STRUCTURAL CONCRETE SOFTWARE SYSTEM

ADAPT-Builder® 20

NEW FEATURES SUPPLEMENTAL MANUAL

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CONTENTS

1 Introduction

This supplemental manual provides descriptions and instruction on ADAPT-Builder's latest features. These new features have been introduced to meet the needs for general analysis, design, and reporting capabilities and to increase productivity and efficiency in program use.

These latest features can be categorized into 3 groups: Analysis and Design improvements, Modeling improvements and Reporting improvements.

1.1 Analysis and Design Improvements

New Design Codes – ACI318-2019: The program has been updated to include applicable provisions from ACI318-19: Building Code Requirements for Structural Concrete

Concrete Rupture Modulus: ADAPT-Builder 20 now includes the option for the user to over-ride the program default and user define the modulus of rupture (flexural tension cracking stress) for cracked deflection of reinforced concrete and post-tensioned slabs and beams.

Punching Shear for Two-Way Slabs: Design for two-way shear has been improved in the program These improvements are part of a phased approach for Builder. Additional improvements will continue to be added in upcoming releases. Graphical reporting improvements for punching shear are included in later sections in this document.

Performance: Multicore functionality has been improved and extended ADAPT-Builder's frame solver.

Load Combinations: The program has been improved to retain user-defined load combinations after selecting a different design code.

1.2 Modeling Improvements

Property Grids: A dockable property grid has been included for efficient control and modification of properties, parameters and other inputs related to modeled components as single- or multiple-selected entities. The property grid is intended to replace single modifications made in individual component property dialogues or through use of Modify>Modify Selection. However, these legacy options remain in ADAPT-Builder 20.

Colorization: A dockable user interface of colorization is included and located at the bottom of the property grid interface. The colorize controls can be used to

visually inspect the model components by properties, material assignments and other sortable parameters.

Support Line Dynamic Editor Improvements: New options have been added for control of column and middle strip creation for RC and PT usability modes.

1.3 Reporting Improvements

Compiled Report Generation: A settings option has been added to pre-define report settings that previously had required the report option to be opened and set up before producing a compiled report.

One-Way Shear Results in Graphical Display: For models including beams and one-way slabs requiring shear reinforcement, new graphical options have been added to **Result Display Settings** for shear demand, capacity, utilization, shear reinforcement.

Punching Shear in Graphical Display: The graphical punching shear checks from **Result Display Settings>Analysis>Two-Way Shear** now includes the following enhancements:

- The governing load combination for the Strength envelope and the governing critical section (layer) for envelope or single-selected strength combinations when the option for **Stress Ratio** is selected.
- The effective depth for the 1st critical section (layer) is reported when **Condition** is selected.

Idealized Section Integrity Check: A new graphical option that checks the geometric and section property integrity of an idealized to a physical design section has been included in **Result Display Settings>Analysis>Investigation.**

The following chapters will provide a detailed overview of the new improvements, as needed, and describe their use and application. Where appropriate, theoretical and/or design code background will be added.

2 Analysis and Design Improvements

2.1 New Design Codes – ACI 318-2019

The program has been updated to include applicable provisions from ACI318-19: Building Code Requirements for Structural Concrete. Those provisions in the latest design standard that have been included in ADAPT-Builder include:

- Reinforcement strain limit has been revised for all criteria and system types (beam, one-way and two-way slabs for RC and PT mode).

  ACI 318-19, 7.3.3.1 states that non-prestressed slabs shall be tension-controlled in accordance with Table 21.2.2.

  ACI 318-14 stated that for non-prestressed slabs, εt, shall be at least 0.004.

- Minimum flexural reinforcement for non-prestressed, reinforced one- and two-way slabs shall meet a minimum area of flexural reinforcement of 0.0018Ag. See ACI318-19, 7.6.1.1.

- For two-way non-prestressed, reinforced concrete slabs the equation for modulus of rupture is modified for f_y exceeding 80,000 psi. ACI 318-19, 8.3.1.1 states that for fy exceeding 80,000 psi, the calculated deflection limits in 8.3.2 shall be satisfied assuming a reduced modulus of rupture, fr = 5*f'c^1/2. This change applies to cracked deflection calculations in the program where fr is used to calculate cracking moments, Mcr. A new option for user-defined fr value is described later in this document.

- Minimum extensions for deformed reinforcement were revised per ACI 318-19, Figure 8.7.4.1.3 for deformed reinforcement in two-way slabs without beams such that the 50% of column strip top reinforcement shall be as defined in ACI 318-14, but not less than 5d where d is the distance from the extreme compression fiber to centroid of longitudinal tension reinforcement. The algorithm for bar curtailment in BuilderSum was adjusted. In case code ACI 2019 and curtailment rules is ACI, top bar curtailment is extended to 5*D.

- The reinforcement strain limit for beams was revised per ACI 318-19, 9.3.3.1. This section states that "Non-prestressed beams with Pu < 0.10(f'cAg) shall be tension-controlled in accordance with Table 21.2.2."

- For the calculation of the minimum flexural reinforcement amount for beams with fy exceeding 80,000 psi, ACI 318-19, 9.6.1.2 states that the value of fy shall be limited to a maximum of 80,000 psi.

Table 9.7.6.2.2—Maximum spacing of legs of shear reinforcement

Required V_s		Maximum s, mm			
		Nonprestressed beam		Prestressed beam	
		Along length	Across width	Along length	Across width
$\le 0.33\sqrt{f'_c}b_w d$	Lesser of:	$d/2$	d	$3h/4$	$3h/2$
		600			
$> 0.33\sqrt{f'_c}b_w d$	Lesser of:	$d/4$	$d/2$	$3h/8$	$3h/4$
		300			

- One-way shear strength provisions for non-prestressed members in relation with Vc for non-prestressed members have been modified per ACI 318-19, 22.5.5.1. This section states that for non-prestressed members, Vc shall be calculated by Table 22.5.5.1 and sections 22.5.5.1.1 through 22.5.5.1.3.

Table 22.5.5.1—V_c for nonprestressed members

Criteria	V_c		
$A_v \ge A_{v,min}$	Either of:	$\left[0.17\lambda\sqrt{f'_c}+\frac{N_u}{6A_g}\right]b_w d$	(a)
		$\left[0.66\lambda(\rho_w)^{1/3}\sqrt{f'_c}+\frac{N_u}{6A_g}\right]b_w d$	(b)
$A_v < A_{v,min}$	$\left[0.66\lambda_s\lambda(\rho_w)^{1/3}\sqrt{f'_c}+\frac{N_u}{6A_g}\right]b_w d$		(c)

Notes:
1. Axial load, N_u, is positive for compression and negative for tension.
2. V_c shall not be taken less than zero.

The new Table 22.5.5.1 introduces a criterion for Av and Av,min, that results in a set of equations to calculate Vc.

- ACI 318-19, 22.5.5.1.1 states Vc shall not be great than 5*f'c^0.5*bw*d.
- ACI 318-19, 22.5.5.1.2 states that the value of Nu / 6*Ag shall not be taken greater than 0.05 f'c.
- ACI 318-19, 22.5.5.1.3 introduces a new size modification factor to be included when Av<Av,min.

$$\lambda_s = \sqrt{\frac{2}{1+\frac{d}{10}}} \le 1$$

- The requirements for Av,min for non-prestressed and prestressed beams are given in ACI318-19, 9.6.3.1 and 9.6.3.2. The provisions have changed from older version of the code. The program has been modified to include the provisions found below for non-prestressed beams.

9.6.3.1 For nonprestressed beams, minimum area of shear reinforcement, $A_{v,min}$, shall be provided in all regions where $V_u > \phi\lambda\sqrt{f'_c}\,b_w d$ except for the cases in Table 9.6.3.1. For these cases, at least $A_{v,min}$ shall be provided where $V_u > \phi V_c$.

Table 9.6.3.1—Cases where $A_{v,min}$ is not required if $V_u \le \phi V_c$

Beam type	Conditions
Shallow depth	$h \le 10$ in.
Integral with slab	$h \le$ greater of $2.5t_f$ or $0.5b_w$ and $h \le 24$ in.
Constructed with steel fiber-reinforced normalweight concrete conforming to 26.4.1.5.1(a), 26.4.2.2(i), and 26.12.7.1(a) and with $f'_c \le 6000$ psi	$h \le 24$ in. and $V_u \le \phi 2\sqrt{f'_c}\,b_w d$
One-way joist system	In accordance with 9.8

For prestressed beams they are as follows:

9.6.3.2 For prestressed beams, a minimum area of shear reinforcement, $A_{v,min}$, shall be provided in all regions where $V_u > 0.5\phi V_c$ except for the cases in Table 9.6.3.1. For these cases, at least $A_{v,min}$ shall be provided where $V_u > \phi V_c$.

The calculation for minimum shear reinforcement Av,min remain similar to previous code editions and are as follows:

Table 9.6.3.4—Required $A_{v,min}$

Beam type	$A_{v,min}/s$		
Nonprestressed and prestressed with $A_{ps}f_{se} < 0.4(A_{ps}f_{pu} + A_s f_y)$	Greater of:	$0.75\sqrt{f'_c}\frac{b_w}{f_{yt}}$	(a)
		$50\frac{b_w}{f_{yt}}$	(b)
Prestressed with $A_{ps}f_{se} \geq 0.4(A_{ps}f_{pu} + A_s f_y)$	Lesser of:	Greater of: $0.75\sqrt{f'_c}\frac{b_w}{f_{yt}}$	(c)
		Greater of: $50\frac{b_w}{f_{yt}}$	(d)
		$\frac{A_{ps}f_{pu}}{80 f_{yt} d}\sqrt{\frac{d}{b_w}}$	(e)

- The calculation of Vc for prestressed members has been modified for those members where the full effective prestress force has been transferred to concrete. ACI318-19, 22.5.6.2 in now considered as shown below.

22.5.6.2 For prestressed flexural members with $A_{ps}f_{se} \geq 0.4(A_{ps}f_{pu} + A_s f_y)$, V_c shall be calculated in accordance with Table 22.5.6.2, but need not be less than $2\lambda\sqrt{f'_c}\, b_w d$. Alternatively, it shall be permitted to calculate V_c in accordance with 22.5.6.3.

Table 22.5.6.2—Approximate method for calculating V_c

	V_c	
Least of (a), (b), and (c):	$\left(0.6\lambda_s\sqrt{f'_c} + 700\frac{V_u d_p}{M_u}\right)b_w d$ [1],[2]	(a)
	$(0.6\lambda_s\sqrt{f'_c} + 700)b_w d$	(b)
	$5\lambda_s\sqrt{f'_c}\, b_w d$	(c)

[1] M_u occurs simultaneously with V_u at the section considered.

[2] When calculating the $V_u d_p/M_u$ term in Eq. 22.5.6.2(a), d_p is the distance from the extreme compression fiber to the centroid of prestressed reinforcement. It shall not be permitted to take d_p as $0.80h$ as in 22.5.2.1.

- For two-way shear of slabs, a new size effect factor, λ_s is introduced in the allowable concrete shear stress, Vc, without shear reinforcement. ACI 318-19, Table 22.6.5.2 now incorporates the size effect factor, λ_s in equations (a), (b), and (c).

Table 22.6.5.2—v_c for two-way members without shear reinforcement

v_c		
Least of (a), (b), and (c):	$4\lambda_s\lambda\sqrt{f'_c}$	(a)
	$\left(2+\frac{4}{\beta}\right)\lambda_s\lambda\sqrt{f'_c}$	(b)
	$\left(2+\frac{\alpha_s d}{b_o}\right)\lambda_s\lambda\sqrt{f'_c}$	(c)

Notes:
(i) λ_s is the size effect factor given in 22.5.5.1.3.
(ii) β is the ratio of long to short sides of the column, concentrated load, or reaction area.
(iii) α_s is given in 22.6.5.3.

This change accounts for the impact of depth effects on two-way shear capacity of concrete without shear reinforcement. For slabs over 10" in depth, the calculation of Vc will be reduced as compared to previous code versions. The size factor is the same as introduced above in the one-way shear modifications.

$$\lambda_s = \sqrt{\frac{2}{1+\frac{d}{10}}} \leq 1$$

- For the check of cracked deflections at service level conditions, the effective moment of inertia, I_e equations have been revised for non-prestressed members.

  ACI 318-19, 24.2.3.5 states that for non-prestressed members, unless obtained by a more comprehensive analysis, effective moment of inertia (Ie) shall be calculated in accordance with Table 24.2.3.5.

$$M_{cr} = \frac{f_r I_g}{y_t} \qquad (24.2.3.5)$$

Table 24.2.3.5—Effective moment of inertia, I_e

Service moment	Effective moment of inertia, I_e, in.^{4}	
$M_a \le (2/3)M_{cr}$	I_g	(a)
$M_a > (2/3)M_{cr}$	$\dfrac{I_{cr}}{1-\left(\dfrac{(2/3)M_{cr}}{M_a}\right)^2\left(1-\dfrac{I_{cr}}{I_g}\right)}$	(b)

In ACI 318-19, R24.2.3.5, the effective moment of inertia approximation developed by Bischoff and Scanlon is adopted and Branson equation (ACI 318-14, Eq. 24.2.3.5a) is removed from ACI 318-19.

For prestressed members, the provisions found in ACI318-14 continue to apply and are described in ACI318-19, 24.2.3.9.

24.2.3.9 For prestressed Class T and Class C slabs and beams as defined in 24.5.2, deflection calculations shall be based on a cracked transformed section analysis. It shall be permitted to base deflection calculations on a bilinear moment-deflection relationship or I_e in accordance with Eq. (24.2.3.9a)

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1-\left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \qquad (24.2.3.9a)$$

where M_{cr} is calculated as

$$M_{cr} = \frac{(f_r + f_{pe})I_g}{y_t} \qquad (24.2.3.9b)$$

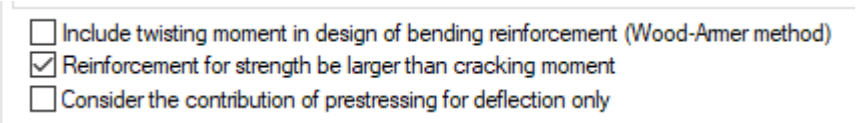
2.2 Concrete Rupture Modulus

ADAPT-Builder 20 now includes the option for the user to over-ride the program default and user define the modulus of rupture (flexural tension cracking stress) for cracked deflection of reinforced concrete and post-tensioned slabs and beams. In the Criteria>Concrete dialogue menu, concrete material properties include a new section for Modulus of rupture.

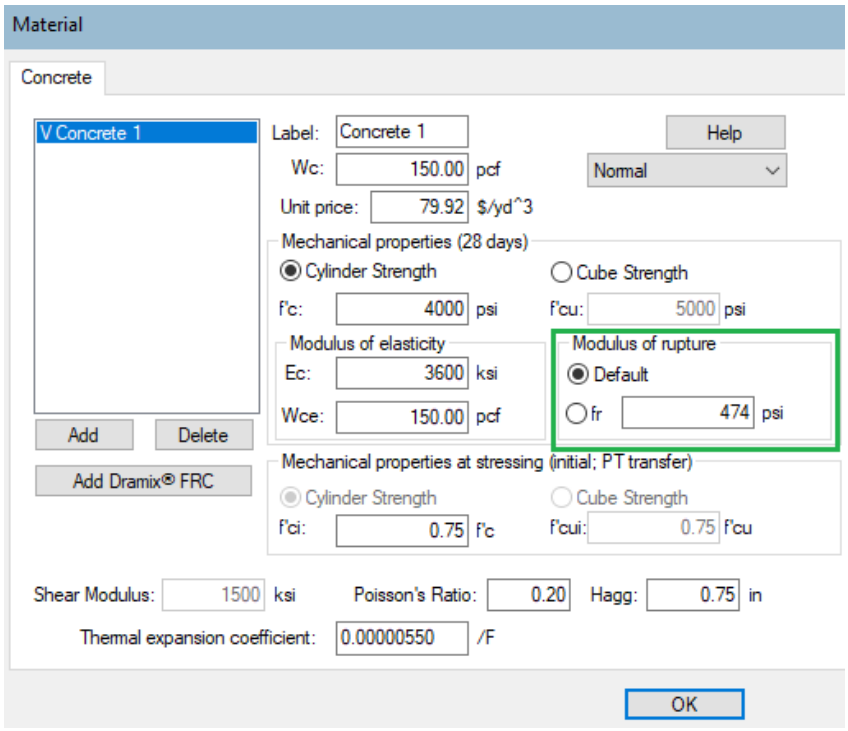
The value entered here for ‘fr’ is used in two areas of the program.

- When calculating the cracking moment, Mcr as defined in the sections above for calculation of Ieff when cracked deflection calculations are considered in the software.

- In ACI318 strength reinforcement for bonded prestressed systems should exceed 1.2*Mcr. If this option is selected, as shown below, from Criteria>Analysis/Design Options the program calculates the cracking moments, Mcr based on the defined modulus of rupture assigned to the concrete in question. In the case where a design section intersects multiple regions with different concrete assignments, the program uses the properties associated with the concrete material having the lowest value for compressive strength, f’c.



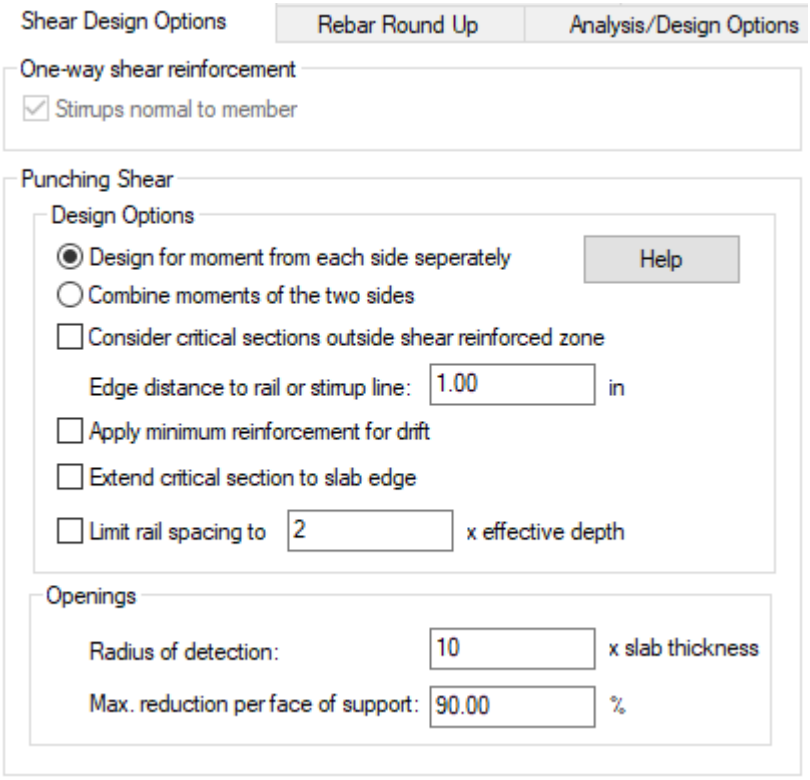
Note that the program does not adjust the user-defined input for concrete weight and the user-defined value should reflect any modifiers necessary to be applied to the rupture modulus.



