Andhra Pradesh State Skill Development Corporation

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Extended Three-Dimensional Analysis of Building System

Defining Structural Elements

DEFINING STRUCTURAL ELEMENTS

Objective

This chapter describes how to define Structural elements like beam, column & slab sections.

FRAME SECTIONS

Click the Define menu > Section Properties > Frame Sections command, which will display the Frame Properties form. The Frame Properties form allows for the definition of new sections as well as the review of existing sections. To make steel frame sections from property files available click the Import New Properties button, or to add user defined sections click the Add New Property button.

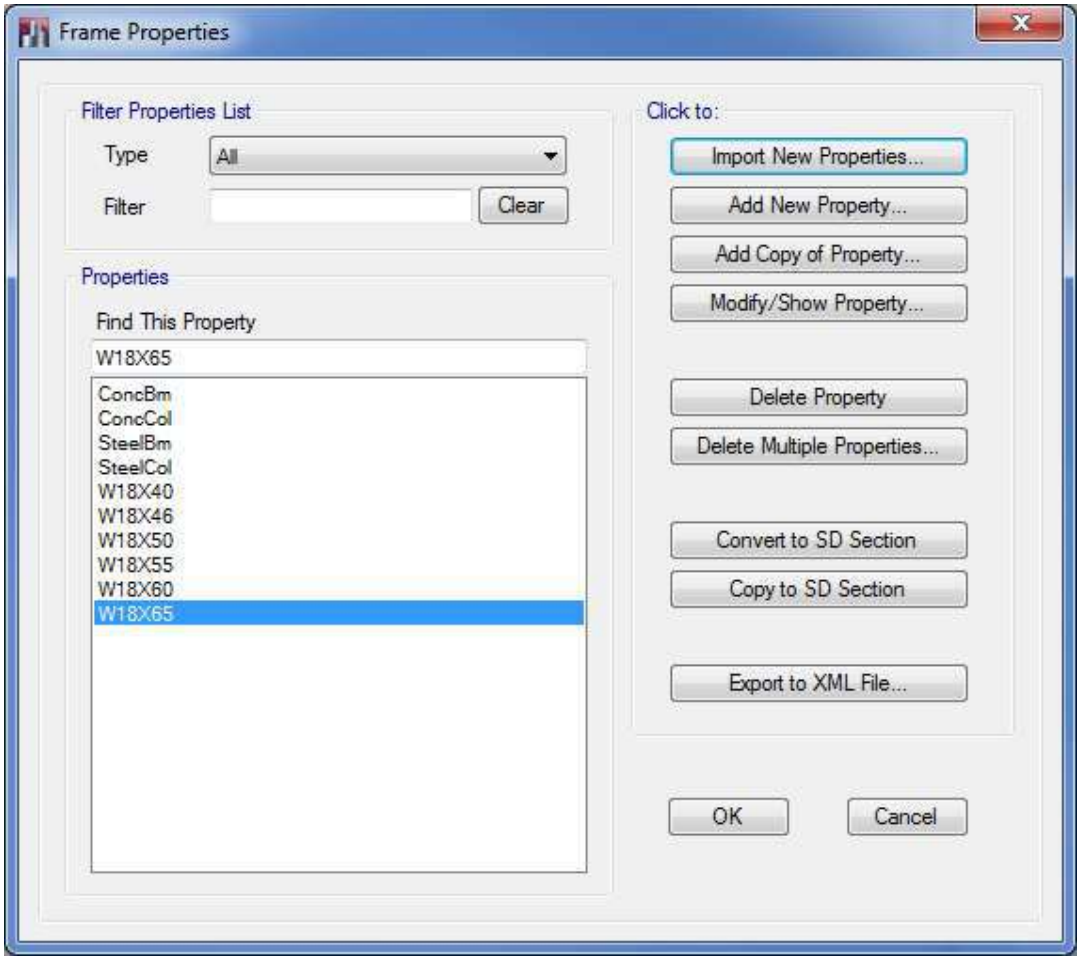

Figure: Frame Properties form

Filter Properties List

- **Type** drop-down list. This drop-down list can be used to limit the list of section shapes displayed in the *Properties* display area on the left-hand side of the form. For example, if Pipe is selected, only pipe sections will be displayed.
- **Filter** edit box. Use the Filter edit box to limit the list to make selection of the frame section easier. Use the Clear Filter button to restore the full list of frame sections.

Properties

- Find This Property edit box. This edit box is useful to locate a property definition in the long list of frame property definitions in the display area. Type the name of a property in this edit box to locate it quickly.
- Properties display area. The program ships with a number of shape libraries (.xml files). The section properties shown in this display area are from those shape libraries. The library (ies) used by the program is influenced by the Steel and Concrete codes that were selected when the model was originally started. The list of available shapes can be modified using the Import New Properties and Add New Property buttons, as explained in the following bullet items. Thus, if the current model was initialized from an existing model (i.e., the *Initialize from Existing .edb File* option was used on the Model Initialization form), the list may have been altered in the previous model.

