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KISSsoft Tutorial: Bolt Analysis in Accordance with VDI 2230

1 Starting KISSsoft

1.1 Starting the software

Once you have installed and activated KISSsoft either as a test or licensed version, follow these steps to call the KISSsoft system. Usually you start the program by clicking "Start→Program Files→KISSsoft 03-2011→KISSsoft". This opens the following KISSsoft user interface:

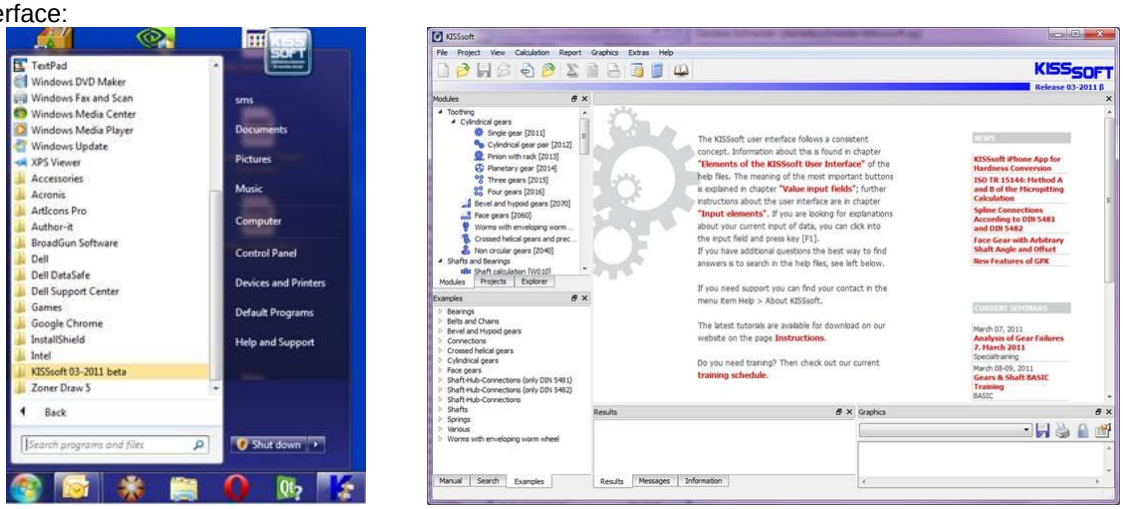


Figure 1.1 Starting KISSsoft, initial window

1.2 Selecting a calculation

In the Modules tree window, select the **"Modules"** tab “Double-Click” on “Bolts” to call the calculation for bolts:

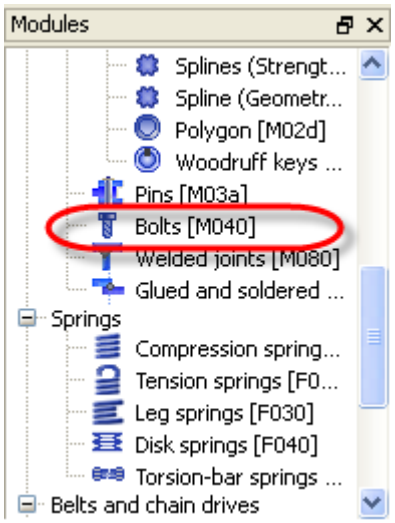


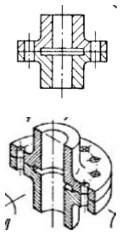
Figure 1.2 Selecting the "Bolts" calculation module

2 Calculation of a flanged connection

2.1 Task

Size and verify the bolting for a flanged coupling using the following data:

Torque to be transmitted	13kNm	Flange inside diameter	215mm
Reference diameter	258 mm	Coefficient of friction	0.15
Number of bolts on reference circle	12	Effective axial force, lower value	0kN
		Effective axial force, upper value	10kN
Material flange (left/right)	GG25/34CrNiMo6	Bolt strength class	10.9
Thickness flange (left/right)	22 mm/18 mm	Type: Hexagon head screw with shank (AB) ISO4014	
Surface flange (left/right)	N7/N8		
Flange outside diameter	320 mm	Tightening: with dynamometric key	



The connection is made using through bolts (notation as specified in VDI 2230:2003 - bolted joint) with nuts, and with washers under the nuts and under the bolt head. If units need to be changed, “Right-Click” on the unit to the right of the data input cell and select the desired units for input. Input this data in the **"Basic data"** tab as follows:

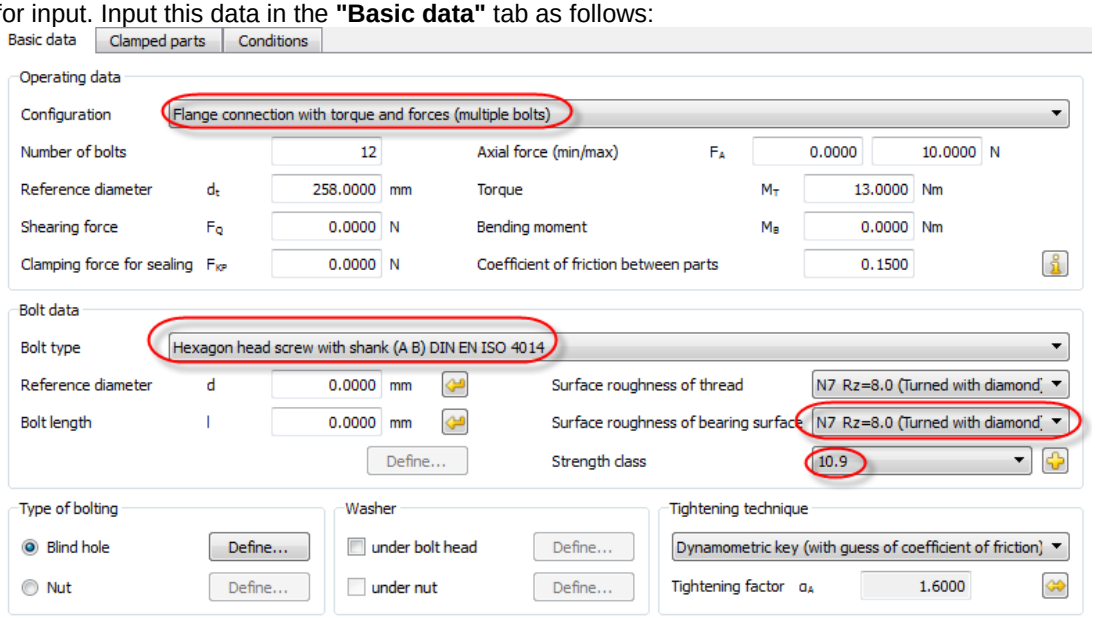


Figure 2.1 Inputting known data, selecting the calculation method

2.2 Proposal for a reasonable bolt diameter

After you have defined the load and input the basic data for the bolt, click the **"Sizing button"** in the main window and the program proposes values for a suitable bolt diameter. This proposal is based on a simplified bolt layout as specified in VDI 2230: 2003. This method usually results in over-dimensioned bolts. Experience shows that the minimum permitted bolt diameter is often one or two sizes smaller! Note the message that appears when you click the Sizing button. If you click the Sizing button, the software suggests a bolt diameter that is based on VDI 2230: 2003.

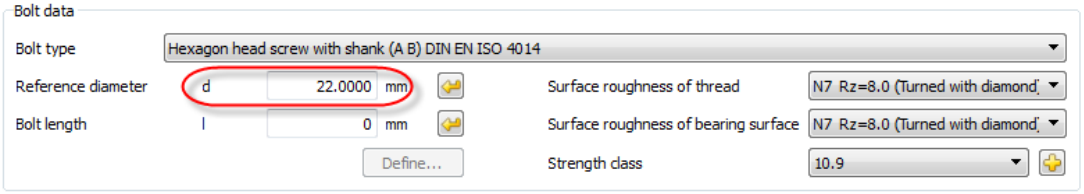


Figure 2.2 Sizing the bolt diameter

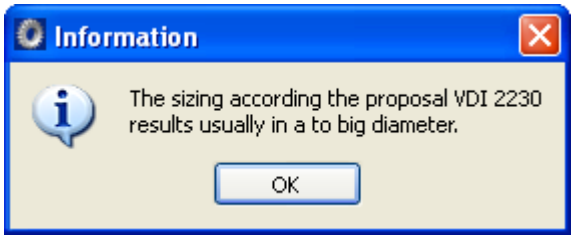


Figure 2.3 Message indicating that the proposed bolt diameter may be too large

You can reduce the nominal diameter to 16 mm, manually:

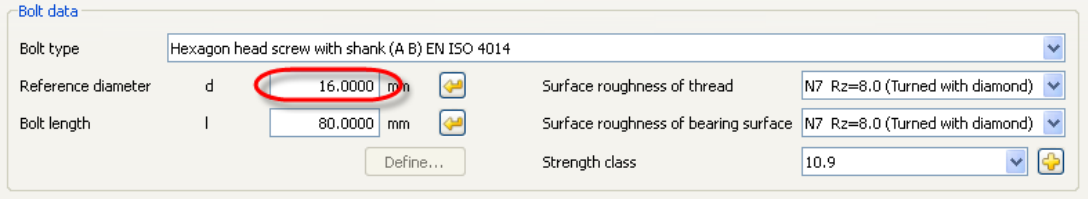


Figure 2.4 Reference bolt diameter set to 16 mm manually

2.3 Defining the nuts and washers

In the **"Basic data"** tab, you can now input the data for the nuts and washers:

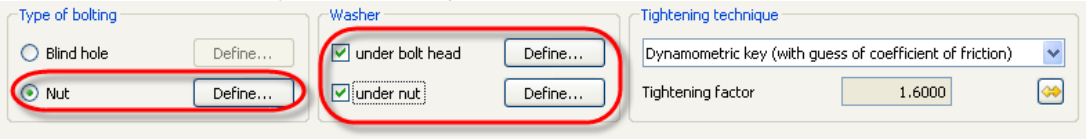
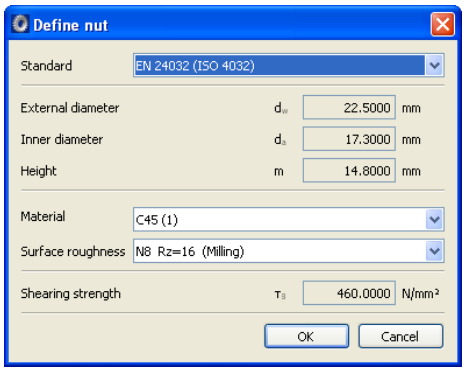
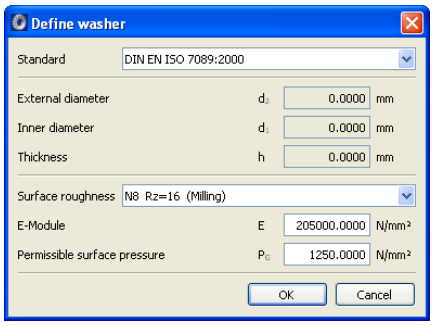


Figure 2.5 Calling the subscreens for defining washers and nuts



Either select the nut from the standard or input your own geometry



Washer details. Either select the washer from the standard or input your own

Figure 2.6 Defining the nut and washers. (The values for the diameter etc. do not appear until you input the data)

Values for all fields will be entered automatically after choosing the standard, entering the material and surface roughness.

2.4 Defining clamped parts

The **"Clamped parts"** tab contains all the details about clamped parts. As a flanged connection is being calculated, the software recommends you define the geometry of the clamped parts (flange) as segments of an annulus:

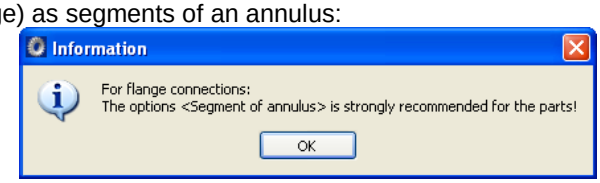


Figure 2.7 Note: define "segments of an annulus" when calculating flange connections

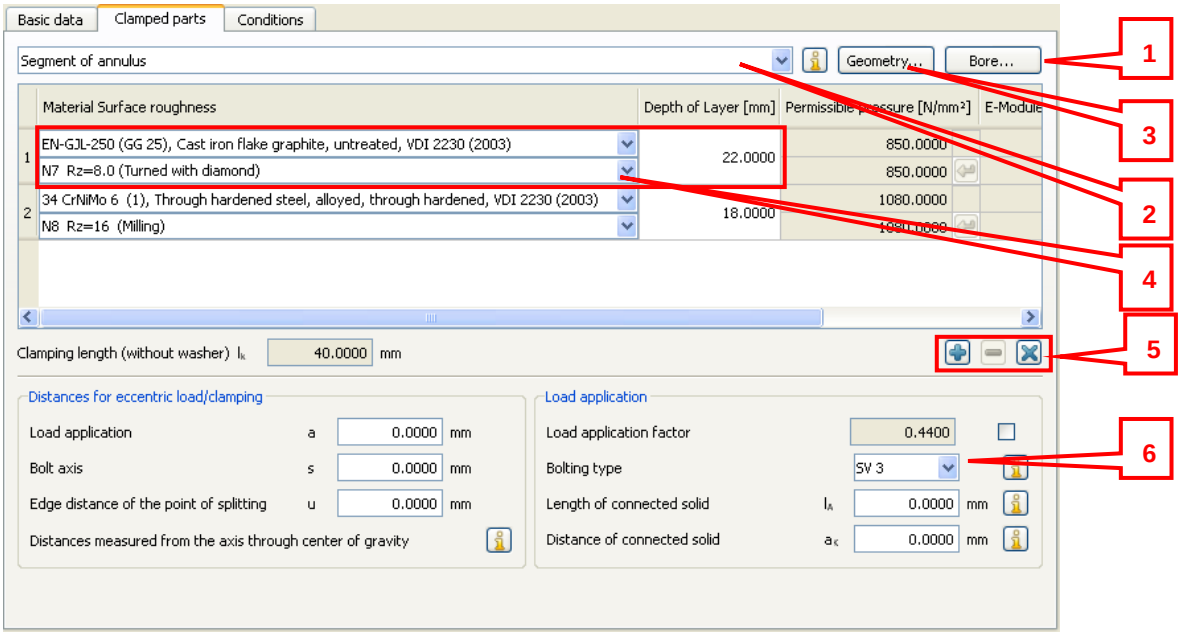
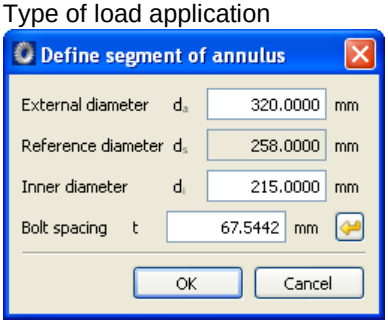
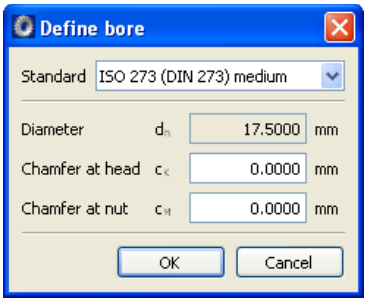