2.3 Punching Shear for Two-Way Slabs

Design for two-way shear has been improved in the program in several ways that are described below. These improvements are part of a phased approach for Builder. Additional improvements will continue to be added in upcoming releases. Graphical reporting improvements for punching shear are included in later sections in this document.

- **Criteria reorganization** – The user dialogue for entering two-way shear criteria and design selections has been reorganized as shown in the image below. The option to select studs or stirrup reinforcement has been removed and is now defined by selecting the column/s and using the property grid. This is described below in more detail.

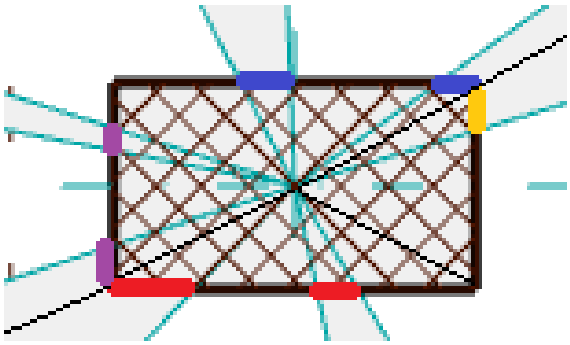


- **Recognition of openings –** In the current implementation, an opening in the vicinity of a column is treated the same as slab edge no matter of its size. If for example a small opening is close to a column, the whole side of a column is disregarded from the punching shear check, which is in some cases very conservative.

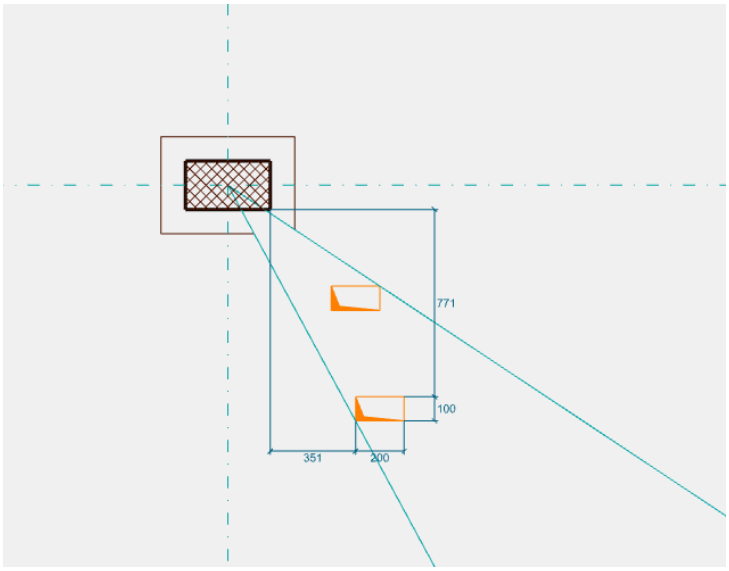
  The check for punching shear has been improved in the detection and handling of openings as per ACI code requirements. This new method for handling of openings is enabled only when an ACI code version is

selected. Two new input parameters are shown in the **Punching Shear** dialogue window shown above. These include:

- Radius of detection – This setting is used to determine at what distance from the face of support will openings be detected and deducted from the critical sections that fall within the opening. The input is based on a multiple of slab thickness. Any opening that is within or intersected by this imaginary boundary will be considered in the reduction of the critical perimeter.
- Max. reduction per face of support – This setting means that if the opening projection lines that intersect the column face are more than 90% of the column face (or user-defined value) that side will be considered as free edge. As an example, in the image below the lengths of the opening projection are shown in 4 different colors: Purple (-R side), Blue (+S side), Yellow (+R side), and Red (-S side). The opening projection rays are taken from the center of the column to the extreme outer corners of the opening. The lengths of intersection between the rays and column sides are compared. If the total sum of projection ray lengths exceed 90% of the column side dimension, the side is ignored in the punching shear check.



In the case where openings overlap with the projection ray region, the total region is combined as is shown in the image below. In this case, that portion of critical sections at layers moving away from the column face are deducted from the total critical section length.

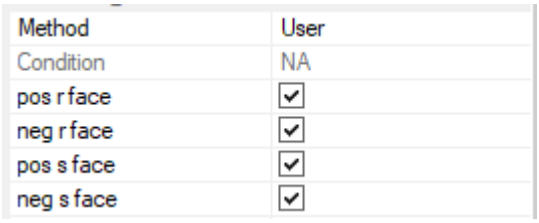


- **Punching shear parameters and input Property Grid –** When selecting columns or qualifying walls that are considered for the punching shear check, the program includes a section in the new Property Grid for Punching Shear analysis and design parameters. Note that the user can select a single column or multiple columns to modify the parameters. These are defined below.

Punching Shear	
Method	Auto
Condition	NA
Precompression	0.125 ksi
Reinforcement type	Studs
Stud diameter	0.375 in
Number of rails along r	2
Number of rails along s	2
Spacing of studs	Uniform
Reduction of critical se...	Auto
Total Angle	0.00 °

  - **Method** – Auto (default) or User. When **Auto** is selected the program automatically classifies the column as Interior (4-sided), End/Edge (3-sided), or Corner (2-sided) condition. If the distance from the column face to the free edge of slab is >4*slab thickness, the side is considered. If **User** is selected, additional user checkboxes are enabled for the positive and negative r and s local axis directions. The local R axis follows the global X direction, and the local S axis follows the global Y direction. If a box is selected the program considers that side as of the critical section. In essence, all 4 boxes selected is the same as an automatically defined Interior condition. This allows

the user to classify the column as they see fit rather than depending on the program auto-classifying for all columns.



- **Condition –** When the method is set to **Auto**, this reports the classification for the column as Interior, End/Edge, or Corner
- **Precompression –** Sets the default value used in the calculation of two-way concrete shear strength for prestressed slab conditions. The previous versions the program hard coded to 125psi. This allows the user to change that value for Fpc.
- **Reinforcement type** – Stud or stirrup
- **Stud or bar diameter –** Depending on the reinforcement type, this gives pull-down selection for stud diameters or bar sizes for stirrups.
- **Number of rails along r –** This specifies how many rails are assigned to the column r side. In previous versions this was hard coded for both sides so for rectangular columns where more rails were needed on the column long side, this setting was prohibitive. Note that the global setting for limiting the rail spacing to a multiple of the effective depth supersedes this value if more rails are needed.
- **Number of rails along s -** This specifies how many rails are assigned to the column s side. In previous versions this was hard coded for both sides so for rectangular columns where more rails were needed on the column long side, this setting was prohibitive. Note that the global setting for limiting the rail spacing to a multiple of the effective depth supersedes this value if more rails are needed.
- **Spacing of studs –** Only applies if **Stud** is selected as the reinforcement type with **Uniform** or **Calculated** selection options. If Uniform is selected, the program normalizes the spacing of studs to give the same spacing. **Calculated** gives the spacing in unique ranges with like spacing values. When **Uniform** is selected, the program uses the least spacing from the calculated outcome and applies this over the total rail length.

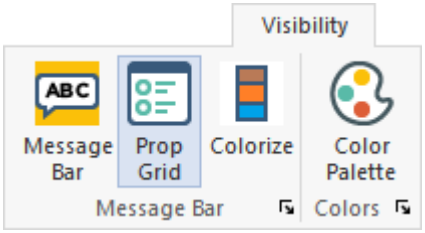
- **Reduction of critical section –** Always set as **Auto** and sets the program to check for openings in the vicinity of columns to reduce the critical section lengths.
- **Total angle –** Reports the total and all angles from the positive r local axis direction counterclockwise to the projection ray to the opening corners. These angles are used in determining the length of reduction for critical sections that pass through openings within the opening scan tolerance.

Total Angle	73.50 °
Angle 1	9.42, 45.00 °
Angle 2	45.00, 55.86 °
Angle 3	123.02, 135.00 °
Angle 4	135.00, 150.08 °

3 Modeling Improvements

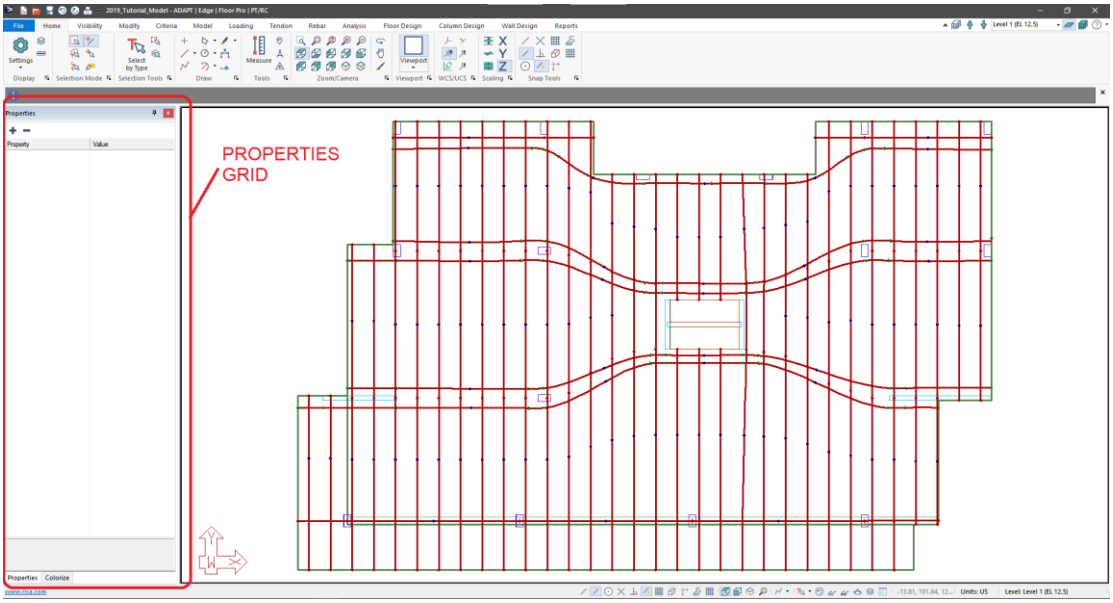
3.1 Properties Grid

The **Properties Grid** is a new improvement to the user-interface for the release of **ADAPT-Builder 20**. The **Properties Grid** is a docked window, that facilitates user efficiency when modifying a single component or a selection of components. In addition, the user can use the property grid to filter-select components. The **Properties Grid** is open by default but can be made active or inactive by going to *Visibility →Message Bar* and clicking the **Prop Grid** icon shown highlighted below.



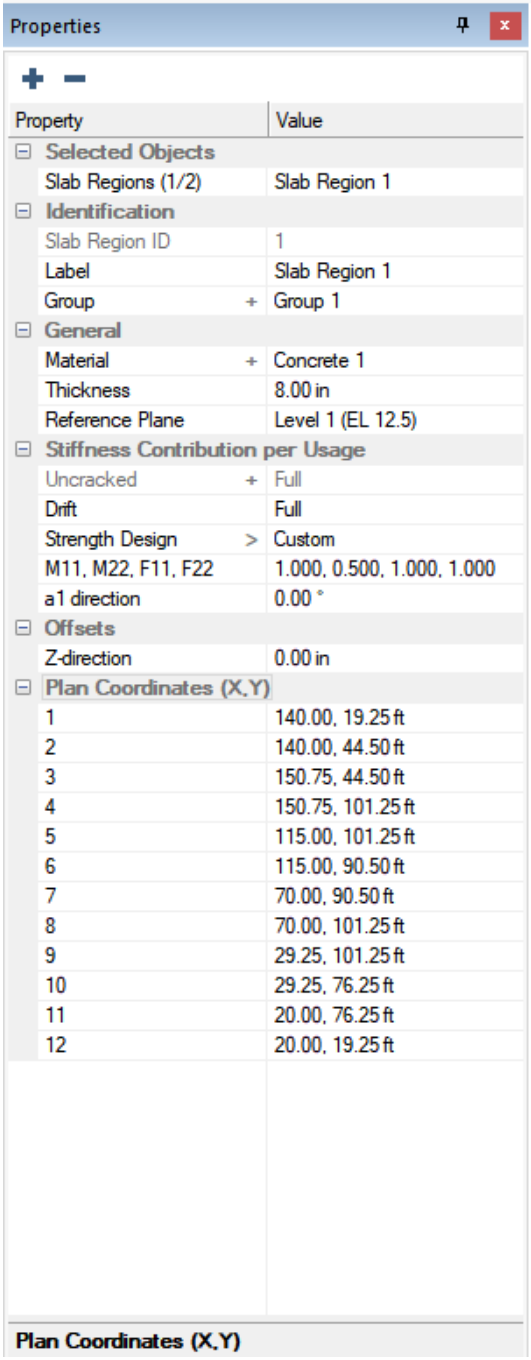
3.1.1 Interface

In **ADAPT-Builder 20** the new **Properties Grid,** by default, opens on the left side of the user interface as shown below. The user can dock this window on any side of the modeling interface or allow it to float on screen.

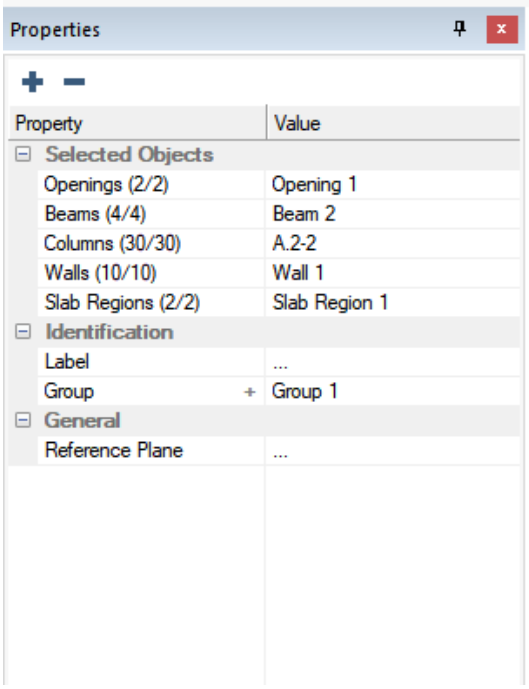


As the user selects components on the screen the two columns within this window pane will populate with like criteria of the component(s)

you selected. If the user selects only one component all properties for that component will be available. If the user selects multiple components the list will populate with the properties that are similar between the selected components.



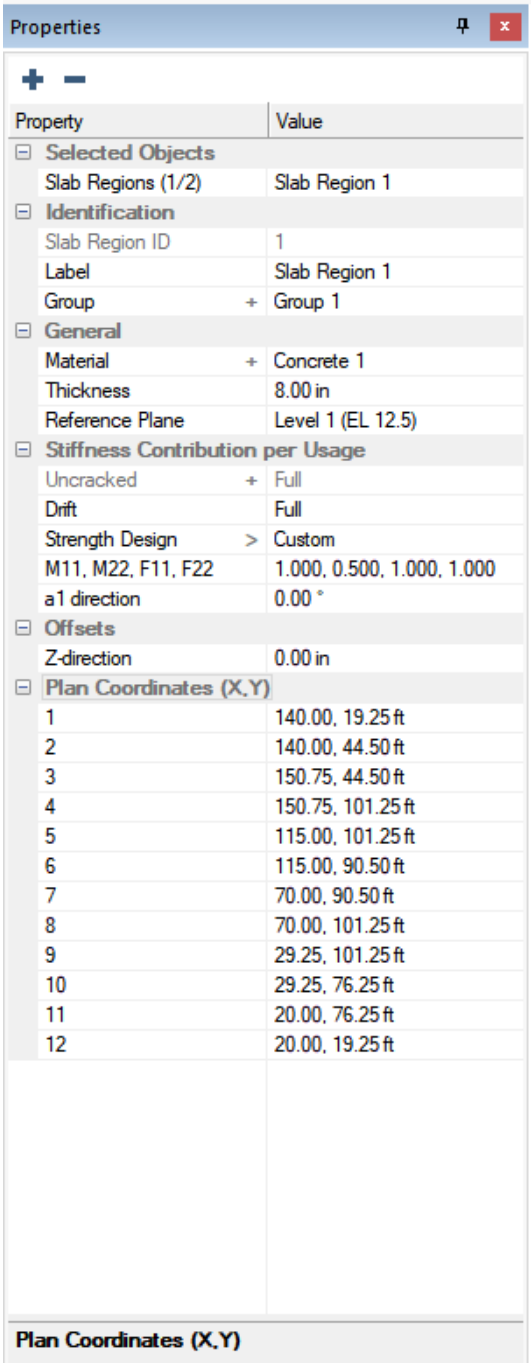
Single-Selection View



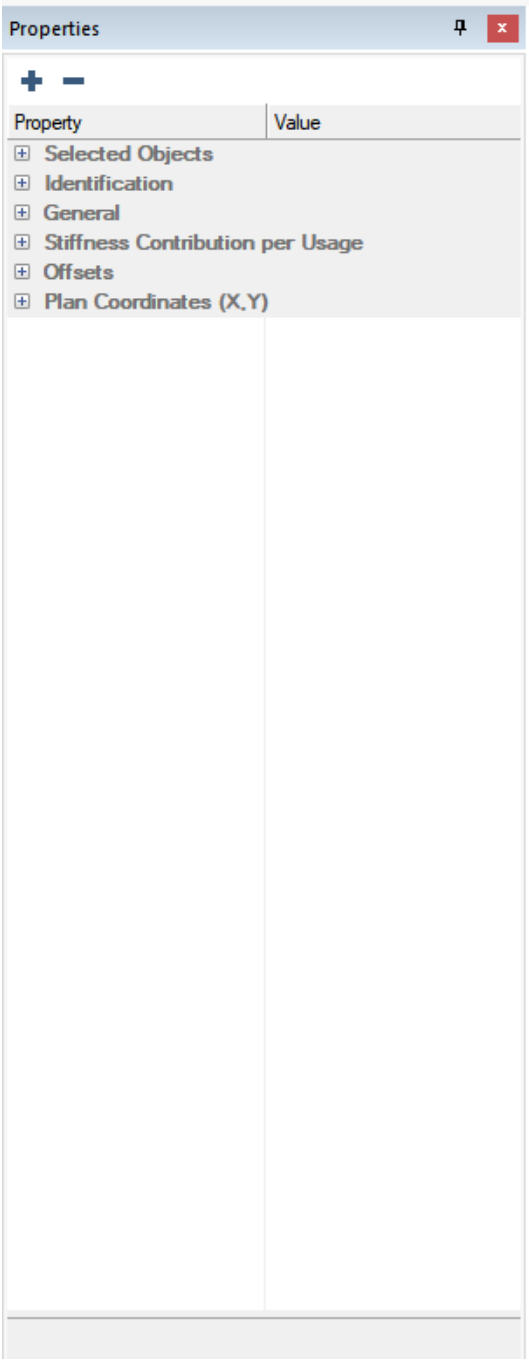
Multi-Selection View

The **Properties Grid** consists of two columns of information as shown in the previous figures. The left column is titled *Property* and lists available properties of the component from within the **Properties Grid**. The right column is titled *Value* and lists the value assigned to that property. Note that some of the properties within the **Properties Grid** are specific to the **Properties Grid** and cannot be found in the component's properties window. Examples of these are the *Punching Shear* category when columns are selected and *Beam Design Criteria* when support lines are selected.

