



Tutorial

# AISC 360-10 Bolts (14th, 2010)

Updated on: November 6th 2023

Tested with: SDC Verifier 2023 R2

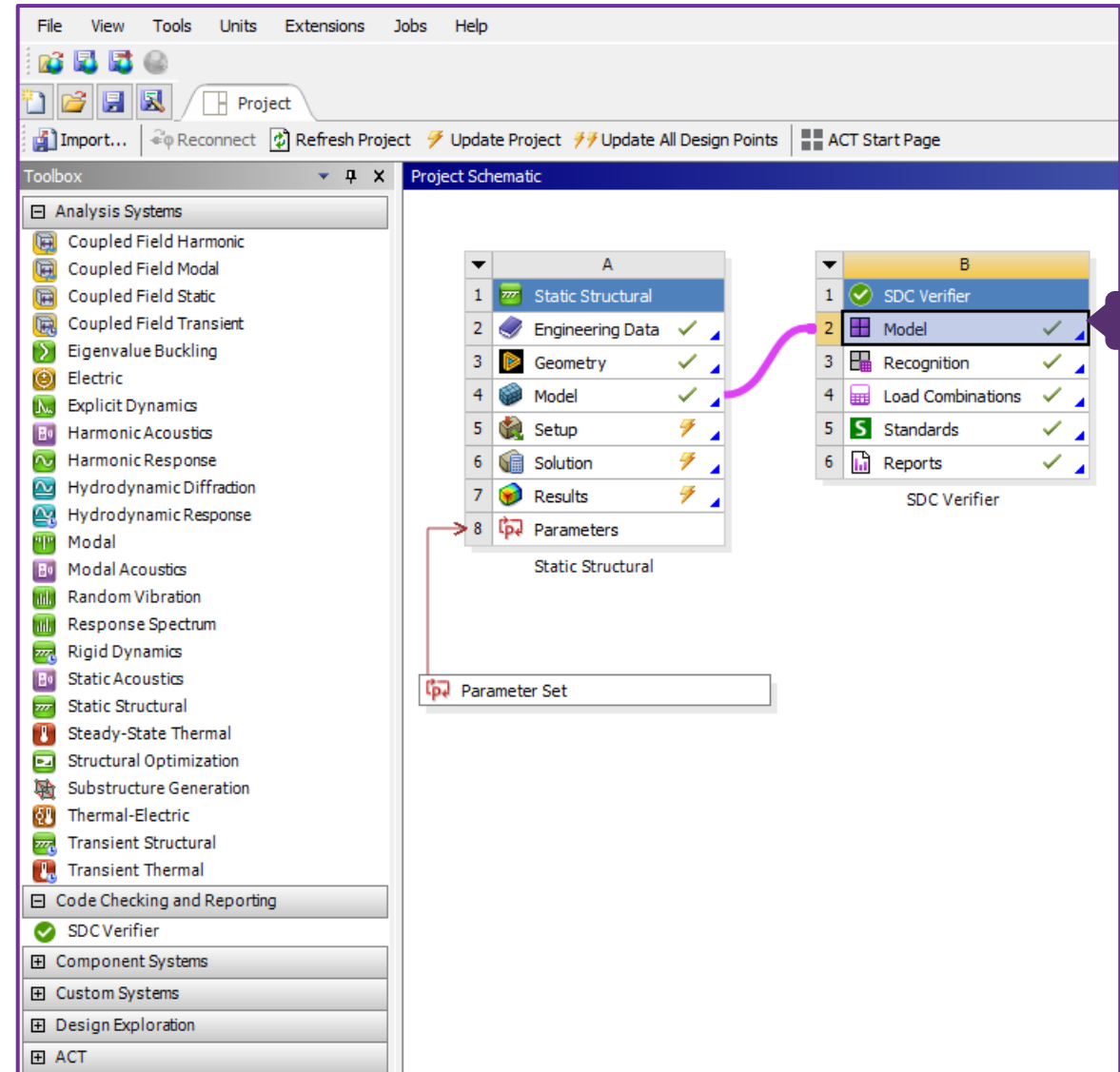
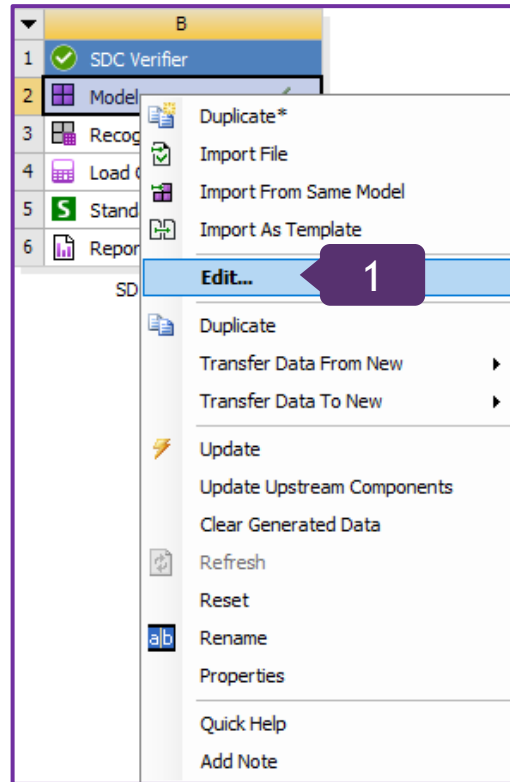
ANSYS Workbench 2023 R2

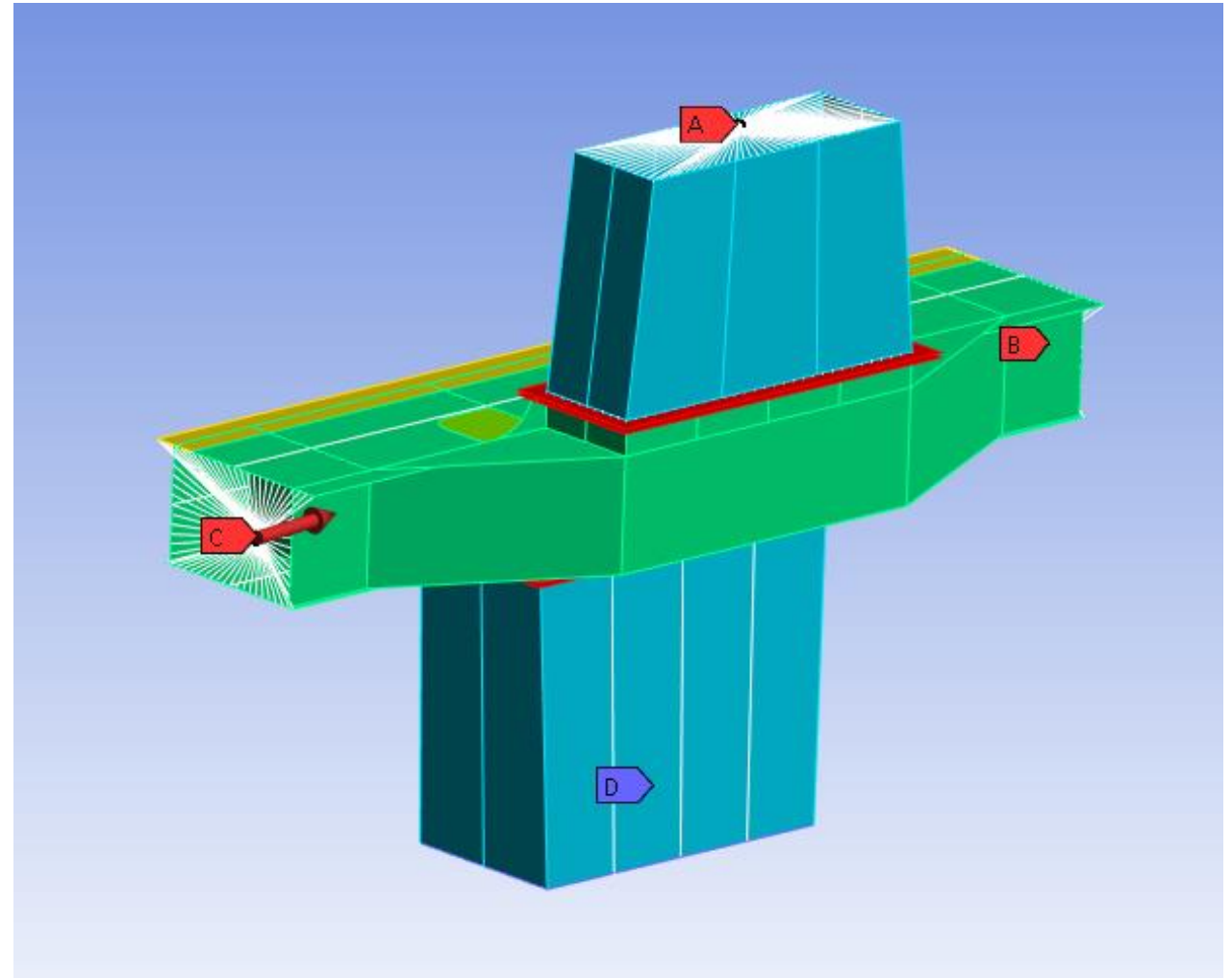
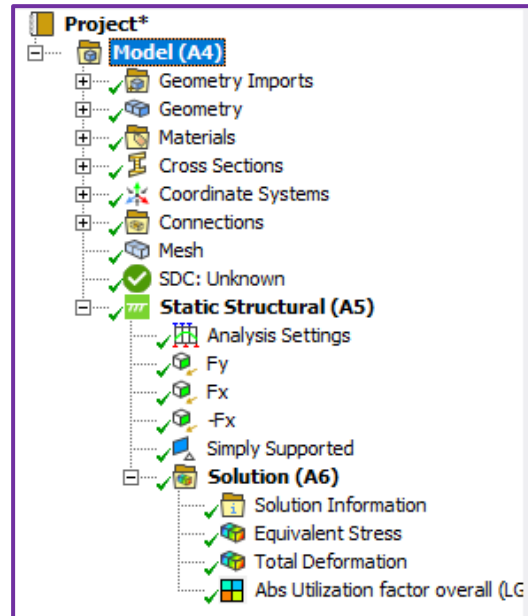
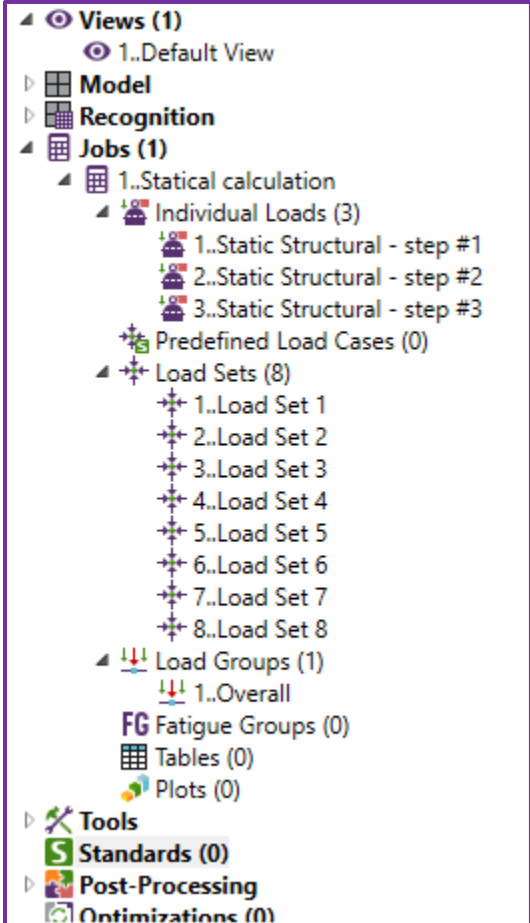
- In this tutorial, AISC 360-10 Bolts (14th, 2010) Check is reviewed in details.
- A plate model (bolts modeled as beams) structure has been used as a start FEM model.
- An Extreme table, showing the worst result on selection, has been created;
- Criteria Plot with Utilization factor overall has been previewed

