

Joint Analysis using the BOLTCALC Program

A joint analysis involves the determination of whether the bolted joint and an individual bolt comprising the joint can sustain the forces being applied. This analysis can include both a torque analysis and a thread stripping analysis if these are relevant to the joint design. The analysis involves determining the joint characteristics and its response to applied forces.

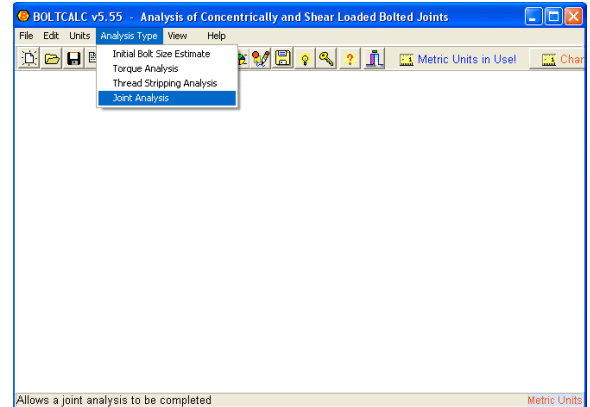
The Joint Analysis module of the program will check the likelihood of failure by any one of five mechanisms:

1. The bolt preload being insufficient to resist the applied forces.
2. The bolt being directly over loaded by the applied forces.
3. Fatigue failure of the bolt.
4. Excessive bearing stress under the nut face, bolt head or within the joint itself.
5. Thread stripping of the internal or external threads.

The program allows a comprehensive model of the joint to be created. By being comprehensive, complex joints require quite a lot of data relating to the joint to be entered. The following slides show examples of analyses demonstrating some of the program's capabilities.

The screenshot shows the 'Remarks' tab of the 'Joint Analysis Data Entry Form'. It includes fields for 'Title of the Analysis (Optional)', 'Remarks about the joint details can be added in the box below. (Optional - Maximum of 255 characters)', 'Name of Person Completing this Analysis (Optional)', 'Name of Person Requesting this Analysis (Optional)', 'Job Reference Details (Optional)', 'Calculation Number/Reference (Optional)', 'Load Case Reference (Optional)', and 'Recommendations/Notes (Optional)'. A 'Calculate' button is at the bottom.

The screenshot shows the 'Forces' tab of the 'Joint Analysis Data Entry Form'. It includes sections for 'Axially Applied Force' with a value of 0.0 N, 'Clamp Force Needed to Resist a Shear Force Loading' with a value of 0.0 N, 'Residual Clamp Force' with a value of 0.0 N, and 'Lower Limit of the Dynamic Force' with a value of 0.0 N. Each section has a diagram illustrating the force application. A 'Calculate' button is at the bottom.



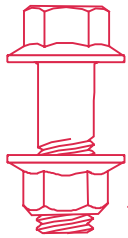
(Above) Start BOLTCALC ensuring that the units are set to the appropriate units (metric or inch). On the main menu do to 'Analysis Type' and then click on the entry marked 'Joint Analysis'.

(Side) The Joint Analysis Data Entry Form will open. Different pages on this form can be accessed by clicking on the tab at the top of the form. To go to the Remarks page - click the Remarks tab. On this page - reference information can be entered that will be displayed with the results. Entering data on this page is optional.

The Title of the Analysis will be used on graphs displayed and in the main heading of the results. The other entries such as Remarks, Job Reference Details etc. can be used to reference the analysis.

In the Recommendations/Notes section, information relating to the analysis will be stored. This will be displayed with the results. These notes can be as long as you wish. They are stored by the program (when the data is saved) in a file with a .txt extension having the same name as the data file that you save the data under.

(Side) The Forces page contains details relating to the forces that are applied to the joint.



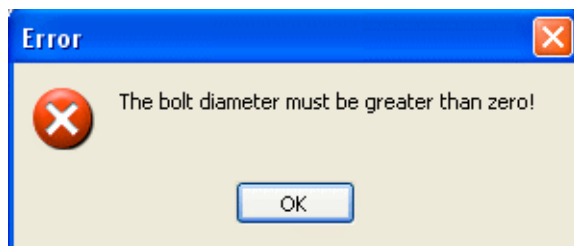
Joint Analysis using the BOLTCALC Program (continued)

(Above) The Bolt Details page contains information about the fastener size being used.

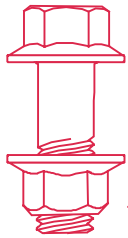
(Above) The Property Details page contains information about the fastener strength. Other forms can be opened to provide additional information by clicking on the appropriate button,

(Above) Specific details about the joint are entered via the Joint Details page. Other data entry forms can be opened from this form.

(Above) The Tightening Details page allows data to be entered on how the joint is to be tightened and tightening related information.

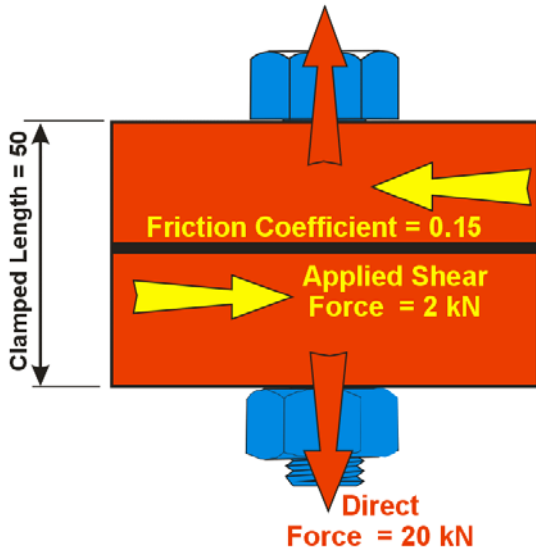


(Side) If the Calculate button is pressed before all the data is entered, or alternatively invalid data is entered (such as the clearance hole being bigger than the nut diameter), an error message will be generated by BOLTCALC.



