eAssistant
the engineering assistant

A calculation example
Shaft calculation with strength according to DIN 743

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Contents

1 The first calculation example

The following example is to support you with a very fast start into the shaft calculation module with its numerous possibilities. This example shows a shaft with a fixed and movable bearing and an extra mass.

1.1 Start the calculation module

Please login with your user name and your password. Select the module through the tree structure of the Project Manager by double-clicking on the module or clicking on the button 'New calculation'.

The calculation module is opened in a new window.

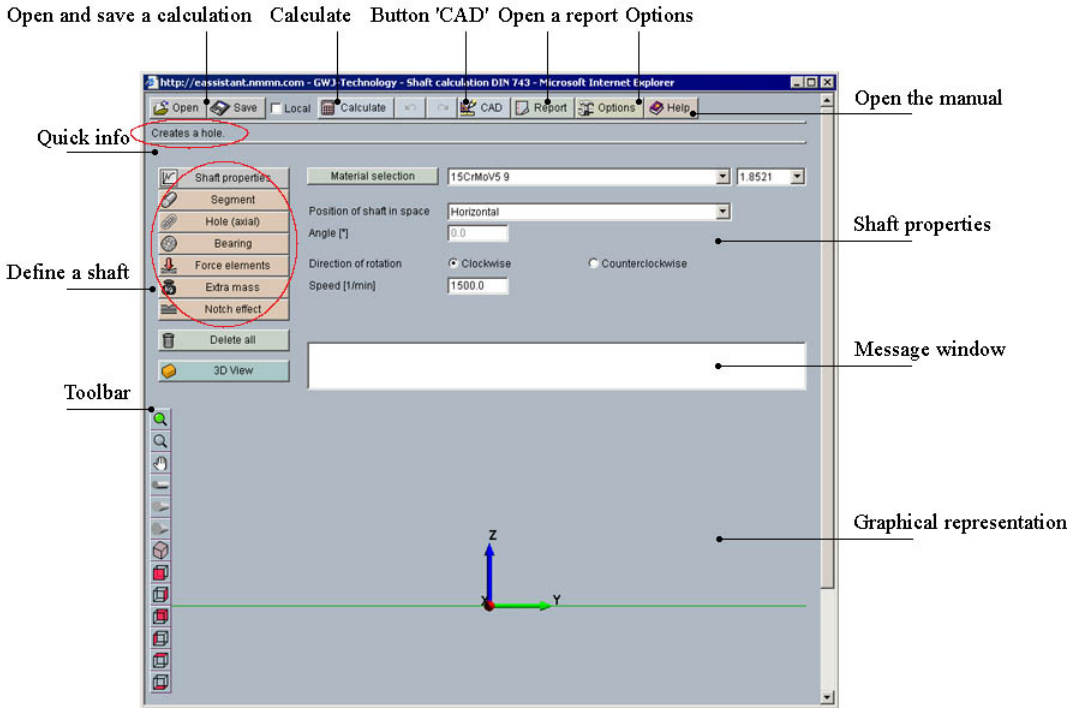

Figure 1: A general overview

1.2 Create a shaft segment

Create the first shaft segment

1. Click on the button 'Segment'.

Figure 2: Create the first segment

2. Enter a length of '50 mm' and a diameter of '20 mm' into the input fields.

Please note: If you right-click into the input field, then you can change the unit of measurement very easily.

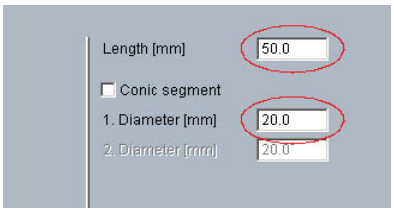

Figure 3: Define the first segment

The first segment is represented.

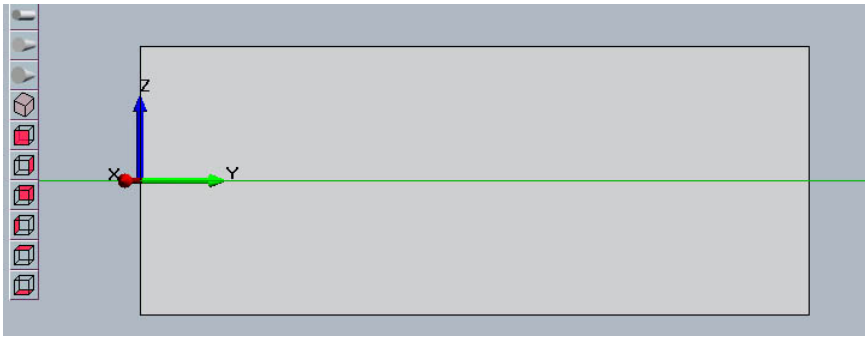

Figure 4: Representation of the created and defined shaft segment

Create the second shaft segment

1. Click on the button 'Segment'.

Figure 5: Create the second segment

2. Enter a length of '400 mm' and a diameter of '50 mm' into the input fields.

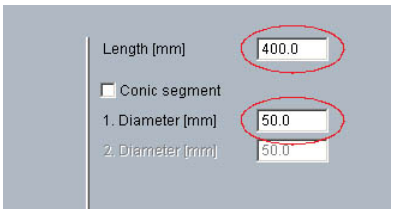

Figure 6: Define the second segment

This segment is represented.

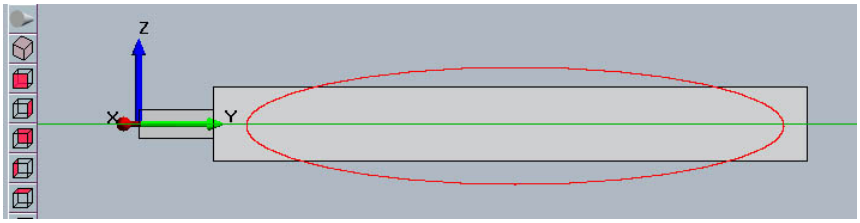

Figure 7: Representation of the second segment

Copy and add the shaft segments

The button 'Segment' allows you to add a third shaft segment. But you can also copy and add a segment. The next step is to create a third segment by using the buttons 'Copy' and 'Add'.

1. Click on the segment that you would like to copy.

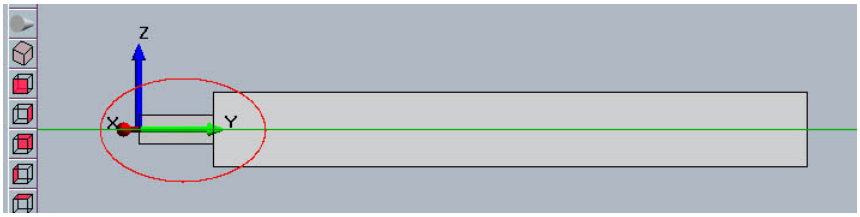

Figure 8: Select the first segment

2. Click on the button 'Copy'.

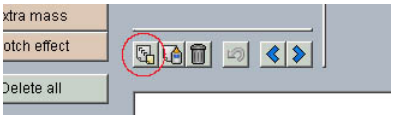

Figure 9: Copy the first segment

Note: If you right-click, you can also copy and add a segment. Then a new context menu is opened and you can select the 'Copy' and 'Add' options.