# Open a Starter Model


1

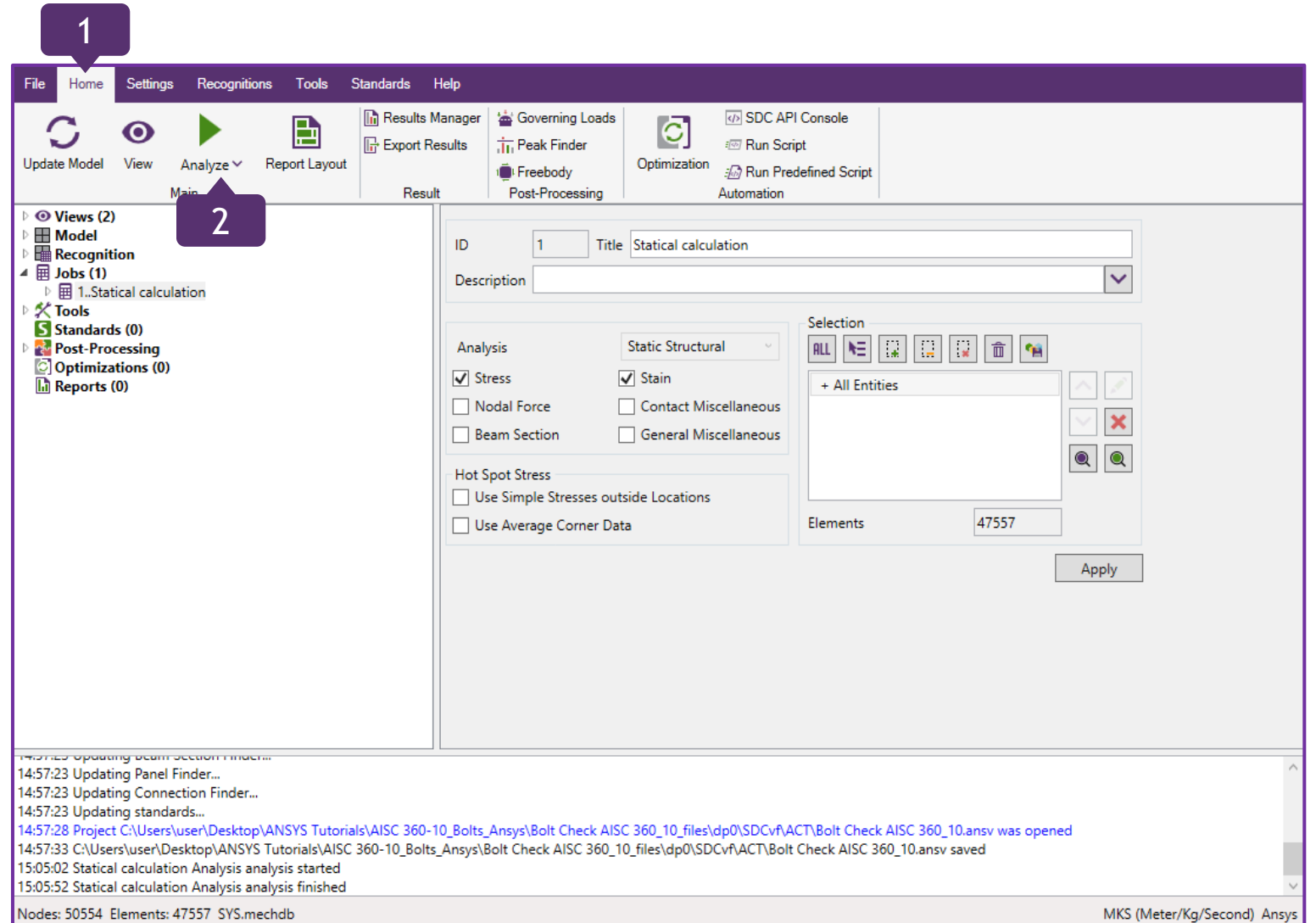
Double Click or right click on **Model**  
If right click, in context menu press **Edit**





# Run Analysis

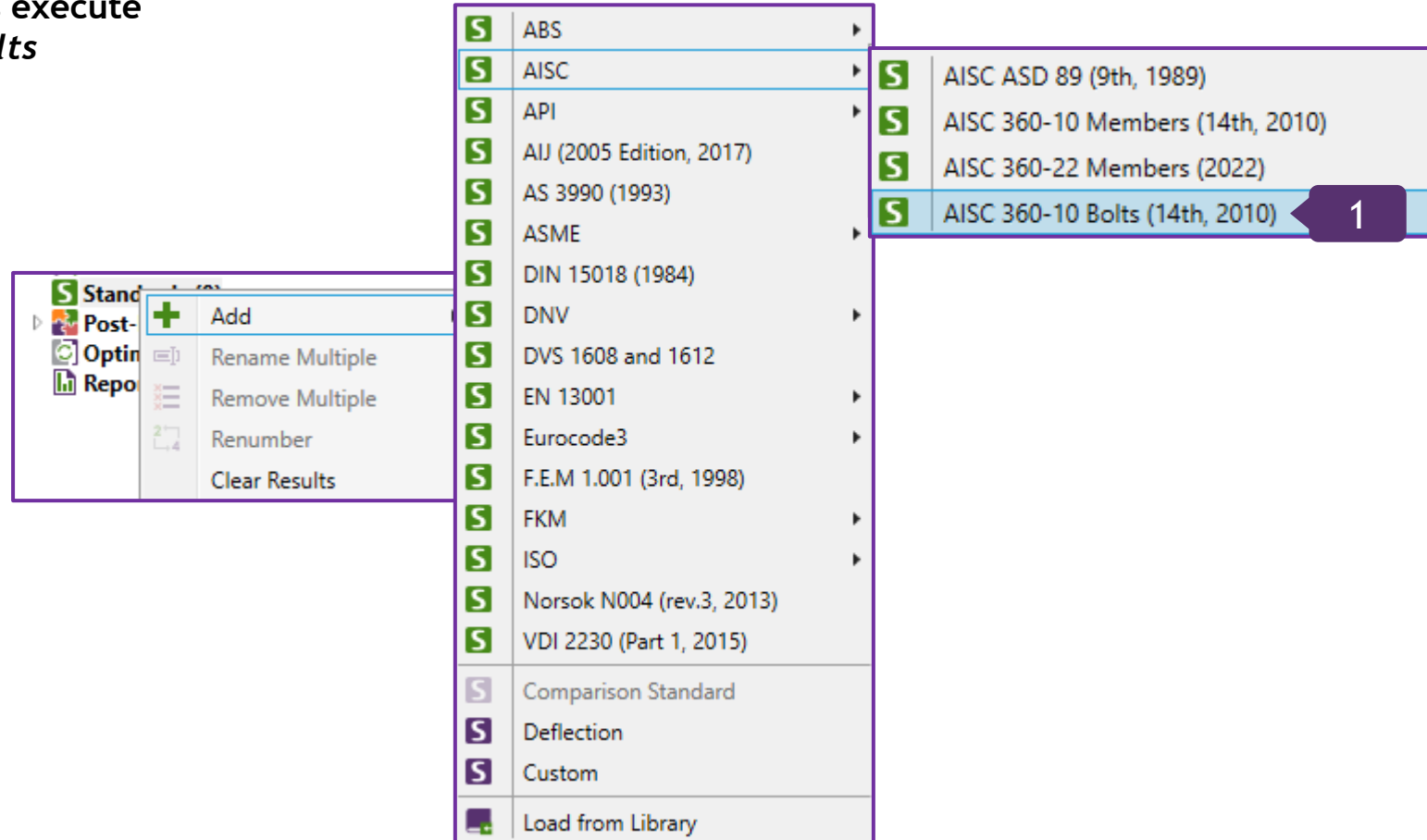
- 1 Go to *Home* section on the Ribbon.
- 2 Press  on the toolbar to analyze job.



# Add AISC 360-10 Bolts (14th, 2010) Standard

1

In the *Model tree*, in Standards execute  
*Add => AISC => AISC 360-10 Bolts*  
*(14th,2010)*



# Reference tables of AISC 360-10 Bolts (14th, 2010)

TABLE J3.2 Nominal Strength of Fasteners and Threaded Parts, ksi (MPa)		
Description of Fasteners	Nominal Tensile Strength, $F_{nt}$ , ksi (MPa) <sup>[a]</sup>	Nominal Shear Strength in Bearing-Type Connections, $F_{nv}$ , ksi (MPa) <sup>[b]</sup>
A307 bolts	45 (310)	27 (188) <sup>[c] [d]</sup>
Group A (e.g., A325) bolts, when threads are not excluded from shear planes	90 (620)	54 (372)
Group A (e.g., A325) bolts, when threads are excluded from shear planes	90 (620)	68 (457)
Group B (e.g., A490) bolts, when threads are not excluded from shear planes	113 (780)	68 (457)
Group B (e.g., A490) bolts, when threads are excluded from shear planes	113 (780)	84 (579)
Threaded parts meeting the requirements of Section A3.4, when threads are not excluded from shear planes	$0.75F_u$	$0.450F_u$
Threaded parts meeting the requirements of Section A3.4, when threads are excluded from shear planes	$0.75F_u$	$0.563F_u$

TABLE J3.1M Minimum Bolt Pretension, kN*		
Bolt Size, mm	Group A ( e.g., A325M Bolts)	Group B ( e.g., A490M Bolts)
M16	91	114
M20	142	179
M22	176	221
M24	205	257
M27	267	334
M30	326	408
M36	475	595

\*Equal to 0.70 times the minimum tensile strength of bolts, rounded off to nearest kN, as specified in ASTM specifications for A325M and A490M bolts with UNC threads.

TABLE J3.3M Nominal Hole Dimensions, mm				
Bolt Diameter, mm	Hole Dimensions			
	Standard (Dia.)	Oversize (Dia.)	Short-Slot (Width × Length)	Long-Slot (Width × Length)
M16	18	20	18 × 22	18 × 40
M20	22	24	22 × 26	22 × 50
M22	24	28	24 × 30	24 × 55
M24	27 <sup>[a]</sup>	30	27 × 32	27 × 60
M27	30	35	30 × 37	30 × 67
M30	33	38	33 × 40	33 × 75
≥ M36	$d + 3$	$d + 8$	$(d + 3) \times (d + 10)$	$(d + 3) \times 2.5d$

<sup>[a]</sup> Clearance provided allows the use of a 1-in. bolt if desirable.

- 2..AISC 360-10 Bolts
  - Input
    - Constants (7)
    - Types (3)
    - Characteristic (9)
    - Classifications (0)
    - Standard Tables (0)
  - Checks (4)
    - 1..Bolt Check
    - 2..Bolt Check ASD
    - 3..Bolt Check LRFD
    - 4..Bolt Overall

Standard contains 4 checks:

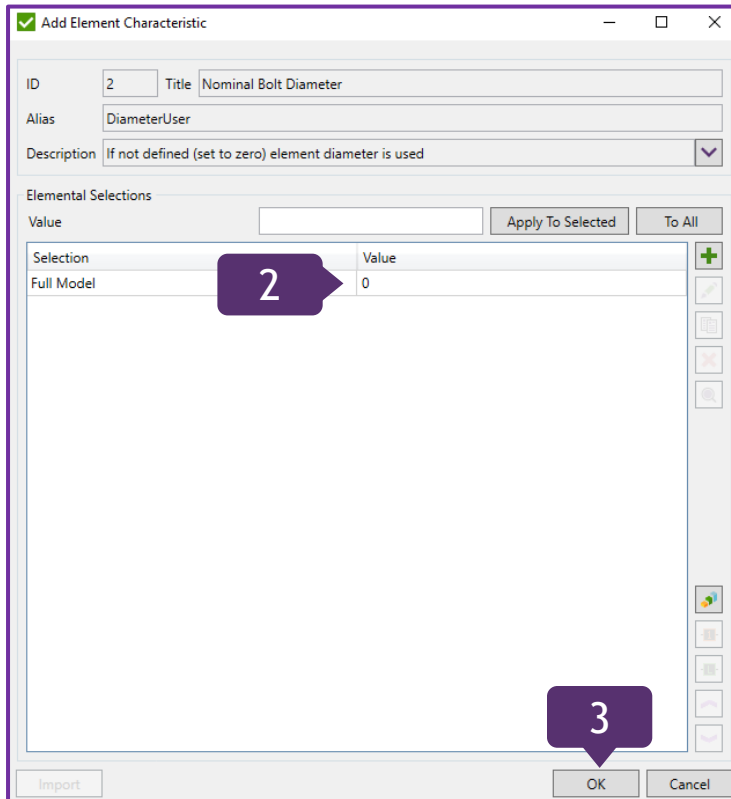
- 1 - Bolt Check;
- 2 - Bolt Check ASD;
- 3 - Bolt Check LRFD;
- 4 - Bolt Overall.

# Define Nominal Bolt Diameter

1 Press  in Nominal Bolt Diameter

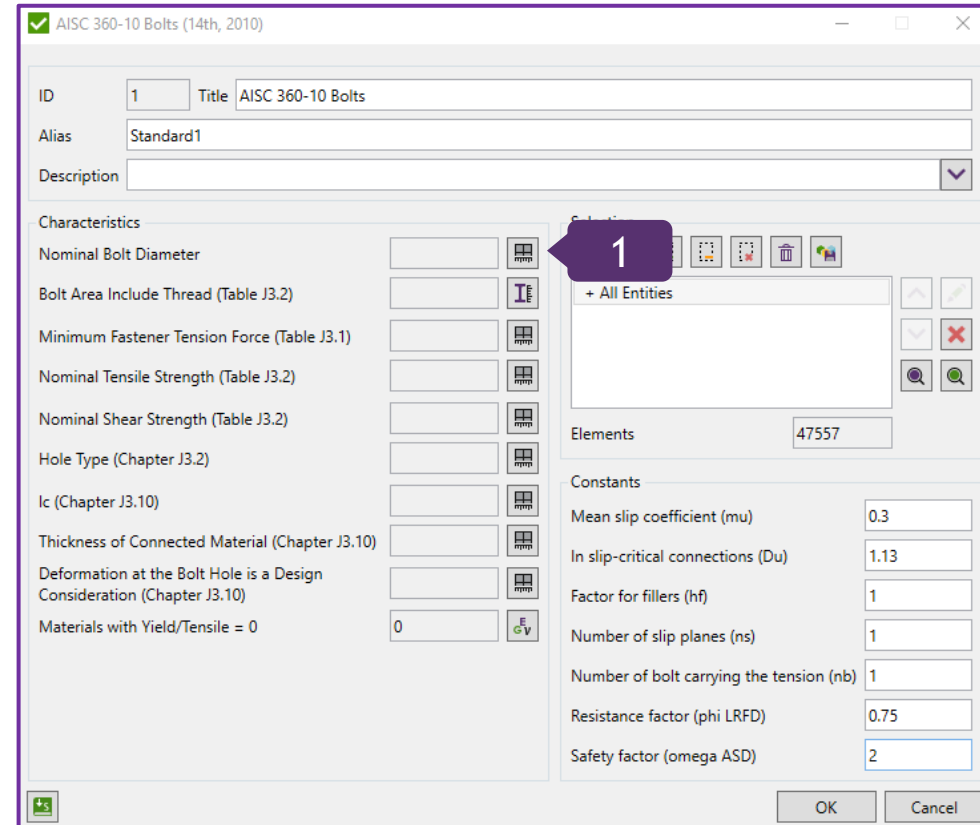
2 Selection Value: 0

3 Press OK



Selection	Value
Full Model	0

Nominal Bolt Diameter is a diameter of bolt in connection. If it is not defined (set to zero), an element diameter is used.



