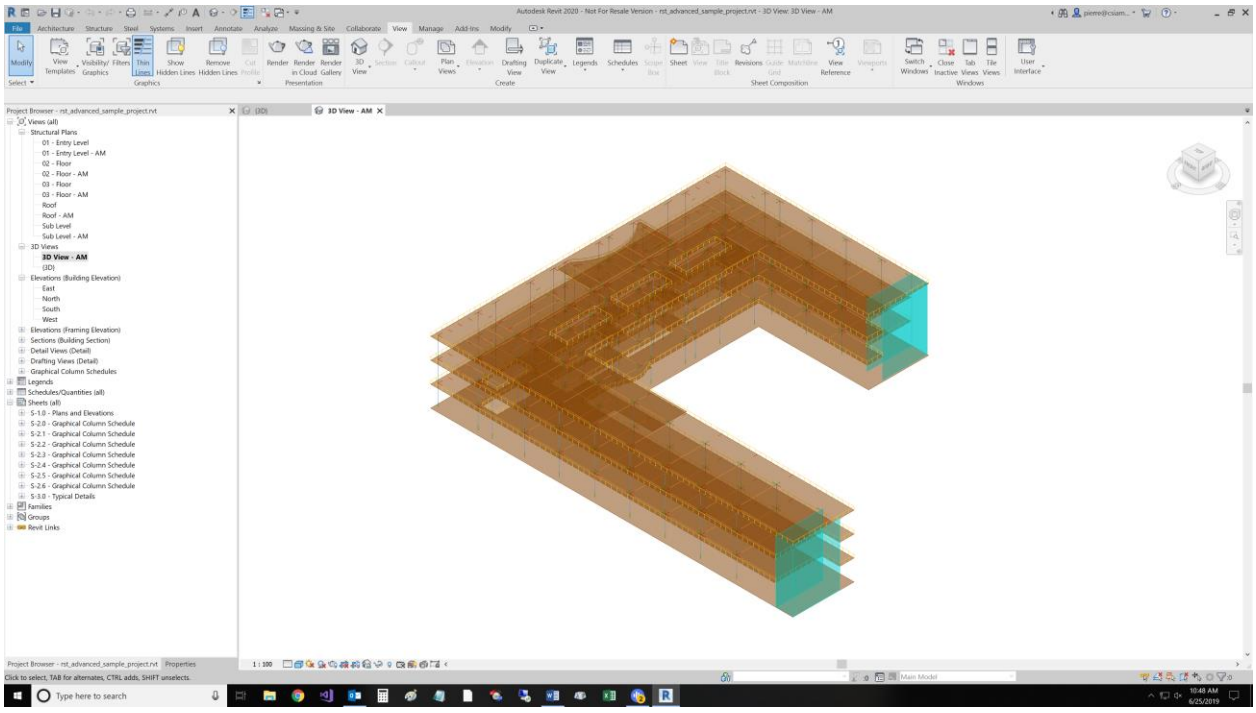
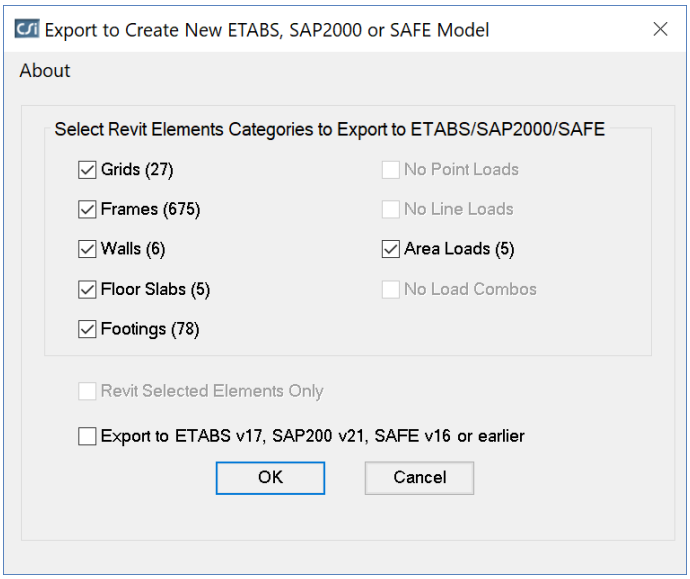


Figure 4: Revit Analytical Model View

The following describes the steps to export a Revit project to ETABS:

- To **create** a new ETABS model, from the Revit menu select, Tools>External Tools>**Export to Create New ETABS SAP2000 or SAFE Model**. To **update** an existing ETABS model, from the Revit menu select, Tools>External Tools>**Export to Update Existing ETABS or SAFE Model**.

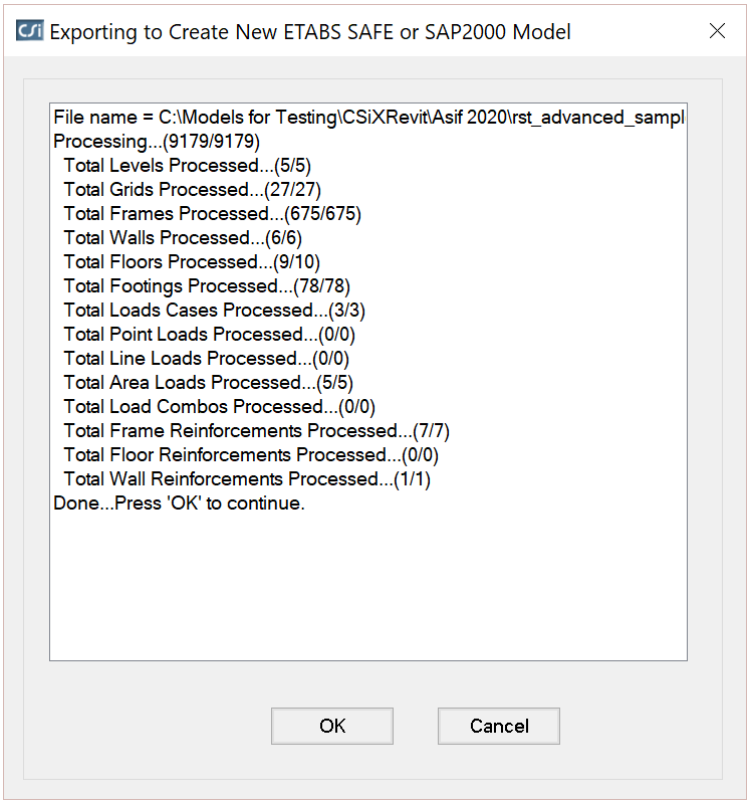
- CSiXRevit counts the elements in the Revit project and displays the Export to Create New ETABS SAP2000 or SAFE Model form, or Export to Update Existing ETABS or SAFE Model form as may be the case:



- Select the categories of Revit elements to export. If you have selected some elements prior to starting the command and wish to only export those elements, check the corresponding box near the bottom of the form.

- To export to ETABS v17 or earlier, check the corresponding box near the bottom of the form.

- Once you have made your selections, click OK. The Exporting to Create New ETABS SAP2000 or SAFE Model or Exporting to Update Existing ETABS or SAFE model information message box is shown and displays the progress of the export:

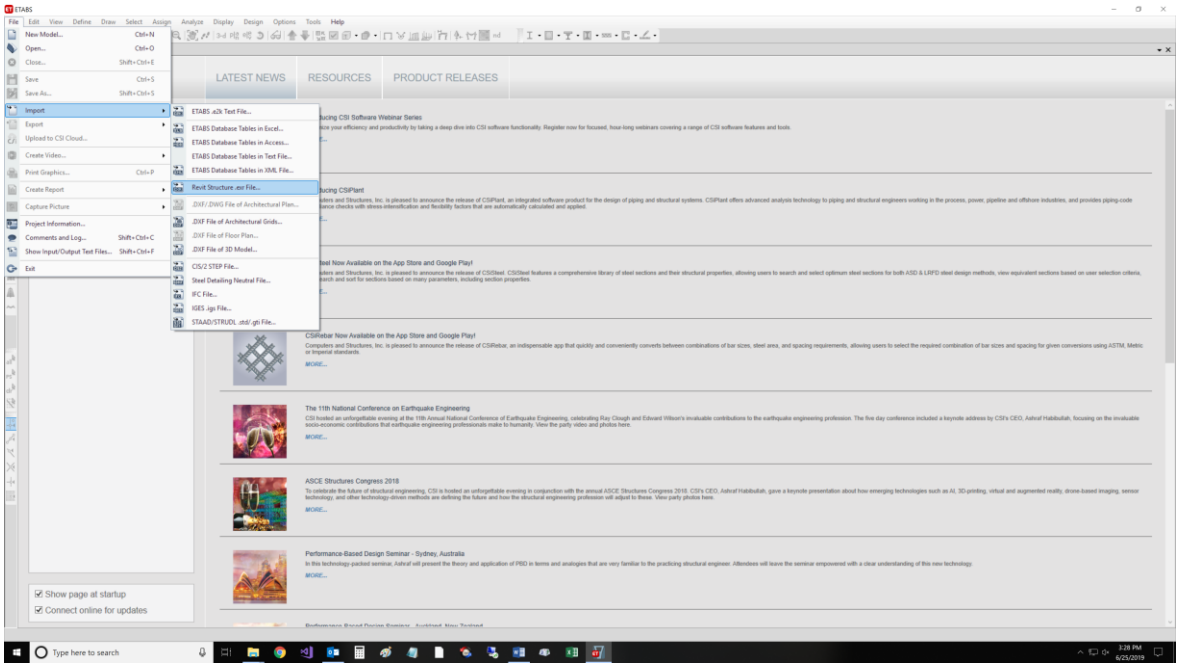


Once the process is complete, click OK. You are now asked to select a destination folder and filename. The file will be given the extension .exr.

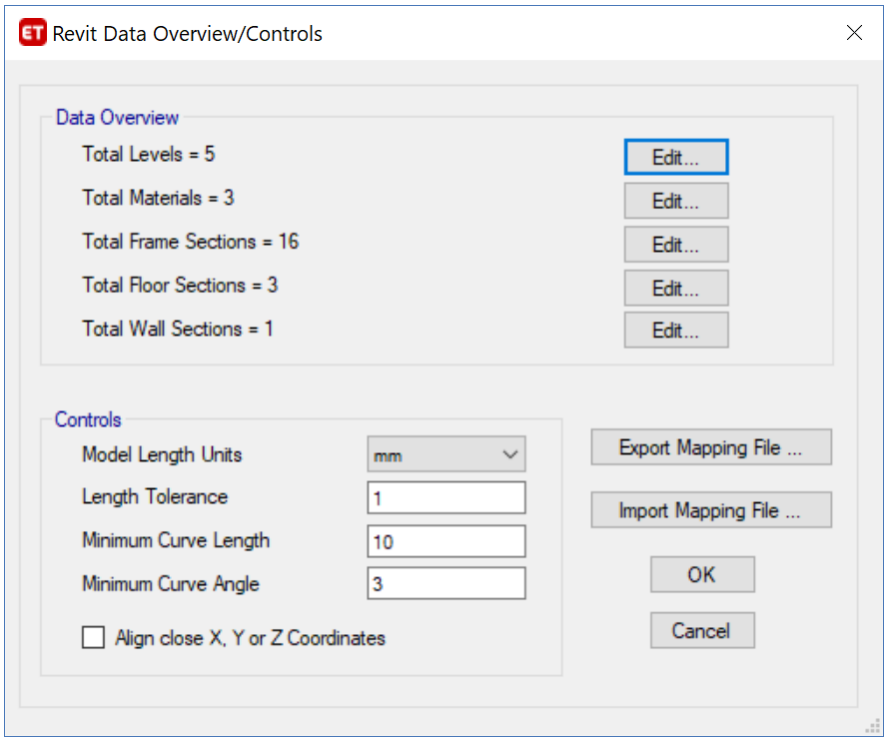
You are now ready to import the .exr file in ETABS:

- Start ETABS if it is not already running.
- To create a new ETABS model from your Revit project, you should not have any model open, not even an ETABS blank model (an ETABS blank model actually includes four story levels). By default, ETABS creates a new model based on your .exr file. To update an existing ETABS model, open it.

- From the menu, select File>Import>Revit Structure .exr file, and then select the .exr file to import. If you are creating a new model, this command is available from the ETABS Start Page.



The Revit Data Overview/Controls form is displayed:

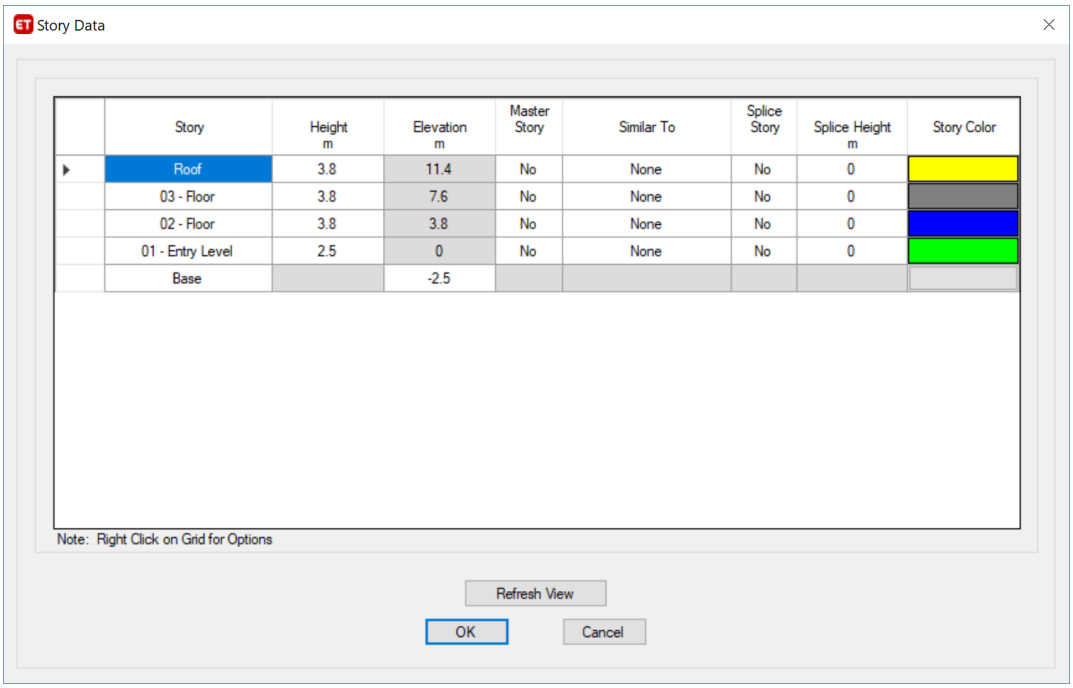


The top section of this form provides access to more forms which let you specify how Revit levels, materials and families are imported in ETABS.

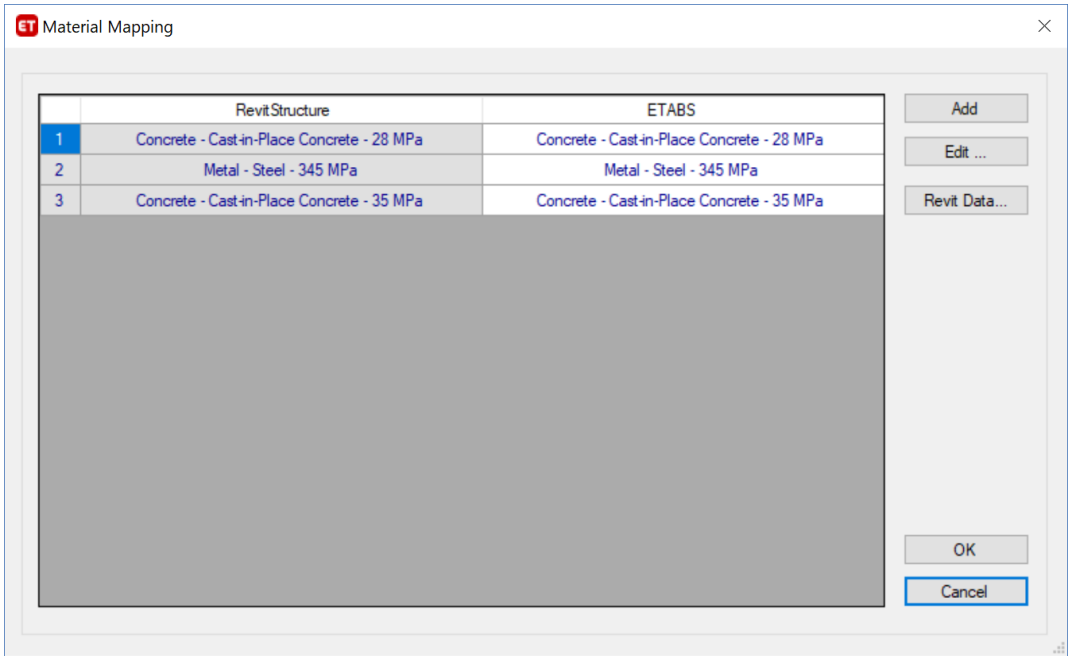
Any material property with a zero value, any unrecognized section, any section with a default material displays a warning. If a material property was not defined, or a material was not assigned in Revit, you can address the issue before the ETABS model is created. These issues can be addressed by clicking the corresponding **Edit** button.