Joint Analysis using the BOLTTMCALC Program (continued)

Simple Example Calculation - Metric Units



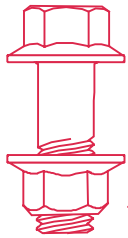
(Below) On the Shear Force form enter 0.15 as the friction coefficient and 2000 as the applied shear force. Press the Calculate button to determine that a clamp force of 13333 N is required to prevent slip. Click 'Ok' button to close the form.

(Side) Click on the Bolt Details tab at the top of the form to change pages. Click on the button marked 'Select Thread Size from a Database' and select the M12 x 1.75 thread. Details about this thread will be transferred onto the main form as shown. Enter the clamp length as 50 mm.

(Side) An M12 property class 10.9 bolt secures the joint shown. The joint plates are made from steel having yield strength of 500 N/mm². Will there be any problems with the joint?

The finish is Dacromet, and the fastener is to be tightened using a torque wrench. The clearance hole diameter used is 13 mm.

(Below) Start BOLTTMCALC ensuring that the units are set to metric. On the main menu do to 'Analysis Type' and then click on the entry marked 'Joint Analysis'. On the Forces page, enter 20000 as the Axially Applied Force. To determine the value needed for the clamp force to resist shear loading, click on the button marked 'Additional Assistance on Shear Force Determination'



Joint Analysis using the BOLTTMCALC Program (continued)

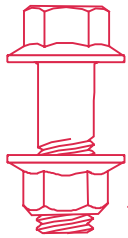
(Side) On the Property Details page of the form, click on the button marked 'Consult the Fastener Material Database' and select the 10.9 property class that appears. Leave other entries on this page at their default values.

(Below) On the Joint Details page, enter 500 for the value of the limiting surface pressure. Except the default values on the rest of the page.

(Side) The values on the Tightening Details page can be accepted at their default values since they are appropriate for this example. Click the 'Calculate' button.

(Below) The results will be displayed on the main form. To check that the joint entered corresponds to what you think it should be - click the speed button shown to display a joint drawing – or alternatively – click the View menu option.

(Below side) A drawing of the joint will be displayed. To view other charts - click on the tabs at the top of the form. Click on the 'Close' button to return to the main form.

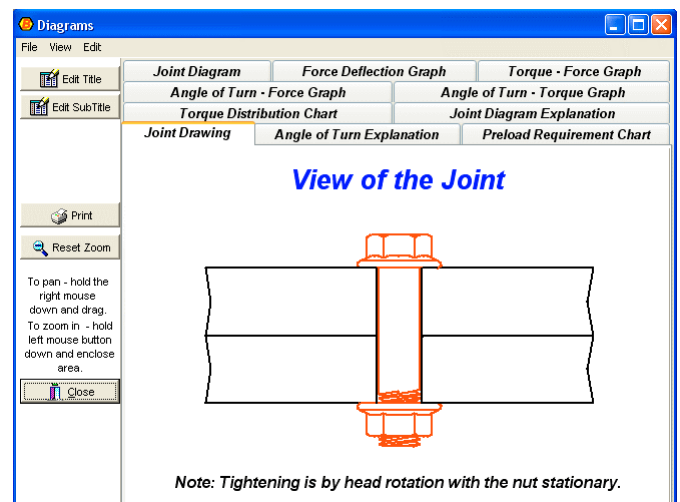


Joint Analysis using the BOLTTMCALC Program (continued)

(Side) By scrolling down the form the results can be displayed. It will be seen that all safety factors are above 1 except for the surface pressure analysis. If this is not resolved it is likely that excessive embedding loss will be experienced. One simple way to resolve the problem is to use flanged fasteners. Go back to the Bolt Details page of the data entry form.

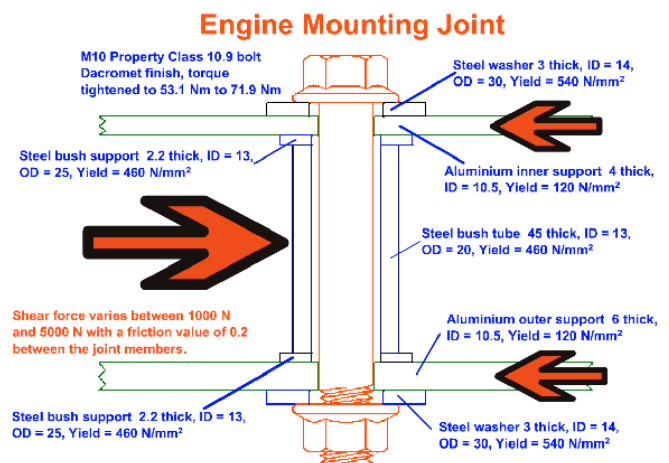
To change the type nut - click on the Flange Nut button under the nut details section. To change the bolt - click the Flanged Head button. The values shown on the form should reflect the new sizes. Click the 'Calculate' button to see what effect this will give.

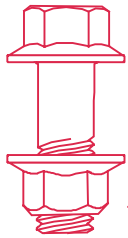
(Below) As can be seen the effect of the flanged head fasteners is to reduce the bearing stress to an acceptable level. To check the joint drawing - click on the speed button, or use the View menu. The drawing should reflect that flanged fasteners are being used.



Example Complex Joint

(Side) The engine mounting joint shown is significantly more complicated than the previous example and consists of a number of plates, washers and a tube. The following shows how BOLTTMCALC analyses the joint.





