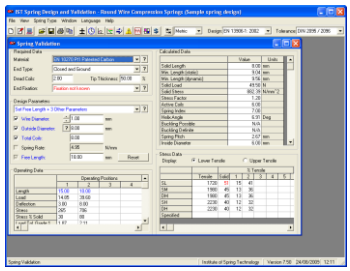
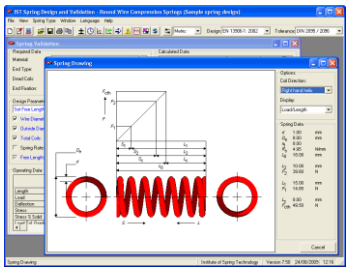
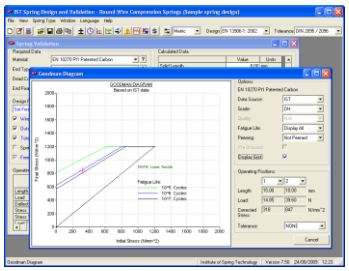
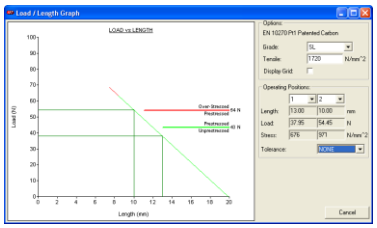
IST Spring Design & Validation

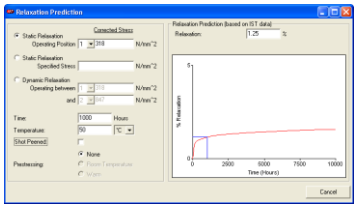
v7.5

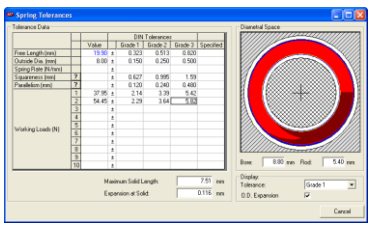












Institute of Spring Technology

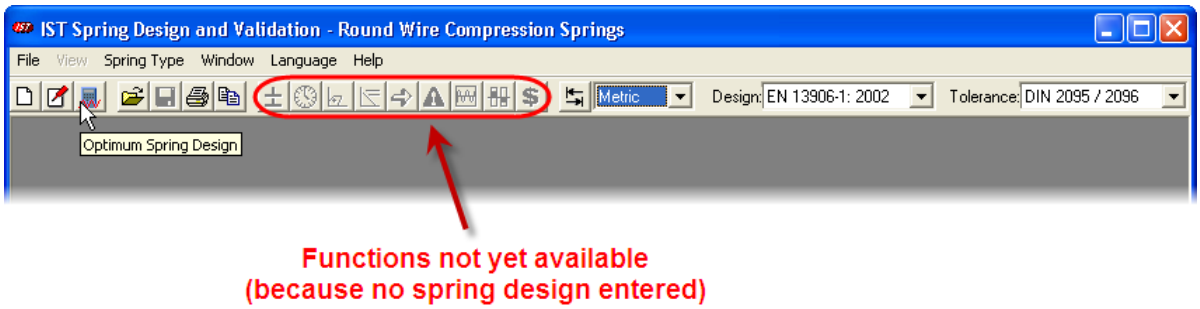
Contents

Getting Started

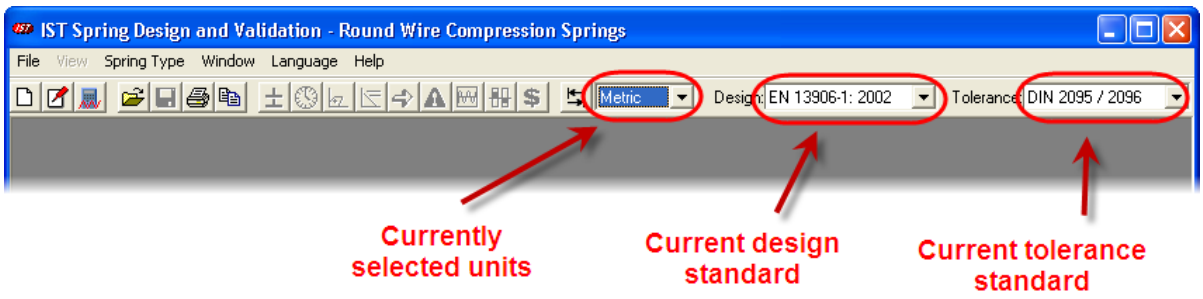
The IST Spring Design and Validation software provides a range of functions designed to aid the process of validating existing spring designs or creating new designs. The F1 function key provides access to contextual help at any time during operation of the software.

Menus and Toolbar

The menus and toolbar shown at the top of the screen are used for activating the windows providing the program functions. The menus list all the functions available to the user while the toolbar buttons provide quick access to the design and validation windows. Holding the cursor over a toolbar button for about one second displays the name of the button. Buttons providing functionality not currently available are disabled.



The toolbar also contains three dropdown lists displaying the current units, design standard and tolerance standard. These initially display the default values set in the Setup program but may be altered at any time during operation of the software.

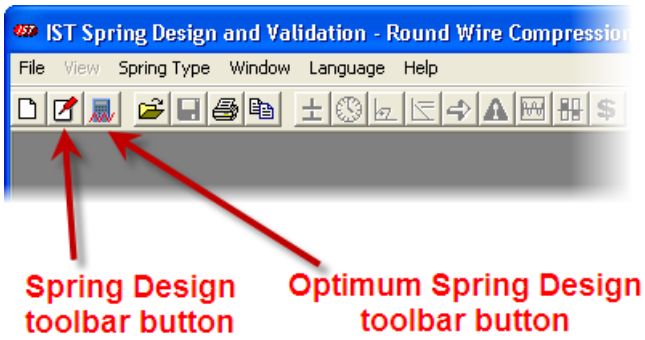


Design and Validation

The Spring Validation window is displayed when the program starts up and is used to enter details of a known spring design. Once a design has been successfully input the full functionality of the program becomes available and those toolbar buttons and menu items that were previously disabled, become enabled.

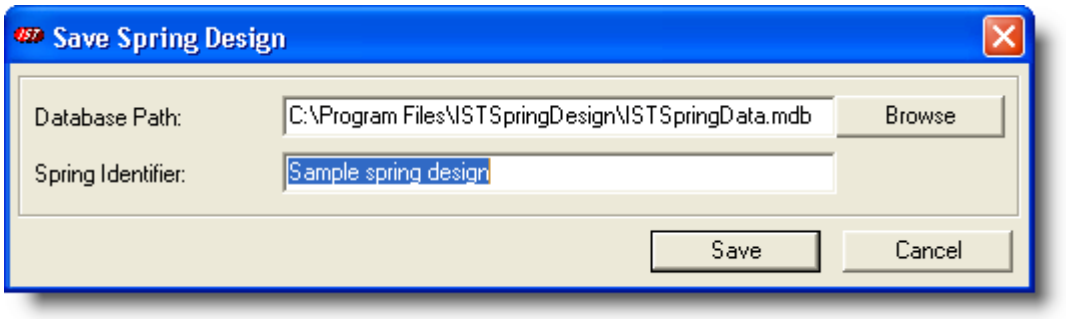
If the Spring Design & Optimisation module has been purchased, this provides alternative starting points. Either the Spring Design window or the Optimum Spring Design window may be activated and used to create

a design from known requirements. The design may then be transferred to the validation window providing access to the other windows. You cannot have both of these design windows open at the same time.

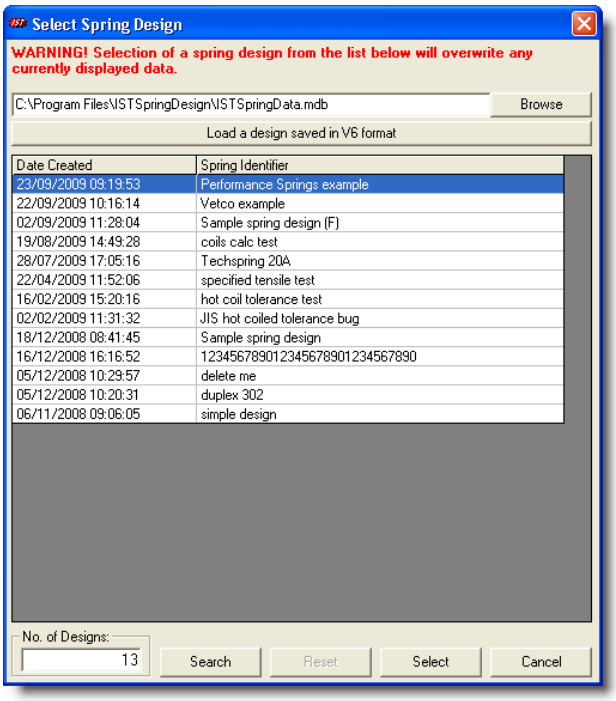


Saving and Opening Spring Designs

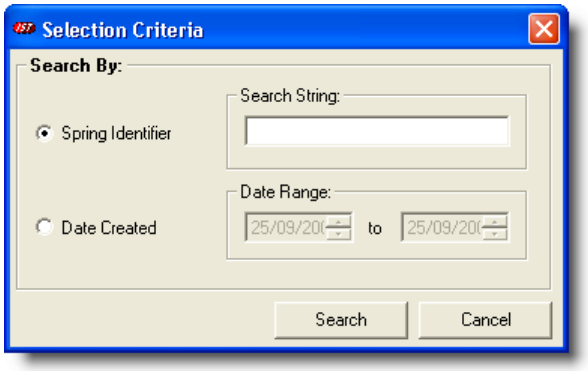
The current spring design may be saved to the database at any time by clicking on the appropriate toolbar button or choosing the Save Current Design item form the File menu. A prompt to input a spring identifier is displayed, and the current spring design and options set in other windows are saved against this identifier for later use.