"Click To" Buttons

1. Import New Properties button

Click this button to access the Frame Property Shape Type form; select a *Section Shape* from the drop-down list or click a *Frequently Used Shape Type* to display the Frame Section Property Import Data form. Use that form to specify a database of section types from which shapes can be selected for import into the model file.

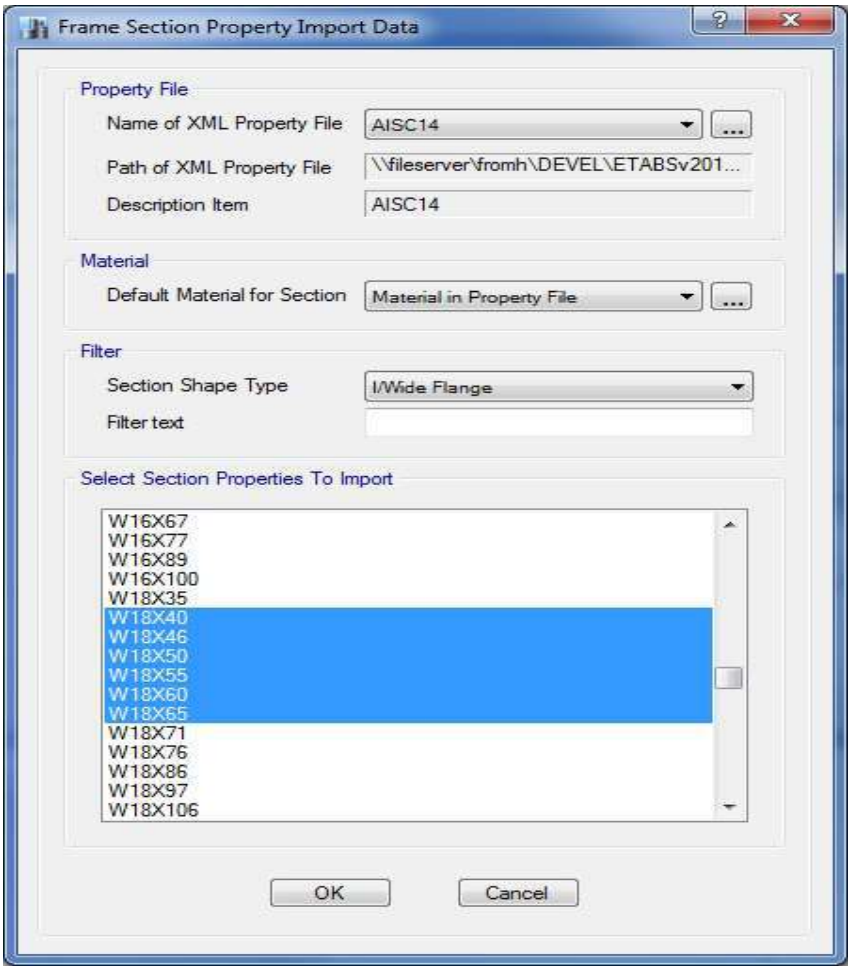

Figure: Frame Section Property Import Data Form

Additional form/window: Add XML Property Files

The Frame Section Properties to Import form can be used to specify a database of section types from which are selected section properties for import into the model.

- **Name of XML Property File** drop-down list and button. Click this drop-down list to review the extensive library of section shapes available in ETABS, including AISC14, BSShapes2006, Indian and so forth. If necessary, click the button to the right of the drop-down list to display the Add XML Property Files window, which can be used to locate an .xml file containing additional section shapes to be incorporated into the model file.
- **Path of XML Property File** display box. The path to the .xml file to be imported is shown in this display box.
- **Description Item** display box. The name of the .xml file selected for importing is shown in this display box.
- **Material - Default Material for Section** drop-down list. This drop-down list can be used to select a specific material property for use in the sections imported into the model file. The button to the right of the drop-down list can be used to access the Define Materials form and specify a new material property definition.
- **Filter - Section Shape Type** drop-down list. This drop-down list can be used to narrow the selection of sections to be imported to a specific type (e.g., Angle or Pipe, and so on).
    - **Filter text** edit box. Use the edit box to limit the display of sections using specified criteria.
- **Select Section Properties to Import** display area. The names of the sections to be imported display in this area. If nothing is shown in this area, the library selected in the *Name of XML Property File* drop-down list does not contain the type of section selected in *Section Shape Type* drop-down list.
  Highlight the section names to be imported and click the OK button to complete the import

2. Add New Property button

Click the Add **New Property** button to display the **Frame Property Shape Type** form. Use that form to add a new property to the model file.