Joint Analysis using the BOLTCALC Program (continued)

(Side) Go to the Forces pages and click on the button marked 'Additional Assistance on Shear Force Determination' to allow the shear force to be entered.

(Below) On the Shear Force form, enter 2 for the number of shear planes and 5000 as the shear load. Click the Calculate button to establish that 12500 N is needed to prevent slip. Click the 'Ok' button.

In certain joints a shear force is applied that the bolt has to resist. If no other design provision has been made, such as the use of dowel pins, the bolt will have to provide sufficient clamp force to prevent movement between the clamped parts.

CLAMP FORCE

SHEAR FORCE

Single Shear (Shear Planes = 1)

Double Shear (Shear Planes = 2)

Number of shear planes in the joint

Coefficient of friction between the plates

Value of the shear force applied N

Clamp force required to prevent slippage N

(Side) On the Bolt Details page click on the button 'Select Thread Size from a Database' and select the M10 x 1.5 thread. The information will be transferred on to this page. Click the 'Property Details' tab at the top to move to the next page.

(Below) On the Property Details page click on the button 'Consult the Fastener Material Database' and select the property class 10.9. The information will be transferred on to this page.

(Below side) On the Joint Details page click on the button 'Multi-Plate Analysis' to allow the joint details to be entered.

Joint Analysis Data Entry Form

Remarks Forces Bolt Details Property Details Joint Details Tightening Details

The static forces on a joint can be considered in three parts. Whether or not all three forces act on the joint depends upon the application, however a force value is required to be entered into at least one of the boxes.

Axially Applied Force

Value of the Axially Applied Force N

The axially applied force is the value of the force that is applied along the same axis as the bolt. It has the effect of relieving the bolt's clamp force and increasing the possibility of the joint slipping or failing in some other manner.

Clamp Force Needed to Resist a Shear Force Loading

Force required to resist shear loading N

A shear force can be applied to the joint, a clamp force generated by the bolt results in a frictional force that resists this shear force. The clamp force needed to prevent this movement is entered here.

Additional Assistance on Shear Force Determination

Residual Clamp Force

Residual clamping force required N

Additional Assistance on the Residual Force

Lower Limit of the Dynamic Force

Lower limit of the dynamic force N

Additional Assistance on Dynamic Forces

Joint Analysis Data Entry Form

Remarks Forces Bolt Details Property Details Joint Details Tightening Details

Fastener Thread Details

Fastener Diameter mm Thread Pitch mm Shank Diameter mm

Select Thread Size from a Database

Thread Details

Tightening of the Bolt Head or Nut

☒ Fastener Head Tightened ☐ Nut Tightened

Nut Details

☐ Standard Hexagon Nut ☐ Flanged Nut

Outer Bearing Diameter of nut mm

Outer Bearing Diameter of the Fastener Head

☐ Standard Hexagon Head ☒ Flanged Head ☐ Other

Outer Bearing Diameter of fastener head mm

Inner Bearing Diameter of the Fastener

☒ Inner Bearing Diameter equal to clearance hole diameter ☐ User defined Inner Bearing Diameter

Inner Bearing Diameter of fastener head mm

Clamped Length

Bolt Clamp Length mm

This is the distance over the clamped parts, specifically it is the distance between the underside of the bolt head to the nut face if a nut is used. This is illustrated in the diagram at the right.

In the case of a bolt or stud being tapped into a block or plate, the clamped length is the distance over the plate, or plates, that are compressed by the tightening of the fastener.

Joint Analysis Data Entry Form

Remarks Forces Bolt Details Property Details Joint Details Tightening Details

Fastener Strength Grade Selection

Bolt Standard

Grade or Property Class (Optional)

Fastener yield strength (0.2% strain) N/mm²

The Fastener Material Database contains listings of the most common fastener materials.

A key value used in the calculations is the yield strength of the fastener material. Because for many bolting materials there is not a definite yield point that is easily defined, the 0.2% permanent set stress is usually specified instead.

Fatigue Properties of Fastener Material

To determine if the fastener will fail as a result of fatigue, the endurance limit must be determined. The program can calculate the endurance limit based upon equations fitted to test data.

☒ Rolled Thread Before Heat Treatment ☐ Rolled Thread After Heat Treatment ☐ Machine Cut Thread ☐ User Defined Properties ☐ Allow for Joint Face Angularity

Lower bound values used to allow for the inherent scatter in such data and depends upon the diameter of the bolt and the production process used to produce the thread. The default value is to be rolled before heat treatment.

If the bearing surface of the bolt head or nut is out of square with the bolt axis, then a reduction in the fatigue endurance strength can be anticipated. Click on the button for a form to be displayed to allow for this effect to be taken into account.

Modulus of Elasticity for the Fastener

The Modulus of Elasticity or Young's Modulus for the bolt is a measure of the stiffness of the material. It can be found by consulting engineering textbooks. The default value quoted is that for steel, change this value as appropriate.

Modulus of Elasticity for the bolt N/mm²

Modulus of Elasticity for the Joint Material

☒ Steel ☐ Aluminium ☐ Other

Modulus of Elasticity for the material clamped by the fastener N/mm²

Joint Analysis Data Entry Form

Remarks Forces Bolt Details Property Details Joint Details Tightening Details

Fastener Clearance Hole

☒ Fine ☐ Medium ☐ Coarse ☐ User defined

Clearance holes to ISO 273

Diameter of through hole mm

Limiting Surface Pressure for the Joint Material

Value for the limiting surface pressure N/mm²

Use of a Nut or a Tapped Hole

☒ Use of a Nut ☐ Use of a Tapped Hole

Clamped Parts Stiffness Details

☒ Plate ☐ Boss or Sleeve ☐ Multi-Plate Joint ☐ User Defined Stiffness

For the program to be able to determine the joint stiffness, details of the joint type must be entered. If the joint consists of items of differing materials or varying hole sizes - use the multi-plate analysis facility.