The properties within the grid are listed within categories. The user can expand and collapse the categories to hide or show specific properties. At the top of the **Properties Grid** window we can see two icons, the *Expand All* icon and the *Collapse All* icon. The *Expand All* icon will expand all categories within the **Properties Grid**. The *Collapse All* icon conversely, will allow the user to collapse all the categories shown in the **Properties Grid**.



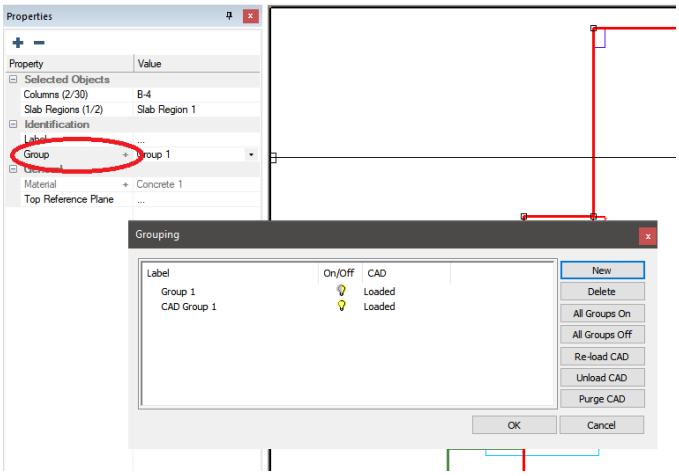
Properties Grid with All Categories Expanded



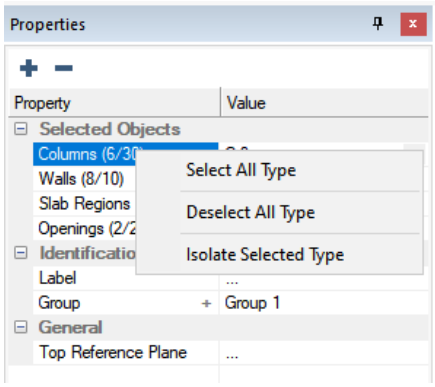
Properties Grid with All Categories Collapsed

3.1.2 Property Column

The *Property* column of the **Properties Grid** lists the properties whose values can be modified by the user through this interface. If a property that can be selected is defined by the user in another location of the software, a shortcut to the window where the property is defined is provided within the *Property* column of the **Properties Grid**. The shortcut is denoted by a + icon to the right of the property name. The + denotes that the user may click on the cell of this property, in the *Property* column, and the program will open the dialog window for defining the clicked-on property. An example can be seen in the following screenshot. The user clicked on the Group cell of the property window (highlighted in red) and the program opened the Grouping window where a user can define new groups.



Another useful option that can be found in the *Property* column of the **Properties Grid** is the ability to filter-select components. The user can right-click on a selected component type in the *Selected Option* category to get a list of right-click options.



The user can *Select All Type, Deselect All Type, and Isolate Selected Type.* The *Select All Type* option will select all the given type of the

components visible on screen. The *Deselect All Type* option will remove the given type of components from the current selection set. The *Isolate Selected Type* option will remove all other components not in the given type from the selection set.

3.1.3 Value Column

The right column within the **Property Grid** is titled *Value*. This column displays the value assigned to the property. The component is updated on-the-fly when the property is modified by the user. The user can also define the properties of a component they are modeling in this pane during the modeling procedure.

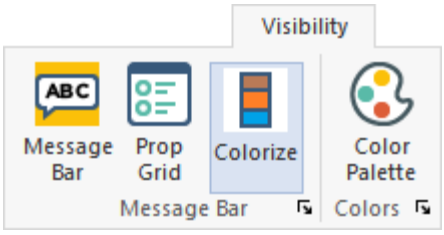
If the user has selected multiple components with a similar property, the *Value* column will either show, (a) the value of the currently selected components property if all the selected components have the same value for that property or, (b) the program will show three dots (…) representing that the value is different between the selected components. The user can then click the three dots and enter a new value if they want the property to be the same value across all selected components.

3.1.4 Description Pane

The *Description Pane* is located at the bottom of the **Properties Grid** window. When a user clicks on a property in either the *Property* or *Value* column the program will display, in the *Description Pane,* a detailed description of the selected property.

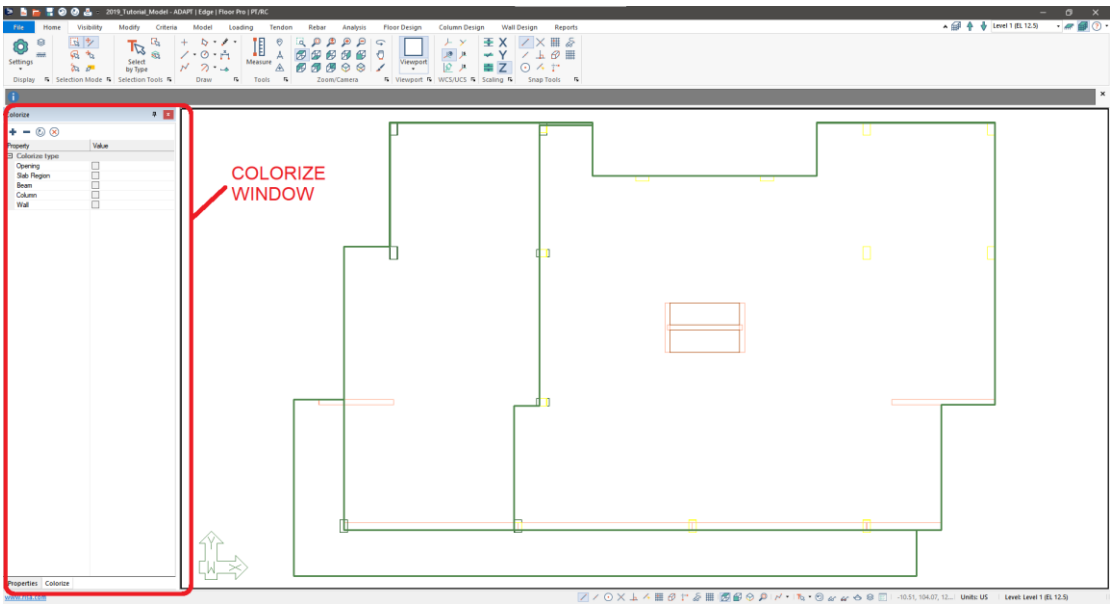
3.2 Colorize Option

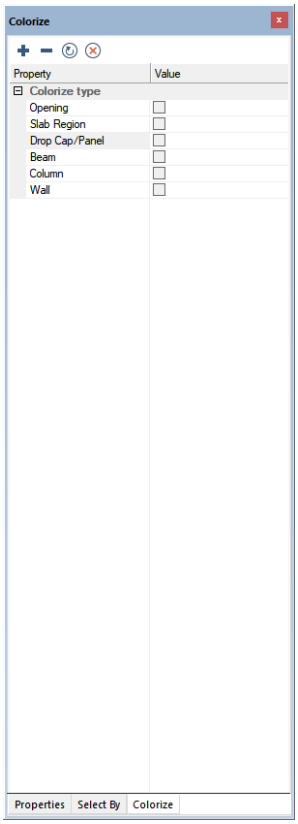
In addition to the **Properties Grid, ADAPT-Builder 20** includes a new **Colorize** option that can be used to visually inspect the model components by property. The **Colorize** window is a docked window, that colorizes user selected components based on user selected properties. In addition, the user can use the **Colorize** dialog window to filter-select components. The **Colorize** window is open by default as a tab in the docked left panel, however, it can be made active or inactive by going to *Visibility →Message Bar* and clicking the **Colorize** icon shown highlighted below.



3.2.1 Interface

In **ADAPT-Builder 20** the new **Colorize** window**,** by default, opens on the left side of the user interface in the *Colorize* tab as shown below. The user can dock this window on any side of the modeling window or allow it to float on screen. The **Colorize** window and the **Properties Grid** can be separated from each other and docked independently.





In the larger view of the **Colorize** window (shown above), we have a few icons at the top of the window. The first two icons are the *Expand All* icon and the *Collapse All* icon. The *Expand All* icon will expand all categories within the **Colorize** window. The *Collapse All* icon conversely, will allow the user to collapse all the categories shown in the **Colorize** window.

In addition to the *Expand All* and *Collapse All* icons at the top of the **Colorize** window we also have the *Refresh* and the *Clear* icons. When a model is opened the program populates the *Colorize* window's *Property* column with the names of components that are visible on screen. If the user turns on or off the display of components while the **Colorize** window is open, invoking the *Refresh* icon will refresh the component list of the **Colorize** window to include the currently visible components on the screen. This list is not updated on-the-fly. The *Clear* icon is used to clear the colorization of the components and return them to their default coloring.

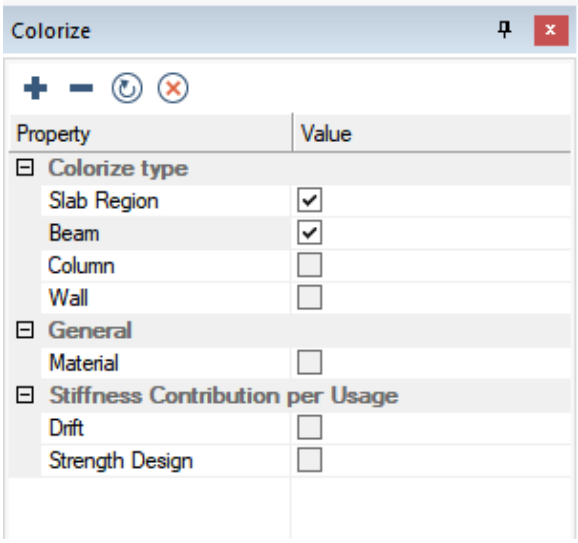
The **Colorize** window consists of two columns of information as shown in the previous figure. The left column is titled *Property* and lists the currently visible components in the model window as well as the properties, by category, the components can be colorized by. The right column is titled *Value* and consists of selection boxes the user can check and uncheck to filter what component and property or properties the program is colorizing for.

In the first iteration of the **Colorize** feature the program can colorize the following components by property.

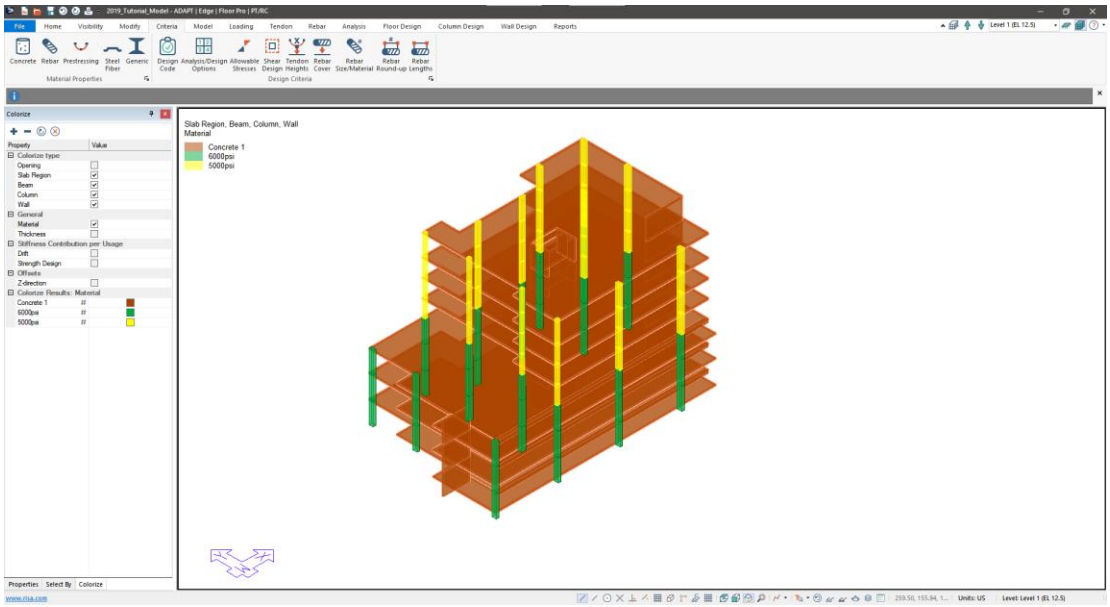
- Slab Region
- Column
- Wall
- Beam
- Opening
- Drop Cap/Panel
- Point Support
- Line Support
- Support Line
- Tendon

Within the **Colorize** window the properties the components can be filtered by are listed within categories. The first category is the *Colorize Type* category. The user can select the component type visible in the model for colorizing here. The following categories in the list will consist of properties the components can be colorized by.

If a user chooses a single component, the properties the component can be colorized by become visible. If the user selects multiple components, the properties that are consistent between the components will be displayed. With slabs and beams selected in an example model, the **Colorize** widow shows the properties as shown in the following figure.



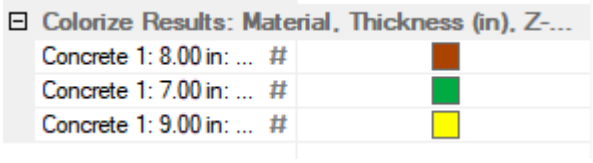
The user can then choses the property or properties they want to colorize the check marked components by. For example, in the ADAPT-Builder 20 Tutorial Model if we show the beams, slabs, columns and walls, and then colorize by material the following view would appear on screen.



The components of the model are shown colorized per the value of the property selected. A legend appears in the upper left showing the color and the property the color corresponds with. This tool makes it easy for the user to perform integrity checks on their model prior to analyzing. In addition, the **Colorize** option improves the visibility of the model when viewing like components with different properties.

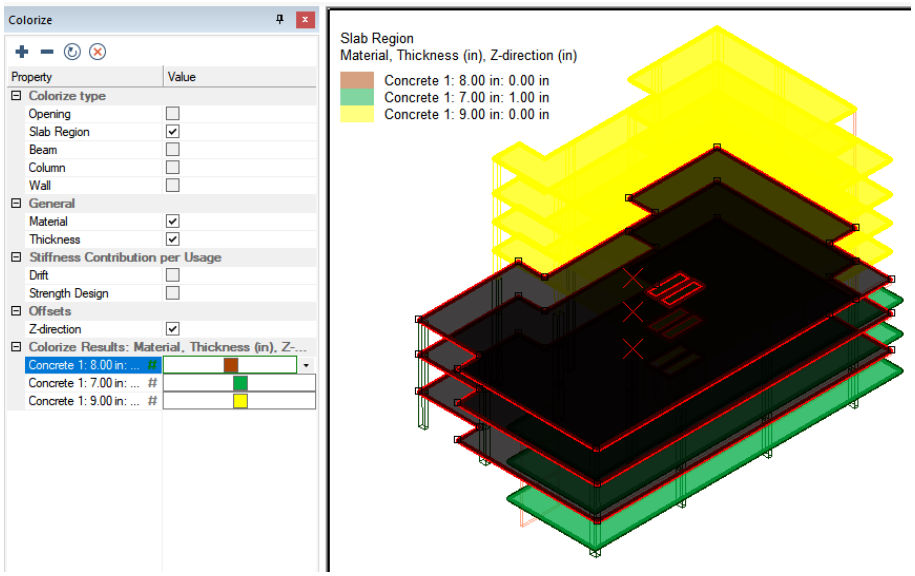
3.2.2 Filter-Select

An added feature to the **Colorize** option is the ability to filter-select based on colored component. Once the user has selected the components to color and the properties to colorize by, the **Colorize** window is populated with the *Colorized Results:* category. In this category the program lists the different properties the components fall into in the *Property* column. In the *Value* column the program shows the corresponding color for the colorized properties.



If the user left-click's on the cell in the *Property* column in this category, the program will select the corresponding slabs. A subsequent click on a different cell in the *Property* column in this category will add that colorized selection set to the currently selected group. Clicking on a selected colorized group will remove those components from the selection set. Selected colorized groups will appear with a green colored # symbol in the *Property* cell. If the colorized set is not selected it will

show with a grey colored # symbol. An example is shown in the below screenshot, the first color set has been selected.

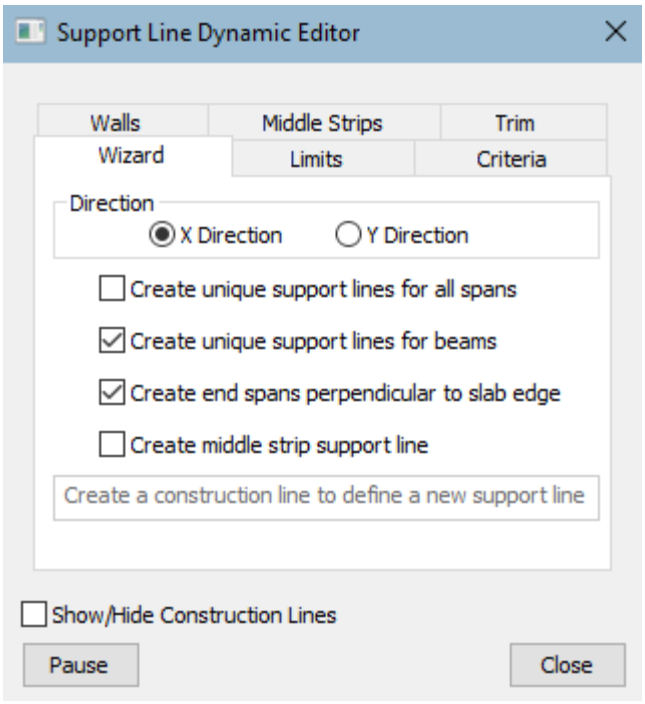


The user can select components in the manner described above and then switch to the **Properties Grid** and make modifications to selection sets as needed.