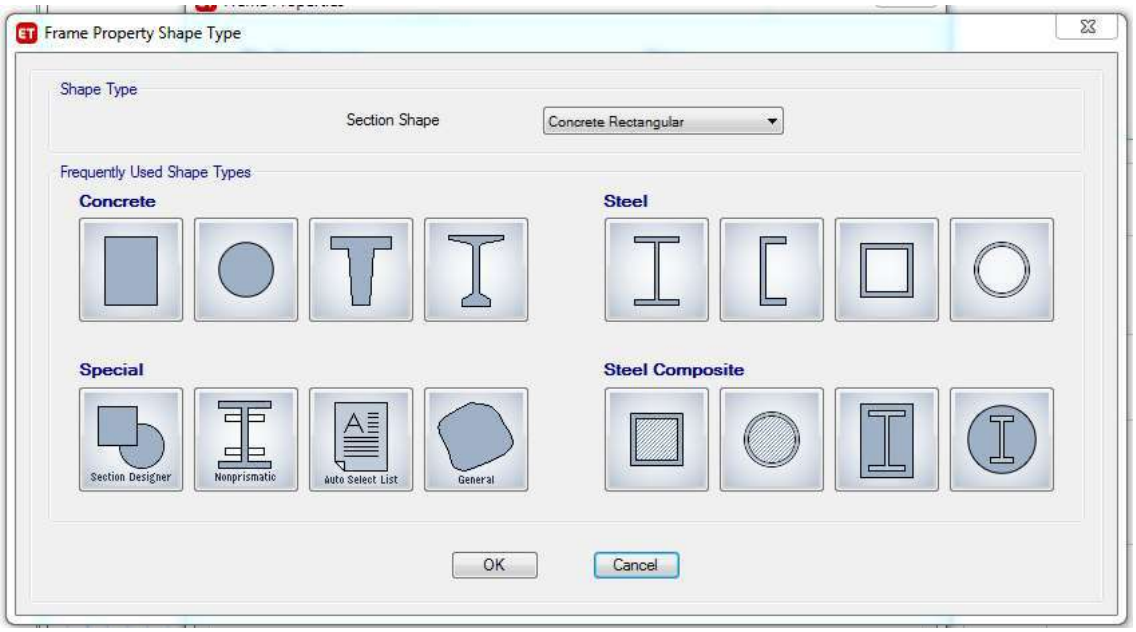

Figure: Frame Property Shape Type form

Use the Frame Section Property Data form to specify property data parameters for a frame section definition. The specific parameters available depend on the section shapes, which include a wide range of steel and concrete shapes as well as a General shape, a steel joist shape, a Non prismatic section, a section defined using Section Designer, and the Auto Select Section List option.

Common to All Shapes

▪ **Property Name** edit box. Common to the forms for all section shapes and the Auto Select option, use the default name shown or type a new one in this edit box.

▪ **Modify/Show Notes** button. Common to the forms for all section shapes, click this button to display the Frame Property Notes form. The form can be used to add notes about frame section properties to the model file. Type the notes directly into the large text box area. Notes also can be reviewed using this form.

▪ **Section Shape** drop-down list. Common to the forms for all section shapes, when available, this drop-down list can be used to select a different section shape.

TIP: Because the Auto Select and Non Prismatic options involve the use of lists of sections, ensure that the appropriate lists are created first (i.e., the sections to the used in the Auto Select and Non prismatic section definitions must appear in the large display area on the left-hand side of the Frame Properties form). Similarly, the material properties, display colors, section dimensions, and frame property/stiffness modification factors of those sections should be reviewed/established before the Auto Select and Non prismatic section definitions are completed.

Common to Most Shapes:

▪ **Material** drop-down list. The material property for the selected shape is displayed in this drop-down list. If necessary, the drop-down list can be used to select a different material property definition. Use the button to the right of the drop-down list to display the Define Materials form

and add or modify a material property definition. For Auto Select and Non prismatic sections, the materials are defined in the frame section definitions that comprise the Auto Select list and the Start and End sections used to specify the non-prismatic section, respectively.

◦**Encased Rectangle and Encased Circle shapes.** The Encasement Material can be specified using the drop-down list near the bottom of the form; clicking the button to the right of the drop-down list will display the Define Materials form so that a new material definition can be added to the model if needed. If the Material definition (shown in the Material display box at the top of the form) for the Embedded I-Section needs revision, first define an I-Section with the required steel material definition, and then select that I-section from the Embedded I-Section drop-down list.

◦BU I Cove Plate (Built-up I Section with Cover Plates) shape (i.e., built-up cover plate). Select the frame section using the I-Section Data drop-down list, or click the button to the right of the drop-down list to display the Frame Section Property Import Data form and import additional sections.

In addition, the yield stress for the top and bottom flange and the web can be overwritten.

Material definitions can be specified for the top and bottom cover plates by checking the Include Top Cover Plate and Include Bottom Cover Plate check boxes and then selecting a material definition from the Material drop-down list.

