



Tutorial

# **Eurocode3 Bolts (EN 1993-1-8, 2005)**

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

Updated on: November 2nd 2023

Tested with: SDC Verifier 2023 R2

Siemens Simcenter 3D 2306

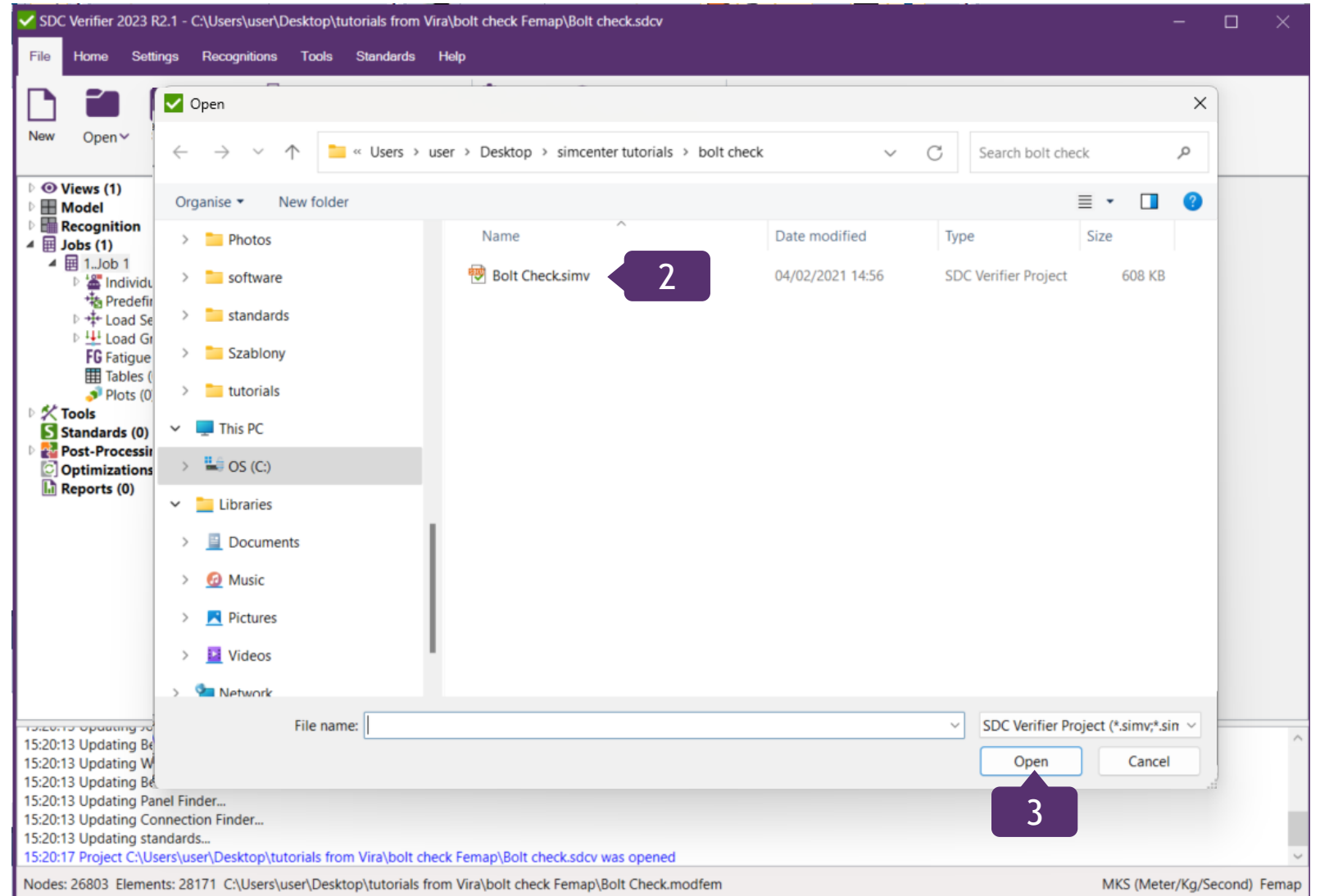
- In this tutorial, Eurocode3 Bolts Check is reviewed in details;
- A plate model (bolts modeled as beams) structure has been used as a start FEM model;
- An Extreme table, showing the worst result on selection, has been created;
- Criteria Plot with Utilization factor overall has been previewed

# Open the Starter Model

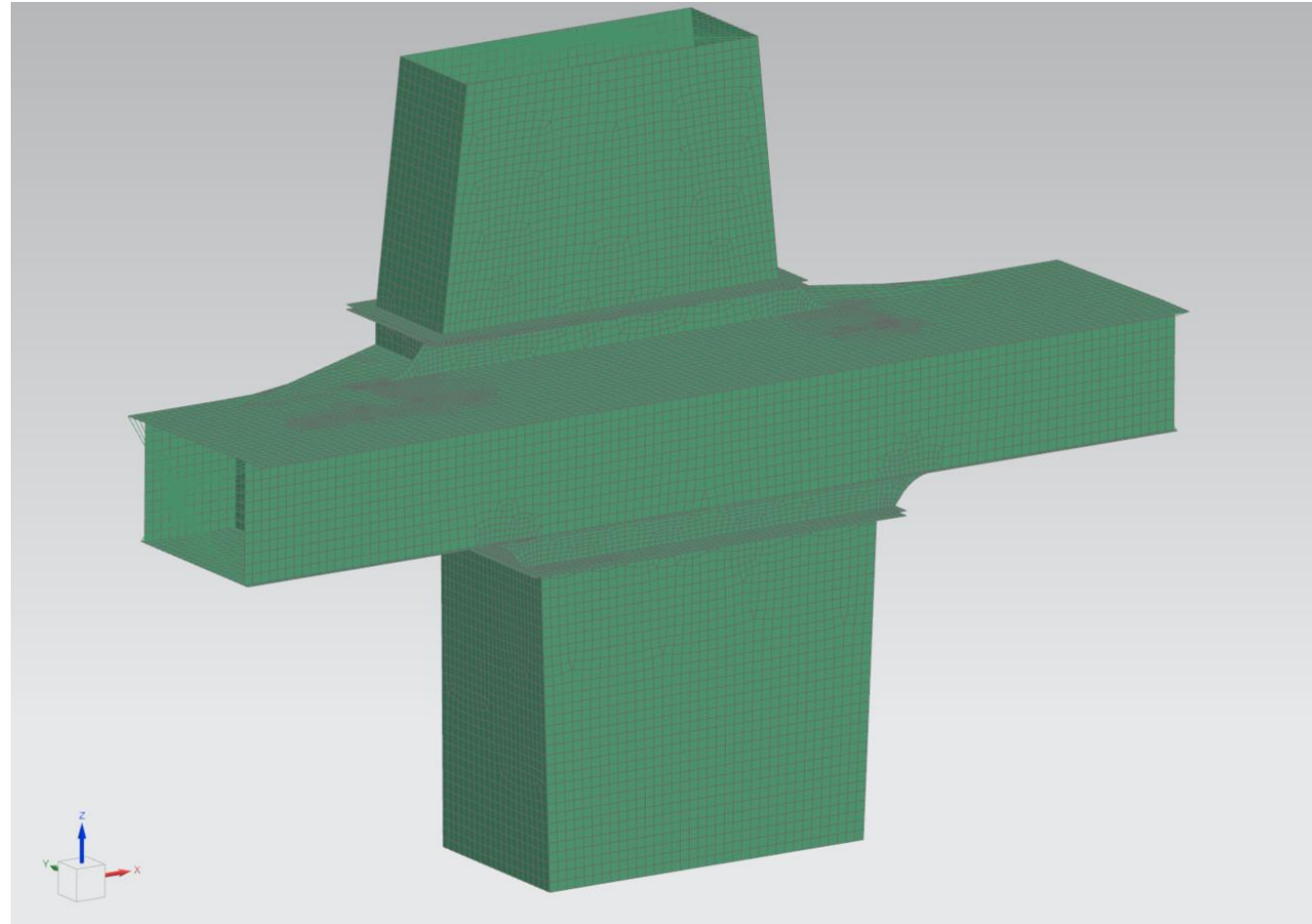
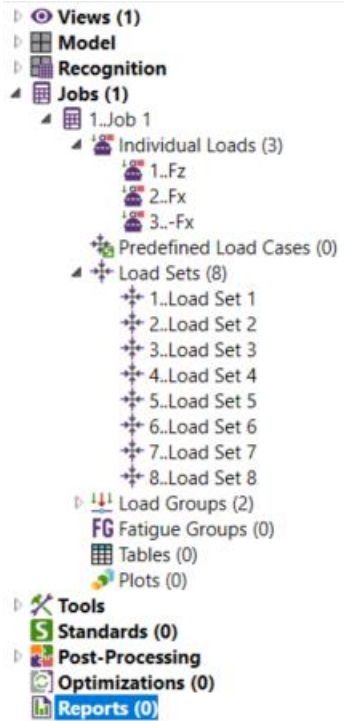
1 Launch SDC Verifier for FEMAP ✓

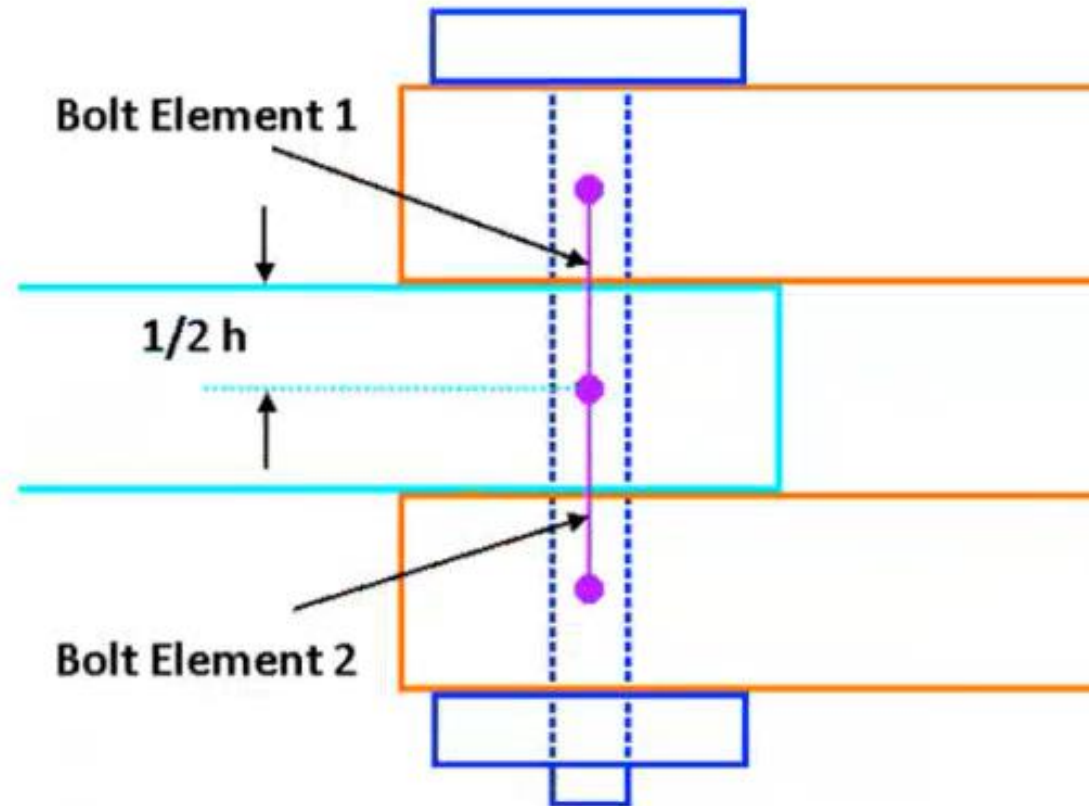
2 Open project *Bolt Check*


3 Press *Open*

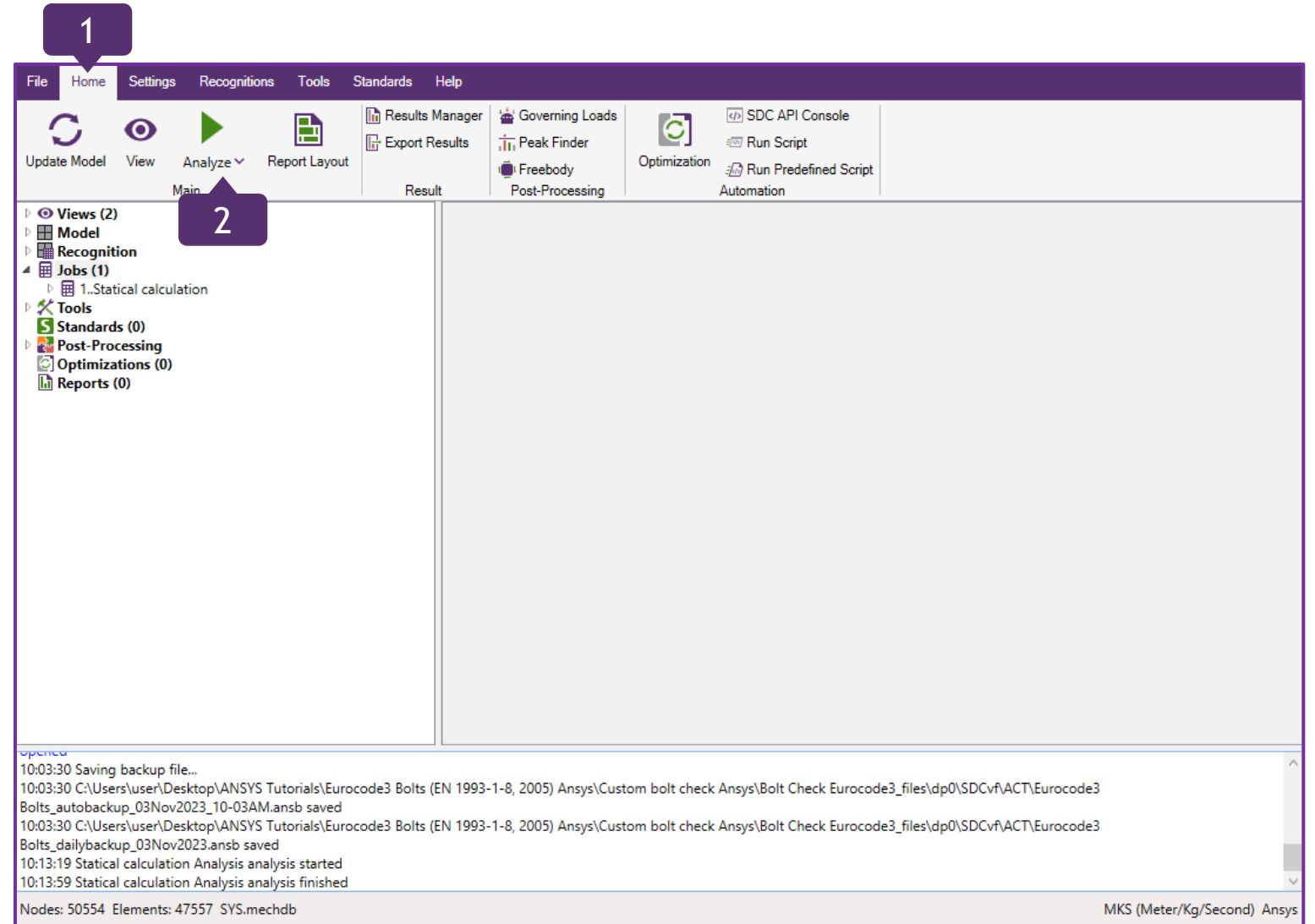


The project in this tutorial has predefined boundary conditions, load combinations and load groups. The model contains plate and beam elements. Bolts are modeled as beam elements.



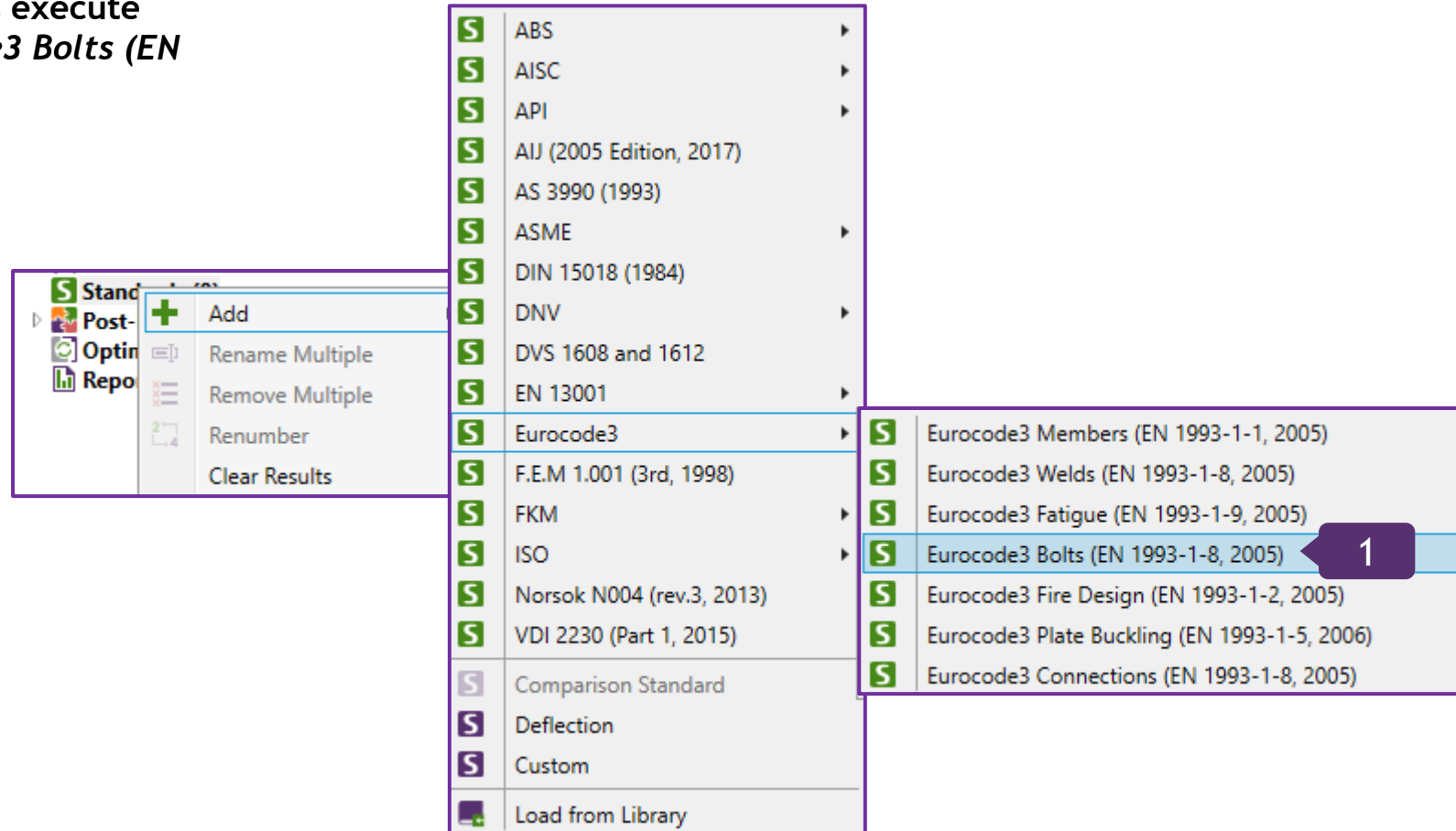


- 1 Go to *Home* section on the Ribbon.
- 2 Press  on the toolbar to analyze job.



1

In the *Model tree*, in Standards execute  
*Add => Eurocode3 => Eurocode3 Bolts (EN 1993-1-8, 2005)*



# Define Position Of The Bolt In The Direction Of Load

1

Press  in Position Of The Bolt In The Direction Of Load

2

Elemental Selections Id: *End bolts*

3

Press **OK**

Position of the bolt in the direction of load - bolts need to be defined as end bolts or inner bolts in connection.

**Add Element Characteristic**

ID: 5 Title: Position of the bolt in the direction of load

Alias: Position\_in\_the\_direction\_of\_load

Description:

Elemental Selections Id: **2** End bolts

Selection	Value
Full Model	End bolts

**3** OK Cancel

**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Value
Position Of The Bolt In The Direction Of Load	<b>1</b> Bolt Perpendicular To The Direction Of Load
Bolt Threat Pitch	
Shear Plane Position	
Countersunk Bolt	
Class Of Friction Surfaces	
Thickness Of Countersinking	
Connection In Tension	
End Distance (Figure 3.1)	
Edge Distance (Figure 3.1)	
Structure Made From Steel Conforming To	

Constant

Constant	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel



# Define Bolt Thread Pitch

1 Press  in Bolt Thread Pitch

2 10..Bolt M24 (154 bodies): 0.003

3 Press **OK**

**Properties Characteristics**

ID: 1 Title: Bolt thread pitch

Alias: P

Description: In model units

Properties

Property	Value
1..T = 0.01 (39 bodies, matld 26)	0
2..T = 0.008 (10 bodies, matld 26)	0
3..T = 0.025 (4 bodies, matld 26)	0
4..T = 0.018 (matld 26)	0
5..T = 0.015 (2 bodies, matld 26)	0
6..L100x50x6_bridge (3 bodies)	0
7..T = 0.005 (matld 26)	0
8..L100x50x6_bracing columns (6 bodies)	0
9..L100x50x6_WS (8 bodies)	0
10..Bolt M24 (154 bodies)	0.003
11..Connections (3 bodies)	0

OK Cancel

Bolt thread pitch is the distance between threads expressed that has to be defined.

**Eurocode3 Bolts (EN 1993-1-8, 2005)**


ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)


Alias: Standard1


Description:


Option


Position Of The Bolt In The Direction Of Load: Defined


Bolt Thread Pitch:  1


Shear Plane Position: 


Countersunk Bolt: 


Class Of Friction Surfaces: 


Thickness Of Countersinking: 


Connection In Tension: 


End Distance (Figure 3.1): 


Edge Distance (Figure 3.1): 


Structure Made From Steel Conforming To: 


Position Of The Bolt Perpendicular To The Direction Of Load: 


Hole Diameter: 


Hole Type: 

Thickness Of The Connected Plates: 

Number Of The Friction Planes: 

Net Area: 

Spacing P1 (Figure 3.1): 

Spacing P2 (Figure 3.1): 

Constant

Gamma M0 (Table 2.1): 1.1

Gamma M2 (Table 2.1): 1.25

Gamma M3 (Table 2.1): 1.25

Gamma M3 Ser (Table 2.1): 1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

# Define Shear Plane Position

1

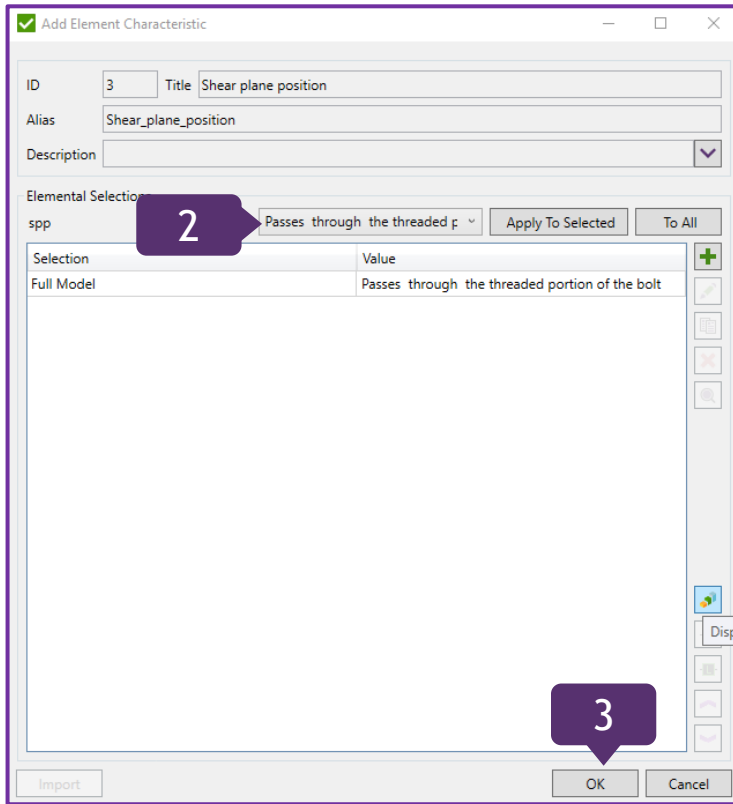
Press  in Shear Plane Position

2

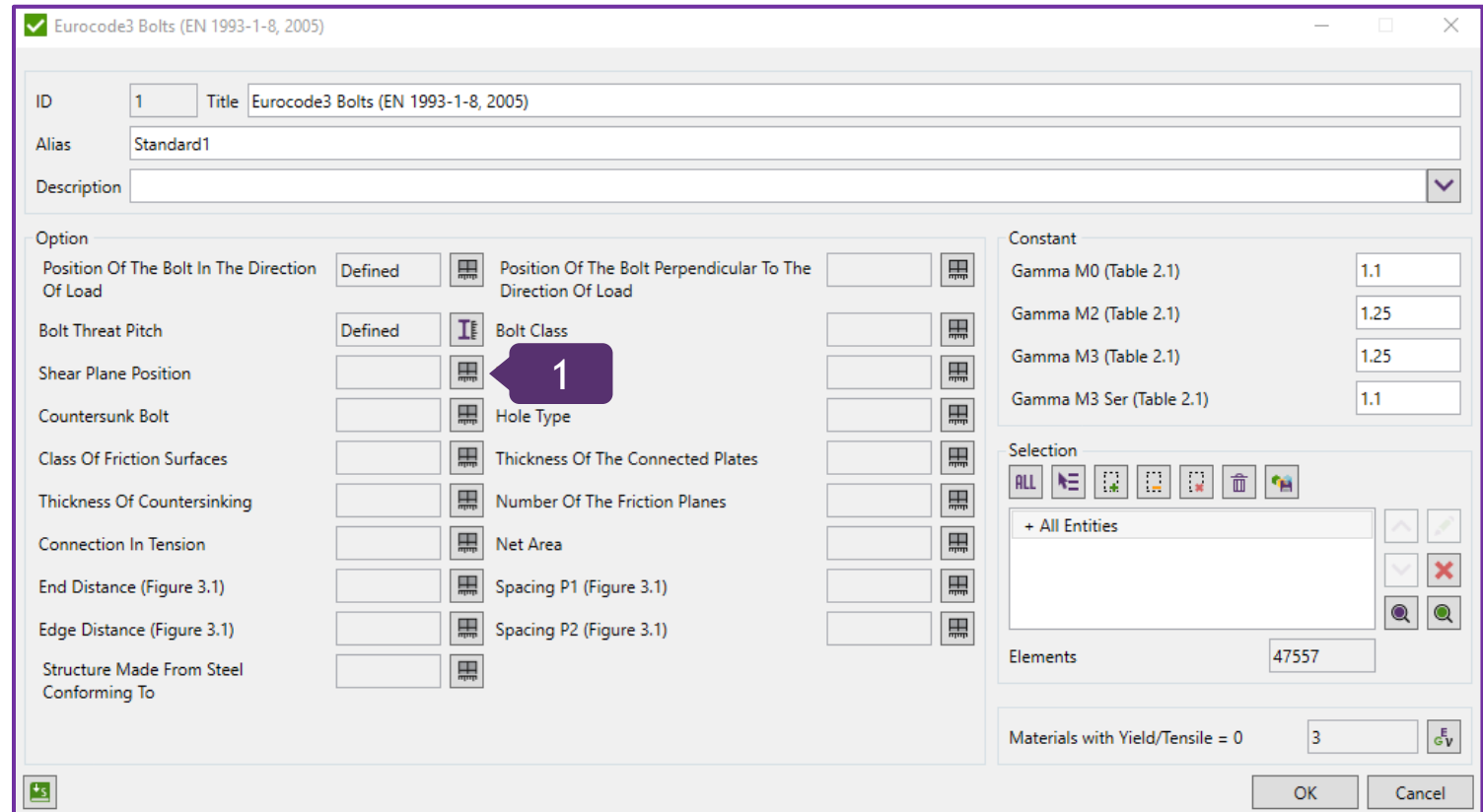
Elemental Selections spp: *Passes through the threaded portion of the bolt*

3

Press **OK**



Shear plane position - select if plane passes through the unthreaded or the threaded portion of the bolt.



