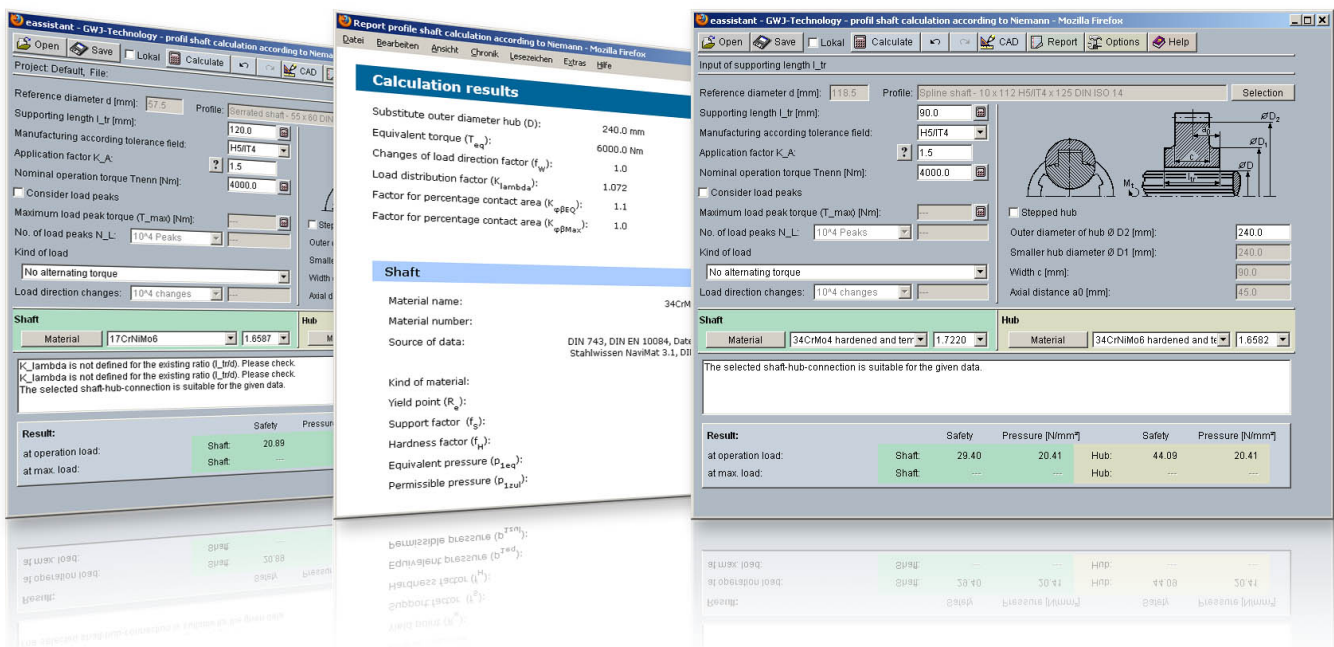


# Calculation Example

## Splined Shaft According to Niemann



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## 0.1 Calculation Example: Splined Shaft for Lifting Gear

We have prepared the following example to guide you through the calculation module. This calculation example is based on: G. Niemann, H. Winter, B.-R. Hoehn: Maschinenelemente Band I: Konstruktion von Verbindungen, Lagern, Wellen. Springer Verlag, 3rd Edition, 2001: p. 857 Example 4: Splined shaft for lifting gear.

### 0.1.1 Start the Calculation Module

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

The screenshot shows the 'eAssistant - GWJ-Technology - profil shaft calculation according to Niemann - Mozilla Firefox' window. The interface includes a menu bar (Open, Save, Lokal, Calculate, CAD, Report, Options, Help) and a main area with input fields and a technical drawing of a splined shaft-hub connection.

**Input Fields:**

- Reference diameter  $d$  [mm]: 60.5
- Profile: Spline shaft - 8 x 56 H5/IT4 x 65 DIN ISO 14
- Supporting length  $l_{tr}$  [mm]: 120.0
- Manufacturing according tolerance field: H5/IT4
- Application factor  $K_A$ : 1.5
- Nominal operation torque  $T_{enn}$  [Nm]: 4000.0
- ☐ Consider load peaks
- Maximum load peak torque ( $T_{max}$ ) [Nm]: ---
- No. of load peaks  $N_L$ : 10^4 Peaks
- Kind of load: No alternating torque
- Load direction changes: 10^4 changes
- ☐ Stepped hub
- Outer diameter of hub  $\varnothing D_2$  [mm]: 100.0
- Smaller hub diameter  $\varnothing D_1$  [mm]: 100.0
- Width  $c$  [mm]: 120.0
- Axial distance  $a_0$  [mm]: 60.0

**Shaft and Hub Materials:**

- Shaft Material: 17CrNiMo6, 1.6587
- Hub Material: 17CrNiMo6, 1.6587

**Message:** The selected shaft-hub-connection is suitable for the given data. There are no material data for the reference diameter of the hub. Please check!