3. Select the second segment and place next to this segment the third one.

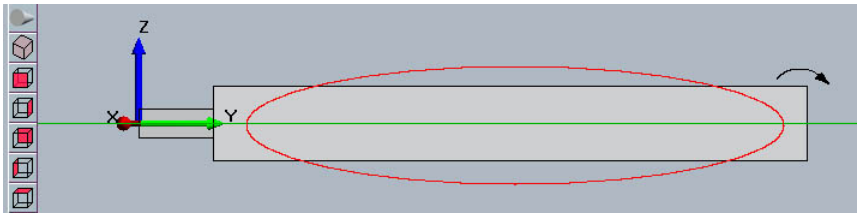

Figure 10: Select the second segment

4. Click on the button ‘Add’.

Figure 11: Add the segment

The copied segment is added as a third shaft segment.

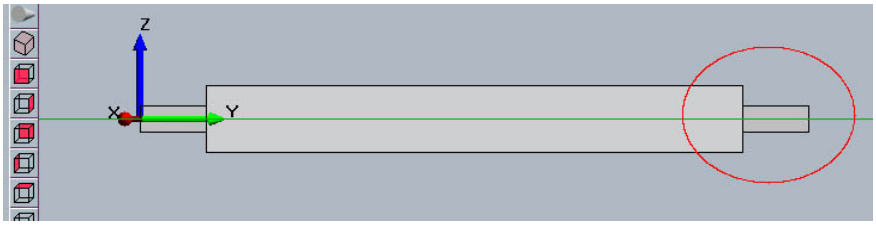

Figure 12: Add the third shaft segment

1.3 Create an axial hole

Create the first axial hole

1. Click on the button ‘Hole (axial)’.

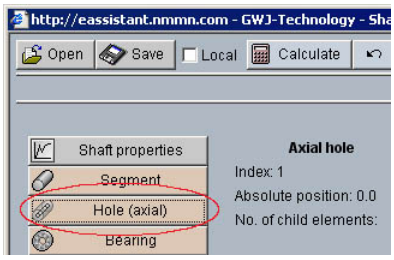

Figure 13: Create the first axial hole

2. Enter a length of ‘70 mm’ and a diameter of ‘0 mm’ into the input fields.

Figure 14: Define the first axial hole

Create the second axial hole

1. Click on the button 'Hole (axial)'.

2. Enter a length of '360 mm' and a diameter of '40 mm' into the input fields.

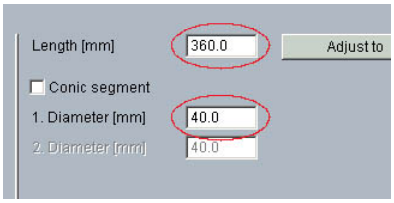

Figure 15: Define the second axial hole

The hollow shaft is represented.

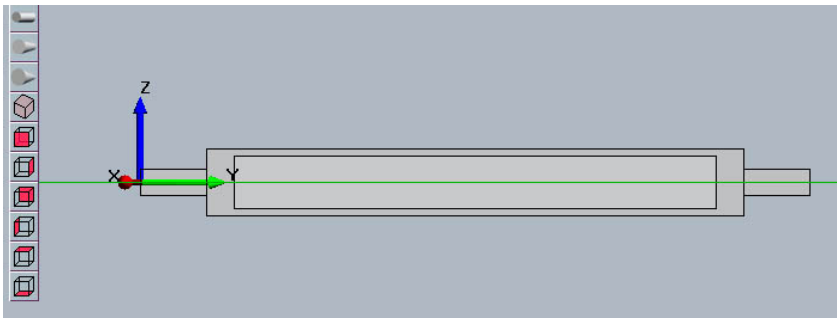

Figure 16: Representation of the axial hole

Note: A selection of elements directly in the representation by using the keyboard is also possible. If you would like to change from the value input of shaft segments to the selection mode, you have to press the 'Page down' key. Afterwards the two arrow keys enable you to move the elements to the left or to the right side. To move from the shaft segments to the axial holes, please use the cursor keys 'Up' and 'Down'. By using the 'Page-up' key you can change to the value input of a selected element.

1.4 Add a bearing

Add the first bearing

1. Select the shaft segment from the representation, onto which the bearing is to be positioned.

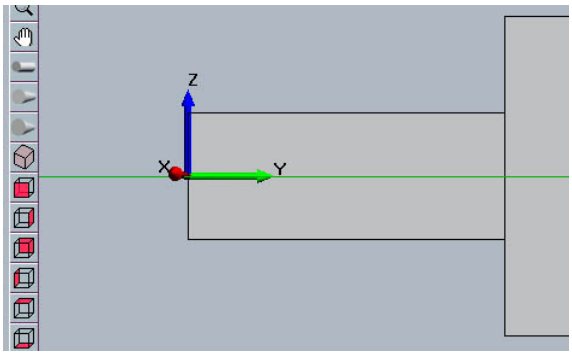

Figure 17: Select a segment

2. Click on the button ‘Bearing’.

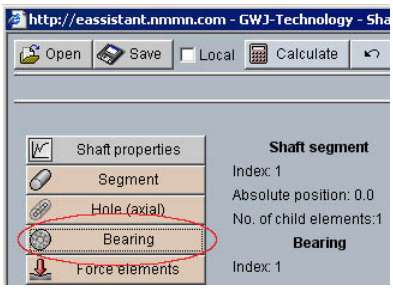

Figure 18: Button ‘Bearing’

A bearing is added.

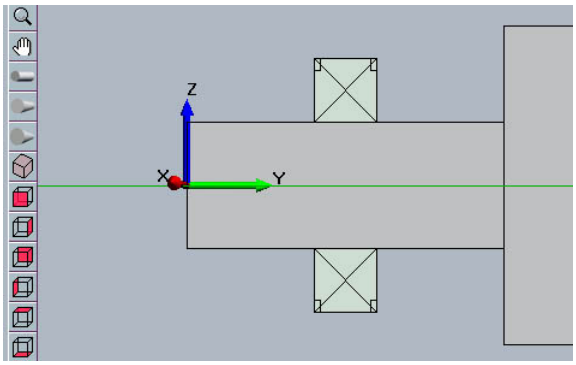

Figure 19: Add the first bearing

3. Then define the bearing with position, width, diameter and the kind of bearing arrangement. In this case please choose ‘fixed bearing’ from the listbox.

