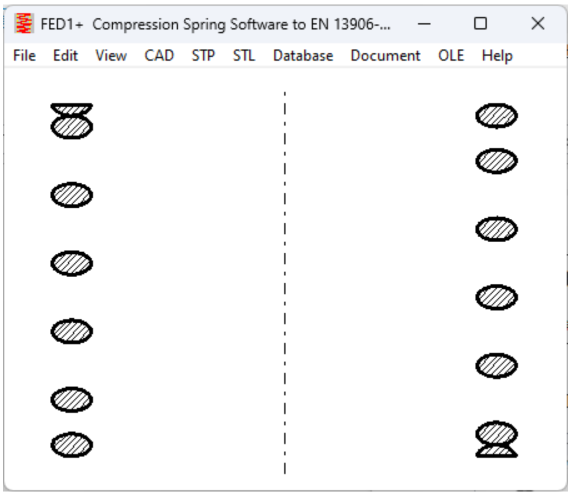
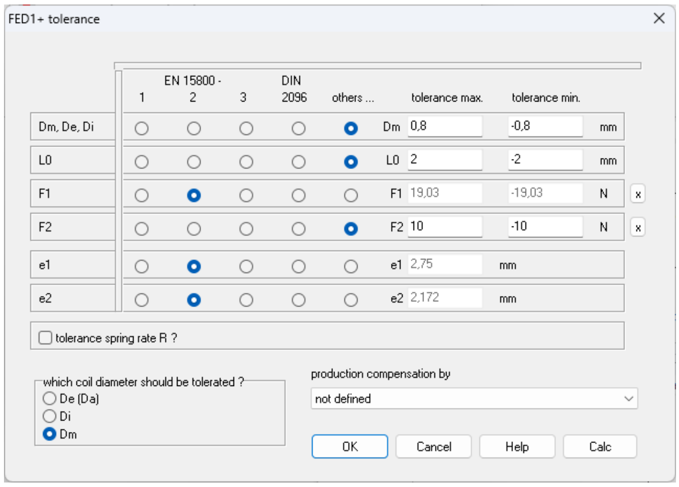
by Fritz Ruoss

FED1+, FED2+, FED6, FED17: Spring load tolerances if rectangular or elliptic wire





Standard tolerances for coil springs only exist for springs with a round wire cross section. For springs with square, rectangular, elliptical or hollow wire cross-sections, tolerances for the spring force according to EN 15800 grades 1,2,3 have previously been calculated with the width or the larger of the height and width of the wire cross section. With tolerances according to DIN 2096, a special cross section has no effect; the wire diameter is not included in the tolerance calculation of the spring load.
In the new versions, the width or the maximum value of height and width is no longer used for special cross-sections for tolerances according to quality grade 1,2,3 according to EN 10080. A replacement diameter is now calculated: dref = (32/pi*It)^(1 /4). This substitute diameter of a round wire cross-section results with the same spring rate as the rectangular wire and is therefore used to calculate the EN10800 tolerances of spring forces and spring length.
The standard expression now includes the area moment of inertia torsion (It) and equivalent diameter (dref).

MAIN DIMENSIONS

Wire shape			rectangular
Wire width	b	mm	3,2 ± 0,025
Wire height	h	mm	6 ± 0,025
Area moment of inertia torsion	It	mm4	43,4
Reference wire diameter	d ref	mm	4,585

In the case of helical compression springs and helical tension springs, the wire is subjected to torsion; the spring rate is the same if the width and height of the rectangular cross-section are swapped. It's different with torsion springs, where the wire is subjected to bending.

Spring rate and shear stress for helical compression springs of rectangular wire

FED1+ Compression Spring Software to EN 13906-1 - rectang.f...

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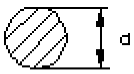
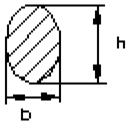
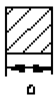
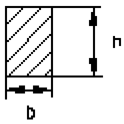
wire section	W_t	I_t	$R=\frac{4 \cdot G \cdot I_t}{\pi \cdot Dm^3 \cdot n}$	$\tau_{max}=\frac{F \cdot Dm}{2 \cdot W_t}$
	$\frac{\pi}{16} \cdot d^3$	$\frac{\pi}{32} \cdot d^4$	$\frac{G \cdot d^4}{8 \cdot Dm^3 \cdot n}$	$\frac{8 \cdot Dm \cdot F}{\pi \cdot d^3}$
	$\frac{\pi}{16} \cdot h \cdot b^2$	$\frac{\pi}{16} \frac{h^3 \cdot b^3}{h^2 + b^2}$	$\frac{G \cdot h^3 \cdot b^3}{4 Dm^3 \cdot n \cdot (h^2+b^2)}$	$\frac{8 \cdot Dm \cdot F}{\pi \cdot b^2 \cdot h}$
	$0{,}208 \cdot a^3$	$0{,}141 \cdot a^4$	$\frac{0{,}18 \cdot G \cdot a^4}{Dm^3 \cdot n}$	$\frac{2{,}4 \cdot Dm \cdot F}{a^3}$
	$c_2 \cdot h \cdot b^2$	$c_1 \cdot h \cdot b^3$	$\frac{4 \cdot G \cdot c_1 \cdot h \cdot b^3}{\pi \cdot Dm^3 \cdot n}$	$\frac{Dm \cdot F}{2 \cdot c_2 \cdot h \cdot b^2}$

n=h/b	1	1,5	2	3	4	6	10	>> 10
c_1	0,141	0,196	0,229	0.263	0,281	0,298	0,312	0.333
c_2	0,208	0,231	0,246	0.267	0,282	0,299	0,312	0.333

F1-E-102

FED1 Spring rate and shear stress for rectangular and elliptical wire

Spring rate and bending stress of helical torsion springs of rectangular wire

FED3+ Torsion Spring Calculation to EN 13906-3 V 22.0 #0144...