Selecting the Open Spring Design option or a recently accessed design from the File menu, or clicking the appropriate toolbar button, activates a window for selection of the required design. After selection the design is loaded in the Spring Validation window and all saved options are set. Note that clicking on the “Date Created” or “Spring Identifier” headers sorts the saved designs by that field, and clicking again sorts in the opposite direction.

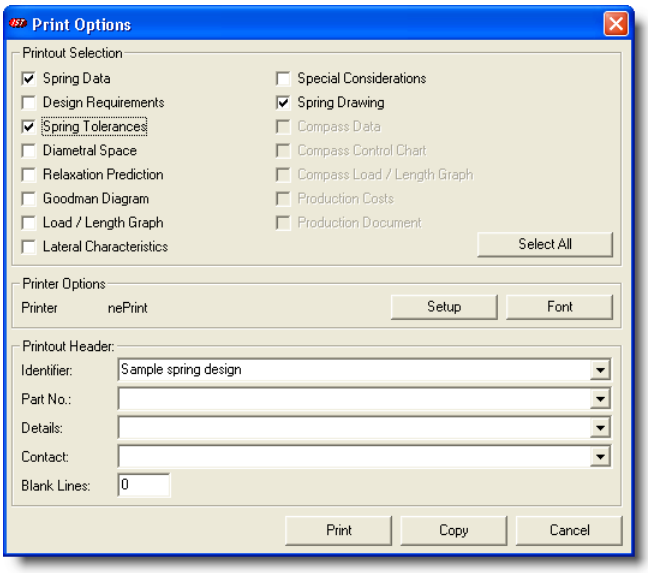


You can also click on the Search button to filter results by a word or phrase in the Spring Identifier, or to limit by a range of dates:



Printing and Copying

Details of the current spring design may be sent to the printer or copied to the clipboard at any time, by clicking on the toolbar buttons or selecting the appropriate button from the File menu. The same window is shown for either printing or copying, as below. Note that you can print as many pages as you want at a time, but if you are copying, you should tick only one item at a time.



The Copy button sends a copy of the printout to the clipboard as a bitmap, so that it can be pasted into any supporting document, such as a Word file or an email. An example is pasted below.

INSTITUTE OF SPRING TECHNOLOGY Date: 28/09/2009 10:32:29

Identifier: Sample spring design

Spring Type Round Wire Compression

Designed To:	EN 13906-1: 2002	
Tolerance Standard:	DIN 2095 / 2096	

Material

EN 10270 Pt1 Patented Carbon

Youngs Mod (E):	206000	N/mm^2
Rigidity Mod (G):	81500	N/mm^2
Density:	.00000785	Kg/mm^3
Unprestress:	0-45	%
Prestress:	45-56	%
End Type:	Closed and Ground	
Dead Coils:	2.00	
Tip Thickness:	50.00	%
End Fixation:	Fixation not known	

Design Parameters

Wire Diameter:	1.00	mm	
Outside Diameter:	8.00	mm	
Total Coils:	8.00		
Spring Rate:	4.95	N/mm	(Calculated)
Free Length:	18.00	mm	

Calculated Data

Solid Length:	8.00	mm
Min. Length (static):	9.04	mm
Min. Length (dynamic):	9.56	mm
Solid Load:	49.50	N
Solid Stress:	882.39	N/mm^2
Stress Factor:	1.20	
Active Coils:	6.00	
Spring Index:	7.00	
Helix Angle:	6.91	Deg
Buckling Possible:	Not Applicable	
Buckling Definite:	Not Applicable	
Spring Pitch:	2.67	mm
Inside Diameter:	6.00	mm
Mean Coil Dia.:	7.00	mm
Wire Length:	176.94	mm
Weight / 1:	0.00109	Kg
Natural Freq:	74004	RPM

Stress Data

	Lower Tensile	Solid	% Tensile Operating Positions 1	2
SL	1720	51 P	15 U	41 U
SM	1980	45 U	13 U	36 U
DM	1980	45 U	13 U	36 U
SH	2230	40 U	12 U	32 U
DH	2230	40 U	12 U	32 U
Specified				

Operating Data

	Operating Positions 1	2
Length (mm)	15.00	10.00
Load (N)	14.85	39.60
Deflection (mm)	3.00	8.00
Stress (N/mm^2)	265	706
Stress % Solid	30	80
Load Tol. Grade 1 (N)	1.87	2.11
Load Tol. Grade 2 (N)	2.97	3.34
Load Tol. Grade 3 (N)	4.75	5.35
O.D. Expansion (mm)	0.0205	0.0546

Setup Program

The setup program provides a method of customizing various aspects of the spring design software. It can be run from the “IST Setup” shortcut in the program group “IST Spring Design & Validation v7.xx”.

Database Management

Two database files are used by the design software: a materials database file and a spring design database file. The materials database file contains data specifying materials and their properties and other technical data while the design database file is used to store spring designs created by the user.

The default location for both these files is the folder containing the IST Spring Design and Validation Program, generally C:\Program Files\ISTSpringDesign. However either or both database files may be moved to any folder locally or on a network and their location set in the Database Management section of the setup program.

After a large quantity of data has been added to or deleted from either database file, the file may be compacted using the Compact button, to maintain efficiency of data access.

Materials Database

The list of materials contained in the materials database file may organized into a preferred order, and new materials may be added, by selecting the Materials List button. To move one or more materials up or down the list, simply select them and click the up or down arrows. If you want to add a new user-specified material, this is explained in more detail later.

Design Database

More than one copy of the design database file may be made in different locations to allow flexible storage of design data. The file location specified here becomes the default file used for spring design storage and retrieval but other design database files may be navigated to at the point of loading or saving.

Design Deletion

The Design Deletion button allows designs in the default database to be deleted when no longer required.

Costing Module Setup

This button accesses the windows used to specify Cost Centres and Secondary Operations used in the Costing Module, if purchased. When the software is supplied the Costing Module password is set to **12345678**.

System Defaults

The system defaults section of the window allows various default program options to be set as listed below:

Language

Allows selection of the language in which the software is to be displayed.

Units

Allows selection of the default units, metric or imperial, to be used when the program starts up. The selected units may be changed at anytime during operation of the software.

Design Method

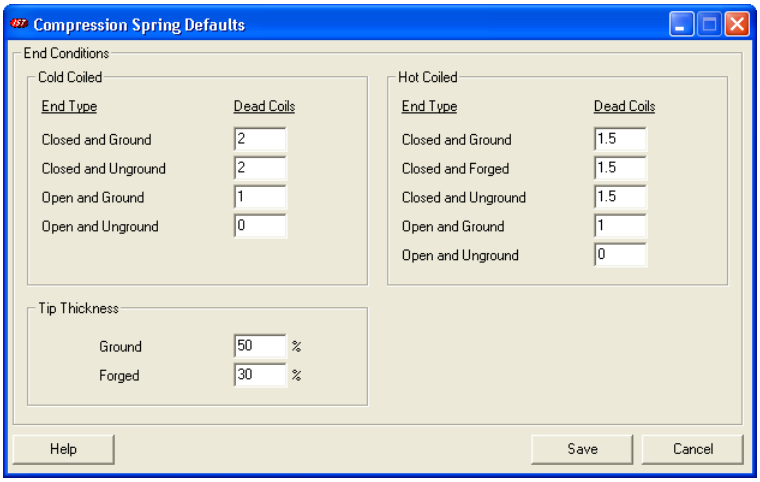
Allows selection of the default design method to be used during spring design and validation. The selected method may be changed at anytime during operation of the software. In addition to the standard methods, parameters defining additional methods may be set by selecting the Add New button.

Default Weight

Allows selection of the number of springs to be used in weight calculations. This can be 1, 100 or 1000.