Load Introduction Level

☒ 0.5 ☐ Other

Value for the load introduction ratio

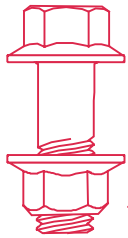
The forces that are axially applied to a joint can be considered to act at some point within the clamped parts. The closer that this load introduction level is to the middle of the joint, the smaller will be the force sustained by the bolt.

The fraction of the clamped length that lies between the load introduction levels is normally taken as 0.5, i.e. the load is introduced at the mid-points between the plates. This ratio can be changed to suit the particular design arrangement.

Embedding Details

☒ Program Calculated ☐ User Entered Value

There is always some degree of preload loss due to permanent deformation of the contact surfaces that are subjected to high surface stress. The program will provide an estimate of such loss based upon experimentally derived values.



Joint Analysis using the BOLTCALC Program (continued)

(Side) The Joint Details Form will appear. This form allows each plate of the joint to be entered in sequence starting from the joint item next to the bolt head.

(Below) Start by entering details of the washer next to bolt head. Click on the button marked 'Next Joint Item' to move to the next item.

(Below Side) Place 14 in the box above and continue adding each layer of the joint to the form. The data can be edited directly using the table at the bottom of the form. The sequence in which the entries are made is important. When complete, click the 'OK' button.

Joint Details Form

Fastener Bearing Diameter: Outer Bearing Diameter of Fastener Head: 18.70 mm, Inner Bearing Diameter of Nut/Tapped Part: 10.5 mm, Outer Bearing Diameter of Nut/Tapped Part: 18.70 mm

Description of Joint Item: [Empty]

Joint Type: ☐ Plate, ☐ Circular Hole, ☐ Elongated Hole Type A, ☐ Elongated Hole Type B, ☐ Boss

Modulus of Elasticity: ☒ User Defined Value, ☐ Steel, ☐ Aluminium

Inner Diameter: [Empty] mm, Joint Item Thickness: [Empty] mm, Modulus of Elasticity E: [Empty] N/mm², Compressive Yield Strength: [Empty] N/mm², Outer Diameter: [Empty] mm, Length of Elongated Hole: [Empty] mm

Details about the Joint Type: Diagram showing a Boss and a Plate with dimensions: Outer Diameter, Inner Diameter, Thickness, and Length.

Details about the Hole Type: Diagram showing an Elongated Hole Type A and an Elongated Hole Type B with dimensions: Length and Inner Diameter.

Next Joint Item, Previous Joint Item, Insert Joint Item, Delete Current Joint Item

The order that the joint items are entered is of importance. Specifically, the first item should be the plate or boss adjacent to the bolt head, followed by the one below this one and so on.

Description of Joint Item	Joint Type	Hole Type	Inner Dia	Thickness	Modulus of Elasticity E	Yield Strength	Outer Dia	Elongated Hole Length
			0	0	0	0	0	0

OK, Cancel, Help

Joint Details Form

Fastener Bearing Diameter: Outer Bearing Diameter of Fastener Head: 18.70 mm, Inner Bearing Diameter of Nut/Tapped Part: 10.5 mm, Outer Bearing Diameter of Nut/Tapped Part: 18.70 mm

Description of Joint Item: Washer

Joint Type: ☐ Plate, ☐ Circular Hole, ☐ Elongated Hole Type A, ☐ Elongated Hole Type B, ☒ Boss

Modulus of Elasticity: ☒ User Defined Value, ☐ Steel, ☐ Aluminium

Inner Diameter: 14 mm, Joint Item Thickness: 3 mm, Modulus of Elasticity E: 208000 N/mm², Compressive Yield Strength: 540 N/mm², Outer Diameter: 30 mm, Length of Elongated Hole: 0 mm

Details about the Joint Type: Diagram showing a Boss and a Plate with dimensions: Outer Diameter, Inner Diameter, Thickness, and Length.

Details about the Hole Type: Diagram showing an Elongated Hole Type A and an Elongated Hole Type B with dimensions: Length and Inner Diameter.

Next Joint Item, Previous Joint Item, Insert Joint Item, Delete Current Joint Item

The order that the joint items are entered is of importance. Specifically, the first item should be the plate or boss adjacent to the bolt head, followed by the one below this one and so on.

Description of Joint Item	Joint Type	Hole Type	Inner Dia	Thickness	Modulus of Elasticity E	Yield Strength	Outer Dia	Elongated Hole Length
Washer	B	C	14	3	208000	540	0	0

OK, Cancel, Help

Joint Details Form

Fastener Bearing Diameter: Outer Bearing Diameter of Fastener Head: 18.70 mm, Inner Bearing Diameter of Nut/Tapped Part: 14 mm, Outer Bearing Diameter of Nut/Tapped Part: 18.70 mm

Description of Joint Item: Washer

Joint Type: ☐ Plate, ☐ Circular Hole, ☐ Elongated Hole Type A, ☐ Elongated Hole Type B, ☒ Boss

Modulus of Elasticity: ☒ User Defined Value, ☐ Steel, ☐ Aluminium

Inner Diameter: 14 mm, Joint Item Thickness: 30 mm, Modulus of Elasticity E: 208000 N/mm², Compressive Yield Strength: 540 N/mm², Outer Diameter: 30 mm, Length of Elongated Hole: 0 mm

Details about the Joint Type: Diagram showing a Boss and a Plate with dimensions: Outer Diameter, Inner Diameter, Thickness, and Length.