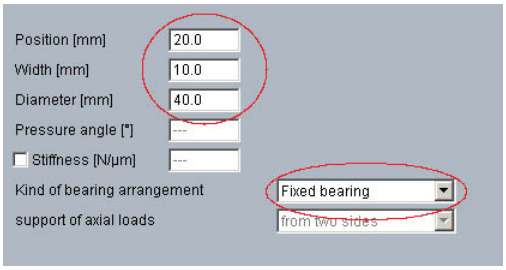

Figure 20: Define the first bearing

Add the second bearing (by using the buttons 'Copy' and 'Add')

1. Select the existing bearing from the representation.

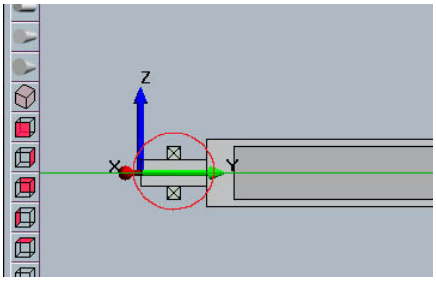

Figure 21: Select the first bearing

2. Click on the button 'Copy'.

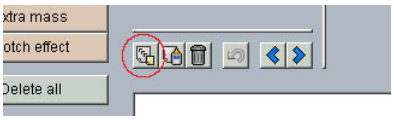

Figure 22: Button 'Copy'

Note: If you right-click, a new context menu is opened. In this context menu you will find the two options 'Copy' and 'Add'.

3. Select the last shaft segment.

Figure 23: Select the last shaft segment

4. Click on the button 'Add'.

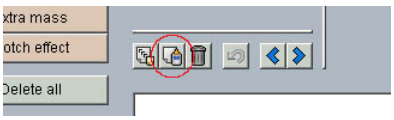

Figure 24: Button 'Add'

The second bearing is added.

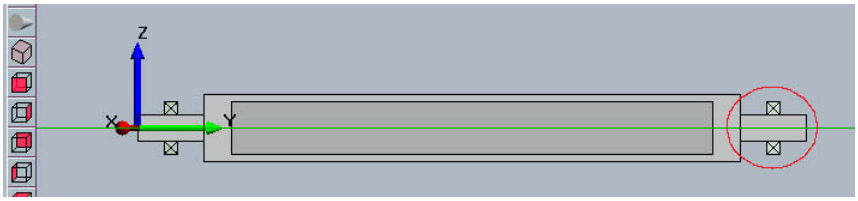

Figure 25: Add the second bearing

5. Because the bearing was copied, it is already defined with position, width and diameter. Define only the kind of bearing arrangement. Please select 'Movable bearing' from the listbox.

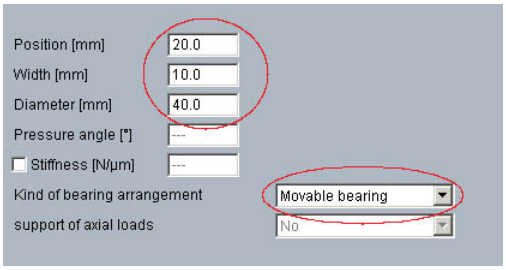

Figure 26: Define the second bearing

1.5 Define a load as an extra mass

1. Select a shaft segment, where the load element is to be placed.

Figure 27: Select a shaft segment

2. Click on the button 'Extra mass'.

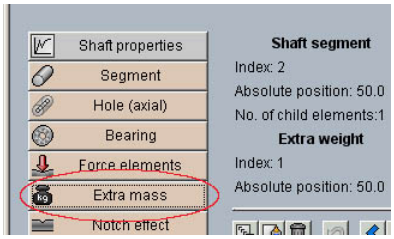

Figure 28: Button 'Extra mass'

The extra mass is positioned on the shaft segment.

3. Please define the extra mass with the entries for position '50 mm', width '300 mm' and mass '1350 kg'.

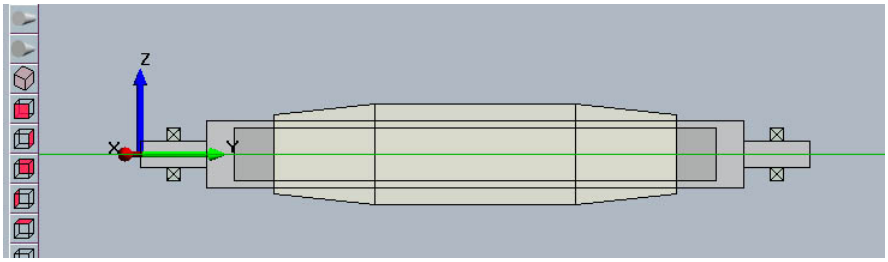

Figure 29: An extra mass is added

1.6 The definition of notch effects

1. Click on the button 'Notch effect'.

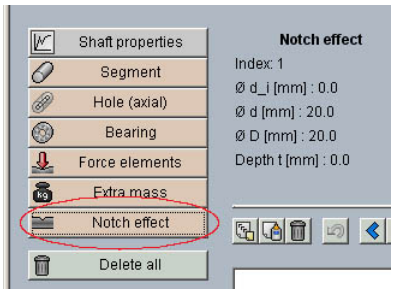

Figure 30: Button 'Notch effect'

A notch effect is added and can be placed on the shaft.

2. Select the kind of notch effects from the listbox.

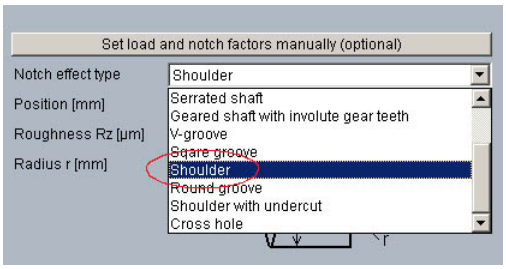

Figure 31: Kind of notch effects

3. Define the following notch effects:

   - at the left shaft section: the notch effect type 'Shoulder'
     (roughness $R_z = 5$ mm and radius $r = 10$ mm)
   - at the right shaft section: enter the same values for notch effect type, roughness and radius
   - at the shaft center: select the notch effect type 'Interference fit'

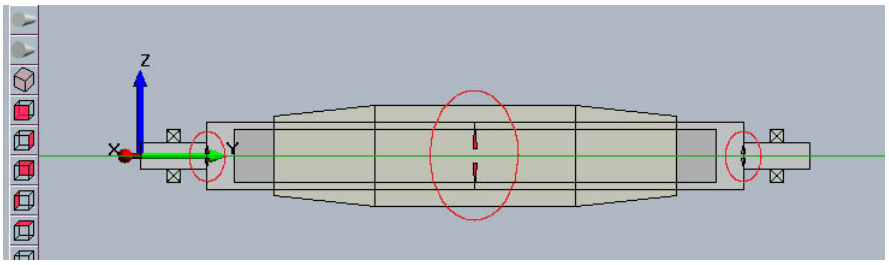

Figure 32: Notch effects

1.7 The accomplishment of the calculation

After defining the shaft geometry, bearings, loads and notch effects, the calculation can be accomplished by using the button 'Calculate'.