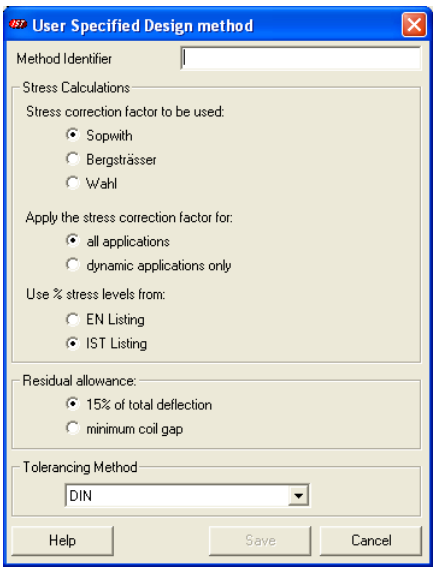
Compression Spring Defaults

The standard values for various properties of a compression spring are shown below. Advanced users may wish to alter these to give more realistic calculations.



Adding a Design Method

This window is used to specify details of a non-standard design method to be used in the Spring Design and Validation Program.



Stress Calculations

The stress correction factor for the design method should be selected from the list displayed. This factor may be used in all stress calculations or stress calculations for dynamic use only.

The maximum recommended stress levels for unprestressed and prestressed springs, as a percentage of the tensile strength of the spring material, may be taken either from EN listings or IST listings. Note that the EN listing is based on applying the stress correction factor for dynamic calculations only while the IST listing is based on applying the stress correction factor to all applications.

Residual Allowance

Calculation of the residual allowance may be based on either a minimum coil gap or 15% of total deflection.

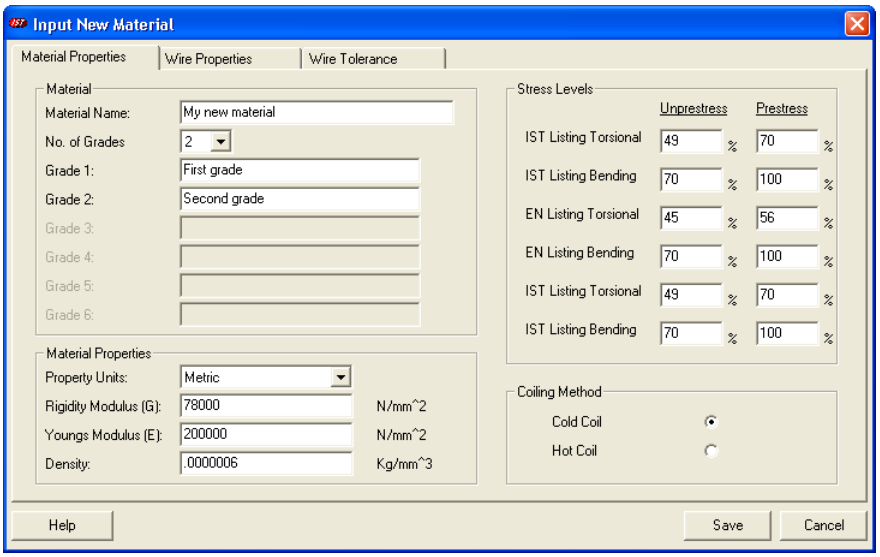
Tolerance Rules

The default tolerance rules to be used with this design method should be selected.

After completing the selections and entering an identifier by which this design method may selected, details of the method are saved by clicking on the Save button.

Adding a Material

This window is used to specify details of a material to be added to those in the materials database file, or to modify details for a material added previously. The window has three tabs for specification of material properties, wire sizes and wire tolerances respectively.



Material Properties

The material name, number of grades and grade identifier are specified in the top right of the Material Properties tab. The units in which the material properties are to be entered may be specified as metric or imperial and the Rigidity Modulus, Young's modulus and density should be entered in the selected units.

The maximum recommended percentage of solid stress to be used are required for both torsional and bending stresses for designing using EN and IST methods

The coiling method used for the material is selected as cold or hot-coiled.

Wire Sizes

On the wire sizes tab the sizes in which the material is available should be listed together with the lower and upper limits of the tensile strength for each wire size for the grade(s) in which that wire size is available.

Wire Tolerance

A list of wire tolerances against the maximum wire size to which that tolerance applies should be specified on this tab.

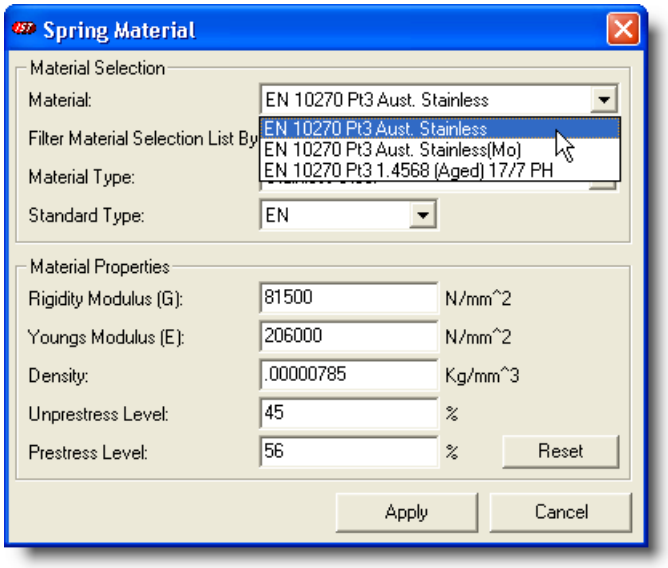
Once all required data has been entered the data is saved by clicking on the Save button.

Spring Validation

This window is used for the input of spring data on which calculations are performed to verify a spring design. Data input is performed by direct input of numbers in the boxes provided and by selecting items from dropdown lists or activating help windows where a ? button is shown next to the list. Using the mouse or the TAB or ENTER keys to move to the next item to be input causes the current data to be validated and calculations to be performed when all required data has been entered. Each item to be input is explained more fully below.

Spring Material

The spring material is first selected from the dropdown list or from the Material Properties window activated by clicking on the ? button (displayed next to the dropdown list). This window displays material properties, which may be modified if required, and must be activated if the User Specified material option is selected to input values for these properties. It also allows you to filter the material list to find one more easily – in the example below, the Material Type was changed to Stainless Steel and the Standard Type to EN, giving a much shorter list of three materials.



End Conditions

Once the material has been selected the end type options appropriate to that material are available for selection, again by either using the dropdown list or from the help window. Selection of an end type results in default values being displayed for the number of dead coils, tip thickness and end fixation, with the default end fixation shown in red until a selection is made. Note that, for ground end types, the selected end type option is displayed in red when the wire size specified is considered to be too small for end grinding.

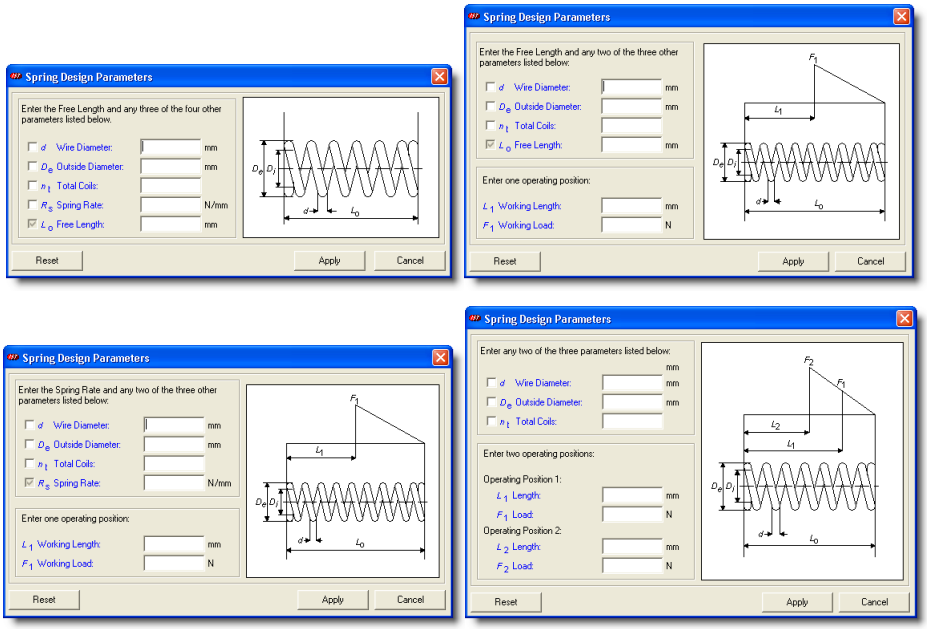
Design Parameters

Four methods of inputting data defining the spring design are available:

- Input the Free Length and three of the following parameters: Wire Diameter, Outside Diameter, Total Coils, Spring Rate

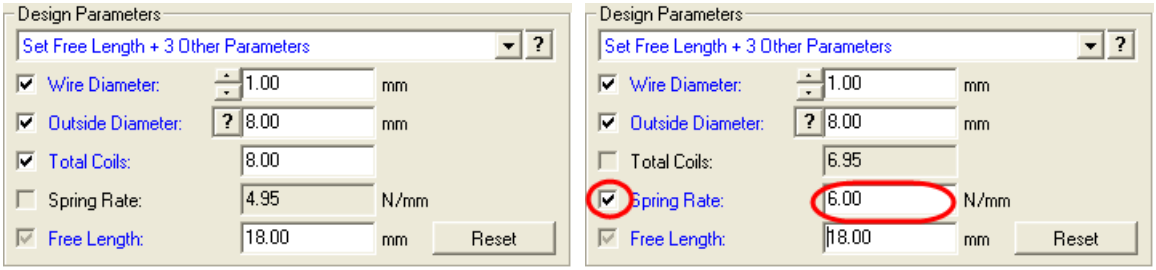
- Input the Free Length, one operating position (load at length) and two of the following parameters: Wire Diameter, Outside Diameter, Total Coils
- Input the Spring Rate, one operating position (load at length) and two of the following parameters: Wire Diameter, Outside Diameter, Total Coils
- Input two operating positions (load at length) and two of the following parameters: Wire Diameter, Outside Diameter, Total Coils

The method to be used is selected from the dropdown list. The data may then be input directly in this window or in the help window appropriate to the method selected, activated by clicking the ? button. This popup window is different in each case, adjusting to the input parameters needed.