Details about the Hole Type: Diagram showing an Elongated Hole Type A and an Elongated Hole Type B with dimensions: Length and Inner Diameter.

Next Joint Item, Previous Joint Item, Insert Joint Item, Delete Current Joint Item

The order that the joint items are entered is of importance. Specifically, the first item should be the plate or boss adjacent to the bolt head, followed by the one below this one and so on.

Description of Joint Item	Joint Type	Hole Type	Inner Dia	Thickness	Modulus of Elasticity E	Yield Strength	Outer Dia	Elongated Hole Length
Steel bush support	B	C	13	2.2	208000	480	25	0
Bush hole	B	C	13	45	208000	480	20	0
Steel bush support	B	C	13	2.2	208000	480	25	0
Outer support	P	C	10.5	6	71000	120	0	0
Washer	P	C	14	30	208000	540	0	0

OK, Cancel, Help

Joint Analysis Data Entry Form

Remarks | Forces | Bolt Details | Property Details | Joint Details | Tightening Details

Tightening Factor: 1.6

Select the Tightening Factor Directly from a Table

Determine the Tightening Factor based upon Frictional Scatter

The tightening factor is defined as the maximum bolt preload divided by the minimum value anticipated for the tightening method.

The tightening factor is a measure of the scatter in a bolt's preload as a result of the tightening method used. The tightening factor is used in the program so that the calculations are based upon the minimum anticipated preload value.

Coefficient of Friction for the bolt thread and under the nut or bolt head

Thread Friction Database: Friction coefficient in the bolt threads: 0.12, Nut Face Friction Database: Friction coefficient under the bolt head or nut face: 0.12

Thread Friction Description: Dacromet Finish

Head Friction Description: Dacromet Finish

Bolt Tightening Condition

Help - Bolt Tightening

☒ Yield Factor, ☐ Tightening Torque, ☐ Assembly Preload

Specify which of the three ways you wish to use to specify the bolt loading.

Prevailing Torque Value

The prevailing torque is the torque required to run a nut (or bolt) down a thread on certain types of fasteners that are designed to resist vibration loosening.

☒ No Prevailing Torque, ☐ User entered value, ☐ Nylon/polyester patch, ☐ Chemical Adhesive Coating, ☐ All metal steel nut Classes 5 to 9, ☐ All metal steel nut Class 10

If a thread size has been selected from the thread database then a minimum value for the type of prevailing torque feature will be presented when the appropriate item is selected on the left. (If available in the database)

Prevailing Torque Present: 0.000 Nm

Condition/Feature causing the Prevailing Torque: [Empty]

Calculate, Cancel, Help

(Side) On the Tightening Details page, click on the radio button marked 'Tightening Torque'.

(Below) The Tightening Torque Specification Form allows upper and lower tightening torque values to be entered. Enter 53.1 as the lower value and 71.9 as the upper value. Click on the 'OK' button.

Tightening Torque Specification

The information presented on this form depends upon the type of analysis that is being completed. When a torque analysis is being completed a simplified set of information is presented.

If the tightening torque specification is known then this can be entered into the boxes below. This value must be less than the torque value that would result in the yield stress of the fastener being exceeded. The tightening torque that results in the yield point of the bolt being reached (given the conditions specified in the data entered previously) is presented for information purposes.

A tightening torque specification usually defines upper and lower figures for the torque so as to provide a tolerance for assembly personnel to work within. The upper value specified on this form is used for preload determination since this value will generate the highest value. If you do not wish to use a tightening torque tolerance - please specify the lower value to be the same as the upper value.

Tightening torque to result in the yield point of the bolt being reached: 77.83 Nm

Lower Value of Tightening Torque: 70.04 Nm, Upper Value of Tightening Torque: 70.04 Nm

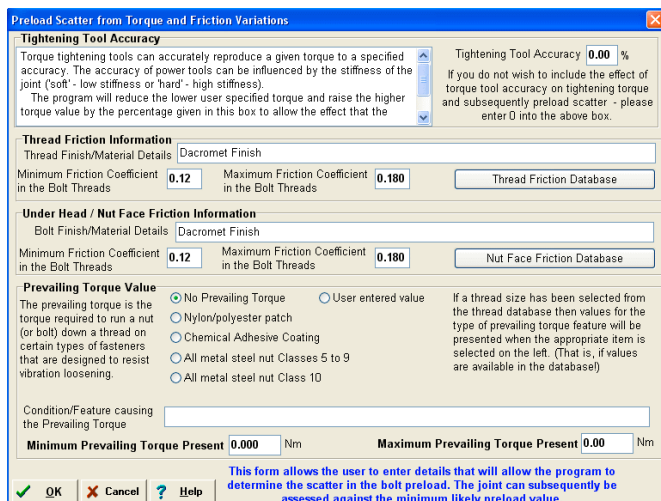
OK, Cancel, Torque +/- % Range: 7, Insert Torque Range based on a %, Insert Torque Range from a Table

Joint Analysis using the BOLTCALC Program (continued)

(Side) On the Tightening Details Page, click on the button marked 'Determine the Tightening Factor based upon Frictional Scatter'.

There are two ways the program can allow for preload variation. One is by use of a tightening factor and the other is by determining the preload variation directly from the torque and frictional variations. In this example, we are going to use the latter.

(Below) This form allows details about the friction conditions to be included. Accept the default values and click the 'Ok' button.



Preload Scatter from Torque and Friction Variations

Tightening Tool Accuracy
Torque tightening tools can accurately reproduce a given torque to a specified accuracy. The accuracy of power tools can be influenced by the stiffness of the joint ('soft' - low stiffness or 'hard' - high stiffness). The program will reduce the lower user specified torque and raise the higher torque value by the percentage given in this box to allow the effect that the tool accuracy has on the tightening process.