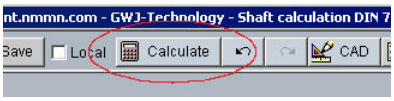

Figure 33: Button 'Calculate'

Now you reach the calculation part.

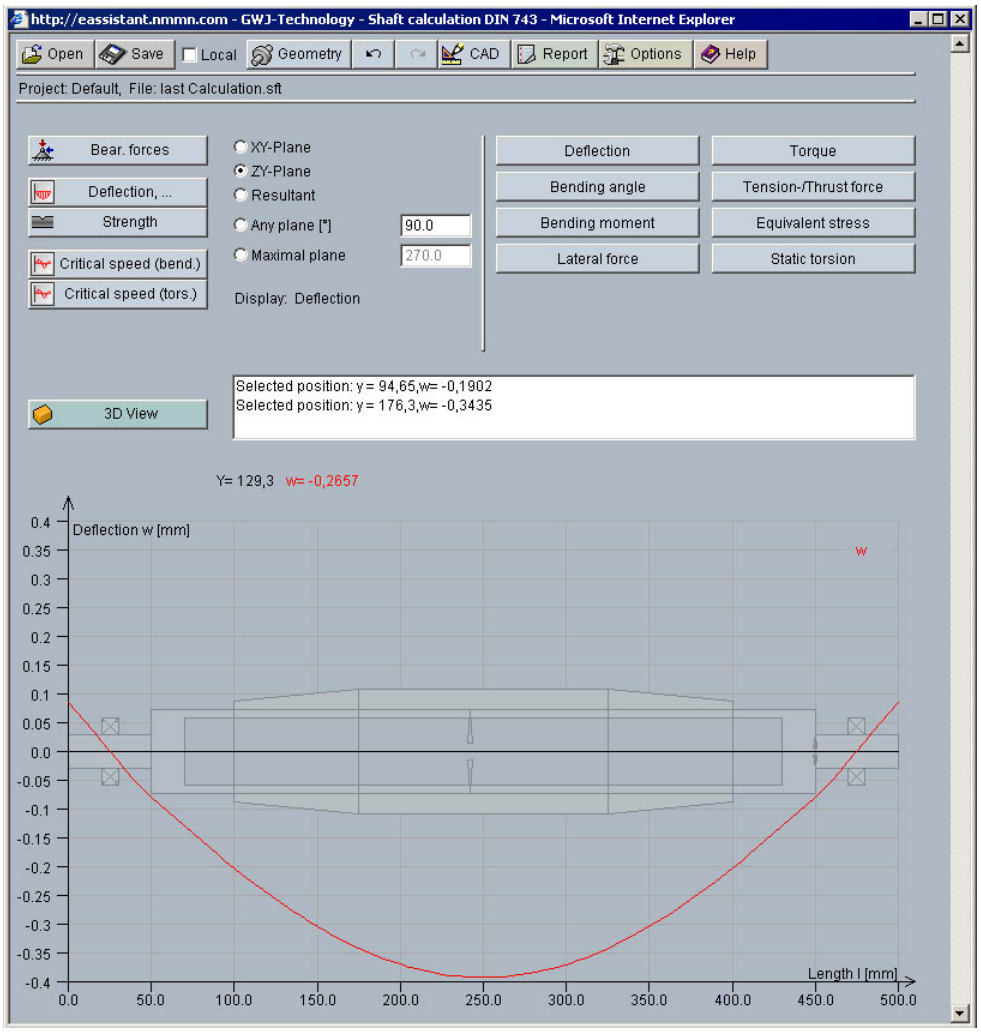

Figure 34: Calculation part

Please note: After clicking on the button 'Calculate', this button changes from 'Calculate' into 'Geometry'. Thus you can switch to the geometry part again.

In the calculation part you can accomplish your calculation, but you cannot change the geometry of the shaft. To change the geometry, please go back to the geometry part again by using the button 'Geometry'.

Here you can accomplish the different calculations.

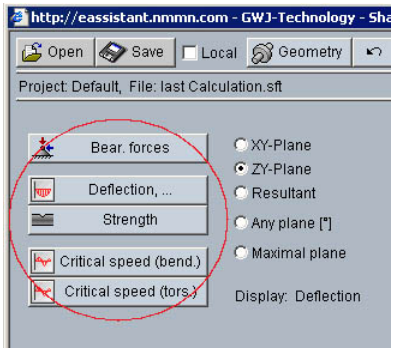

Figure 35: Different calculations

Here you find the different interactive diagrams of forces and moments.

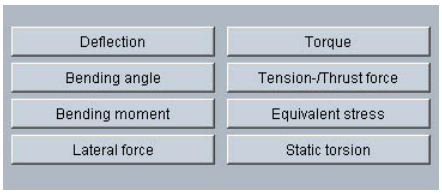

Figure 36: Interactive diagrams of forces and moments

You can select all values for deflection directly from the representation by a simple mouse-click. The values appear in the text field.

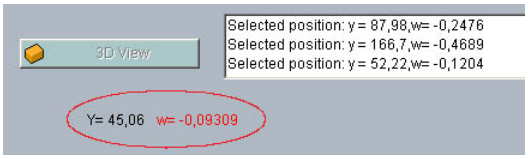

Figure 37: Select values by mouse-click

The calculation of strength according to DIN 743

Click on the button 'Strength' in the calculation part.

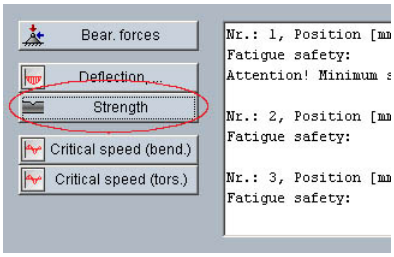

Figure 38: Button 'Strength'

The complete strength calculation according to DIN 743 for static and fatigue proof of strength is accomplished automatically.