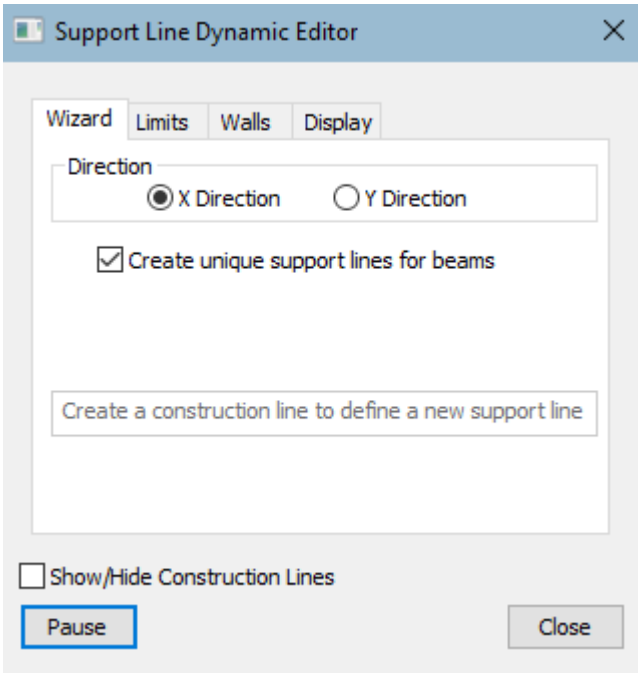
3.3 Dynamic support line Editor

New options and reorganization have been added to the **Support line Dynamic Editor** for efficient creation, modification and user customization of support lines and design strips. Most importantly, the ability for auto-generation of middle strips has been reintroduced in this version, for use in either RC or PT mode. The intent of this section is to define and introduce the new options found in this editor below for ADAPT-Builder 20 as compared to the 1st iteration of this editor as introduced in the 2019 version. Only new features or modified options will be described. For a description of the old editor features, refer to the **ADAPT-Builder 2019 New Features Supplement**.

The images below show the **Support Line Dynamic Editor** selection options for the ADAPT-Builder 20 and 2019 versions as a quick reference to the new tabs added. The contents of each new tab feature are described in the new few sections.

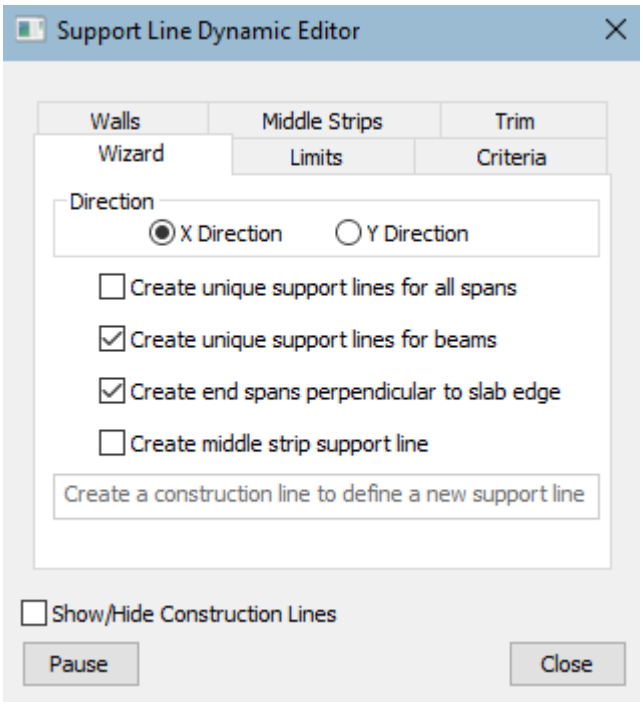


ADAPT-Builder 20.0.0



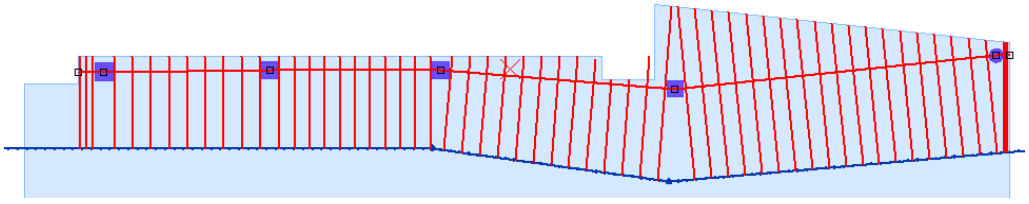
ADAPT-Builder 2019.0/1/2

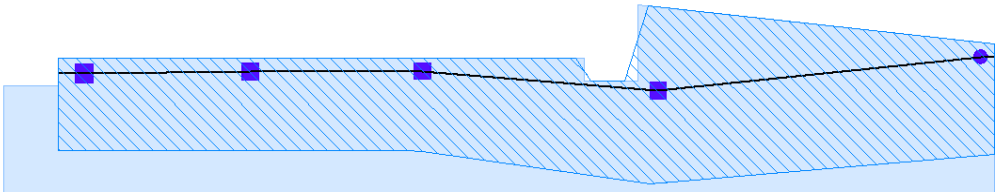
3.3.1 Wizard Tab



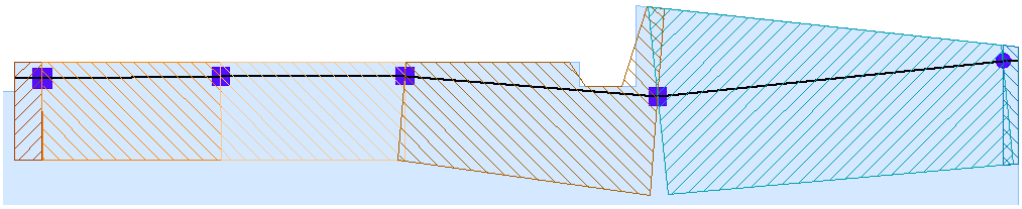
Create unique support line for all spans: When using the Support Line Wizard to create support lines, when this option is selected, the program will break up a continuous support line into separate support lines for each span (between each support the construction line passes through). This can be useful in combination with the new tools for allocation of column strip percentage so that the user can assign difference values in each span versus the same column strip allocation over a continuous, multi-span condition.

The images below show the difference in use of this tool when it is selected versus not being selected. The first two images below show support line and design strip when the option is turned off. The program creates a continuous support line and strip.

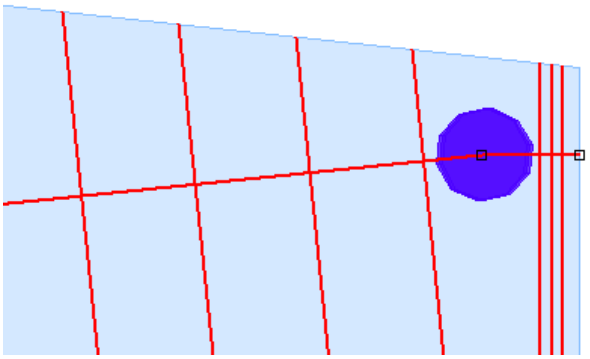




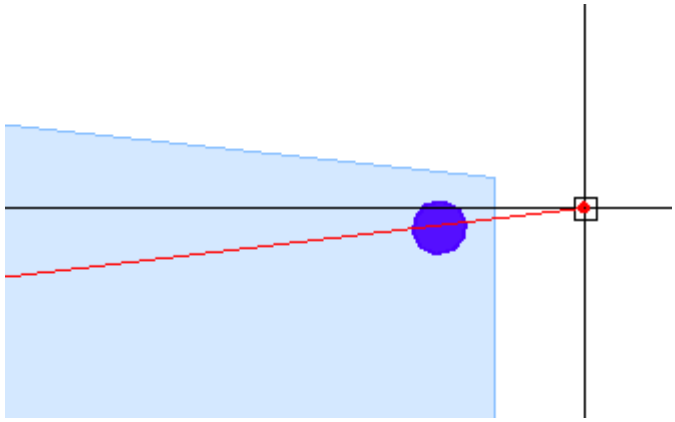
The support line and design strips when the option is active creates six unique regions as shown below.



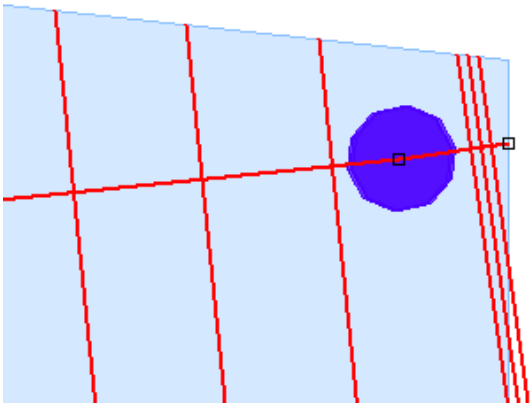
Create end spans perpendicular to slab edge: This option aligns the ends of support lines to be perpendicular to the slab edge. When the construction line is used to create a support line through use of the wizard, it is not practical to align the construction line perpendicular with the slab edge, nor are the snap tools active when drawing a construction line.



Support line edge created with perpendicular option enabled.



Construction line exiting slab edge at angle other than perpendicular at slab edge.



Support line end created with perpendicular option turned off. The support line follows the construction line vector.

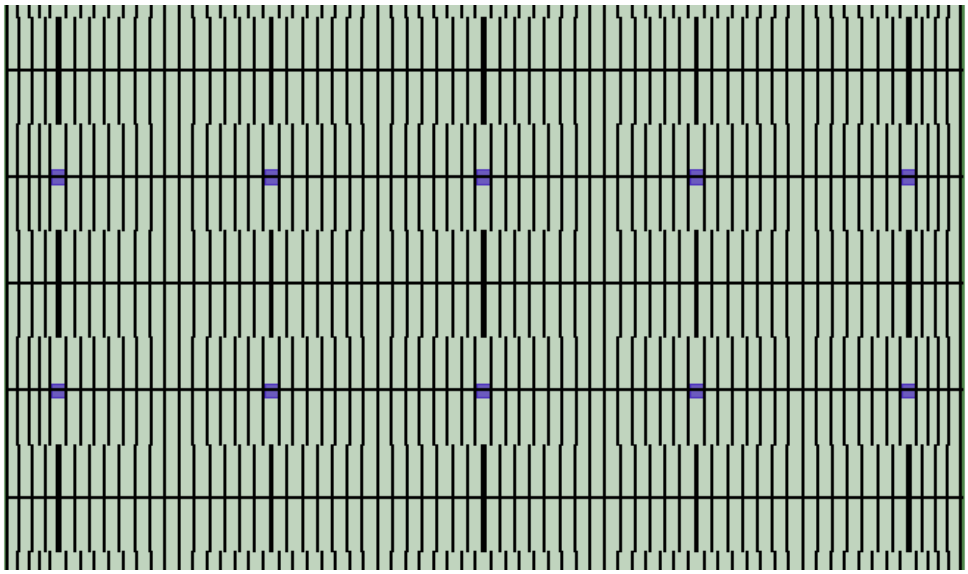
Create middle strip support line: This option automatically tags a support line as “Middle Strip” in the Property Grid as shown below. This tag is especially important in how tributary regions are created by the program.

Design Strip	
Tributary Detection Tol...	2.000 ft
Middle Strip	☑

When a support line is tagged as “Middle Strip” the tributary boundary will extend to the column strip boundary regardless of whether the column strip has a boundary setting as None, % distance, or max limit. Below are examples of different conditions and the outcomes of the tributary regions.

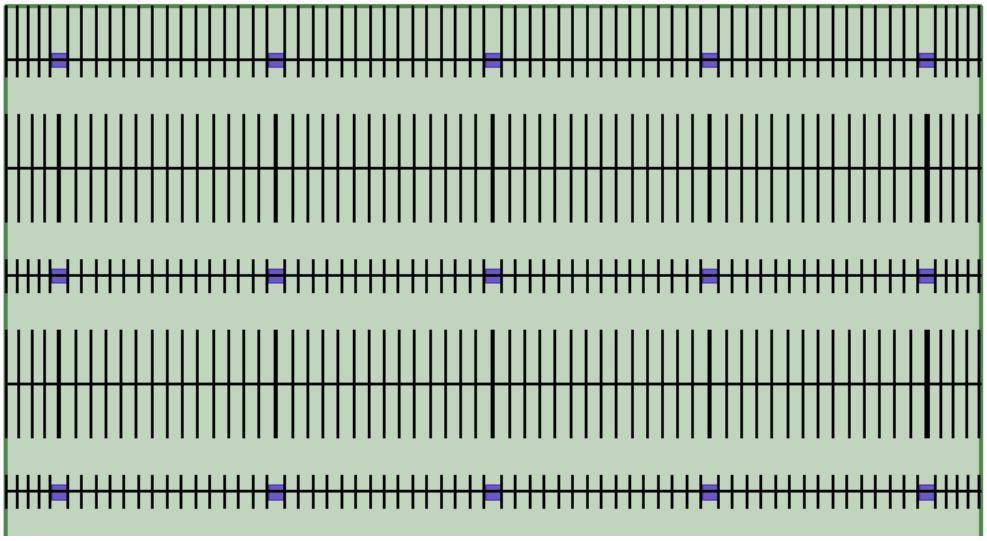
Case 1: The width limits for Column support lines are set to **NONE** and Middle support lines not set to **MIDDLE STRIP**

The typical bay width and length is 30’ x 30’. In this case the column strip is automatically ½ the distance to the adjacent support line and the middle strip is ½ the distance each side to the adjacent support line. This results in the column strip within the bay being 1/4 *bay width and the middle strip being ½*bay width.



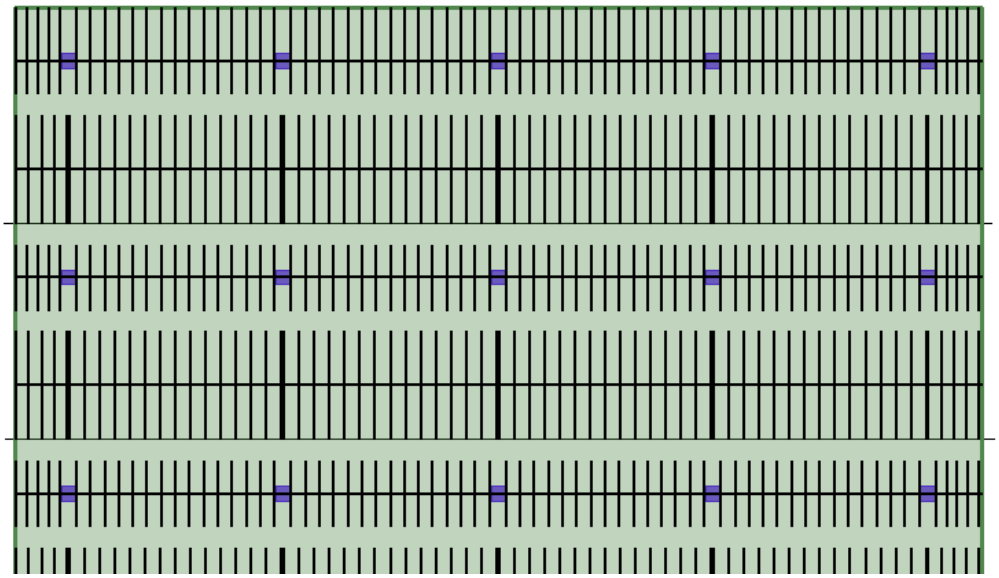
Case 2: The width limits for Column support lines are set to **% between (15%)** and Middle support lines not set to **MIDDLE STRIP**

In this condition the support line representing the middle strip support line but not tagged as **MIDDLE STRIP** is limited to ½ the distance (15’ in this case) to the adjacent support line. The column strips are extended 0.15*distance to each side of the support line to the next support line. For this case, the distance between support lines is 15’. The column strip distance is therefore 0.15*15 = 2.09’ each side of the support line representing the column strip.



Case 3: The width limits for Column support lines are set to **Max Width (4.5')** and Middle support lines not set to **MIDDLE STRIP**

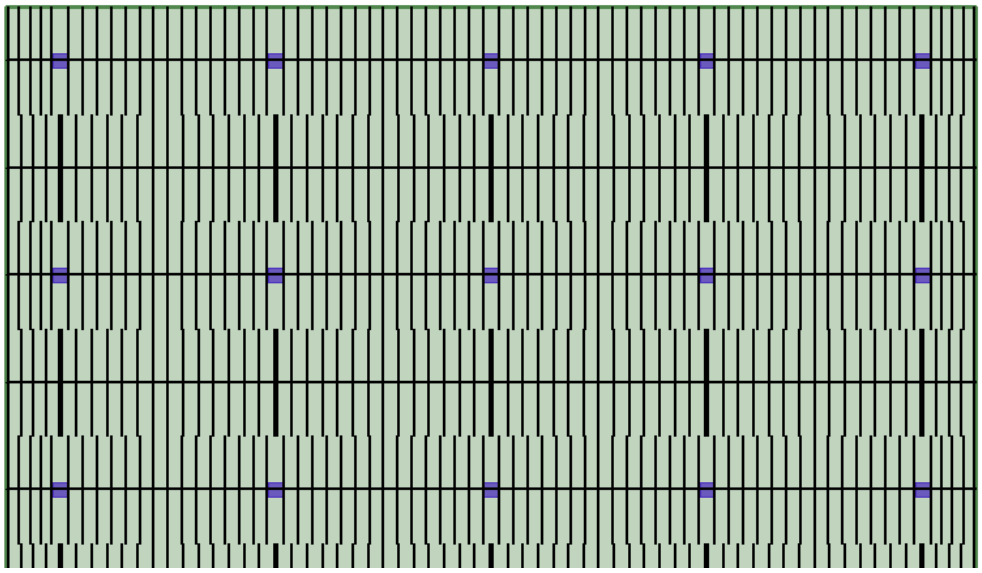
In this condition the support line representing the middle strip support line but not tagged as **MIDDLE STRIP** is limited to ½ the distance to the adjacent support line (15' in this case). The column strips are extended to the direct input for the max width of 4.5'.