Characteristics	Value
Nominal Bolt Diameter	
Bolt Area Include Thread (Table J3.2)	
Minimum Fastener Tension Force (Table J3.1)	
Nominal Tensile Strength (Table J3.2)	
Nominal Shear Strength (Table J3.2)	
Hole Type (Chapter J3.2)	
Ic (Chapter J3.10)	
Thickness of Connected Material (Chapter J3.10)	
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	
Materials with Yield/Tensile = 0	0

Constants	Value
Mean slip coefficient ( $\mu$ )	0.3
In slip-critical connections ( $D_u$ )	1.13
Factor for fillers ( $h_f$ )	1
Number of slip planes ( $n_s$ )	1
Number of bolt carrying the tension ( $n_b$ )	1
Resistance factor ( $\phi$ LRFD)	0.75
Safety factor ( $\omega$ ASD)	2



# Define Bolt Area Include Thread (Table J3.2)

1

Press  in Bolt Area Include Thread (Table J3.2)

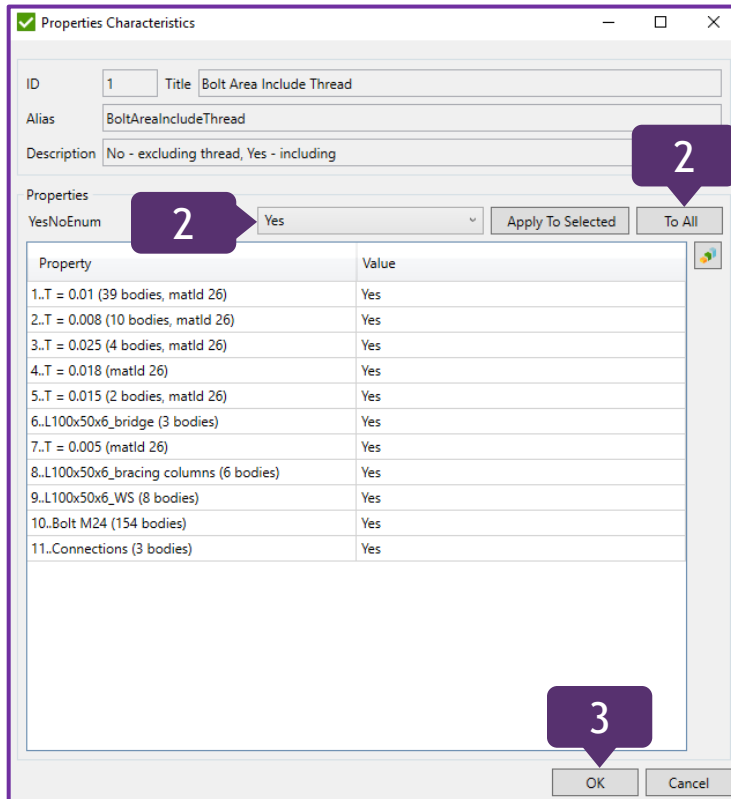
2

Properties YesNoEnum: Yes and press *To All*

3

Press *OK*

Bolt Area Include Thread provides two options: set Yes if to take into account the bolt thread; set No if to neglect it (Table J3.2)



Properties Characteristics

ID: 1 Title: Bolt Area Include Thread

Alias: BoltAreaIncludeThread

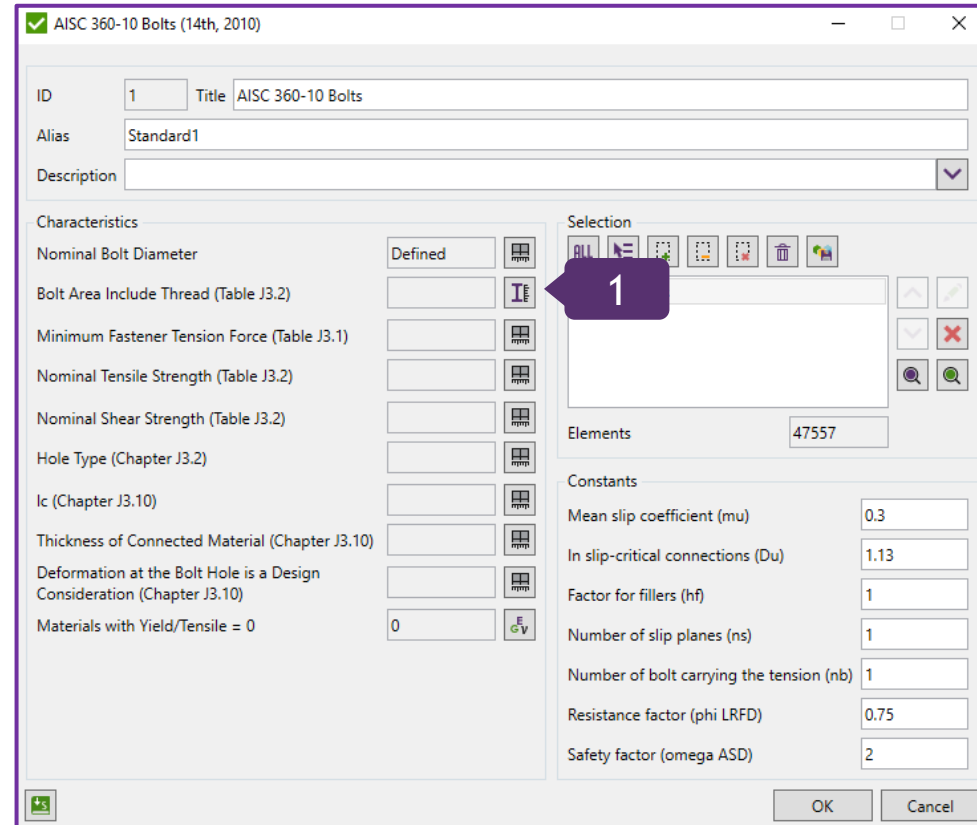
Description: No - excluding thread, Yes - including

Properties YesNoEnum: Yes

Apply To Selected To All

Property	Value
1..T = 0.01 (39 bodies, matld 26)	Yes
2..T = 0.008 (10 bodies, matld 26)	Yes
3..T = 0.025 (4 bodies, matld 26)	Yes
4..T = 0.018 (matld 26)	Yes
5..T = 0.015 (2 bodies, matld 26)	Yes
6..L100x50x6_bridge (3 bodies)	Yes
7..T = 0.005 (matld 26)	Yes
8..L100x50x6_bracing columns (6 bodies)	Yes
9..L100x50x6_WS (8 bodies)	Yes
10..Bolt M24 (154 bodies)	Yes
11..Connections (3 bodies)	Yes

OK Cancel



AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter

Bolt Area Include Thread (Table J3.2)

Minimum Fastener Tension Force (Table J3.1)

Nominal Tensile Strength (Table J3.2)

Nominal Shear Strength (Table J3.2)

Hole Type (Chapter J3.2)

Ic (Chapter J3.10)

Thickness of Connected Material (Chapter J3.10)

Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)

Materials with Yield/Tensile = 0

Selection

Elements: 47557

Constants

Mean slip coefficient (mu): 0.3

In slip-critical connections (Du): 1.13

Factor for fillers (hf): 1

Number of slip planes (ns): 1

Number of bolt carrying the tension (nb): 1


Resistance factor (phi LRFD): 0.75

Safety factor (omega ASD): 2

OK Cancel

# Define Minimum Fastener Tension Force (Table J3.1)

1

Press  in Minimum Fastener Tension Force (Table J3.1)

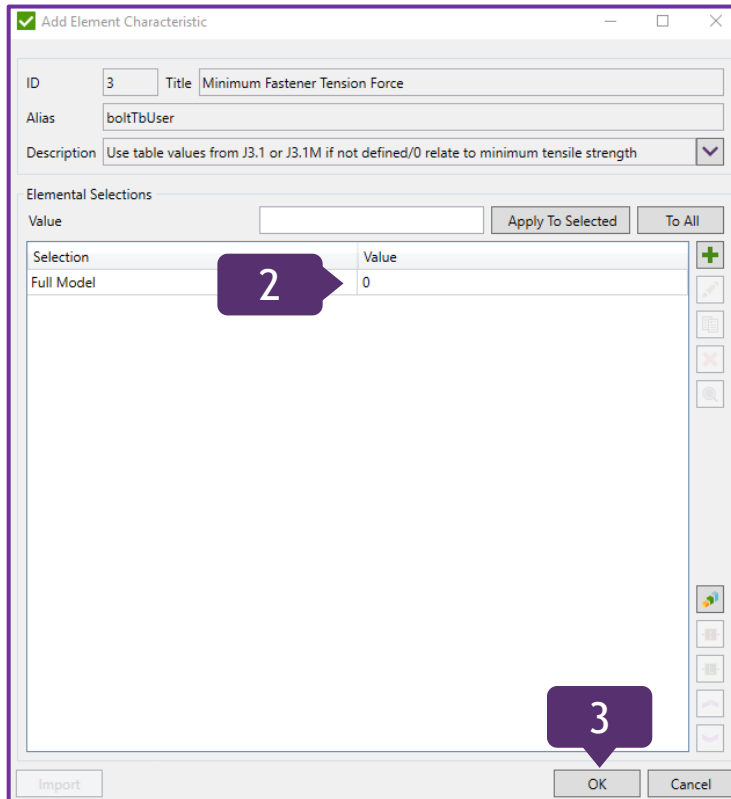
2

Selection Value: 0

3

Press **OK**

Minimum Fastener Tension Force - values from Tables J3.1 and J3.1M. If not defined (set to zero) - 70% of the minimum tensile strength of bolts will be used.



✓ Add Element Characteristic

ID: 3 Title: Minimum Fastener Tension Force

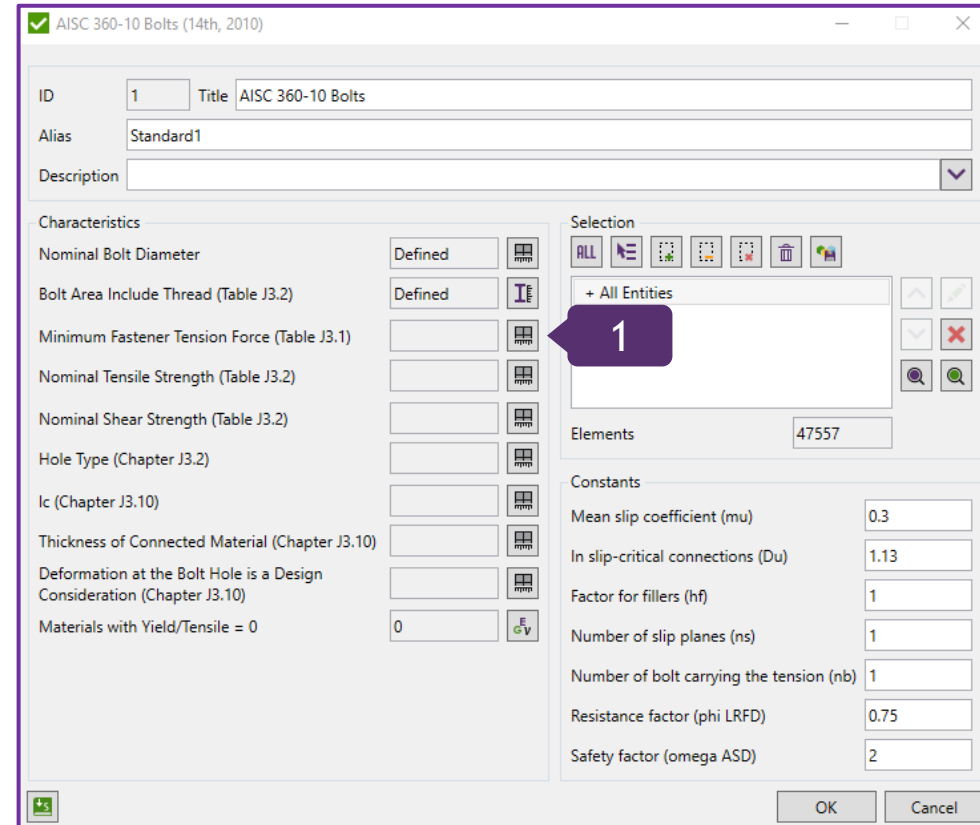
Alias: boltTbUser

Description: Use table values from J3.1 or J3.1M if not defined/0 relate to minimum tensile strength