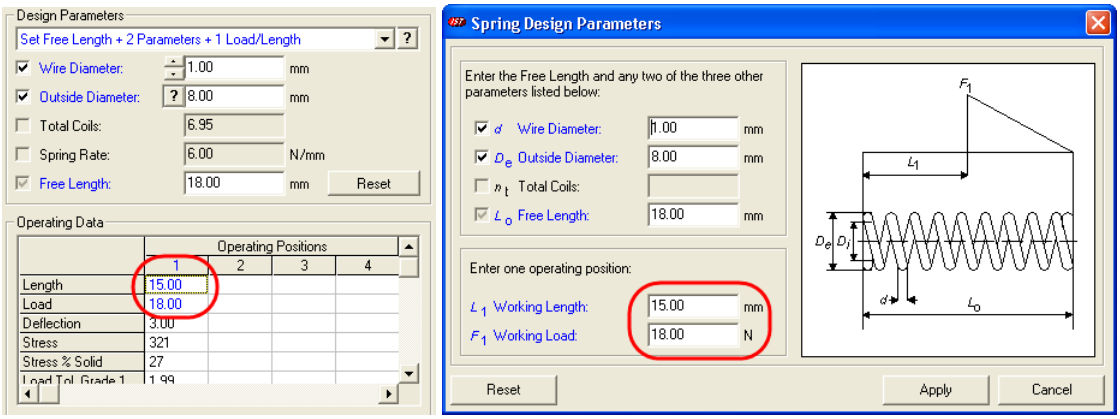


In each method, after input of one of the optional parameters, the box next to the parameter is checked. Once the required number of parameters have been input, the remaining optional parameter, referred to as the calculated variable, is disabled. To change the calculated variable, click on the box next to the parameter required as the new calculated variable, causing that parameter to become disabled and the previous calculated variable to be enabled.

This is best explained by the example below. Values were entered for wire diameter, outside diameter, number of coils and free length. The rate was calculated as the remaining variable, and so was shown with a gray background (and the tick box disabled). If we then decided to adjust this design slightly by finding the number of coils that would change the rate from 4.95 N/mm to 6 N/mm, we do this by unticking the box next to the Total Coils variable, and altering the value in the Rate box to 6, as shown in the right-hand picture. This makes the number of coils the calculated variable, and the software decreases it to 6.95 to match the new rate.



Where the selected method requires the input of operating data, the appropriate length(s) and load(s) are either entered directly into the Operating Data grid in the Validation window or in the help window for the selected method, as shown below.



Once all required data has been input the program calculates and displays values for the optional design parameter, operating positions, stress data and additional calculated spring data. The Spring Tolerances, Relaxation Data, Goodman Diagram, Load / length Graph, Lateral Characteristics, Special Considerations and Spring Drawing windows for this design also become available, where appropriate.

The design may be edited by altering any of the input data after which all data is recalculated and displayed, or by clicking the RESET button to clear the design parameters and operating data.

Operating Data

This Operating Data grid is used for the input and display of data for up to 10 working positions for the spring. To input data, use the mouse to position to the required grid position and then type in the required value. The horizontal scroll bar is used to scroll along the operating positions and the vertical scroll bar is used to view additional data calculated for the operating position.

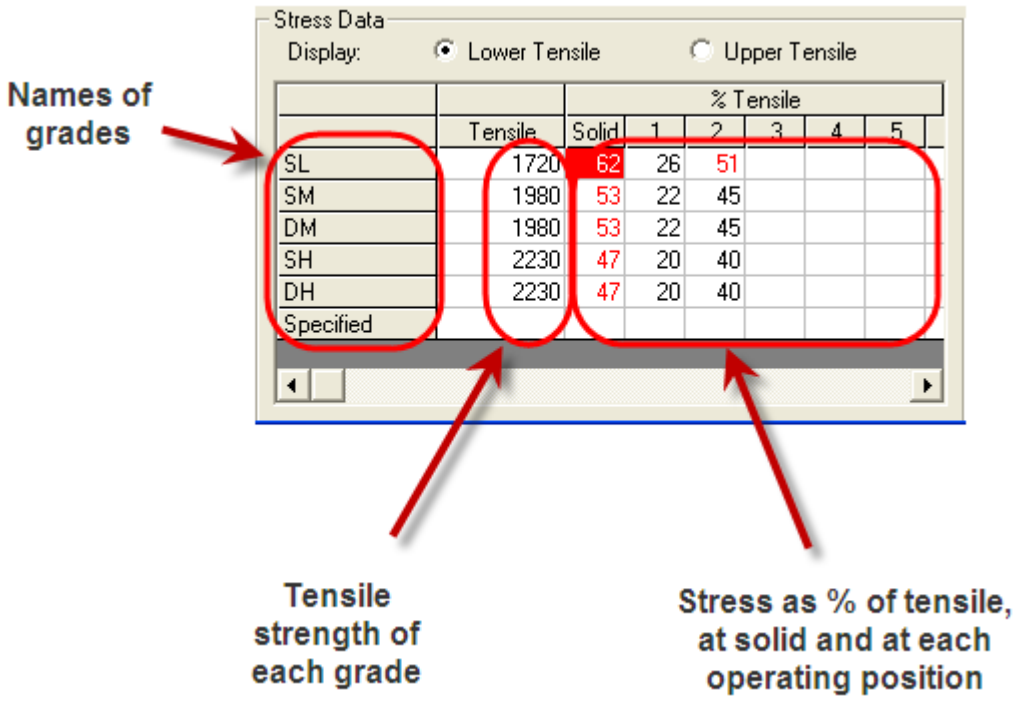
Where the first position, or first and second positions, are used as part of the design criteria (see above) both a length and load value must be input. To display information for other operating positions, the length, load or deflection at that position may be entered and the other values are calculated. Additional data displayed in the grid are as follows:

- Stress. The induced operating stress under the axial deflection.
- Stress % solid. The stress value as a percentage of the solid stress value (displayed in red if greater than 85).
- Load tolerance. The tolerance values for each quality grade as calculated in the selected tolerance standard. When the spring design is outside of the standard, tolerance values are calculated but are shown in red, with the specific reason given by clicking the RIGHT mouse button on the value.
- O.D. Expansion. The increase in the outside diameter of the spring when it is compressed to the specified operating position.

Stress Data

Once a material has been selected, the grades in which it is available are displayed in the Stress Data section of the window. When data input is complete, the tensile strengths for the specified wire size are shown together with the stress at the solid position and specified operating positions as a percentage of the tensile strength. The tensile strength displayed is either the lower or upper value specified for the material grade as

indicated by the option buttons above the display grid. Changing the option updates the data displayed in the grid.



Where the actual tensile strength of the material to be used is known, this may be entered in the grid in the first column of the Specified row. Percentage stress values for the solid and operating positions are then calculated and displayed for this tensile strength.

The display color of the percentage stress values depends on the specified unprestressed and prestressed limits for the selected material. These limits are shown on the Material Properties window, activated by clicking the ? button next to the material selection list. The colors represent the following:

- Value displayed in black. Less than the specified unprestressed limit
- Value displayed in red. Greater than the specified unprestressed limit but less than the prestressed limit
- Background in red. Greater than the prestressed limit.

Hovering the mouse over a value displayed in red or with a red background displays the reason for the color change.

Spring Design

The Spring Design window is shown via the button highlighted above, and is only available if you have purchased the Design module (now sold as the Design & Optimisation module).This window is used for the input of data on which calculations are performed to produce a spring design. Data input is performed by direct input of numbers in the boxes provided and by selecting items from dropdown lists or activating help windows where a ? button is shown next to the list. Using the mouse or the TAB or ENTER keys to move to the next item to be input causes the current data to be validated and calculations to be performed when all required data has been entered. Each item to be input is explained more fully below.

Spring Material

The spring material is first selected from the dropdown list or from the Material Properties window activated by clicking on the ? button displayed next to the dropdown list. This window displays material properties, which may be modified if required, and must be activated if the User Specified material option is selected to input values for these properties.