The bottom section of the form displays general controls that ETABS uses when importing the Revit project. The units selected here are used as the default units of the ETABS model. The length tolerance is the tolerance ETABS uses to align close X, Y, Z coordinates and to create connectivity when creating the finite element model for analysis. The Minimum Curve Length and Angle let you control how a curve is divided into straight line segments. When you check the Align close X, Y or Z Coordinates, ETABS may make small adjustments to the original coordinates in the .exr file. Adjustments are then made to the coordinates of grid lines, frame objects, and edges of shell objects that are parallel or almost parallel to the horizontal plane X or Y axis in the exr file. These adjustments are two-fold: All imported such items are made actually parallel to the X or Y axis as applicable; and all such items that are almost aligned with each other are actually aligned.

- To review the various story levels imported from Revit click the **Edit** button. The ETABS Story Data form is displayed, letting you change story heights and other story parameters, and add or delete story levels.

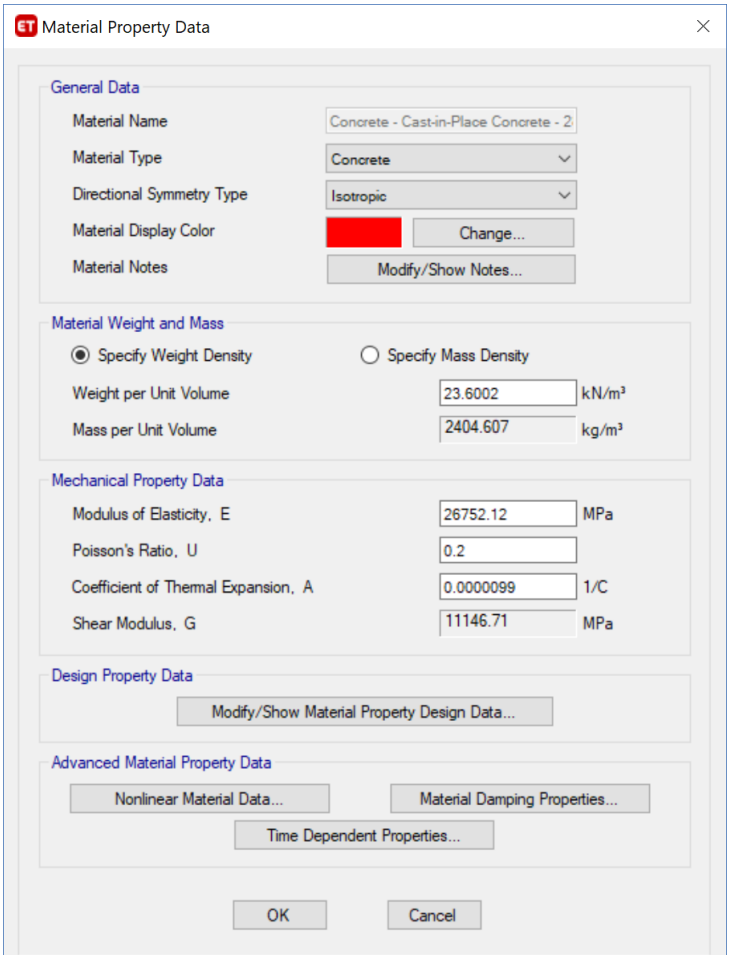


- To review the Revit material properties imported, select the **Edit** button next to "Total Materials". The Material Mapping form is displayed:

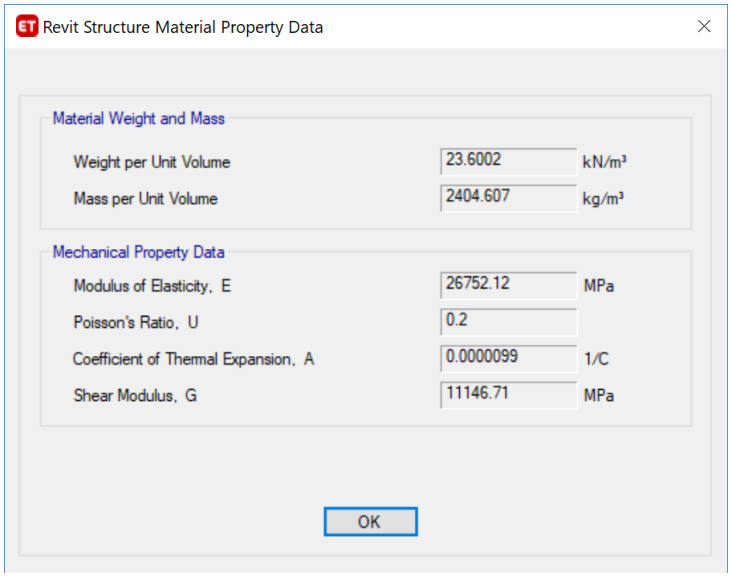


In this model, three materials are imported. Any new ETABS material is created with the same name as the Revit material name. To map the Revit Material to a material other than the

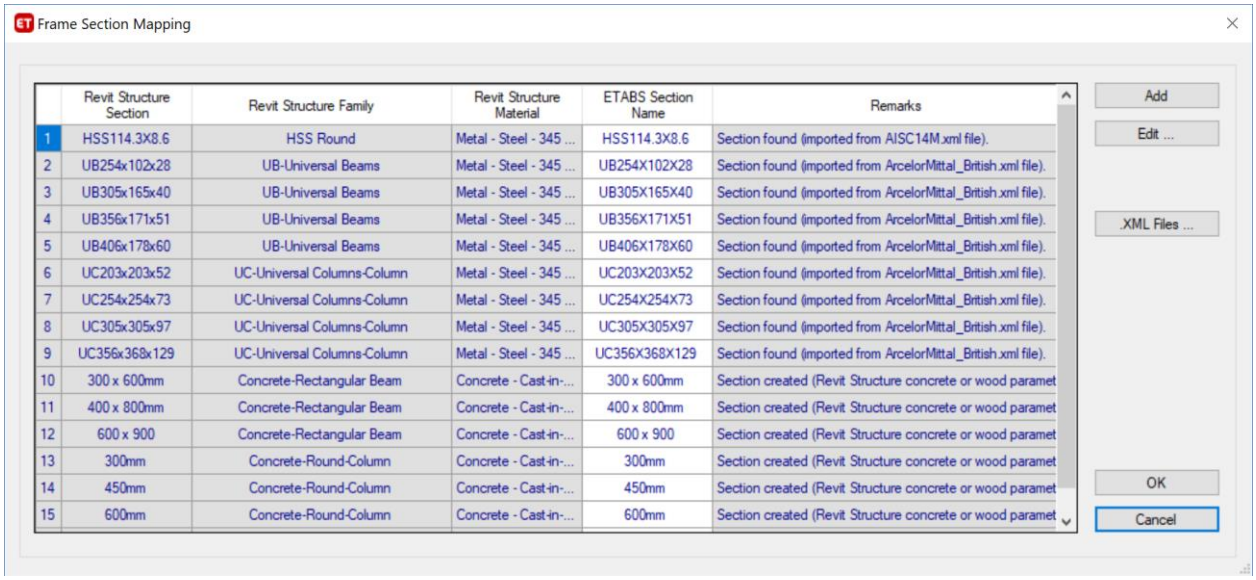
new ETABS material created, click on the ETABS material name. A combo box will be displayed with all of the existing ETABS materials currently in the ETABS model. To create a new material property to map your Revit material to, click **Add**. The ETABS Add Material form is then displayed. To see the properties of any imported material, select the material and click **Edit**. The ETABS Material Property Data form is then displayed:



- To check the original properties of the material in Revit, click “Revit Data...” The Revit Material Property Data form is displayed:



- To see the Revit family types imported, select the **Edit** button next to “Total Frame Sections”. The Frame Section Mapping form is displayed:

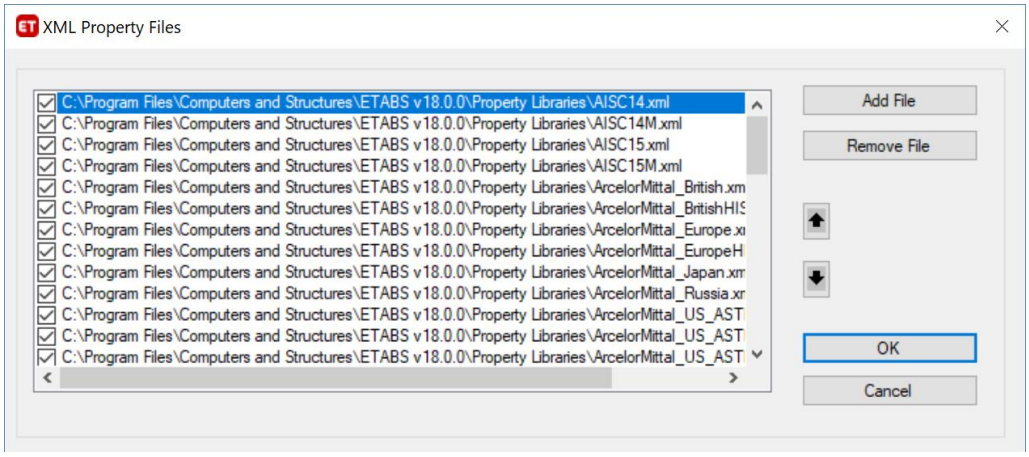


	Revit Structure Section	Revit Structure Family	Revit Structure Material	ETABS Section Name	Remarks
1	HSS114.3X8.6	HSS Round	Metal - Steel - 345 ...	HSS114.3X8.6	Section found (imported from AISC14M.xml file).
2	UB254x102x28	UB-Universal Beams	Metal - Steel - 345 ...	UB254X102X28	Section found (imported from ArcelorMittal_British.xml file).
3	UB305x165x40	UB-Universal Beams	Metal - Steel - 345 ...	UB305X165X40	Section found (imported from ArcelorMittal_British.xml file).
4	UB356x171x51	UB-Universal Beams	Metal - Steel - 345 ...	UB356X171X51	Section found (imported from ArcelorMittal_British.xml file).
5	UB406x178x60	UB-Universal Beams	Metal - Steel - 345 ...	UB406X178X60	Section found (imported from ArcelorMittal_British.xml file).
6	UC203x203x52	UC-Universal Columns-Column	Metal - Steel - 345 ...	UC203X203X52	Section found (imported from ArcelorMittal_British.xml file).
7	UC254x254x73	UC-Universal Columns-Column	Metal - Steel - 345 ...	UC254X254X73	Section found (imported from ArcelorMittal_British.xml file).
8	UC305x305x97	UC-Universal Columns-Column	Metal - Steel - 345 ...	UC305X305X97	Section found (imported from ArcelorMittal_British.xml file).
9	UC356x368x129	UC-Universal Columns-Column	Metal - Steel - 345 ...	UC356X368X129	Section found (imported from ArcelorMittal_British.xml file).
10	300 x 600mm	Concrete-Rectangular Beam	Concrete - Cast-in-...	300 x 600mm	Section created (Revit Structure concrete or wood paramet
11	400 x 800mm	Concrete-Rectangular Beam	Concrete - Cast-in-...	400 x 800mm	Section created (Revit Structure concrete or wood paramet
12	600 x 900	Concrete-Rectangular Beam	Concrete - Cast-in-...	600 x 900	Section created (Revit Structure concrete or wood paramet
13	300mm	Concrete-Round-Column	Concrete - Cast-in-...	300mm	Section created (Revit Structure concrete or wood paramet
14	450mm	Concrete-Round-Column	Concrete - Cast-in-...	450mm	Section created (Revit Structure concrete or wood paramet
15	600mm	Concrete-Round-Column	Concrete - Cast-in-...	600mm	Section created (Revit Structure concrete or wood paramet

The first three columns display the original Revit family type, original family name, and the material assigned to any section imported from Revit. The fourth column is the ETABS section the Revit section is mapped to. The final column describes how the section is mapped or created.

Only the ETABS Section Name column is editable. Clicking any row in the column displays a combo box that includes all section properties currently loaded in the current ETABS model. To add a section to the list, click the **Add** button the right side.

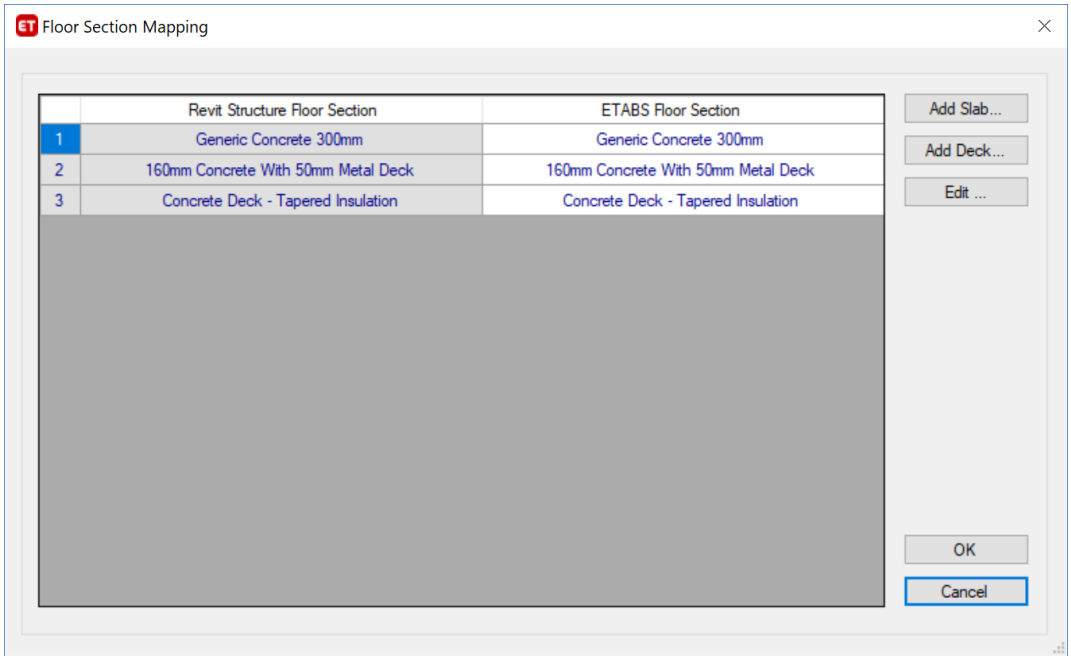
When ETABS imports the Revit data, it initially tries to match Revit section names to ETABS section names. It first searches through the loaded ETABS database sections. If no match is found, ETABS then searches all the ETABS section property files (.XML). It will map the section to the first section name that matches. To specify which files are searched, click the **.XML Files** button on the right side. The XML Property Files form is displayed:



All the .xml property files present in the ETABS installation directory are selected by default. A file can be added or removed from the ETABS search by checking or unchecking its checkbox in the list. To add a new file, click on the **Add File** button. To change the order in which ETABS searches the files, move their names up and down in the list using the arrow key buttons on the right side.

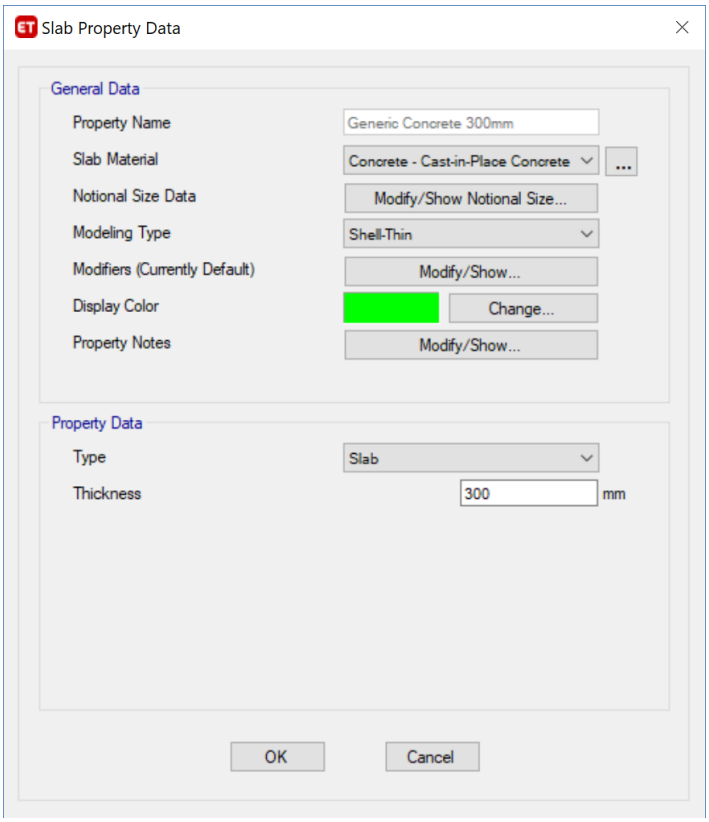
As in the Material Mapping form, details about the Frame Section Mapping can be edited by selecting the row, and clicking the **Edit** button.