Tightening Tool Accuracy: %

Thread Friction Information
Thread Finish/Material Details:
Minimum Friction Coefficient in the Bolt Threads: Maximum Friction Coefficient in the Bolt Threads: Thread Friction Database

Under Head / Nut Face Friction Information
Bolt Finish/Material Details:
Minimum Friction Coefficient in the Bolt Threads: Maximum Friction Coefficient in the Bolt Threads: Nut Face Friction Database

Prevailing Torque Value
The prevailing torque is the torque required to run a nut (or bolt) down a thread on certain types of fasteners that are designed to resist vibration loosening.

☒ No Prevailing Torque ☐ User entered value
☐ Nylon/polyester patch
☐ Chemical Adhesive Coating
☐ All metal steel nut Classes 5 to 9
☐ All metal steel nut Class 10

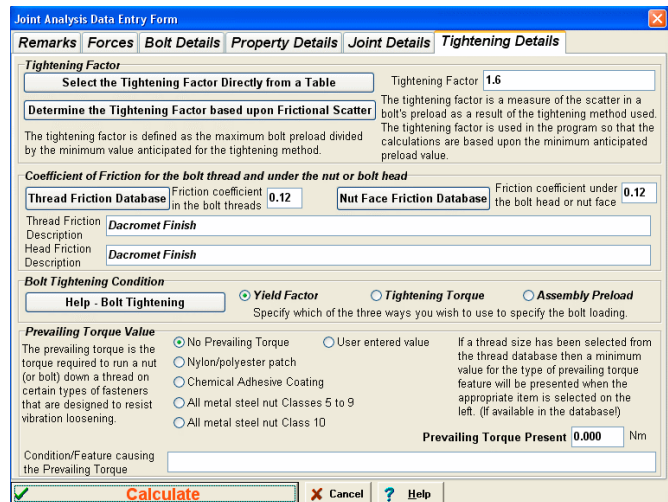
If a thread size has been selected from the thread database then values for the type of prevailing torque feature will be presented when the appropriate item is selected on the left. (That is, if values are available in the database)

Condition/Feature causing the Prevailing Torque:

Minimum Prevailing Torque Present: Nm Maximum Prevailing Torque Present: Nm

OK Cancel Help

(Side) Click the 'Calculate' button from the data entry form and the results will be displayed on the main form. As can be seen there is a bearing stress problem. To check the validity of the data - click on the speed button shown to view a joint drawing.



Joint Analysis Data Entry Form

Remarks Forces Bolt Details Property Details Joint Details Tightening Details

Tightening Factor
Select the Tightening Factor Directly from a Table Tightening Factor:
Determine the Tightening Factor based upon Frictional Scatter

The tightening factor is a measure of the scatter in a bolt's preload as a result of the tightening method used. The tightening factor is used in the program so that the calculations are based upon the minimum anticipated preload value.

Coefficient of Friction for the bolt thread and under the nut or bolt head
Thread Friction Database: Friction coefficient in the bolt threads: Nut Face Friction Database: Friction coefficient under the bolt head or nut face:

Thread Friction Description:
Head Friction Description:

Bolt Tightening Condition
Help Bolt Tightening ☒ Yield Factor ☐ Tightening Torque ☐ Assembly Preload
Specify which of the three ways you wish to use to specify the bolt loading.

Prevailing Torque Value
The prevailing torque is the torque required to run a nut (or bolt) down a thread on certain types of fasteners that are designed to resist vibration loosening.

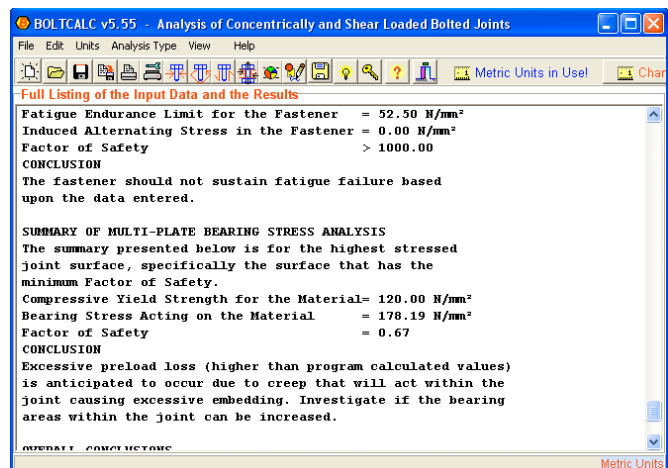
☒ No Prevailing Torque ☐ User entered value
☐ Nylon/polyester patch
☐ Chemical Adhesive Coating
☐ All metal steel nut Classes 5 to 9
☐ All metal steel nut Class 10

If a thread size has been selected from the thread database then a minimum value for the type of prevailing torque feature will be presented when the appropriate item is selected on the left. (If available in the database)

Prevailing Torque Present: Nm

Condition/Feature causing the Prevailing Torque:

Calculate Cancel Help



BOLTCALC v5.55 - Analysis of Concentrically and Shear Loaded Bolted Joints

File Edit Units Analysis Type View Help

Full Listing of the Input Data and the Results

Fatigue Endurance Limit for the Fastener = 52.50 N/mm²
Induced Alternating Stress in the Fastener = 0.00 N/mm²
Factor of Safety > 1000.00

CONCLUSION
The fastener should not sustain fatigue failure based upon the data entered.

SUMMARY OF MULTI-PLATE BEARING STRESS ANALYSIS
The summary presented below is for the highest stressed joint surface, specifically the surface that has the minimum Factor of Safety.