Case 4: The width limits for Column support lines are set to **NONE** and Middle support lines are set to **MIDDLE STRIP**

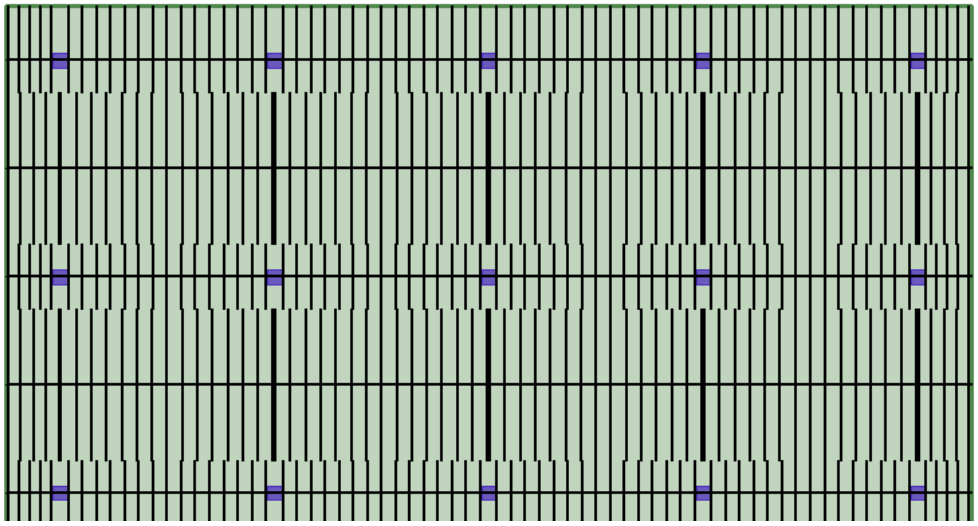
In this condition the support line representing the middle strip support line tagged as **MIDDLE STRIP** fills in the gap relative to the rule set for the column strip support line. For this case, the column strip is

automatically generated as ½ the distance to the adjacent support line on each side. Therefore, the length is 7.5’ for the column strips to each side of the support line and the middle strip is 15’.



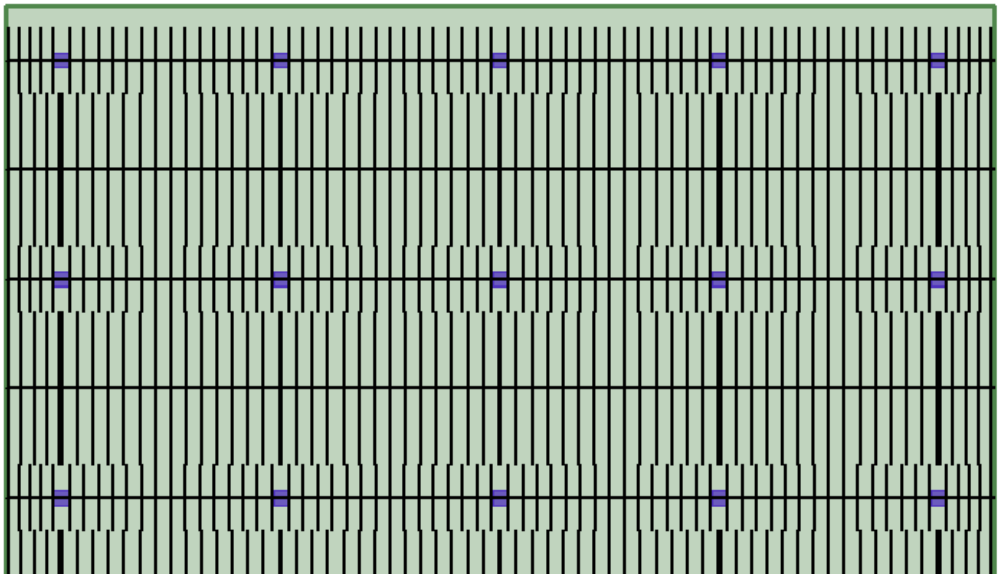
Case 5: The width limits for Column support lines are set to **% between (15%)** and Middle support lines are set to **MIDDLE STRIP**

In this condition the support line representing the middle strip support line tagged as **MIDDLE STRIP** fills in the gap relative to the rule set for the column strip support line. For this case, the column strip is set to a percent between of 15%. This leads to the column strip width being set as 4.5’ each side of the support line and the middle strip filling in the gap at 21’.

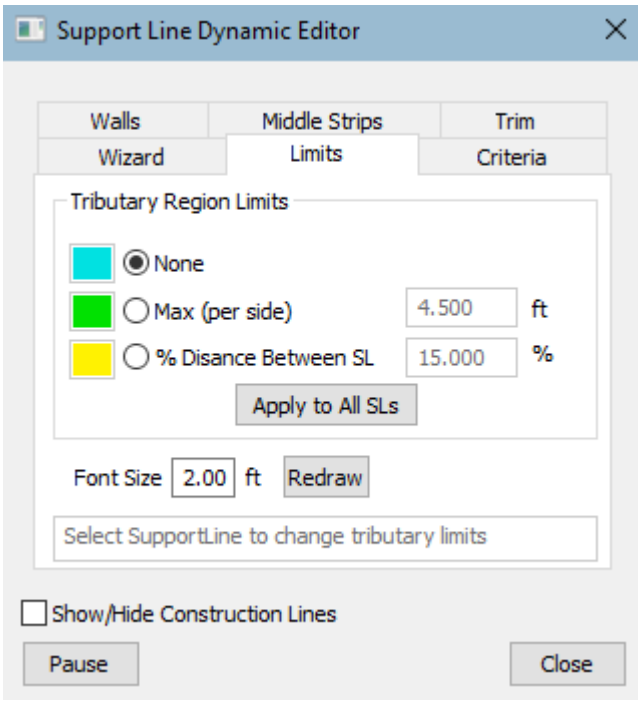


Case 6: The width limits for Column support lines are set to **Max Width (4.5')** and Middle support lines are set to **MIDDLE STRIP**

In this condition the support line representing the middle strip support line tagged as **MIDDLE STRIP** fills in the gap relative to the rule set for the column strip support line. For this case, the column strip is set to a percent between of 15%. This leads to the column strip width being set as 4.5' each side of the support line and the middle strip filling in the gap at 21'. Note at the column strip support line at the top edge of the slab a gap exists between the strip boundary and edge of slab. This is caused due to the setting of max width of 4.5' of each side. The cantilevered distance is greater than 4.5'.



3.3.2 Limits Tab

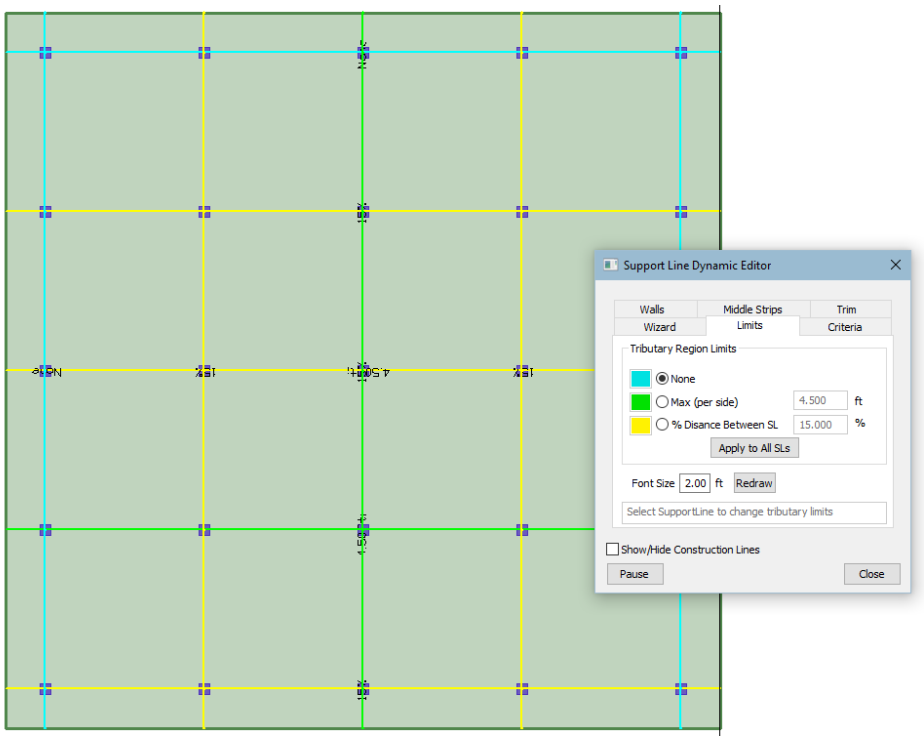


Tributary Region Limits: This setting assigns how the selected support line will be treated when the design strips are generated. The six cases above describe all conditions and settings for this option. These settings are typically applied to only those support lines representing column strips. Middle strip creation is handled separately through manual definition and tagging as a "Middle Strip" or through the creation using the **Middle Strip** tab. In other words, middle strips are commonly set as None for tributary region limits.

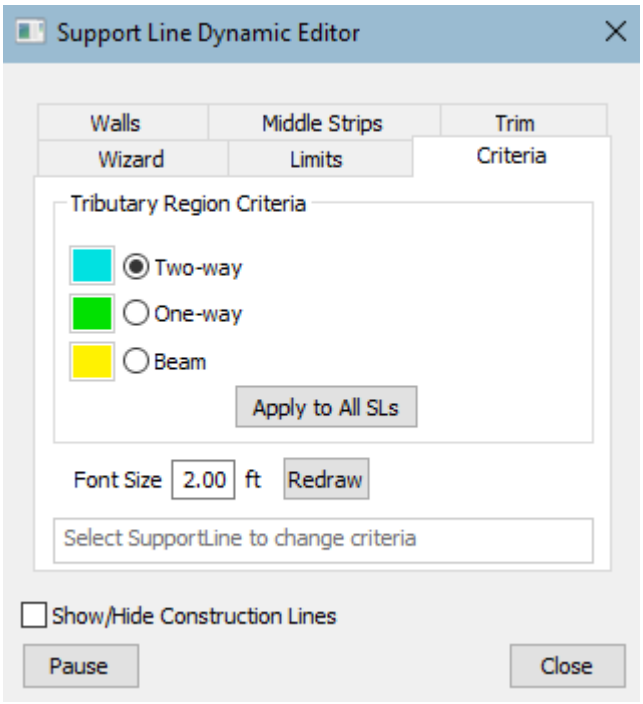
- None (Cyan) – The program will select the "natural" tributary for the support line as being ½ the distance to the next support line.
- Max per side (Green) – This sets the distance of the tributary width to each side of a support line to the user-defined max value.
- % Distance Between DL (Yellow) – This sets the distance of the tributary width to each side of a support line to the % of the tributary width at each side.

When you select **Apply to All SLs** the program will set the tributary region limit to each support line modeled in both X and Y directions. If you select only a single support line, the program will change only that support line.

Font Size: This sets the font size for the text showing the tributary region limit setting. The image below shows an example of a mixed set of support lines with different limit conditions. Note that the colorized indication is only active while in the **Dynamic Support Line Editor**.



3.3.3 Criteria Tab

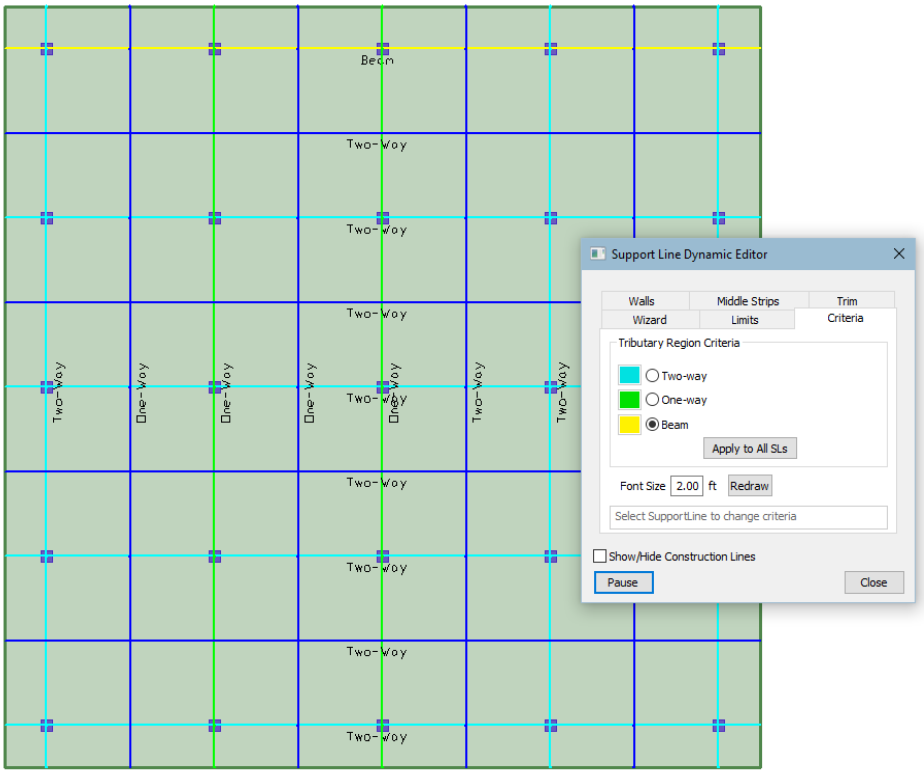


Tributary Region Criteria: This setting assigns how the selected support line will be treated for design criteria. Design criteria is used by the design algorithm to determine how minimum reinforcement, strength reinforcement, shear requirments, flexural stresses, etc. are handled.

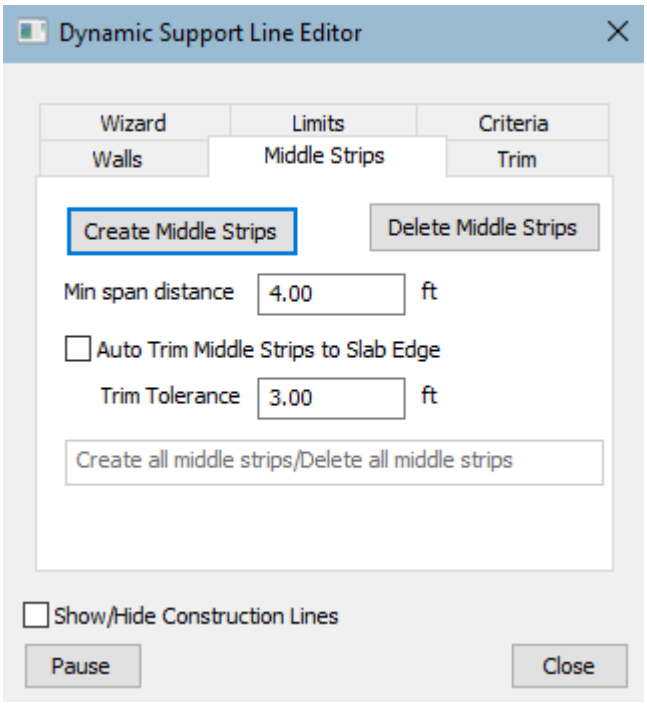
- Two-way (Cyan) – Sets the design criteria as two-way slab. If tendons intersect the design section, two-way PT criteria is used, otherwise RC criteria is used. Allowable stress input, reinforcement size, and bar cover is dependent on this setting.
- One-way (Green) – Sets the design criteria as one-way slab. If tendons intersect the design section, one-way PT criteria is used, otherwise RC criteria is used. Allowable stress input, reinforcement size, and bar cover is dependent on this setting.
- Beam (Yellow) – Sets the design criteria as beam. If tendons intersect the design section PT beam criteria is used, otherwise RC criteria is used. Allowable stress input, reinforcement size, and bar cover is dependent on this setting.

When you select **Apply to All SLs** the program will set the criteria type to each support line modeled in both X and Y directions. If you select only a single support line, the program will change only that support line.

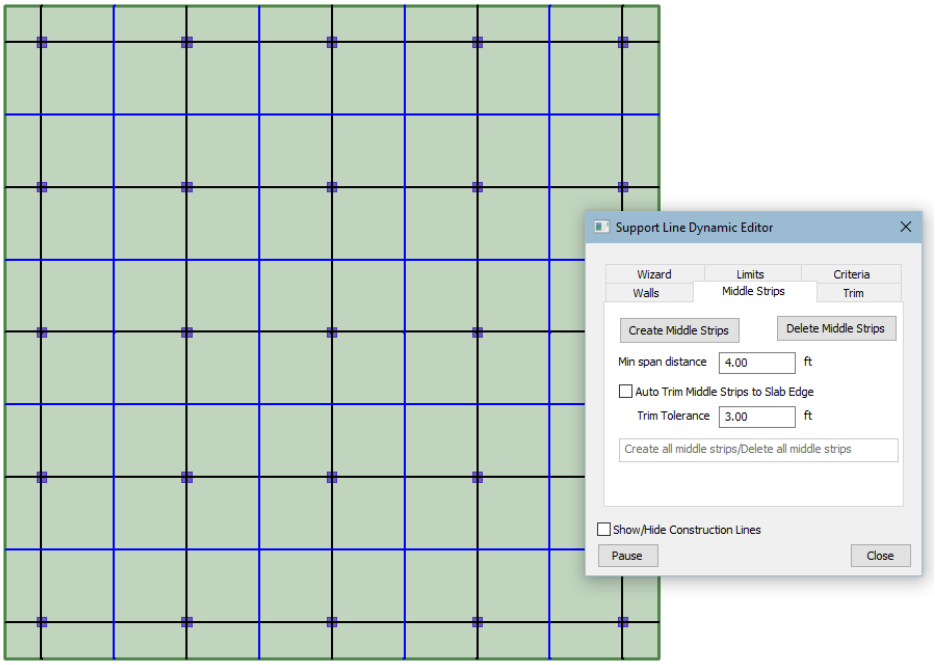
Font Size: This sets the font size for the text showing the tributary region limit setting. The image below shows an example of a mixed set of support lines with different Criteria settings. Note that the colorized indication is only active while in the **Dynamic Support Line Editor**.



3.3.4 Middle Strips Tab



Create Middle Strips: This option will automatically generate middle strip support lines between already-defined column strip support lines. These are colored in blue while active in the **Dynamic Support Line Editor**.

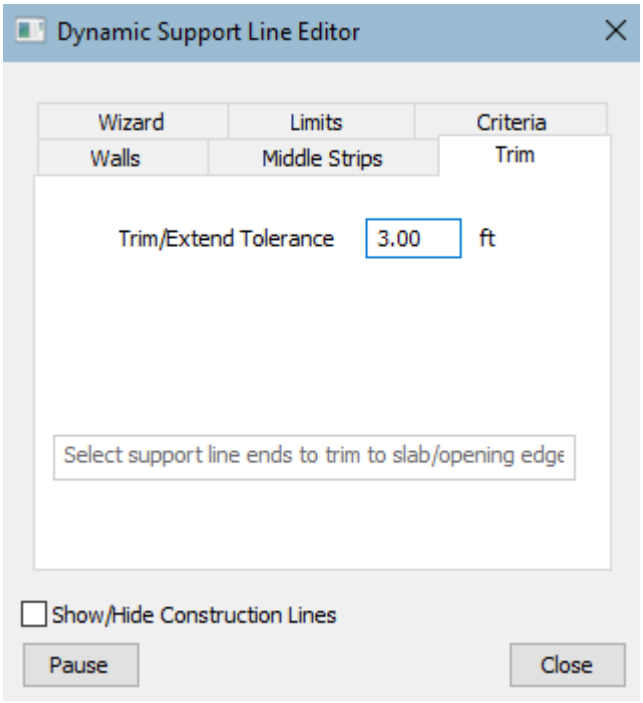


Delete Middle Strips: This deletes the auto-generated middle strip support lines.

