BELLEVILLE
Disc Spring Calculation Program

Julien-Francoise Belleville was awarded a patent in 1861 for a spring designed like a cone-shaped ring shell capable of absorbing large axial forces with relatively small spring travel. This spring design principle corresponds to the disc spring in use today.

Disc springs have become indispensable in a host of applications. The use of disc springs is common in applications requiring high spring forces and small deflections. Applications requiring a high degree of safety are also reliably covered by this type of spring. Mubea has manufactured technical springs for more than seven decades and has been involved in the development of high quality disc springs.

With this program, we hope to give our customers an aid to simplify selection of the best possible spring for the application from the extensive range Mubea has to offer.

Note:

All rights to the Bellevilledesign.xls calculation program, in particular the right to reproduction, is reserved by Mubea Tellerfedern und Spannelemente GmbH.

Despite careful testing of this program, we can not guarantee an error free calculation program.

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Installing Bellevilledesign.xls

Hardware requirements

To use Bellevilledesign.xls you will need the following hardware:

- A CD-ROM drive

- 1 MB free space on the hard drive

Software requirements

Bellevilledesign.xls is designed as a Microsoft Excel for Windows™ application. The following software must be installed on your PC:

- Microsoft Windows™, version 95 or later

- Microsoft Excel 97™

Installation

Copy Bellevilledesign.xls from the CD-ROM onto the computer's hard drive. Open the program in the same manner as other Excel programs. To prevent the file from being inadvertently changed you may wish to protect the document using Excel's "protect sheet" feature under the tools menu.

For additional information or assistance please contact us at

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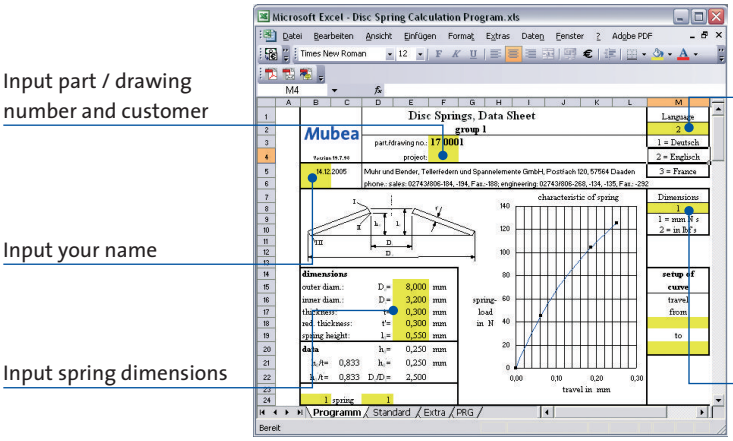
Program description

Starting the program

Bellevilledesign.xls is stored in an Excel workbook. The calculation sheet is active upon opening the file. The computer screen should display information as shown below:



The program is formatted so that it can be printed out as a data sheet for documentation.

Input cells

The work sheet contains all necessary input cells and calculations. The input cells are highlighted in yellow. All other fields of the work sheet are locked so that unintentional overwriting is prevented.

Language

The language option enables you to select between three languages:

- 1 for German
- 2 for English
- 3 for French

Enter the number of the desired language in the field provided. After leaving this input cell, all entries on the work sheet will be shown in the language selected.

Units

The program allows the selection of either Metric or English Customary units.

Part /drawing no. and customer

You can enter the part / drawing number and the customer name for the project in the fields part/drawing no. and customer for tracking purposes. The program automatically enters the Mubea part number if a stock disc spring is selected.

Disc spring dimensions

The geometry of the spring is input in the field designated “dimensions”. The dimensions can be changed individually. In many cases it may helpful to select a spring from the comprehensive range of standard Mubea disc springs as described below.

Spring selection

To select one of Mubea’s standard springs, click on the “standard” or “extra” tab in the area at the bottom edge of the screen.

Standard / extra

The “standard” table contains a list of springs per DIN 2093 that are available ex stock. All existing special dimensions according to Mubea factory standards are listed in the table marked “extra”.

To simplify spring selection, the table has pre-calculated the force and travel as well as the edge stresses for various spring deflections.