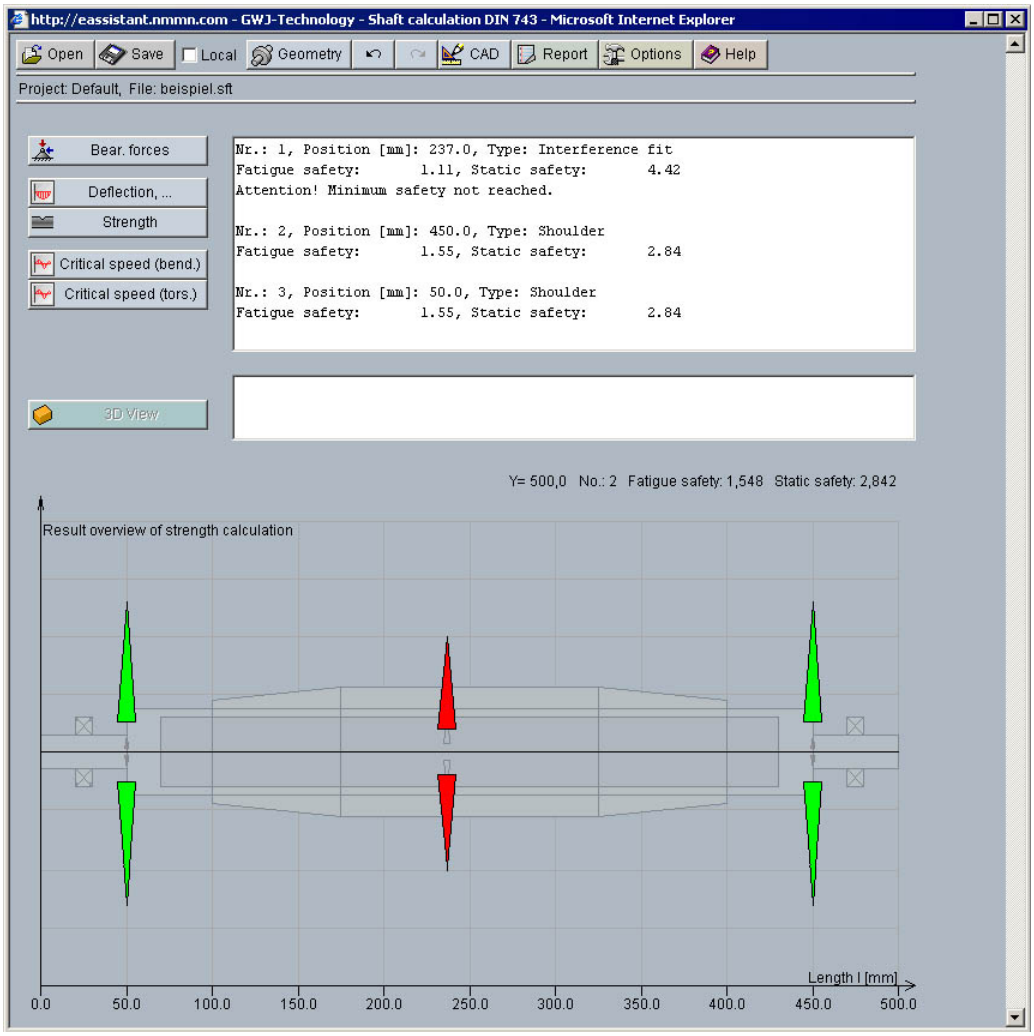

Figure 39: Strength calculation with a representation of the cross-sections

The most important results are displayed in the text field. The calculation report gives you detailed intermediate results.

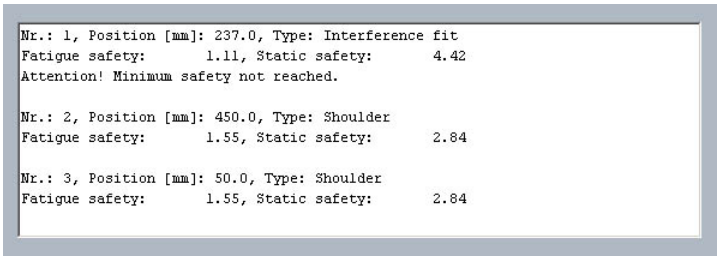

Figure 40: Results

Additionally all results for the several cross-sections are represented in three different colors.

- Red cross-section: the minimum safety is not reached.
- Green cross-section: The safety is fulfilled (from the defined minimum safety to the triple; the setting occurs via the button 'Options'.
- Blue cross-section: the cross section has a safety more than the triple of the minimum safety.

1.8 The documentation: The calculation report

Finally you can generate a calculation report. Click on the button 'Report'.

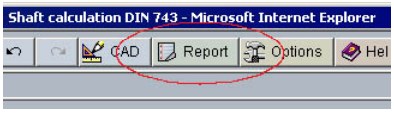

Figure 41: Button 'Report'

The report configuration allows you to select different diagrams and results which will appear later in your calculation report.

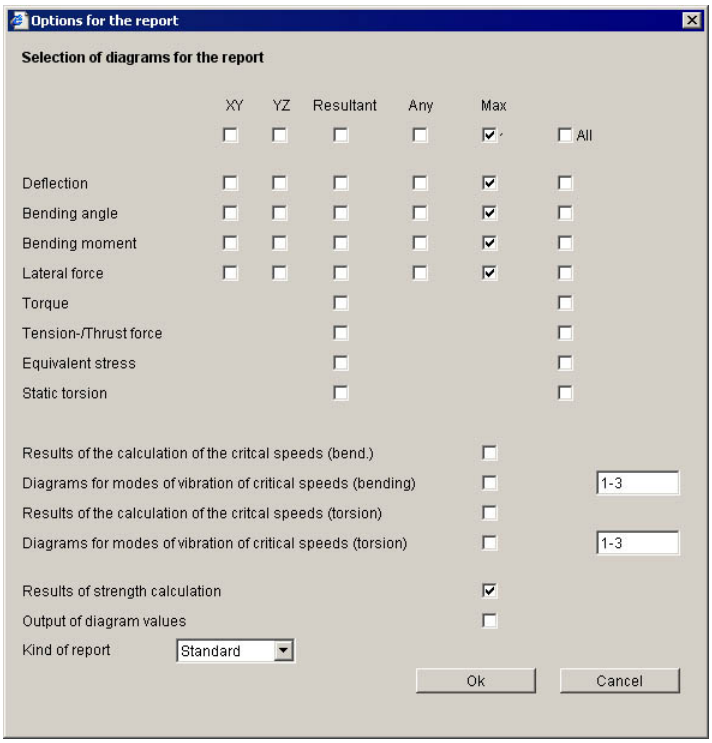

Figure 42: Report configuration

During the generation of the report, a waiting screen appears.

But you can continue the work into the shaft module. The length of time, for the generation of the report, depends on the number of diagrams that have to be generated.

The report includes a table of contents. Through this all results can be called very fast. All input data and results are listed. You can print the report or you can save the report in a HTML format. Later you can open the generated report in a web browser or open it in Microsoft Word.