Figure 2.8 Definitions of screw-connected parts, calls to the relevant sub-screens

(1) Definition of bore (The clearance diameter through which the fastener must pass)
(2) Select the type of the connected parts, here **"Segments of annulus"**,
(3) Definition of the geometry of the segments of an annulus
(4) Input depth of layer, select material and surface roughness
(5) Add new depth of layer:
Remove depth of layer:
Clear all:
(6) Type of load application



Details about the outside-,inside- and reference diameter and bolt spacing (click the sizing button to define the bolt spacing value)



Details of the bore; you can define your own bore diameter by selecting **"Own definition"** in **"Standard"** and inputting the diameter in the **"Diameter"** field.

Figure 2.9 More details about the type of connected parts

2.5 Definition of the bolt

In the **"Basic data"** tab you can now define the bolt length by clicking the "Sizing button"  (smallest standard bolt length) or input a value manually. The calculation is now complete and the connection is displayed in the graphics window:

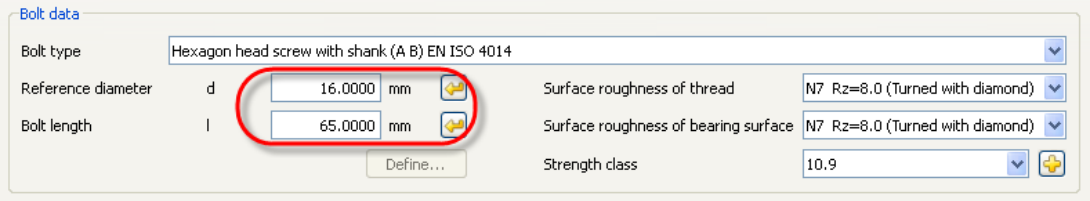


Figure 2.10 Final definition of the bolt

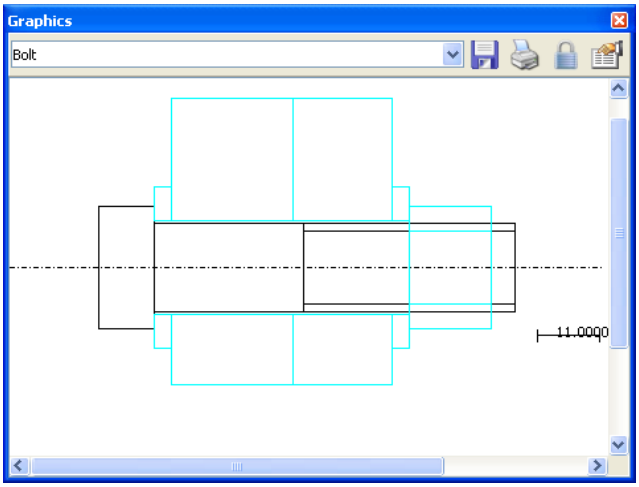


Figure 2.11 Display showing bolt with flange, washers and nut

3 Analysis and results

3.1 Performing the analysis, report

You have now predefined all the data, so you can now verify the connection. To do this, click the  icon (1) in the command bar (or press F5). The most important results are displayed in the **"Results"** window. To call the formal report, either press F6 or click the  icon (2). To return from the report back to the analysis, click the  icon in the tool bar. Make selections from the selection list to change the graphic (screw) displayed here down on the right-hand side.