- To see the Revit floor sections imported, select the **Edit** button next to "Total Floor Sections". The Floor Section Mapping form is displayed:

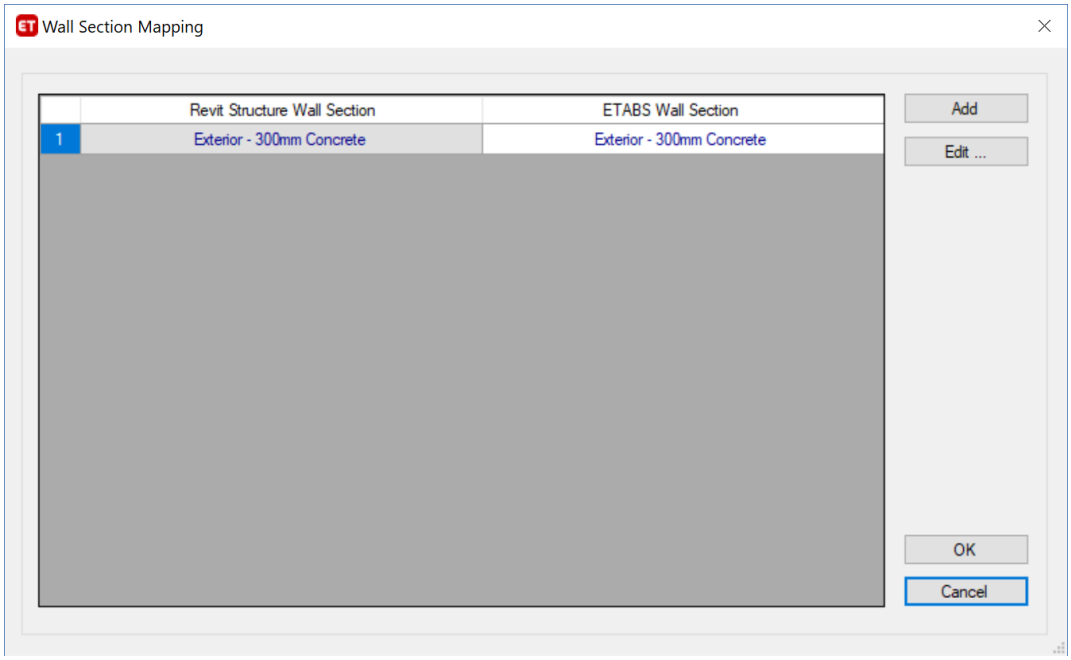


Again, you can specify the ETABS floor section the Revit floor type gets mapped to. By default an equivalent ETABS floor section is created and mapped. To create a new deck or slab section, use the buttons on the right side. After adding the deck or slab, the new ETABS floor section will show up in the drop down list.

- To check the definition of an ETABS section, click on the row and then click the **Edit…** button. The ETABS Slab Property Data or Deck Properties Data form, as applicable, is displayed:



- To see the Revit wall sections imported, select the **Edit** button next to “Total Wall Sections”. The Wall Section Mapping form is displayed:



Again, you can specify the ETABS wall section the Revit wall type gets mapped to. By default an equivalent ETABS wall section is created and mapped. To create a new wall section use the **Add** buttons on the right side. After adding the wall, the new ETABS wall section shows up in the drop down list.

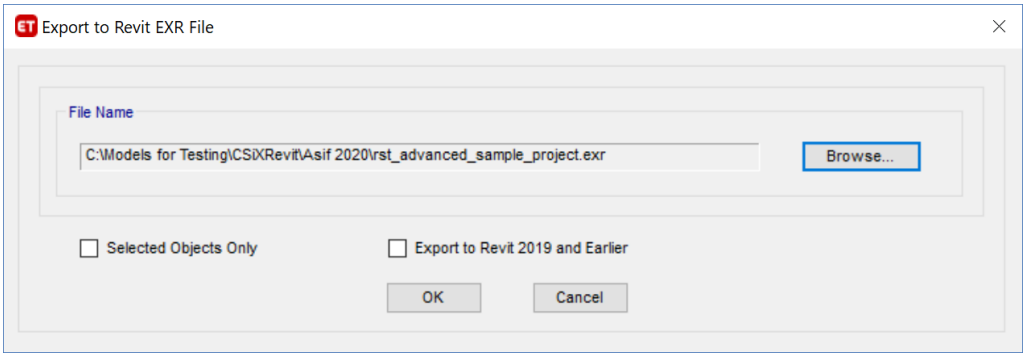
- To store the mapping created in a file from which it can later be retrieved, click the **Export Mapping File** button in the Revit Data Overview/Controls form.
- To import a previously exported mapping, click the **Import Mapping File** button.
- Once you are satisfied with the mapping of materials and sections, in the Revit Data Overview/Controls form select **OK**. The ETABS model is created.

2.5.2 Importing from ETABS to Create/Update a New/Existing Revit Project

The following steps describe how to export your ETABS analytical model to create or update a Revit project:

- Once you have edited, analyzed and designed the model in ETABS, save it by selecting File>Save.
- Select File>Export>**Revit Structure .exr File.**

  The **Export to Revit .EXR File** form is displayed.



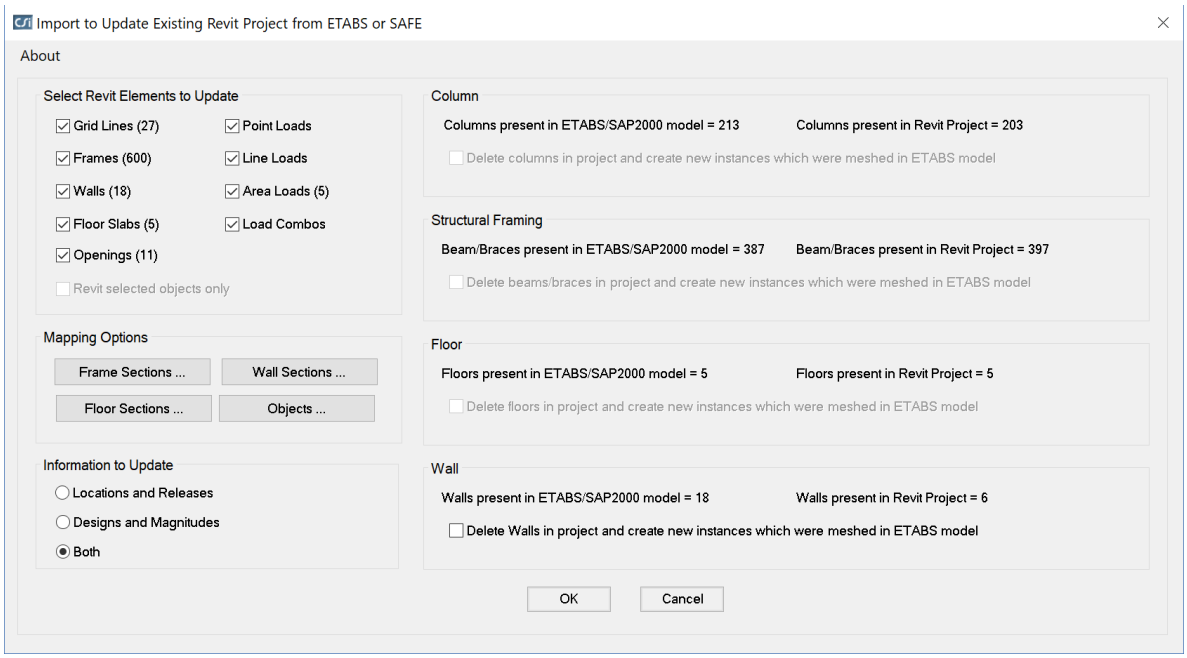
- Click the **Browse...** button to change the destination folder and filename.
- If you have selected objects in the model, and would like to export only those, select the corresponding checkbox.
- To export to Revit 2019 or earlier, select the corresponding checkbox.
- Click OK.

You are now ready to import the .exr file in Revit:

- Start Revit if it is not already running.
- To **create** a new Revit project from your ETABS model, open a Revit template that you would like to import your ETABS model into. It is not required, but the import will be faster and more predictable if you load all the beam, column, brace, deck, slab and wall families you would like ETABS sections to map to prior to importing.
- From the Revit menu select, Tools>External Tools>**Import to Create New Revit Project from ETABS, SAP2000 or SAFE**.
- Select the .exr file you would like to import. CSiXRevit will try to load any required families that are not already loaded.
- To **update** an existing Revit project, first open it. Again, if you have new sections you defined in ETABS, the import will come in faster and will be more predictable if you load all the beam, column, brace, deck, slab and wall families you would like ETABS sections to map to prior

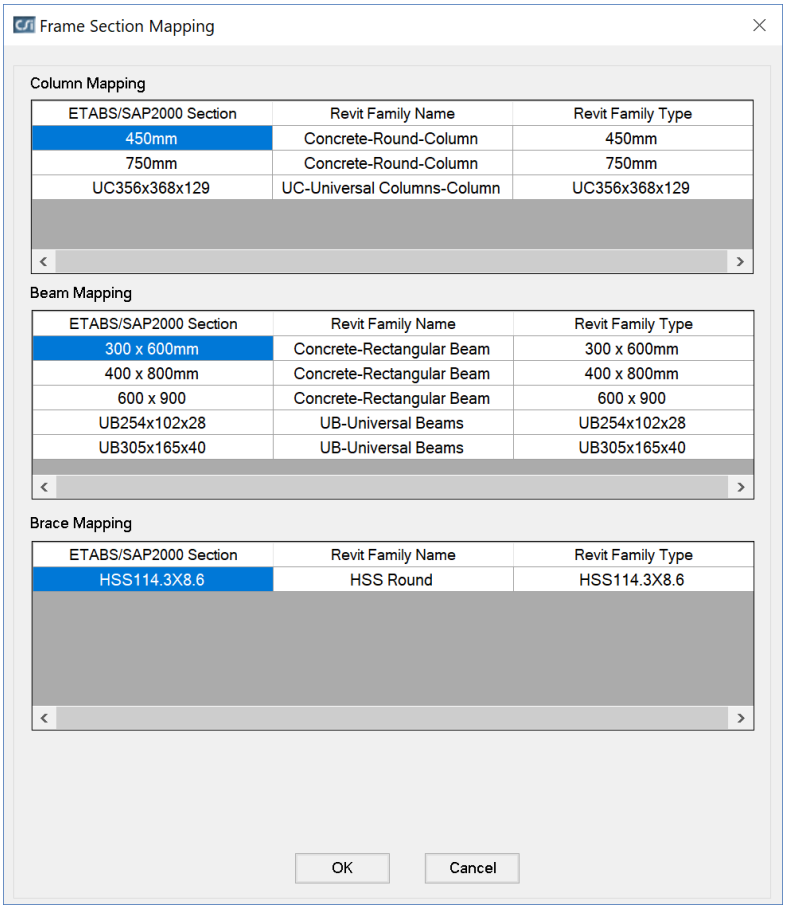
to importing. From the Revit menu select, Tools>External Tools>**Import to Update Existing Revit Project from ETABS.** Select the .exr file to import.

- Whether you are creating a new Revit project or updating an existing Revit project, after selecting the .exr file, the following form is displayed:



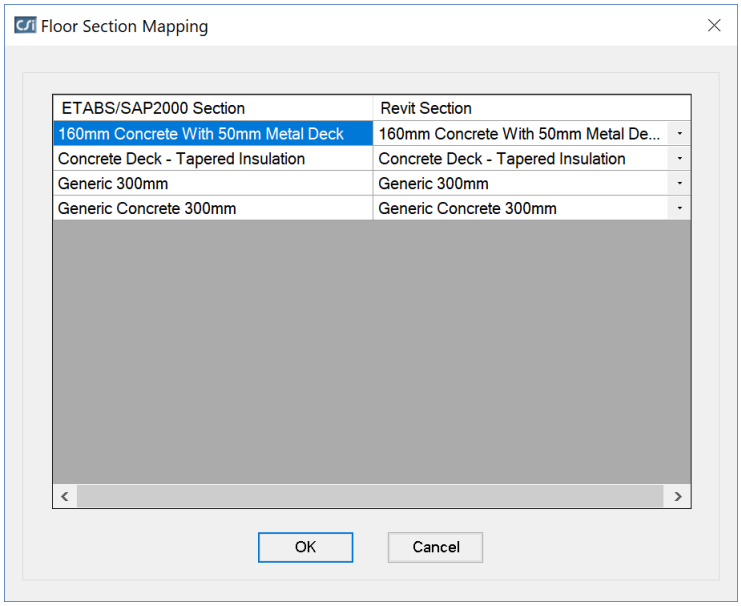
On the left side of the form, you can control the types of ETABS objects to import into the Revit project and the mapping of ETABS sections to Revit types.

- Clicking the **Frame Sections** button under "Mapping Options" displays the Frame Section Mapping form:



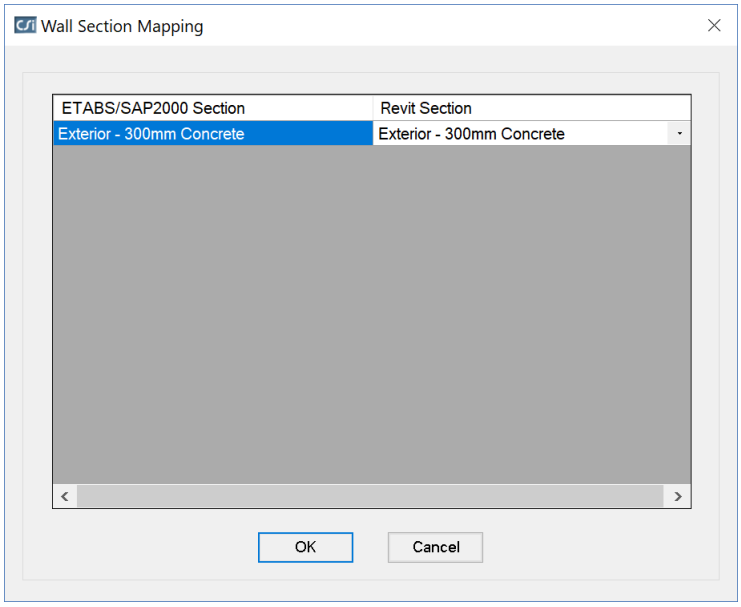
Changes to the mapping of ETABS sections to Revit sections can be made here. All Revit column beam and brace families and family types currently loaded in the project are displayed in the drop down lists.

- Clicking the **Floor Sections** button displays the Floor Section Mapping form:



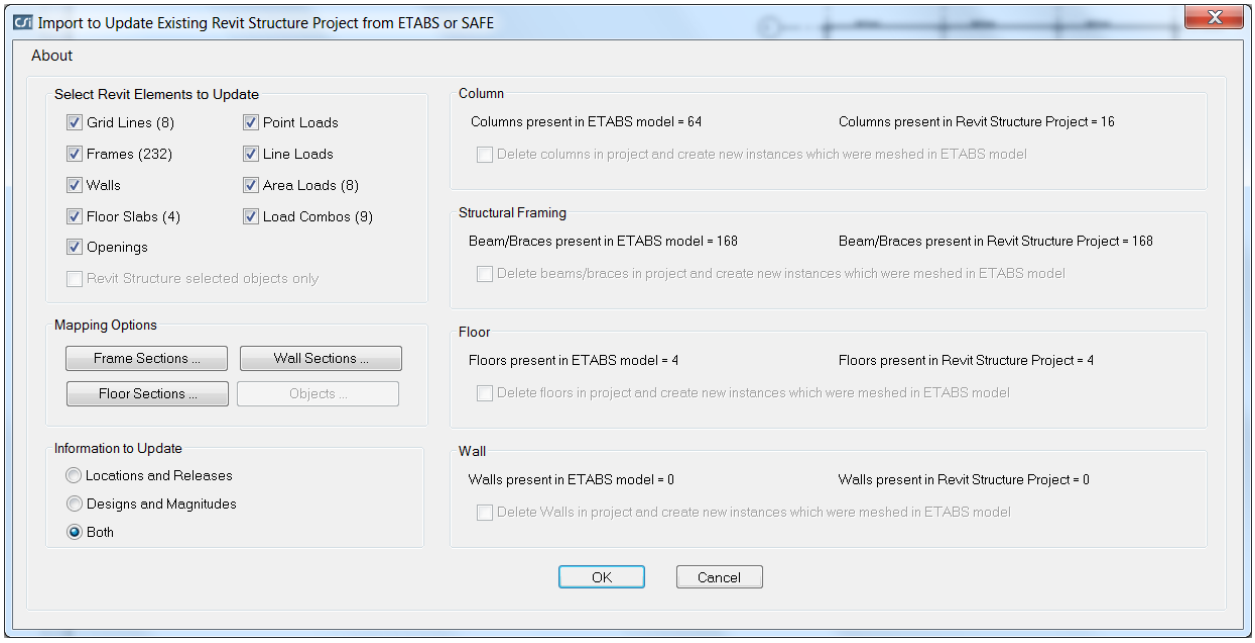
Changes to the mapping of ETABS floor sections to Revit sections can be made here. All Revit floor families currently loaded are displayed in the drop down lists.

- Clicking the **Wall Sections** button displays the Wall Section Mapping form:



Changes to the mapping of ETABS wall sections to Revit sections can be made here. All Revit wall families currently loaded are displayed in the drop down lists.

- If you are updating a Revit project from an ETABS model, you have the choice to only update locations and releases, only update designs and load magnitudes, or update both:



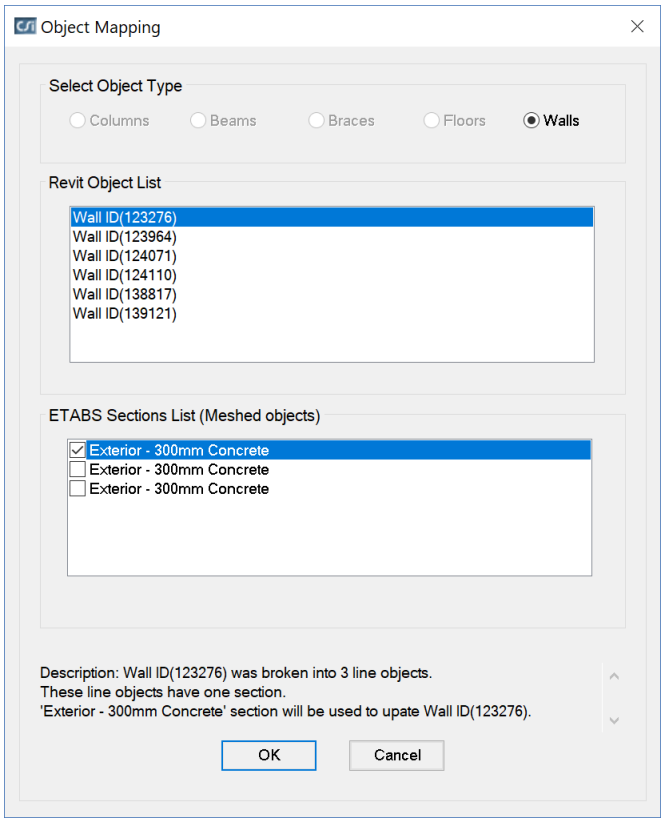
- Also, when updating a Revit project from an ETABS model, there can be instances in which the 1:1 mapping of Revit elements to ETABS objects is lost because objects were meshed in ETABS. If this is the case, you have two options:

  - Delete the existing Revit elements, and let CSiXRevit create new elements corresponding to the objects that are meshed in ETABS.