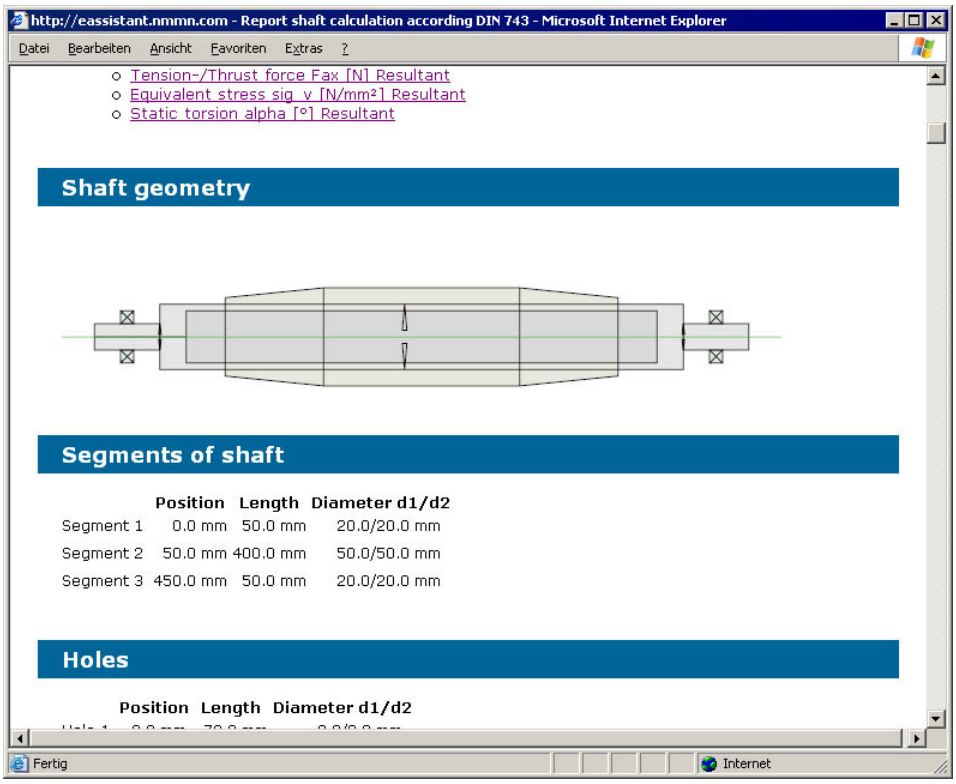

Figure 43: Calculation report

The report is available in a HTML format or in a PDF format.

- To save the report in the HTML format, please select 'File' → 'Save as' from your brower menu bar. Select the file type 'Webpage complete', then just click on the button 'Save'.
- If you click on the symbol 'Print', then you can print the report very easily.
- If you click on the symbol 'PDF', then the report appears in the PDF format. If you right-click on this symbol, you should see the 'Save Target As' option. Click on that symbol and you will see the dialog box for saving the calculation report.

In HTML all graphics are displayed in the GIF format. In case a SVG viewer is available, you can display all graphics in the SVG format. Right-click on the picture, then you can zoom in and zoom out.

1.9 Save the calculation

After accomplishment of your calculation, you can save the calculation. There you have the possibility to save either on the eAssistant server or on your own workstation locally. Click on the button 'Save'.

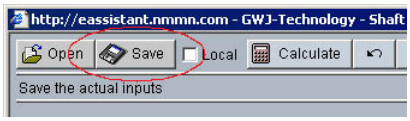

Figure 44: Button 'Save'

If you have activated the option 'Enable file save local' in the Project Manager and the option 'Local' in the calculation module, a standard Windows dialog for saving the file on your workstation appears.

Please note: You must not forget that the calculation module has to be closed to activate the option 'Enable file save local'.

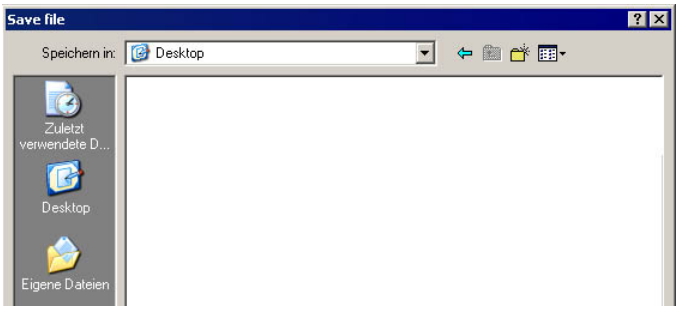

Figure 45: Standard Windows dialog for saving the file

In case this option is not activated, a new window is opened and you can save the calculation on the eAssistant server.

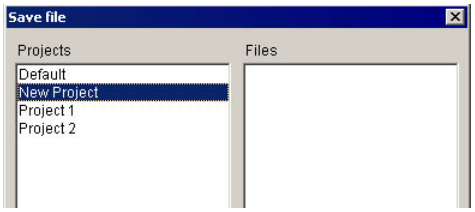

Figure 46: Save the calculation

Please enter a name into the input field 'Filename' and click on the button 'Save'. Then click on the button 'Refresh' in the Project Manager. Your saved calculation file is displayed in the window 'Files'.

2 The second calculation example

Here you find another example that shows how easy it is to create a shaft.

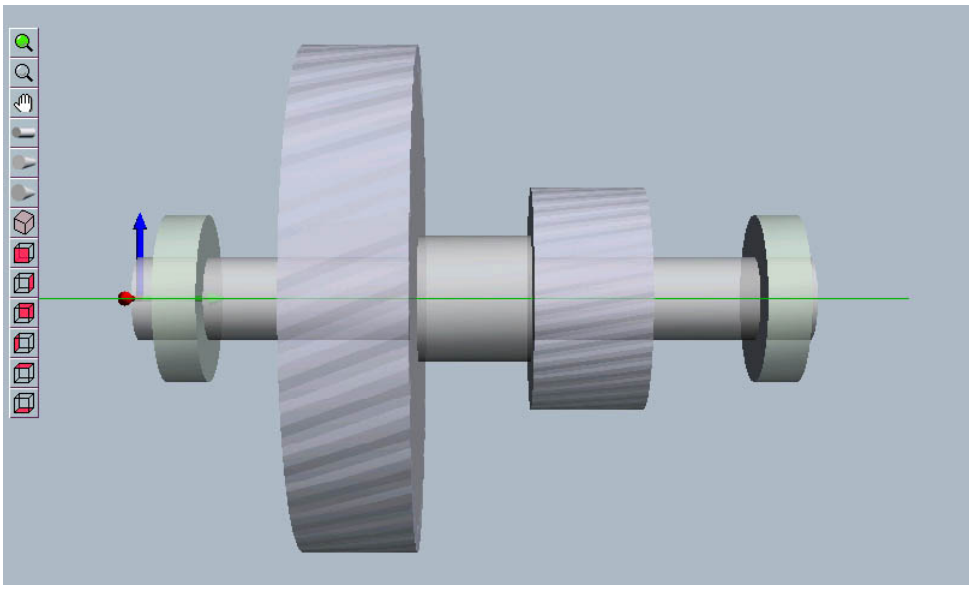

Figure 47: A shaft

2.1 Create shaft segments

Create three shaft segments. Please enter the following input values:

1. shaft segment: length $l_1 = 100$ mm diameter $d_1 = 30$ mm
2. shaft segment: length $l_2 = 40$ mm diameter $d_2 = 45$ mm
3. shaft segment: length $l_3 = 100$ mm diameter $d_3 = 30$ mm

Now you have created the shaft segments.