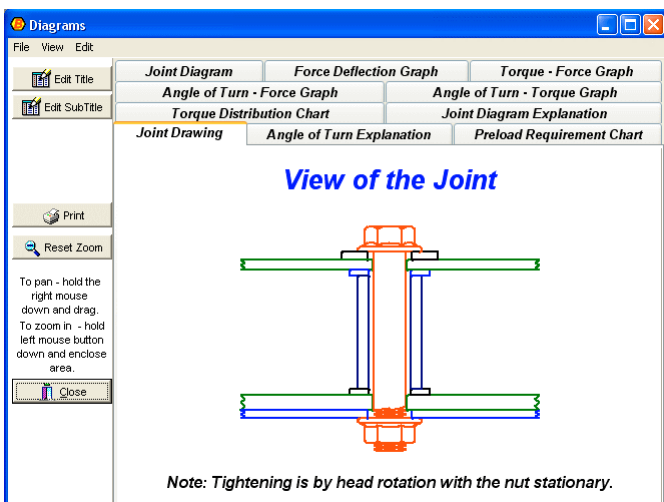
Compressive Yield Strength for the Material = 120.00 N/mm²
Bearing Stress Acting on the Material = 178.19 N/mm²
Factor of Safety = 0.67

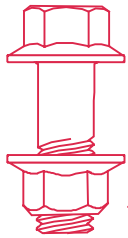
CONCLUSION
Excessive preload loss (higher than program calculated values) is anticipated to occur due to creep that will act within the joint causing excessive embedding. Investigate if the bearing areas within the joint can be increased.

OVERALL CONCLUSIONS

Metric Units

(Side) A view of the joint will be displayed that should look like the one shown. Other charts such as the Torque-Force Graph and the Preload Requirement Chart can provide some useful information about the joint.

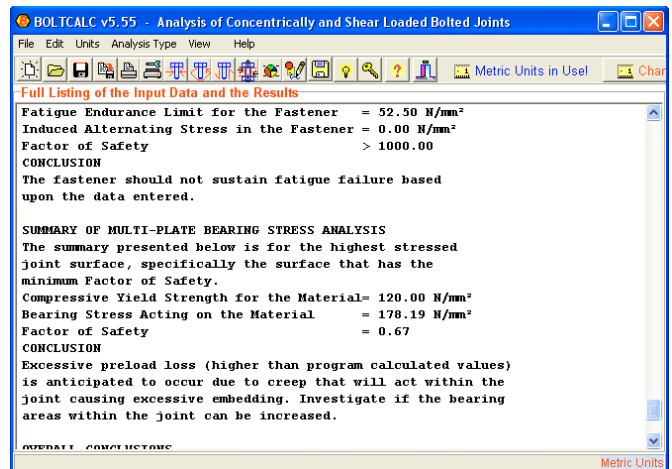
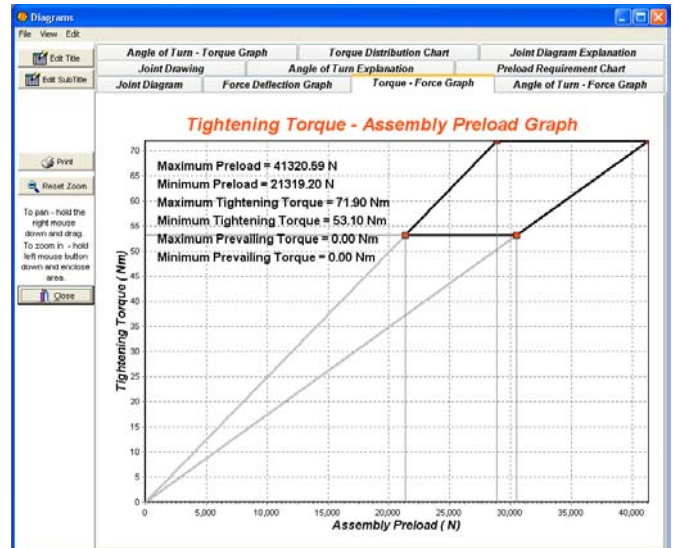
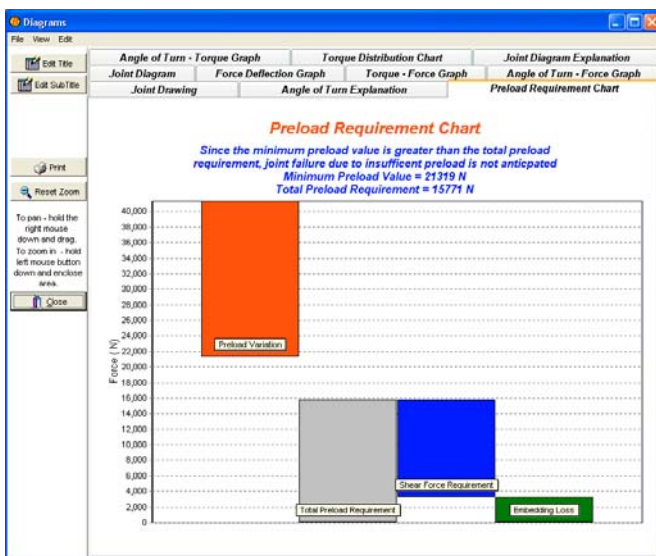




Joint Analysis using the BOLTCALC Program (continued)

(Side) The Tightening Torque - Assembly Preload Graph shows how the preload varies with the torque and friction value. The torque - preload combination can fall anywhere in the region shown.