End Conditions

Once the material has been selected the end type options appropriate to that material are available for selection, again by either using the dropdown list or from the help window. Selection of an end type results in default values being displayed for the number of dead coils, tip thickness. Note that, for ground end types, the selected end type option is displayed in red when the wire size determined by the design process is considered to be too small for end grinding.

Material Grade

The material grades, and, where relevant, qualities, are updated when the spring material is selected and may be selected from the dropdown lists.

Spring Life

The number of cycles for which the spring is required to operate is selected from the list displayed, the contents of which are dependent on whether selected material is suitable for cold or hot coiling and whether fatigue data exists for the material. For static applications the first item in the list is selected. Where fatigue data exists, the list of options will also include lives for dynamic applications. The source of the fatigue data used in the calculations is indicated in the Source dropdown list. For some spring materials data is available from more than one source and the required data source may be selected from the list.

Stressing

The stressing option allows the selection of unprestressed or prestressed springs and displays the defined limiting stress factor for the selected option. A User Specified option is also available. When this option is selected, the limiting stress factor to be used may be input as required.

Shot Peening

The shot peening selection is available for dynamic applications only. When the Shot Peened option is selected and the wire diameter determined by the design process is smaller than that recommended for shot peening (< 1.016mm or 0.04in), the background of the Shot Peened box is displayed in red.

Solid Length

The solid length option determines the way in which the maximum solid length to be used in the design process is calculated. The available options are:

• % Residual. Uses a residual limit, default value 1.15, to determine the maximum solid length. The limit may be modified to any value between 1 and 2.

• Coil Gap. Uses a minimum coil gap to determine the maximum solid length.

• Specified. Allows the user to specify the maximum solid length.

Wire Gauge

This option determines the selection of wire diameters to be used in the design process. Metric or imperial wire gauges may be selected, with the wire diameters for the specified gauge given by clicking on the ? button shown next to the selection list. Alternatively the 'Any Wire Size' or 'Specified Wire Size' option may be selected. The first of these uses small increments to determine the smallest wire size which meets the design requirements, while the second requires a specific wire size to be input, together with the tensile strength of the wire to be used (the ? button shown next to the selection list displays the specified tensile strengths for the specified material and wire diameter).

Design Parameters

The parameters required for the design process in this section are the maximum allowable outside coil diameter, the minimum allowable inside coil diameter, the final working position of the spring and one of the following optional parameters: spring rate, free length or an initial working position. After input of one of the optional parameters, the box next to the parameter is checked and the remaining optional parameters are disabled. To change the selected optional parameter, click on the box next to the selected parameter, causing the value input against that parameter to be cleared

The HELP button in this section activates a window offering an alternative way of entering the design parameters. The RESET button clears all previously entered design parameters.

Note that if you don't have any specific limits on inside and outside coil diameters, you can enter values well outside the size of spring you expect (for example 0.1 to 999 mm).

Design Details

Once all required data has been input the program attempts to produce a design to meet the specified criteria and, if successful, details of the spring design are displayed in this section. If the design process is unsuccessful an error message giving the reason for the process failure is displayed.

The design may be edited by altering any of the design options or parameters after which the design is reprocessed and displayed.

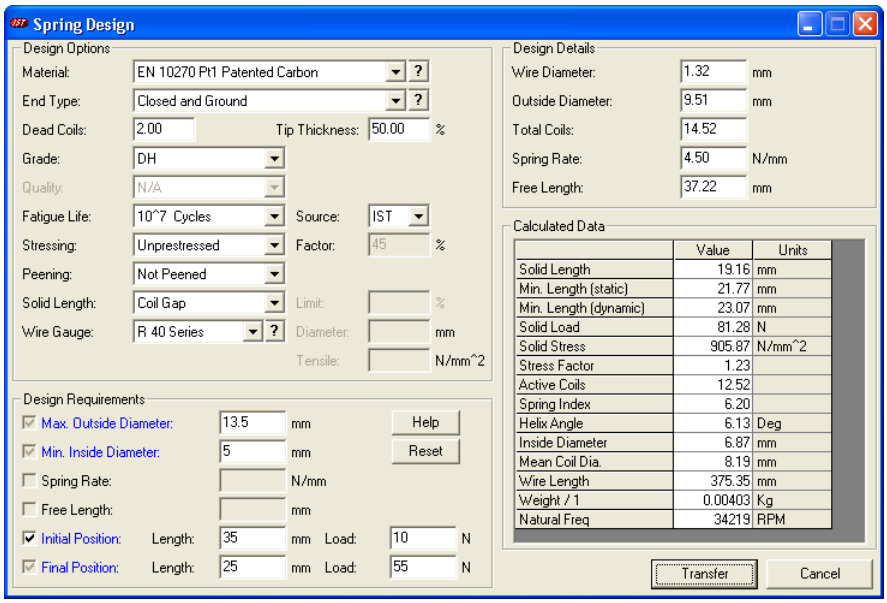
Transfer

When the design process is successful, the Transfer button is enabled. Clicking on this button transfers the current design to the Spring Validation window. The spring design then becomes the system-wide current design and the Spring Tolerances, Relaxation Data, Goodman Diagram, Load / length Graph, Lateral Characteristics, Special Considerations and Spring Drawing windows for this design become available, where appropriate.

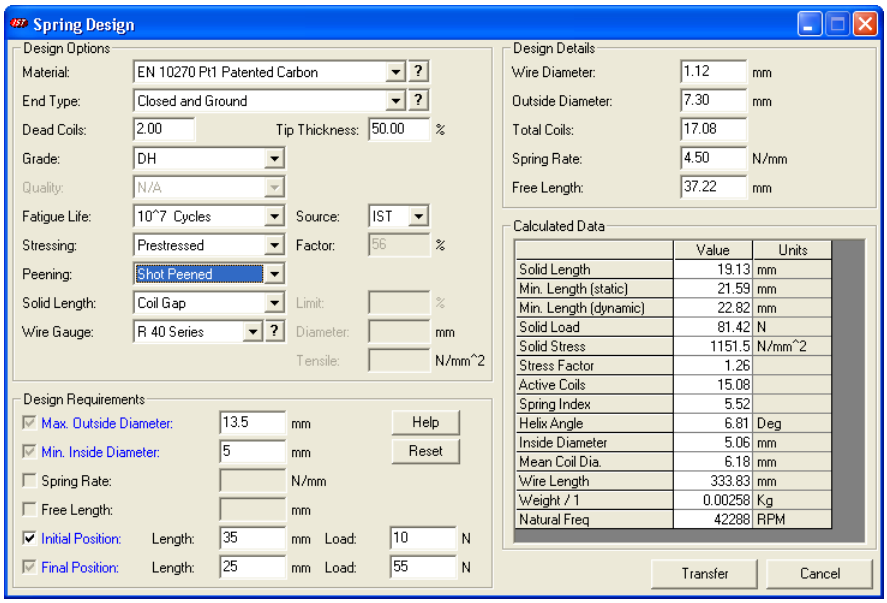
Design Example

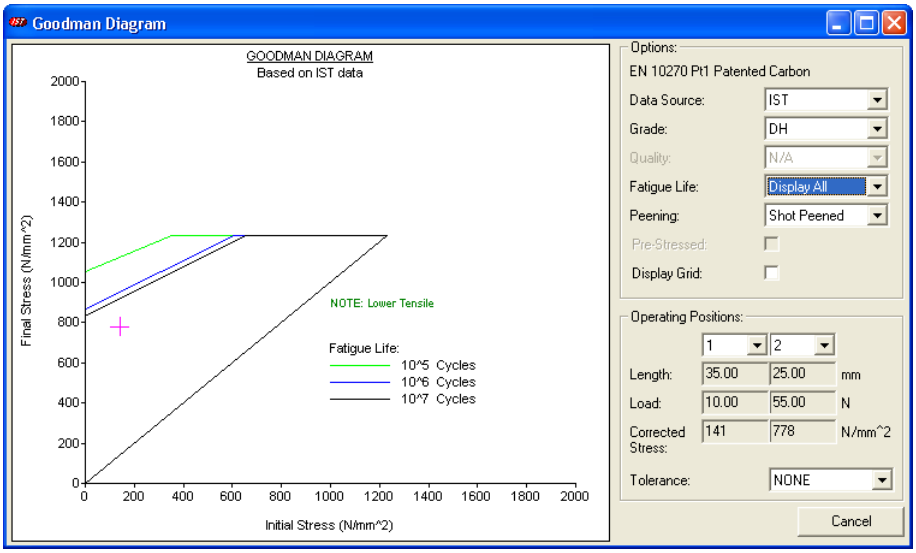
The screenshot below shows a spring design that was entered to meet the following requirements:

- Minimum ID: 5 mm
- Maximum OD: 13.5 mm
- Working position 1: 10 N at 35 mm
- Working position 2: 55 N at 25 mm
- Design life: 10 million cycles, for EN 10270-1 DH wire



This gave the lightest possible spring having a weight of 0.00403 kg. Changing the stressing option to Prestressed lowered the weight to 0.00286 kg, and changing the Peening option to Shot Peened improved the weight again, to 0.00258 kg. This final design is shown below, together with the Goodman diagram shown after Transfer of the design. Note that the suggested design will not always be right on the fatigue life line, especially when the wire is restricted to standard sizes such as here.