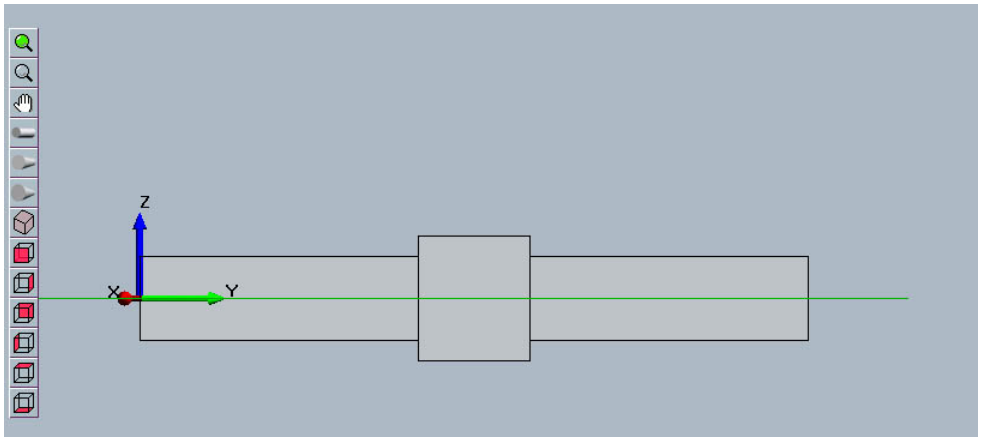

Figure 48: Shaft segments

2.2 Add the bearing

Then add the second bearing. Please enter the following input values:

1. bearing: position = 10 mm width b_1 = 15 mm diameter d_1 = 60 mm fixed bearing
2. bearing: position = 80 mm width b_2 = 15 mm diameter d_2 = 60 mm movable bearing

The second bearing is added.

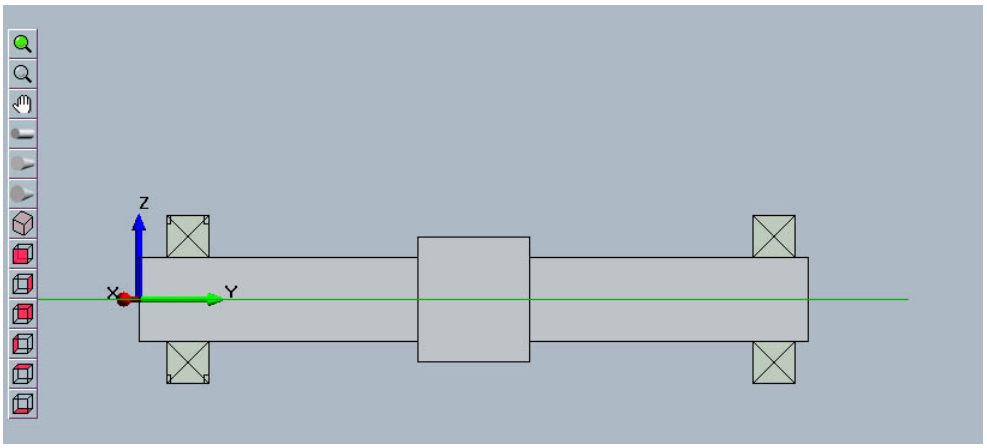

Figure 49: Bearing

2.3 Create the first spur gear

Create the first spur gear. Select the first shaft segment. Click on the button 'Force elements'.

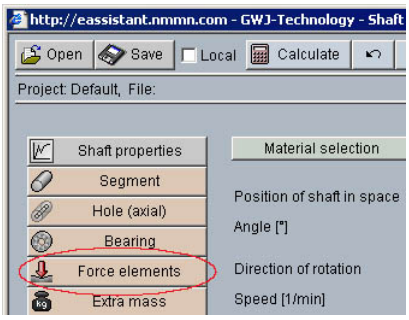

Figure 50: Add a spur gear

A context menu is opened. Select the force element 'Spur gear'

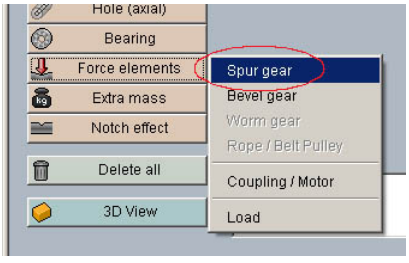

Figure 51: Context menu

A spur gear is added.

Define the first spur gear via the input mask.

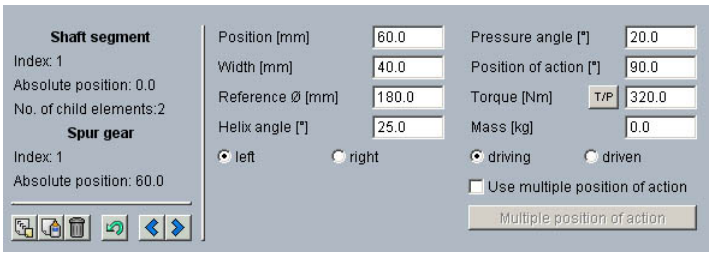

Figure 52: Input mask for spur gears

Input values for the first spur gear:

Position = 60 mm
Width b_1 = 40 mm
Reference circle d_{T1} = 180 mm
Helix angle β_1 = 25°
Pressure angle α_1 = 20°
Position of action = 90°
Torque T_1 = 320 Nm
Mass m_1 = 0.0 kg

After you have defined the spur gear, the element will be represented.