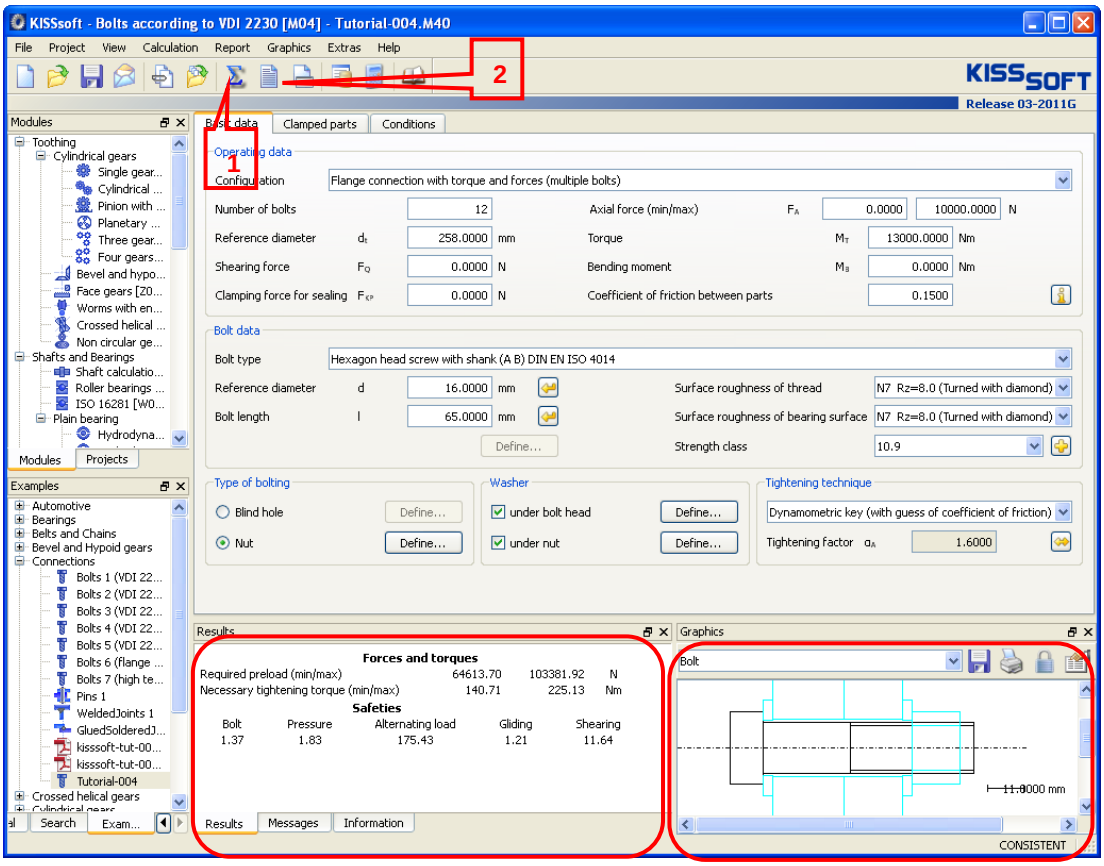


Figure 3.1 Running the calculation, resulting bolt geometry, results overview

You can also display more graphics by clicking the **"Graphics"** menu option:

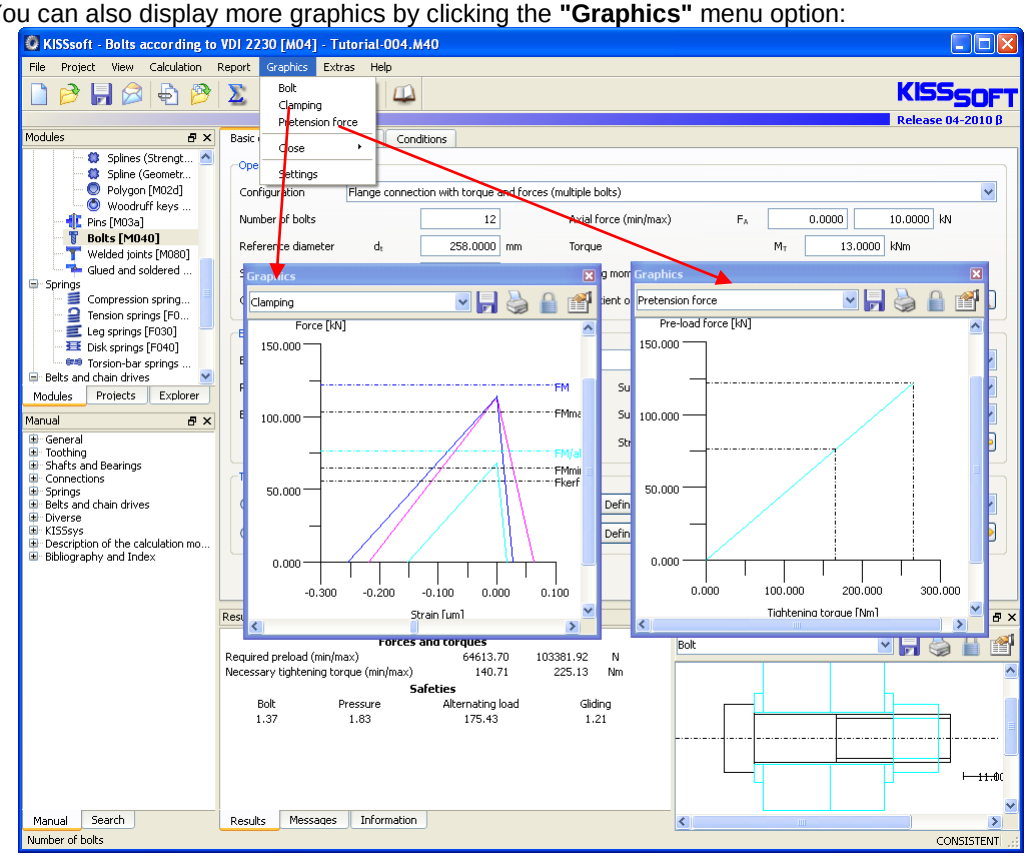


Figure 3.2 Display containing other graphics

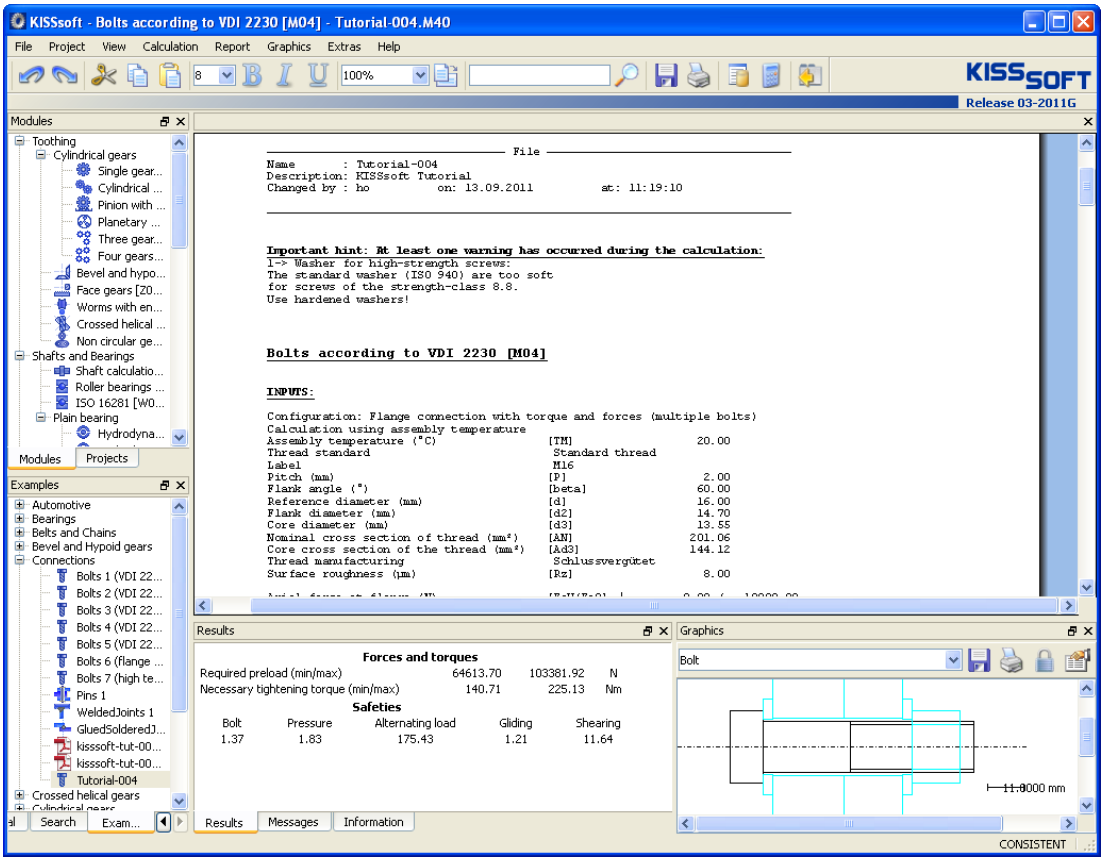


Figure 3.3 Displaying the report and changes to the displayed graphic

3.2 Comments on the results

Results displayed in the main window:

Required preload (pre-tension force) (N), alphaA=1, alphaA eff	Indicates the pre-tension force required to ensure the connection will withstand loads. Both the minimum value (tightening factor=1) and the maximum value (tightening factor=1.6, in this example) are shown.
Necessary tightening torque (starting torque) (Nm), alphaA=1, alphaA eff	Information about the tightening torque achieved, minimum value (tightening factor=1) and also maximum value (tightening factor=1.6, in this example).
Safeties Bolt	Safety factor against yield point
Safeties Pressure	Minimum safety factor of surface pressure
Safeties Alternating load	Safety factor against fatigue of bolt

Results shown in the report, section **"Calculating safeties with the maximum required mounting pre-tension force:** "

Mounting pre-tension force (N)[FM]	In addition to the Necessary tightening torque (starting torque) (see previous table), the report also lists the mounting pre-tension force. This values corresponds to the values for the tightening torque specified in Appendix A of VDI2230
Tightening torque (Nm) [MA]	Value for tightening torque. This values corresponds to the values for tightening torque specified in Appendix A of VDI2230

4 Further calculations

4.1 Analysis with a smaller bolt

Finally, you should check whether M16 is the smallest possible bolt diameter. To do this, reduce the bolt diameter to M14 and then repeat the calculation. The message tells you that a connection using a M14 bolt is not mathematically possible.

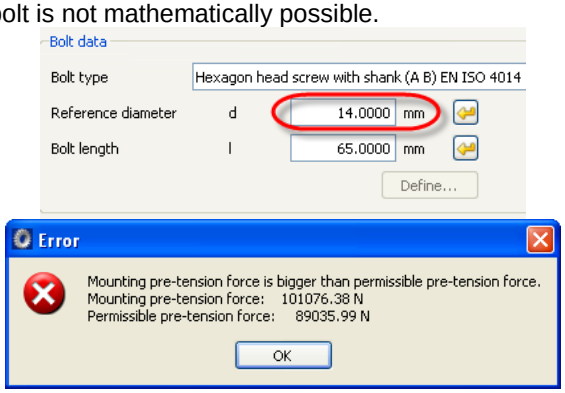


Figure 4.1 New bolt diameter input, -> calculation run, -> error message

4.2 Constraints, settings

You can input more values for the calculation in the input window in the **"Conditions"** tab, and in the **"Calculations/Settings"** menu option. However, this requires a detailed knowledge of VDI guideline 2230: 2003.

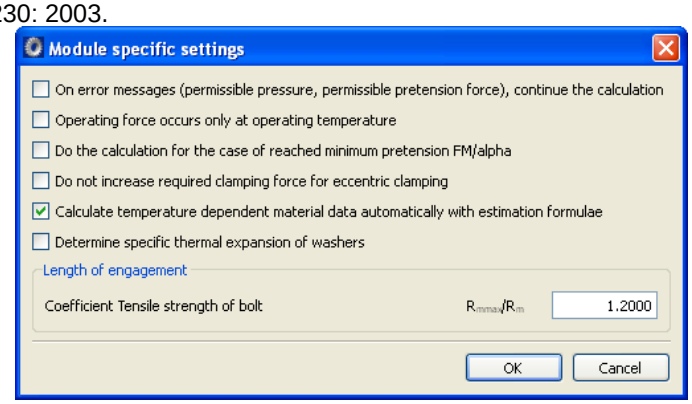


Figure 4.2 Module-specific settings

The critical values in the calculation are the assumed coefficients of friction between the thread and thread hole and between the head/nut and clamped part. You must enter these values in the **"Conditions"** tab. The VDI guideline propose a number of different friction coefficients. Click the "Info buttons"  to display these in the information window.