**Result Table:**

	Safety	Pressure [N/mm <sup>2</sup> ]	Safety	Pressure [N/mm <sup>2</sup> ]
at operation load:	Shaft: 7.57	72.92	Hub: 9.46	72.92
at max. load:	Shaft: ---	---	Hub: ---	---

Figure 1: Calculation module'

### 0.1.2 Input Values

A splined shaft connection with a splined shaft according to DIN ISO 14 is given. The safety against pressure is required. For our calculation example the following input values are given:

Diameter $d_1$	= 32 mm
Diameter $d_2$	= 38 mm
Number of keys	= 8
Key width	= 6
Supporting length $l_{tr}$	= 40 mm
Manufacturing according to tolerance field	= H7/IT7
Application factor	= 1
Nominal operation torque $T_{enn}$	= 2400 Nm
Maximum load peak torque $T_{max}$	= 2400 Nm with number of load peaks $> 10^7$
No alternating torque	

Outer diameter of hub  $D_2$  = 45 mm  
 Material shaft = C45 hardened and tempered  
 Material hub = C45 hardened and tempered

### 0.1.3 The Calculation

#### Profile Geometry Selection

In order to find the right profile, click the button 'Selection'.

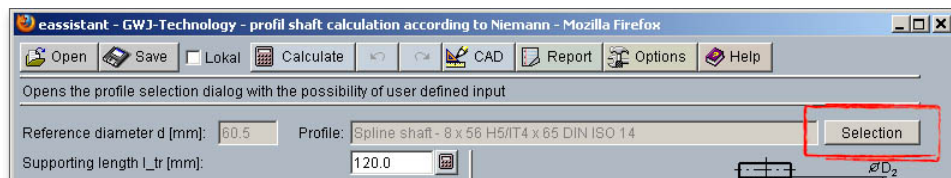


Figure 2: 'Selection' button

Select from the listbox 'Standard geometry data' the splined shaft profile according to DIN ISO 14 medium series.

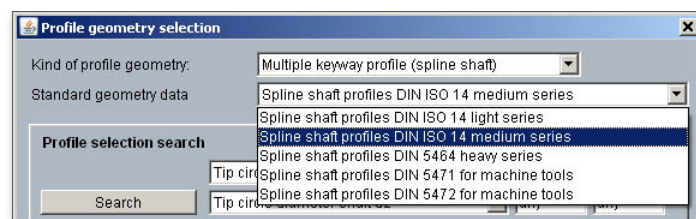


Figure 3: Profile geometry selection

You can narrow your search by entering certain parameters in order to find the right profile quicker. Just add the diameter  $d_1$ , the number of keys as well the key width. Click on the button 'Search'.

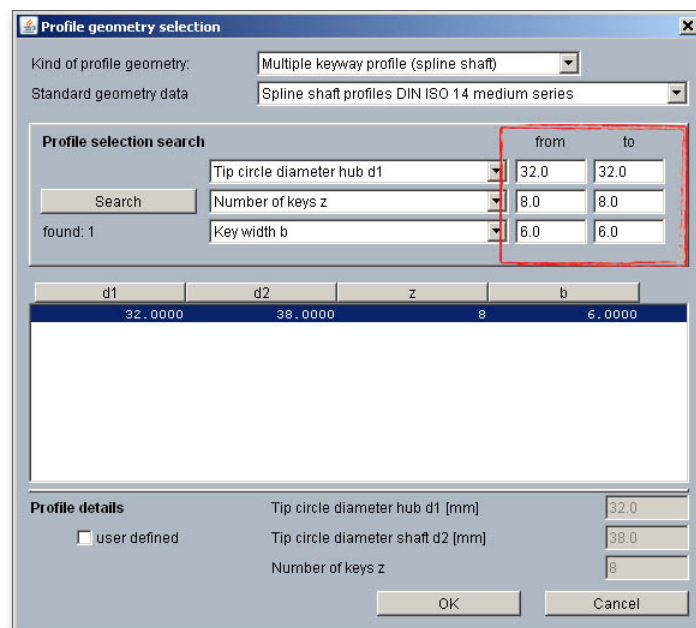


Figure 4: Refine the profile geometry selection

After clicking the button 'Search', only one profile remains. Please select the profile and click the button 'OK'.