Min Span Distance: This threshold is used to set the minimum span distance for a column strip support line that the program uses to generate the middle strip.

Auto Trim Middle Strip to Slab Edge: When this is selected, the program will auto trim/extend the ends of middle strips to the slab edge located within the tolerance setting.

3.3.5 Trim Tab

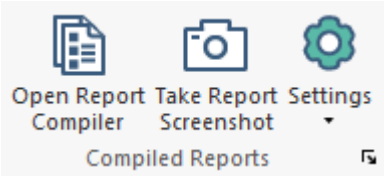


Trim/Extend Tolerance: This option trims ends of support lines at slab edges or openings if the end is within the tolerance setting. Select the endpoint of the support line to trim or extend.

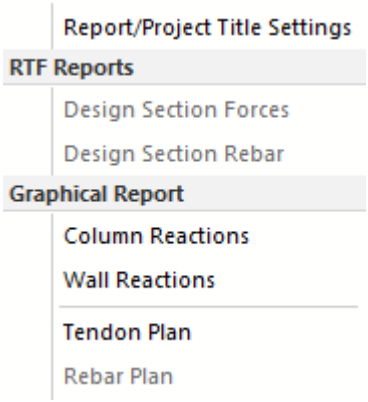
4 Reporting Improvements

4.1 Compiled Report Generation

A settings option has been added to pre-define report settings that previously had required the report option to be opened and set up before producing a compiled report. This new feature is found from Reports>Compiled Reports>Settings.

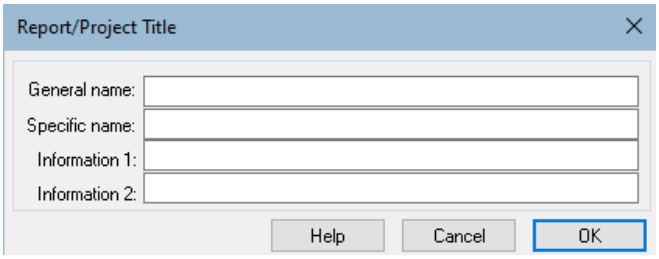


The following options are given for pre-defining settings for tabular and graphical results.



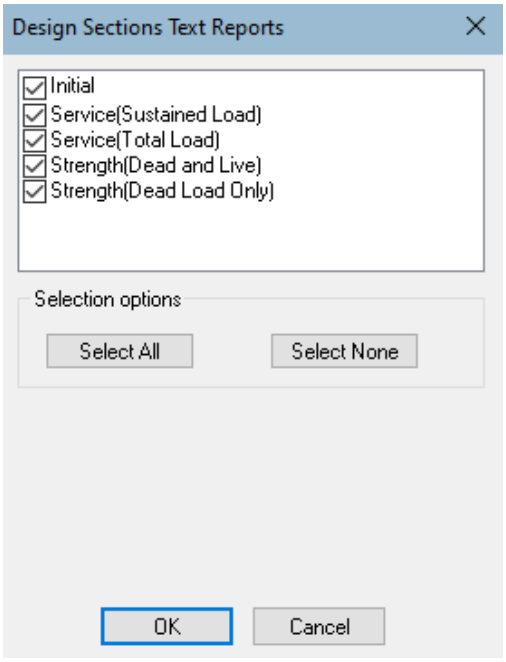
4.1.1 Report/Project Title Settings

Report information for General and Specific name and generic information blocks are specified in this report. This information is used as part of the report page header and title block for graphical output produced by the **Report Compiler**.

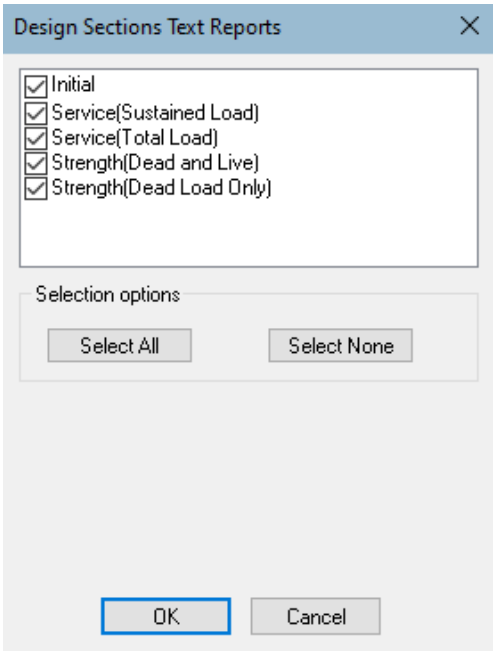


4.1.2 RTF Reports

Design Section Forces: Sets the combinations to produce Design Section Forces for.

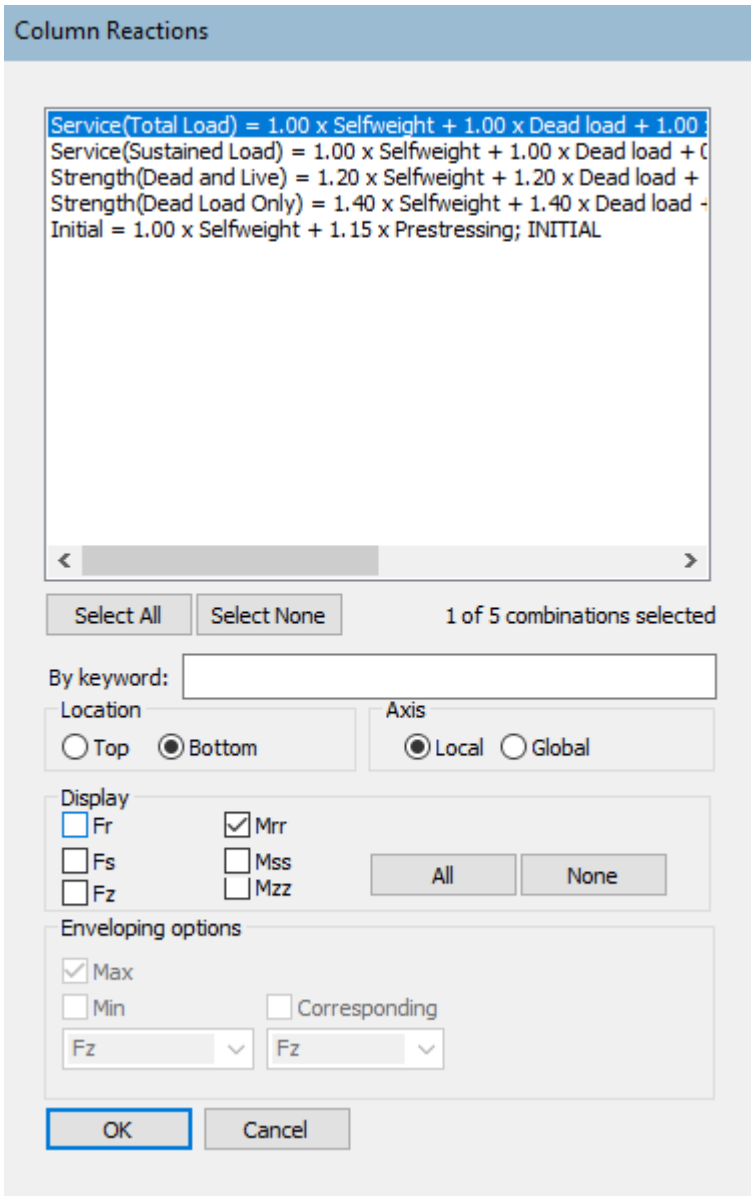


Design Section Rebar: Sets the combinations to produce reinforcement area tables for.

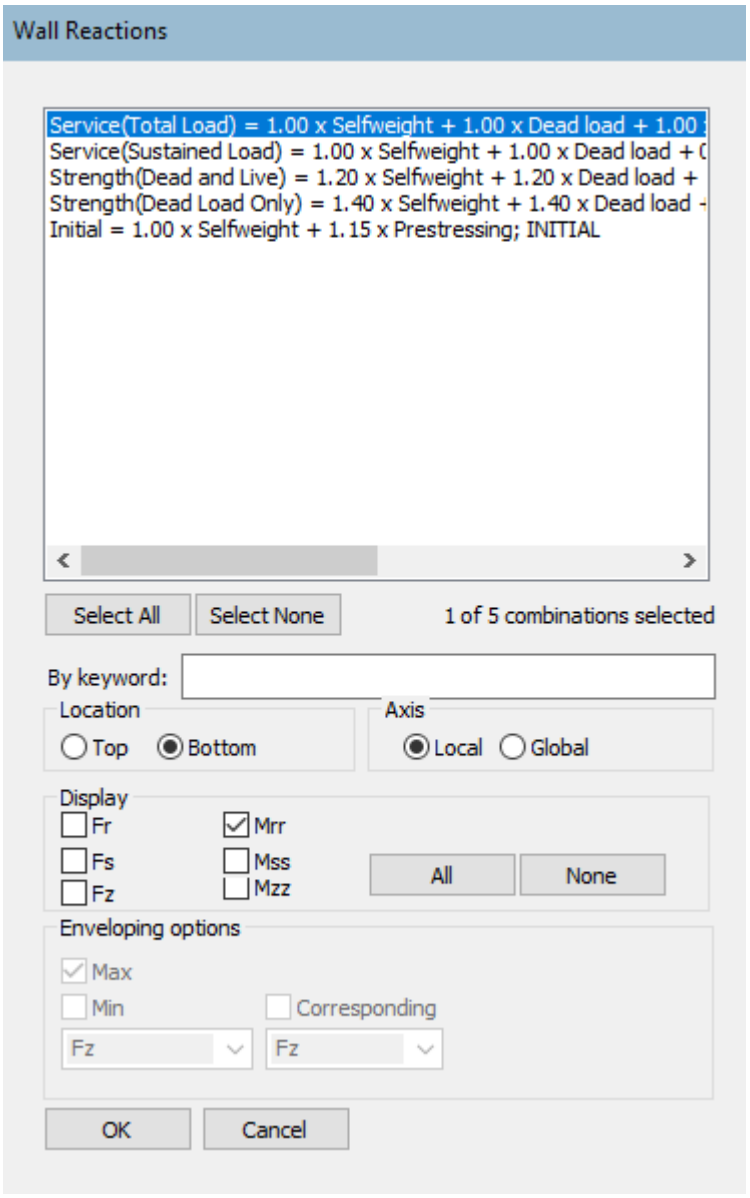


4.1.3 Graphical Reports

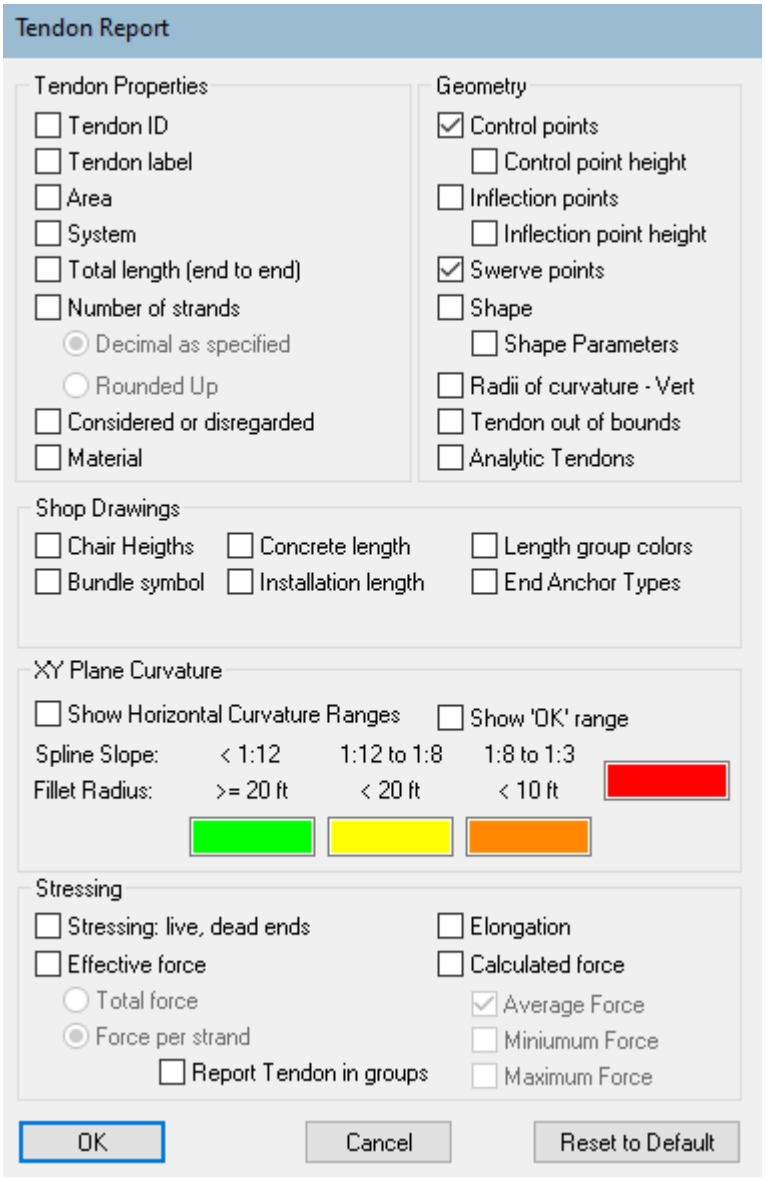
Column Reactions: Sets the display settings for graphical column reactions shown on plan. Note that **Display** is active only when a single combination is selected. **Enveloping Options** is active if a group of combinations is selected.



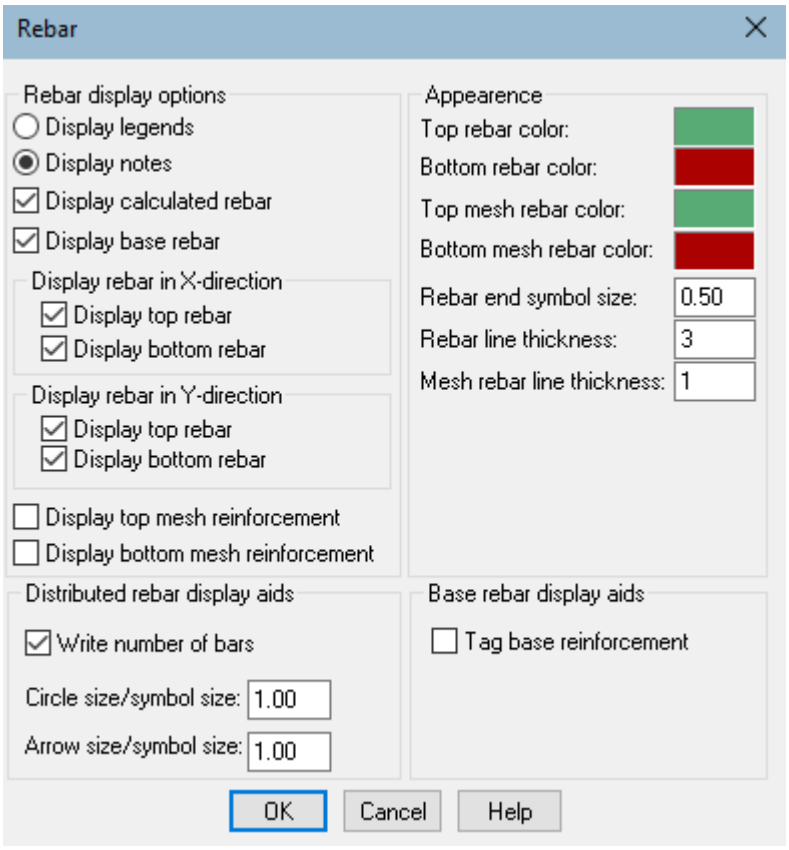
Wall Reactions: Sets the display settings for graphical wall reactions shown on plan. Note that **Display** is active only when a single combination is selected. **Enveloping Options** is active if a group of combinations is selected.



Tendon Plan: Launches Tendon Display Settings to set the tendon display options for the compiled report.



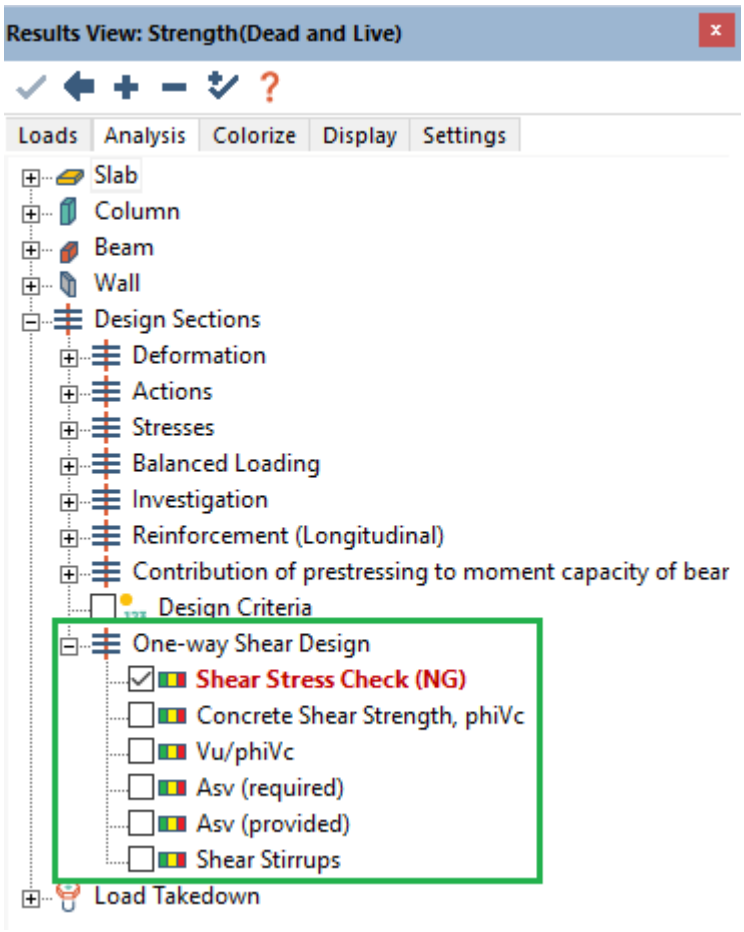
Rebar Plan: Launches Rebar Display Settings to set the rebar display options for the compiled report. Note that the **Calculated Rebar Plan** from the **Floor Design** or **Rebar** ribbon must be produced before this report setting is active.