Elemental Selections

Selection	Value
Full Model	0

Import OK Cancel



✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter: Defined

Bolt Area Include Thread (Table J3.2): Defined

Minimum Fastener Tension Force (Table J3.1):

Nominal Tensile Strength (Table J3.2):

Nominal Shear Strength (Table J3.2):

Hole Type (Chapter J3.2):

Ic (Chapter J3.10):

Thickness of Connected Material (Chapter J3.10):

Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10):

Materials with Yield/Tensile = 0: 0

Selection

+ All Entities

Elements: 47557

Constants

Mean slip coefficient (mu): 0.3

In slip-critical connections (Du): 1.13

Factor for fillers (hf): 1

Number of slip planes (ns): 1

Number of bolt carrying the tension (nb): 1


Resistance factor (phi LRFD): 0.75

Safety factor (omega ASD): 2

OK Cancel

# Define Nominal Tensile Strength (Table J3.2)

1

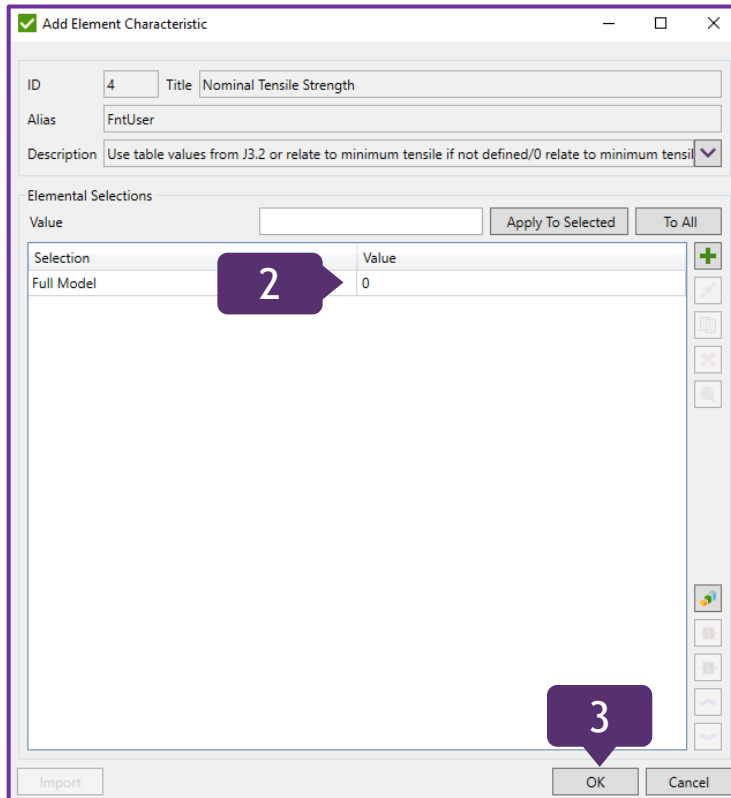
Press  in Nominal Tensile Strength (Table J3.2)

2

Selection Value: 0

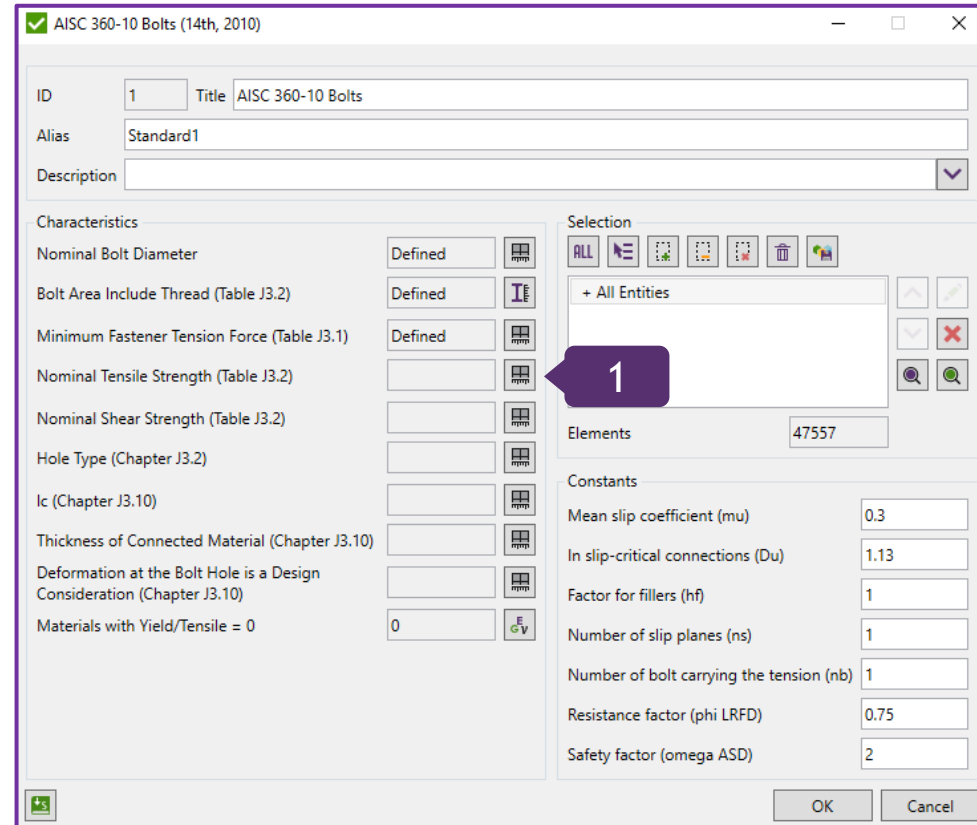
3

Press *OK*



Selection	Value
Full Model	0

Nominal Tensile Strength - values from Table J3.2 (Fnt). If not defined (set to zero) - 75% of the minimum tensile strength of bolts will be used.




Characteristics	Defined
Nominal Bolt Diameter	Defined
Bolt Area Include Thread (Table J3.2)	Defined
Minimum Fastener Tension Force (Table J3.1)	Defined
Nominal Tensile Strength (Table J3.2)	Defined
Nominal Shear Strength (Table J3.2)	Defined
Hole Type (Chapter J3.2)	Defined
Ic (Chapter J3.10)	Defined
Thickness of Connected Material (Chapter J3.10)	Defined
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	Defined
Materials with Yield/Tensile = 0	0

Constants	Value
Mean slip coefficient (mu)	0.3
In slip-critical connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

# Define Nominal Shear Strength (Table J3.2)

1

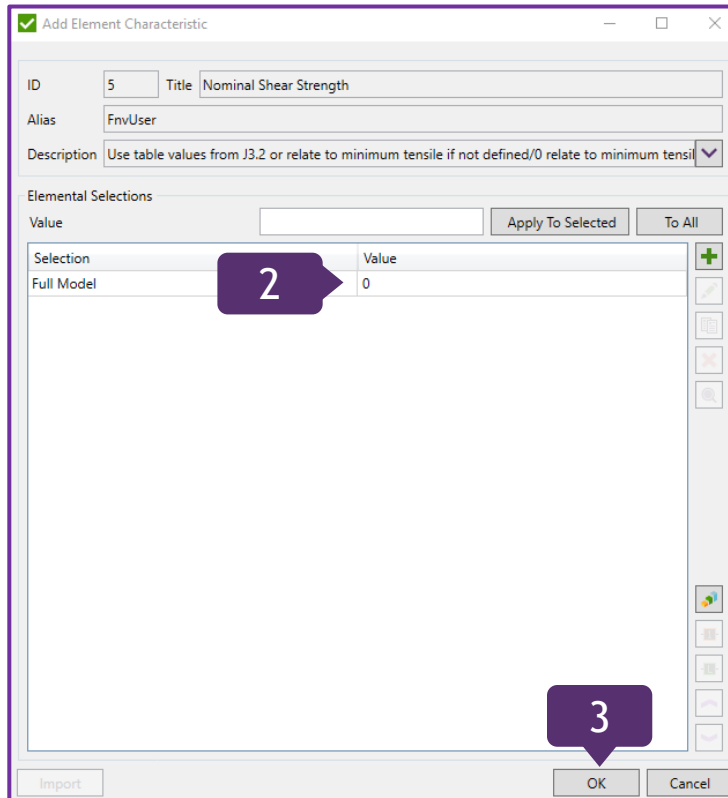
Press  in Nominal Shear Strength (Table J3.2)

2

Selection Value: 0

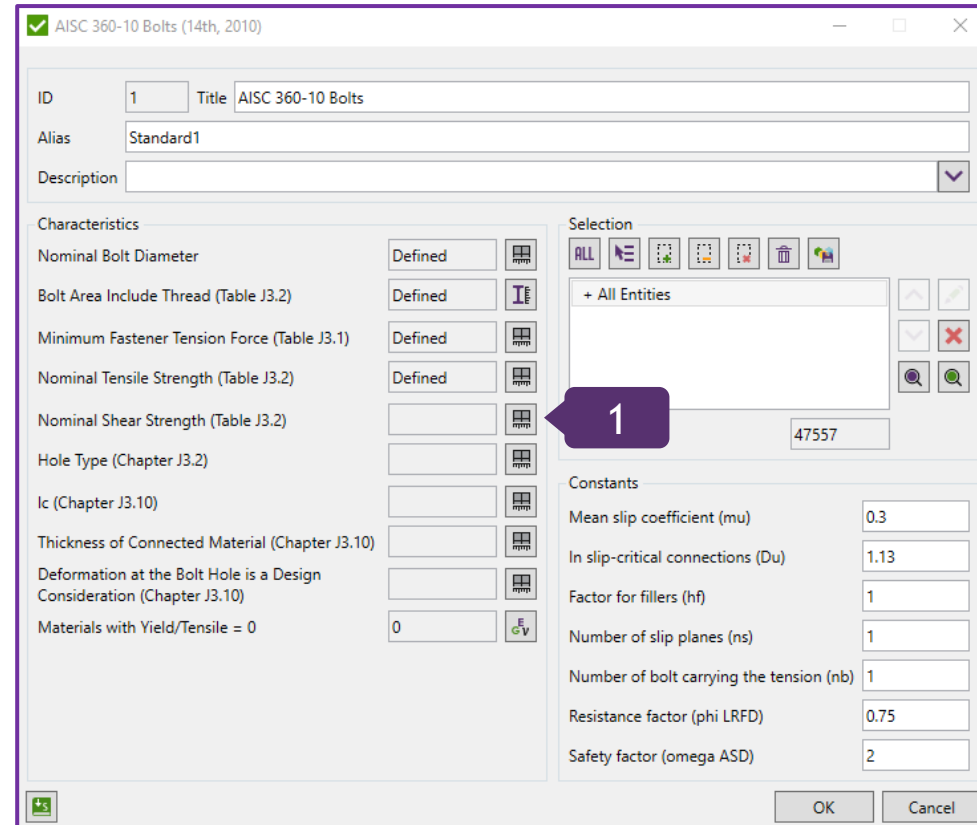
3

Press OK



Selection	Value
Full Model	0

Nominal Shear Strength - values from Table J3.2 (Frv). If not defined (set to zero) - 56.3% or 45% of the minimum tensile strength of bolts will be used.



Characteristics	Defined
Nominal Bolt Diameter	Defined
Bolt Area Include Thread (Table J3.2)	Defined
Minimum Fastener Tension Force (Table J3.1)	Defined
Nominal Tensile Strength (Table J3.2)	Defined
Nominal Shear Strength (Table J3.2)	47557
Hole Type (Chapter J3.2)	
Ic (Chapter J3.10)	
Thickness of Connected Material (Chapter J3.10)	
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	
Materials with Yield/Tensile = 0	0

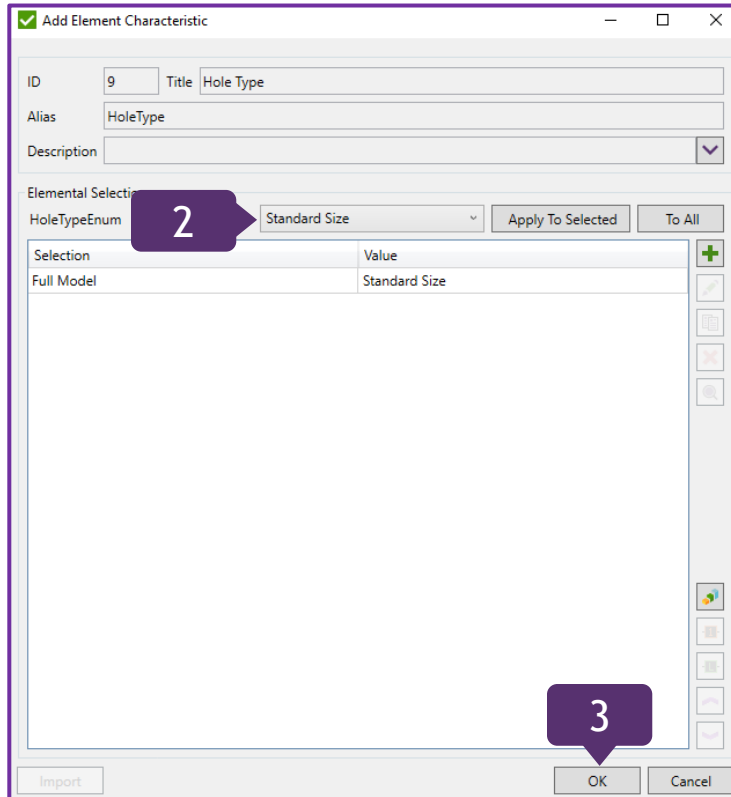
Constants	Value
Mean slip coefficient (mu)	0.3
In slip-critical connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