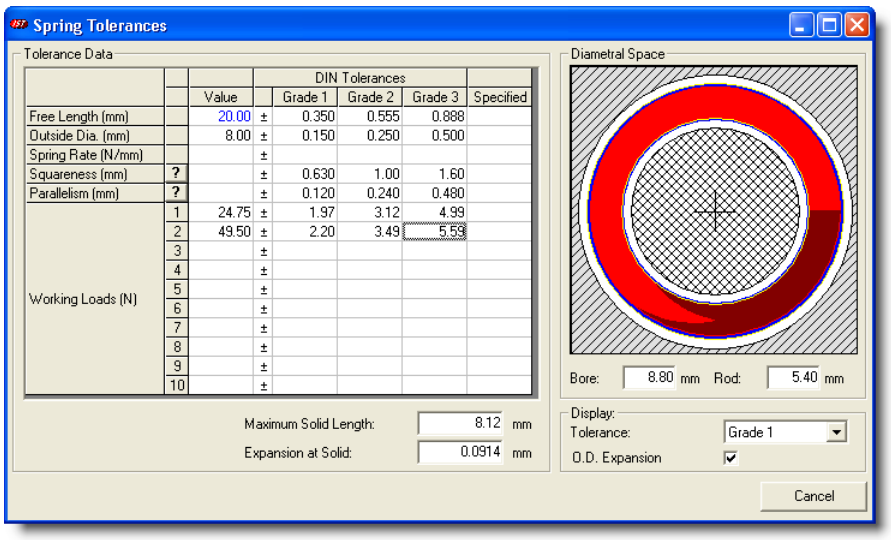

Goodman Diagram
GOODMAN DIAGRAM
Based on IST data
Final Stress (N/mm^2)
Initial Stress (N/mm^2)
NOTE: Lower Tensile
Fatigue Life:
10^5 Cycles
10^6 Cycles
10^7 Cycles
Options:
EN 10270 Pt1 Patented Carbon
Data Source: IST
Grade: DH
Quality: N/A
Fatigue Life: Display All
Peening: Shot Peened
Pre-Stressed:
Display Grid:
Operating Positions:
1
2
Length: 35.00 25.00 mm
Load: 10.00 55.00 N
Corrected Stress: 141 778 N/mm^2
Tolerance: NONE
Cancel

Spring Tolerances

The tolerance window is available from the relevant button in the toolbar. The data displayed in this window is calculated to the tolerance standard displayed in the button bar at the top of the screen, so in the example below DIN 2095/2096. Selecting a different tolerance standard from the dropdown list updates the calculations to the newly selected standard, so it is easy to compare different tolerancing methods.

Tolerance Data

This section of the window shows the calculated tolerances to the selected tolerance standard for the parameters listed and all quality grades defined by the standard.



The table displays tolerances for some or all of the following parameters, depending on the tolerance standard selected: free length, outside diameter, spring rate, squareness and parallelism (so for example spring rate is not shown in the screenshot above, as it is not included in DIN 2095). Load tolerances for all defined operating positions are also displayed. Tolerance values are calculated and displayed in separate columns of the table for each quality grade defined by the standard. Tolerance values are shown in red where they are out of scope of the tolerance standard, with the specific reason given by clicking the RIGHT mouse button on any value displayed in red

The Specified column of the table allows input of user specified tolerance values for any or all of the listed parameters.

The Maximum Solid Length and The Expansion At Solid are also displayed in this section. The maximum solid length is the value as calculated from the standard and takes account of the tolerance of the material wire diameter. The expansion at solid is the increase in the outside diameter of the spring when it is compressed to the solid position.

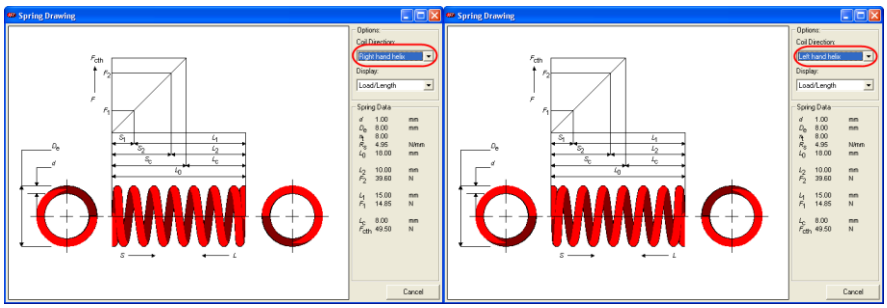
Diametral Space

The diametral space section of the window shows the inside and outside diameters of the spring with the tolerance bands and outside diameter expansion being shown in blue. The influence of the outside diameter expansion is shown by using the check box to toggle the display. Selection from the dropdown list of tolerance grades updates the display using the outside diameter tolerance for the specified grade.

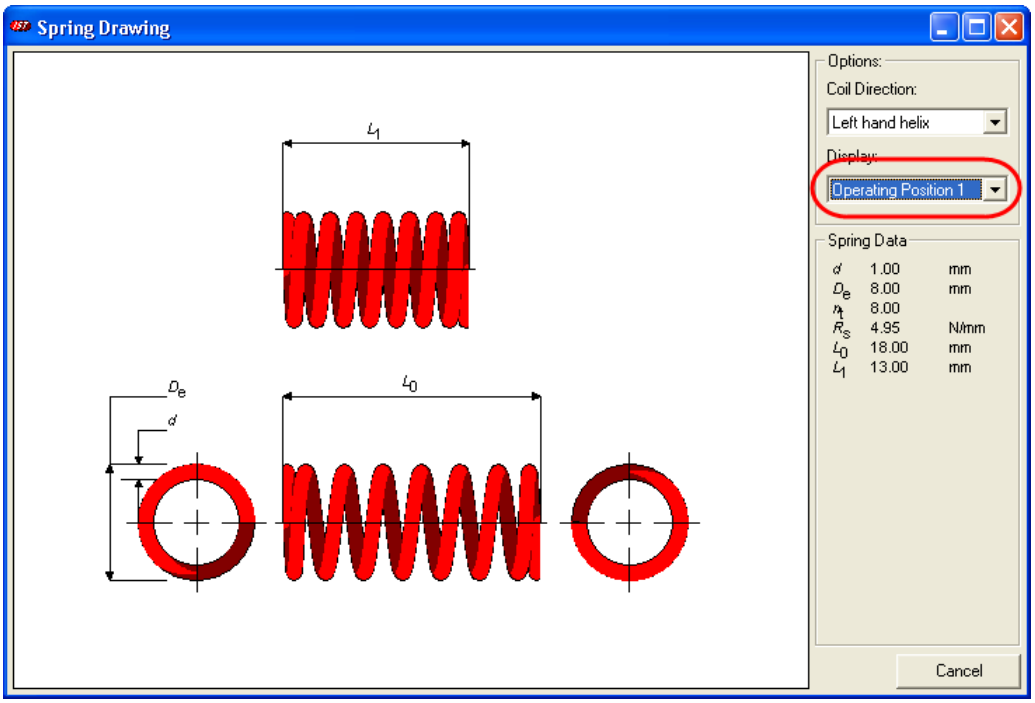
The bore and rod diameters used in the Diametral Space display are shown in the boxes beneath the display and may be modified as required. Where the current spring design has been transferred from the Spring Design window, the values used for bore and rod diameters default to the maximum and minimum diameter values input on design window. Please note that the initial values here are given as 10% above the outside diameter, and 10% below the inside diameter respectively. These are not design guidelines, but merely starting points that you can overwrite with relevant dimensions.