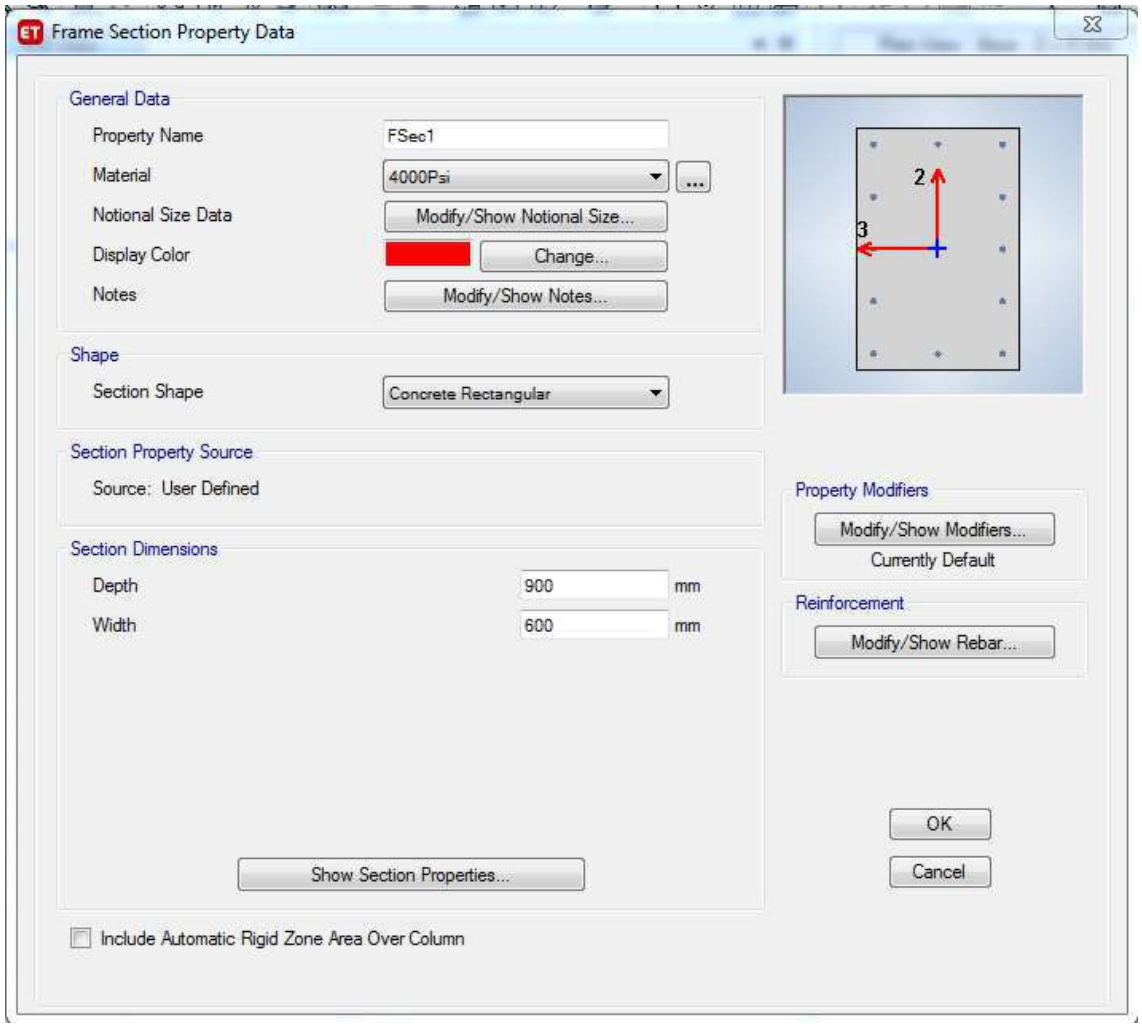

Figure: Frame Section Property Data form

- **Notional Size Data** - Modify/Show Notional Size button. Click this button to display the Time Dependent Parameters form and specify the notional size parameters for creep and shrinkage behavior.

- **Display Color** display box and Change button. The frame sections to which this section property definition is assigned will be shown using this display color. Click the Change button to display the Color form and specify a different color.

- **Section Property Source**: In most cases, the Section Property Source is User Defined because the Frame Section Property Data form is used to specify the section property data.

- **Section Dimensions**. The edit boxes in this area of the form are specific to the shape selected and are assumed to be self-explanatory. Type revised values in the edit boxes as necessary.

- **Show Elastic Section Properties** and **Show Section Properties** button. Depending on the shape, click one of these buttons to display the Frame Section Properties form. The data are defaults associated with built-in and imported section types, or the data are automatically calculated by ETABS on the basis of specified dimensions. The values are shown for review purposes only and cannot be edited unless the property definition is for a General section. Brief explanatory hover text displays when the mouse cursor is placed (not clicked) on a row in the Item column (left-hand side) of the form.

- Sketch display area. A sketch of the selected section shape is displayed.

- **Modify/Show Modifiers** button. Click this button to display the Property/Stiffness Modification Factors form. Use that form to specify the desired modification factors. Note that modification factors can be assigned here or alternatively directly to frame objects. Note that it is intended that the modification factors should be defined either here or as part of an assignment, but not both.