# Define Hole Type (Chapter J3.2)

1 Press  in Hole Type (Chapter J3.2)

2 Elemental Selections HoleTypeEnum:  
*Standard Size*

3 Press *OK*



✓ Add Element Characteristic

ID: 9 Title: Hole Type

Alias: HoleType

Description:

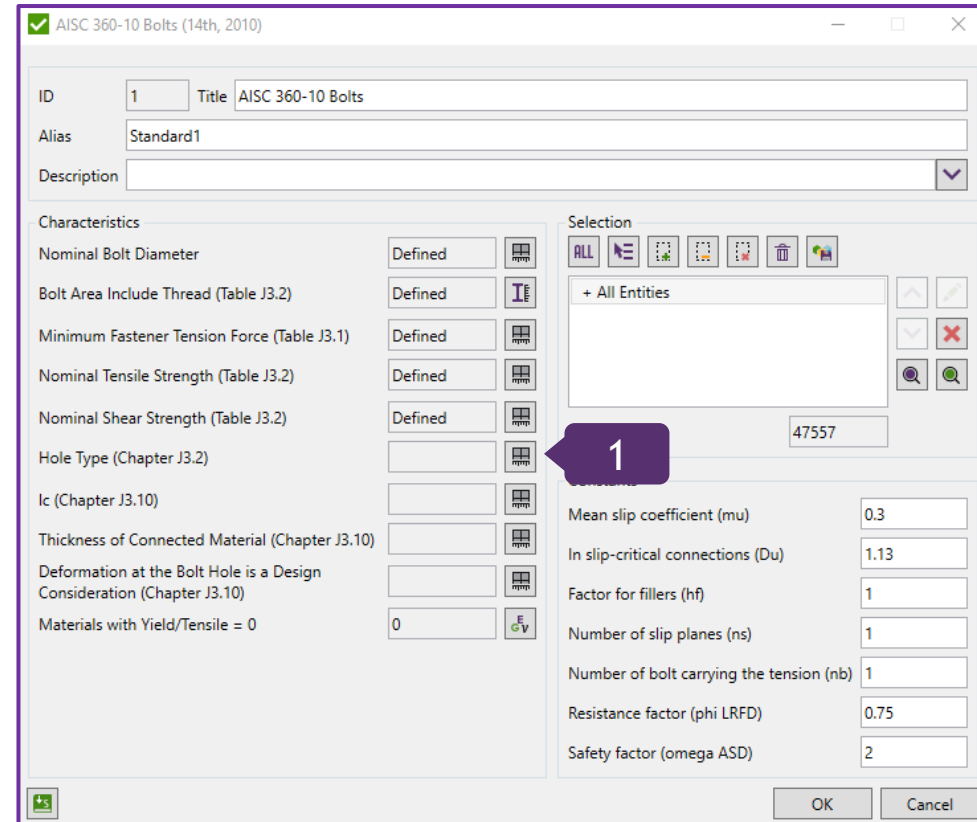
Elemental Selections

HoleTypeEnum: Standard Size

Selection: Full Model Value: Standard Size

OK Cancel

Hole Type - type of hole has to be defined (Table J3.3)



✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter: Defined

Bolt Area Include Thread (Table J3.2): Defined

Minimum Fastener Tension Force (Table J3.1): Defined

Nominal Tensile Strength (Table J3.2): Defined

Nominal Shear Strength (Table J3.2): Defined

Hole Type (Chapter J3.2): Standard Size

Ic (Chapter J3.10):

Thickness of Connected Material (Chapter J3.10):

Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10):

Materials with Yield/Tensile = 0: 0

Selection

+ All Entities

Mean slip coefficient (mu): 0.3

In slip-critical connections (Du): 1.13

Factor for fillers (hf): 1

Number of slip planes (ns): 1

Number of bolt carrying the tension (nb): 1

Resistance factor (phi LRFD): 0.75

Safety factor (omega ASD): 2

OK Cancel

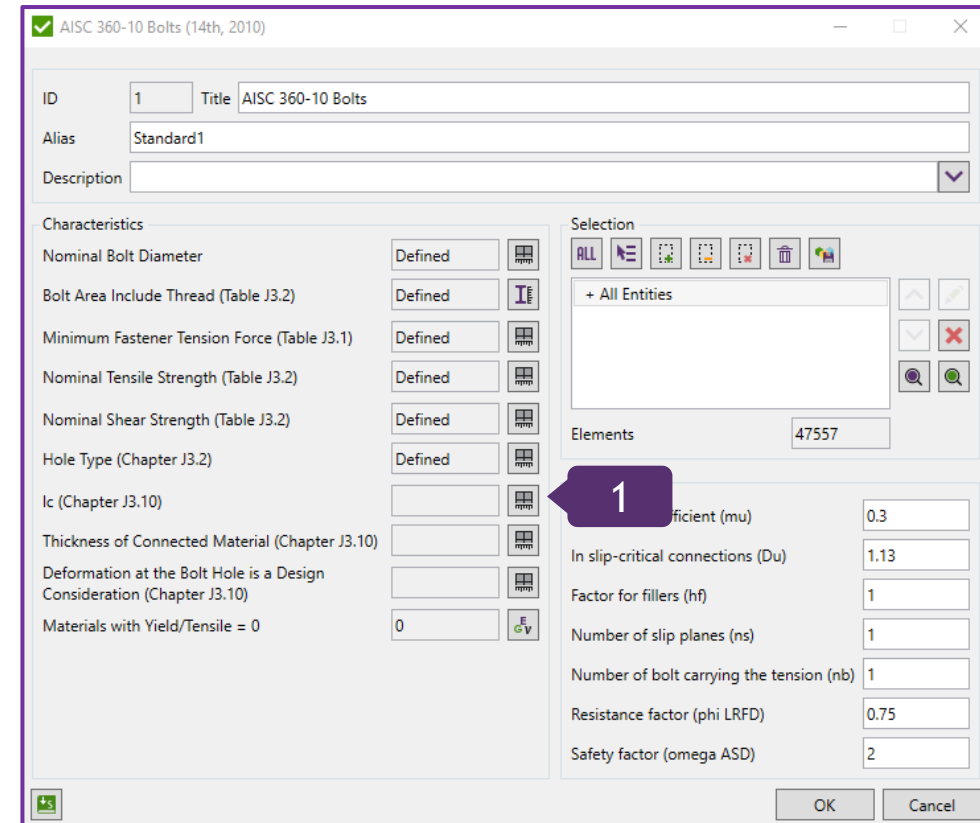
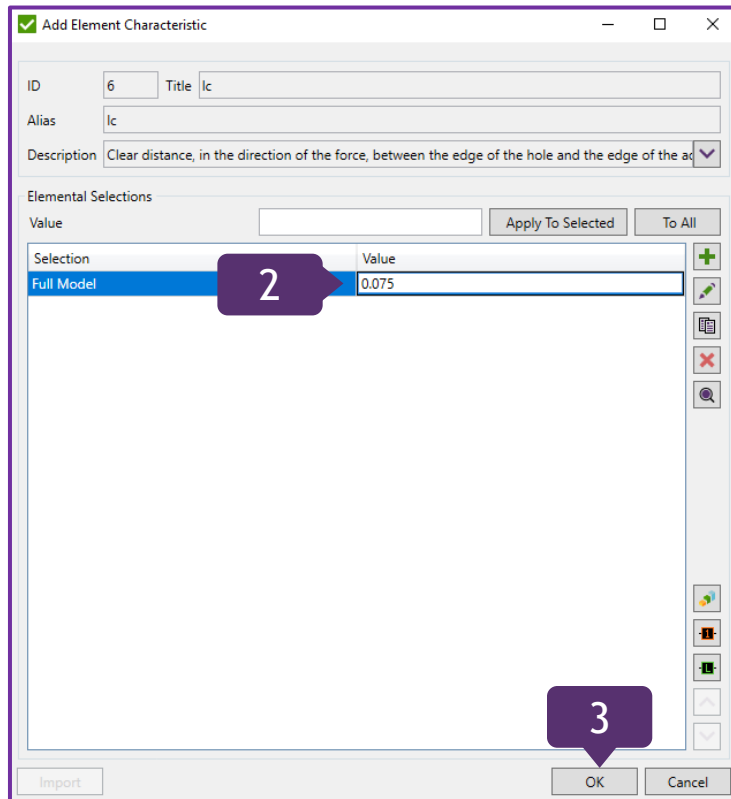
# Define Ic (Chapter J3.10)

1 Press  in Ic (Chapter J3.10)

2 Selection Value: 0.075

3 Press OK

Ic is a clear distance, that is in the direction of the force, between the edge of the hole, the edge of the adjacent hole or the edge of the material (Chapter J3.10)



# Define Thickness of Connected Material (Chapter J3.10)

1

Press  in Thickness of Connected Material (Chapter J3.10)

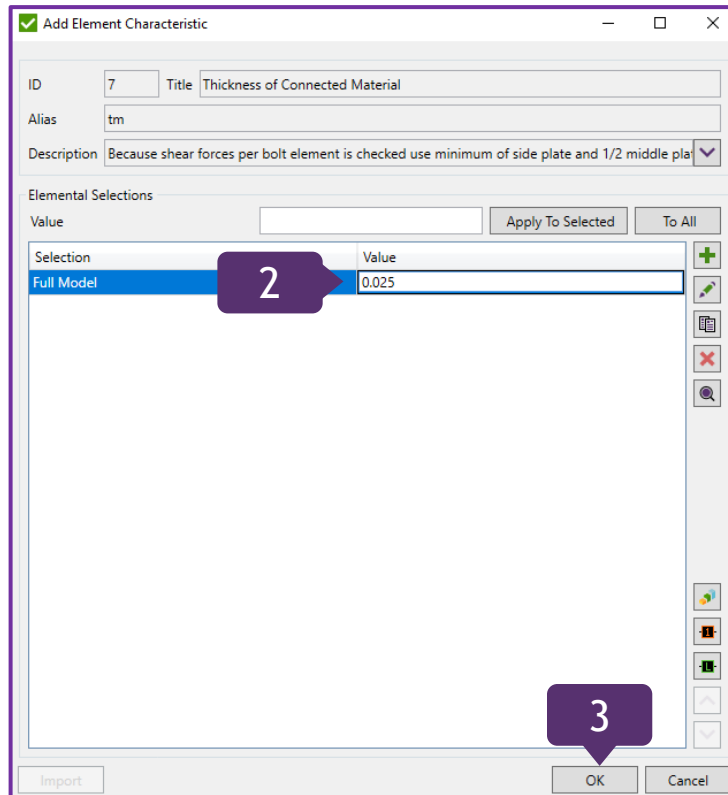
2

Selection Value: 0.025

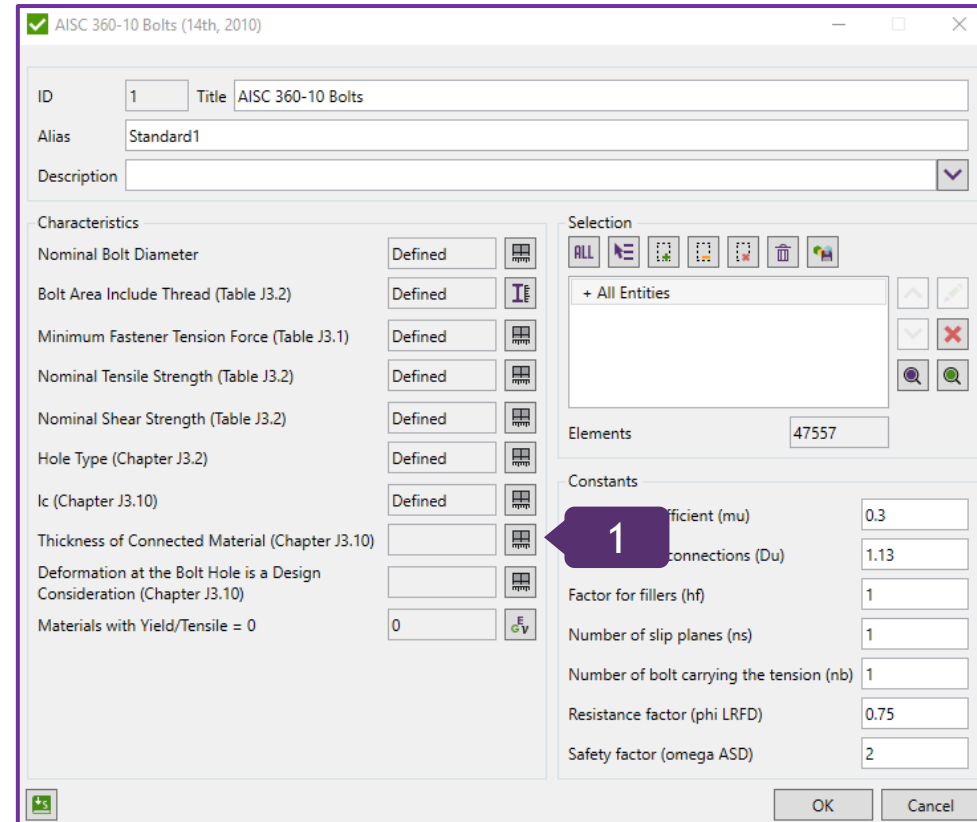
3

Press OK

Thickness of Connected Material - because shear forces per bolt element are checked, use minimum of side plate and 1/2 middle plate (Chapter J3.10)