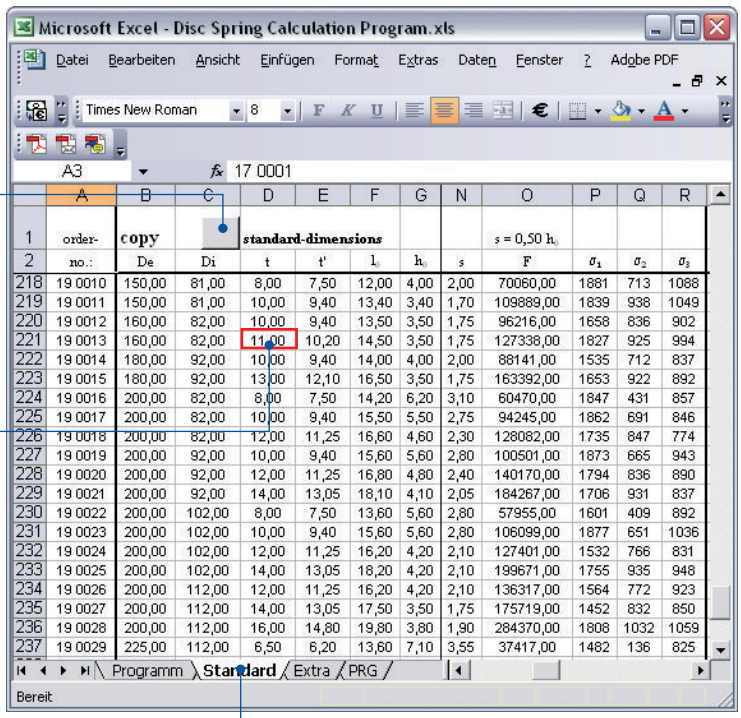
Copying dimensions

Move the cursor to the line with the desired spring dimensions. Click any cell here. Clicking on the copy button will copy the selected data onto the calculation sheet.

Click here to copy the selected spring dimensions into the calculation sheet

To select a particular spring highlight a cell in the row of that spring

"Standard" Index



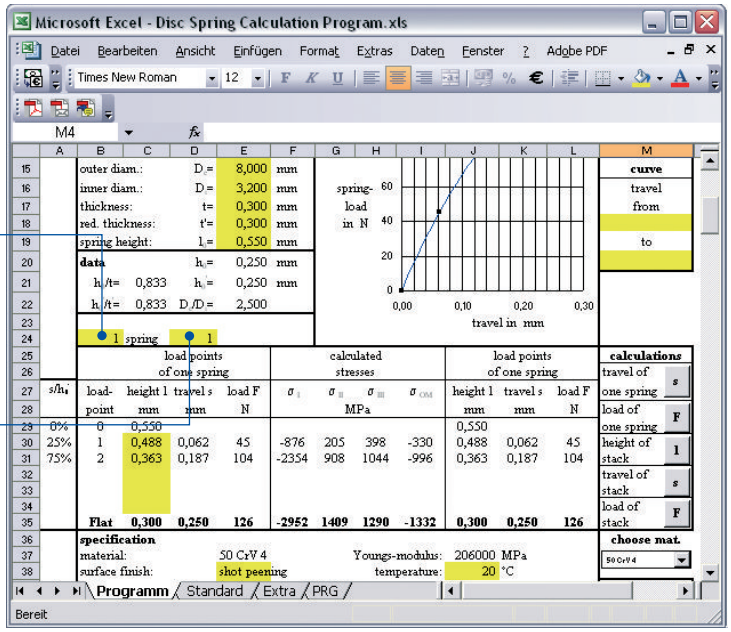
When the copy command is selected, Bellevilledesign.xls will automatically switch back to the calculation sheet.

Spring column

Key in the required number of springs or spring packages to be stacked in series in the left input field. Key in the number of springs stacked in parallel to form a package in the right input field. One spring stack made of four spring packages, each of which has two springs stacked in parallel will have a total of 4 x 2 = 8 individual springs.

Number of springs or spring packages in series

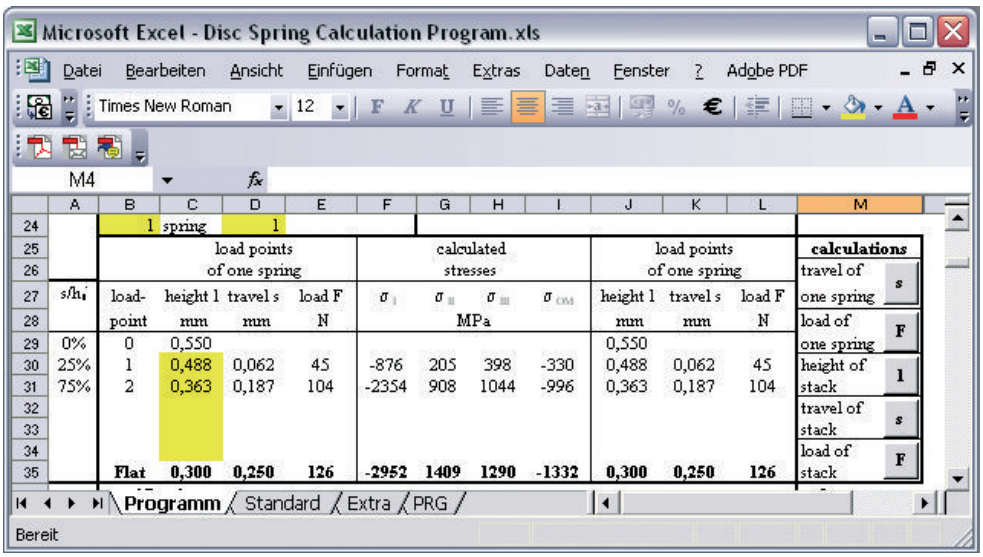
Number of springs in parallel



Load points

The cell area shown below is used for calculating the load points of the individual springs and spring stack. Forces and deflections may be calculated for five load points by entering the spring height of the individual spring.