Used for Specific Shapes

- **Modify/Show Rebar** button. This button appears on the forms for Rectangular, Encased Rectangle, Encased Circle, Tee, and Angle shapes when the Material is concrete. Clicking the button displays the Frame Section Property Reinforcement Data form. Use the form to define the reinforcement for the shape.

Frame Section Property Reinforcement Data Form

When reinforcement is included in a section property definition (i.e., section properties are specified as rectangular, circular, T, Angle, encased rectangle, or encased circle concrete members), use the Frame Section Property Reinforcement Data form to also specify some of the reinforcing information for those members.

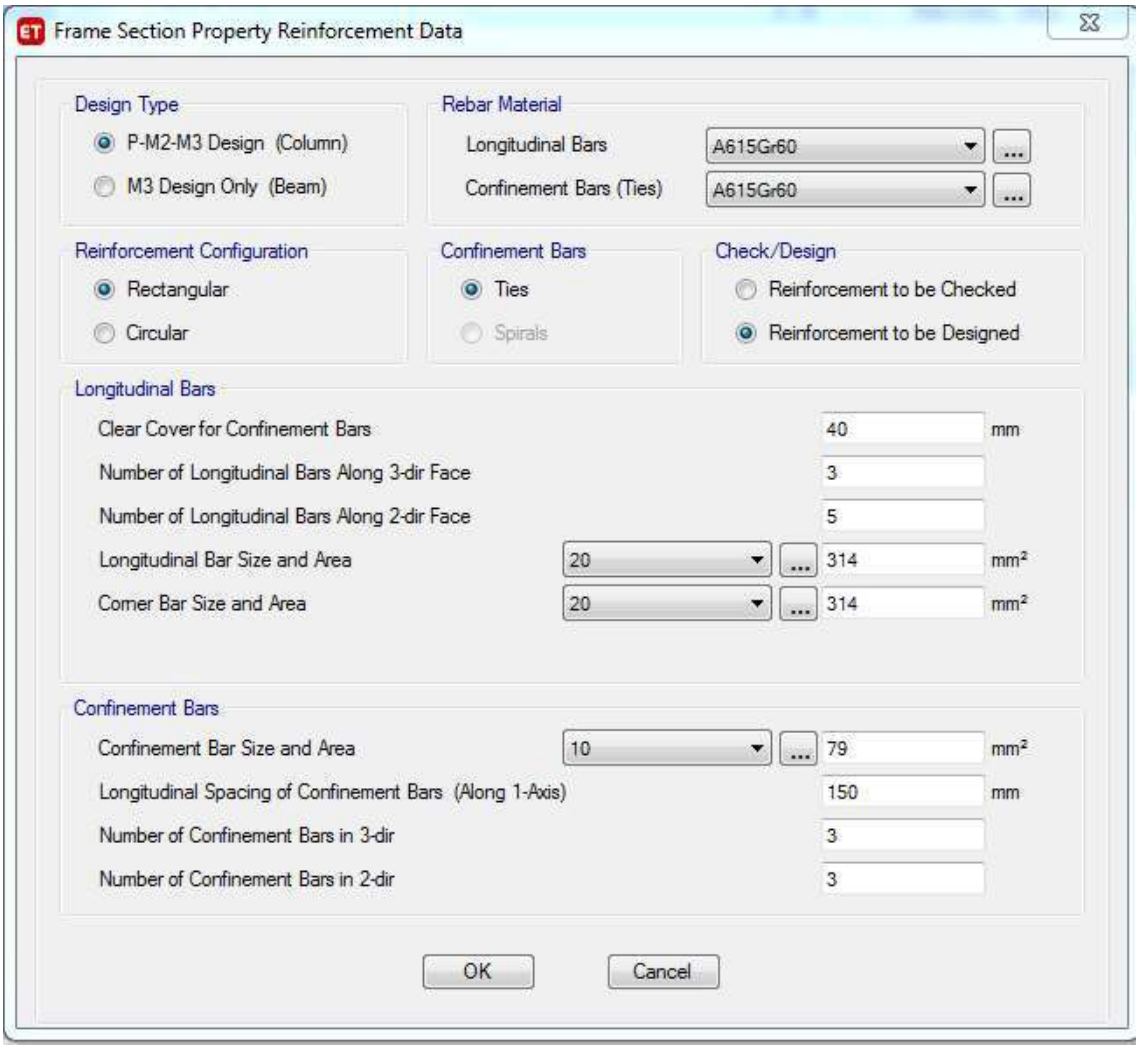

Figure: Frame Section Property Reinforcement Data Form

Rebar Material

On the right side of the form, this area is used to specify the material for the longitudinal and transverse steel.

- **Longitudinal Bars** drop-down list and **Confinement Bars (Ties)** drop-down list. The Material Property for the bars is shown in the drop-down list. Click the button to the right of the drop-down list to access the **Define Materials** form and define a new material property, if necessary.