Selection	Value
Full Model	0.025




Characteristic	Value
Nominal Bolt Diameter	Defined
Bolt Area Include Thread (Table J3.2)	Defined
Minimum Fastener Tension Force (Table J3.1)	Defined
Nominal Tensile Strength (Table J3.2)	Defined
Nominal Shear Strength (Table J3.2)	Defined
Hole Type (Chapter J3.2)	Defined
Ic (Chapter J3.10)	Defined
Thickness of Connected Material (Chapter J3.10)	Defined
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	Defined
Materials with Yield/Tensile = 0	0

Constant	Value
Coefficient (mu)	0.3
Connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

# Define Deformation at the Bolt Hole is a Design Consideration

1

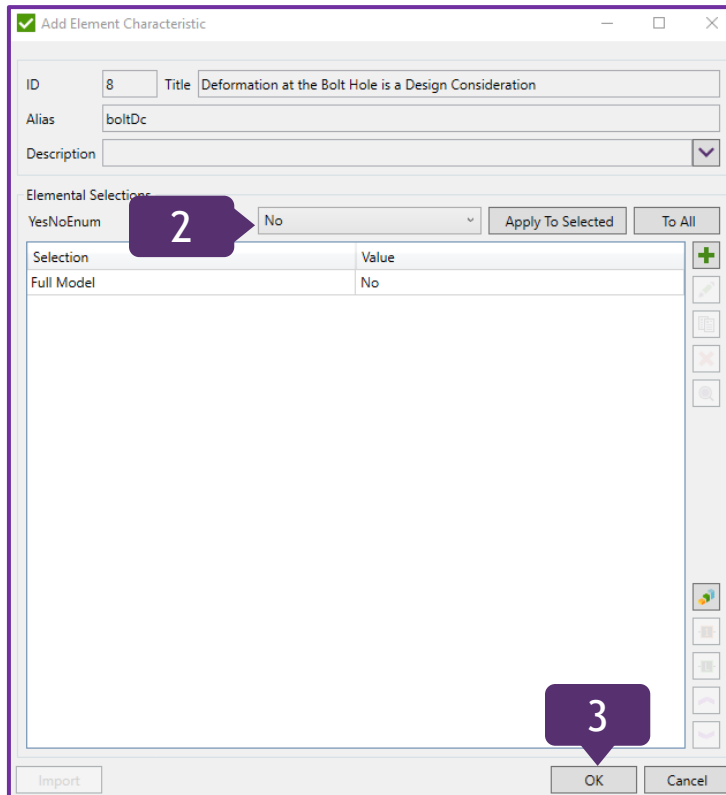
Press  in Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)

2

Elemental Selections YesNoEnum: No

3

Press OK



✓ Add Element Characteristic

ID: 8 Title: Deformation at the Bolt Hole is a Design Consideration

Alias: boltDc

Description:

Elemental Selections:

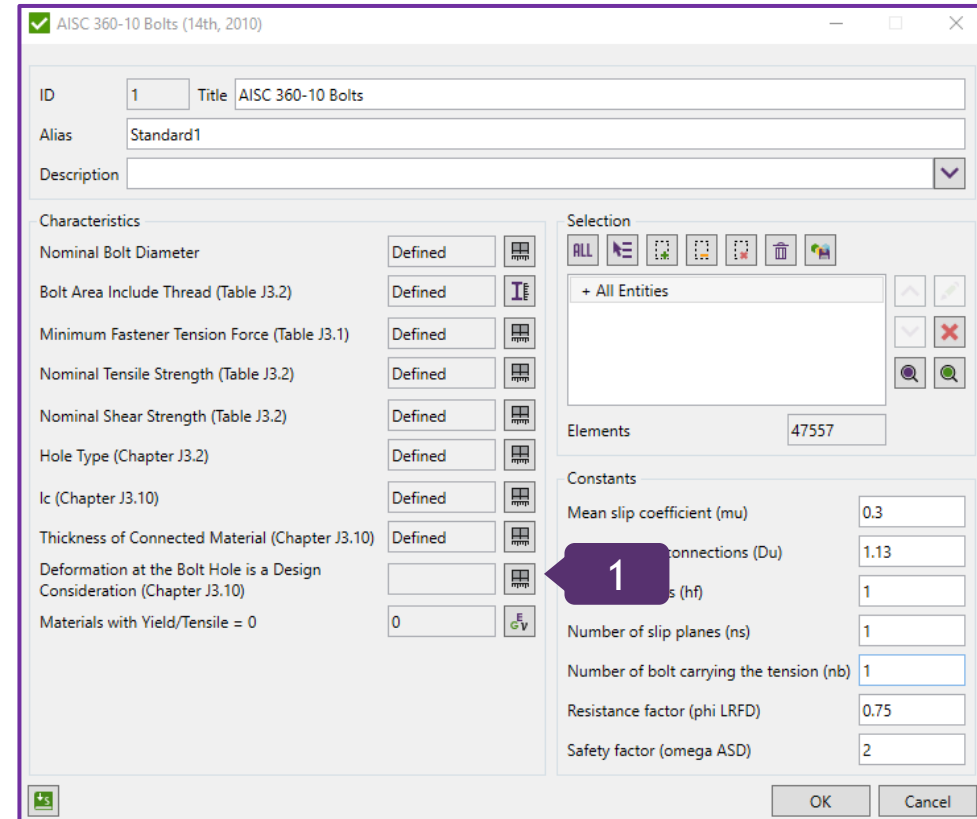
YesNoEnum: No (Callout 2)

Selection: Full Model

Value: No

OK Cancel

Deformation at the Bolt Hole is a Design Consideration - set Yes if it is provided for design of construction.



✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics:

Nominal Bolt Diameter: Defined

Bolt Area Include Thread (Table J3.2): Defined

Minimum Fastener Tension Force (Table J3.1): Defined

Nominal Tensile Strength (Table J3.2): Defined

Nominal Shear Strength (Table J3.2): Defined

Hole Type (Chapter J3.2): Defined

Ic (Chapter J3.10): Defined

Thickness of Connected Material (Chapter J3.10): Defined

Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10): (Callout 1)

Materials with Yield/Tensile = 0: 0

Selection:

+ All Entities

Elements: 47557

Constants:

Mean slip coefficient (mu): 0.3

Connections (Du): 1.13

Connections (hf): 1

Number of slip planes (ns): 1

Number of bolt carrying the tension (nb): 1

Resistance factor (phi LRFD): 0.75

Safety factor (omega ASD): 2

OK Cancel



# The Explanation of Constants

✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter	Defined	
Bolt Area Include Thread (Table J3.2)	Defined	
Minimum Fastener Tension Force (Table J3.1)	Defined	
Nominal Tensile Strength (Table J3.2)	Defined	
Nominal Shear Strength (Table J3.2)	Defined	
Hole Type (Chapter J3.2)	Defined	
Ic (Chapter J3.10)	Defined	
Thickness of Connected Material (Chapter J3.10)	Defined	
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	Defined	
Materials with Yield/Tensile = 0	0	

Selection

+ All Entities

Elements: 47557

Constants


Mean slip coefficient (mu)	0.3
In slip-critical connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

OK Cancel

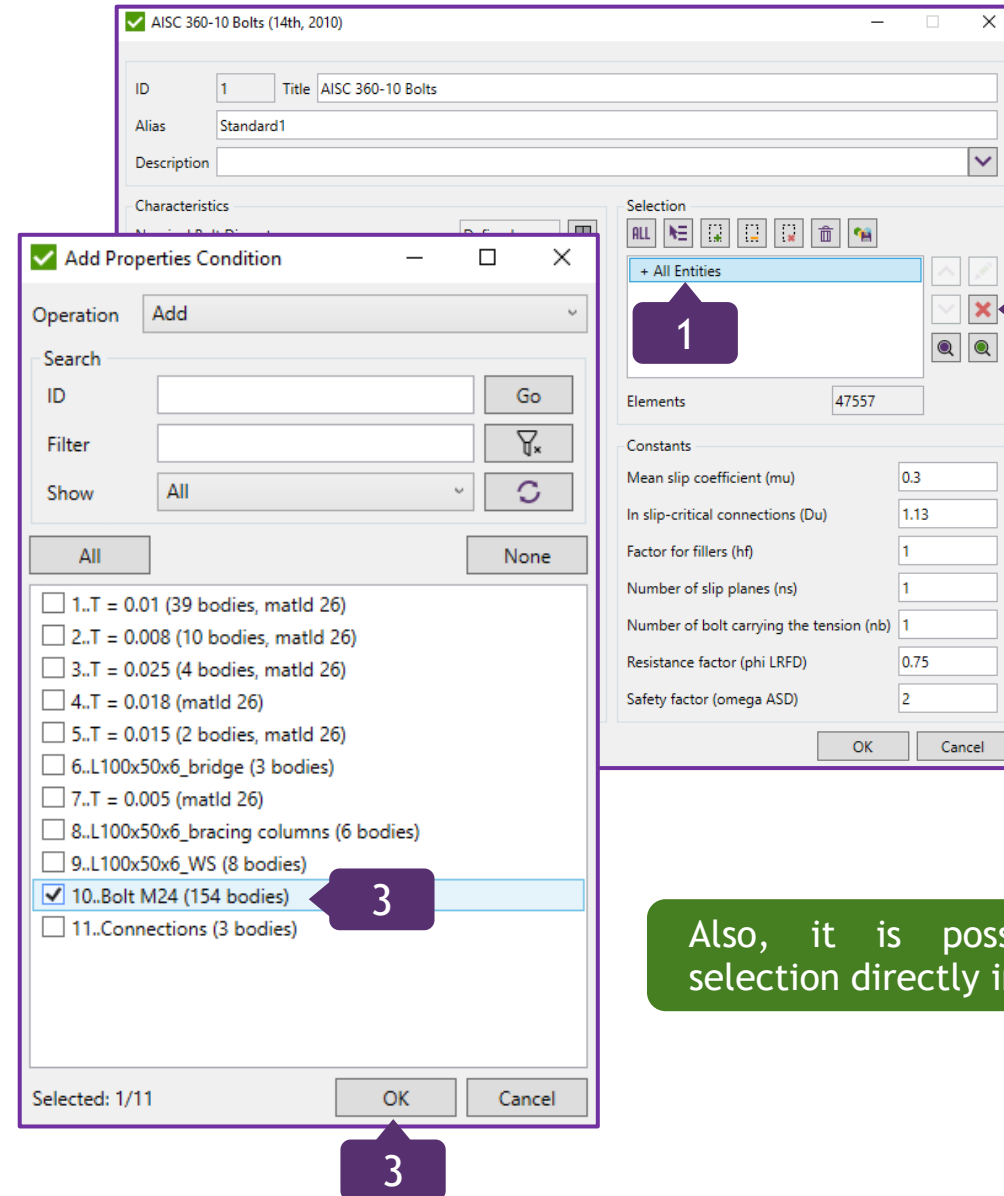
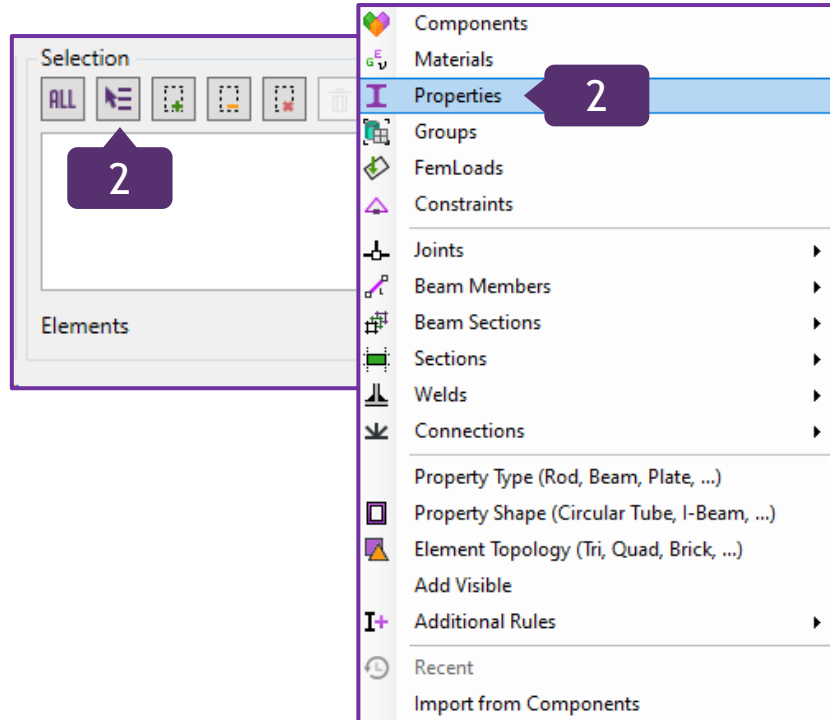
mu - a coefficient of friction between plates needs for slip check;  
Du - multiplier that reflects the ratio of the mean installed bolt pretension to the specified minimum bolt pretension;  
hf - factor for fillers;  
ns - number of slip planes required to permit the connection to slip;  
nb - number of bolts carrying the applied tension;  
phi LRFD - factor for calculation by LRFD method;  
Omega ASD - factor for calculation by ASD method;

# Change Selection

1 Select **+All Entities** and press  to remove them

2 In Selection, press  and select **Properties**

3 Select **Property 10.Bolt\_M24** (154 bodies) and press **OK**



Also, it is possible to change selection directly in Check settings.