Load point o always corresponds to the unloaded spring or spring stack. Mark any cell in the row of interest to change the spring forces and deflections for your application. To input the desired values use the “calculations” input menu on the right edge of the screen, since the cells cannot be directly overwritten.



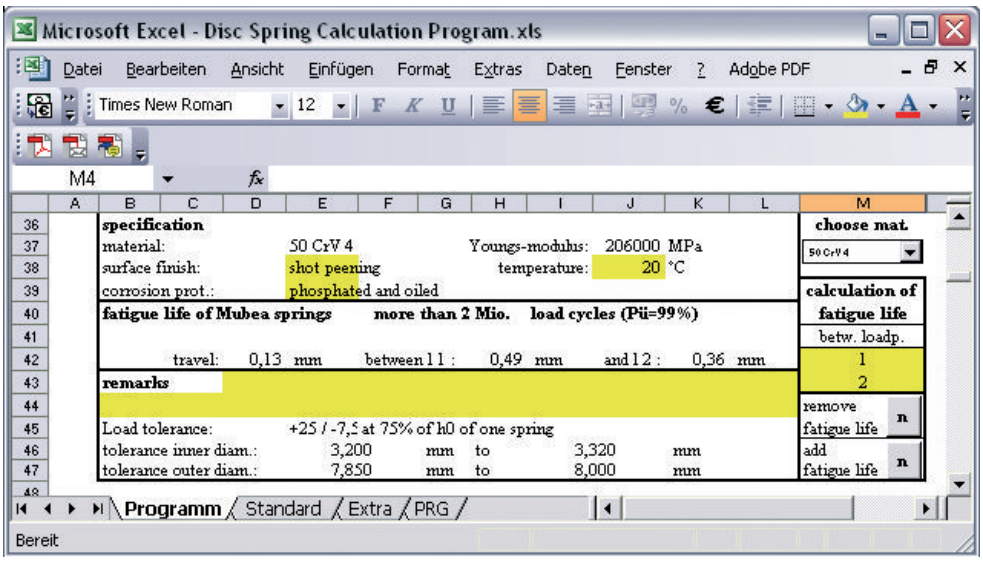
The last load point corresponds to the flat position of the spring. Should the spring deflect over the flat position (s>Ho), the construction must ensure tension-free unloading on the edges of the disc springs without changing the point of load application.

Edge stresses

Bellevilledesign.xls calculates the significant edge stresses σ_I, σ_{II}, σ_{III} and σ_{OM}.

Materials

The cells shown below are used to specify the material properties and operating temperature. The material is selected from the drop-down menu on the right edge of the screen. The Young's modulus is changed automatically. Please consult Mubea if materials other than 50CrV4 and Ck67 are used.



Fatigue life

Bellevilledesign.xls will calculate the expected fatigue life based upon the input parameters. Load point 1 is normally used as the lower pulsating stress and load 2 as the higher pulsating stress. By keying in other load points in the input fields on the right edge of the screen, the fatigue life for other load points can be calculated.

Under certain circumstances, a warning will be displayed in place of the fatigue life. In this case please consult Mubea.

Please note:

The fatigue life is only calculated for shot peened disc springs made of 50CrV4 or Ck67 operating at T=200 C.

Canceling fatigue life

Should the disc springs be subjected to a rarely alternating or static load, the fatigue life calculation can be deleted from the data sheet by clicking the "remove fatigue life" tab on the right side of the screen.

Warnings

Possible warnings are listed below.

warning	corrective action
upper tension too high	reduce disc spring deflection
S2 is too great	increase the number of springs or use multi-stacking of a thinner spring
S1 too small	danger of cracks from pressure tension- increase F1, pre-load force
Temperature too high/too low	where necessary cool; when using special materials, please consult Mubea
More than 60 springs	springs subjected to varying loads in the stack - reduce the number of springs
More than 15 spring	springs subjected to varying loads in the stack - reduce the packages number of spring packages

Please consult Mubea if it is not possible to eliminate the warnings by modifying the spring design or application requirements.

Remarks

The last field of the calculation sheet is provided for user notes / remarks. The spring force tolerances and spring dimensions are also listed in this area.

Diagram

The spring characteristic curve is integrated on the first page of calculations. An enlarged version of this curve including the pertinent edge stresses with a table of values is provided on subsequent pages of the program. The stress calculations can be eliminated from the graph by changing the input on the right side of the graph.

Static load

The maximum compressive stress, σ_I, calculated on the top inside edge of the disc spring is the most critical for static applications. The stress at position σ_I has the largest magnitude and has the most influence on the relaxation of the spring.

The calculated compressive stress at the flat condition at position σ_I should not exceed the values shown below for springs made of high grade steel in accordance with DIN 17221 and DIN 17222.

De / Di	σ_I [N/mm2]
1,5	-2600
2,0	-3400
2,5	-3600

Allowable stresses / relaxation / dimensional tolerances

The allowable stresses for the selected material are shown on the last calculation page. Furthermore, the relaxation at T=200 C and 1000 C is listed. The dimensional tolerances of the spring selected according to the Mubea disc spring manual are also shown on this page.