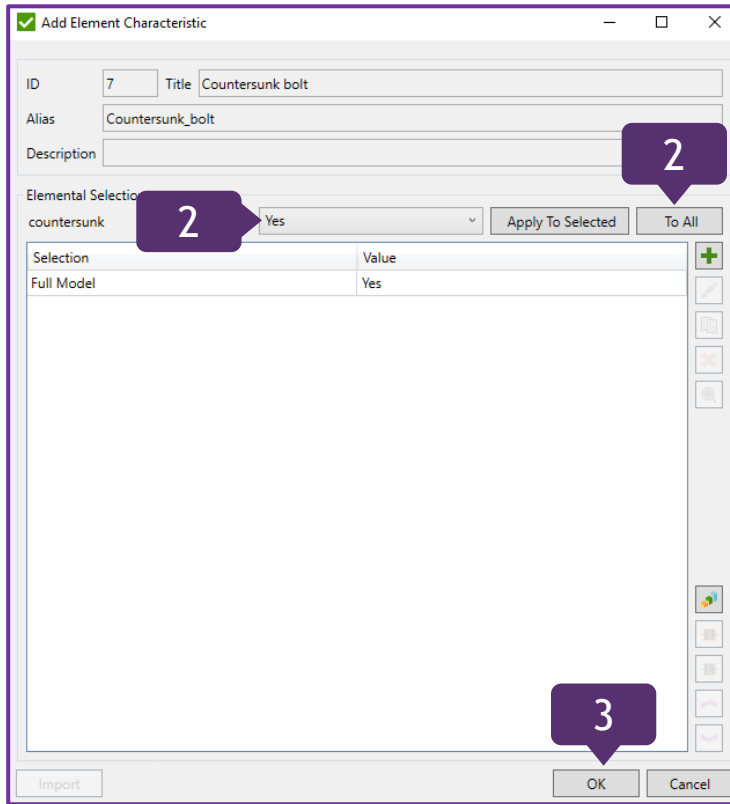
# Define Countersunk Bolt

1 Press  in Countersunk Bolt

2 Elemental Selections countersunk: Yes and press *To All*

3 Press *OK*

Countersunk bolt - type of bolt has to be defined.



✓ Add Element Characteristic

ID: 7 Title: Countersunk bolt

Alias: Countersunk\_bolt

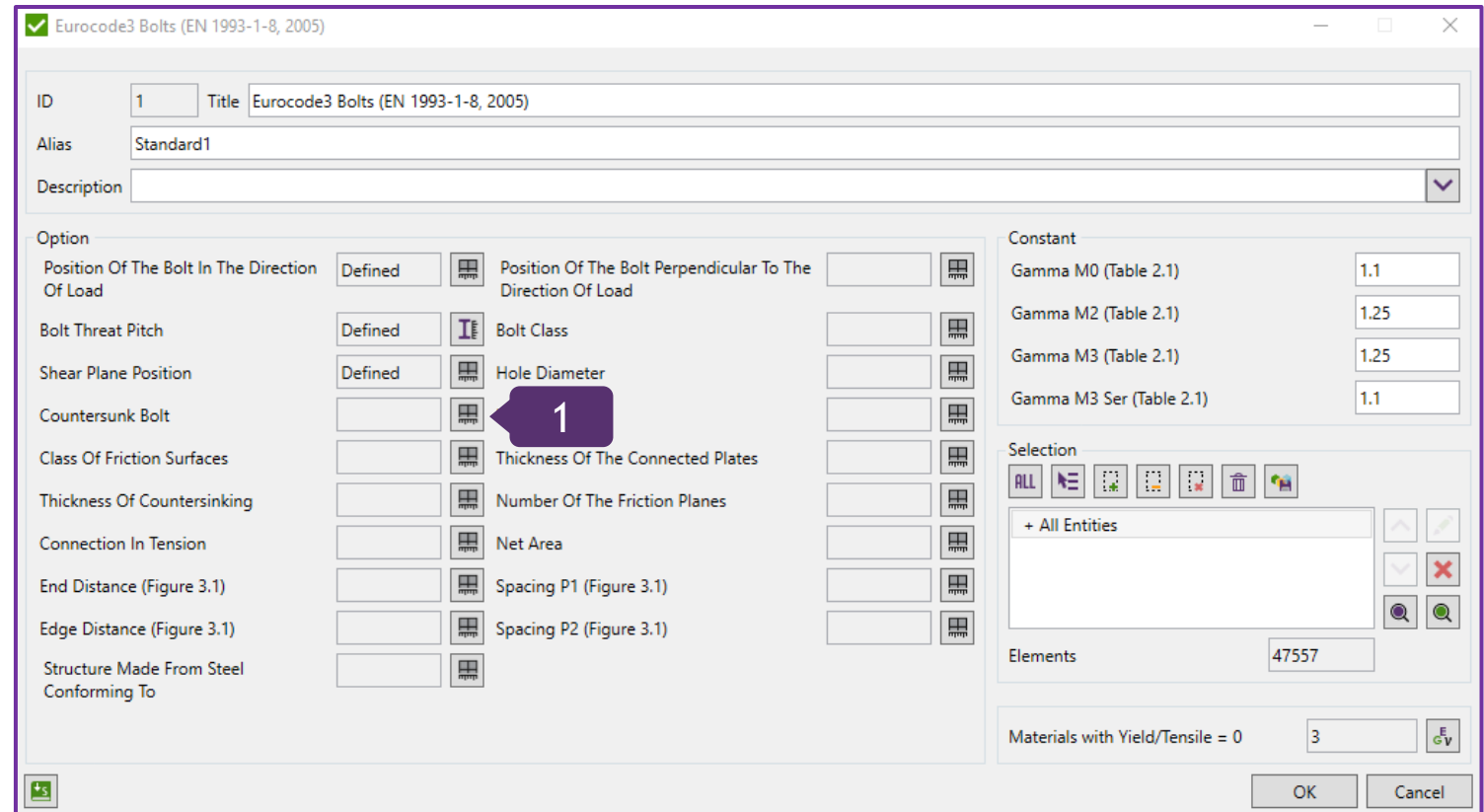
Description:

Elemental Selection: countersunk Yes

Apply To Selected To All

Selection	Value
Full Model	Yes

Import OK Cancel




✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option:

- Position Of The Bolt In The Direction Of Load: Defined
- Bolt Threat Pitch: Defined
- Shear Plane Position: Defined
- Countersunk Bolt: 
- Class Of Friction Surfaces:
- Thickness Of Countersinking:
- Connection In Tension:
- End Distance (Figure 3.1):
- Edge Distance (Figure 3.1):
- Structure Made From Steel Conforming To:

Position Of The Bolt Perpendicular To The Direction Of Load:

Bolt Class:

Hole Diameter:

Thickness Of The Connected Plates:

Number Of The Friction Planes:

Net Area:

Spacing P1 (Figure 3.1):

Spacing P2 (Figure 3.1):

Constant:

- Gamma M0 (Table 2.1): 1.1
- Gamma M2 (Table 2.1): 1.25
- Gamma M3 (Table 2.1): 1.25
- Gamma M3 Ser (Table 2.1): 1.1

Selection:

ALL

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

# Define Class Of Friction Surfaces

1 Press  in Class Of Friction Surfaces

2 Elemental Selections cfs: A

3 Press OK

Class of friction surfaces - select A, B, C or D class (Table 3.7)

**Add Element Characteristic**

ID: 9 Title: Class of friction surfaces

Alias: Class\_of\_friction\_surfaces

Description: Used in Table 3.7 to take slip factor for pre-loaded bolts

Elemental Selections cfs: A

Selection	Value
Full Model	A

OK Cancel

**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Value
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load
Bolt Threat Pitch	Defined	Bolt Class
Shear Plane Position	Defined	Hole Diameter
Countersunk Bolt	Defined	Hole Type
Class Of Friction Surfaces		1
Thickness Of Countersinking		Number Of The Friction Planes
Connection In Tension		Net Area
End Distance (Figure 3.1)		Spacing P1 (Figure 3.1)
Edge Distance (Figure 3.1)		Spacing P2 (Figure 3.1)
Structure Made From Steel Conforming To		

Constant

Constant	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

**BS EN 1993-1-8:2005**  
**EN 1993-1-8:2005 (E)**

**Table 3.7: Slip factor,  $\mu$ , for pre-loaded bolts**

Class of friction surfaces (see 1.2.7 Reference Standard: Group 7)	Slip factor $\mu$
A	0,5
B	0,4
C	0,3
D	0,2
<p><b>NOTE 1:</b> The requirements for testing and inspection are given in 1.2.7 Reference Standards: Group 7.</p> <p><b>NOTE 2:</b> The classification of any other surface treatment should be based on test specimens representative of the surfaces used in the structure using the procedure set out in 1.2.7 Reference Standards: Group 7.</p> <p><b>NOTE 3:</b> The definitions of the class of friction surface are given in 1.2.7 Reference Standards: Group 7.</p> <p><b>NOTE 4:</b> With painted surface treatments a loss of pre-load may occur over time.</p>	

# Define Thickness Of Countersinking

1

Press  in Thickness Of Countersinking

2

Selection Value: 0

3

Press OK

Thickness of countersinking - predefine countersinking value.

**Add Element Characteristic**

ID: 11 Title: Thickness of countersinking

Alias: tc

Description: In model units

Elemental Selections

Selection	Value
Full Model	0

2

3

OK Cancel

**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Option	Value
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	
Bolt Threat Pitch	Defined	Bolt Class	
Shear Plane Position	Defined	Hole Diameter	
Countersunk Bolt	Defined	Hole Type	
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	
Thickness Of Countersinking		Friction Planes	
Connection In Tension		Net Area	
End Distance (Figure 3.1)		Spacing P1 (Figure 3.1)	
Edge Distance (Figure 3.1)		Spacing P2 (Figure 3.1)	
Structure Made From Steel Conforming To			

1

Constant

Constant	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

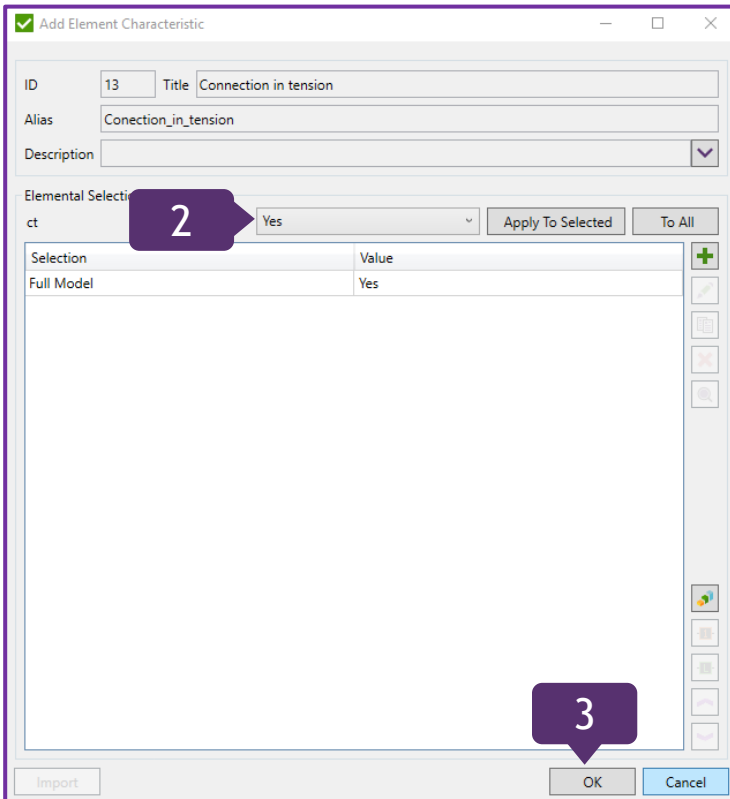
OK Cancel

# Define Connection In Tension

1 Press  in Connection In Tension

2 Elemental Selections ct: Yes

3 Press OK



✓ Add Element Characteristic

ID: 13 Title: Connection in tension

Alias: Conection\_in\_tension

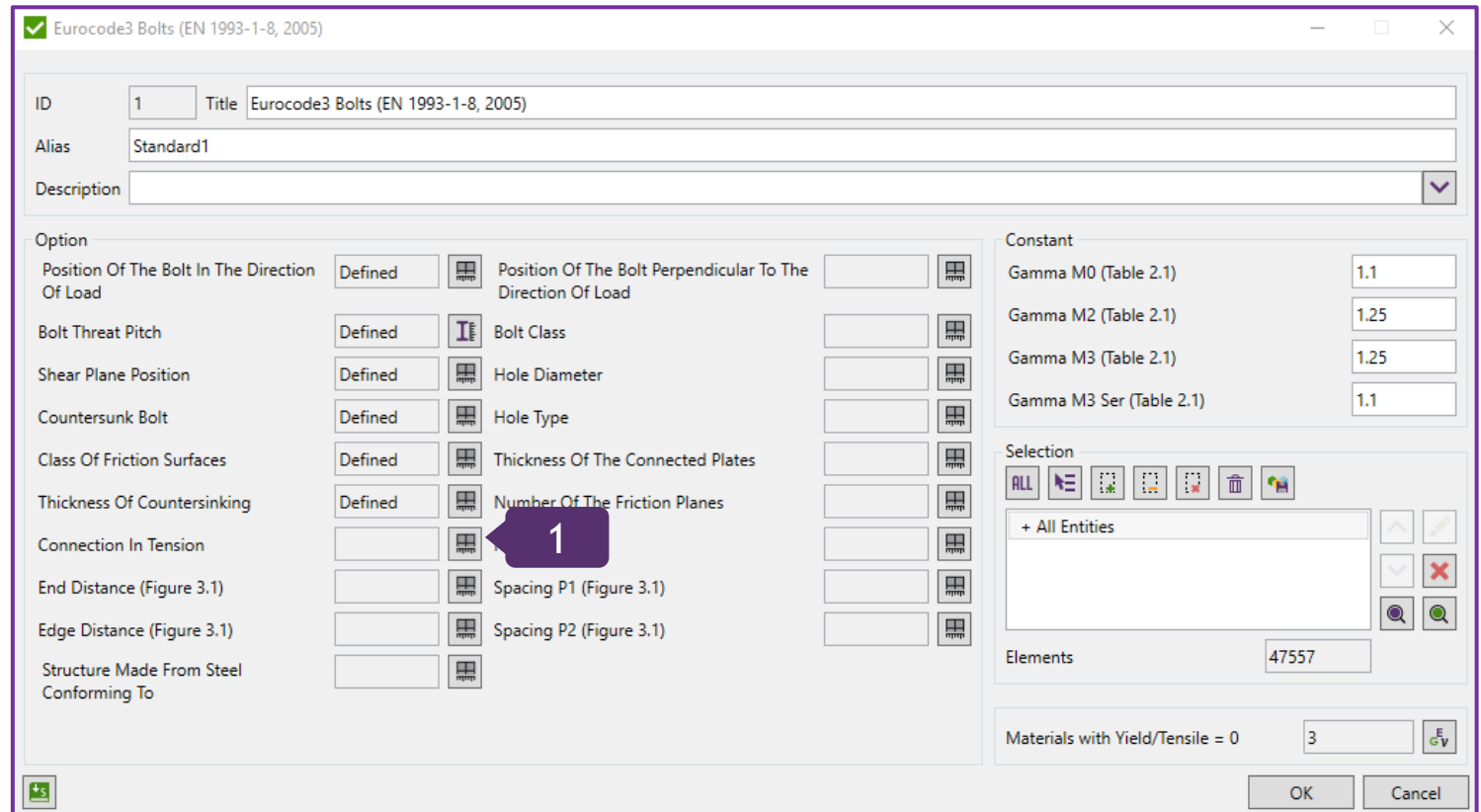
Description:

Elemental Selections: ct: Yes

Selection	Value
Full Model	Yes

Import OK Cancel

Connection in tension - select whether the connection is under tension



✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option:

Option	Status	Parameter	Value
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	
Bolt Threat Pitch	Defined	Bolt Class	
Shear Plane Position	Defined	Hole Diameter	
Countersunk Bolt	Defined	Hole Type	
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	
Thickness Of Countersinking	Defined	Number Of The Friction Planes	
Connection In Tension			
End Distance (Figure 3.1)		Spacing P1 (Figure 3.1)	
Edge Distance (Figure 3.1)		Spacing P2 (Figure 3.1)	
Structure Made From Steel Conforming To			

Constant:

Parameter	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection:

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

Distances between bolts (End Distance E1, Edge Distance E2, Spacing P1 and Spacing P2) have to be defined for each bolt connection with different plates (Figure 3.1);

Structure made from steel conforming to - select limits for maximum and minimum spacing, end and edge distances according to EN 10025 or EN10025-5 (Table 3.3).

To start calculation according to standard, all parameters need to be defined

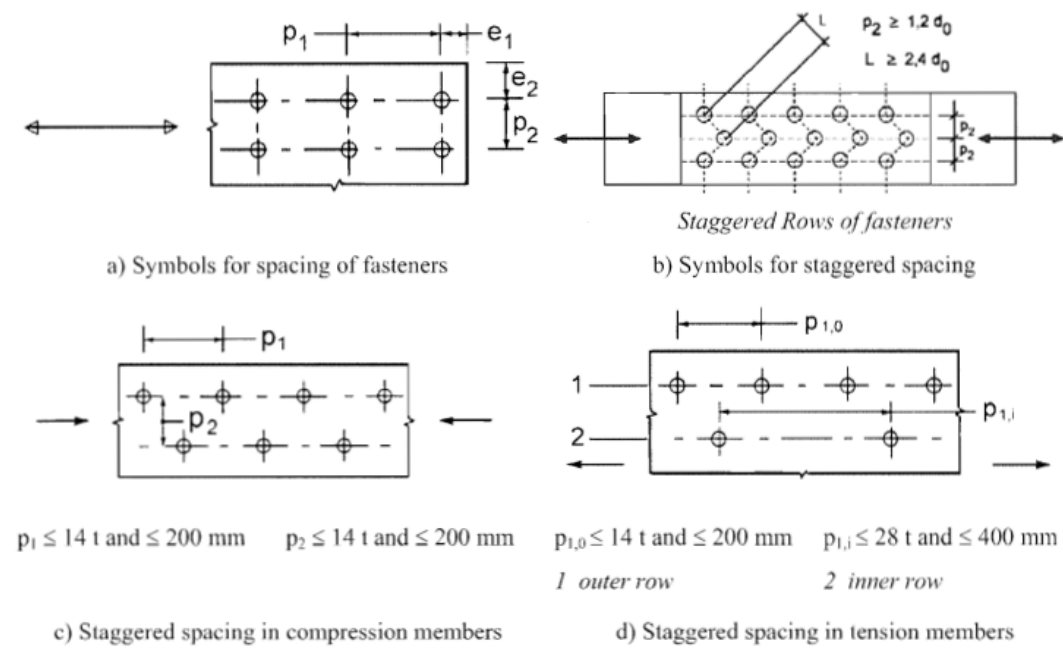


Figure 3.1: Symbols for end and edge distances and spacing of fasteners

✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option	Value	Option	Value
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	
Bolt Threat Pitch	Defined	Bolt Class	
Shear Plane Position	Defined	Hole Diameter	
Countersunk Bolt	Defined	Hole Type	
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	
Thickness Of Countersinking	Defined	Number Of The Friction Planes	
Connection In Tension	Defined	Net Area	
End Distance (Figure 3.1)		Spacing P1 (Figure 3.1)	
Edge Distance (Figure 3.1)		Spacing P2 (Figure 3.1)	
Structure Made From Steel Conforming To			

Constant

Gamma M0 (Table 2.1): 1.1

Gamma M2 (Table 2.1): 1.25

Gamma M3 (Table 2.1): 1.25

Gamma M3 Ser (Table 2.1): 1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

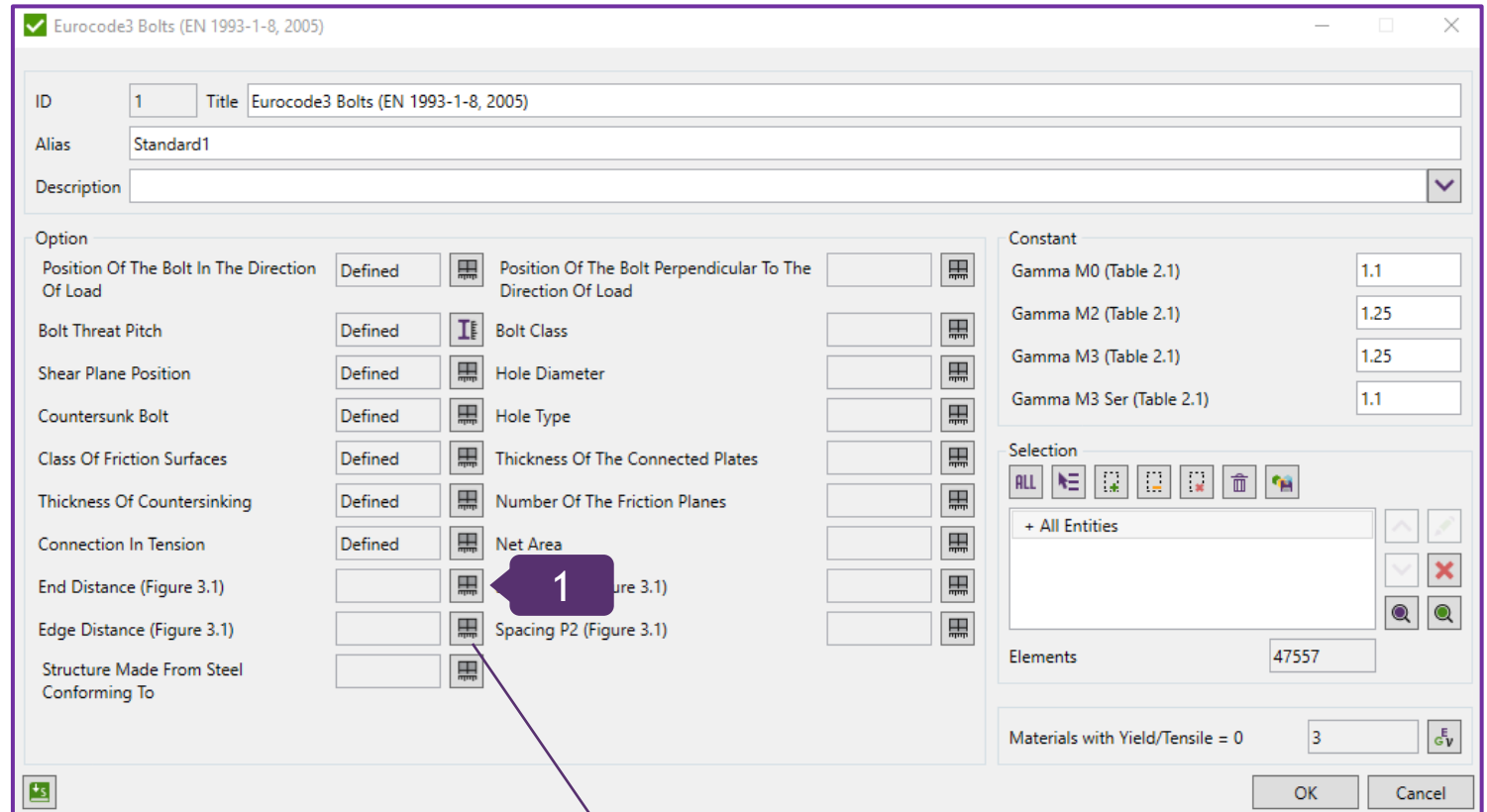
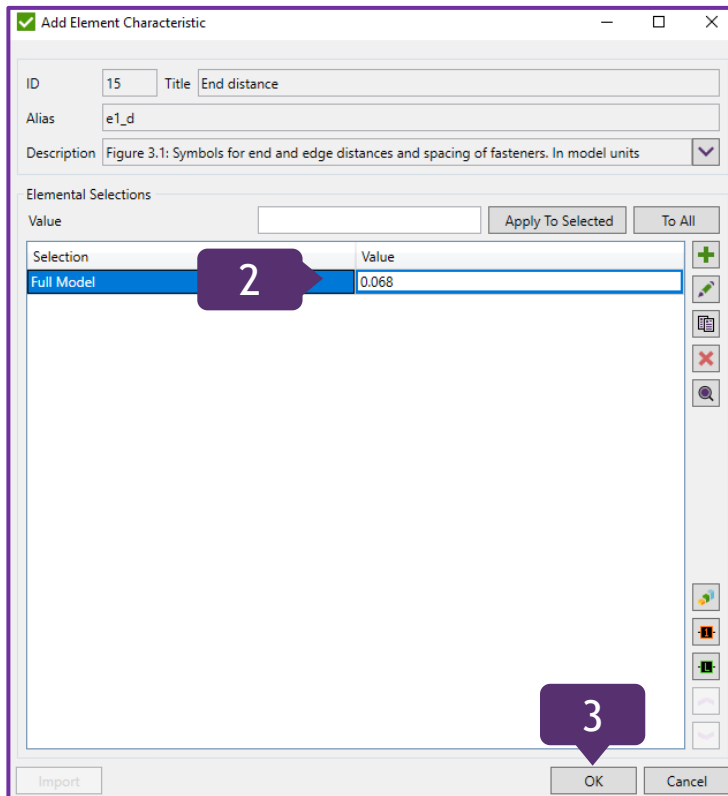


# Define End Distance (Figure 3.1)

1 Press  in End Distance (Figure 3.1)

2 Selection Value: 0.068 and press *To All*

3 Press *OK*



The identical step with the same Value may be carried out for Edge Distance (Figure 3.1) Option to define it.