More detailed descriptions of each of the display setting dialogues referenced above can be found in ADAPT-Builder and ADAPT-Floor Pro User Manuals from HELP>Documentation.

4.2 One-Way Shear Results in Graphical Display

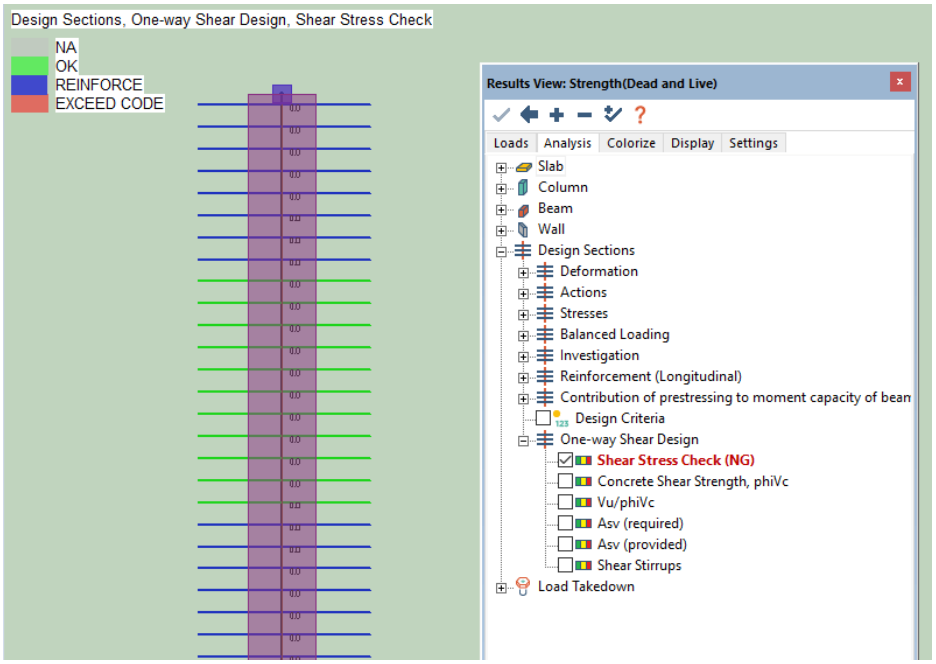
For RC and PT models including beams and one-way slabs requiring one-way shear reinforcement, new graphical options have been added to **Result Display Settings.** These graphical results include Shear Stress Check, Concrete Shear Strength (Vc), Vu/Vc ratio, Asv (required shear reinforcement), Asv (provided shear reinforcement), and shear stirrup reinforcement. These options are available only when a **Strength** or **Strength Envelope** load combination type is selected in the **Loads** tab. The results are displayed along design strips; therefore, the design strip must be displayed with or without the view of design sections from **Floor Design>Strip Results/Visibility.**


Results View: Strength(Dead and Live)
Loads
Analysis
Colorize
Display
Settings
Slab
Column
Beam
Wall
Design Sections
Deformation
Actions
Stresses
Balanced Loading
Investigation
Reinforcement (Longitudinal)
Contribution of prestressing to moment capacity of bear
Design Criteria
One-way Shear Design
Shear Stress Check (NG)
Concrete Shear Strength, phiVc
Vu/phiVc
Asv (required)
Asv (provided)
Shear Stirrups
Load Takedown

4.2.1 Shear Stress Check

This option shows a graphical code check for each design section along a beam or one-way slab design strip for the selected strength load combination or strength envelope. The available code check status indicators are:

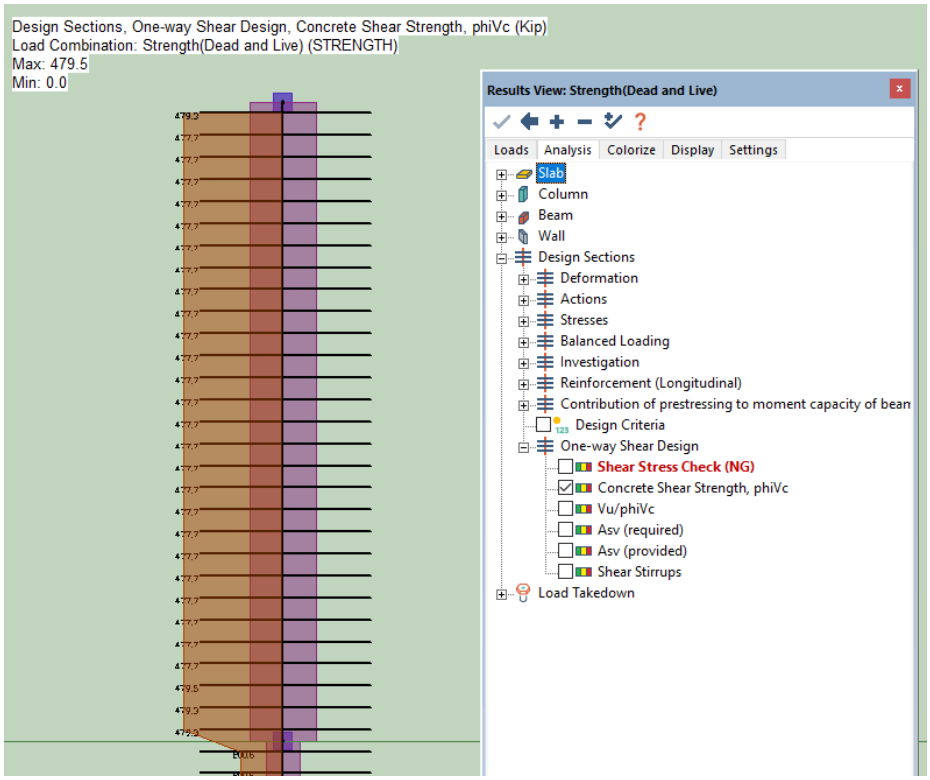
- **NA (Gray)** – Not applicable and design section criteria is set to two-way slab.
- **OK (Green)** – No reinforcement is required for the design section.
- **REINFORCE (Blue)** – Reinforcement is required for the design section.
- **EXCEEDS CODE (Red)** – The one-way shear stress at the section exceeds the code maximum allowable.



4.2.2 Concrete Shear Strength, phiVc

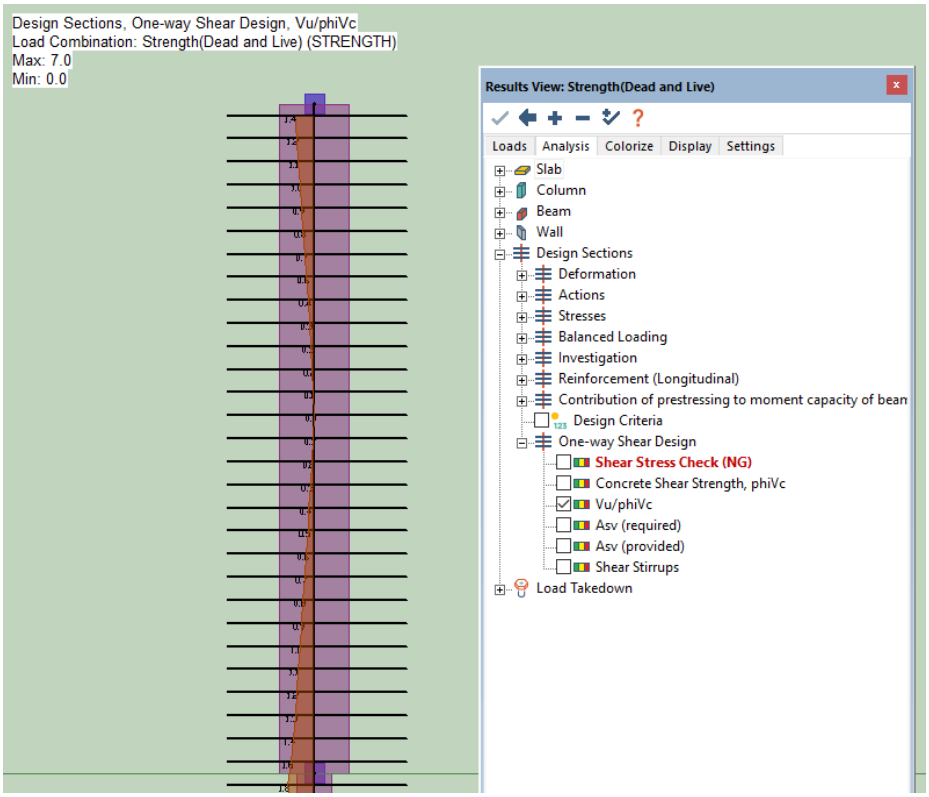
Reports the concrete shear capacity, phiVc (or equivalent for other non-ACI design codes) of each design section (default units of K or kN). The calculated concrete shear capacity is calculated per code requirements for RC or PT sections. Post-tensioned code expressions are used if a tendon intersects the design section.

To view the demand shear values, Vu, select the option from **Result Display Settings>Analysis>Design Sections>Actions>Shear**.



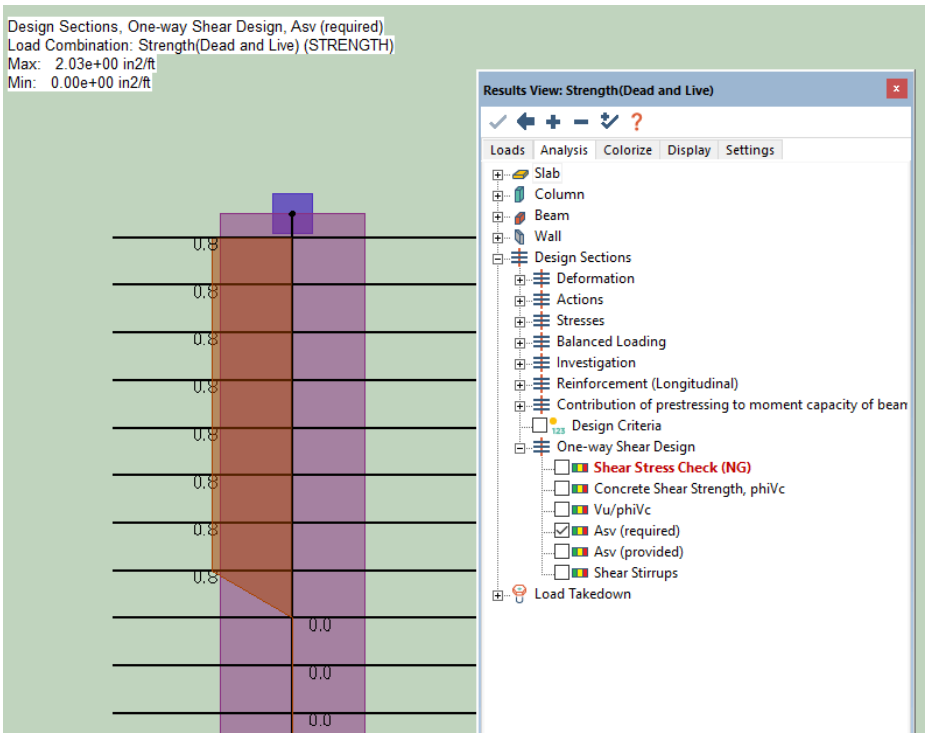
4.2.3 Vu/phiVc

Reports the demand/capacity ratio for the selected strength load combination or envelope. The capacity value is that reported as the concrete shear strength in the previous description.

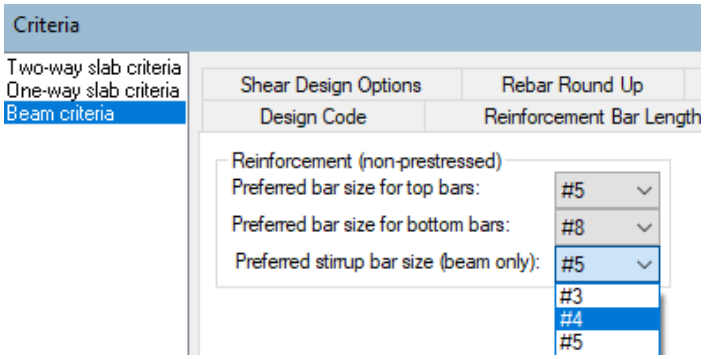


4.2.4 Asv (required)

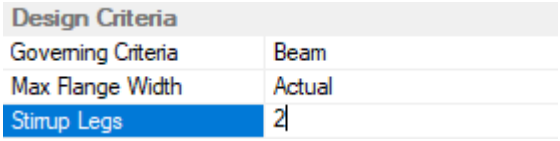
Reports the required area of reinforcement per ft (US units) or per meter (SI units) based on calculation.



Note the shear stirrup size is defined from **Criteria>Rebar Size/Material** having selected the one-way slab or beam criteria option.

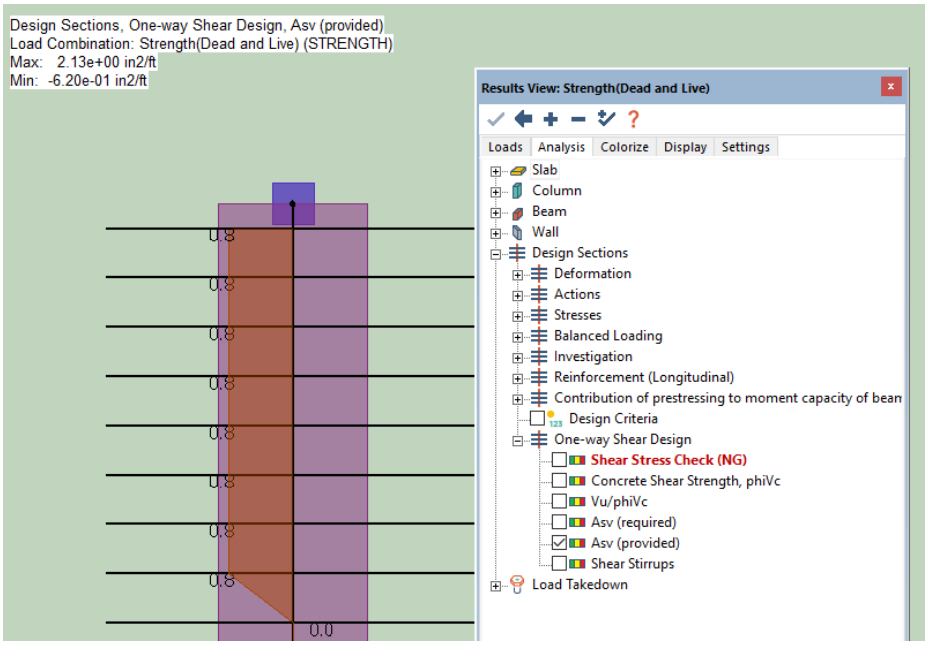


The number of legs can be defined per support line and through the Property Grid for **Stirrup Legs**. This differs from previous versions as the number of legs was a global setting.



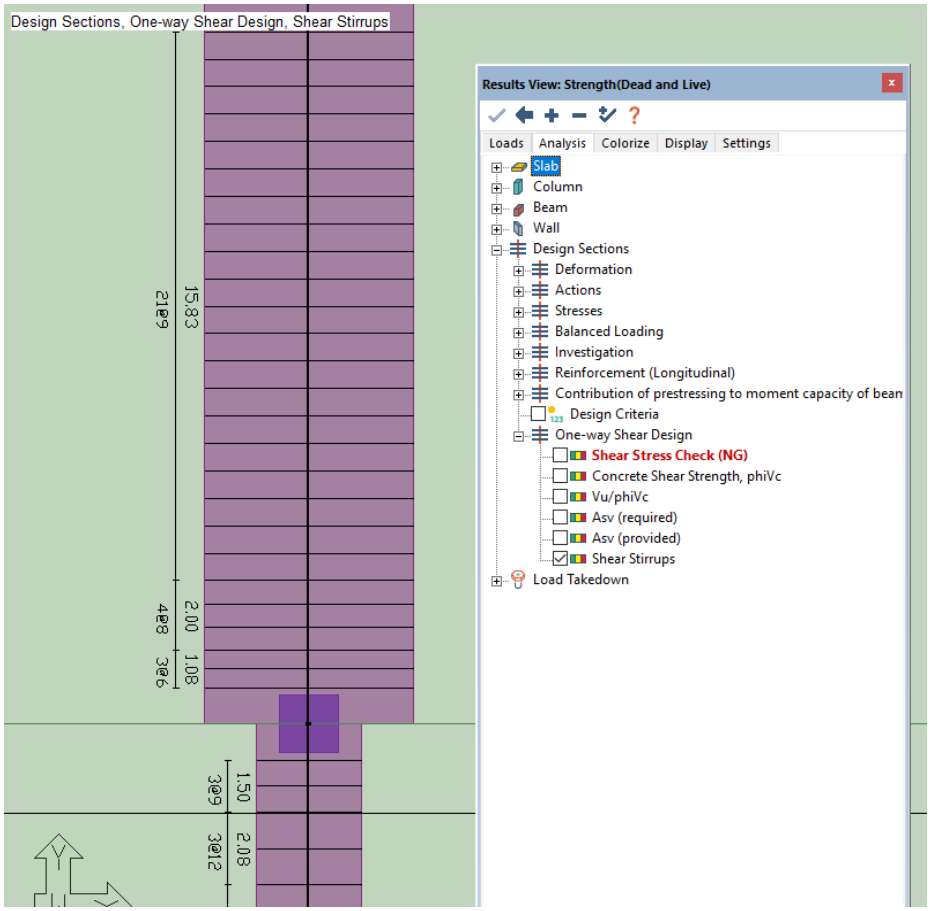
4.2.5 Asv (provided)

Reports the provided area of reinforcement per ft (US units) or per meter (SI units) based on input of number of legs and stirrup size selected for the design.



4.2.6 Shear Stirrups

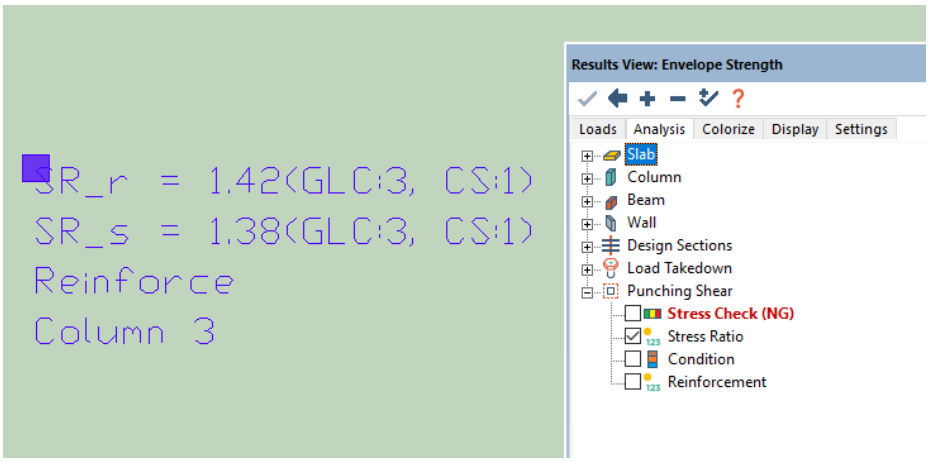
Reports the number of stirrups and associated spacing in each reinforcement zone along the beam or one-way slab. The total length is given for each reinforced zone.