1

Press OK

Custom Check (built-in, not editable)

ID: 1 Title: Bolt Check

Alias: BoltCheck

Description: AISC Chapter J3. BOLTS AND THREADED PARTS

☒ Show Parameter Description

Options

☐ Calculate Results over Directions

☒ Calculate Results over Points

Load Calculation: All Loads

Selection: Beam '10..Bolt M24 (154 bodies)'

Parameters (13) / Replacements (0)

```
Parameter = d (Nominal Bolt Diameter)
if(DiameterUser > 0, DiameterUser, R * 2)

Parameter = Ab (Nominal Unthreaded Body Area of Bolt)
PI * pow(d, 2) / 4

Parameter = boltTb (Minimum Fastener Tension Force)
Description: Table J3.1
if(boltTbUser = 0, Tensile * 0.7 * Ab, boltTbUser)

Parameter = Fnt (Nominal Tensile Strength)
Description: Table J3.2
if(FntUser = 0, Tensile * 0.75, FntUser)

Parameter = Fnv (Nominal Shear Strength)
Description: Table J3.2
if(FnvUser = 0, if(BoltAreaIncludeThread = YesNoEnum.No, Tensile * 0.563, Tensile * 0.45),
FnvUser)

Parameter = RnTensile (Limit States of Tension Rupture)
```

Clear results

OK Cancel

AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter	Defined	
Bolt Area Include Thread (Table J3.2)	Defined	
Minimum Fastener Tension Force (Table J3.1)	Defined	
Nominal Tensile Strength (Table J3.2)	Defined	
Nominal Shear Strength (Table J3.2)	Defined	
Hole Type (Chapter J3.2)	Defined	
Ic (Chapter J3.10)	Defined	
Thickness of Connected Material (Chapter J3.10)	Defined	
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	Defined	
Materials with Yield/Tensile = 0	0	

Selection

+ Beam '10..Bolt M24 (154 bodies)'

Elements: 154

Constants


Mean slip coefficient (mu)	0.3
In slip-critical connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

1

OK Cancel

# Create check parameters table

1

Execute  **Table (expand/extreme)** in Standards => Checks => 1..Bolt Check context menu

2

In Load Group, press 

3

Select **Load Group** => **1..Overall** and press **OK**

4

Table Type: **Extreme (worst result on selection)**

5

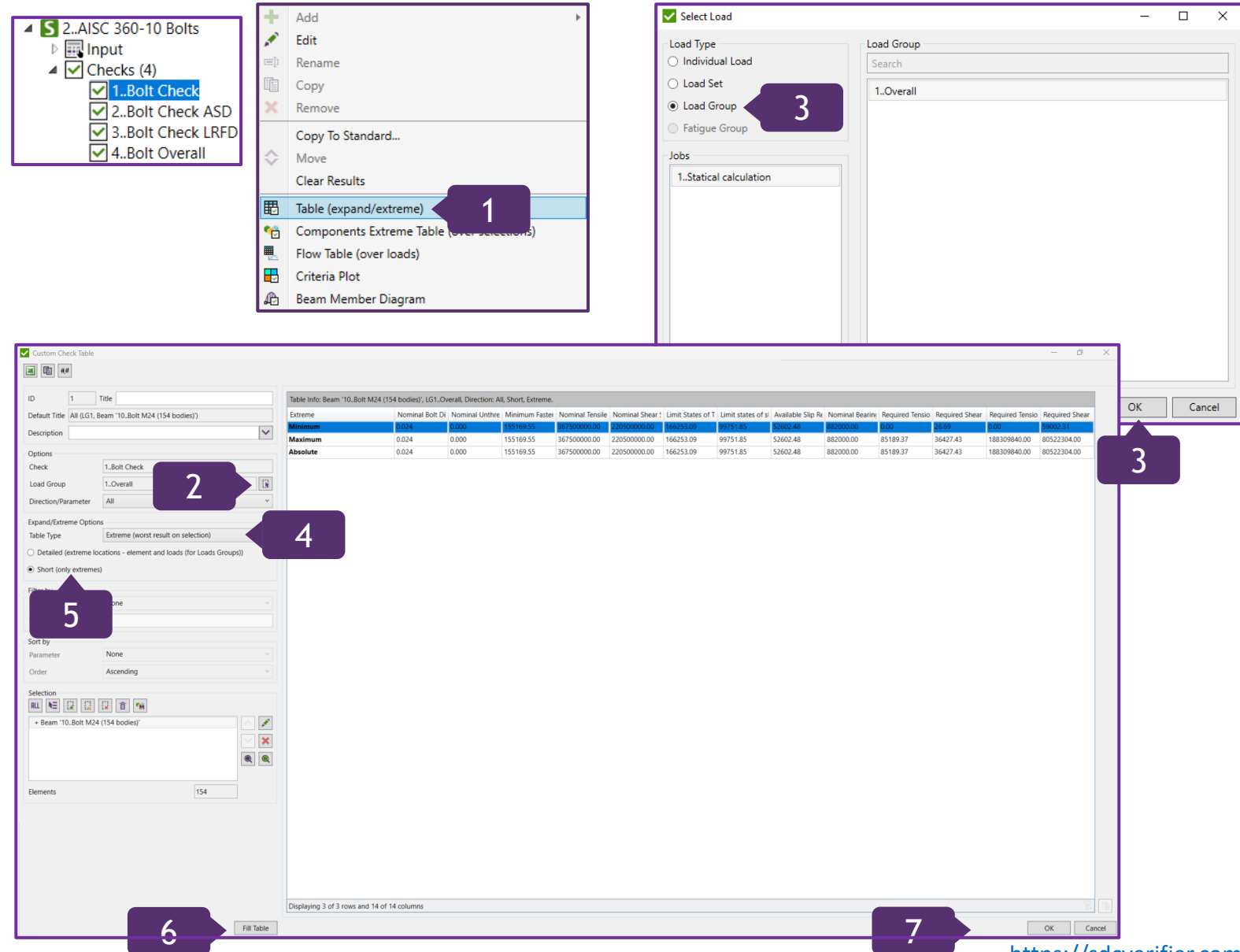
Table Type: **Short (only extremes)- ON**

6

Press **Fill Table**

7

Press **OK**



**2..AISC 360-10 Bolts**

- Input
- Checks (4)
  - 1..Bolt Check
  - 2..Bolt Check ASD
  - 3..Bolt Check LRFD
  - 4..Bolt Overall

**Select Load**

Load Type

- Individual Load
- Load Set
- Load Group**
- Fatigue Group

Load Group

Search

1..Overall

Jobs

1..Static calculation

**Custom Check Table**

ID: 1 Title:

Default Title: All (LG1, Beam "10.Bolt M24 (154 bodies)")

Description:

Options

Check: 1..Bolt Check

Load Group: 1..Overall

Direction/Parameter: All

Expand/Extreme Options

Table Type: **Extreme (worst result on selection)**

☐ Detailed (extreme locations - element and loads (for Loads Groups))

☒ **Short (only extremes)**

Fill Table:

Sort by: None

Order: Ascending

Selection

+ Beam "10.Bolt M24 (154 bodies)"

Elements: 154

Table Info: Beam "10.Bolt M24 (154 bodies)", LG1-Overall, Direction: All, Short, Extreme.

Extreme	Nominal Bolt Di	Nominal Unthre	Minimum Fasten	Nominal Tensile	Nominal Shear	Limit States of T	Limit states of s	Available Slip R	Nominal Bearin	Required Tensio	Required Shear	Required Tensio	Required Shear
<b>Minimum</b>	0.024	0.000	155169.55	367500000.00	220500000.00	166253.09	99751.85	52602.48	882000.00	85189.37	36427.43	188309840.00	80522304.00
<b>Maximum</b>	0.024	0.000	155169.55	367500000.00	220500000.00	166253.09	99751.85	52602.48	882000.00	85189.37	36427.43	188309840.00	80522304.00
<b>Absolute</b>	0.024	0.000	155169.55	367500000.00	220500000.00	166253.09	99751.85	52602.48	882000.00	85189.37	36427.43	188309840.00	80522304.00


Displaying 3 of 3 rows and 14 of 14 columns

Fill Table

OK Cancel

# Create Extreme Table

1

Execute  **Table (expand/extreme)** in Standards => Checks => 4..Bolt Overall context menu

2

In Load Group, press 

3

Select *Load Group* => *1..Overall* and press **OK**

4

Table Type: **Extreme** (worst result on selection)

5

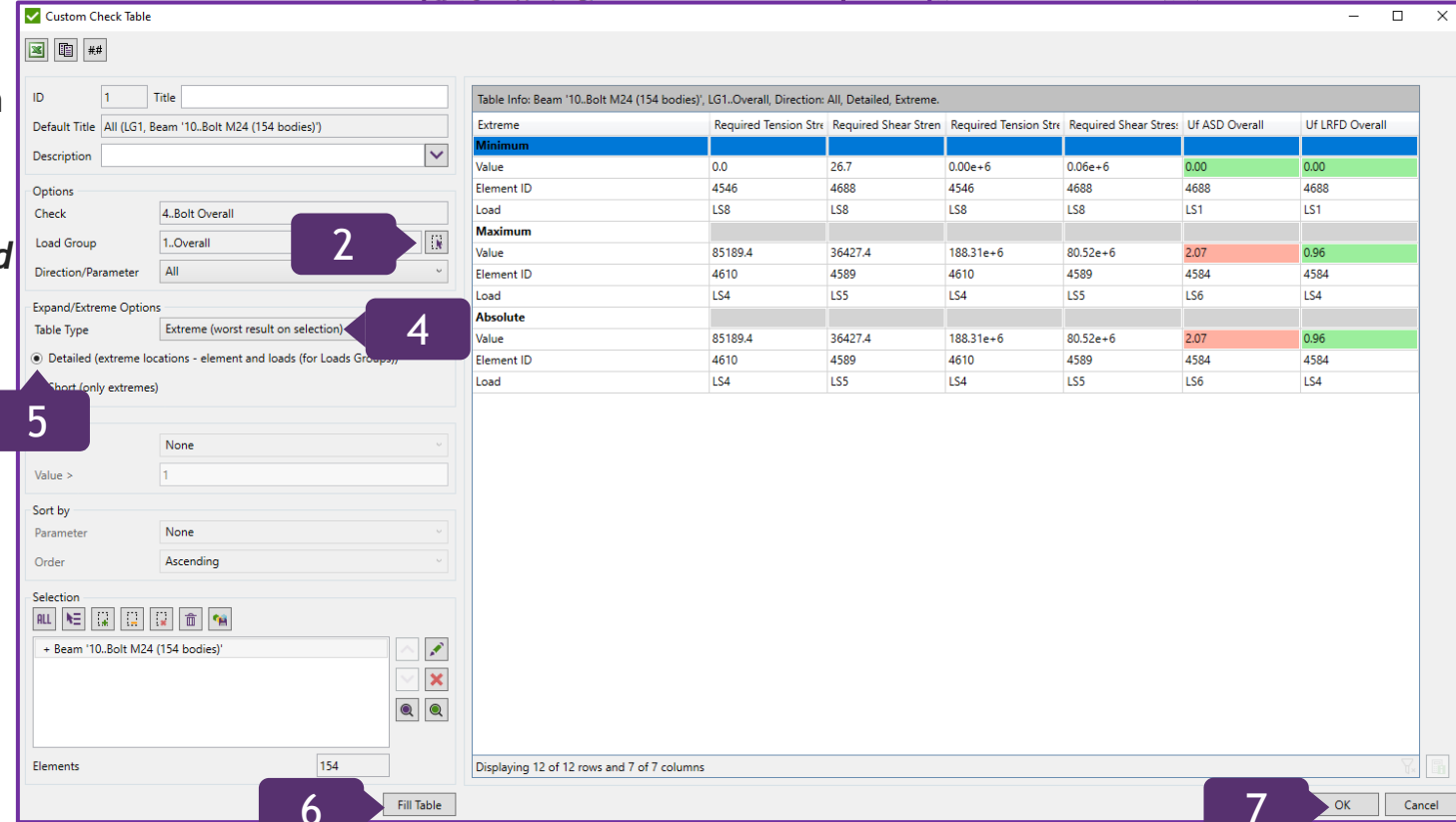
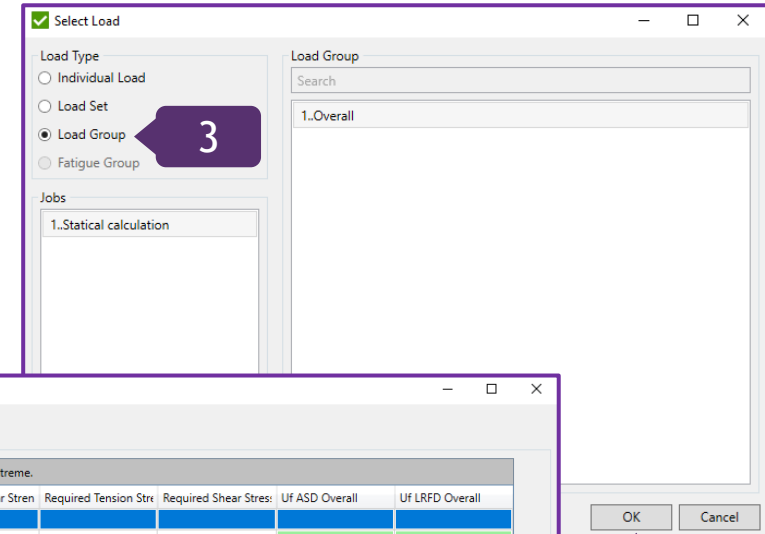
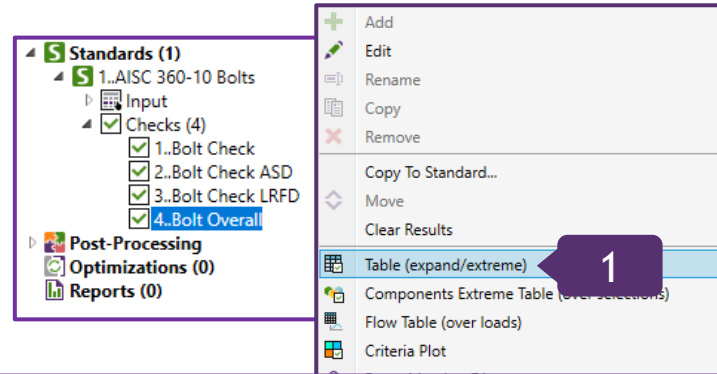
Table Type: *Extreme; Detailed* (extreme locations-element and load (for Load Groups)) - **ON**