# Define Structure Made From Steel Conforming To

1

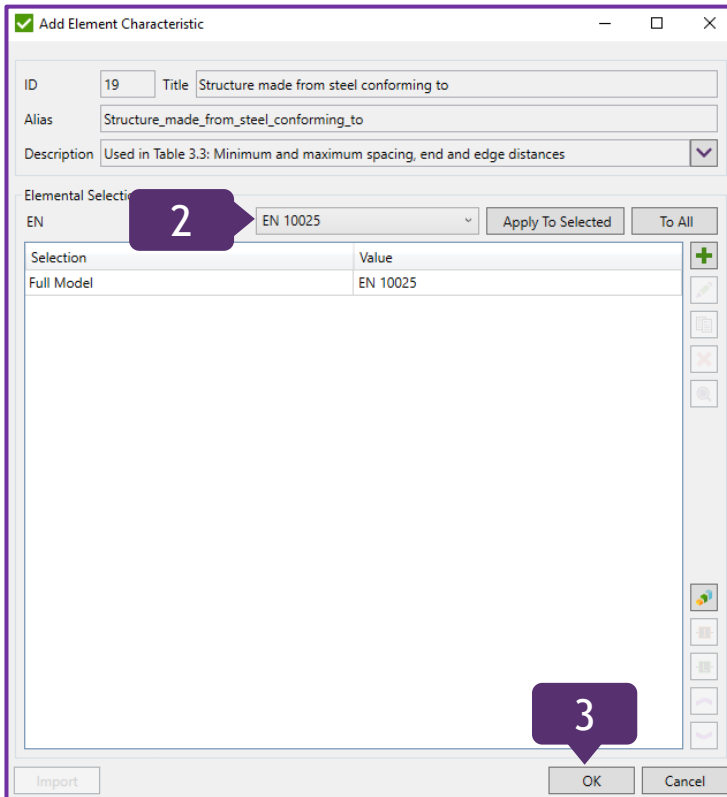
Press  in Structure Made From Steel Conforming To

2

Elemental Selections EN: *EN 10025*

3

Press *OK*



**Add Element Characteristic**

ID: 19 Title: Structure made from steel conforming to

Alias: Structure\_made\_from\_steel\_conforming\_to

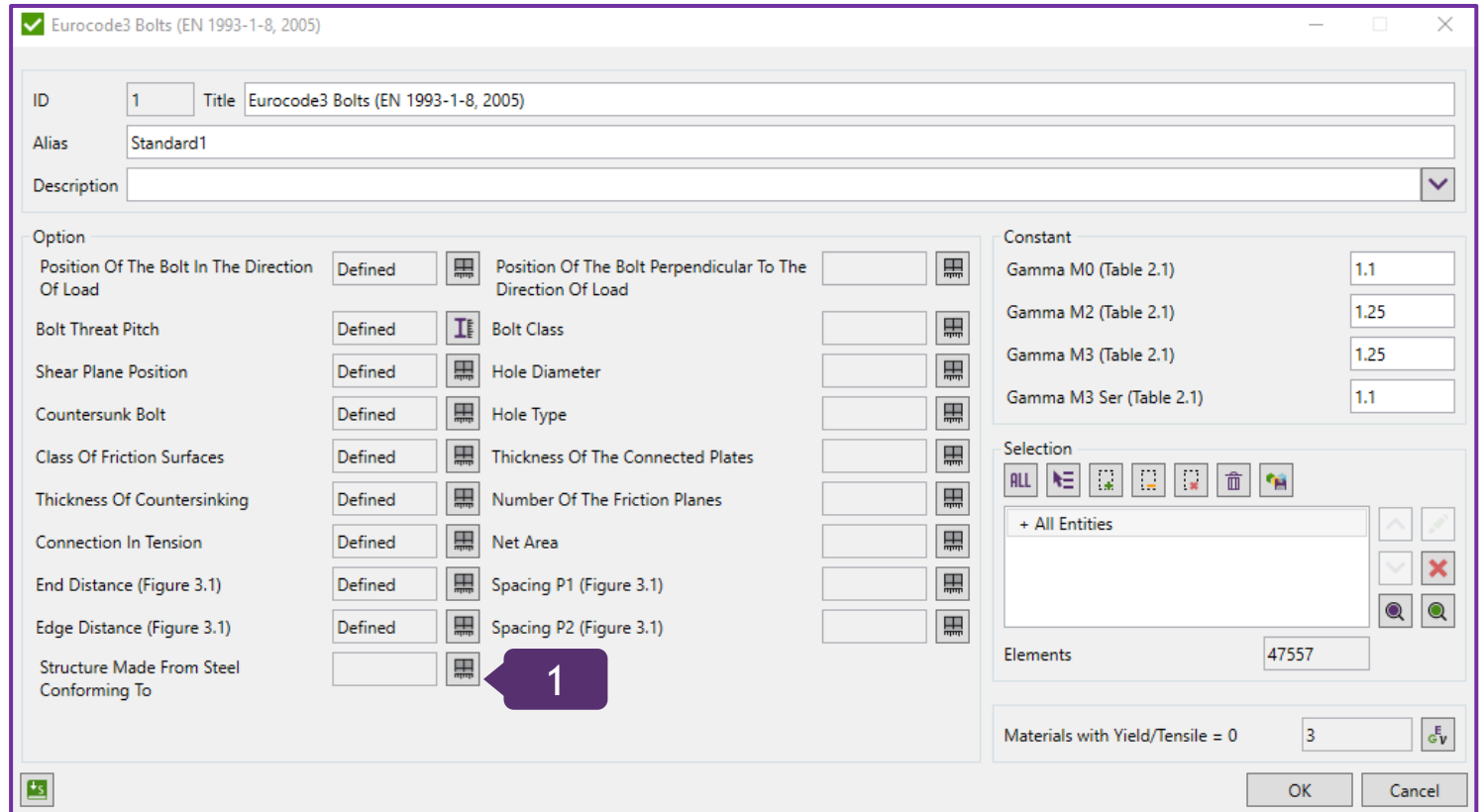
Description: Used in Table 3.3: Minimum and maximum spacing, end and edge distances

Elemental Selections

EN: **2** EN 10025 Apply To Selected To All

Selection	Value
Full Model	EN 10025

**3** OK Cancel



**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Option	Defined
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	Defined
Bolt Threat Pitch	Defined	Bolt Class	Defined
Shear Plane Position	Defined	Hole Diameter	Defined
Countersunk Bolt	Defined	Hole Type	Defined
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	Defined
Thickness Of Countersinking	Defined	Number Of The Friction Planes	Defined
Connection In Tension	Defined	Net Area	Defined
End Distance (Figure 3.1)	Defined	Spacing P1 (Figure 3.1)	Defined
Edge Distance (Figure 3.1)	Defined	Spacing P2 (Figure 3.1)	Defined
Structure Made From Steel Conforming To	<b>1</b>		

Constant

Constant	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

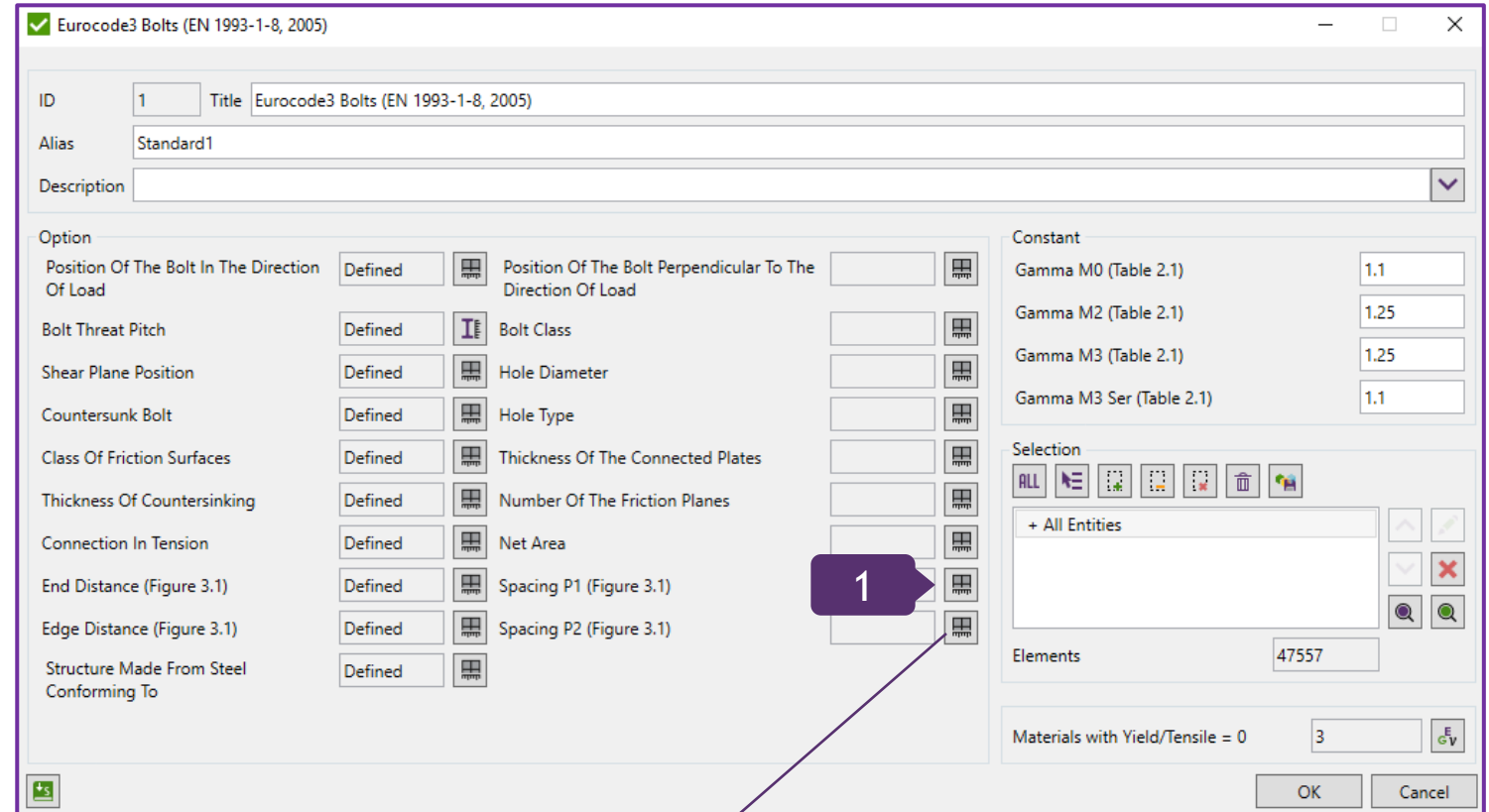
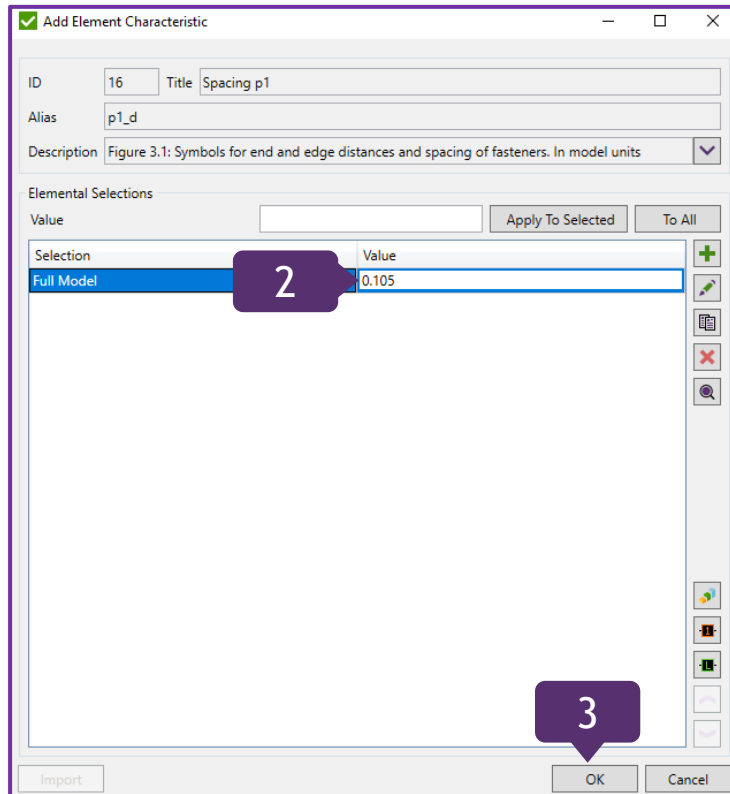
OK Cancel

# Define Spacing P1 (Figure 3.1)

1 Press  in Spacing P1 (Figure 3.1)

2 Selection Value: 0.105

3 Press OK



The identical step with the same Value may be carried out for Spacing P2 (Figure 3.1) Option to define it.

# Define Position Of The Bolt Perpendicular To The Direction Of Load

1

Press  in Position Of The Bolt Perpendicular To The Direction Of Load

2

Elemental Selections pd: *Edge bolts*

3

Press **OK**

Position of the bolt perpendicular to the direction of load - bolts need to be defined as edge bolts or inner bolts in connection.

**Add Element Characteristic**

ID: 6 Title: Position of the bolt perpendicular to the direction of load

Alias: Position\_perpendicular\_to\_the\_direction\_of\_load

Description:

Elemental Selections pd: **2** Edge bolts

Selection	Value
Full Model	Edge bolts

**3** OK Cancel











**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Icon	Value
Position Of The Bolt In The Direction Of Load	Defined		<b>1</b> Position Of The Bolt Perpendicular To The Direction Of Load
Bolt Threat Pitch	Defined		Bolt Class
Shear Plane Position	Defined		Hole Diameter
Countersunk Bolt	Defined		Hole Type
Class Of Friction Surfaces	Defined		Thickness Of The Connected Plates
Thickness Of Countersinking	Defined		Number Of The Friction Planes
Connection In Tension	Defined		Net Area
End Distance (Figure 3.1)	Defined		Spacing P1 (Figure 3.1)
Edge Distance (Figure 3.1)	Defined		Spacing P2 (Figure 3.1)
Structure Made From Steel Conforming To	Defined		

Constant

Constant	Value
Gamma M2 (Table 2.1)	1.1
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

# Define Bolt Class

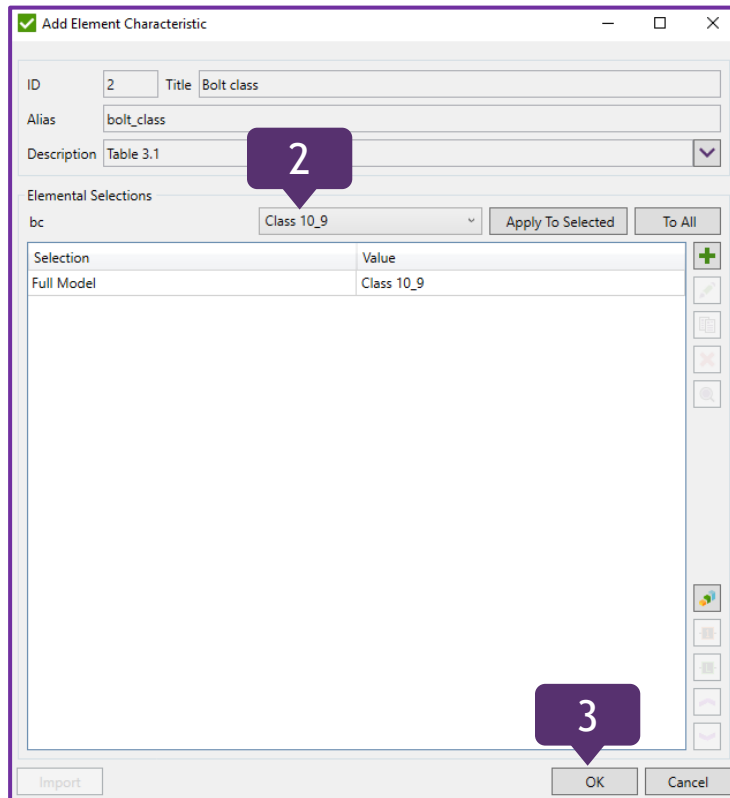
1 Press  in Bolt Class

2 Elemental Selections bc: *Class 10\_9*

3 Press *OK*

**Table 3.1: Nominal values of the yield strength  $f_{yb}$  and the ultimate tensile strength  $f_{ub}$  for bolts**

Bolt class	4.6	4.8	5.6	5.8	6.8	8.8	10.9
$f_{yb}$ (N/mm <sup>2</sup> )	240	320	300	400	480	640	900
$f_{ub}$ (N/mm <sup>2</sup> )	400	400	500	500	600	800	1000



✓ Add Element Characteristic

ID: 2 Title: Bolt class

Alias: bolt\_class

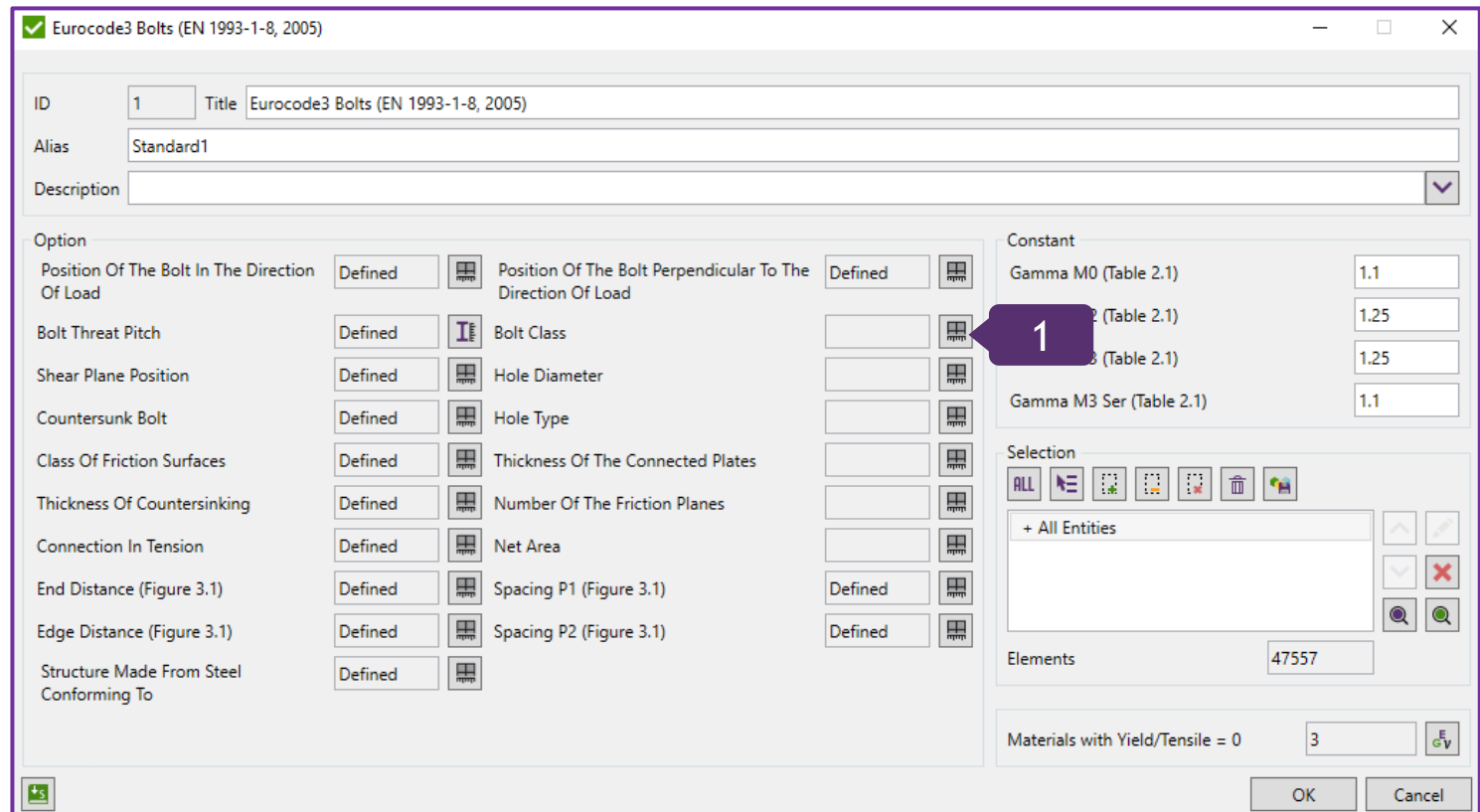
Description: Table 3.1

Elemental Selections

bc: Class 10\_9

Selection	Value
Full Model	Class 10_9

Import OK Cancel



✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Position Of The Bolt In The Direction Of Load: Defined