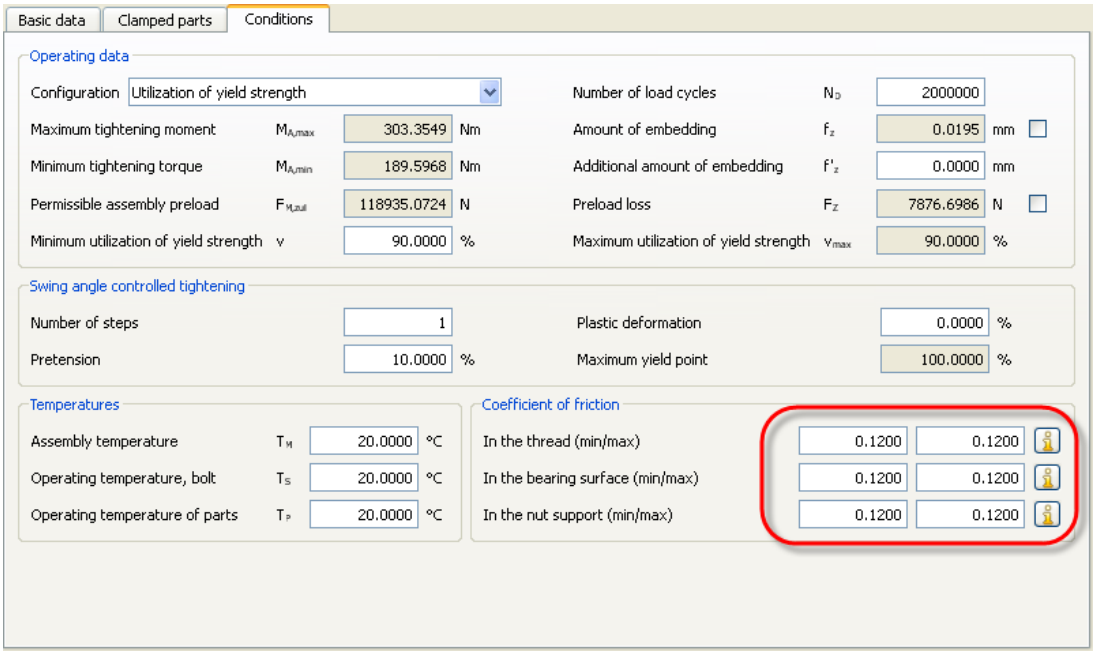


Figure 4.3 Settings used to perform a calculation according to VDI 2230 in the "Conditions" tab

You can also specify the tightening factor in the **"Basic data"** tab.

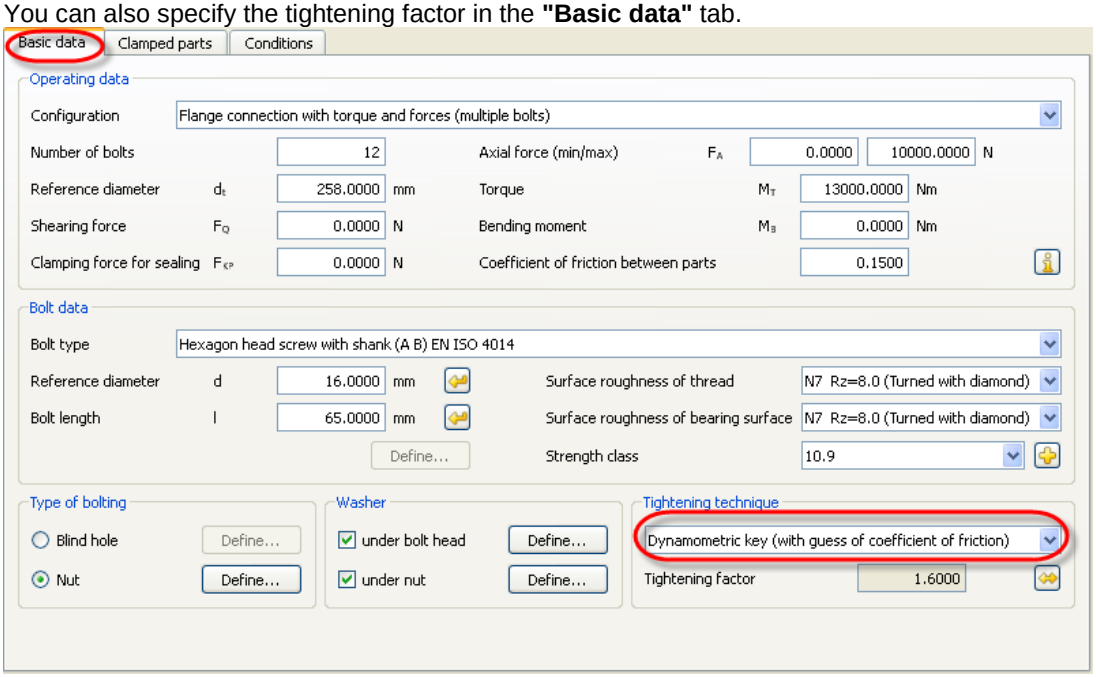


Figure 4.4 Tightening factor in Basic data