  - Keep the existing elements as they are and use object mapping to control the assignment of section properties during the import.

- If you choose the second option, there may be situations in which you will need to make some choices. For example, if a column in Revit runs from the ground floor to the top floor as a single element, when imported into ETABS, the column is cut at every floor level. When it is designed, different sections might be assigned to each segment of the column. When the column (that is now meshed in ETABS) is imported back into Revit, you have the option to 1) delete the original column in Revit and have CSiXRevit create a column with the varying sections or to 2) select one of the frame sections for the entire length of that column. To do this, select the corresponding checkbox and click the **Objects** button under Mapping Options.

The Object Mapping form is displayed:



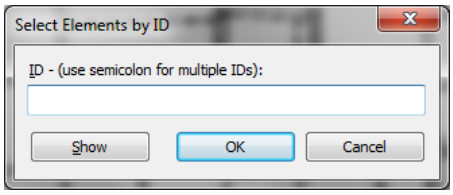
In this case, Column ID (139774) spans three floors in Revit but was meshed into three pieces in ETABS. When coming back into Revit, you can choose which section to assign to the entire length of the column. The same can be done with meshed beams, braces, floors and walls.

- Once you are satisfied with the object mappings, select OK and the ETABS model will be imported.

2.5.3 Reviewing the Log File (.log)

Every time a model is sent from Revit to ETABS or from ETABS to Revit, a file with the extension .EXRlog is created if it does not exist, or appended if it already exists. This file lists the project or model name, the direction of the data exchange, and the time and date. It also lists any errors or omissions encountered in generating or importing the .exr file, and therefore, should be checked every time data is transferred. The .EXRlog file also lists the build numbers for CSiXRevit and Revit. Finally, in the case of an incremental import, the changes made to the Revit project are listed.

Each Revit element is identified by its "Revit ID". You can view the element IDs by selecting Manage->Select by ID in the Revit ribbon, typing an ID, and clicking the **Show** button:



Revit will find a view that contains the element, switch to that view, and highlight the element.

2.5.4 Known Limitations of CSiXRevit with ETABS

- Revit floors that are grouped together may be treated as openings when importing into ETABS.
- Materials imported into Revit from ETABS may not always have their property values properly transferred. For this reason, material property values must be carefully checked in Revit after importing from ETABS.

3 Revit and SAP2000 Data Exchange

Data can be exchanged between Revit and SAP2000 along the following paths:

- Exporting from a Revit project to create new SAP2000 model.
- Exporting from a Revit project to update a previously exported or previously imported SAP2000 model. SAP2000 v17.2.0 or later is required.
- Importing from SAP2000 to create a new Revit project.
- Importing from SAP2000 to update a previously imported or previously exported Revit project. In this case, you may choose to update locations, designs, or both. SAP2000 v17.2.0 or later is required.

The actual data transferred varies in each case.

3.1 Exporting from Revit to create a new SAP2000 Model

The table below provides an overview of the data transferred from Revit to SAP2000:

Action	Project Element	**Supported**	Notes
Creation of…			
	Grid Lines		Does not transfer.
	Materials		
	Steel		
	Concrete		Does not transfer reinforcement properties.
	Aluminum		Imports as isotropic “Other” SAP2000 material type.
	Generic		
	Other		
	Wood		

	Columns and Framing Elements		Transfers geometry, beam and brace y and z justifications, and end releases into SAP2000. Ignores end offsets.
	Column and Framing Element Sections		
	Rolled Steel Sections		Loads equivalent SAP2000 section profiles from the SAP2000 .PRO files specified during import of the .exr file into SAP2000.
	Bar Joists		Imports with “None” properties.
	Concrete Sections		Creates and maps equivalent SAP2000 sections.
	Walls		Imports walls as SAP000 area objects with wall openings imported as separate area objects with “None” properties. Imports curved Revit walls as a series of short planar SAP2000 area objects. Warped walls with more than four sides not imported.
	Wall Properties		Creates and maps equivalent SAP2000 thick shell sections.
	Floors		Imports floors as SAP000 area objects with floor openings imported as separate area objects with “None” properties.
	Slabs Properties		Creates and maps equivalent SAP2000 thick shell sections.
	Slab on Deck Properties		Creates and maps equivalent SAP2000 thick shell sections with directional stiffness modifiers.
	Footings		Does not transfer.
	Point Loads		Creates SAP2000 joints if the load does not coincide with a previously created joint and does not line up with any frame objects. This will cause model instability that needs to be addressed.
	Line Loads		Creates SAP2000 frame objects with “None” properties if the load does not overlap any other frame object. If the load also does not line up with any imported floor or wall, it will cause model instability that needs to be addressed.

	Area Loads		Does not transfer.
	Load Cases		
	Load Combinations		

3.1.1 Grid Lines

Revit grid lines are not imported in SAP2000.

3.1.2 Materials

All Revit materials are imported into SAP2000 as isotropic materials. The following Revit material attributes are imported into SAP2000:

- Material Name: The same name is used in SAP2000.
- Material Class: Concrete and steel set to equivalent SAP2000 material types. Generic, aluminum, and wood material types set as "Other" SAP2000 material type.
- Young's Modulus: The first of Revit's three Young's modulus values (one for each direction) sets the SAP2000 material Young's modulus (E) value. If this value is zero, the default SAP2000 value is used.
- Poisson's Ratio: The first of Revit's three Poisson's Ratio values (one for each direction) sets the SAP2000 material Poisson's Ratio (U) value. If this value is zero, the default SAP2000 value is used.
- Shear Modulus: The first of Revit's three Shear Modulus values (one for each direction) is compared to the value of the material Shear Modulus (G) computed by SAP2000. If the two differ by more than one percent in SAP2000, a warning is reported in the log file.
- Thermal Expansion Coefficient: The first of Revit's three thermal expansion coefficients (one for each direction) sets the SAP2000 material thermal expansion coefficient (Alpha). If this coefficient is zero, the default SAP2000 value is used.
- Unit weight: The Revit unit weight sets both the SAP2000 material weight density (w) and mass density (m). In SAP2000 the mass density is calculated by dividing the weight density by the gravitational constant (g). If the unit weight is zero, the default SAP2000 value is used.
- Behavior: Revit uses this tag to distinguish between isotropic and orthotropic materials. All Revit materials are imported as isotropic materials in SAP2000. Any orthotropic material generates a warning in the log file.
- Concrete Compression: In the case of a concrete material, the Revit concrete compression sets the SAP2000 concrete compressive strength f'c.

- Lightweight: The value of this tag is used to identify a concrete material as lightweight concrete in SAP2000.
- Yield Stress: In the case of a steel material, this value sets the SAP2000 minimum yield stress Fy. If the yield stress is zero, the default SAP2000 value is used.
- Tensile Strength: In the case of a steel material, this value sets the SAP2000 minimum tensile stress Fu. If the tensile stress is zero, the default SAP2000 value is used.

The following Revit material attributes are not imported in the current version of SAP2000:

- Damping Ratio
- Bending Reinforcement
- Shear Reinforcement
- Resistance Calculation Strength
- Shear Strength Reduction
- Steel Reduction Factor

Only those materials associated with walls, framing, or floors in the Revit project are imported into SAP2000.

3.1.3 Structural Column and Framing Elements

The following Revit structural column and framing element attributes are imported into SAP2000:

- End Points: For straight column and framing elements and curved framing elements other than arc shaped, the coordinates of the end points of the lines defining the analytical model of the element are retrieved and SAP2000 joint objects with identical coordinates are located or created as needed. SAP2000 views two joints as coincident if none of their coordinates differ by more than $1/100^{th}$ of a foot. This level of precision corresponds to the level of precision in the Revit database. When the analytical model of an element includes rigid links, the SAP2000 joint objects are created at the ends of the rigid links with SAP2000 joints offsets created to model the link. For arc shaped framing elements, the coordinates of the end points of the elements themselves are imported instead of the end points of their analytical models because these analytical models consist of series of short straight segments and such a tessellation is not required in SAP2000. Columns are imported with the Local Axis 1 always pointing up, and beams and braces with their Local Axis 1 always in the first quadrant, which means that the end joints may have been switched compared to the Revit end points.
- Curvature: Straight elements are imported as straight SAP2000 frame objects. Curved framing elements that are not arc shaped are imported as series of short SAP2000 objects based on the lines defining their analytical models. Arc shaped framing elements are imported as arc shaped SAP2000 line objects.

- Family Type: See Frame Object Properties below.
- End Releases: All frame releases defined in Revit are imported into SAP2000 as line object releases. Releases that cause model instability are restrained and a warning is reported in the log file.
- Beam or Brace Justification: In Revit, the insertion point of a framing element is defined by the following two parameters:
  - y-Direction Justification
  - z-Direction Justification

SAP2000 calculates the corresponding cardinal point based on these two parameters. If these parameters are not defined, then the default cardinal point (middle center) is chosen.

- Column Orientation and Beam and Brace Cross-Section Rotation: This angle measures the rotation of the member around its longitudinal axis in Revit and sets the value of the "Rotation about 1" angle in elements imported into SAP2000. The two angles are measured identically in both programs except they differ by 90º in the case of columns.

The following Revit frame member attributes are not imported into the current version of SAP2000:

- Column Beam and Brace Vertical End Offsets: Revit column beams and brace vertical end offsets are not imported into SAP2000 because Revit element end points are retrieved from their analytical models.
- Column Insertion Point: The cardinal point of imported columns is always middle center.

3.1.4 Structural Column and Framing Element Sections

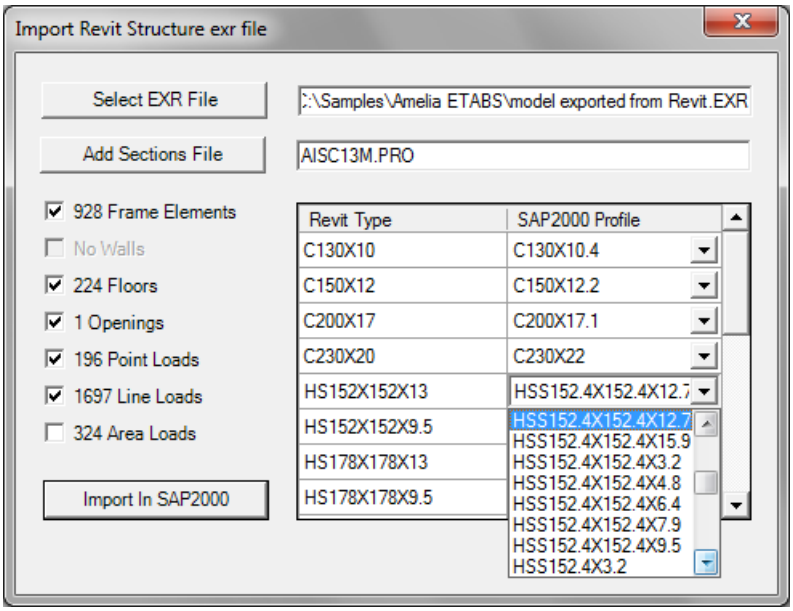
Structural column and frame element sections are defined in Revit by their assigned family type.

When reading an .exr file, SAP2000 attempts to match each Revit frame member family type to an identically named section profile defined in the AISC13.pro file (or AISC13M.pro depending on the display unit system in use when importing begins).

In the absence of such a match, SAP2000 checks if the type is from one of the parametric families (Table 2) for which it knows how to generate sections for.

Any frame member type not matched becomes an unrecognized type for which SAP2000 requires additional user input.

This additional input is entered in the Import Revit .exr file form displayed when an import into SAP2000 begins. Here all unrecognized types are listed in a table, allowing them to be manually matched to predefined SAP2000 section profile names or, as a last resort, to the SAP2000 "None" property.



Here additional section properties databases (.PRO files) can be loaded. When adding a properties file (.PRO), the unrecognized Revit types are checked against the section profile names in this file. This may resolve most of the unrecognized types if the correct properties file (.PRO) is chosen.

SAP2000 saves the properties files (.PRO) manually loaded and the manual assignments made here in a file with an .EXRMap extension. When importing into SAP2000 the same Revit project again, SAP2000 will automatically restore these choices.

When loading an .exr file, SAP2000 keeps track of which materials are used in conjunction with which section profiles. When a section profile is always used with the same material, the corresponding section property is named after the profile. If a section profile is used with a number of different materials, the various corresponding section properties will have compound names consisting of the profile name with the relevant material name appended.

The parameters for concrete and wood structural families are listed in the table below:

Member Type	Family Name	Parameters
CONCRETE COLUMNS	CONCRETE-RECTANGULAR-COLUMN	B, H
	CONCRETE-ROUND-COLUMN	B
	CONCRETE-SQUARE-COLUMN	B
	PRECAST-RECTANGULAR COLUMN	B, H CHAMFER

CONCRETE FRAMING	PRECAST-DOUBLE TEE	WIDTH, TEE WIDTH, STEM WIDTH, SLAB DEPTH, DEPTH
	PRECAST-INVERTED TEE	H1, H, B, SEAT
	PRECAST-L SHAPED BEAM	H1, H, B, SEAT
	PRECAST-RECTANGULAR BEAM	B, H
	PRECAST-SINGLE TEE	WIDTH, STEM WIDTH, SLAB DEPTH, DEPTH
WOOD COLUMNS	DIMENSION LUMBER-COLUMN	B, D, SY, SX, IY, IX, A
	GLULAM-SOUTHERN PINE-COLUMN	B, D, SY, SX, IY, IX, A
	GLULAM-WESTERN SPECIES-COLUMN	B, D, SY, SX, IY, IX, A
	PSL-PARALLEL STRAND LUMBER-COLUMN	B, D, SY, SX, IY, IX, A
	TIMBER-COLUMN	B, D, SY, SX, IY, IX, A
WOOD FRAMING	DIMENSION LUMBER	B, D, SY, SX, IY, IX, A
	GLULAM-SOUTHERN PINE	B, D, SY, SX, IY, IX, A
	GLULAM-WESTERN SPECIES	B, D, SY, SX, IY, IX, A
	LVL-LAMINATED VENEER LUMBER	B, D, SY, SX, IY, IX, A
	TIMBER	B, D, SY, SX, IY, IX, A
	OPEN WEB JOIST	B, H
	PLYWOOD WEB JOIST	B, H

Table 2: Parameters used in SAP2000

3.1.5 In-place Family Members

Revit in-place family members are not imported into the current version of SAP2000.

3.1.6 Walls

Revit walls are imported into SAP2000 as area objects. The following Revit wall attributes are imported into SAP2000:

- Analytical Model End Points: The point coordinates are used to locate matching joints already created, and when none are found, create new joints.
- Wall Curves: Curved vertical Revit walls are imported as a series of short planar SAP2000 area objects. Revit controls how the curve is broken into segments.
- Wall Openings (Regular rectangular shape): This refers to wall openings drawn with the Revit selection Modeling>Opening>Wall Opening. These openings are imported into SAP2000 as area objects, with "None" properties, that overlap the area object generated for the wall.
- Wall Thickness and Material: Revit walls may consist of different layers with different thickness and materials. The thickness and material type of the layer with the maximum thickness are used to find or create an appropriate SAP2000 thick shell property. Wall section properties are named after the Revit wall types. The suffix "-WALL" is appended to this name if the name is also used for a floor type.

Warped walls with more than four sides not imported.

3.1.7 Floors

Revit floors are imported into SAP2000 as area objects. The following Revit floor attributes are imported into SAP2000:

- Analytical Model End Points: The point coordinates are used to locate matching joints already created, and when none can be found, create new joints.
- Floor Curves: SAP2000 does not support curved edges in area objects. All curves in Revit floors are approximated as a series of straight segments. Revit controls how the curve is segmented.
- Floor Thickness and Material: Revit floors may consist of different layers. If there is only one layer, its thickness and material are used to define an equivalent SAP2000 thick shell property. If there is more than one layer, and one of the layers corresponds to a Revit deck profile and at least one other is a concrete layer, SAP2000 creates a concrete thick shell property. Its thickness is equal to the total thickness of all the concrete layers and the membrane and bending stiffness modifiers assigned will account for the presence of deck ribs. Floor section properties are named after the Revit floor types.
- Floor Span Direction: Sets the SAP2000 area object local axes.

- Inclined Slabs: Also imported into SAP2000 as area objects.

3.1.8 Openings

Revit openings are imported into SAP2000 as area objects with "None" properties. This includes:

- Floor Openings
- Wall Openings
- Shaft Openings: These are imported as SAP2000 area objects located at the base of the shaft with "None" properties.

3.1.9 Footings

Revit footings are not imported in the current version of SAP2000.