Bolt Threat Pitch: Defined

Shear Plane Position: Defined

Countersunk Bolt: Defined

Class Of Friction Surfaces: Defined

Thickness Of Countersinking: Defined

Connection In Tension: Defined

End Distance (Figure 3.1): Defined

Edge Distance (Figure 3.1): Defined

Structure Made From Steel Conforming To: Defined

Position Of The Bolt Perpendicular To The Direction Of Load: Defined

Bolt Class: Defined

Hole Diameter: Defined

Hole Type: Defined

Thickness Of The Connected Plates: Defined

Number Of The Friction Planes: Defined

Net Area: Defined

Spacing P1 (Figure 3.1): Defined

Spacing P2 (Figure 3.1): Defined

Constant

Gamma M0 (Table 2.1): 1.1

Gamma M2 (Table 2.1): 1.25

Gamma M3 (Table 2.1): 1.25

Gamma M3 Ser (Table 2.1): 1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

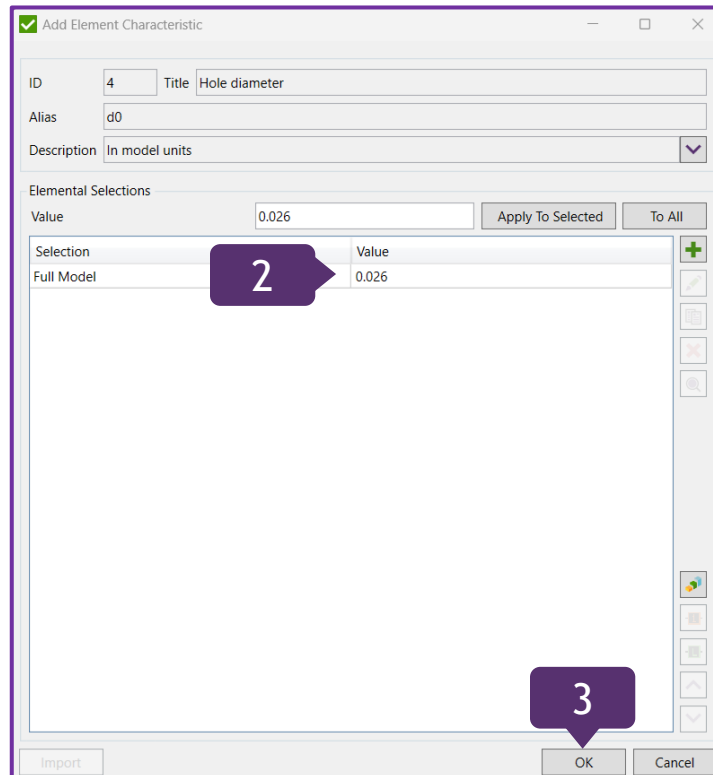
OK Cancel

# Define Hole Diameter

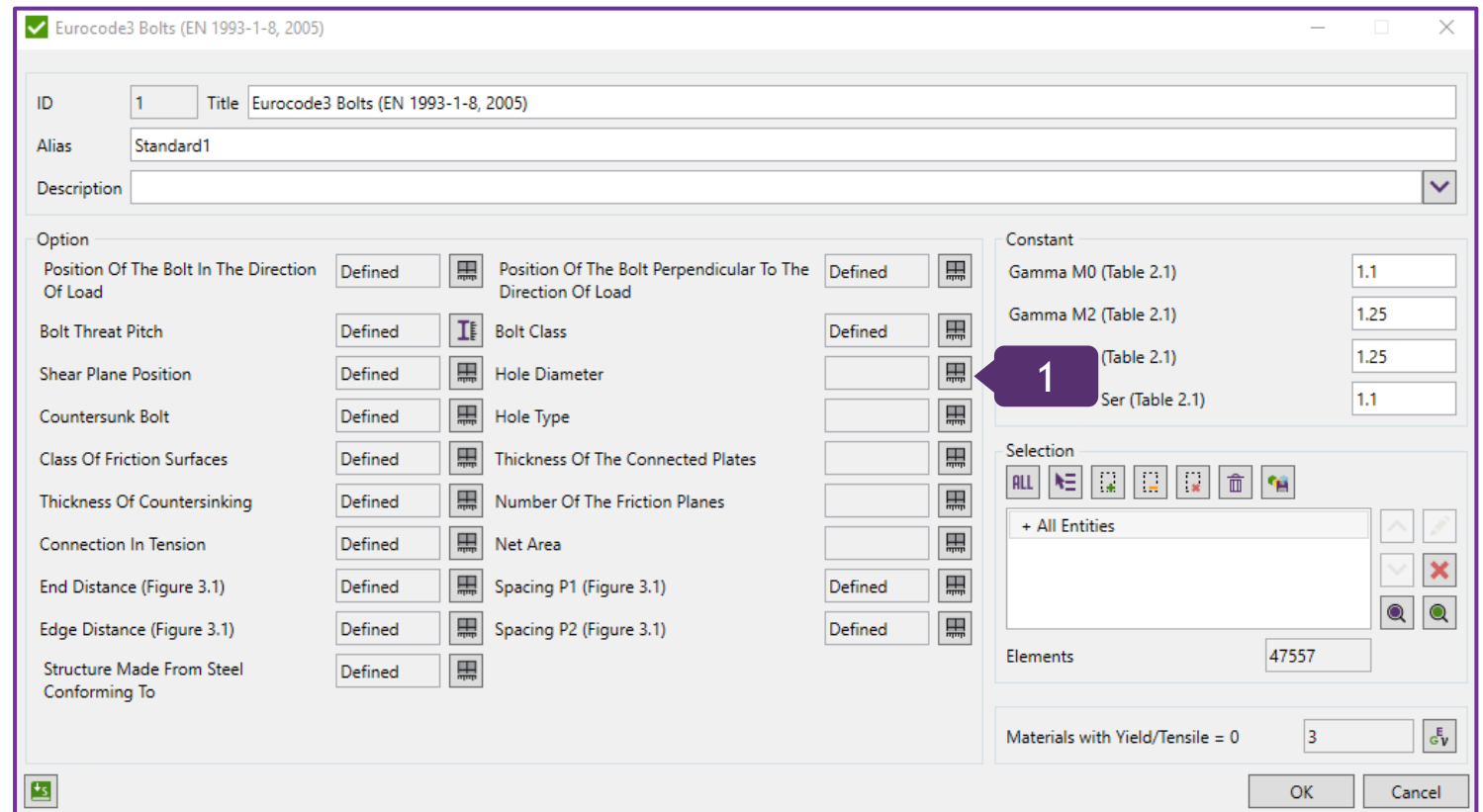
1 Press  in Hole Diameter

2 Selection Value: 0.026

3 Press OK



Hole diameter - to apply diameter of holes for each bolt type.



# Define Hole Type

1

Press  in Hole Type

2

Elemental Selections ht: Normal holes


3

Press OK

Hole type -  $k_s$  factor depends on hole type (Table 3.6).


Table 3.6: Values of  $k_s$

Description	$k_s$
Bolts in normal holes.	1,0
Bolts in either oversized holes or short slotted holes with the axis of the slot perpendicular to the direction of load transfer.	0,85
Bolts in long slotted holes with the axis of the slot perpendicular to the direction of load transfer.	0,7
Bolts in short slotted holes with the axis of the slot parallel to the direction of load transfer.	0,76
Bolts in long slotted holes with the axis of the slot parallel to the direction of load transfer.	0,63


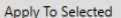

 Add Element Characteristic

ID: 8 Title: Hole type




Alias: Hole\_type


Description: 

Elemental Selections

ht:  Normal holes  


Selection	Value
Full Model	Normal holes




















 Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description: 










Option

Position Of The Bolt In The Direction Of Load	Defined		Position Of The Bolt Perpendicular To The Direction Of Load	Defined	
Bolt Threat Pitch	Defined		Bolt Class	Defined	
Shear Plane Position	Defined		Hole Diameter	Defined	
Countersunk Bolt	Defined		Hole Type		
Class Of Friction Surfaces	Defined		Thickness Of The Connected Plates		
Thickness Of Countersinking	Defined		Number Of The Friction Planes		
Connection In Tension	Defined		Net Area		
End Distance (Figure 3.1)	Defined		Spacing P1 (Figure 3.1)	Defined	
Edge Distance (Figure 3.1)	Defined		Spacing P2 (Figure 3.1)	Defined	
Structure Made From Steel Conforming To	Defined				

Constant


Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1



Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0 

# Define Thickness Of The Connected Plates

1

Press  in Thickness Of The Connected Plates

2

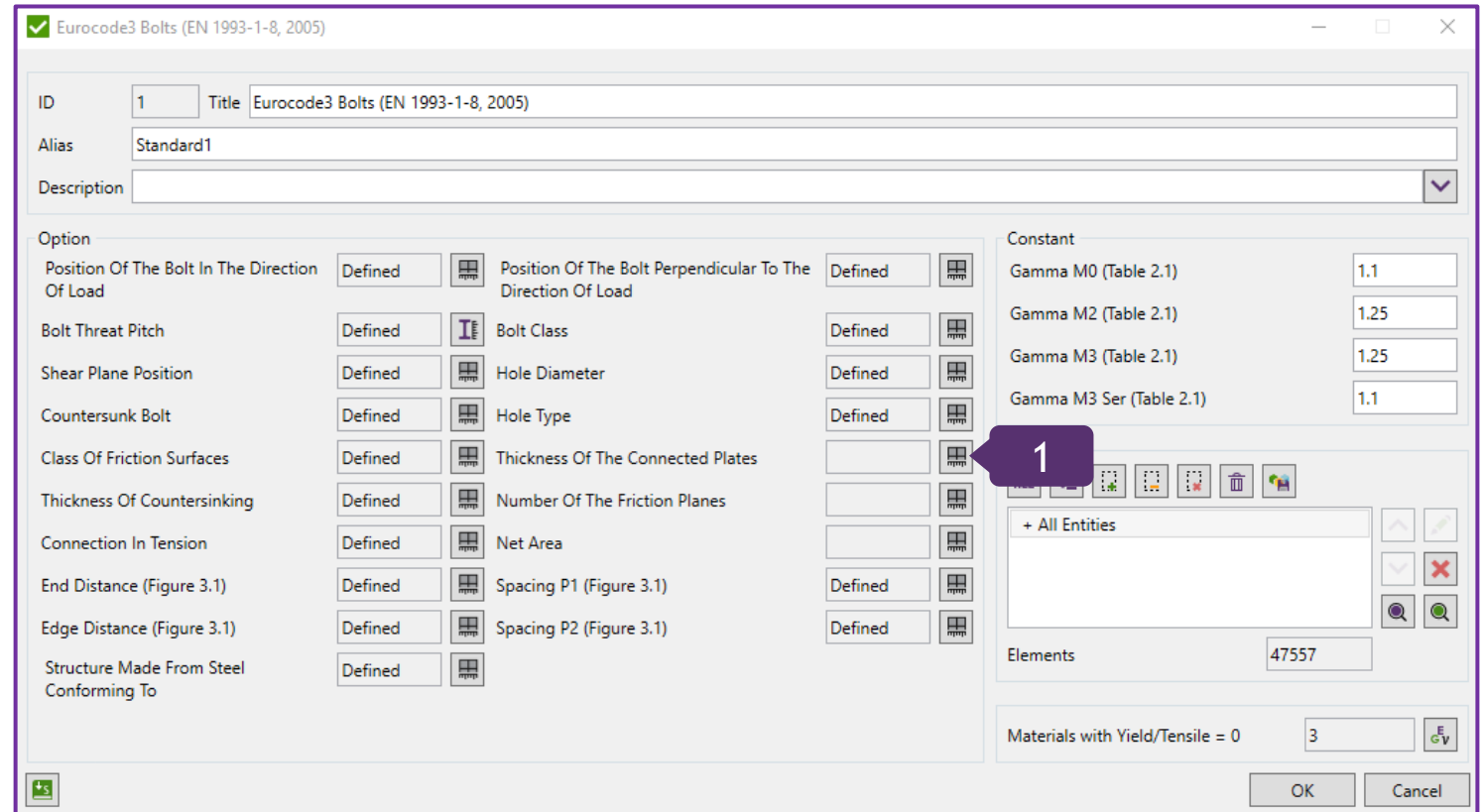
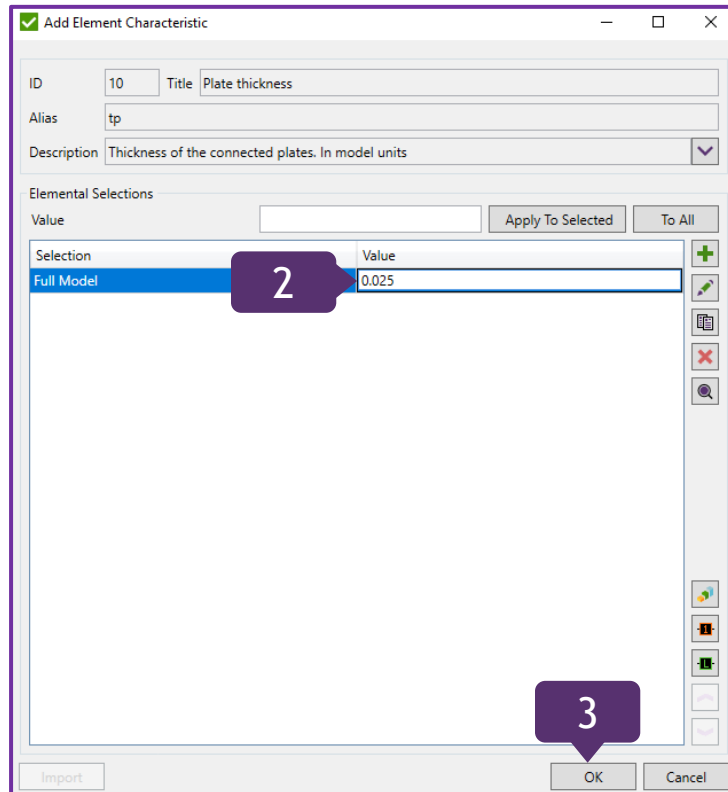
Selection Value: 0.025 (mm)

3

Press OK

All bolted plates in the connection have thickness of 25 mm, so this parameter can be applied to full model.

To run calculation correctly, this parameter needs to be applied as 25 mm (not 0 mm).





# Define Number Of The Friction Planes

1

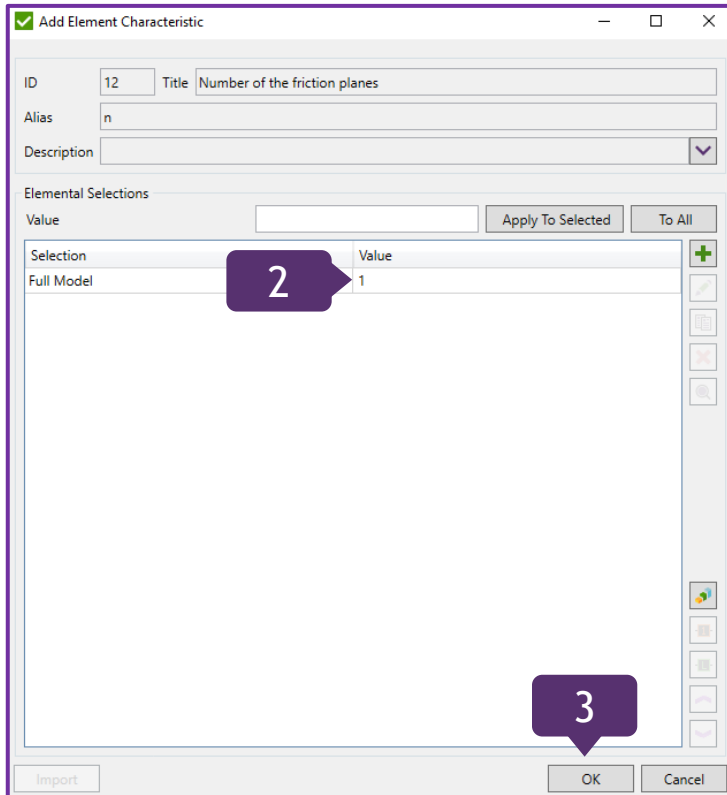
Press  in Number Of The Friction Planes

2

Selection Value: 1

3

Press OK



✓ Add Element Characteristic

ID: 12 Title: Number of the friction planes

Alias: n

Description:

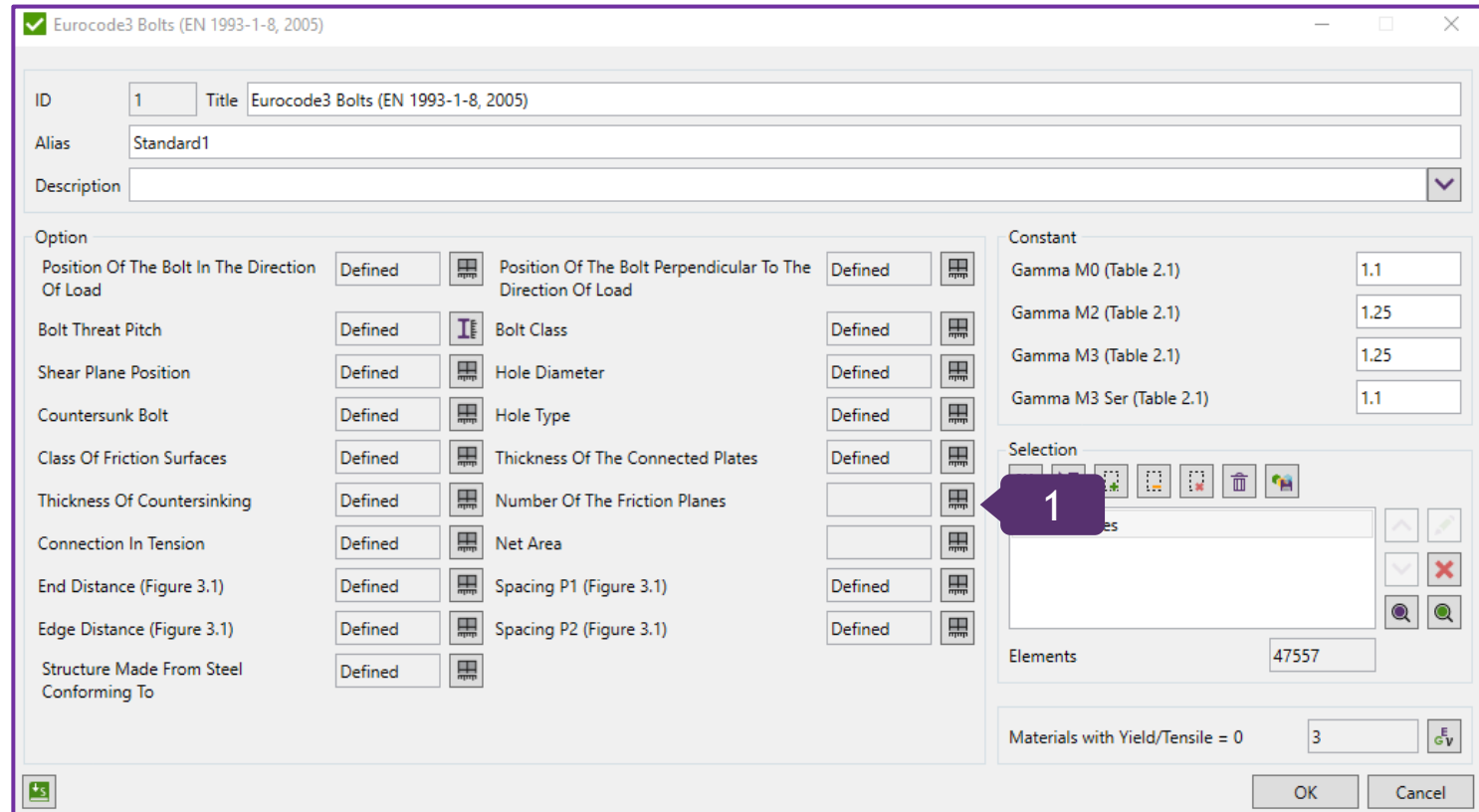
Elemental Selections

Selection	Value
Full Model	1

Apply To Selected To All

Import OK Cancel

Number of the friction planes - each bolted connection in the model contains 2 plates, resulting in one plane of friction.



✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Option	Defined
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	Defined
Bolt Threat Pitch	Defined	Bolt Class	Defined
Shear Plane Position	Defined	Hole Diameter	Defined
Countersunk Bolt	Defined	Hole Type	Defined
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	Defined
Thickness Of Countersinking	Defined	Number Of The Friction Planes	Defined
Connection In Tension	Defined	Net Area	Defined
End Distance (Figure 3.1)	Defined	Spacing P1 (Figure 3.1)	Defined
Edge Distance (Figure 3.1)	Defined	Spacing P2 (Figure 3.1)	Defined
Structure Made From Steel Conforming To	Defined		

Constant

Constant	Value
Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

Selection	Value
Full Model	1

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

# Define Net Area

1 Press  in Net Area

2 Selection Value: 0

3 Press OK

Net area - plate cross section area used for tension verification.

**Add Element Characteristic**

ID: 14 Title: Net area

Alias: Anet

Description:

Elemental Selections

Selection	Value
Full Model	0

Apply To Selected To All

Import OK Cancel

**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Option	Defined	Option	Defined
Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	Defined
Bolt Threat Pitch	Defined	Bolt Class	Defined
Shear Plane Position	Defined	Hole Diameter	Defined
Countersunk Bolt	Defined	Hole Type	Defined
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	Defined
Thickness Of Countersinking	Defined	Number Of The Friction Planes	Defined
Connection In Tension	Defined	Net Area	Defined
End Distance (Figure 3.1)	Defined	Spacing P1 (Figure 3.1)	Defined
Edge Distance (Figure 3.1)	Defined	Spacing P2 (Figure 3.1)	Defined
Structure Made From Steel Conforming To	Defined		

Constant

Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

ALL

Elements: 47557

Materials with Yield/Tensile = 0 3

OK Cancel

GmM0 and - Resistance of members and cross-sections;  
GmM2 - Resistance of bolts, rivets, pins, weld and plates in bearing;  
GmM3 - Slip resistance at ultimate limit state (Category C);  
GmM3 Ser - Slip resistance at serviceability limit state (Category B);

**Table 2.1: Partial safety factors for joints**

Resistance of members and cross-sections	$\gamma_{M0}$ , $\gamma_{M1}$ and $\gamma_{M2}$ see EN 1993-1-1
Resistance of bolts	$\gamma_{M2}$
Resistance of rivets	
Resistance of pins	
Resistance of welds	
Resistance of plates in bearing	
Slip resistance - at ultimate limit state (Category C) - at serviceability limit state (Category B)	$\gamma_{M3}$ $\gamma_{M3,ser}$
Bearing resistance of an injection bolt	$\gamma_{M4}$
Resistance of joints in hollow section lattice girder	$\gamma_{M5}$
Resistance of pins at serviceability limit state	$\gamma_{M6,ser}$
Preload of high strength bolts	$\gamma_{M7}$
Resistance of concrete	$\gamma_c$ see EN 1992

**NOTE:** Numerical values for  $\gamma_M$  may be defined in the National Annex. Recommended values are as follows:  $\gamma_{M2} = 1,25$ ;  $\gamma_{M3} = 1,25$  and  $\gamma_{M3,ser} = 1,1$ ;  $\gamma_{M4} = 1,0$ ;  $\gamma_{M5} = 1,0$ ;  $\gamma_{M6,ser} = 1,0$ ;  $\gamma_{M7} = 1,1$ .