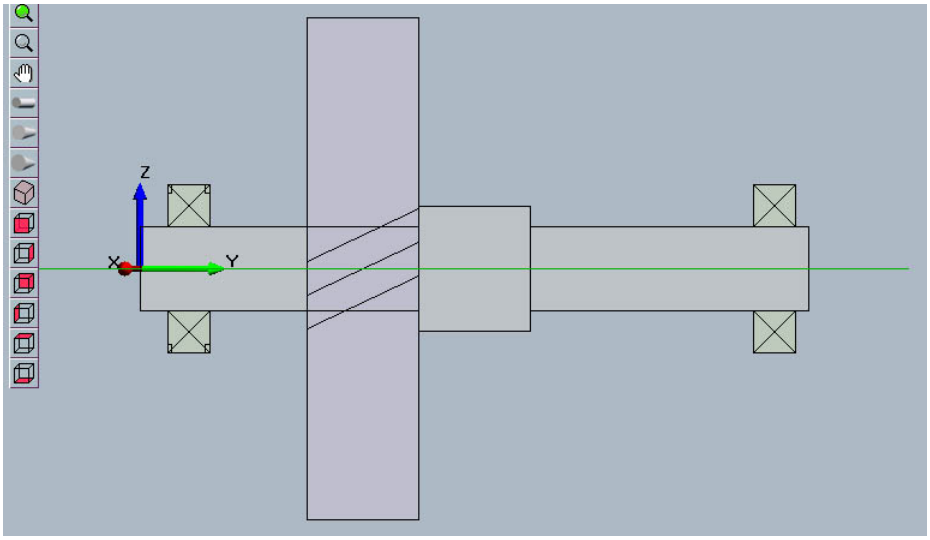

Figure 53: The first spur gear

2.4 Create the second spur gear

To create the second spur gear, select the third shaft segment and click on the button 'Force elements' and add the second spur gear. Please enter the following values into the input mask.

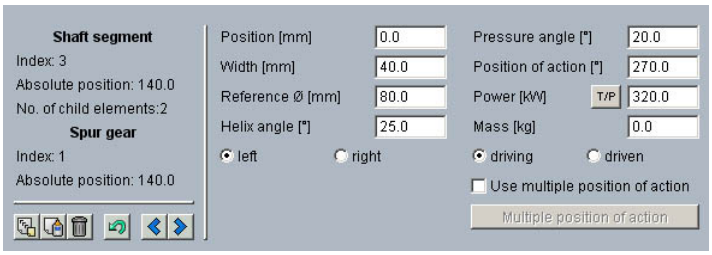

Figure 54: Define the second spur gear

Input values for the second spur gear:

Position = 0 mm
Width b_2 = 40 mm
Reference circle d_{T2} = 80 mm
Helix angle $\beta_2 = 25°$
Pressure angle $\alpha_2 = 20°$
Power of action = 270°
Torque T_2 = 320 Nm
Mass m_2 = 0.0 kg

Both spur gears will be represented.

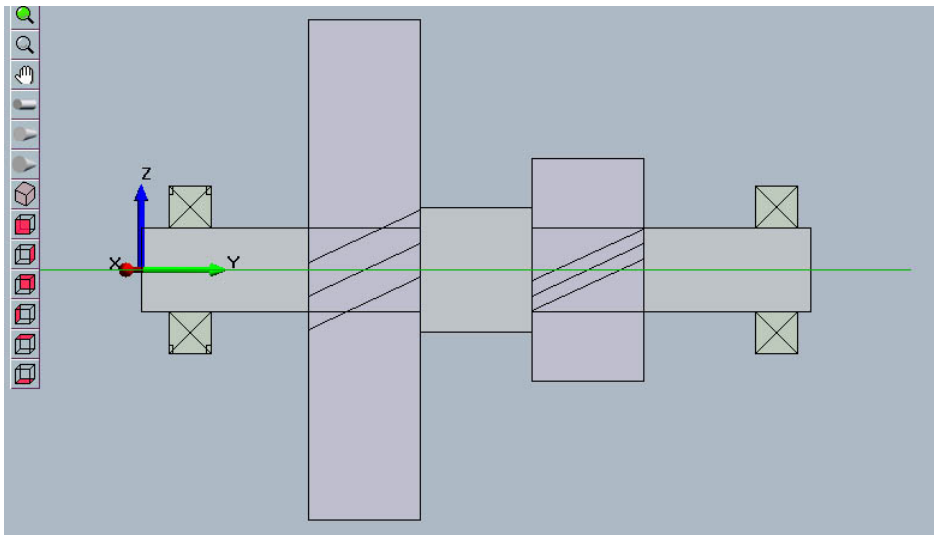

Figure 55: Two spur gears created

Then you can display the shaft in different views. Click on the button '3D view' and select the different views from the toolbar and zoom into the graphic. Click on the button 'Calculate' and switch from the geometry part into the calculation part. There you can accomplish the calculations (find detail information in the section 'How to start the calculation').The button 'Report' allows you to generate a report.

2.5 The 3D view

When you click on the button '3D view', you will get a three-dimensional representation. Here you can select, modify or position the elements by using the mouse.

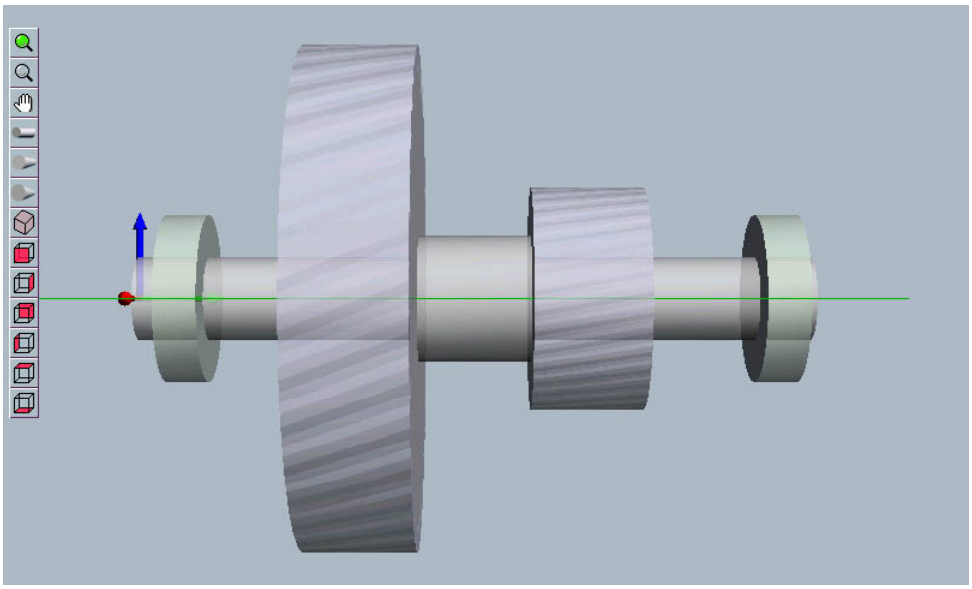

Figure 56: 3D view of the shaft

Our manual is improved continually. Of course we are always interested in your opinion, so we would like to know what you think. We appreciate your feedback and we are looking for ideas, suggestions or criticism. If you have anything to say or if you have any questions, please let us know via telephone *+49 (0) 531 129 399-0* or email *eAssistant@gwj.de*.