Design Type

The options available and the parameters defined using this form depend on the Design Type selected.

- **P-M2-M3 Design (Column)** option. When this option is selected, the following parameters can be specified..

Reinforcement Configuration: (option only available for columns)

- **Rectangular** option. When this option is selected, certain entries in the longitudinal bars and confinement bars areas will become available.
- **Circular** options. When this option is selected, certain items in the longitudinal bars and confinement bars areas will NOT be available.

Longitudinal Bars

- **Clear Cover for Confinement Bars** edit box. This is the distance from the edge of the column to the outer face of the confinement bar. In the special case of rectangular reinforcement in a circular column, the cover is taken to be the minimum distance from the edge of the column to the confinement bar.
- **Number of Longitudinal Bars** edit boxes.
    - **3-dir Face:** This is the number of longitudinal reinforcing bars (including corner rebar) on the two faces of a rectangular column that are parallel to the local 3 axis of the section.
    - **2-dir Face:** This is the number of longitudinal reinforcing bars (including corner rebar) on the two faces of a rectangular column that are parallel to the local 2 axis of the section.
    - When a circular column is selected this entry is the total number of bars in the circular column.
- **Longitudinal Bar Size and Area** drop-down list and edit box. This is the specified size of reinforcing steel for the section. Only one bar size can be specified for a given concrete frame section property.
- **Corner Bar Size and Area** drop-down list and edit box. Use these options to specify the rebar at the corners of the section separately.

Confinement Bars

- **Confinement Bar Size and Area** drop-down list and edit box. This is the specified size of confinement reinforcing steel for the section. Only one confinement bar size can be specified for a given concrete frame section property.
- **Longitudinal Spacing of Confinement Bars (Along 1-Axis)** edit box. Use the default or specify another value for the spacing of the confinement bars.
- **Number of Confinement Bars** edit boxes (only available for rectangular columns).
    - **3-dir:** This is the number of confinement reinforcing bars in a rectangular column that run parallel to the local 3 axis of the section.
    - **2-dir:** This is the number of confinement reinforcing bars in a rectangular column that run parallel to the local 2 axis of the section.

Cover to Longitudinal Rebar Group Centroid: (only available for M3 Design Only - Beams)

Specify rebar cover at the top and bottom of the beam. The **Top** cover is measured from the top of the beam to the centroid of the top longitudinal reinforcing. The **Bottom** cover is measured from the bottom of the beam to the centroid of the bottom longitudinal reinforcing.

Reinforcement Area Overwrites for Ductile Beams: (only available for M3 Design Only - Beams)

Specify areas of longitudinal reinforcing steel that occur at the top and bottom of the left and right ends of the beam. These overwrites are used by the Concrete Frame Design postprocessor as follows:

- When the design shear in a concrete beam is to be based on provided longitudinal reinforcement (that is, the shear design is based on the moment capacity of the beam), ETABS compares the calculated required reinforcement with that specified in the reinforcement overwrites and uses the larger value to determine the moment capacity on which the shear design is based.
- When the minimum reinforcement in the middle of a beam is to be based on some percentage of the reinforcing at the ends of the beam, ETABS compares the calculated required reinforcement at the ends of the a beam with that specified in the reinforcement overwrites and uses the larger value to determine the minimum reinforcement in the middle of the beam.
- When the shear design of columns is to be based on the maximum moment that the beams can deliver to the columns, ETABS compares the calculated required reinforcement with that specified in the reinforcement overwrites and uses the larger value to determine the moment capacity of the beam.

  For any degree of freedom in the frame nonlinear hinge properties assigned to a concrete member that is specified as default, ETABS calculates the hinge force-deformation properties based on the larger of the calculated required reinforcement at the ends of the beam (assuming that the design has been run through the Concrete Frame Design postprocessor) and the specified reinforcement overwrites.

▪ **Mirror about Local 2 Axis / Local 3 Axis** checkboxes. A check box to create a duplicate of the specified shape appears on the forms for Channel, T, Angle, Double Angle, and Cold Formed C, Z, and Hat shapes. With the exception of the Angle shape, the duplicate is oriented relative to the local 2-axis. For the Angle shape, the mirroring is specified about the Local 2 and 3 axes.

▪ **Include Automatic Rigid Zone Area Over Column** - check box. Check the box to add a rigid slab element over the column(s) assigned this frame section property, which prevents deformation of the slab at the column location. The design of the slab is undertaken at the face of the column rather than at the column centerline, which typically results in more appropriate and representative design forces. Design is not performed for the rigid zone element, and the bending properties assigned are one-hundred times stiffer than the surrounding slab property.

3. Add Copy of Property button

a. Highlight an existing property definition in the *Properties* display area on the left-hand side of the form.

b. Click the Add Copy of Property button to display the Frame Section Property Data form; use the form to add a new property definition to the model file based on the originally selected section definition.