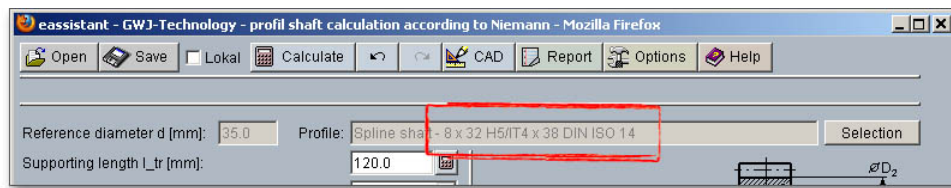


Figure 5: Selected profile

Enter '40 mm' for the supporting length  $l_{tr}$ .

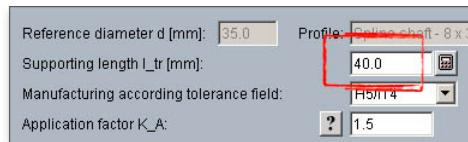


Figure 6: Supporting length

### Tolerance Field

Click the listbox in order to choose the tolerance field 'H7/IT7'.

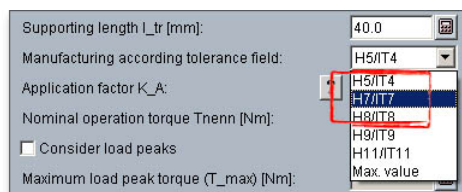


Figure 7: Tolerance selection

The field 'Profile' displays the previously selected tolerance field.

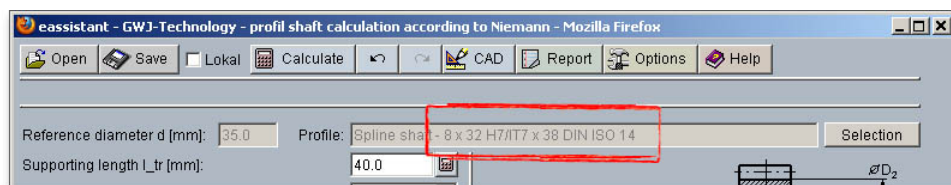


Figure 8: Tolerance field

Please add the application factor as well as the nominal operation factor  $T_{nenn}$ .

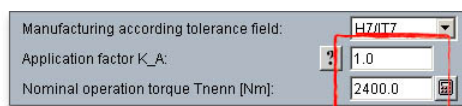


Figure 9: Application factor and nominal operation torque

## Load Peaks

Activate the load peaks und enter '2400' for the maximum load peak torque  $T_{max}$ .

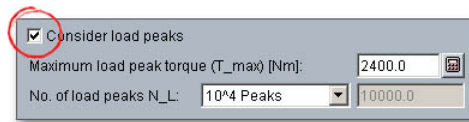


Figure 10: Load peaks and load peak torque  $T_{max}$

Select the number of load peaks from the listbox.

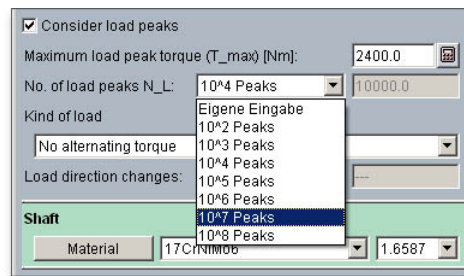


Figure 11: Number of load peaks

## Kind of Load

There is no change in load direction, so enter the default setting 'No alternating torque' for the 'kind of load'.

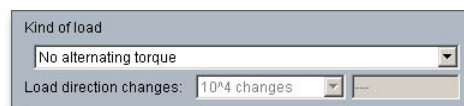


Figure 12: Kind of load

Enter the value '45 mm' for the outer diameter of the hub.



Figure 13: Outer diameter of hub

## Material of Shaft and Hub

Select the material 'C45 hardened and tempered' for the shaft.