3.1.10 Point Loads

The following Revit point load attributes are imported into SAP2000:

- Load Case Name: Sets the load pattern name in SAP2000.
- Location: The point coordinates are used to locate a matching joint already created. SAP2000 views a joints and a point load as coincident if none of their coordinates differ by more than $1/20^{th}$ of a foot. This level of precision corresponds to the level of precision in the Revit database. When no coincident joint is found, SAP2000 looks for an underlying frame object. If no suitable frame object is found, SAP2000 creates a new joint. This new joint creates model instability that needs to be addressed.
- Fx, Fy, Fz, Mx, My, Mz: All forces and moments are defined in the global coordinates system in Revit and defined in SAP2000 in a similar manner.

3.1.11 Line Loads

The following Revit line load attributes are imported into SAP2000:

- Load Case Name**:** Sets the corresponding load case name in SAP2000.
- Start and End Point Locations: These define the start and end points of the line load. A line load overlapping more than one frame object is distributed on the corresponding frame objects. If all or part of the load cannot be assigned to frame objects, new frame objects with "None" properties are created. This will cause model instability if the load does not also line up with any imported floor or wall.
- Fx, Fy, Fz, Mx, My, Mz: All forces and moments are defined in the global coordinates system in Revit and defined in SAP2000 in a similar manner.

3.1.12Area Loads

Revit area loads are not imported in the current version of SAP2000.

3.1.13Load Cases

Revit load cases are imported into SAP2000 as both load patterns and load cases. One load pattern and one load case are both created in SAP2000 for each Revit load case. The following Revit load case attributes are imported into SAP2000:

- Load Case Name: Sets the corresponding load case name in SAP2000.
- Load Case Category: This defines the load case type in SAP2000. The mapping is shown in the following table:

Revit Load Case Category	SAP2000 Load Case Type
Dead	Dead
Live	Live
Wind	Wind
Snow	Snow
Roof Live	Live
Accidental	Other
Temperature	Temperature
Seismic	Quake

3.1.14Load Combinations

The following Revit load combination attributes are imported into SAP2000:

- Load Combination Name: The same name is used in SAP200.
- Load Cases: The same load case list is used in SAP2000.
- Load Case Factors: The same load case factors are used in SAP2000.

3.2 Importing from SAP2000 to create a new Revit Project

The table below provides an overview of the data transferred from SAP2000 to Revit:

Action	Model Element	Supported	Notes
Creation of…			
	Grid Lines		Does not transfer.
	Joints		Does not transfer, but force joint loads transfer.
	Materials (isotropic)		Creates material. Limitation is the Revit project should have one default concrete and one default steel material for duplication, otherwise the material will be created in Revit but its parameters will not be updated, and the property of the new materials are identical to those of the template materials.
	Materials (orthotropic)		Does not transfer.
	Frames		
	Vertical Frames		Creates as columns in Revit.
	Horizontal Frames		Creates as beams in Revit.
	Other Frames		Creates as braces in Revit.
	Cables		Imports as columns, beams, or braces based on their alignment.
	Frame Sections		Creates and maps equivalent Revit sections.
	“None”		Does not transfer frame object.
	Tapered Sections		Does not transfer frame object.
	Steel Sections		.
	Joists		Maps to Revit family types with matching names. If not loaded, family type is located and if found, loaded.
	Concrete Sections		Creates and maps equivalent Revit sections.
	SAP2000 Auto Select Lists		Does not transfer.
	Shells		
	Vertical Shells		Imports as walls in Revit.

	Horizontal Shells		Imports as floors in Revit.
	Shells in other planes		Imports in Revit as floors with a slope. Slope value may require user adjustment.
	Non-planar shells		Does not transfer.
	Shell Properties		
	"None"		Does not transfer the shell.
	Membrane		Does not transfer stiffness modifiers.
	Plate		
	Shell		
	Layered		Does not transfer.
	Planes		
	Vertical Planes		Imports as walls in Revit.
	Horizontal Planes		Imports as floors in Revit.
	Other Planes		Imports in Revit as floors with a slope. Slope value may require user adjustment.
	ASolids		Does not transfer.
	Solids		Does not transfer.
	Link/Support		Does not transfer.
	Tendons		Does not transfer.
	Joint Loads		
	Force		Loads defined in coordinate systems other than local or global do not transfer.
	Displacement		Does not transfer.
	Frame Loads		
	Concentrated		Loads defined in coordinate systems other than local or global do not transfer.
	Distributed		
	Temperature		Does not transfer.
	Strain		
	Target Force		Does not transfer.
	Internal Force		
	Shell and Plane Loads		

	Uniform		Loads defined in coordinate systems, other than local or global do not transfer.
	Uniform to Frame		
	Surface Pressure		
	Pore Pressure		Does not transfer.
	Temperature		
	Strain		
	Load Patterns		Imports as Revit load cases, unless their type does not correspond to a predefined Revit load case category.
	Load Cases		
	Static Linear		Imports into Revit only if all static linear load cases each refer to a single load pattern. Load patterns not imported into Revit are not included in the list of Revit load cases.
	Other than Static Linear		Does not transfer.
	Load Combinations		Imports as Revit load combination only if it refers to more than one load pattern. Load patterns not imported into Revit are not included in the list of Revit load cases.

3.2.1 Grid Lines

SAP2000 grid lines are not imported into Revit.

3.2.2 Joints

While model geometry is imported into Revit, SAP2000 joints themselves are not imported. This restriction includes supports.

3.2.3 Materials

CSiXRevit creates Revit materials with the same names as the SAP2000 materials if they are not already in the project template:

- Material Name: The same name is used in Revit.
- Material Type: Concrete and steel set to equivalent Revit material classes. Aluminum, Cold-formed steel and Other set to Revit Generic material class.
- Concrete Compressive Strength: In the case of a concrete material, CSiXRevit attempts to

create a new concrete material which duplicates a Revit concrete material with the same concrete compressive strength if it can find one in the project template. If not, a new concrete material is created but its concrete compressive strength differs from the original SAP2000 value.

- Lightweight Concrete: In the case of a concrete material, sets the corresponding Revit attribute.

- Minimum Yield Stress: In the case of a steel material, CSiXRevit attempts to create a new steel material which duplicates a Revit steel material with the same minimum yield stress if it can find one in the project template. If not, a new steel material is created but its minimal yield stress differs from the original SAP2000 value.

Only materials associated with exported SAP2000 frame, cable, and area objects are imported into the new Revit project.

3.2.4 Frame Objects

SAP2000 frame objects are imported into Revit as columns, beams, or braces depending on whether they are vertical, horizontal, or inclined. Frame object with "None" properties, non-prismatic properties, or a material that cannot itself be exported are not imported into Revit. The following SAP2000 frame member attributes are imported into Revit:

- Name: The SAP2000 name is imported into Revit as a shared parameter.

- Start and End Joints: The coordinates of their start and end joints set the end points of the new Revit columns, beams, or braces.

- Frame Releases: See Limitations.

- Insertion Point: The insertion points of SAP2000 frame objects that are not vertical are imported into Revit as Z-Direction or Lateral Justification attributes. Revit columns do not feature these attributes and as a result, the insertion points of SAP2000 vertical frame objects are not imported

- Local Axes: Sets Revit Column Orientation and Beam and Brace Cross-Section Rotation.

- Frame Joint Offsets, End Length Offsets: The end points of the new Revit columns, beams, or braces are adjusted based on these.

3.2.5 Frame Object Section Properties

This section explains how CSiXRevit maps SAP2000 frame object section properties to Revit structural column and framing element family types:

- If the Revit project into which the SAP2000 model is being imported already contains a Revit family type with the same name as the section properties of SAP2000 frame object, the SAP2000 frame object with these properties are imported with that Revit family type. The

name comparison is not case-sensitive. Note that if you import an SAP2000 model into Revit, and later redefine a given SAP2000 frame section and then re-import the SAP2000 model, CSiXRevit will not redefine the corresponding Revit family type.

- If the type of the frame section is one of the section shape types listed in Table 4 or Table 5, CSiXRevit creates a new type of the corresponding Revit family in the Revit project based on the original SAP2000 section dimensions, and the SAP2000 frame object with that frame section are imported with that Revit family type.

- If the above did not apply, CSiXRevit looks for a pre-defined family type with a matching name in the active Revit content libraries, and if it finds one, loads that family type in the Revit project and the SAP2000 frame objects with that frame section are imported with that Revit family type.

- If the above still did not work, CSiXRevit looks for a pre-defined family type whose name includes the name of the frame section in the active Revit content libraries, loads that family type in the Revit project and the SAP2000 frame object with that frame section are imported with that Revit family type.

- If none of the above applied, the SAP2000 frame objects are assigned a default Revit family type. You can specify any family type already in the project or any pre-defined family type listed in the active Revit content libraries as a replacement.

Note that you can specify which Revit content libraries are active with the File->Options command, under the File Locations tab and Places… button.

SAP2000 Section Shape	Revit Family
Steel angle	L-Angle-Column.rfa, M_L-Angle-Column.rfa
Steel box	HSS-Hollow Structural Section-Column.rfa, M_HSS-Hollow Structural Section-Column.rfa
Steel channel	C-Channel-Column.rfa, M_C-Channel-Column.rfa
Steel double channel	Double C-Channel-Column.rfa, M_Double C-Channel=Column.rfa
Concrete circular	Concrete-Round-Column.rfa, M_Concrete-Round-Column.rfa
Steel I-shaped	W-Wide Flange-Column.rfa, M_W-Wide Flange-Column,rfa
Steel pipe	Pipe Column.rfa, M_Pipe Column.rfa
Concrete rectangular	Concrete-Rectangular-Column.rfa
Concrete square	Concrete-Square-Column.rfa, M_Concrete-Square-Column.rfa

Table 4: SAP2000 Vertical Frame Object Section Shapes with preset Revit equivalent Families

SAP2000 Section Shape	Revit Family
Concrete angle	Precast-L Shaped Beam.rfa, M_Precast-L Shaped Beam.rfa
Steel angle	L-Angle.rfa, M_L-Angle.rfa
Steel double angle	LL-Double Angle.rfa, M_LL-Double Angle.rfa
Steel box	HSS-Hollow Structural Section.rfa, M_HSS-Hollow Structural Section.rfa
Steel channel	C-Channel.rfa, M_C-Channel.rfa
Steel double channel	Double C-Channel.rfa, M_Double C-Channel.rfa
Concrete I-shaped	Precast-I Shaped Beam.rfa, M_Precast-I Shaped Beam.rfa
Steel I-shaped	W-Wide Flange.rfa, M_W-Wide Flange.rfa
Steel pipe	HSS-Round Structural Tubing.rfa, M_HSS-Round Structural Tubing.rfa
Steel plate	Plate.rfa, M_Plate.rfa
Concrete rectangular	Concrete-Rectangular Beam.rfa, M_Concrete-Rectangular Beam.rfa
Steel rod	Round Bar.rfa, M_Round Bar.rfa
Concrete tee	Precast-Single Tee.rfa, M_Precast-Single Tee.rfa
Steel tee	St-Structural Tee.rfa, M_St-Structural Tee.rfa

Table 5: SAP2000 Non-Vertical Frame Object Section Shapes with preset Revit equivalent Families

3.2.6 Cable Objects

SAP2000 cable area objects are imported into Revit as columns, beams, or braces depending on whether they are vertical, horizontal, or inclined. Cable area object with "None" properties or a material that cannot itself be exported are not imported into Revit. The following SAP2000 cable area object attributes are imported into Revit:

- Name: The SAP2000 name is imported into Revit as a shared parameter.
- Start and End Joints: The coordinates of their start and end joints set the end points of the Analytical Models of the new Revit columns, beams, and braces.
- Properties: The name of SAP2000 properties is exported. When importing cable area objects from an .exr files into Revit, CSiXRevit always attempts to locate and load a Revit family type with the same name.

3.2.7 Area Objects

SAP2000 area objects are imported into Revit in different ways based on their orientation. Vertical area objects are imported into Revit as walls. Horizontal area objects are imported into Revit as floors. Other planar area objects are imported into Revit as floors with a slope. Non-planar area objects, area objects with "None" properties, or with layered properties, are not imported into Revit. The following SAP2000 shell and plane attributes are imported into Revit:

- Name: The SAP2000 name is imported into Revit as a shared parameter.
- Joints: Their coordinates set the corners of the new Revit wall or floor analytical model. In the case of area objects that are neither vertical nor horizontal, floors with a slope are created in Revit. Note that while their slope is initially set correctly, Revit subsequently resets it to a different value. The correct slope is available as a shared parameter named "Computed slope" and you need to reset the slope of the floor to this parameter value.
- Properties: SAP2000 shell, membrane, plate, and plane properties are imported into Revit as wall or floor type and as a single layer. The thickness and material matches the SAP2000 thickness and material. Note that stiffness modifiers are not exported.

3.2.8 Solid Objects, ASolid Objects, Link/SupportObjects, Tendon Objects

SAP2000 Solid objects, ASolid objects, Link/Support objects, and Tendon objects are not imported into Revit.

3.2.9 Force Joint Loads and Frame object Concentrated Loads

SAP2000 force joint loads and frame object concentrated loads are imported into Revit as point loads. Not all force joint loads are imported: see Load Pattern and Coordinate System below. The following SAP2000 force joint load attributes are imported into Revit:

- Load Pattern: It sets the Revit load case name. Loads part of a load pattern that is not itself exported are not imported into Revit.
- Coordinate System: Joint loads and frame object concentrated loads defined in coordinate systems other than the local joint coordinate system or the model global coordinate system are not imported into Revit.
- Force X, Force Y, Force Z, Moment about X, Moment about Y, and Moment about Z: Set the values of Fx, Fy, Fz, Mx, My, Mz in Revit.

Ground displacement joint loads are not imported into Revit.

3.2.10 Frame Object Loads

Frame object distributed loads are imported into Revit as line loads. Distributed loads consisting of a sequence of trapezoidal loads are imported as multiple loads with one Revit line load for each trapezoidal segment. Not all force joint loads are imported: see Load Pattern and Coordinate System below. The following SAP2000 frame object load attributes are imported into Revit:

- Load Pattern: It sets the Revit load case name. Loads part of a load pattern that is not itself exported are not imported into Revit.
- Coordinate System: Frame object distributed loads defined in coordinate systems other than the local joint coordinate system or the model global coordinate system are not imported into Revit.
- Load Type, Direction and Load: Set the values of Fx1, Fx2, Fy1, Fy2, Fz1, Fz2, Mx1, Mx2, My1, My1, My2, Mz1, and Mz2 in Revit. Projected load magnitudes are converted to absolute load magnitudes based on the geometry of the frame object.

Temperature, strain, target force and internal force frame object loads are not imported into Revit.

3.2.11 Area Object Loads

Area object uniform, uniform to frame, and surface pressure loads are imported into Revit as area loads. Not all force joint loads are imported: see Load Pattern and Coordinate System below. The following SAP2000 area object loads attributes are imported into Revit:

- Load Pattern: It sets the Revit load case name. Loads part of a load pattern that is not itself exported are not imported into Revit.
- Coordinate System: Area Object distributed loads defined in coordinate systems other than the local joint coordinate system or the model global coordinate system are not imported into Revit.
- Load Direction and Load: Set the value of Fx1, Fy1, Fz1, in Revit. Projected load magnitudes are converted to absolute load magnitudes based on the geometry of the area object.

Area object temperature loads, strain loads, and pore pressure loads are not imported into Revit.

3.2.12 Load Patterns

SAP2000 load patterns with types corresponding to a predefined Revit load case category are imported into Revit as load cases. The following SAP2000 load pattern attributes are imported into Revit:

- Load Pattern Name: The same name is used in Revit.
- Load Case Type: It sets the Revit load case nature and category. The mapping is shown in the following table:

SAP2000 Load Case Type	Revit Load Case Category
Dead, Super Dead	Dead
Live, Reducible Live, Pattern Live	Live
Roof Live, Ice	Roof Live
Snow	Snow
Wind	Wind
Quake	Seismic
Temperature, temperature gradient	Temperature
Other	Not exported
Not listed above	Not exported

Load patterns with types that do not correspond to any predefined Revit load case category are not imported into Revit, and neither are any of their constituent loads.

3.2.13 Load Cases

If any SAP2000 static linear load case refers to more than one load pattern, than the static linear load cases are imported into Revit as load combinations, in place of the SAP2000 load combinations. The following SAP2000 load case attributes are imported into Revit:

- Load Case Name: The same name is used in Revit.

- Load Patterns: Set the list of Revit load cases. Load patterns not imported are not included in the Revit list.
- Load Pattern Factors: Identical load case factors are used in Revit, unless the load pattern list includes load patterns that were not exported. Their factors are not imported into Revit.

SAP2000 load cases that are not static or are not linear are not imported into Revit.

3.2.14 Load Combinations

If all the SAP2000 static linear load cases each refer to a single load pattern, then the SAP2000 load combinations are exported as Revit load combinations. When load combinations are exported, their following attributes are exported:

- Load Combination Name: The same name is used in Revit.
- Load Cases: Sets the list of Revit load cases. The Revit list is made of the load pattern names that each load case in the SAP2000 list refers to. Load patterns not imported are not included in the Revit list.
- Load Case Factors: If all the load cases in the list of load cases refer to their load patterns with a scale factor of 1, the same load case factors are used in Revit. If any load case refers to a load pattern with a scale factor other than 1, the Revit load case factors are adjusted accordingly. Scale factors for load patterns not imported are not included.