4. Add Modify/Show Property button.

1. Highlight an existing property definition in the *Properties* display area on the left-hand side of the form
2. Click the Modify Show Property button to display the Frame Section Property Data form and review or modify the selected definition without adding a new definition to the model file.

5. Delete Property button

1. Highlight an existing property definition in the *Properties* display area on the left-hand side of the form
2. Click the Delete button to delete the selected definition from the model file. The definition is **not** deleted from the database of section shapes so it can be reloaded into the model file using the Import New Properties button as described above.

6. Delete Multiple Properties button

Click this button to display the Delete Multiple Frame Section Properties form. Use the *Type* drop-down list and the *Filter* edit box to quickly identify those section definitions that can be deleted from the model file. Highlight the properties to be deleted and click the Delete Selected Frame Sections button. Similar to the preceding explanation, the selected definitions are **not** deleted from the database of section shapes so they can be reloaded into the model file using the Import New Properties button as described above.

7. Export to XML File button

Click this button to display the Frame property Export to XML File form. Use that form to select the sections and Auto Select lists to be exported to an XML file. This program feature is valuable when sections or Auto Select lists have been created in one model file and the same sections or Auto Select lists need to be reused (imported) in another model file.

SLAB SECTIONS

Use the Define menu > Section Properties > Slab Sections command to add a new slab property definition; modify or review an existing definition; or delete a property definition.

Note: The Slab Properties form also displays when the Modify/Show Definitions button is clicked on the Shell Assignment - Slab Section form.

1. Click the Define menu > Section Properties > Slab Sections command to access the Slab Properties form. Use the buttons on the form to perform the appropriate action.
   - **Add New Property button.** Click this button to access the Slab Property Data form. Use the various edit boxes, check boxes, and drop-down lists to define the parameters for the slab section.

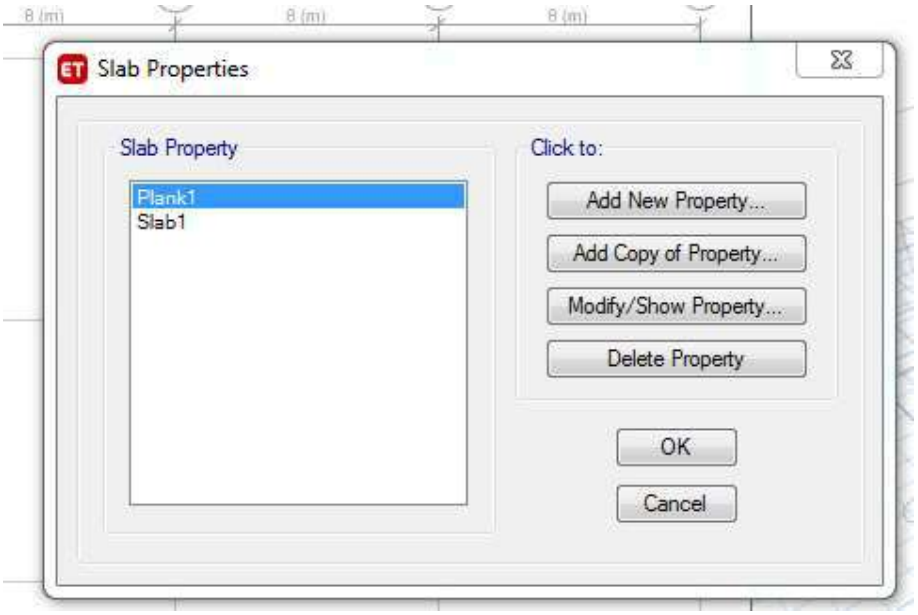

Figure: Slab Properties form

Use the Slab Property Data form to specify a name for the slab property definition, the material, the type of property, any stiffness modifiers, the display color, the geometry, and other parameters.

Note: ETABS has built-in default shell object properties for a SLAB1 definition. Additional definitions can be added and those definitions can be modified. Definitions can be deleted. However, at least one slab property definition must exist, even if it is never assigned to anything.

General Data

- **Property Name** edit box. Use the default or specify another name for the slab section definition. Note that section names must be unique.
- **Slab Material** drop-down list. Choose the material property for the slab from the drop-down list of defined material properties. Or use the button to the right of the drop-down list to display the Define Materials form and add a new material definition (or modify an existing definition).
- **Notional Size Data** - Modify/Show Notional Size button. Click this button to display the Time Dependent Parameters form and specify the notional size parameters for creep and shrinkage behavior.
- **Modeling Type** drop-down list. A slab section can have shell-thin, shell-thick, or membrane behavior.
- Modify/Show Layered Slab Data
- **Modifiers (Currently Default)** - Modify/Show button.Click this button to display the Property/Stiffness Modification Factors form. Use that form to specify the stiffnesses, mass, and weight for the property definition.
- **Display Color** and Change button. The color displayed will be used to indicate the area objects to which this slab definition has been assigned. Click the Change button to display the Color form and select a different color for this definition.