Spring Drawing

The spring drawing is shown via the button highlighted above, but is only available if you have purchased the Graphics module. This window displays a diagram of the spring, including end configurations. The spring may be drawn coiled with either left or right hand helix:

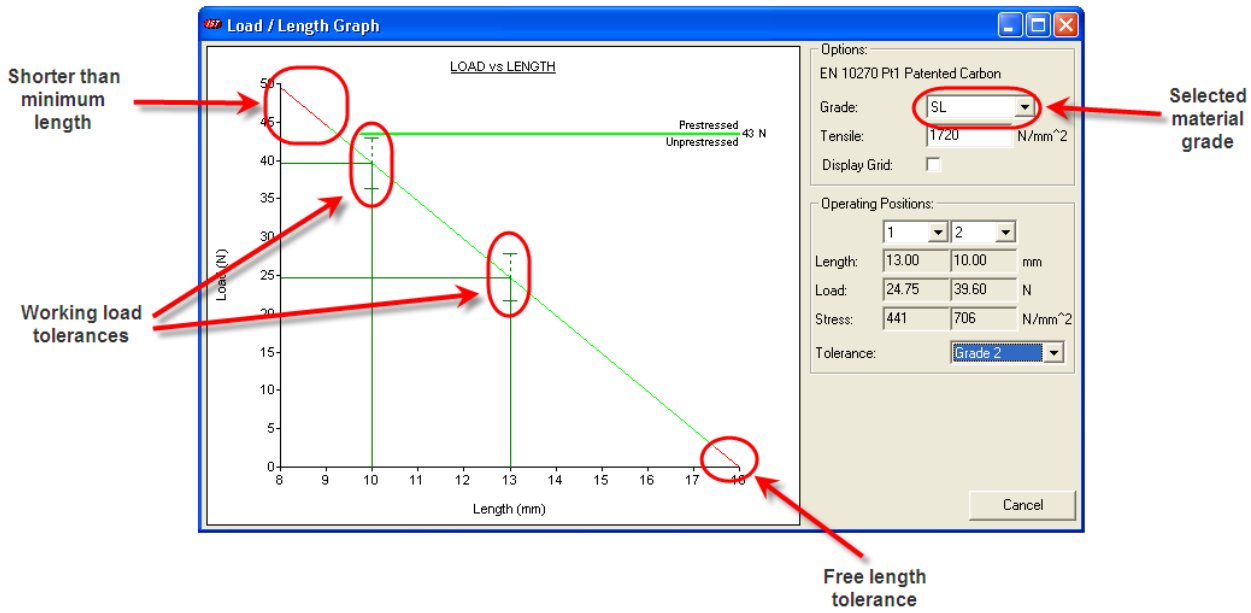


The default diagram shows the unloaded spring, together with associated load / length data. When operating positions have been defined the option of displaying the spring as loaded is also available:



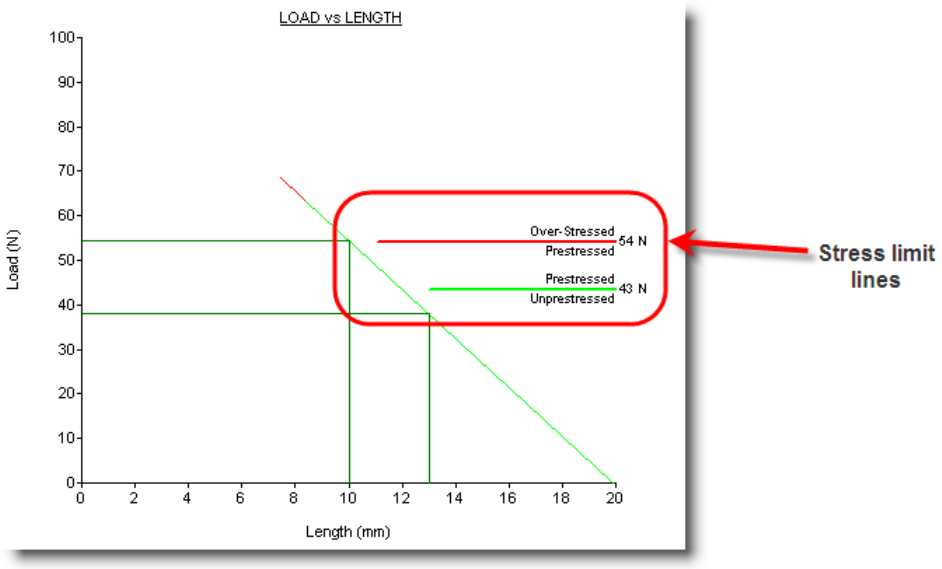
Load/Length Graph

The load/length graph is shown via the button highlighted above, but is only available if you have purchased the Graphics module. This window shows the load deflection display for the current spring design and the selected material grade. The selected grade may be changed after which graph is redrawn.



The upper section of the load / length line shown in red, indicates the residual range or minimum length, depending on the design standard in operation. If a tolerance grade is selected, the lower section of the load / length line is also shown in red to indicate the free length tolerance.

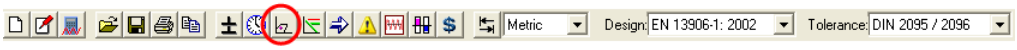
To show where the spring is operating on the graph, two of the defined operating positions may be selected. Lines are added to the graph to indicate the load and length at these positions. If a tolerance grade is selected from the dropdown list, the tolerances for the operating load values are calculated for the current tolerance standard and selected grade and the minimum and maximum load values are indicated on the graph.



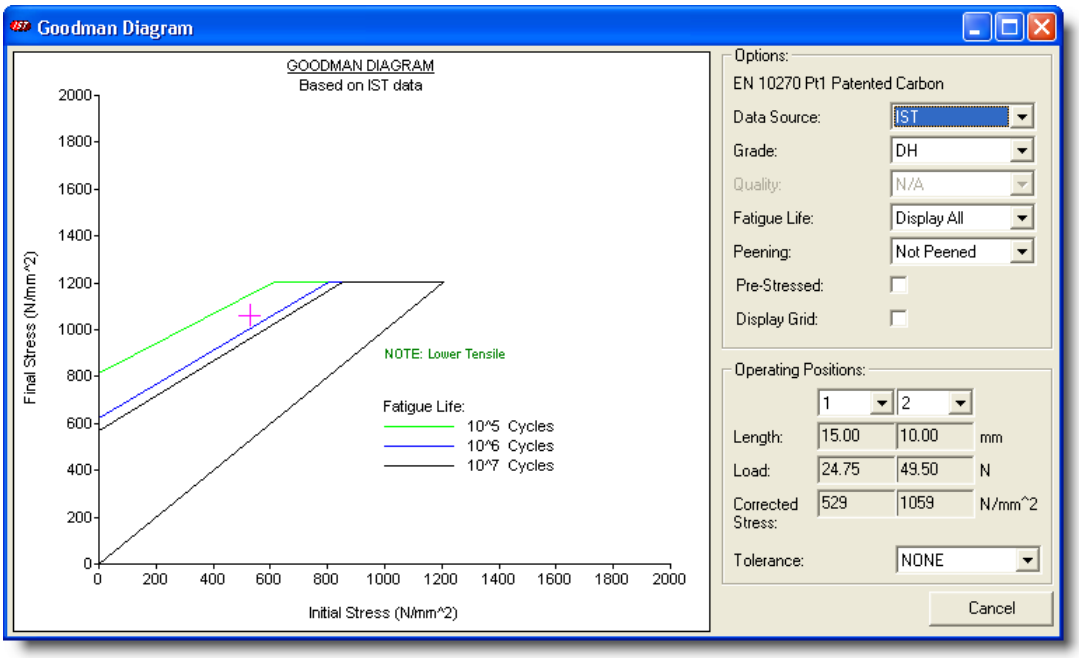
Up to two horizontal lines may be displayed to the right of the load / length line depending on the solid stress of the spring design. These lines represent the unprestress limit and the prestress limit for the selected material, grade and tensile strength. The operating position for an unprestressed spring should fall below the green line whilst for a prestressed spring it should fall below the red line. Where these lines do not appear on the graph the prestress limit and unprestress limit are greater than the maximum load displayed on the graph.

The window may be maximized, using the maximize button in the top right hand corner, increasing the size of the graph. A grid may be added to the graph by clicking on the Display Grid check box.

Goodman Diagram



This window shows the modified Goodman Diagram for the current spring, based on IST interpretation of available data. It is shown by clicking on the highlighted button above, but is only available if you have purchased the Graphics module.



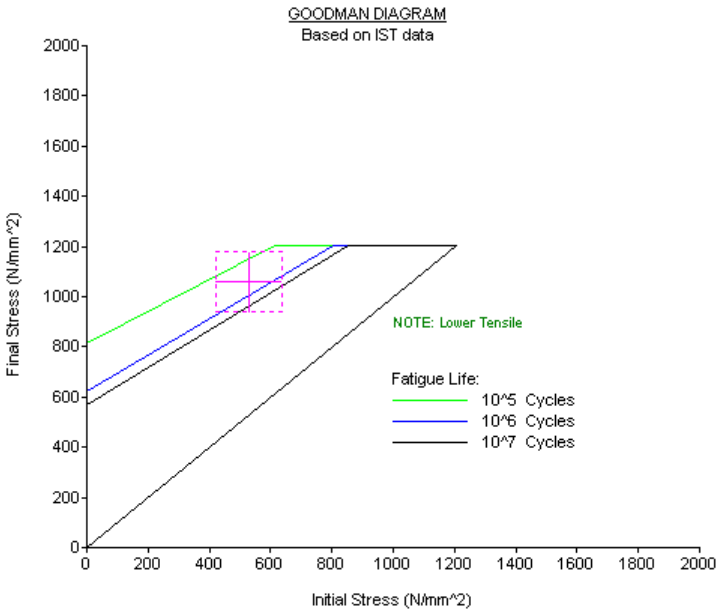
For some spring materials data is available from more than one source and the user may select the required diagram from the Data Source dropdown list. IST's own data has been generated by many years of testing in our specialised laboratories, and is generally the most complete and trustworthy data source.