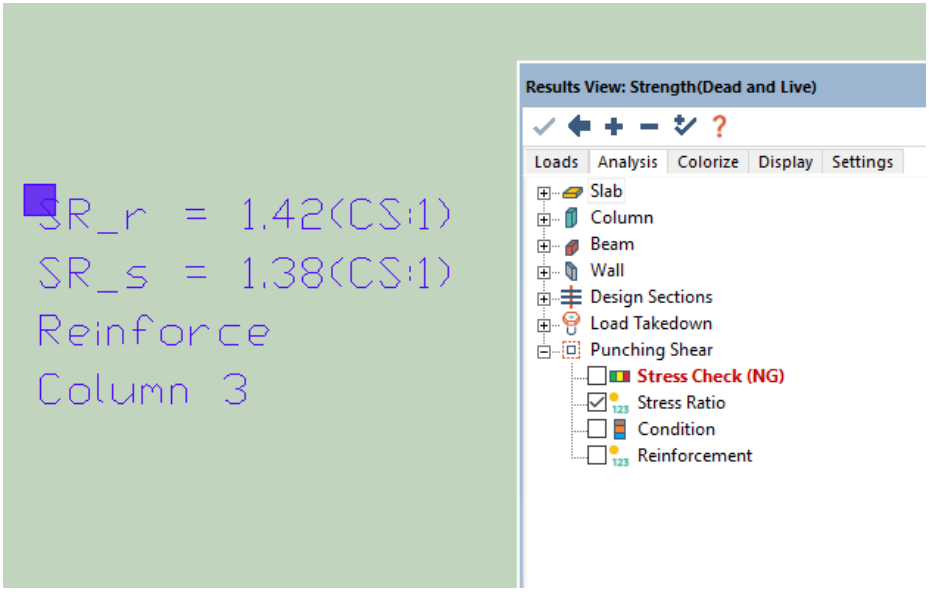
4.3 Punching Shear Results in Graphical Display

The graphical punching shear checks in Result Display Settings>Analysis>Two-Way Shear now include the following enhancements.

- The governing load combination for the Strength envelope and the governing critical section (layer) for envelope or single-selected strength combinations when the option for **Stress Ratio** is selected.

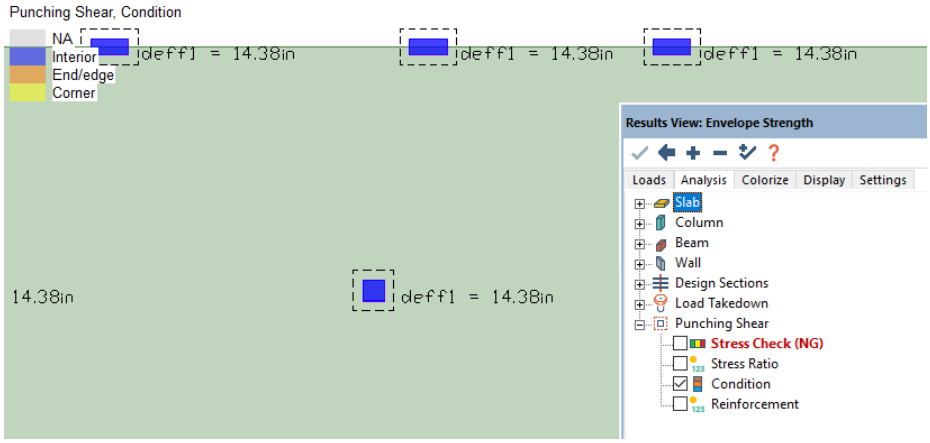


GLC = Govering load combination. The value indicates the sequential combination in the entire list of defined combinations from **Loading>Load Combinations**.



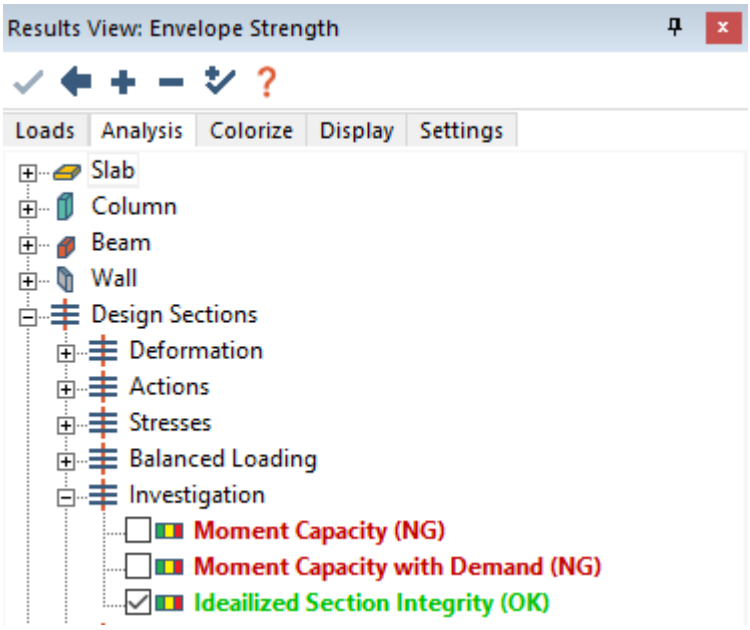
CS = Critical Section that produces the maximum stress ratio. Critical sections (layers) are defined at code-required distances from face of support or previous design section. For example, for ACI, the software spaces critical sections at d/2 for two-way shear design.

- The effective depth for the 1st critical section (layer) is reported when **Condition** is selected. Additional, detailed information for other critical sections can be found from **Reports>Punching Shear>XLS Reports>Punching Shear Reports.**



4.4 Idealized Section Integrity Check

A new graphical option that checks the geometric and section property integrity of an idealized to a physical design section has been included in **Result Display Settings>Analysis>Investigation.** Design sections cut over the width of the design strip are defined as "Physical" design sections. For example, for a flat two-way slab without drop panels/caps, beams or other thickenings or depressions, all design sections are rectangular physical sections. These sections are converted into "Idealized" design sections for the analysis and design of reinforcement and stress checks for the section. These idealized sections are parameterized geometrically for the design application used in the software.

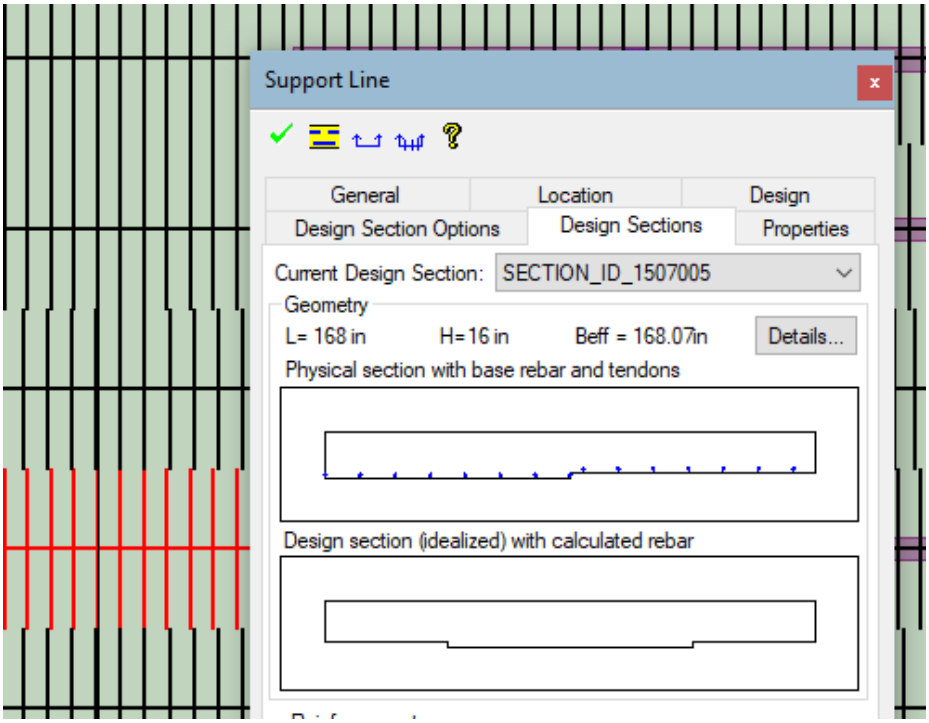


In the case of the rectangular design section described above, the geometric parameters length and thickness are used directly as the idealized values.

Therefore, for a rectangular design section the physical and idealized geometry and section properties are identical and there would be 0% difference between the two in the integrity check.

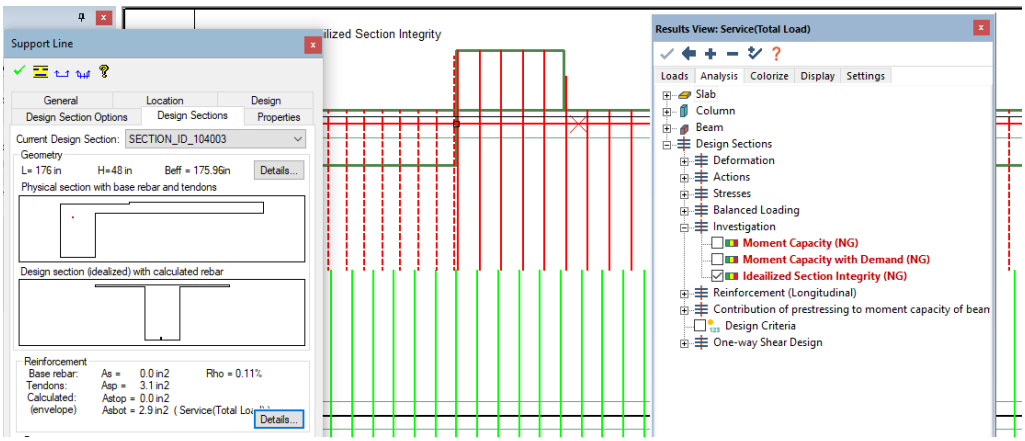
For slabs that have complex geometry including beams, slab depressions, offset slabs, transitions, etc. when a design section cuts through different slab thicknesses and/or offsets the physical and idealized geometry and section properties may differ. The example below shows one such condition where the physical section includes a thicker slab region to the left side of the design section. The idealization maintains the same overall depth, but the thicker region is shifted to the CL of the section relative to a vertical axis through the design section.

The integrity check compares the moment of inertia, area, and centroid location of the physical and idealized design section and where any of these section properties exceed the specified threshold %, the program flags these sections graphically. A color indication of Green represents the check being OK. Red indicates the % difference exceeds the threshold. The threshold % is defaulted to 25% but can be modified from **Result Display Settings>Display>Idealized Section Integrity Criteria.**

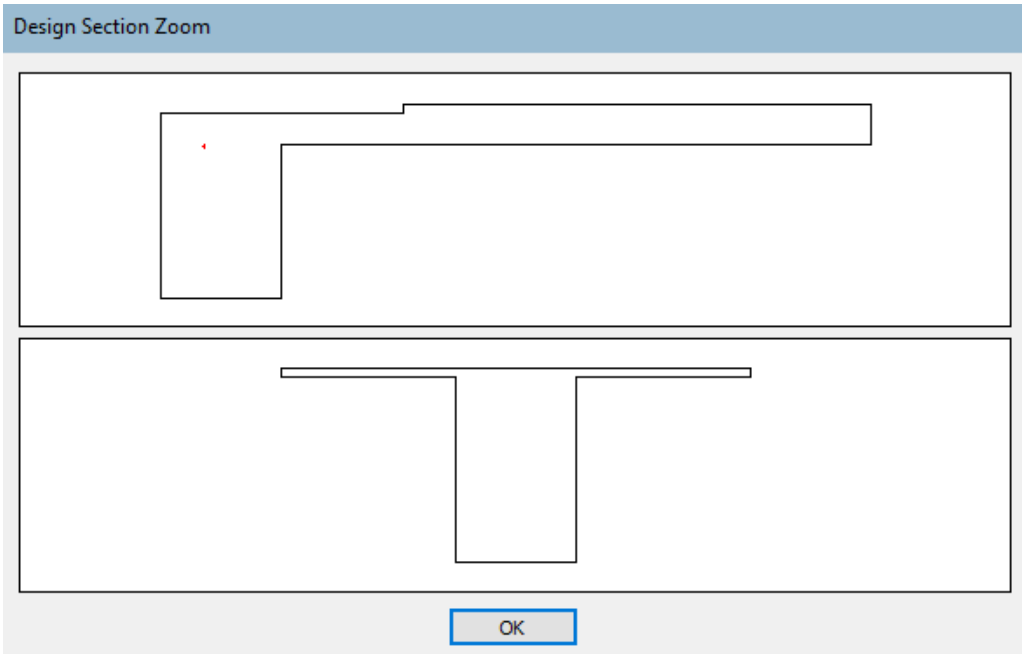


In the case where the section integrity check exceeds the desired threshold, the user should be aware of those locations and modify the design strip, support line layout and splitters so as to generate satisfactory design sections.

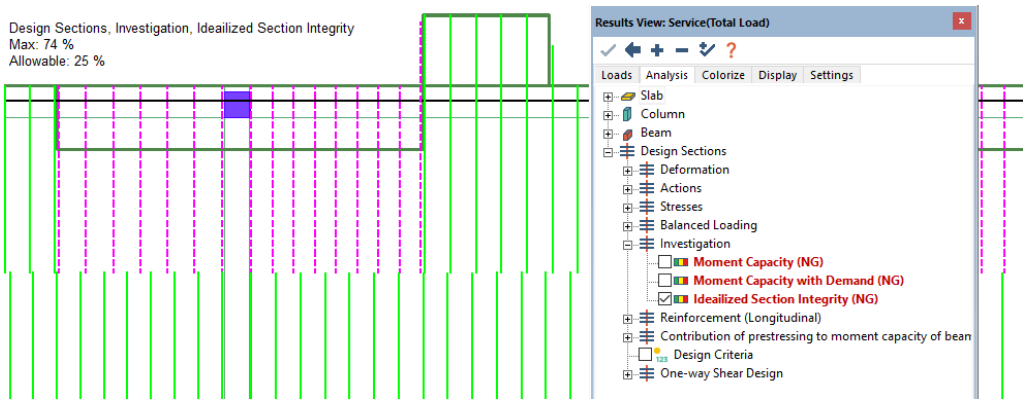
An extreme example is outlined below. The design section extends through a 10” slab with 0” offset, a 8” slab with 2” downward offset with a beam located in the depressed slab region. Note that in this case there is only a single support line on the outside frame line and another below along the first interior frame line.



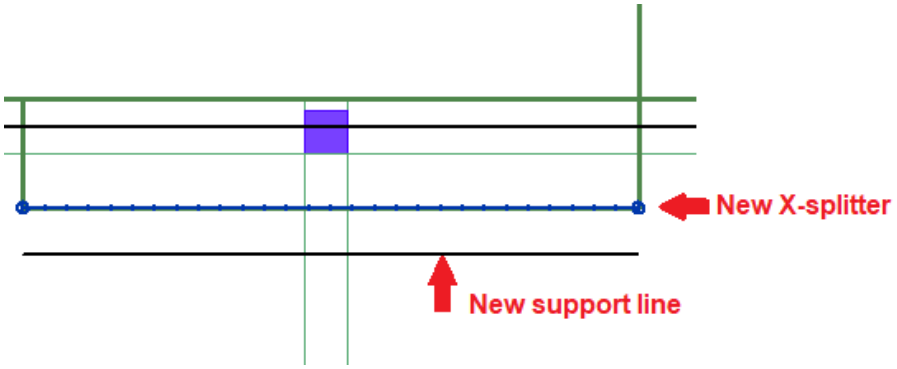
The physical design section is shown below with the true position of slabs and beam. For the idealized design section, the beam and depressed slab are shifted to the CL of section, however, the slab thickness gets reduced due to the offset and slab displacement from the shift.



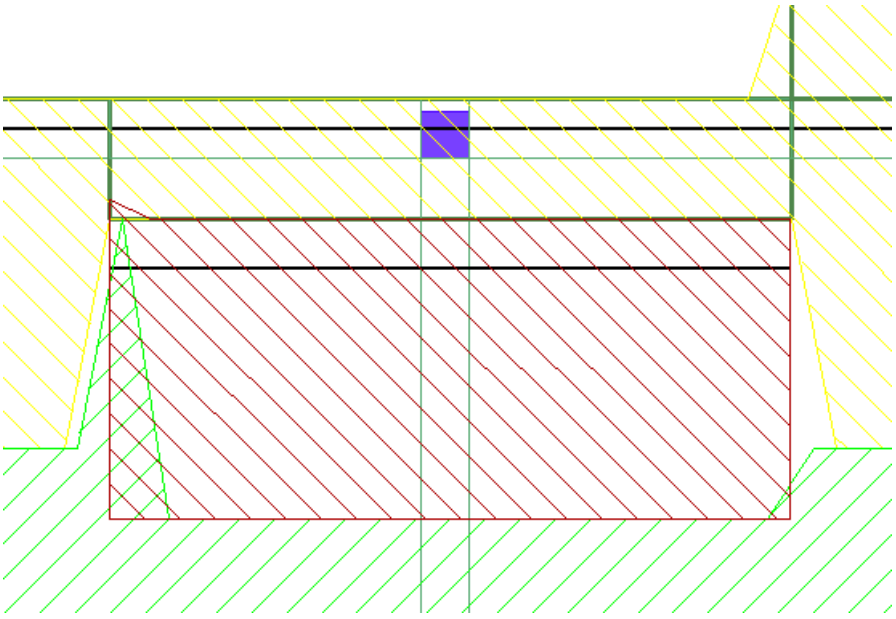
Upon checking the section integrity for this slab, the maximum difference for the check parameters are 74%, far exceeding the allowable of 25%. These are flagged as shown below.



To avoid this situation and modify the input for more reliable and accurate results, another design strip should be created outside of the depressed slab region to split the two slab regions for the offset and non-offset condition.



The outcome of design strips with the new support and splitter intended to isolate the depressed region is shown below. The brown hatched region is the new design strip tributary set as a two-way slab region.



The design results show that this region satisfies the section integrity check and the idealized design section in the depressed region faithfully represents the physical design section.