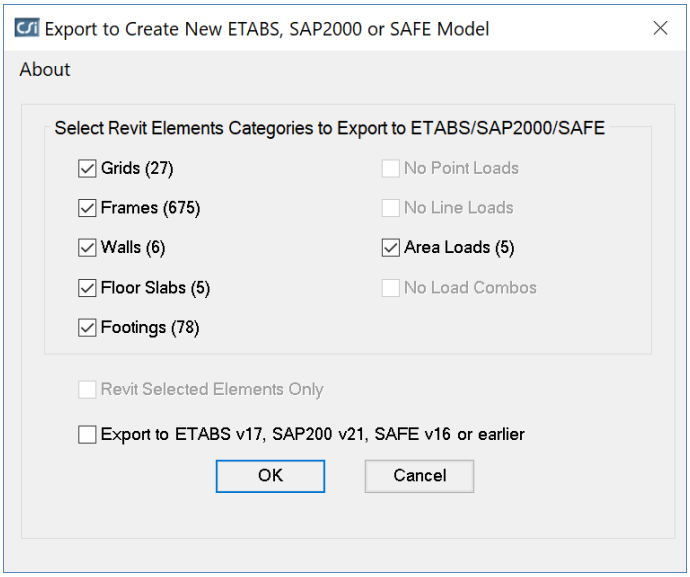
3.3 Procedures

3.3.1 Exporting from Revit to create a new SAP2000 Model

NOTE: CSiXRevit only exports the analytical models of Revit elements. All the analytical models of all Revit elements must be correctly connected to others to ensure the stability of the SAP2000 model generated.

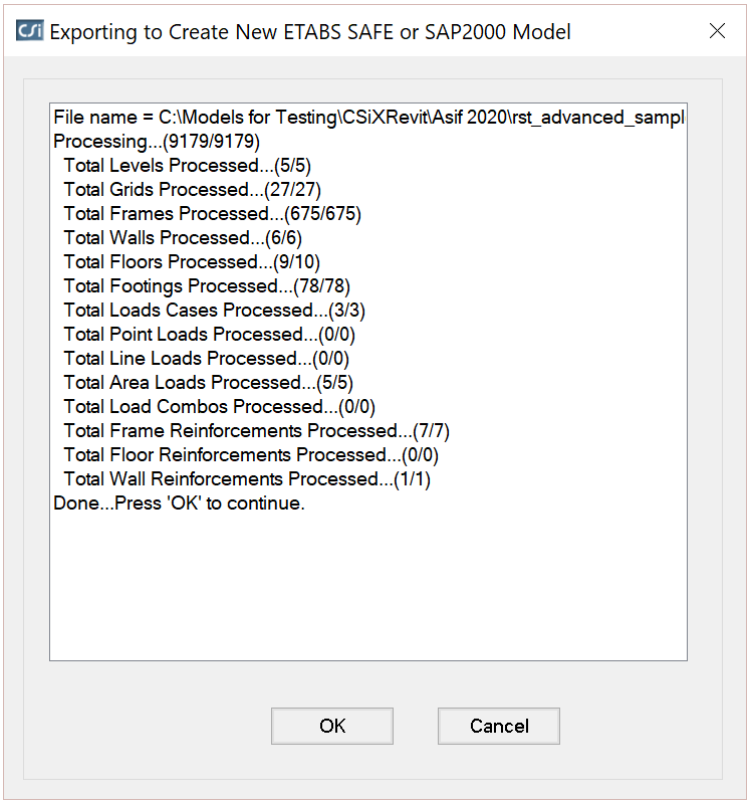
The following steps describe how to export a Revit analytical model into SAP2000:

- With Revit running, open a project you want to export.
- From the Revit menu, select Tools>External Tools>**Export to Create New ETABS or SAP2000 Model**.
- CSiXRevit counts the objects in the Revit project and displays the Export to Create New ETABS or SAP2000 Model form:



- Select the categories of Revit elements to export. If you have selected some elements prior to starting the command and wish to only export these elements, check the corresponding box near the bottom of the form.
- To export to SAP2000 v21, check the corresponding box near the bottom of the form.

- Once you have made your selections, click OK. The Exporting to Create New ETABS SAP2000 or SAFE Model or Exporting to Update Existing ETABS or SAFE model information message box is shown and displays the progress of the export:



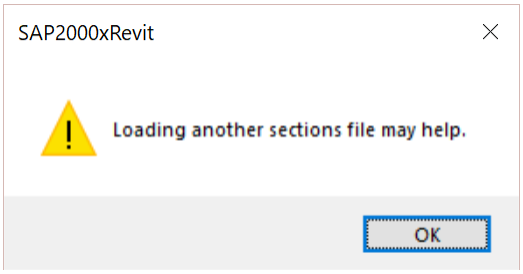
- Once the process is complete, click OK. You are now asked to select a destination folder and filename. The file will be given the extension .exr.

- Start SAP2000 if it is not already running. If it is already running and you want to retain the changes you made to the current model, save the current model.

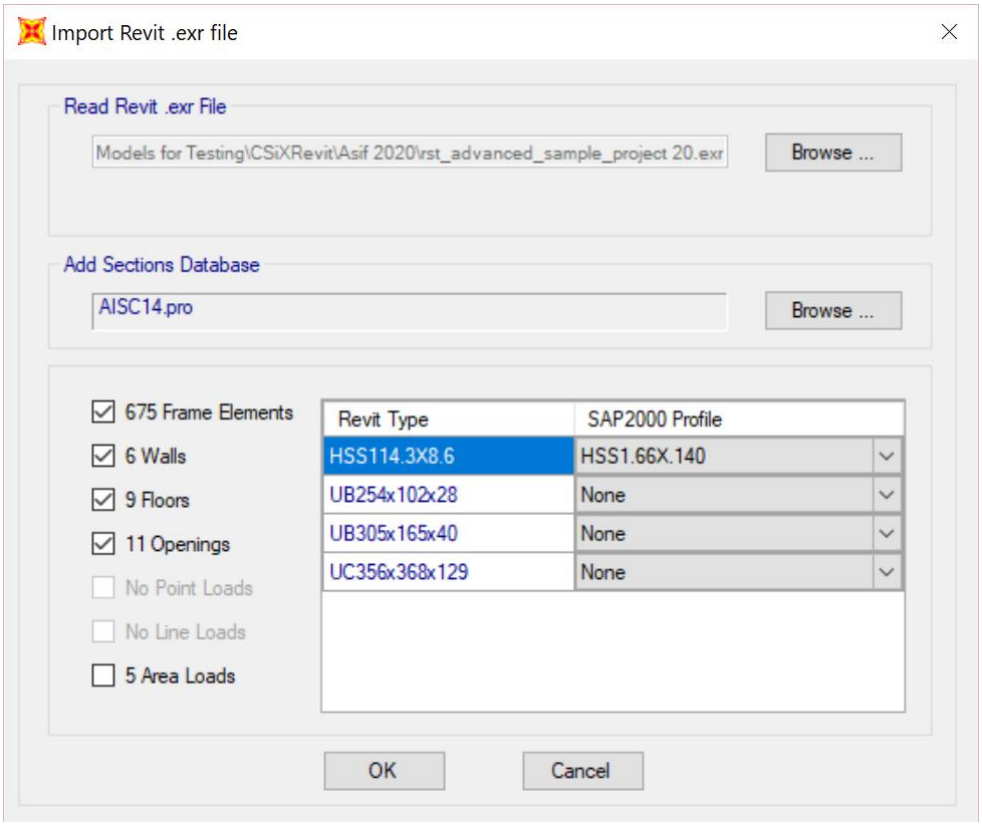
- Select a SAP2000 unit system. If any issues arise during the import part of the exchange, SAP2000 generates a log file in which the locations of the problematic elements are reported in meters if you select metric units, or in feet otherwise.

- From the menu, select **File>Import>Revit Structure .exr File**. The **Import Revit Structure** .exr file form is displayed. Click the **Browse…** button in the Read Revit .exr File field, and select the .exr file to import.

- If some of the family types of the Revit structural column and framing element in the .exr file are not recognized, a warning box is displayed:

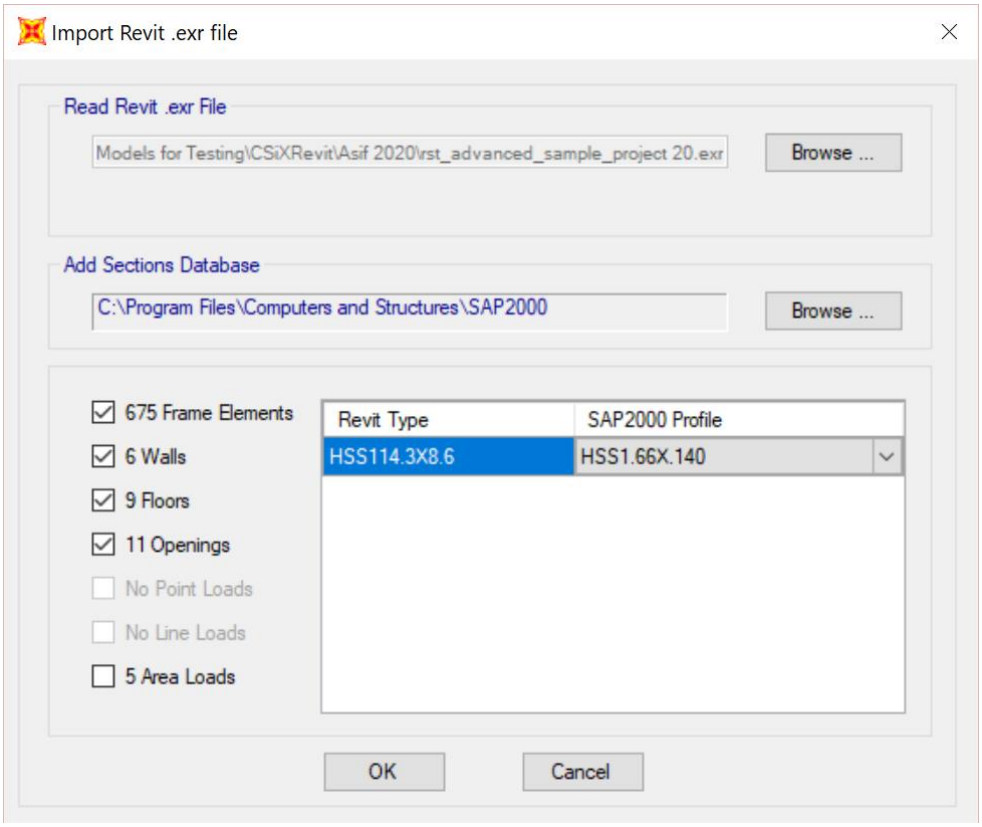


- A summary of the contents of the .exr file is displayed. If some of the family types of the Revit structural column and framing element in the .exr file are not recognized, the form includes a table listing all unrecognized types:



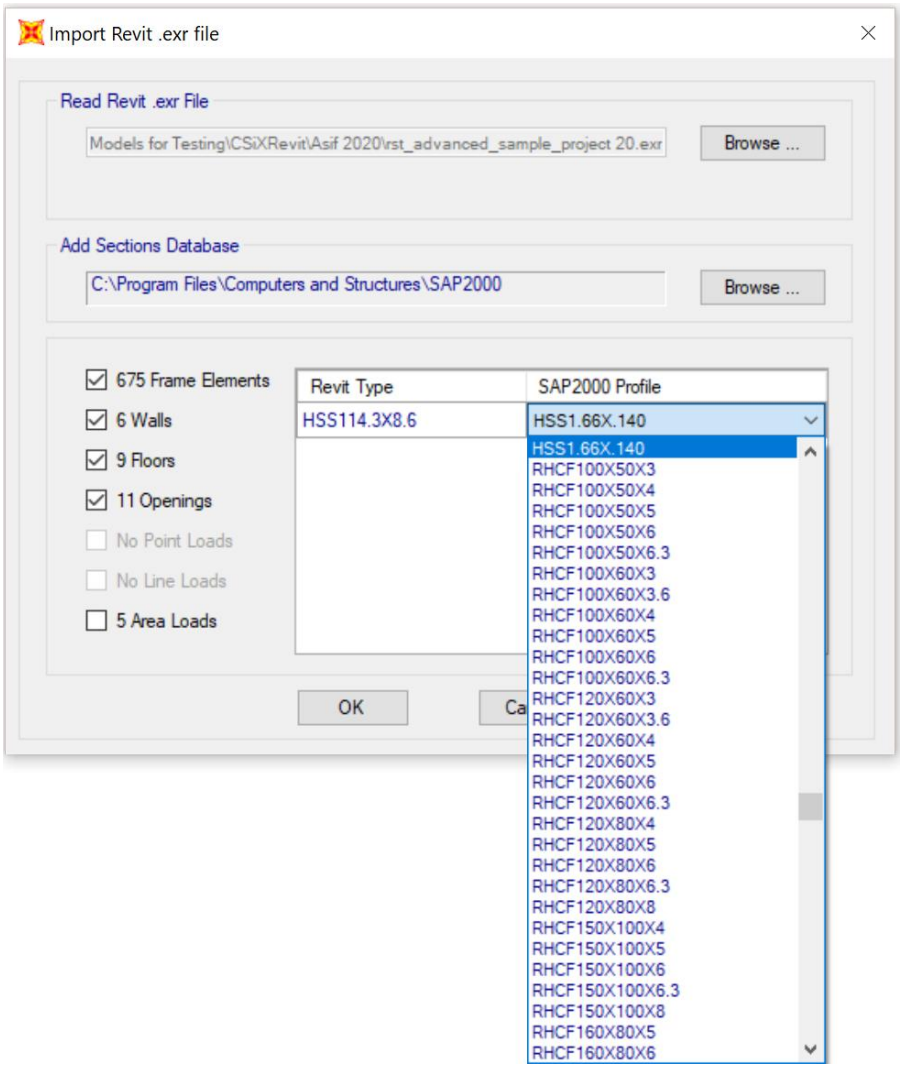
The default SAP2000 profile selected in the right column for each unrecognized type in the left column is the closest alphabetical match in AISC14.pro (or AISC14M.pro depending on the unit system in use when the import began).

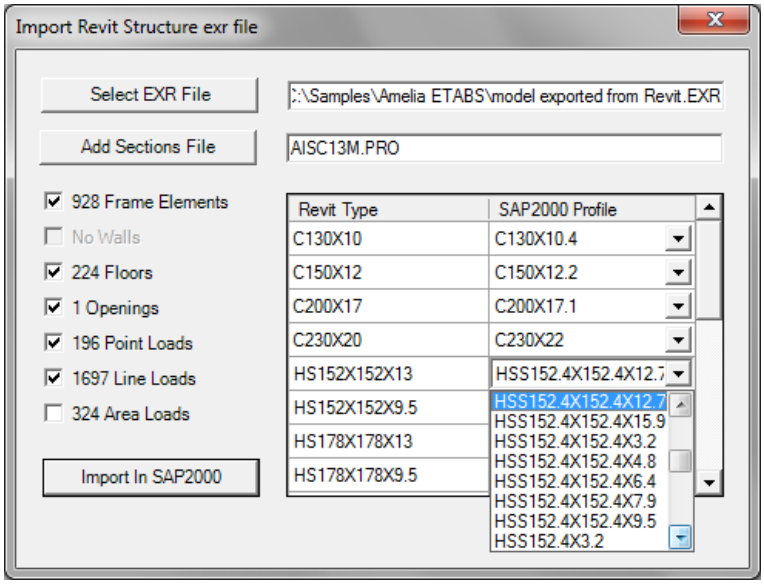
- Click the **Browse…** button in the Add Sections Database field to load another SAP2000 section properties database (.pro file). The Revit types that now have a name match – like UB254x120x28 in the example depicted above – are removed from the list:



- You can load additional section properties databases as needed.

- For each unknown Revit type in the left column, if the corresponding SAP2000 section profile in the right column is not what you want, you can specify another one from the drop-down list of profiles already loaded:





"None" SAP properties are always available at the top of the list.

SAP2000 saves your choices in a file which has an .EXRMap extension. Importing the same Revit project again restores your choices.

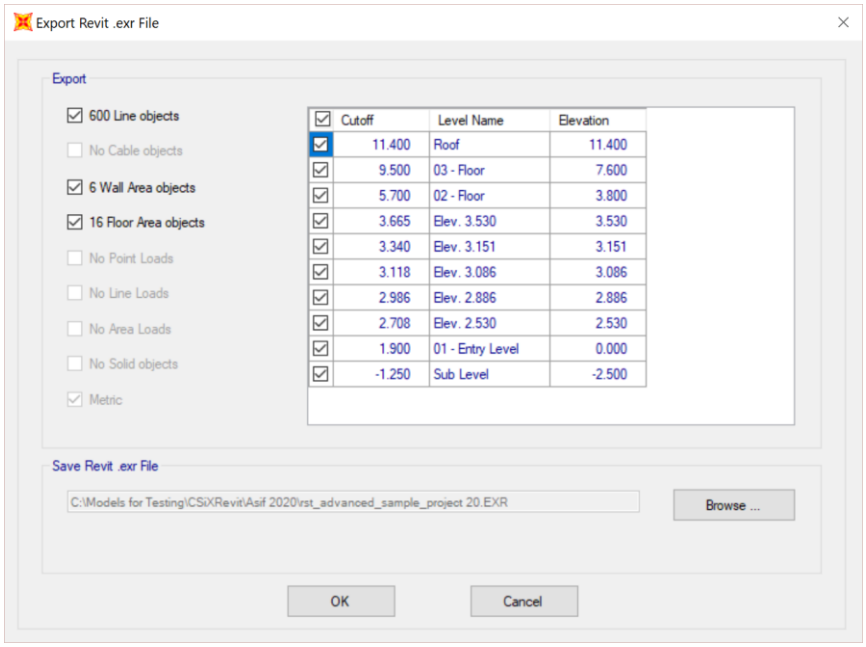
- Select the element categories to import by checking or unchecking the relevant check boxes. (If checking Area Loads, you will receive a reminder that Area Loads cannot be imported into the current version of SAP2000.)
- Click the **Import in SAP2000** button.