6

Press **Fill Table**

7

Press **OK**



# Utilization Factor Plot

1

In Standards, Checks => 4..Bolt Overall, execute *Criteria Plot*

2

In Load Group, press 

3

Select *Load Group*, 1..Overall and press *OK*

4

Parameter: Uf ASD Overall or Uf LRFD Overall methods

5

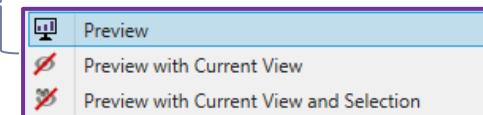
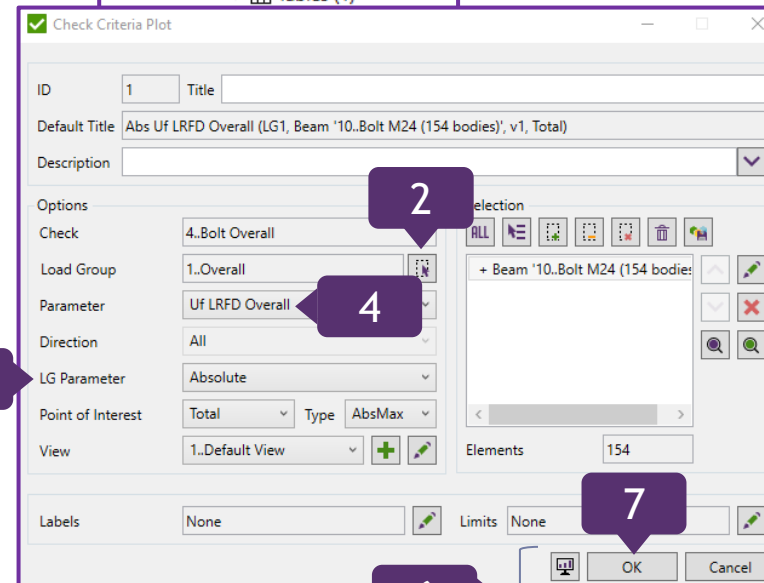
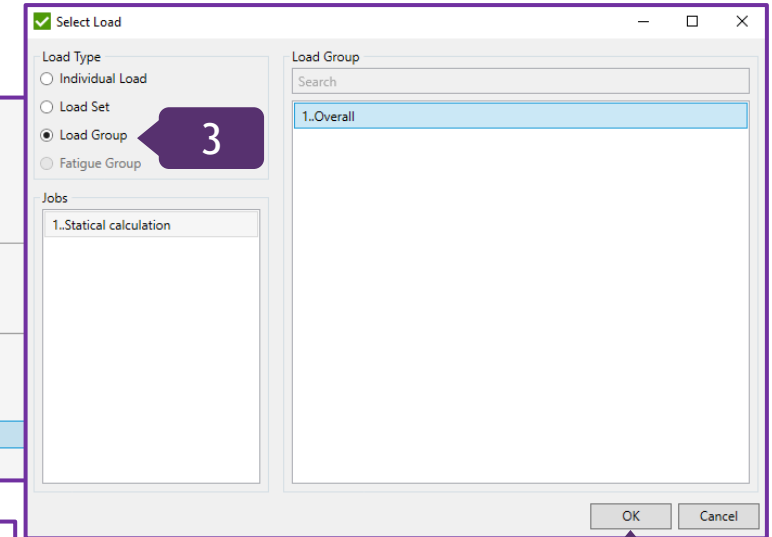
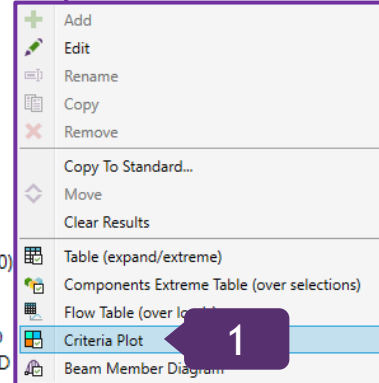
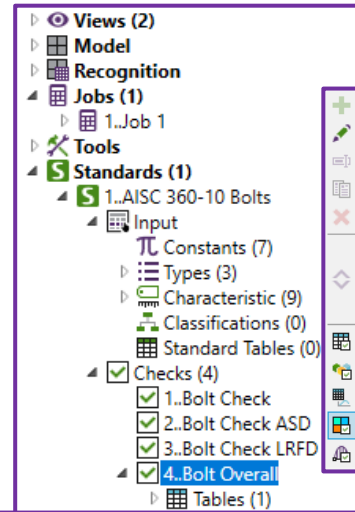
LG Parameter: Absolute

6

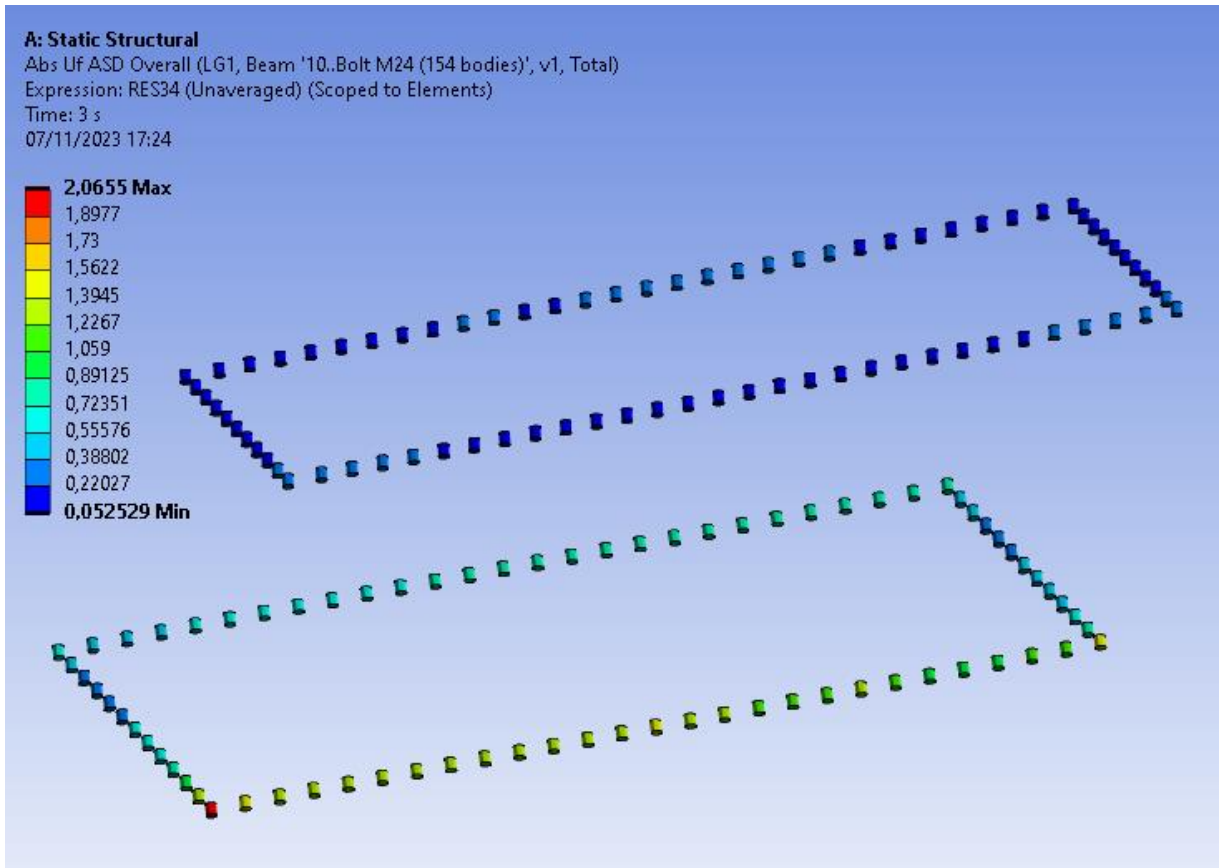
Press , and then *Preview*

7

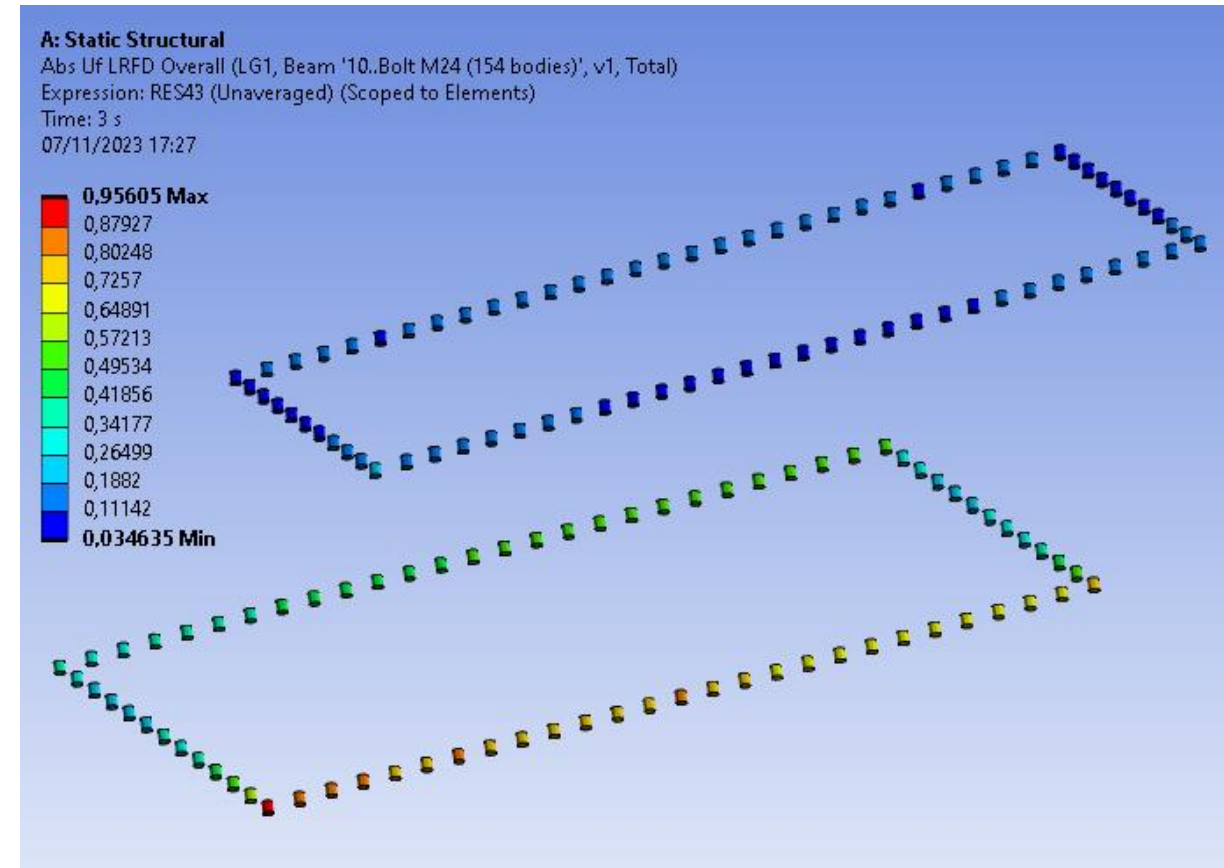
Press *OK*



The results of ASD calculation



The results of LRFD calculation



To learn how to obtain reports, please check a separate Tutorial that depicts the functionality of SDC Verifier Report Designer. It may be downloaded via this link:

<https://sdcverifier.com/tutorials/report-designer/>