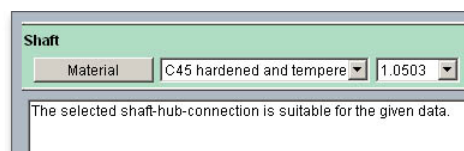
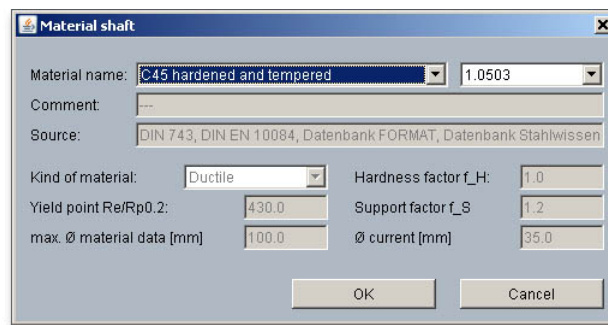


Figure 14: Material for the shaft

**Hinweis:** In case you need further information on the material, click on the button 'Material'.



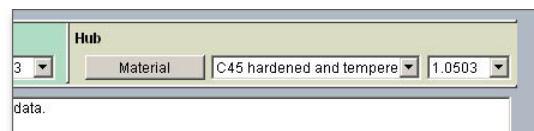
The 'Material shaft' dialog box contains the following fields and values:

- Material name: C45 hardened and tempered
- Comment: ---
- Source: DIN 743, DIN EN 10084, Datenbank FORMAT, Datenbank Stahlwissen
- Kind of material: Ductile
- Hardness factor f<sub>H</sub>: 1.0
- Yield point Re/Rp0.2: 430.0
- Support factor f<sub>S</sub>: 1.2
- max. Ø material data [mm]: 100.0
- Ø current [mm]: 35.0

Buttons: OK, Cancel

Figure 15: Material details

Select the hub material 'C45 hardened and tempered' from the listbox.



The 'Hub' dialog box shows the material selection process:

- Hub: 3
- Material: C45 hardened and tempered
- 1.0503
- data.

Figure 16: Material for the hub

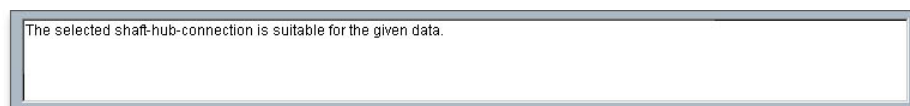
#### 0.1.4 Calculation Results

All results (safeties at operation load and maximum load, the pressures for shaft and hub) will be calculated during every input and will be displayed in the result panel. A recalculation occurs after every data input. Any changes that are made to the user interface take effect immediately.

Result:		Safety	Pressure [N/mm <sup>2</sup> ]		Safety	Pressure [N/mm <sup>2</sup> ]
at operation load:	Shaft:	2.43	212.47	Hub:	2.61	212.47
at max. load:	Shaft:	3.95	179.78	Hub:	4.24	179.78

Figure 17: Calculation results

For our calculation example the splined shaft is sufficiently dimensioned. In addition, the message window contains the hint that this shaft-hub-connection is suitable and can be used.



The message window displays the text: "The selected shaft-hub-connection is suitable for the given data."

Figure 18: Message window

#### 0.1.5 Documentation: Calculation Report

After the completion of your calculation, you can create a calculation report. Click on the 'Report' button. You can navigate through the report via the table of contents that provides links to the input values, results and figures. This calculation report contains all input data, the calculation method as well as all detailed results. The report is available in HTML and PDF format. The calculation report saved in HTML format, can be opened in a web browser or in Word for Windows.

You may also print or save the calculation report:

- To save the report in the HTML format, please select 'File' → 'Save as' from your browser 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.
- When you click on the symbol 'PDF', then the report appears in the PDF format. If you right-click on the PDF symbol, you should see the 'Save Target As' option. Click on that option and you will see the dialog box for saving the report.