✓ Eurocode3 Bolts (EN 1993-1-8, 2005)

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

Option

Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	Defined
Bolt Threat Pitch	Defined	Bolt Class	Defined
Shear Plane Position	Defined	Hole Diameter	Defined
Countersunk Bolt	Defined	Hole Type	Defined
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	Defined
Thickness Of Countersinking	Defined	Number Of The Friction Planes	Defined
Connection In Tension	Defined	Net Area	Defined
End Distance (Figure 3.1)	Defined	Spacing P1 (Figure 3.1)	Defined
Edge Distance (Figure 3.1)	Defined	Spacing P2 (Figure 3.1)	Defined
Structure Made From Steel Conforming To	Defined		

Constant

Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

Selection

+ All Entities

Elements: 47557

Materials with Yield/Tensile = 0: 3

OK Cancel

# Change Selection

1

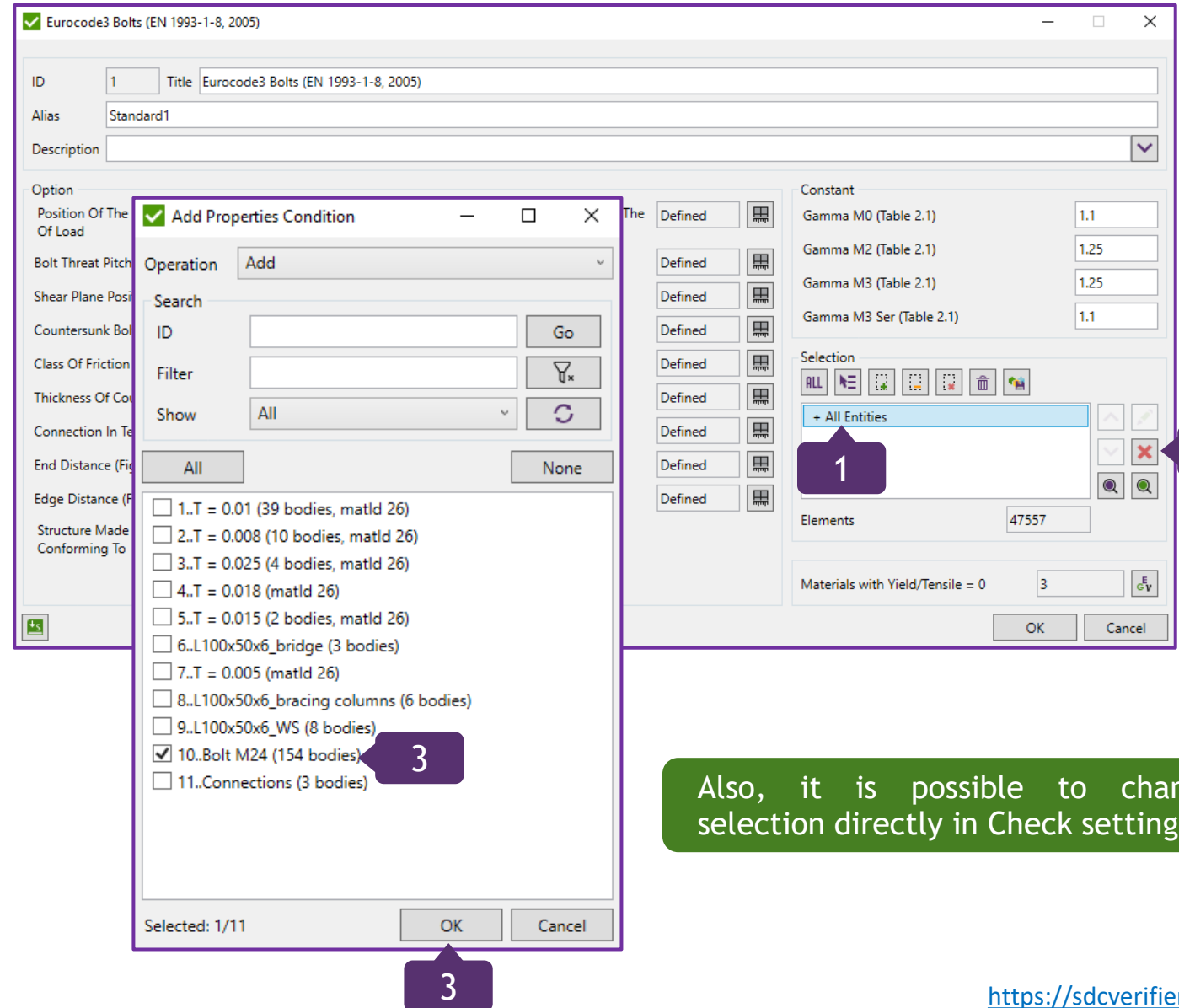
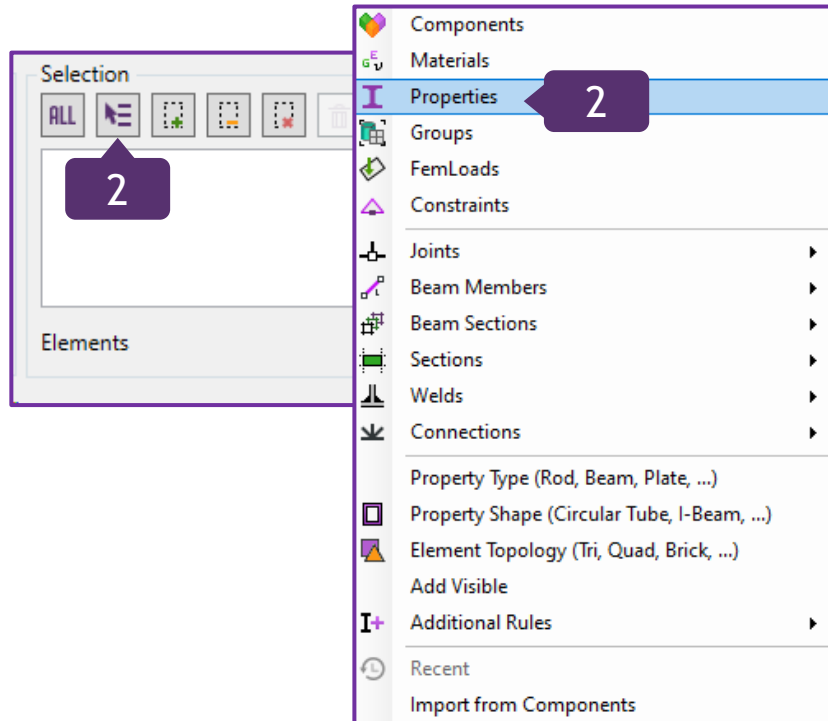
Select **+All Entities** and press  to remove them

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.

# Define Material Characteristics

1

Press  to set the material yield stress and tensile strength

2

Select all Materials (Ctrl+A)

3

Tensile Strength:  $490e+6$

4

Yield Stress:  $355e+6$

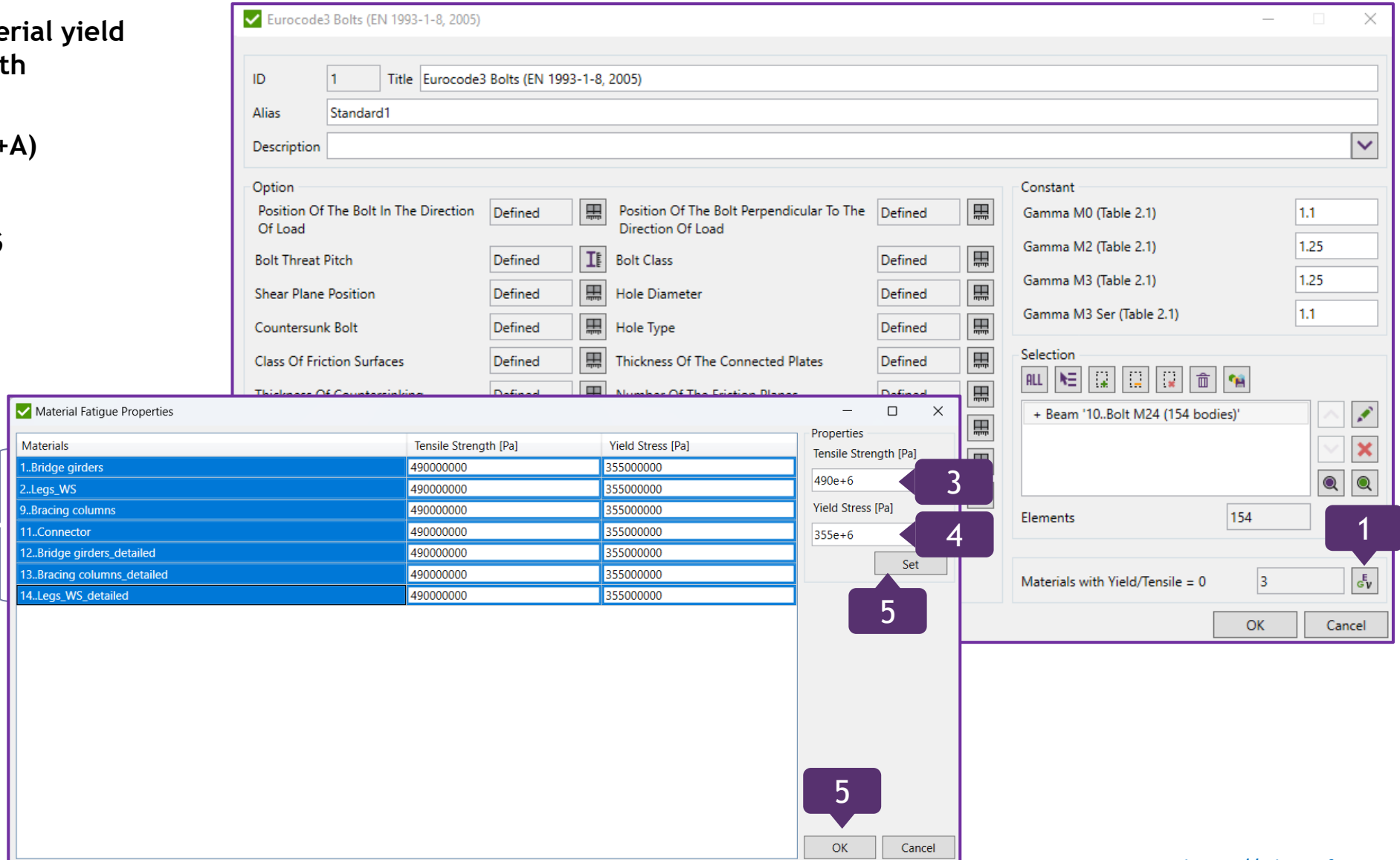
5

Press Set

6

Press OK

2



**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)  
Alias: Standard1  
Description:

Option

Position Of The Bolt In The Direction Of Load: Defined  
Position Of The Bolt Perpendicular To The Direction Of Load: Defined  
Bolt Threat Pitch: Defined  
Bolt Class: Defined  
Shear Plane Position: Defined  
Hole Diameter: Defined  
Countersunk Bolt: Defined  
Hole Type: Defined  
Class Of Friction Surfaces: Defined  
Thickness Of The Connected Plates: Defined  
Thickness Of Countersunk: Defined  
Number Of The Friction Planes: Defined

Constant

Gamma M0 (Table 2.1): 1.1  
Gamma M2 (Table 2.1): 1.25  
Gamma M3 (Table 2.1): 1.25  
Gamma M3 Ser (Table 2.1): 1.1

Selection

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

Elements: 154

Materials with Yield/Tensile = 0: 3

OK Cancel

**Material Fatigue Properties**

Materials	Tensile Strength [Pa]	Yield Stress [Pa]
1..Bridge girders	490000000	355000000
2..Legs_WS	490000000	355000000
9..Bracing columns	490000000	355000000
11..Connector	490000000	355000000
12..Bridge girders_detailed	490000000	355000000
13..Bracing columns_detailed	490000000	355000000
14..Legs_WS_detailed	490000000	355000000

Properties

Tensile Strength [Pa]: 490e+6  
Yield Stress [Pa]: 355e+6  
Set  
OK Cancel

**SDC**  
VERIFIER

**Eurocode3 Bolts (EN 1993-1-8, 2005)**

ID: 1 Title: Eurocode3 Bolts (EN 1993-1-8, 2005)

Alias: Standard1

Description:

**Option**

Position Of The Bolt In The Direction Of Load	Defined	Position Of The Bolt Perpendicular To The Direction Of Load	Defined
Bolt Threat Pitch	Defined	Bolt Class	Defined
Shear Plane Position	Defined	Hole Diameter	Defined
Countersunk Bolt	Defined	Hole Type	Defined
Class Of Friction Surfaces	Defined	Thickness Of The Connected Plates	Defined
Thickness Of Countersinking	Defined	Number Of The Friction Planes	Defined
Connection In Tension	Defined	Net Area	Defined
End Distance (Figure 3.1)	Defined	Spacing P1 (Figure 3.1)	Defined
Edge Distance (Figure 3.1)	Defined	Spacing P2 (Figure 3.1)	Defined
Structure Made From Steel Conforming To	Defined		

**Constant**

Gamma M0 (Table 2.1)	1.1
Gamma M2 (Table 2.1)	1.25
Gamma M3 (Table 2.1)	1.25
Gamma M3 Ser (Table 2.1)	1.1

**Selection**

ALL [Icons]

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

Elements: 154

Materials with Yield/Tensile = 0: 3

1

OK Cancel

## 3.4.1 Shear connections

(1) Bolted connections loaded in shear should be designed as one of the following:

a) **Category A: Bearing type**

In this category bolts from class 4.6 up to and including class 10.9 should be used. No preloading and special provisions for contact surfaces are required. The design ultimate shear load should not exceed the design shear resistance, obtained from 3.6, nor the design bearing resistance, obtained from 3.6 and 3.7.

b) **Category B: Slip-resistant at serviceability limit state**

In this category preloaded bolts in accordance with 3.1.2(1) should be used. Slip should not occur at the serviceability limit state. The design serviceability shear load should not exceed the design slip resistance, obtained from 3.9. The design ultimate shear load should not exceed the design shear resistance, obtained from 3.6, nor the design bearing resistance, obtained from 3.6 and 3.7.

c) **Category C: Slip-resistant at ultimate limit state**

In this category preloaded bolts in accordance with 3.1.2(1) should be used. Slip should not occur at the ultimate limit state. The design ultimate shear load should not exceed the design slip resistance, obtained from 3.9, nor the design bearing resistance, obtained from 3.6 and 3.7. In addition for a connection in tension, the design plastic resistance of the net cross-section at bolt holes  $N_{net,Rd}$ , (see 6.2 of EN 1993-1-1), should be checked, at the ultimate limit state.

The design checks for these connections are summarized in Table 3.2.

## 3.4.2 Tension connections

(1) Bolted connection loaded in tension should be designed as one of the following:

a) **Category D: non-preloaded**

In this category bolts from class 4.6 up to and including class 10.9 should be used. No preloading is required. This category should not be used where the connections are frequently subjected to variations of tensile loading. However, they may be used in connections designed to resist normal wind loads.

b) **Category E: preloaded**

In this category preloaded 8.8 and 10.9 bolts with controlled tightening in conformity with 1.2.7 Reference Standards: Group 7 should be used.

The design checks for these connections are summarized in Table 3.2.



BS EN 1993-1-8:2005  
EN 1993-1-8:2005 (E)


**Table 3.2: Categories of bolted connections**

Category	Criteria	Remarks
<b>Shear connections</b>		
A bearing type	$F_{v,Ed} \leq F_{v,Rd}$ $F_{v,Ed} \leq F_{b,Rd}$	No preloading required. Bolt classes from 4.6 to 10.9 may be used.
B slip-resistant at serviceability	$F_{v,Ed,ser} \leq F_{s,Rd,ser}$ $F_{v,Ed} \leq F_{v,Rd}$ $F_{v,Ed} \leq F_{b,Rd}$	Preloaded 8.8 or 10.9 bolts should be used. For slip resistance at serviceability see 3.9.
C slip-resistant at ultimate	$F_{v,Ed} \leq F_{s,Rd}$ $F_{v,Ed} \leq F_{b,Rd}$ $\langle AC2 \rangle \sum F_{v,Ed} \leq N_{net,Rd} \langle AC2 \rangle$	Preloaded 8.8 or 10.9 bolts should be used. For slip resistance at ultimate see 3.9. $N_{net,Rd}$ see 3.4.1(1) c).
<b>Tension connections</b>		
D non-preloaded	$F_{t,Ed} \leq F_{t,Rd}$ $F_{t,Ed} \leq B_{p,Rd}$	No preloading required. Bolt classes from 4.6 to 10.9 may be used. $B_{p,Rd}$ see Table 3.4.
E preloaded	$F_{t,Ed} \leq F_{t,Rd}$ $F_{t,Ed} \leq B_{p,Rd}$	Preloaded 8.8 or 10.9 bolts should be used. $B_{p,Rd}$ see Table 3.4.
The design tensile force $F_{t,Ed}$ should include any force due to prying action, see 3.11. Bolts subjected to both shear force and tensile force should also satisfy the criteria given in Table 3.4.		



# Create Extreme Table

1

Execute  **Table (expand/extreme)** in Standards => Checks => 6..Category C and E context menu

2

In Load Group, press 

3

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

4

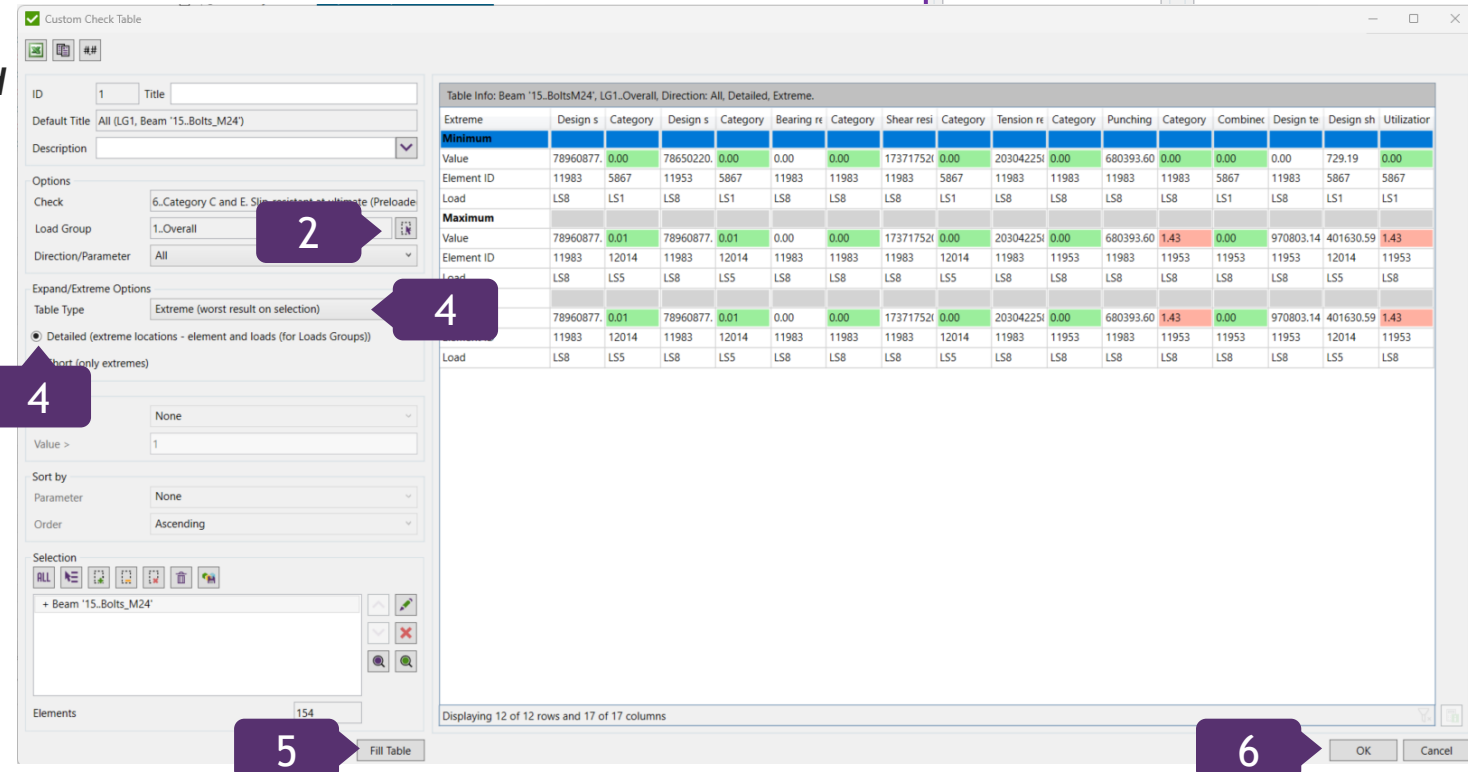
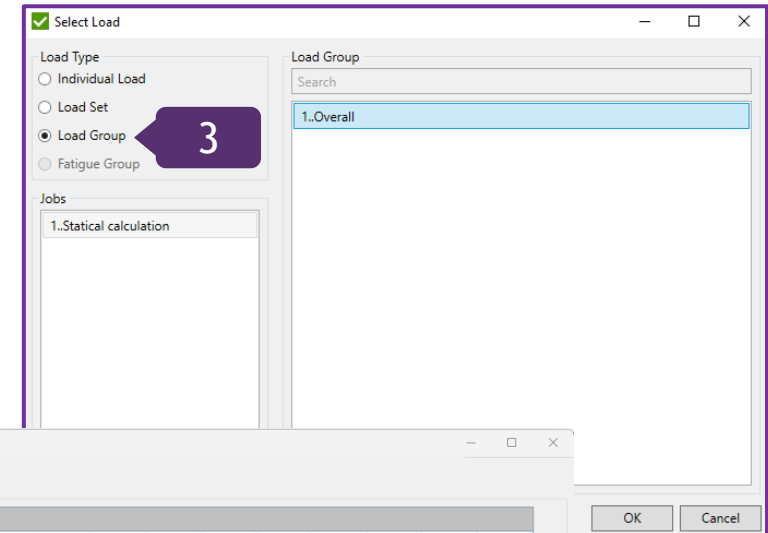
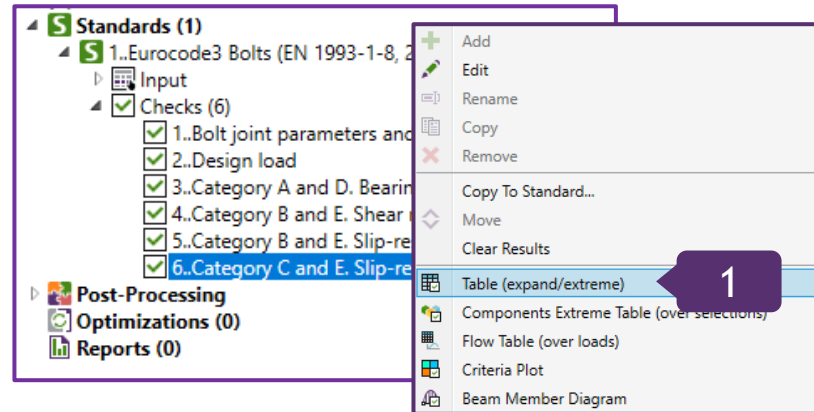
Table Type: **Extreme; Detailed (extreme locations-element and load (for Load Groups))** - ON

5

Press **Fill Table**

6

Press **OK**



# Utilization Factor Plot

1

In Standards, Checks => 6..Category C and E, execute *Criteria Plot*

2

In Load Group, press 

3

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

4

Parameter: *Utilization factor overall*

5

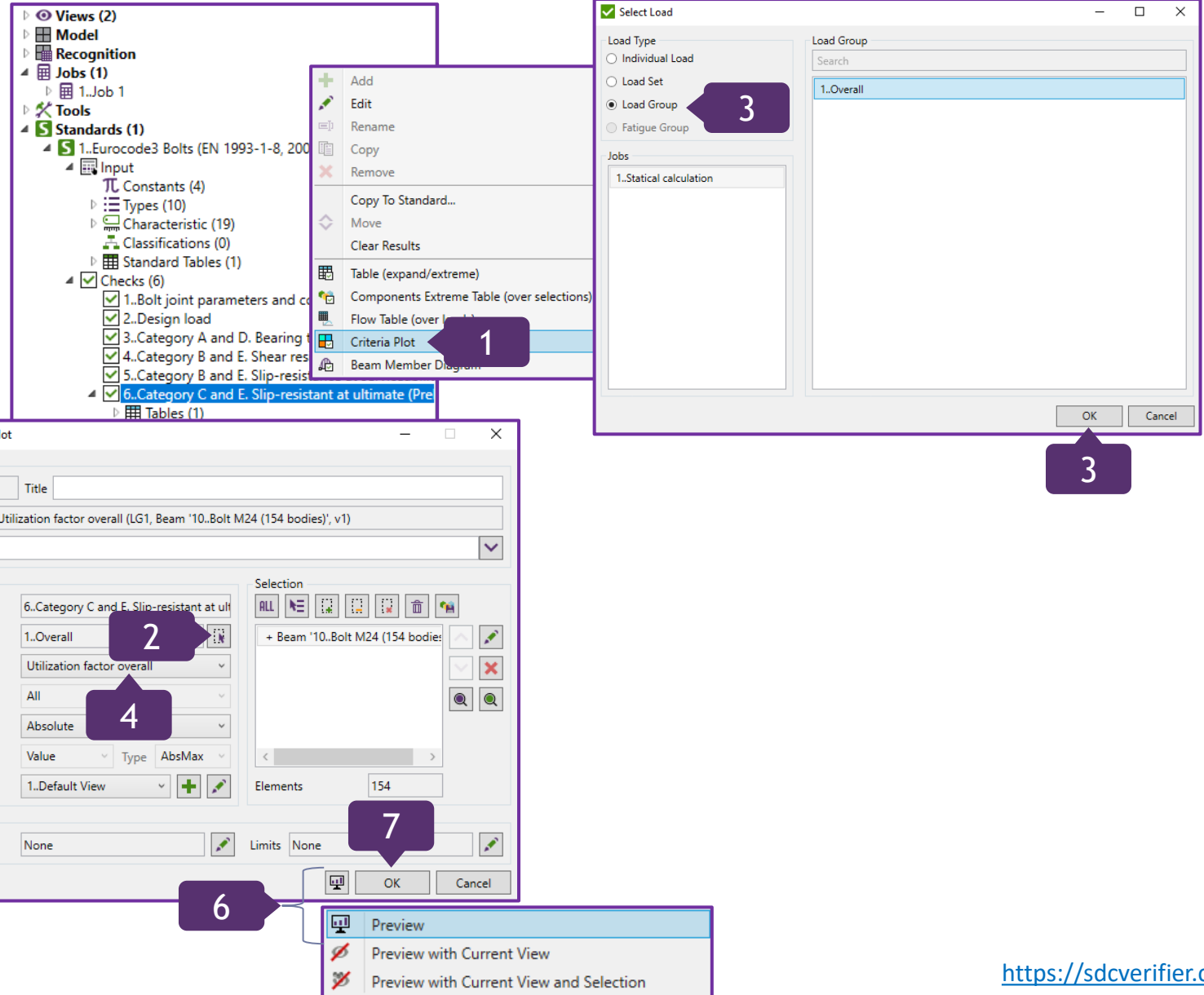
LG Parameter: Absolute

6

Press , and then *Preview*

7

Press *OK*

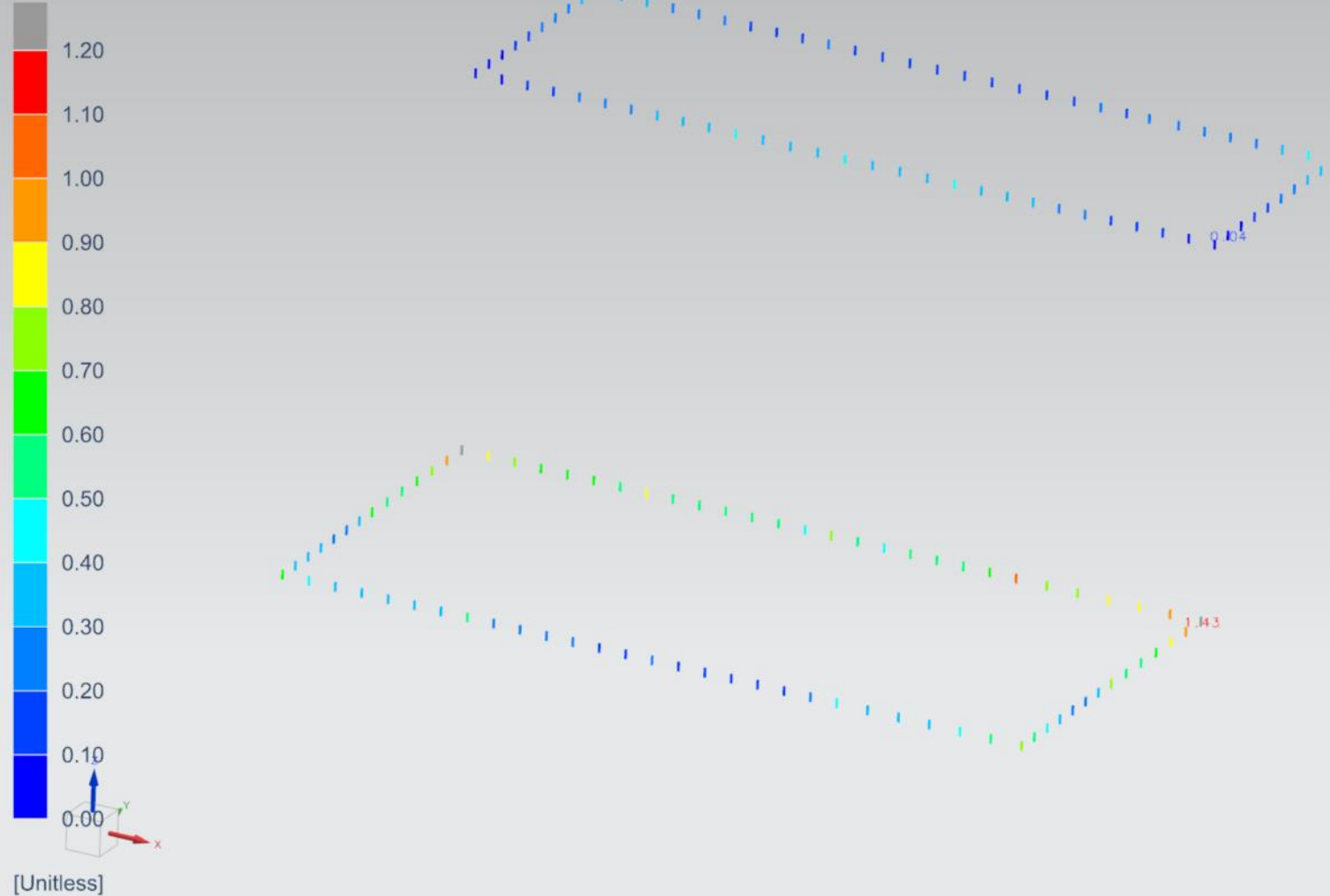


The screenshot illustrates the steps to create a Utilization Factor Plot in SDC Verifier:

- Tree View:** In the 'Standards (1)' section, expand '1..Eurocode3 Bolts (EN 1993-1-8, 200...)' and select '6..Category C and E. Slip-resistant at ultimate (Pre...)' under 'Checks (6)'. A context menu is shown with 'Criteria Plot' selected.
- Select Load Dialog:** The 'Load Type' is set to 'Load Group'. The 'Load Group' list shows '1..Overall' selected. The 'Jobs' list shows '1..Statical calculation'. The 'OK' button is highlighted.
- Check Criteria Plot Dialog:** The 'ID' is 1. The 'Default Title' is 'Abs Utilization factor overall (LG1, Beam '10..Bolt M24 (154 bodies)', v1)'. The 'Options' section shows 'Check' set to '6..Category C and E. Slip-resistant at ultimate', 'Load Group' set to '1..Overall', 'Parameter' set to 'Utilization factor overall', 'Direction' set to 'All', 'LG Parameter' set to 'Absolute', 'Point of Interest' set to 'Value', 'Type' set to 'AbsMax', and 'View' set to '1..Default View'. The 'Selection' section shows 'Beam '10..Bolt M24 (154 bodies)' selected. The 'Elements' count is 154. The 'Labels' are set to 'None' and 'Limits' are set to 'None'. The 'Preview' button is highlighted.
- Preview Menu:** The 'Preview' menu is open, showing options: 'Preview', 'Preview with Current View', and 'Preview with Current View and Selection'.

# Utilization Factor Plot

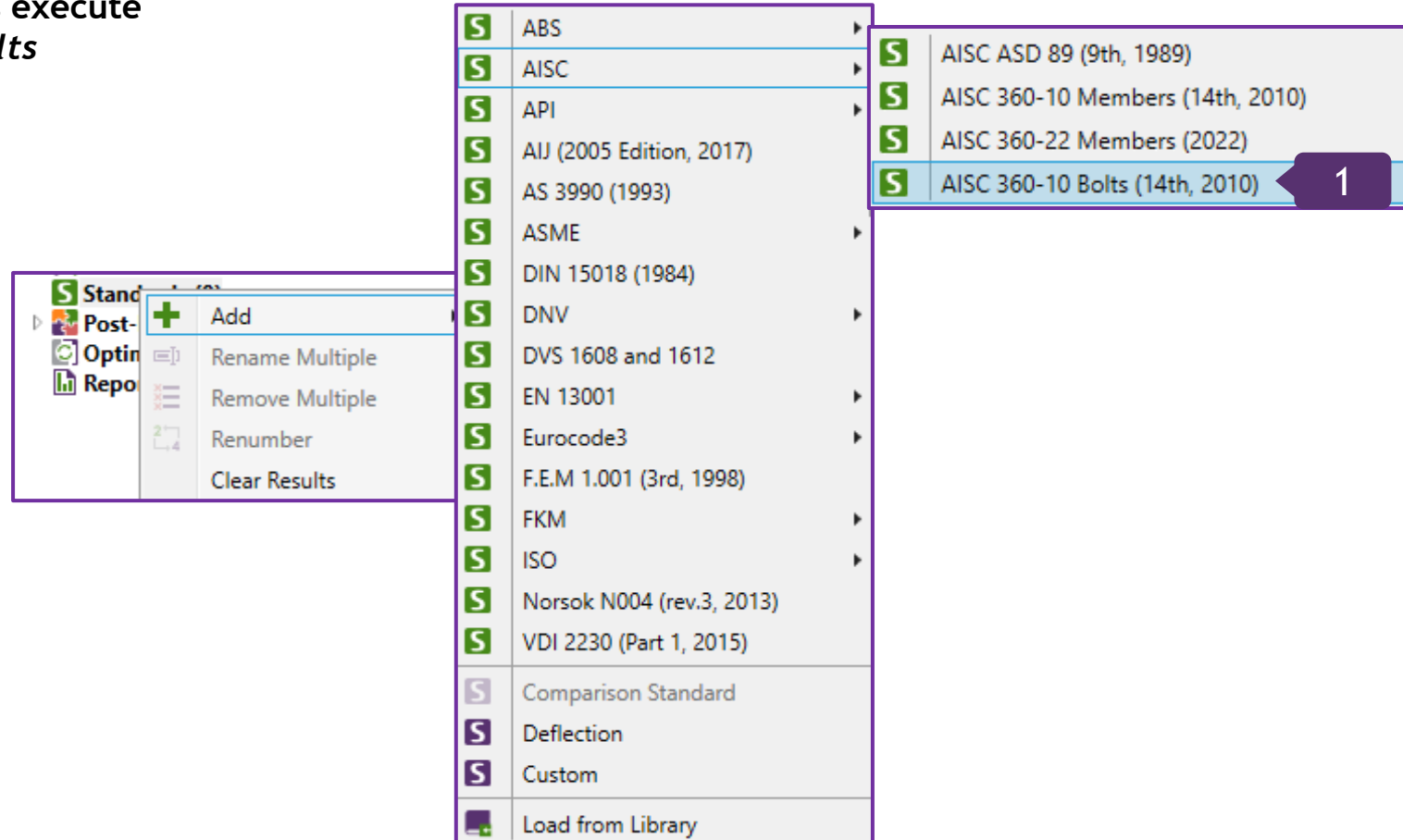
Bolt Check : Job 1 Linear Result  
SdcData, Static Step 1  
Members - Elemental, Scalar  
Formula Used : SdcExpression  
Min : 0.04, Max : 1.43, Units = Unitless



# 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)

<b>TABLE J3.2</b> <b>Nominal Strength of Fasteners and Threaded Parts, ksi (MPa)</b>		
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	$0.75F_u$	$0.563F_u$

<b>TABLE J3.1M</b> <b>Minimum Bolt Pretension, kN*</b>		
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.

<b>TABLE J3.3M</b> <b>Nominal Hole Dimensions, mm</b>				
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:

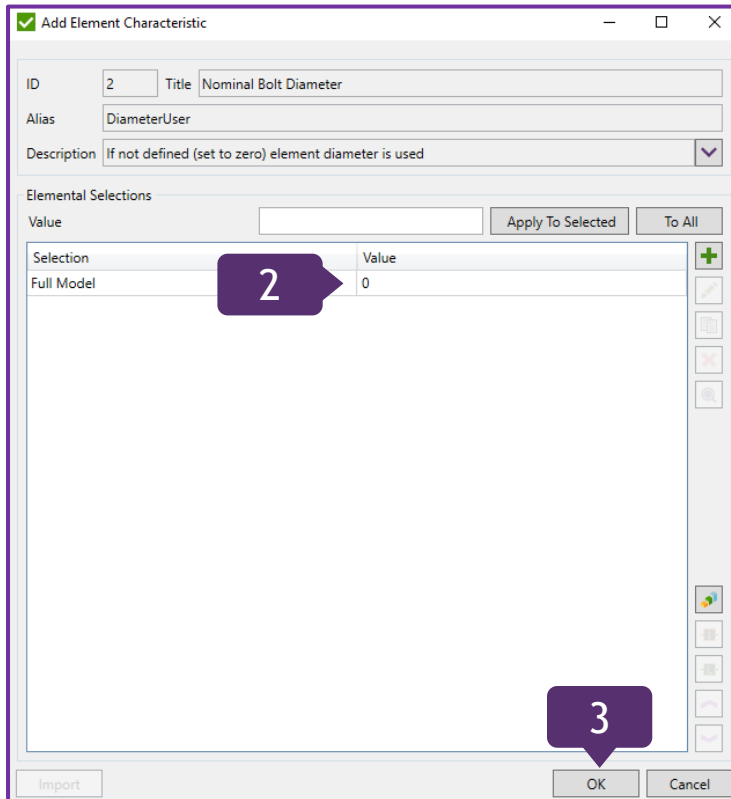
- 1 - Bolt Check;
- 2 - Bolt Check ASD;
- 3 - Bolt Check LRFD;
- 4 - Bolt Overall.

# Define Nominal Bolt Diameter

1 Press  in Nominal Bolt Diameter

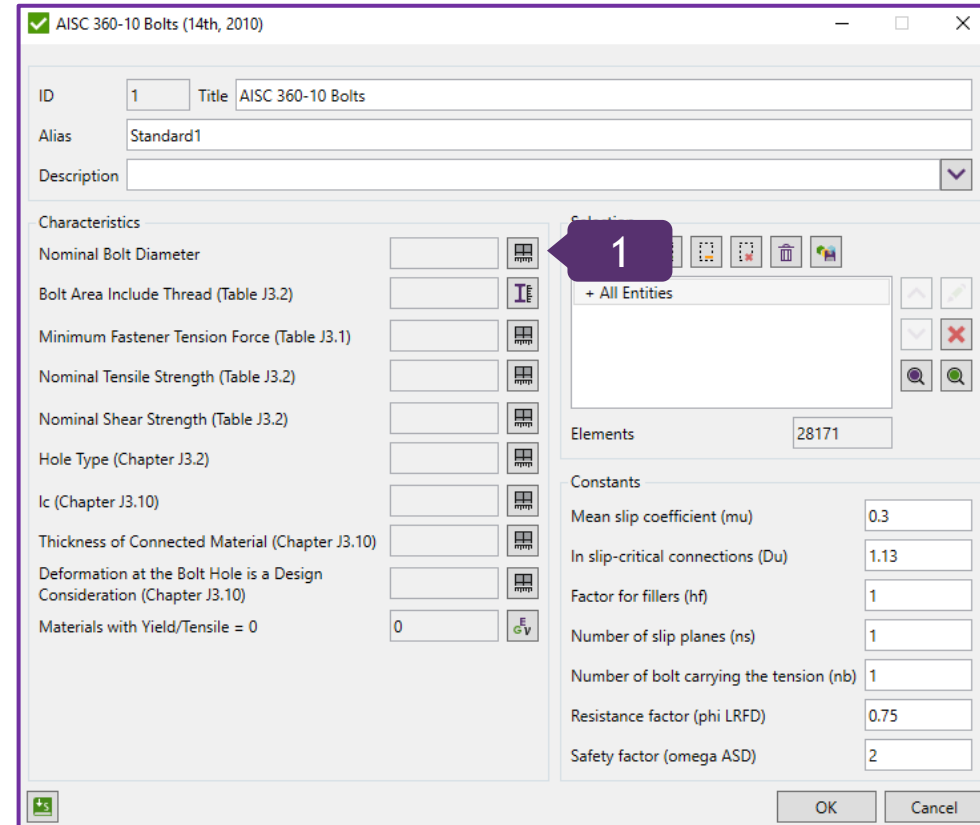
2 Selection Value: 0

3 Press OK



Selection	Value
Full Model	0

Nominal Bolt Diameter - diameter of bolt in connection, if not defined (set to zero) 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

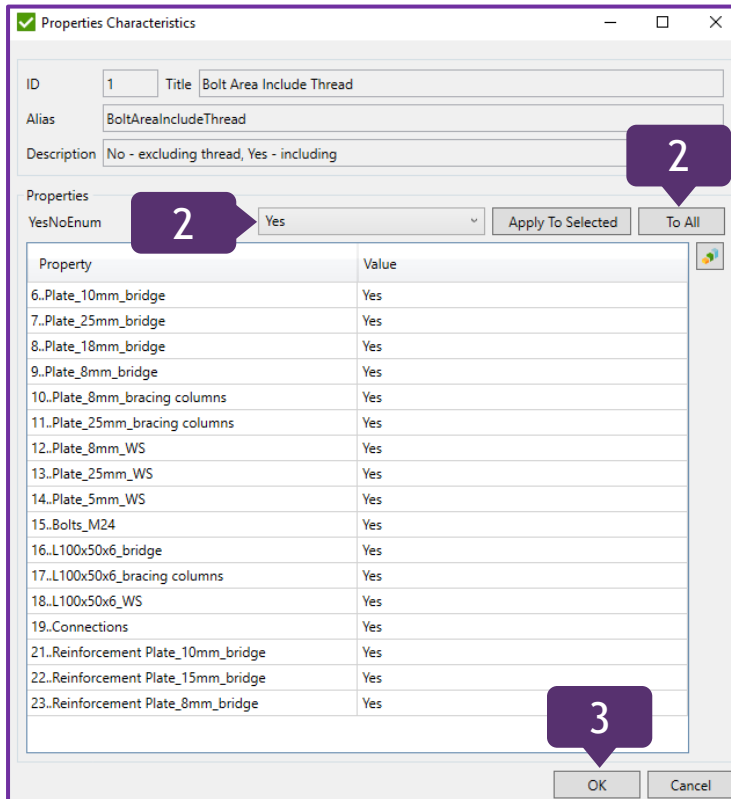
Press  in Bolt Area Include Thread (Table J3.2)

2

Properties YesNoEnum: Yes and press *To All*

3

Press *OK*



Properties Characteristics

ID: 1 Title: Bolt Area Include Thread

Alias: BoltAreaIncludeThread

Description: No - excluding thread, Yes - including

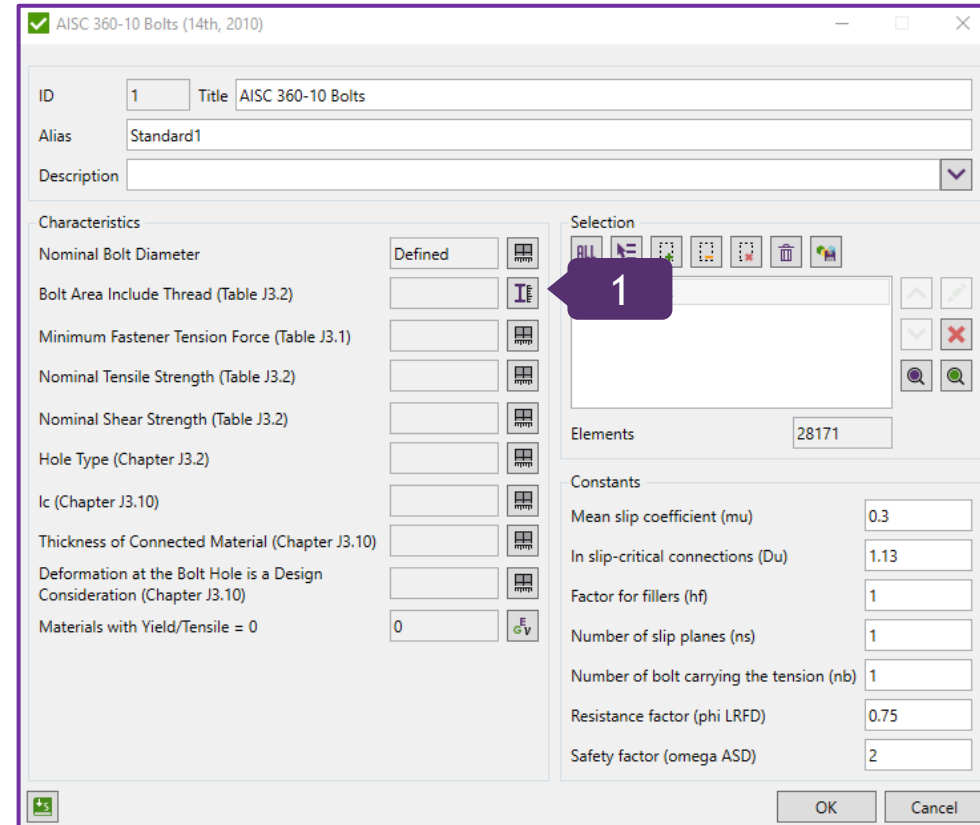
Properties

YesNoEnum: Yes Apply To Selected To All

Property	Value
6..Plate_10mm_bridge	Yes
7..Plate_25mm_bridge	Yes
8..Plate_18mm_bridge	Yes
9..Plate_8mm_bridge	Yes
10..Plate_8mm_bracing columns	Yes
11..Plate_25mm_bracing columns	Yes
12..Plate_8mm_WS	Yes
13..Plate_25mm_WS	Yes
14..Plate_5mm_WS	Yes
15..Bolts_M24	Yes
16..L100x50x6_bridge	Yes
17..L100x50x6_bracing columns	Yes
18..L100x50x6_WS	Yes
19..Connections	Yes
21..Reinforcement Plate_10mm_bridge	Yes
22..Reinforcement Plate_15mm_bridge	Yes
23..Reinforcement Plate_8mm_bridge	Yes

OK Cancel

Bolt Area Include Thread - set Yes to take into account of bolt thread/ No if do not take into account (Table J3.2)



AISI 360-10 Bolts (14th, 2010)


ID: 1 Title: AISI 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Nominal Bolt Diameter: Defined

Bolt Area Include Thread (Table J3.2):  1

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

Elements: 28171

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

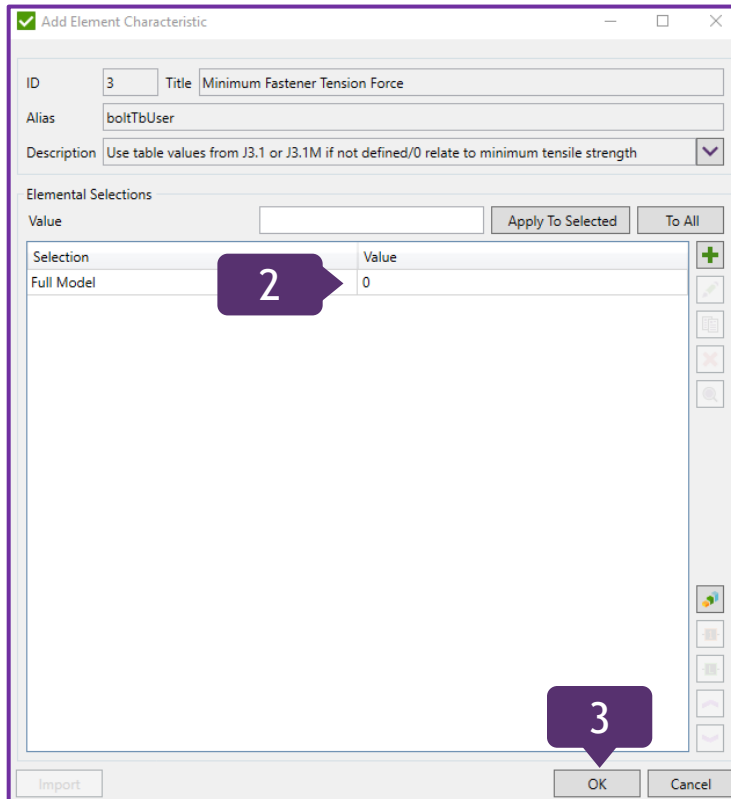
Press  in Minimum Fastener Tension Force (Table J3.1)

2

Selection Value: 0

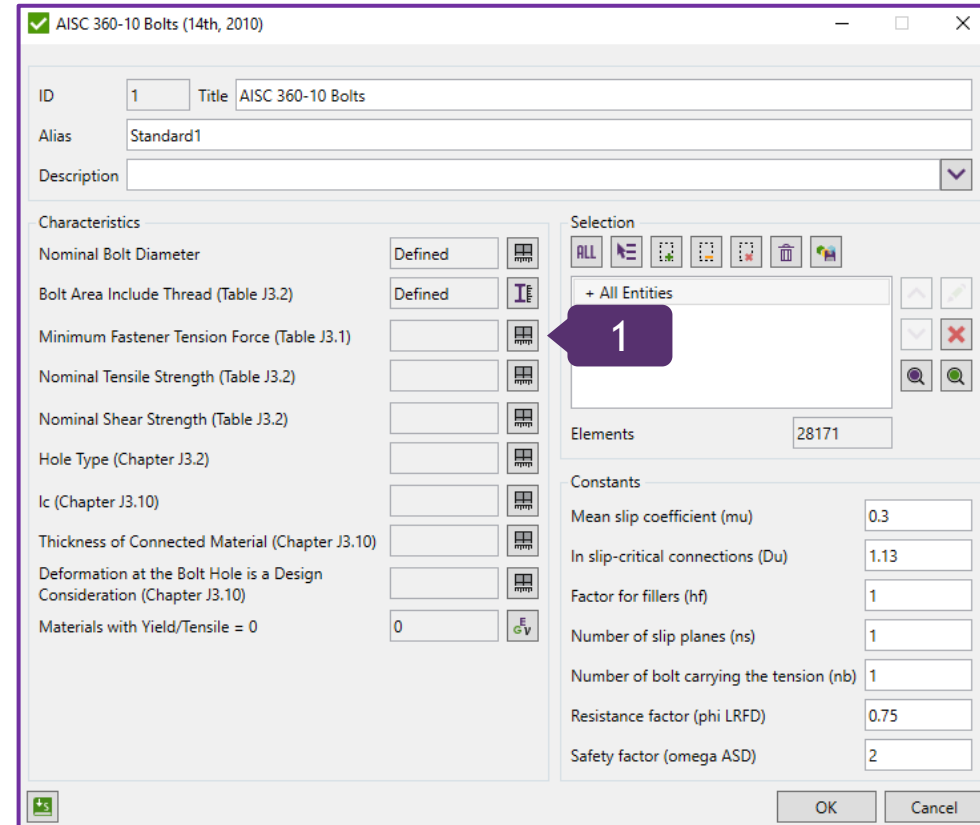
3

Press **OK**



Selection	Value
Full Model	0

Minimum Fastener Tension Force - values from J3.1 or J3.1M if not defined/0 relate to minimum tensile strength



Characteristics	Defined
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

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



# Define Nominal Tensile Strength (Table J3.2)

1

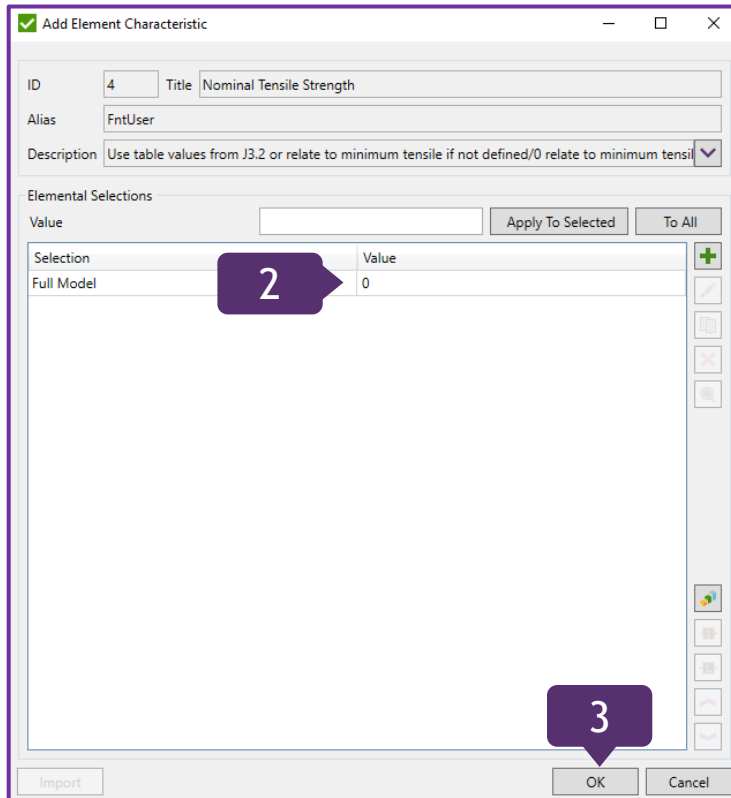
Press  in Nominal Tensile Strength (Table J3.2)