The required material grade (and quality, where applicable), prestress option, shot peening option and fatigue life may be selected. After any of these options are modified, the Goodman Diagram is redrawn to reflect the new selections. Specific warning messages are displayed on the diagram when the spring design is operating outside of normal design recommendations.

The fatigue life and shot peening selections include the Display All option. For the fatigue life Display All option, the Goodman Diagram displays data for all the available fatigue lives. For the shot peening Display All option, the Goodman Diagram displays both unpeened and shot peened data. Either, but not both, of these options may be selected.

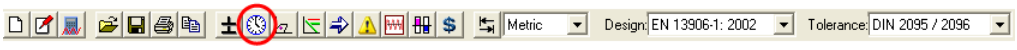
To show where the spring is operating on the graph, two of the defined operating positions must be selected. A cross marks the intercept of the two positions on the graph. If a tolerance grade is selected from the dropdown list, the tolerances for the stress values are calculated for the current tolerance standard and selected grade and a tolerance rectangle is drawn around the cross to mark the area in which the intercept could occur with the spring remaining in tolerance. The example below shows DIN 2095 Grade 3 tolerances

for an example spring design – it is important to be aware of the effect the tolerances can have! In this case the spring could last indefinitely or for less than 100,000 cycles, and still be within the tolerance.



The window may be maximized, using the maximize button in the top right hand corner, increasing the size of the Goodman Diagram. A grid may be added to the Goodman diagram by clicking on the Display Grid check box.

Relaxation Prediction



This window displays relaxation data applicable to the current spring material, and is available via the button highlighted above. It is only available if you have purchased the Graphics module.

Either static or dynamic relaxation data may be displayed by selecting the appropriate option at the top left of the window. For static relaxation the stress may be either the stress at one of the operating positions defined in the current spring design, or a stress input by the user, up to the solid stress of the spring. Dynamic relaxation calculations may be performed between any two of the defined operating positions. ***Note that all relaxation data displayed is based on corrected stresses.***

The relaxation time and temperature values default to 1000 hours and 20 C respectively. These values may be modified to give a relaxation time of between 72 and 10000 hours and a relaxation temperature of between 20 and a maximum value defined for the current spring material. Relaxation may also be calculated for shot peened and prestressed springs by selecting the appropriate options.

After setting the parameters the percentage relaxation prediction is calculated and displayed. A graph showing the percentage relaxation curve for times up to 10000 hours is also displayed. Both the percentage relaxation value and the graph are updated when any of the relaxation parameters are changed.

Lateral Characteristics

This window is shown via the button highlighted above, and displays the lateral characteristics of the current spring design at the free position and each defined operating position. The lateral data for the free length or operating position is calculated and displayed when the user enters the required lateral deflection value in the Deflection column of the table.

The data displayed in the table is explained below.

Axial Data

- **Length** The free length and operating lengths of the spring.
- **Load** The operating loads of the spring.
- **Stress** The calculated stress imposed by the axial load/deflection of the spring at each operating position.

Lateral Data

- **Rate** The calculated rate for the spring when deflected in the lateral direction whilst being deflected in the axial direction.
- **Deflection** The required lateral deflection, input by the user.
- **Load** The load calculated from the lateral deflection input by the user and the calculated lateral rate of the spring.
- **Stress** The stress induced by the lateral deflection alone and based upon the value input by the user.

Combined Data

- **Stress** The combination of the axial stress and the lateral stress induced from the combination of the axial and lateral deflections. here.

Special Considerations

The Special Considerations window is shown via the button highlighted above. This window shows Special Considerations based on the latest research performed by IST. The window is divided into two sections and the data displayed in each section is explained below.

Influence of the change in wire diameter induced during coiling

Depending upon the material selected and the index of the spring, the material cross section may not be circular. The method of coiling, whether the spring is produced on a single point coiling machine, a twin point coiling machine or a mandrel coiling machine, also has an influence. The upsetting of the material and the influence on the theoretical spring rate and solid length is calculated and displayed.

The calculated value for Spring Rate is displayed together with the predicted percentage change in rate and the predicted rate due to the upsetting of the material for each of the coiling methods. Similarly the Solid Length, the predicted percentage change in solid length and the predicted solid length are displayed.

Tangling

In this section of the screen a prediction of the susceptibility to tangling of springs of the current design is displayed. Both susceptibility to crossover and parallel tangling are displayed. Crossover tangling occurs with the axes of the tangling springs not parallel, while parallel tangling occurs with the axes off the springs parallel. Clicking on the HELP button displays a diagrammatic representation of crossover and parallel tangling.

For both types of tangling the possible values displayed are:

- NO. No potential to tangling
- YES. The springs do have potential to tangle.
- POSSIBLE. The springs may possibly tangle, though this is not definite.

When springs have the potential to tangle no force is required to entangle them. However when springs are predicted as not having the potential to tangle they can still be forced together to cause entanglement. The Tangling Force value displayed is the predicted force required to cause entanglement of the springs. This value will be shown as zero when the springs are susceptible to entanglement.

Compass (Computer Aided Spring Setting)

The Compass window is shown via the button highlighted above, but is only available if you have purchased the Compass module. This window is used for the input of data used to aid spring setting. Dimensional and load deflection characteristics of the required spring are input together with measured characteristics of the coiled spring. This data is then used to calculate optimum setting to produce the required spring.

Data input is performed by direct input of numbers in the boxes. Tolerance data may be entered either as a value or as a percentage of the mean value. Using the mouse or the TAB or ENTER keys to move to the next item to be input causes the current data item to be validated. When all required data has been entered the Compute button, used to perform the spring setting calculations, becomes available. Each item to be input is explained more fully below.

Specified Characteristics

In this section the mean outside diameter, free length and spring rate are transferred from the current validation window and may not be edited in the Compass window. Operating length/load characteristics are also transferred but, while the length values may not be edited, the load values may be modified with no effect on the validation window.

Values for the maximum allowable solid length, the outside diameter tolerance and the tolerance at the final load must be entered, together with one of the other tolerance values i.e. free length, spring rate, or initial load. A further option allows for both free length and initial load tolerances to be input. As data is input, values not required for that option are disabled. The Reset button removes all optional input data from this section and re-enables all input.

The Tolerance Help button displays another window with different options on tolerance conditions and the ability to calculate the required input for the program.

Measured Characteristics

This section is used to enter measured characteristics of the spring, including dimensions directly from the coiling machine and spring dimensions and load deflection characteristics, dependent on the options selected in the previous section, after all processing.

Compute

Once all required data has been entered the Compute button becomes enabled. This performs the necessary calculations and displays another window with the results of these calculations.

Compass Control Chart

This window is used to display the results of Compass calculations. The main, graphical, section of the screen shows both measured characteristics and characteristics of the optimum spring. On the right of the screen the solid stress levels of the optimum spring are displayed, and in the lower section, the required spring dimensions at the coiling machine to achieve the optimum spring.

Spring Characteristics

The display in this section contains boxes displaying tolerance, measured and optimum data for outside diameter, free length, final load, total coils, solid length, and initial load or spring rate, where corresponding

tolerance values have been entered in the Compass window. Although no tolerance is entered for total coils, a broad band is displayed to provide a graphical presentation. Similarly for free length, where no tolerance values have been input, a broad band is displayed to provide scope for adjustment.

Each box contains two columns displaying a graphical representation of the measured and optimum values compared to the specified mean and tolerance values. The upper and lower tolerances, either specified or estimated, are given above and below the columns, and the measured value shown in blue and the optimum value shown in purple at the bottom of each box.

The left hand column in each box represents the measured value and the right hand column represents the optimum value of the characteristic. All columns, apart from the solid length, have a line across the middle to represent the mean value, whilst the top and bottom of each column represent the tolerance extremes. The slider bars to the right of the optimum column in the outside diameter, free length and total coils boxes allow the operator to adjust the optimum value and to see the influence the adjustment has on the other displayed characteristics. The mouse is used to slide the cursor on the slider bar up or down, or to click the up and down arrows to change the value by a small increment, or to click either side of the cursor to change the value by a larger increment.

The solid length box displays the maximum allowable solid length at the top. This is determined from the maximum allowable value specified in the Compass window, minus an additional clearance, and all calculations in the software are based on this value.

Solid Stress

The Solid Stress box displays the solid stress of the optimum spring as a percentage of the tensile strength for each grade of the specified spring material. The display color of each grade depends on the specified unprestressed and prestressed limits for the selected material. The colors represent the following:

- Value displayed in black. Less than the specified unprestressed limit
- Value displayed in red. Greater than the specified unprestressed limit but less than the prestressed limit
- Background in red. Greater than the prestressed limit.

Coiling Machine

The Coiling Machine display shows the required spring dimensions at the coiling machine to achieve the required optimum spring.

Graph

The graph button displays another window showing a graph of the load deflection characteristics of the spring.

Contact IST

IST can be reached at the following address. Please do not hesitate to get in touch if you have any problems, questions, comments or suggestions about our software.

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