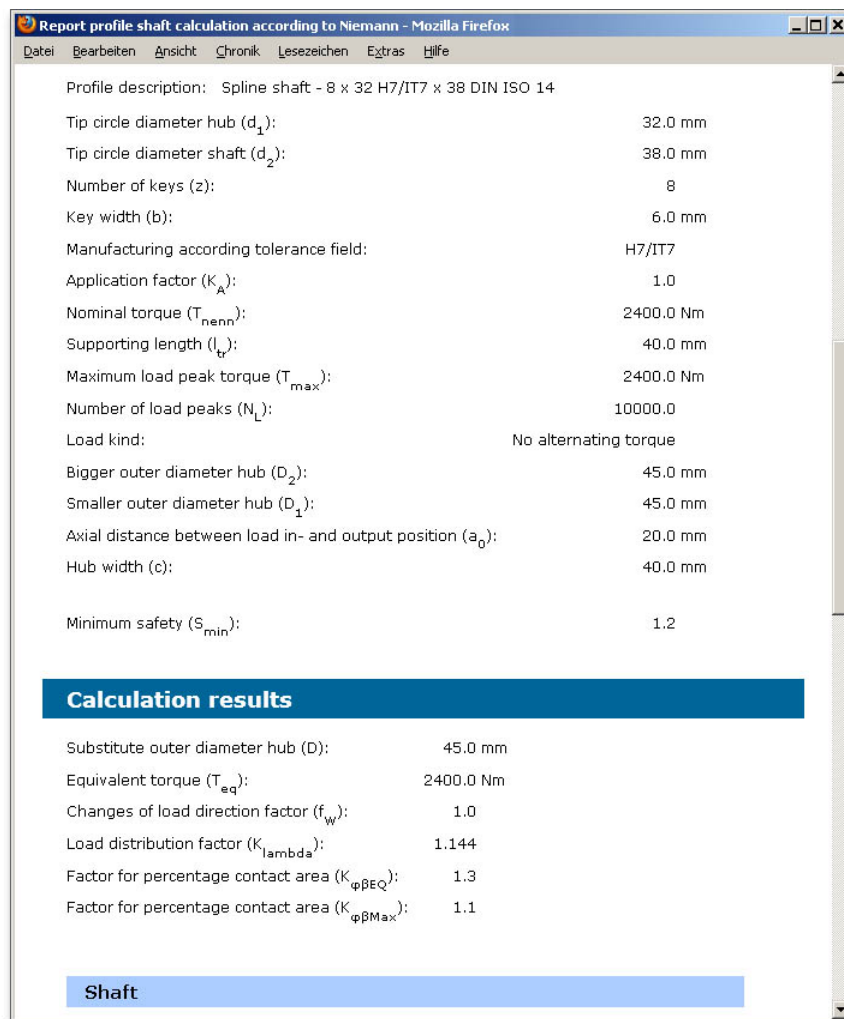


Figure 19: Calculation report

### 0.1.6 How to Save the Calculation

When the calculation is finished, you can save it to your computer or to the eAssistant server. Click on the button 'Save'.

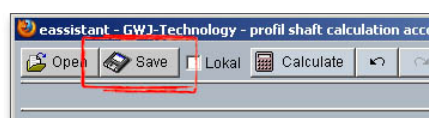


Figure 20: 'Save' button



Before you can save the calculation to your computer, you need to activate the checkbox 'Enable save data local' in the project manager and the option 'Local' in the calculation module. A standard Windows dialog for saving files will appear. Now you will be able to save the calculation to your computer.

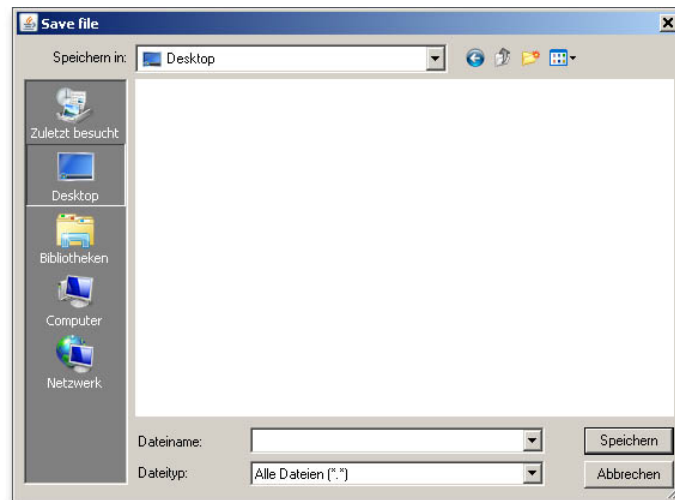


Figure 21: Windows dialog for saving the file

In case you do not activate the option in order to save your files locally, then a new window is opened and you can save the calculation to the eAssistant server. 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'.

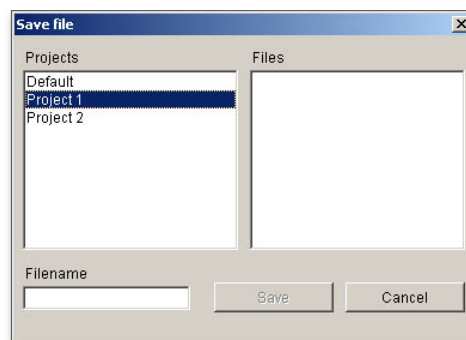


Figure 22: Save the calculation

**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 phone +49 (0) 531 129 399-0 or email [eAssistant@gwj.de](mailto:eAssistant@gwj.de).**