2

Selection Value: 0

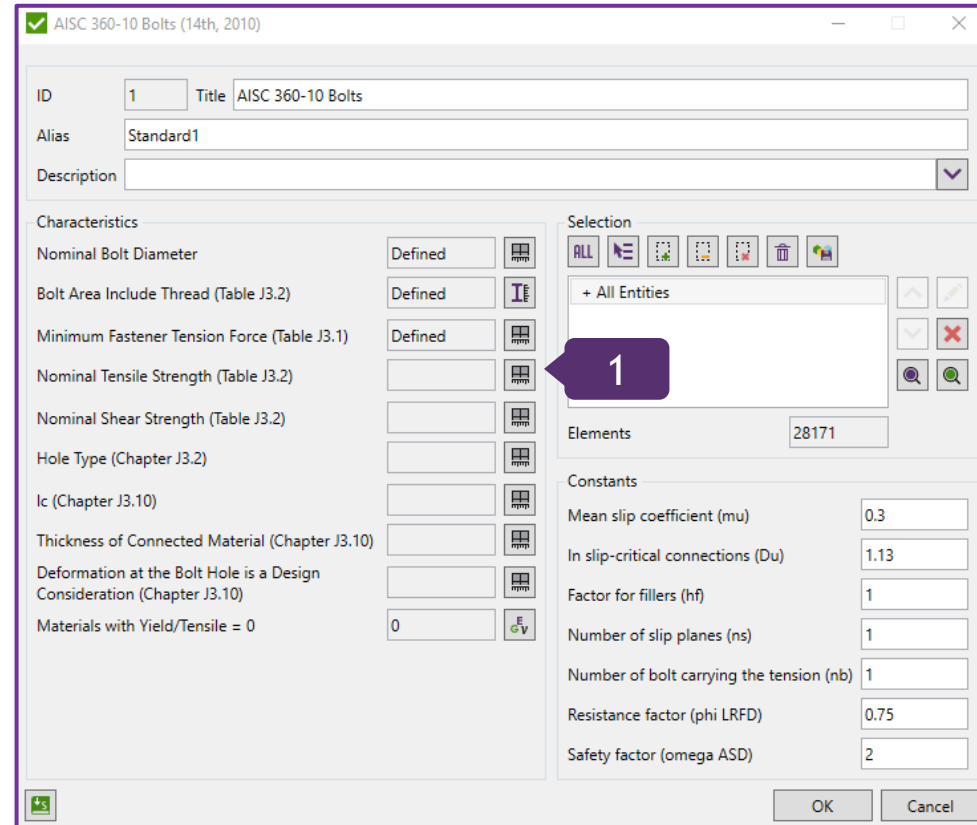
3







Press OK



Selection	Value
Full Model	0

Nominal Tensile Strength - values from J3.2 or relate to minimum tensile if not defined/0 relate to minimum tensile strength




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)	
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 (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

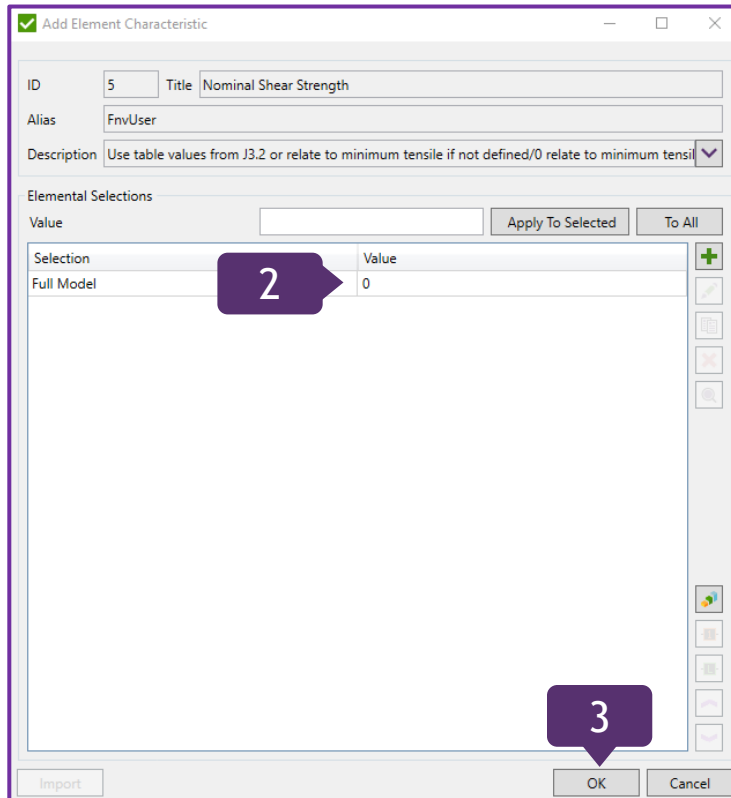
Press  in Nominal Shear Strength (Table J3.2)

2

Selection Value: 0

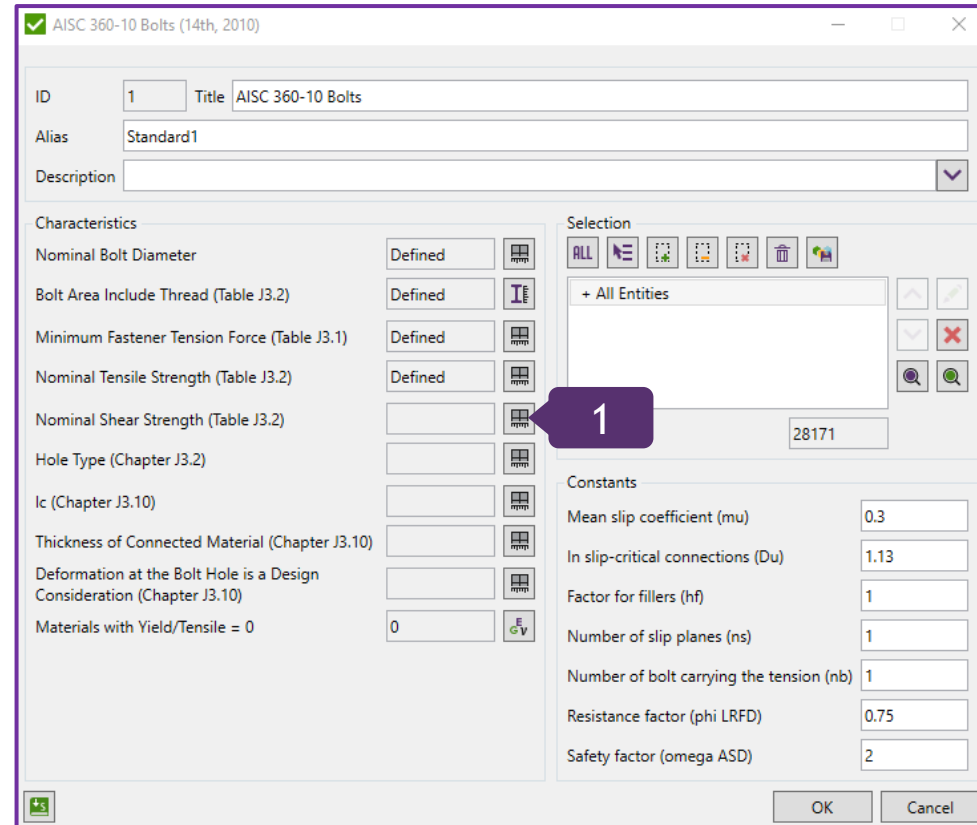
3

Press OK



Selection	Value
Full Model	0

Nominal Shear Strength - values from J3.2 or relate to minimum tensile if not defined/0 relate to minimum tensile strength



Characteristics	Defined	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	28171
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	

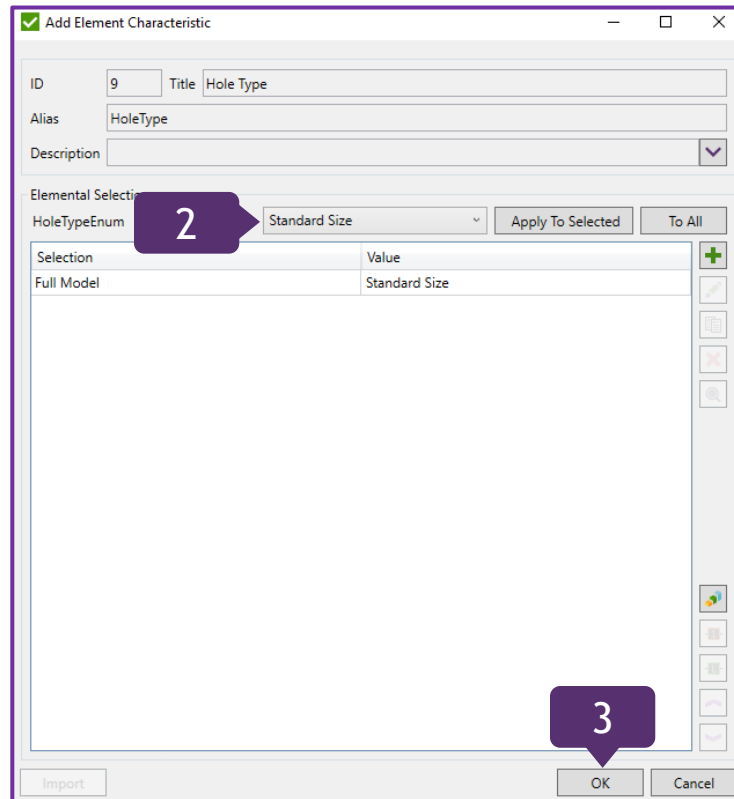
Constants	Value
Mean slip coefficient (mu)	0.3
In slip-critical connections (Du)	1.13
Factor for fillers (hf)	1
Number of slip planes (ns)	1
Number of bolt carrying the tension (nb)	1
Resistance factor (phi LRFD)	0.75
Safety factor (omega ASD)	2

# Define Hole Type (Chapter J3.2)

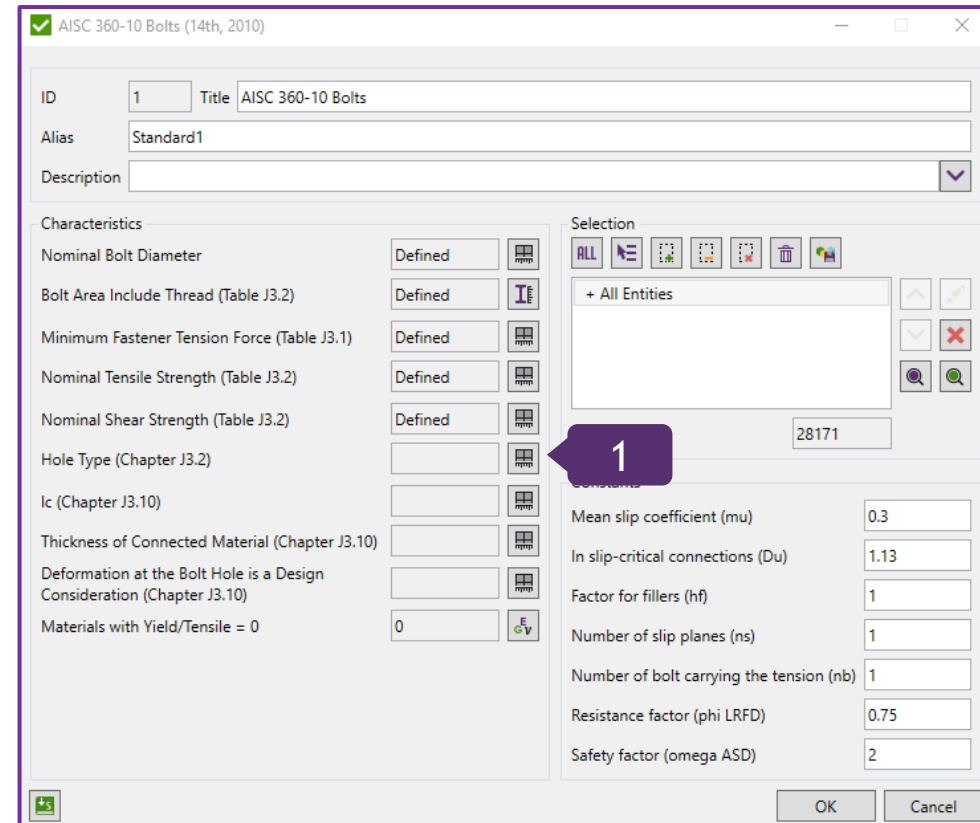
1 Press  in Hole Type (Chapter J3.2)

2 Elemental Selections HoleTypeEnum:  
*Standard Size*

3 Press *OK*



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



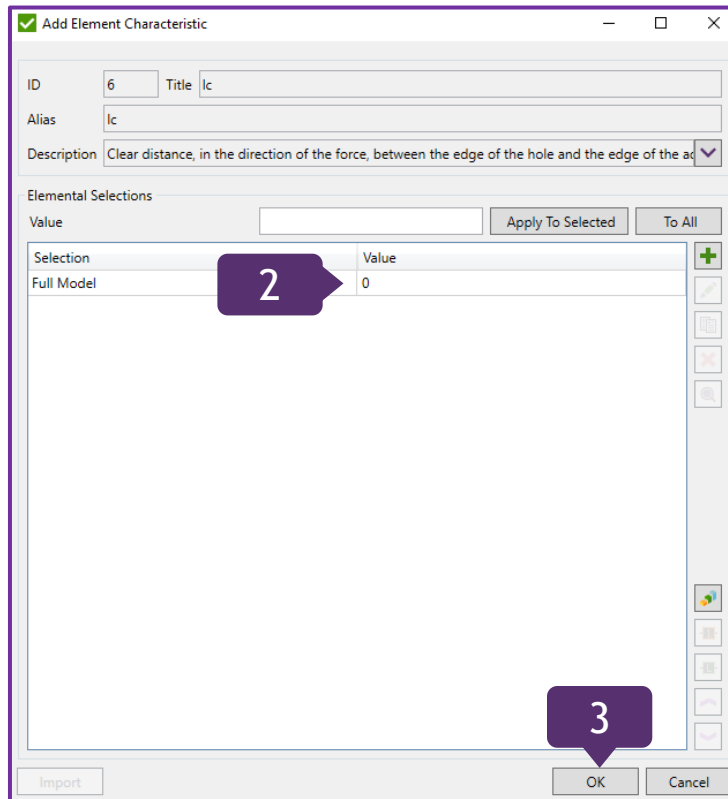
# Define Ic (Chapter J3.10)

1 Press  in Ic (Chapter J3.10)

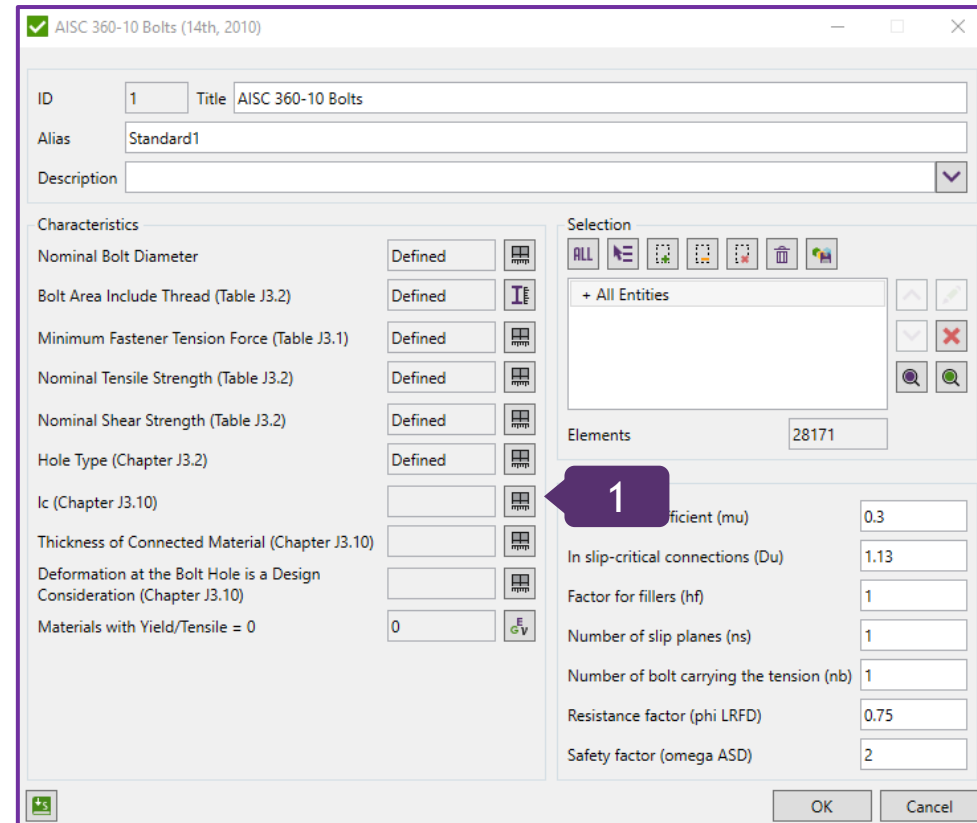
2 Selection Value: 0

3 Press OK

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



Selection	Value
Full Model	0



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

Property	Value
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 Thickness of Connected Material (Chapter J3.10)

1

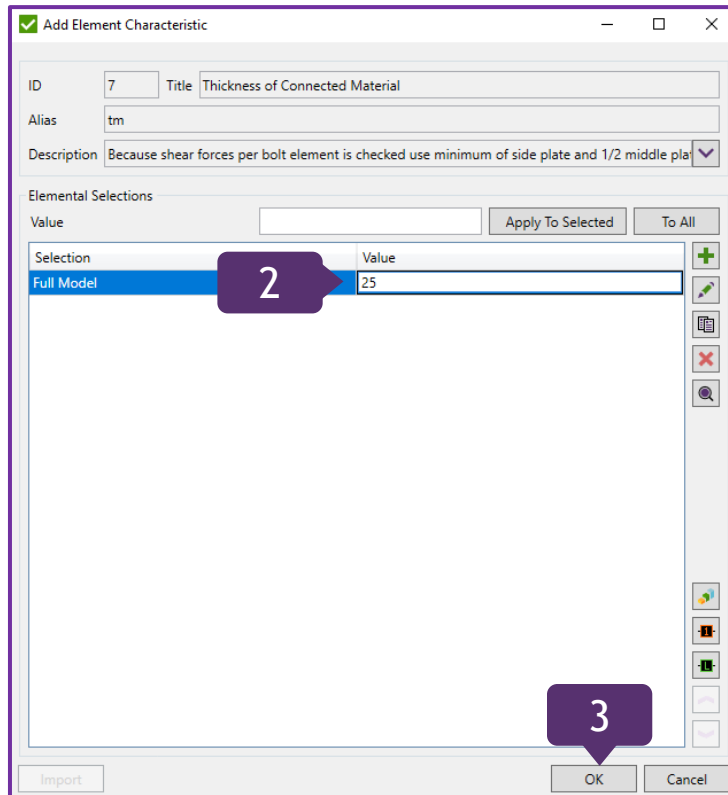
Press  in Thickness of Connected Material (Chapter J3.10)

2

Selection Value: 25

3

Press OK



✓ Add Element Characteristic

ID: 7 Title: Thickness of Connected Material

Alias: tm

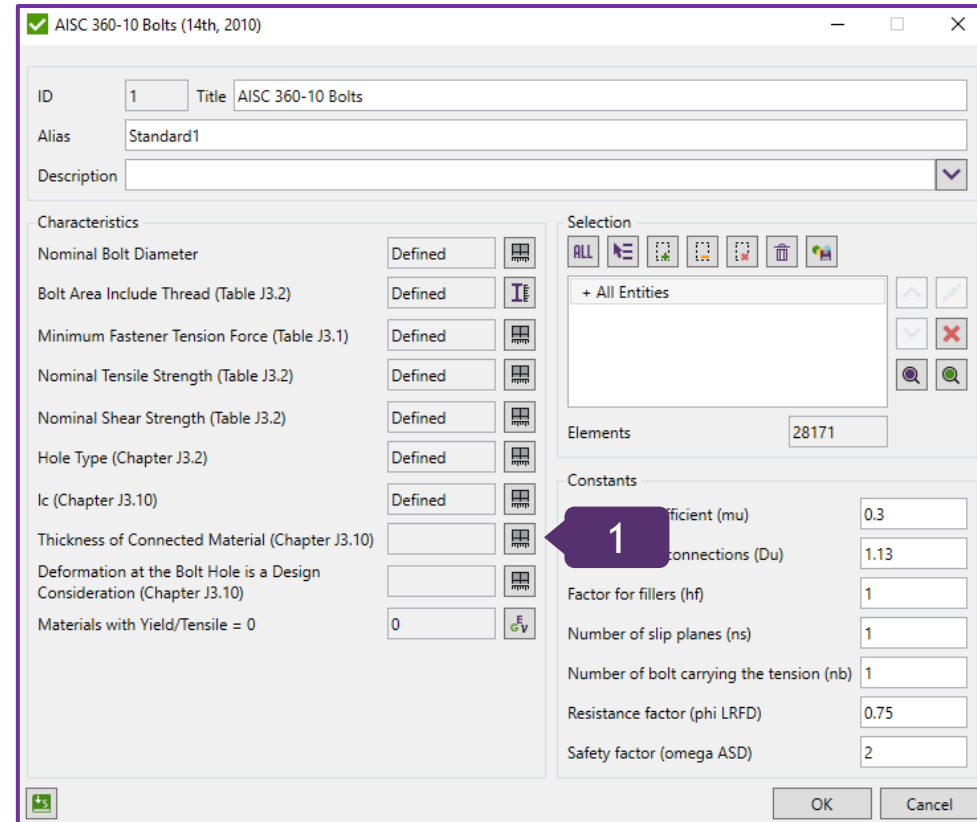
Description: Because shear forces per bolt element is checked use minimum of side plate and 1/2 middle plate

Elemental Selections

Selection	Value
Full Model	25

Import OK Cancel

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)



✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

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)	
Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)	
Materials with Yield/Tensile = 0	0

Selection

+ All Entities

Elements: 28171


Constants

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

OK Cancel

# Define Deformation at the Bolt Hole is a Design Consideration

1

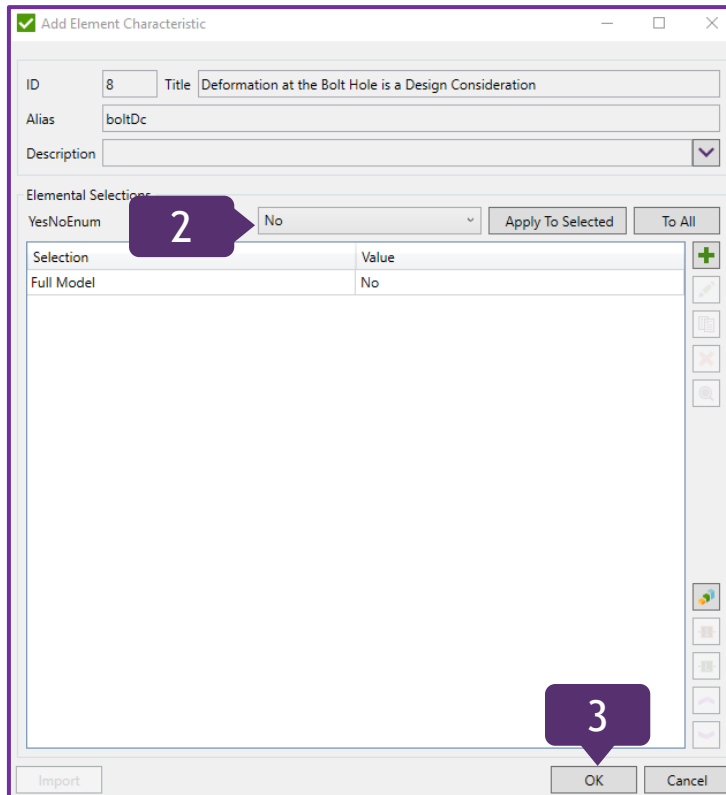
Press  in Deformation at the Bolt Hole is a Design Consideration (Chapter J3.10)

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:

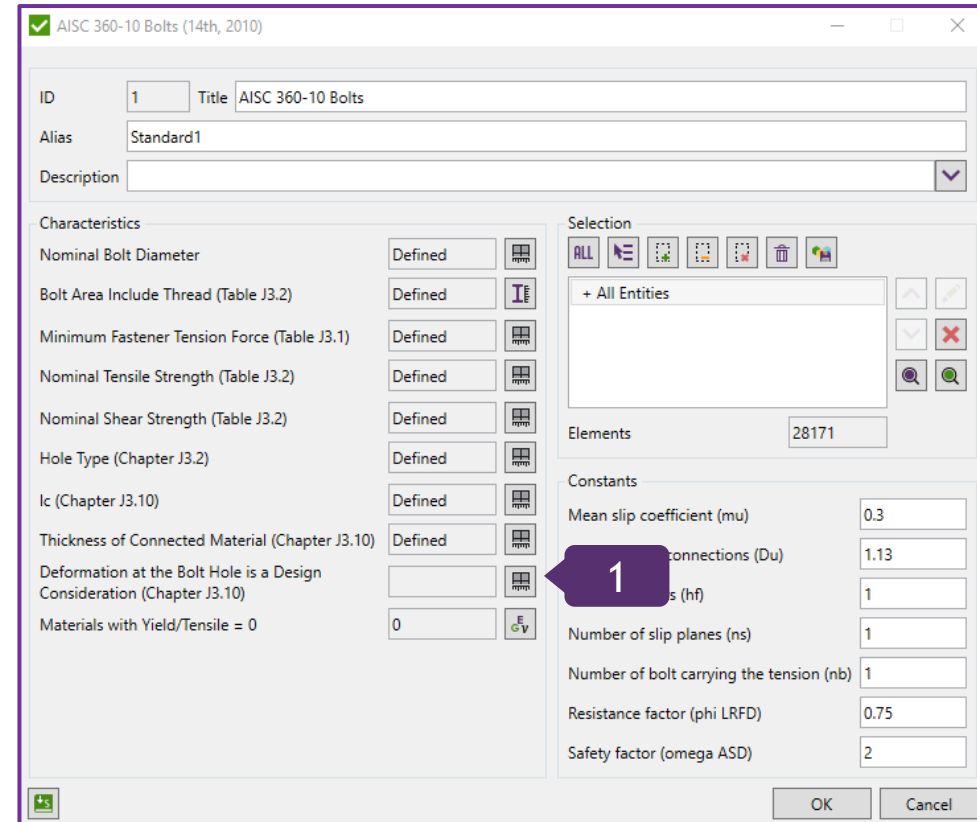
Elemental Selections:

YesNoEnum: No (Callout 2)

Selection: Full Model Value: No

Import OK Cancel (Callout 3)

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): Defined (Callout 1)
- Materials with Yield/Tensile = 0: 0

Selection:

+ All Entities

Elements: 28171

Constants:

- Mean slip coefficient ( $\mu$ ): 0.3
- Connections ( $D_u$ ): 1.13
- Connections ( $h_f$ ): 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

OK Cancel

# The Explanation of Constants

✓ AISC 360-10 Bolts (14th, 2010)

ID: 1 Title: AISC 360-10 Bolts

Alias: Standard1

Description:

Characteristics

Characteristic	Value	Unit
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	EV

Selection

+ All Entities

Elements: 28171

Constants

Constant	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

OK Cancel

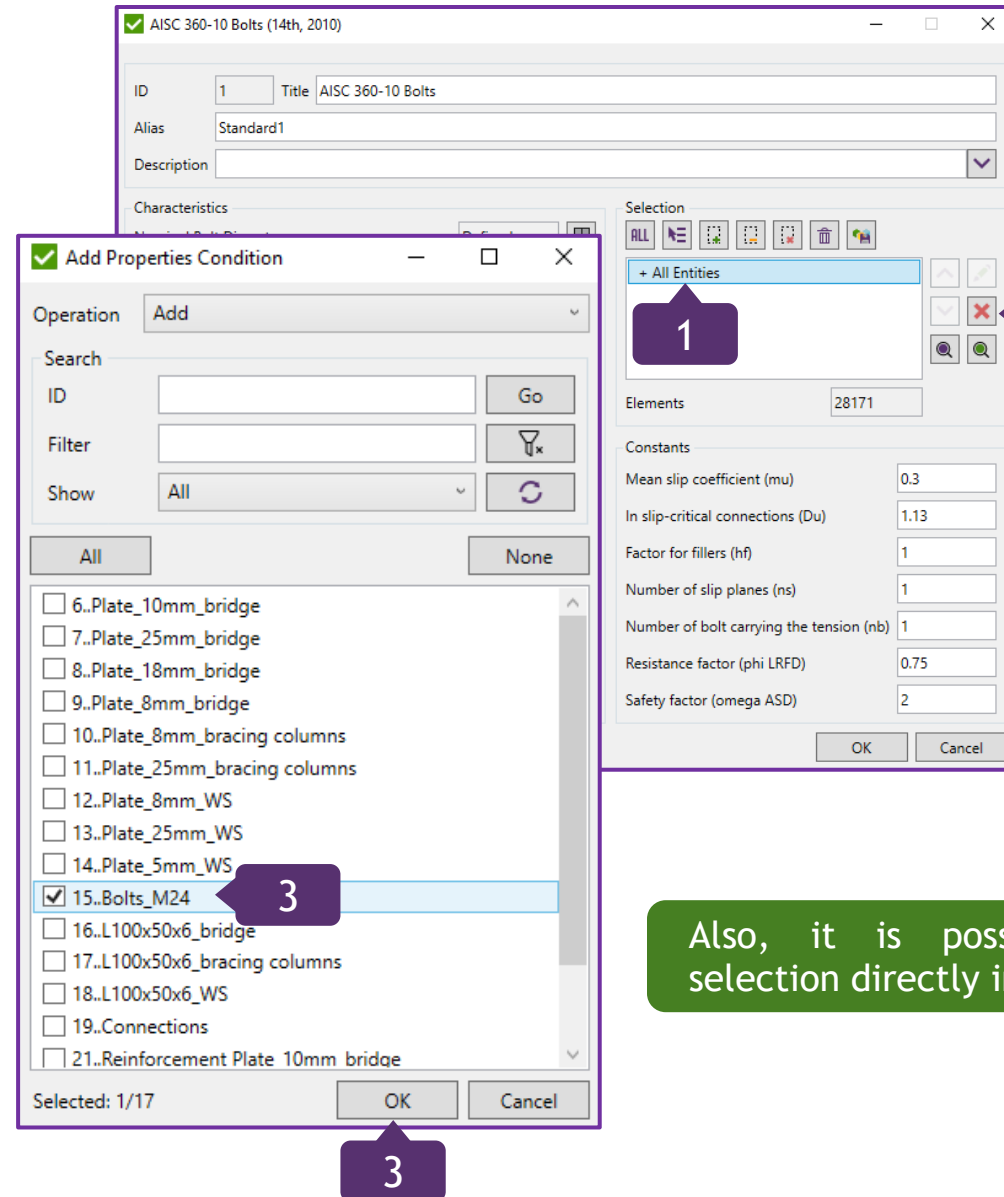
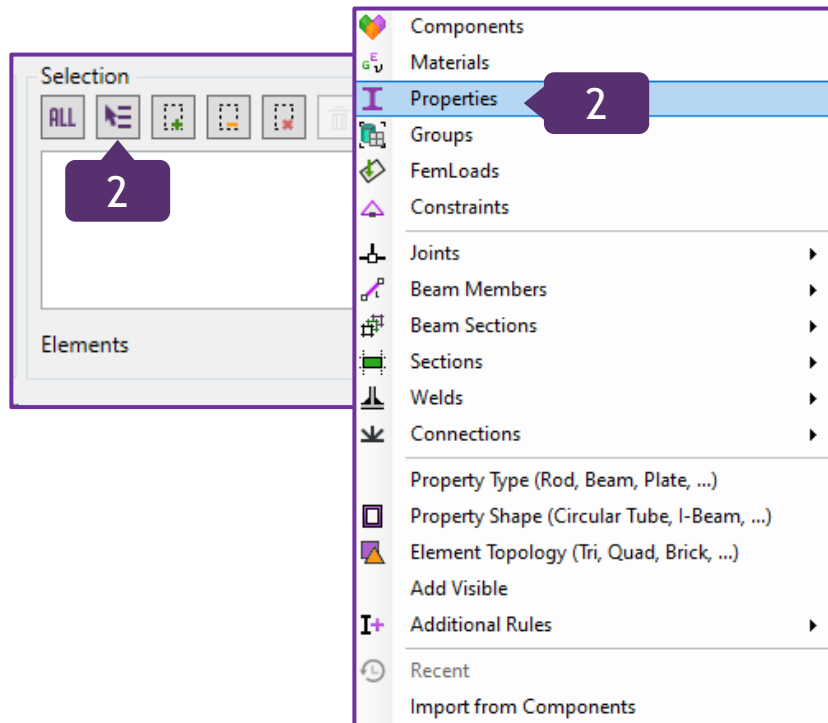
mu - a coefficient of friction between plates needs for slip check;  
Du - multiplier that reflects the ratio of the mean installed bolt pretension to the specified minimum bolt pretension;  
hf - factor for fillers;  
ns - number of slip planes required to permit the connection to slip;  
nb - number 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 15.Bolts\_M24** 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 '15..Bolts\_M24'

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

ALL

+ Beam '15..Bolts\_M24'

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

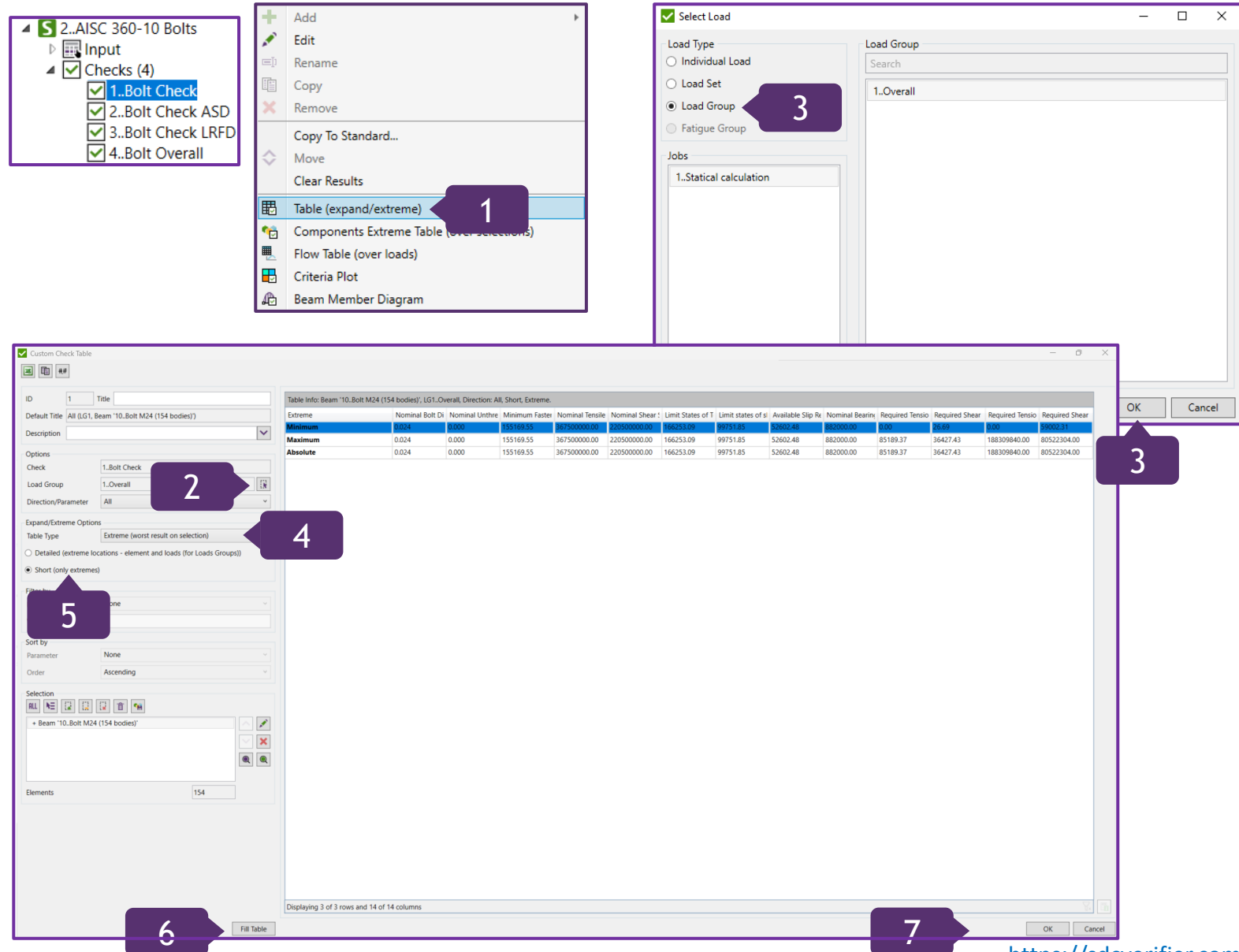
Table Type: **Short (only extremes)**- **ON**

6

Press **Fill Table**

7

Press **OK**




The screenshot displays the SDC Verifier software interface with several windows and callouts illustrating the steps to create a check parameters table:

- Project Tree:** Shows a hierarchy under '2..AISC 360-10 Bolts' with 'Input' and 'Checks (4)'. The 'Checks (4)' folder is expanded, showing '1..Bolt Check', '2..Bolt Check ASD', '3..Bolt Check LRFD', and '4..Bolt Overall'. A callout '1' points to the '1..Bolt Check' item.
- Context Menu:** A right-click menu is open over '1..Bolt Check'. The menu items include 'Add', 'Edit', 'Rename', 'Copy', 'Remove', 'Copy To Standard...', 'Move', 'Clear Results', 'Table (expand/extreme)', 'Components Extreme Table (over selections)', 'Flow Table (over loads)', 'Criteria Plot', and 'Beam Member Diagram'. A callout '2' points to the 'Table (expand/extreme)' option.
- Select Load Dialog:** A dialog box titled 'Select Load' is open. It has radio buttons for 'Individual Load', 'Load Set', 'Load Group' (selected), and 'Fatigue Group'. A callout '3' points to the 'Load Group' option. The 'Load Group' list shows '1..Overall'. There is an 'OK' button at the bottom right.
- Custom Check Table Dialog:** A dialog box titled 'Custom Check Table' is open. It has fields for 'ID' (1) and 'Title'. The 'Default Title' is 'All (LG1, Beam "10.Bolt M24 (154 bodies)")'. The 'Description' is 'All (LG1, Beam "10.Bolt M24 (154 bodies)")'. The 'Options' section has 'Check' set to '1..Bolt Check', 'Load Group' set to '1..Overall', and 'Direction/Parameter' set to 'All'. A callout '4' points to the 'Expand/Extreme Options' section. The 'Table Type' is set to 'Extreme (worst result on selection)'. The 'Short (only extremes)' option is selected. A callout '5' points to the 'Fill Table' button. The 'Sort by' is 'None' and 'Order' is 'Ascending'. The 'Selection' list shows '+ Beam "10.Bolt M24 (154 bodies)"'. The 'Elements' field shows '154'. A callout '6' points to the 'Fill Table' button. A callout '7' points to the 'OK' button. The table data is displayed in the background.

Extreme	Nominal Bolt Di	Nominal Unthre	Minimum Fasten	Nominal Tensile	Nominal Shear	Limit States of T	Limit states of s	Available Slip Rp	Nominal Bearing	Required Tensio	Required Shear	Required Tensio	Required Shear
Minimum	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
Maximum	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
Absolute	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

# 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..Envelope** and press **OK**

4

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

5

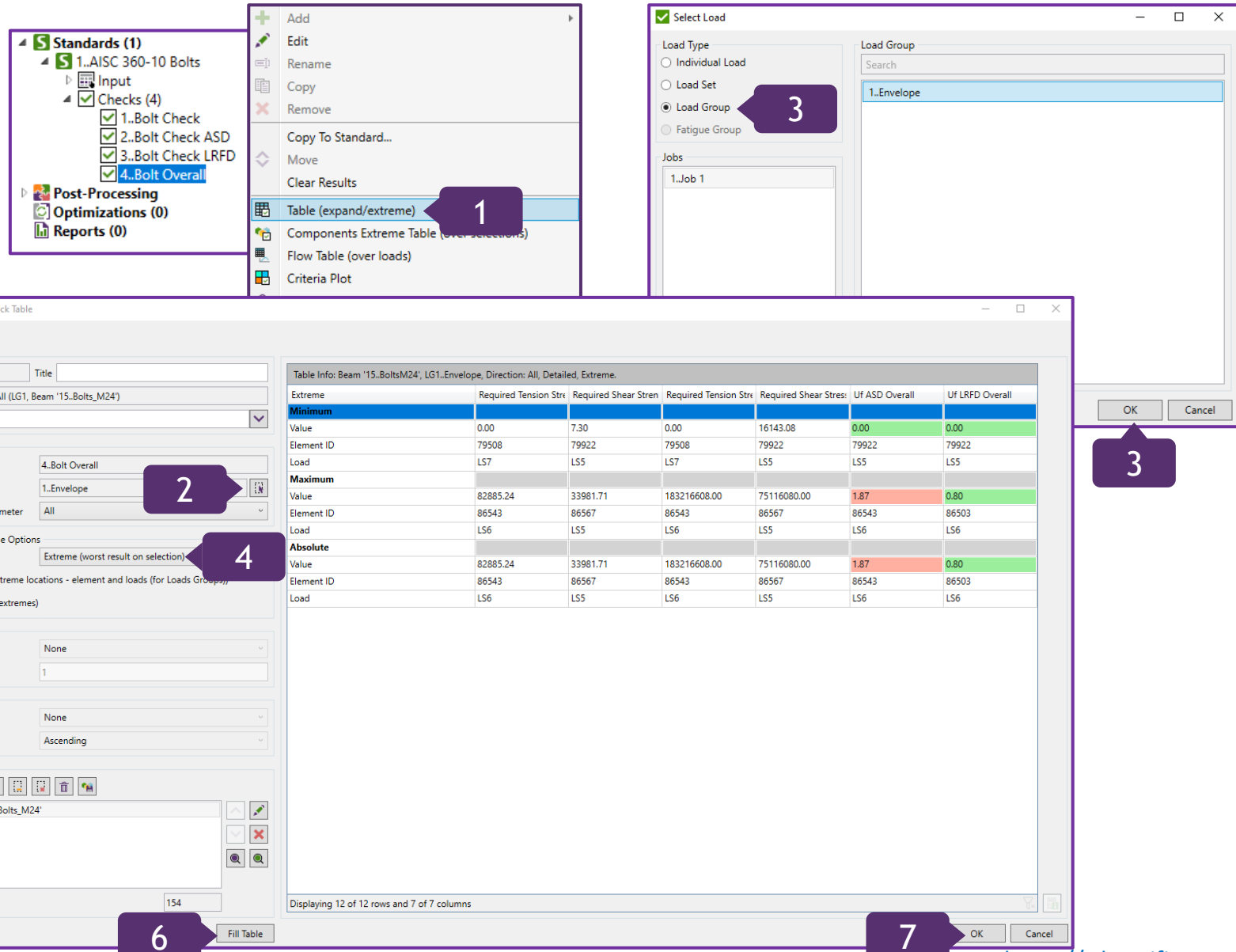
Table Type: **Extreme; Detailed** (extreme locations-element and load (for Load Groups)) - **ON**

6

Press **Fill Table**

7

Press **OK**



**Standards (1)**

- 1..AISC 360-10 Bolts
  - Input
    - Checks (4)
      - 1..Bolt Check
      - 2..Bolt Check ASD
      - 3..Bolt Check LRFD
      - 4..Bolt Overall
  - Post-Processing
  - Optimizations (0)
  - Reports (0)

**Select Load**

Load Type

- ☐ Individual Load
- ☐ Load Set
- ☒ Load Group
- ☐ Fatigue Group

Load Group

1..Envelope

**Custom Check Table**

ID: 1 Title:

Default Title: All (LG1, Beam '15..Bolts\_M24')

Description:

Options

Check: 4..Bolt Overall

Load Group: 1..Envelope

Direction/Parameter: All

Expand/Extreme Options

Table Type: Extreme (worst result on selection)

☒ Detailed (extreme locations - element and loads (for Load Groups))

Short (only extremes)

Value >: 1

Sort by: None

Parameter: None

Order: Ascending

Selection

+ Beam '15..Bolts\_M24'

Elements: 154

**Fill Table**

**Table Info:** Beam '15..BoltsM24', LG1..Envelope, Direction: All, Detailed, Extreme.

Extreme	Required Tension Str	Required Shear Str	Required Tension Str	Required Shear Str	UF ASD Overall	UF LRFD Overall
<b>Minimum</b>						
Value	0.00	7.30	0.00	16143.08	0.00	0.00
Element ID	79508	79922	79508	79922	79922	79922
Load	LS7	LS5	LS7	LS5	LS5	LS5
<b>Maximum</b>						
Value	82885.24	33981.71	183216608.00	75116080.00	1.87	0.80
Element ID	86543	86567	86543	86567	86543	86503
Load	LS6	LS5	LS6	LS5	LS6	LS6
<b>Absolute</b>						
Value	82885.24	33981.71	183216608.00	75116080.00	1.87	0.80
Element ID	86543	86567	86543	86567	86543	86503
Load	LS6	LS5	LS6	LS5	LS6	LS6

Displaying 12 of 12 rows and 7 of 7 columns

**OK** **Cancel**

# Utilization Factor Plot

1

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

2

In Load Group, press 

3

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

4

Parameter: Uf ASD Overall or Uf LRFD Overall methods

5

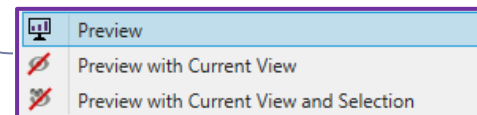
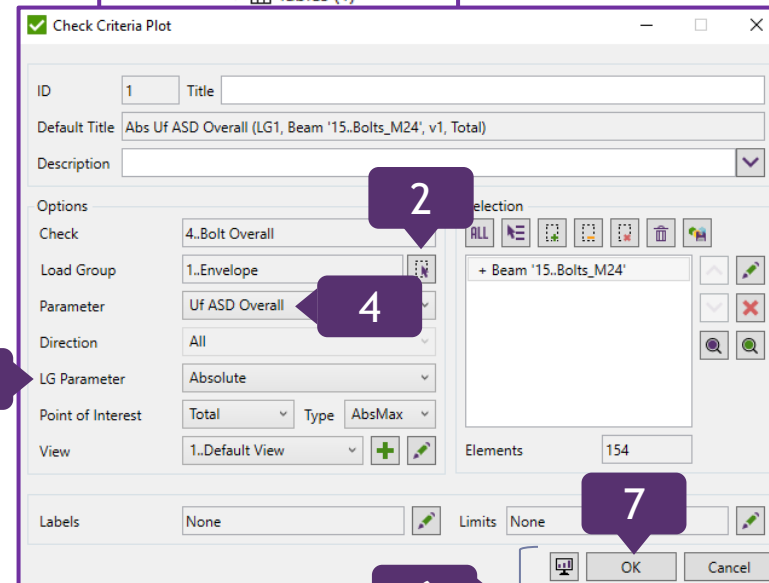
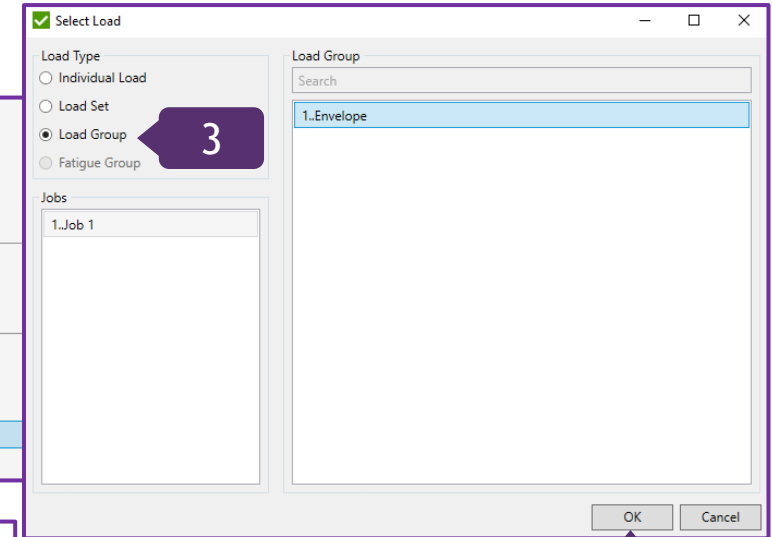
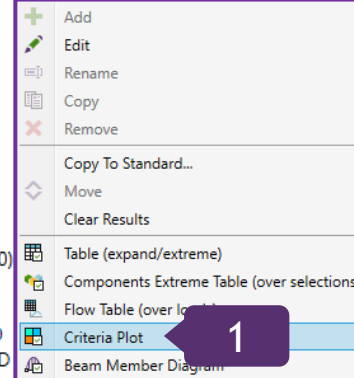
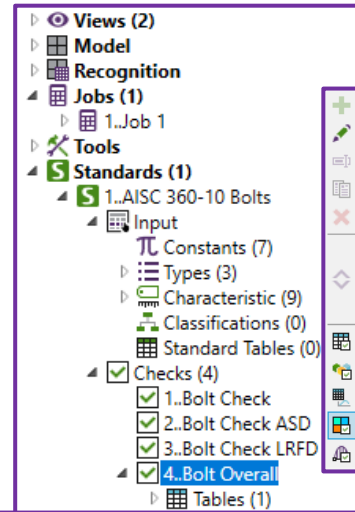
LG Parameter: Absolute

6

Press , and then *Preview*

7

Press *OK*



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/>