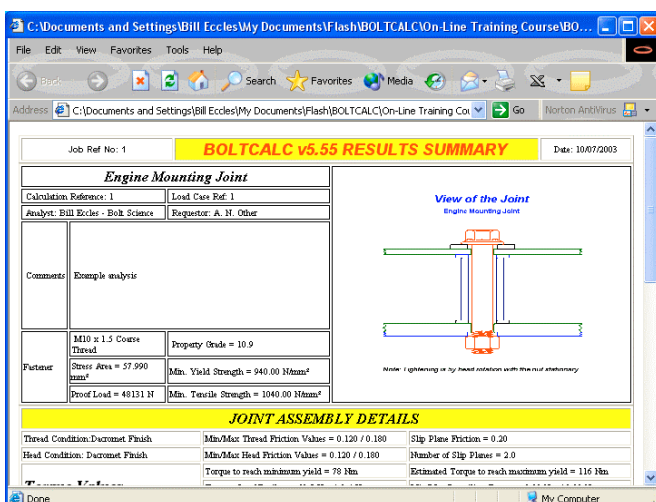
(Below) The Preload Requirement Chart shows the preload variation relative to the preload requirement and what this requirement comprises.



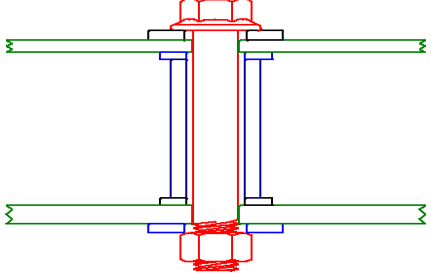
(Above) To view a summary of all the results, click on the speed button (or alternatively select the option from the File menu) and follow the on-screen instructions.

(Side) BOLTCALC will launch your default browser and the results will be displayed. This single page summary provides a useful document for recording the analysis for archival purposes.

(Next Page) A summary of the analysis for this joint is shown on the next page.



Job Ref No: 1		BOLTCALC v5.55 RESULTS SUMMARY		Date: 15/07/2003	
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Engine Mounting Joint				<p style="text-align: center;">View of the Joint Engine Mounting Joint</p>  <p style="text-align: center;"><i>Note: Tightening is by head rotation with the nut stationary.</i></p>			
Calculation Reference: 1		Load Case Ref: 1					
Analyst: Bill Eccles - Bolt Science		Requestor: A. N. Other					
Comments Example analysis		M10 x 1.5 Coarse Thread				Property Grade = 10.9	
		Stress Area = 57.990 mm ²				Min. Yield Strength = 940.00 N/mm ²	
Fastener		Proof Load = 48131 N		Min. Tensile Strength = 1040.00 N/mm ²			

JOINT ASSEMBLY DETAILS					
Thread Condition: Dacromet Finish		Min/Max Thread Friction Values = 0.120 / 0.180		Slip Plane Friction = 0.20	
Head Condition: Dacromet Finish		Min/Max Head Friction Values = 0.120 / 0.180		Number of Slip Planes = 2.0	
Torque Values		Torque to reach minimum yield = 78 Nm		Estimated Torque to reach maximum yield = 116 Nm	
		Torque Specification = 62.5 Nm ± 9.4 Nm		Min/Max Prevailing Torque = 0.00 Nm / 0.00 Nm	
		Minimum Tightening Torque = 53.10 Nm		Maximum Tightening Torque = 71.90 Nm	
Bolt Preload Values		Minimum Preload = 21319 N		Maximum Preload = 41321 N	
		Tightening Factor = Max Preload / Min Preload = 1.94		Min Static Slip Capacity = 21319 x 0.20 x 2.0 = 8528 N	

DETAILS OF APPLIED FORCES		Axial Force = 0 N		Lower value of the applied axial dynamic force = 0 N (Used in fatigue analysis.)	
		Direct Shear Force = 5000 N		Clamp Force required to prevent shear movement = 12500 N	
				Force required for functional reasons (e.g. clevis pull up, gasket prestress, etc.) = 0 N	

JOINT ANALYSIS RESULTS					
Preload Analysis		Preload Loss from Embedding = 3262 N		Axial Force reducing the joints clamp force = 0 N	
		Minimum Preload Required = 3262 + 12500 = 15762 N		Maximum Preload Required = 15762 x 1.94 = 30550 N	
		Factor of Safety = 41321 / 30550 = 1.35			
		Conclusion: The fastener will provide sufficient preload to resist the forces entered.			

Bearing Stress Analysis							
(Note: Face A is closest to the bolt head.)							
Joint Item	Thickness	Compressive Yield	Bearing Stress Face A	Bearing Stress Face B	Compressive Yield Force Face A	Compressive Yield Force Face B	Factor of Safety
Washer	3.000 mm	540.00 N/mm ²	342.32 N/mm ²	178.19 N/mm ²	65182 N	125219 N	1.58
Inner Support	4.000 mm	120.00 N/mm ²	178.19 N/mm ²	155.16 N/mm ²	27826 N	31956 N	0.67
Steel bush support	2.200 mm	460.00 N/mm ²	155.16 N/mm ²	227.75 N/mm ²	122499 N	83456 N	2.02
Bush tube	45.000 mm	460.00 N/mm ²	227.75 N/mm ²	227.75 N/mm ²	83456 N	83456 N	2.02
Steel bush support	2.200 mm	460.00 N/mm ²	227.75 N/mm ²	155.16 N/mm ²	83456 N	122499 N	2.02
Outer support	6.000 mm	120.00 N/mm ²	155.16 N/mm ²	178.19 N/mm ²	31956 N	27826 N	0.67
Washer	3.000 mm	540.00 N/mm ²	178.19 N/mm ²	342.32 N/mm ²	125219 N	65182 N	1.58
Total Joint Thickness = 65.400 mm		Minimum Factor of Safety on Bearing Stress within Joint = 0.67					
Conclusion: The bearing stress exceeds the compressive yield strength - deformation may result leading to excessive preload loss.							