  After a few moments, SAP2000 displays the newly imported model.
- If any issues arise during the import part of the exchange, you will be prompted to review the log file.

3.3.2 Importing from SAP2000 to create a New Revit Project

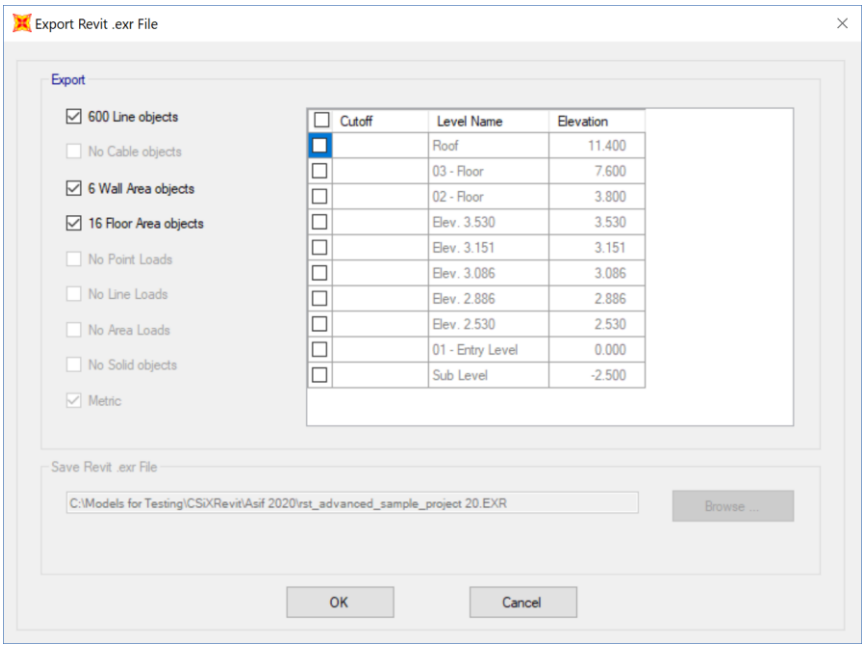
The following steps describe how to export a SAP2000 model to create a new Revit project:

- With SAP2000 running, open a model you want to export.
- Select File>Export>**Revit Structure .exr File.** The Export Revit Structure .exr File form is displayed. It includes a summary of the model contents on the left side and a table with level names on the right side:



- Unlike ETABS or Revit, SAP2000 does not include the concept of story levels because it is a general-purpose analysis program. Therefore, Revit levels need to be created when a SAP2000 model is imported into Revit. The form gives you control over which levels are created, their names, their elevations, and how exported SAP2000 objects are assigned to them in Revit.

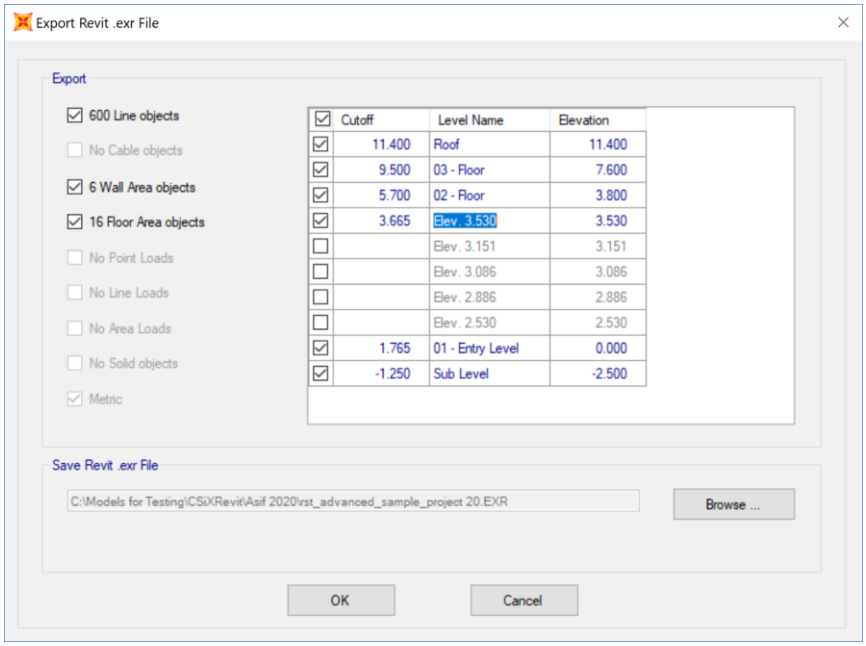
- If the joints in the SAP2000 model occur at many different z elevations, you will probably want to create Revit levels only for a small subset of these elevations. In that case, uncheck the check box at the top of the levels table. It unchecks all the levels at once:



- Check the box next to each story level you want created. As you check levels, SAP2000 computes default cutoff elevations and displays them in the "At or Below" field. SAP2000 area objects are imported into Revit as walls, floors, or ramps and SAP2000 frame and cable objects are imported into Revit as columns, beams or braces. The top and bottom levels of these Revit walls, columns and braces, and the reference levels of these beams and slabs are assigned based on the relationship between the level cutoff elevations and the z-coordinates of the joints defining the original SAP2000 objects.

- You can override any cutoff elevation by typing over a new elevation and pressing the TAB key – as long as you do not set it lower than the corresponding level elevation, or higher than the elevation of the next level to be created above.

- Likewise, you can rename any level by typing a new name, and change its elevation by typing a new elevation:



  SAP2000 saves your level data in a file which has an .EXRMap extension. Exporting the same SAP20000 model again restores your level data.

- Select what to export by checking or unchecking the relevant check boxes.

- The Metric check box controls the units in which level elevations are displayed, the family names of the concrete section types created in Revit, and the units of the log file.

- By default, the .exr file written is written in the same folder as the model and its name is the name of the model with an .exr extension. To save the .exr file in a different folder or under a different name, click the **Browse...** button.

- Click the **OK** button.

- If any issues arise during the export part of the exchange, you will be prompted to review the log file. Please take a moment to do so.

You are now ready to import the .exr file in Revit. You import an .exr file written by SAP2000 exactly like an .exr file written by ETABS, as explained in Importing from ETABS to Create/Update a New/Existing Revit Project.

3.3.3 Known Limitations of CSiXRevit with SAP2000

- Materials imported into Revit from SAP2000 may not always be properly mapped or the property values may not always be properly transferred. For this reason, material mapping and material property values should always be carefully checked in Revit after importing from

SAP2000.

- See other limitations described in the previous sections for SAP2000.

4 Revit and SAFE Data Exchange

Data can be exchanged between Revit and SAFE along the following paths:

- Exporting from a Revit project to create a new SAFE model.
- Exporting from a Revit project to update a previously exported or previously imported SAFE model.
- Importing from a SAFE model to create a new Revit project.
- Importing from SAFE to update a previously imported or previously exported Revit project.

The actual data transferred varies in each case.

4.1 Exporting from Revit to create a new SAFE model

The table below provides an overview of the data imported in SAFE when exporting from Revit to create a new SAFE model:

Action	Project Element	Supported	Notes
Creation of…			
	Grid Lines		
	Story Levels		Lets you select which horizontal slice of the project to import.
	Materials		
	Structural Columns and Structural Framing		Imports only concrete columns, braces and beams, and only columns with rectangular or circular section, and only beams with rectangular section.

	Steel Column and Framing Family Types		
	Concrete Column and Framing Family Types		Imports only circular or rectangular column sections, and only rectangular beam sections.
	Walls		Slanted walls and walls with material other than concrete not imported.
	Wall Family Types		Creates and maps equivalent SAFE wall sections.
	Wall Openings		
	Floors		Floors with a filled steel deck or made of a material other than concrete not imported. Sloped floors with more than four outer corners are projected on a horizontal plane.
	Floor Family Types		Creates and maps equivalent SAFE slab and deck sections.
	Floor Openings		
	Footings		
	Point Loads		
	Line Loads		
	Area Loads		Non-uniform area loads not imported.
	Load Cases		Creates both a SAFE load pattern and load case for each Revit load case.
	Load Combos		

4.1.1 Grids

The following Grid attributes are created in SAFE:

- Grid Name: The same grid name is used in the SAFE grid bubble.
- Grid Points: The start and end points are used to define the general grid line in SAFE.
- Curved Grid: The center point, radius, start angle and aperture are used to define the circular grid line in SAFE.

4.1.2 Materials

The following material attributes are created in SAFE:

- Material Name: The same name is used in SAFE.

- Material Type: The Revit material type is used to identify the SAFE material type, namely Concrete, Steel or Other.

- Young's Modulus: The Young's modulus values from Revit set the SAFE material Young's modulus (E). These three values (for the three different directions) cannot be zero in SAFE. If the first value is zero, then the default SAFE value is used. If any of the remaining two are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.

- Poisson's Ratio: Poisson's Ratio values from Revit set the SAFE material Poisson's Ratio (u). These three values (for the three different directions) cannot be zero in SAFE. If the first value is zero, then the default SAFE value is used. If any of the remaining two are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.

- Shear Modulus: Shear Modulus value from Revit set the SAFE material Shear Modulus (G). If the Revit material is defined as isotropic, then SAFE calculates this value on the basis of the Young's Modulus and the Poisson's Ratio. In the case of an orthotropic material, these three values (for the three different directions) cannot be zero in SAFE. If the first value is zero, then the default SAFE value is used. If any of the remaining two are zero, then the first non-zero value is used.

- Thermal Expansion Coefficient: The thermal expansion coefficient from Revit sets the SAFE material thermal expansion coefficient (Alpha). These three values (for the three different directions) cannot be zero in SAFE. If the first value is zero, then the default SAFE value is used. If any of the remaining two values are zero, then the first non-zero value is used. For an isotropic material, the first value is used for all other directions.

- Weight Density and Mass Density: The unit weight value from Revit sets the SAFE material weight density (w) and mass density (m). In SAFE, the mass density is calculated by dividing the weight density by the gravitational constant (g). The weight density cannot be zero in SAFE. If the unit weight is zero in Revit, then the default SAFE densities are used.

- Damping Ratio: This value is not in used in the current version of SAFE.

- Bending Reinforcement: The bending reinforcement value from Revit sets the SAFE material main reinforcement Fy if the type is concrete. If this value is zero in Revit, then the default SAFE value is used.

- Shear Reinforcement: The shear reinforcement value from Revit sets the SAFE material shear reinforcement Fy if the type is concrete. If this value is zero in Revit, then the default SAFE value is used.

- Resistance Calculation Strength: The resistance calculation strength from Revit sets the SAFE material f'c factor. If this value is zero in Revit, then the default SAFE value is used.

- Behavior: The Revit behavior tag is used to identify the isotropic or orthotropic materials in SAFE.

- Concrete Compression: The concrete compression value from Revit sets the SAFE material f'c if the type is concrete.
- Lightweight: The Revit lightweight tag is used to identify the lightweight concrete material in SAFE.
- Shear Strength Reduction: This value is not in used in the current version of SAFE.
- Yield Stress: This value is not in used in the current version of SAFE.
- Tensile Strength: This value is not in used in the current version of SAFE.
- Steel Reduction Factor: This value is not in used in the current version of SAFE.

Only those materials linked with floors, walls, or frames in the Revit project are imported into SAFE.

SAFE writes a warning in the .EXRLog file it writes when a default value is used while importing materials from the Revit project.

4.1.3 Concrete Structural Columns and Framing

The following Revit column and framing element attributes are imported into SAFE:

- Frame Curves: Straight framing elements are imported as straight SAFE frame objects. Curved framing elements that are not arc shaped are imported as series of short SAFE objects based on the lines defining their analytical models. Arc shaped beams are imported as arc shaped SAFE beams.
- Frame End Points and Curves: For straight column and framing elements and curved framing elements other than arc shaped, the coordinates of the end points of the lines defining the analytical model of the element are retrieved and SAFE joint objects with identical coordinates are created. When the analytical model of an element includes rigid links, the SAFE joint objects are created at the ends of the rigid links with SAFE joints offsets created to model the link. For arc shaped framing elements, the coordinates of the end points of the elements themselves are imported instead of the end points of their analytical models because these analytical models consist of series of short straight segments and such a tessellation is not required in SAFE. Columns are imported with the Local Axis 1 always pointing up, and beams and braces with their Local Axis 1 always in the first quadrant, which means that the end joints may have been switched compared to the Revit end points.
- Frame Sections: Only columns with rectangular or circular sections and beams with rectangular sections can be imported.
- End Releases: End releases defined in the element analytical models are imported into SAFE. SAFE restricts releases that would cause an analytical instability, such as for example torsion released at both ends. When that happens, SAFE writes a warning in the .EXRlog file it writes. When SAFE joints have been switched compared to Revit end points, end releases are also switched.

- Insertion Points: In Revit, the beam insertion point is defined by the following two parameters:
  - Z-Direction Justification
  - Lateral Justification

  SAFE calculates the corresponding cardinal point on the basis of these two parameters. If these parameters are no defined for a beam then the default cardinal, Top Center, is chosen. Columns and braces are imported with a Middle Center insertion point.

- End Offsets: When the analytical model of an element includes rigid links, these are imported as end offsets. You can visualize them by looking at the model in extruded view. In addition, when a beam has its z-Direction Justification parameter set to Other, an additional vertical offset is created at both ends of the SAFE frame object based on the value of the z-Direction Offset parameter. Other beam offset parameters such as Start Level Offset and End Level Offset are not taken into consideration because, except for arc shaped members, end joints are located based on the end points of the analytical model which already reflects the values of these parameters. When SAFE joints have been switched compared to Revit end points, end offsets are also switched.

- Orientation Angles: The SAFE Local Axis 2 Angle of columns is computed based on their rotation as internally stored in Revit. The SAFE Local Axis 2 Angle of beams and braces is computed based on the value of their Cross-Section Rotation parameter. When SAFE joints have been switched compared to Revit end points, rotations are adjusted accordingly.

4.1.4 In-place family members

Revit in-place family members are not imported into SAFE.

4.1.5 Walls

The following wall attributes are imported into SAFE:

- Points: The coordinate of all points defined in the wall analytical model are retrieved and SAFE joint objects with identical coordinates are created. Revit walls may be defined as having more than four corners, but SAFE walls can only have three or four nodes. Revit walls with more than four outer corners are broken into several four node walls, with a few three node walls when some of the edges are sloped. Also, multi-story walls are broken into several single story SAFE walls. This is required for reporting and concrete reinforcement design.

- Wall Curve: Arc shaped curved walls with horizontal bases and tops are imported as SAFE curved walls. Straight wall edges are imported as such. Other edges are tessellated, with the degree of approximation defined internally by Revit, and the wall is imported as a series of walls. Note that when a Revit wall is arc shaped in plane but its top is not horizontal, its top curve is not an arc and will be tessellated.

- Wall Openings: Wall openings are not imported in SAFE.

- Wall Thickness: A Revit wall has different layers, each having different thickness and material properties. SAFE only considers the layer with the maximum thickness when importing the data from Revit.

- Wall Materials: All the materials assigned to the different layers of a Revit wall are imported into SAFE. However, only one material is assigned to the SAFE wall section property. Users have the option in SAFE to change the material, if necessary. The material of the wall layer with the maximum thickness is used.

Slanted walls, with their top not lined up with the base when looked at from above, are not imported.

4.1.6 Floors

The following floor attributes are imported into SAFE:

- Floor Points: The coordinate of all points defined in the floor analytical model are retrieved and SAFE joint objects with identical coordinates are created.

- Floor Curves: Floor edges that are arc shaped are imported as arcs in SAFE. Straight floor edges are imported as such. All other curved floor edges are tessellated, with the degree of approximation defined internally by Revit. Floors with more than four outer corners are projected onto a horizontal plane at an elevation matching their average elevation.

- Number of Layers: Floors with a filled steel deck or made of a material other than concrete cannot be imported. SAFE only considers the layer with the maximum thickness when importing the data from Revit.

- Layer Thickness: SAFE only considers the layer with the maximum thickness when importing the data from Revit.

4.1.7 Openings

The following openings are imported into SAFE from Revit:

- Horizontal Openings: These are imported as opening in the floors.

- Wall Openings: These are imported as openings in the walls (vertical planes).

- Shaft Openings: These are imported as openings in the floors if their vertical extents include the story level being imported.

4.1.8 Point Loads

The following point load attributes are imported into SAFE from Revit:

- Load Case Name: It sets the corresponding load case name in SAFE.

- Location: It is used to define the point of application of the load.

- Fx, Fy, Fz, Mx, My, Mz: All forces and moments applied in the global direction, in Revit, are transferred in a similar manner into SAFE.

If a point load is not directly on top of a SAFE wall, column, or beam, a SAFE beam with None properties is created to tie the load to the structure.

4.1.9 Line Loads

The following line load attributes are imported into SAFE from Revit:

- Load Case Name**:** It sets the corresponding load case name in SAFE.
- Start and End Point Locations: Used to define the start and end point of the line load. Line loads carrying the gravitational load and overlapping more than one beam are distributed to the corresponding beams in SAFE. In the case of a lateral line load, users must check no line load overlaps more than one beam; otherwise it is not processed in the SAFE analysis.
- Fx, Fy, Fz, Mx, My, Mz: All forces and moments applied in the global direction, in Revit, are transferred in a similar manner into SAFE. A Revit line load which includes more than one of these components is imported as several SAFE line loads because SAFE line loads are unidirectional.