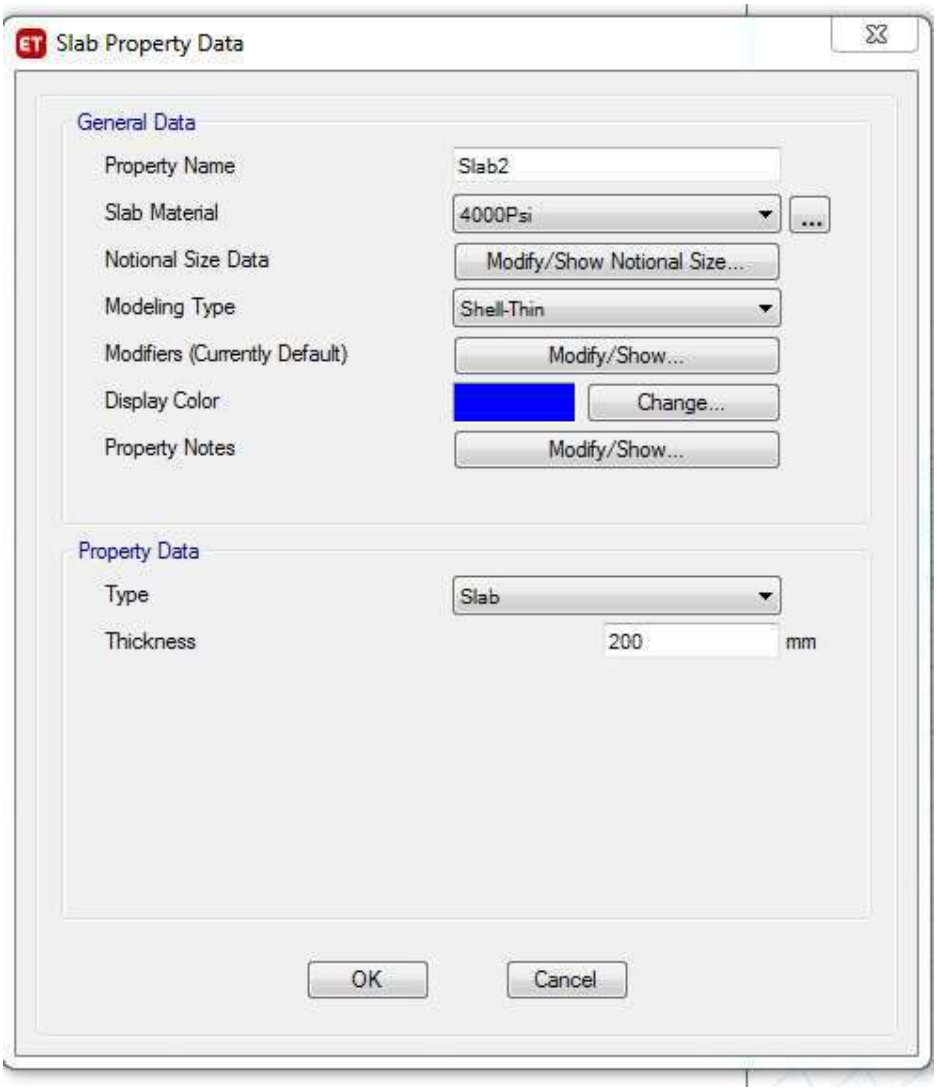

Figure: Slab Property Data form

Property Data

- **Type** drop-down list. Choose the type of slab: slab, drop, ribbed, or waffle. The option selected determines the other parameters required.
  - **Slab** -- Use the default uniform thickness for the slab or specify another by typing directly in the edit box.
  - **Drop** -- Use the default thickness for the drop slab or specify another by typing directly in the edit box.
  - **Stiff** -- Use the default thickness for the stiff slab or specify another by typing directly in the edit box. This slab is used to model rigid zones over columns and walls. Design is not performed for the stiff slab, and the bending properties assigned are one-hundred times stiffer than those calculated based on the specified thickness.
  - **Ribbed** -- Specify the overall depth,the slab thickness, the width of the stem top and bottom, the rib spacing perpendicular to the rib direction, and the direction of the ribbing parallel to a specified local axis.

- **Waffle** -- Specify the overall depth, the slab thickness, the width of the stem top and bottom, and the spacing of the ribs parallel to the slab 1 axis and the spacing of the ribs parallel to slab-2 axis.

- **Add Copy of Property button**

1. Highlight a property name in the Slab Property area of the form.
2. Click the Add Copy of Property button to display the Slab Property Data form and add a new definition to the model file based on the selected property definition.

- **Modify/Show Property button**

1. Highlight a section name in the *Slab Property* area of the form.
2. Click the Modify/Show Property button to display the Slab Property Data form and review/modify the selected property definition without adding a new definition to the model file.

- **Delete Property button**

1. Highlight a definition name in the *Slab Property* area of the form.
2. Click the Delete Property button to remove the selected property definition from the model file.