4.1.10 Area Loads

The following area load attributes are imported into SAFE from Revit:

- Load Case Name: It sets the corresponding load case name in SAFE.
- Points: Points are used to define the geometry of the loading area. Curved edges that are arc shaped are imported as arcs. Straight edges are imported as such. Other edges are tessellated, with the degree of approximation defined internally by Revit.
- LoadX, LoadY, and LoadZ: All loads applied in the global direction in Revit are transferred in a similar manner into SAFE.

Non-uniform surface loads are not supported in SAFE and not imported.

4.1.11 Load Cases

The following load case attributes are imported into SAFE from Revit:

- Load Case Name: The same name is used for the SAFE load case.
- Load Case Category: It is used to define the load case type in SAFE. The mapping is shown in the following table:

Revit Load Case Category	SAFE Load Case Type
Dead	Dead
Live	Live
Wind	Wind
Snow	Snow
Roof Live	Live
Accidental	Other
Temperature	Other
Seismic	Quake

4.1.12 Load Combos

The following load combination attributes are imported into SAFE from Revit:

- Load Combination Name: The same name is used for the SAFE Load Combination Name.
- Load Cases: The same load cases list is used in SAFE to define the Load Combination.
- Load Case Factor: The same load case factors are used for the corresponding load cases in the SAFE load combination.

4.2 Exporting from Revit to update an existing SAFE model

The table below provides an overview of the data imported in SAFE when exporting from Revit to update an existing SAFE model:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Story Levels		
	Materials		Creates equivalent SAFE materials.
	Frames		Transfers geometry, offsets, y and z justifications, and end releases into SAFE.
	Frame Sections		
	Steel Sections		Maps to SAFE database sections.
	Concrete Sections		Creates and maps equivalent SAFE sections.
	Walls		
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Floor Openings		
	Footings		Creates fixed joint restraints in SAFE wherever a footing occurs in Revit.
	Joint Loads		
	Frame Loads		
	Shell Loads		
	Load Cases		
	Load Combos		
Update of…			
	Grids		
	Story Levels		
	Materials		

	Frames		
	Frame Sections		
	Steel Sections	X	
	Concrete Sections		
	Walls		Walls with changing number of sides are replaced.
	Wall Properties		
	Wall Openings		.
	Floors		
	Slabs Properties		
	Floor Openings		Floor openings with changing number of sides are replaced.
	Point Loads		
	Line Loads		
	Area Loads		
	Load Cases		
	Load Combos		
Deletion of…			
	Grids		
	Story Levels		
	Frames		
	Walls		
	Wall Openings		
	Floors		
	Floor Openings		
	Footings		
	Point Loads		
	Line Loads		
	Area Loads		
	Load Cases		
	Load Combos		

NOTE: Deletion of objects when updating a model only works if you are sending the entire model. If the “selection only” update feature is used, deletion of items is not supported.

4.3 Importing from SAFE to create a new Revit Project

The table below provides an overview of the data imported in Revit when creating a new Revit project:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Materials		Imports Concrete and Steel materials into Revit from SAFE. Limitation is the Revit project should have one default concrete and one default steel material for duplication, otherwise the material will be created in Revit but its parameters will not be updated, and the properties of the new materials are identical to those of the template materials.
	Frames		
	Frame Sections		
	Concrete Sections		Creates and maps equivalent Revit sections. See mapping below.
	Walls		Slanted walls not imported.
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Footings		
	Load Cases		
	Joint Loads		
	Frame object Loads		Creates equivalent Revit point line loads and trapezoidal line loads.
	Surface Loads		Creates equivalent Revit area loads.
	Load Combos		

Mapping of SAFE section types to Revit families:

Columns

SAFE	Revit Family
Rectangular	Concrete-Rectangular-Column.rfa
Square	Concrete-Square-Column.rfa
Circular	Concrete-Round-Column.rfa

Beams and Braces

SAFE	Revit Family
Rectangular or Square	Concrete-Rectangular Beam.rfa

4.4 Importing from SAFE to Update an Existing Revit Project

The table below provides an overview of the data imported in Revit when updating an existing Revit project:

Action	Model Element	Supported	Notes
Creation of…			
	Grids		
	Story Levels		
	Materials		
	Frames		
	Frame Sections		
	Steel Sections		
	Concrete Sections		Creates and maps equivalent Revit sections. See mapping at end of previous section.
	Walls		
	Wall Properties		
	Wall Openings		
	Floors		
	Slabs Properties		
	Deck Properties		
	Floor Openings		
	Footings		
	Load Cases		
	Joint Loads		
	Line Loads		
	Area Loads		
	Load Combos		
Update of…			
	Grids		
	Story Levels		
	Materials		

	Frames		Updates changes to column locations only for columns not meshed in SAFE and with a 1:1 correspondence between Revit and SAFE. You can choose between leaving columns meshed in SAFE in their original Revit locations and replacing them with the SAFE meshed columns.
	Frame Sections		
	Steel Sections		
	Concrete Sections		Updates Beam, Column and Brace section assignments; however section parameters themselves do not update. If you would like to bring in the changes to the parameters from SAFE, create a new section with the desired parameters in SAFE and assign the new section to the frame.
	Walls		Updates changes in wall location only for walls not meshed in SAFE and with a 1:1 correspondence between Revit and SAFE. You can choose between leaving walls meshed in SAFE in their original Revit locations and replacing them with the SAFE meshed walls.
	Wall Properties		Updates wall type assignments; however wall types themselves do not update. If a wall section is changed in SAFE, it is imported under a new name in Revit.
	Wall Openings		Non-rectangular wall openings are not updated.
	Floors		Replaces floors which moved, were not meshed when brought in from SAFE, and with a 1:1 correspondence between Revit and SAFE. You can choose between leaving floors meshed in SAFE in their original Revit locations and replacing them with the SAFE meshed floors.
	Slabs Properties		Updates floor type assignments; however floor types themselves do not update. If a floor section is changed in SAFE, it is imported under a new name in Revit.
	Deck Properties		
	Floor Openings		Floor openings moved in SAFE are replaced.
	Load Cases		
	Point Loads		
	Line Loads		

	Area Loads		Area loads moved in SAFE are replaced.
	Load Combos		
Deletion of…			
	Grids		
	Story Levels		
	Materials		
	Frames		
	Walls		
	Wall Openings		Non-rectangular wall openings are not deleted.
	Floors		
	Floor Openings		Floor openings imported as a floor shaft and deleted in SAFE are not deleted.
	Load Cases		
	Point Loads		
	Line Loads		
	Area Loads		
	Load Combos		

NOTE: Deletion of objects when updating a model only works if you are sending the entire model. If the "selection only" update feature is used, deletion of items is not supported.

4.5 Procedures

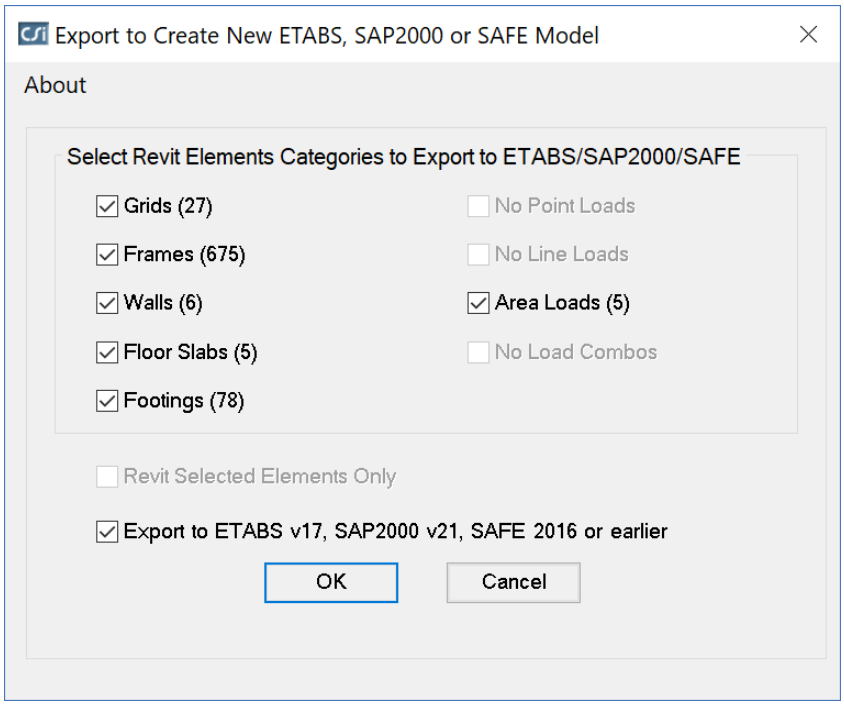
4.5.1 Exporting from Revit to Create/Update a New/Existing SAFE Model

IMPORTANT NOTE: CSiXRevit only exports the analytical models of Revit elements. All the analytical models of all Revit elements must be correctly connected to others to ensure the stability of the SAFE model generated. Walls, columns, beams, and floors of a material type other than concrete are not imported in SAFE, and neither are columns with a section other than circular or rectangular, and beams with a section other than rectangular.

The following steps describe how to send your Revit analytical model to SAFE:

- To **create** a new SAFE model, from the Revit menu select, Tools>External Tools>**Export to Create New ETABS or SAP2000 Model**. To **update** an existing SAFE model, from the Revit menu, select Tools>External Tools>**Export to Update Existing ETABS or SAFE Model**.

  CSiXRevit counts the elements in the Revit project and displays the Export to Create New ETABS, SAP2000, or SAFE Model form, or Export to Update Existing Model form as may be the case:

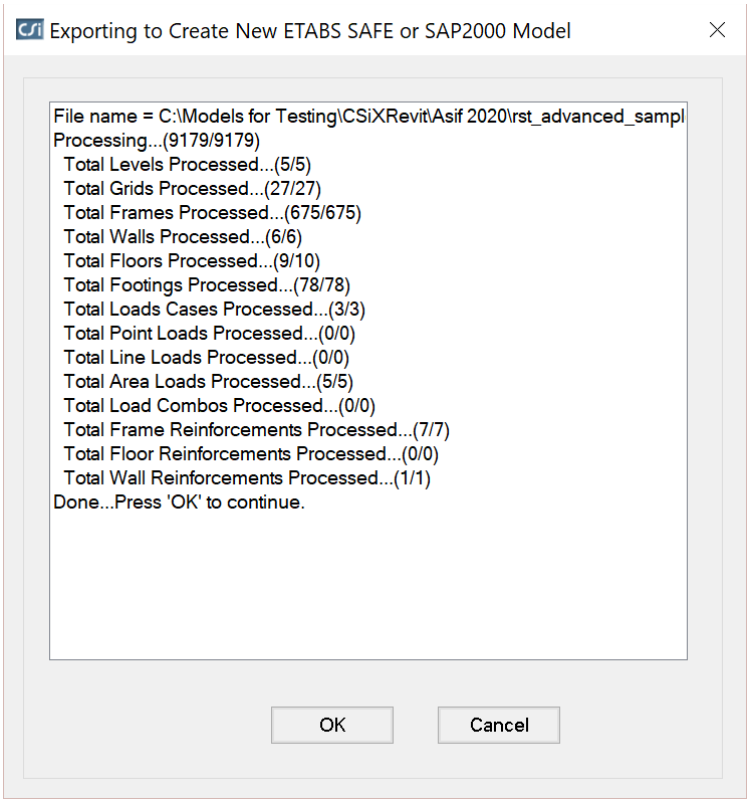


- Select the categories of Revit elements to export to SAFE. If you have selected some elements prior to starting the command and wish to only export those elements, check the corresponding box at the bottom of the form.

  SAFE analyzes horizontal single level structures but you do not need to select Revit elements from a single level. You will choose a level to import in the next step.

- Once you have made your selections, click OK.

  The Exporting to Create New ETABS SAP 2000 or SAFE Model or Exporting to Update Existing ETABS or SAFE model information message box is shown and displays the progress of the export:

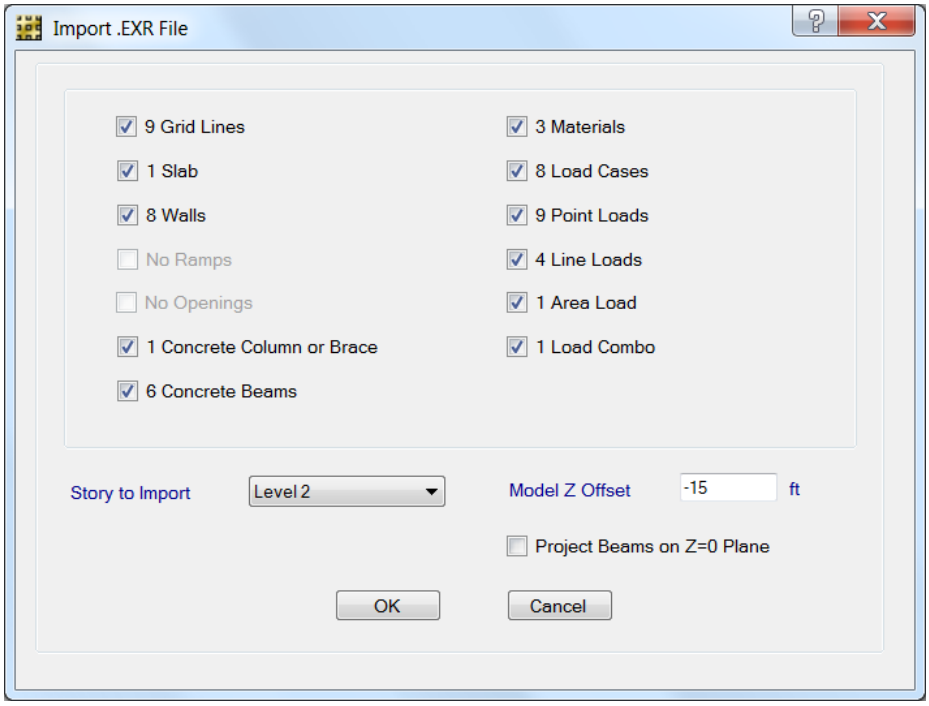


- Once the process has run its course, click OK. You are now asked to select a destination folder and filename. The file will be given the extension .exr.

You are now ready to import the .exr file in ETABS:

- Start SAFE if it is not already running.
- To create a new SAFE model from your Revit project, you should not have any other model open. By default SAFE creates a new model based on your .EXR file.
- To update an existing SAFE model, open it.
- From the menu, select File>Import>EXR Revit file, and then select the .exr file to import. The

Import .EXR File form is displayed:



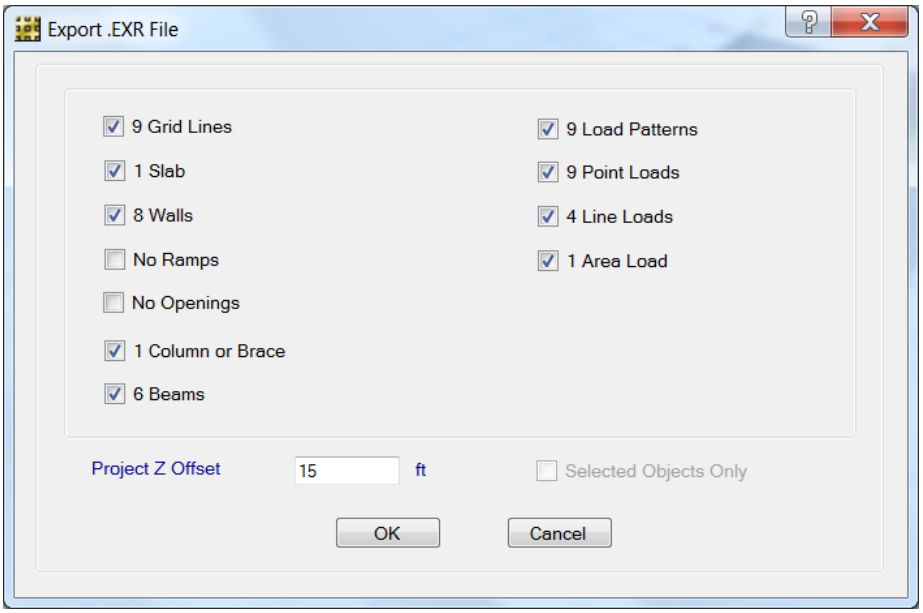
- The form displays the contents of the exr file. Again, you can choose which categories of Revit elements to import or update. If the Revit project has multiple stories you can choose a story to import – or all of them in the case the structure is essentially plane and the story distinctions are not relevant. You can also specify a model Z offset so that the imported floor slabs and beams will be at the zero elevation - making it easier to work with in SAFE.

- Click OK. The SAFE model is created.

4.5.2 Exporting from SAFE to Create/Update a New/Existing Revit Project

The following steps describe how to export your SAFE model to create or update a Revit project:

- Once you have edited, analyzed and designed your structure in SAFE, save the SAFE file by selecting the File>Save.
- In SAFE, select File>Export Model>**EXR File** and specify a destination folder and filename in the form which is displayed.
- The Export .EXR file form is displayed. It shows a count of the SAFE objects available for export. If the model was previously imported from Revit with a model offset other than zero, the opposite Project Z Offset is set by default. If you have selected parts of the model, and would like to send only those selections, check the Selected Objects Only box.



You are now ready to import the .exr file in Revit. You import an .exr file written by SAFE exactly like an .exr file written by ETABS, as explained in Importing from ETABS to Create/Update a New/Existing Revit Project.

4.5.3 Known Limitations of CSiXRevit with SAFE

- Revit floors that are grouped together may be classified as openings when imported in SAFE.
- Materials imported into Revit from SAFE may not always be properly mapped or the property values may not always be properly transferred. For this reason, material mapping and material property values should always be carefully checked in Revit after importing from SAFE.