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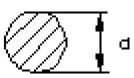
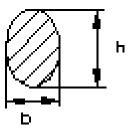
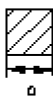
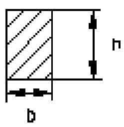
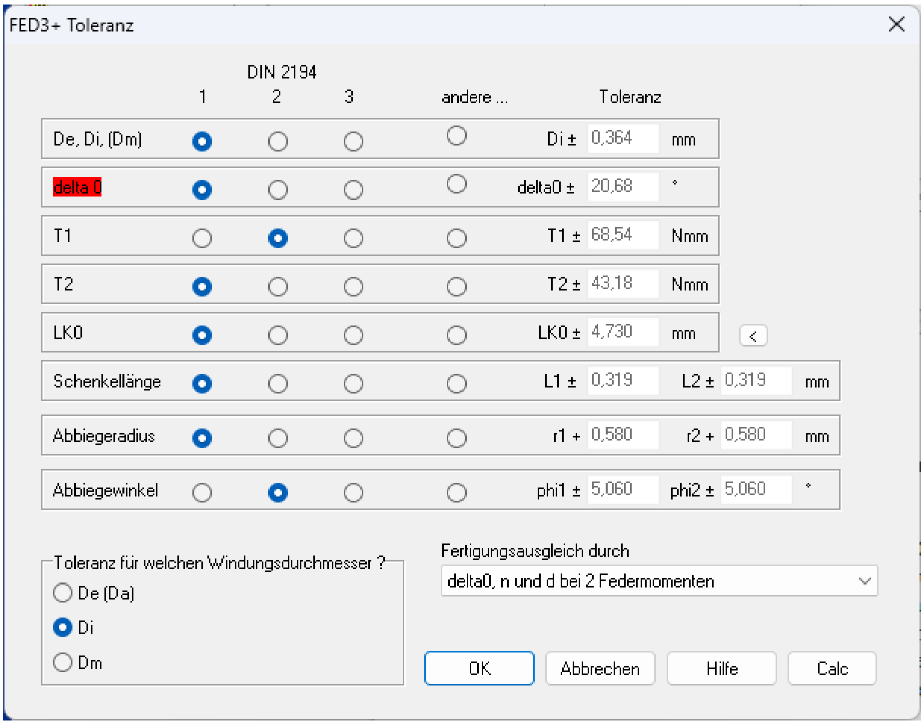
Cross-section wire	W_b	I_y	$R=\frac{E \cdot I_y}{180 \cdot Dm \cdot n}$	$\sigma_{max}=\frac{M_b}{W_b}$
	$\frac{\pi}{32} \cdot d^3$	$\frac{\pi}{64} \cdot d^4$	$\frac{E \cdot d^4}{3666 \cdot Dm \cdot n}$	$\frac{32 \cdot M}{\pi \cdot d^3}$
	$\frac{\pi}{32} \cdot h \cdot b^2$	$\frac{\pi}{64} \, b^3 \cdot h$	$\frac{E \cdot b^3 \cdot h}{3666 \cdot Dm \cdot n}$	$\frac{32 \cdot M}{\pi \cdot b^2 \cdot h}$
	$\frac{1}{6} \, a^3$	$\frac{1}{12} \, a^4$	$\frac{E \cdot a^4}{2160 \cdot Dm \cdot n}$	$\frac{6 \cdot M}{a^3}$
	$\frac{h \cdot b^2}{6}$	$\frac{h \cdot b^3}{12}$	$\frac{E \cdot h \cdot b^3}{2160 \cdot Dm \cdot n}$	$\frac{6 \cdot M}{h \cdot b^2}$

F3-E-101

Source: Dubbel,Roos

FED3 Spring rate and bending stress for rectangular and elliptical wire

FED3+: Spring load tolerances for rectangular, oval, square, elliptic wire



With FED3+, the tolerances for the torque of the torsion spring according to DIN 2194 quality grade 1,2,3 are now calculated similarly to compression and tension springs with an equivalent diameter, which would result in the same spring rate with a round wire cross section. Helical torsion springs are subjected to bending stress, which is why there are different results and replacement diameters than helical extension springs and helical compression springs. The area moment of inertia Ix (not It) of the rectangular cross-section is calculated. The replacement diameter is then (Ix*64/pi)^(1/4).

MAIN DIMENSIONS

Wire shape			**rectangular**
Wire width	**b**	**mm**	**1 ± 0,015**
Wire height	**h**	**mm**	**3 ± 0,015**
Area moment of inertia	**Ix**	**mm4**	**0,25**
Reference wire diameter	**d ref**	**mm**	**1,502**

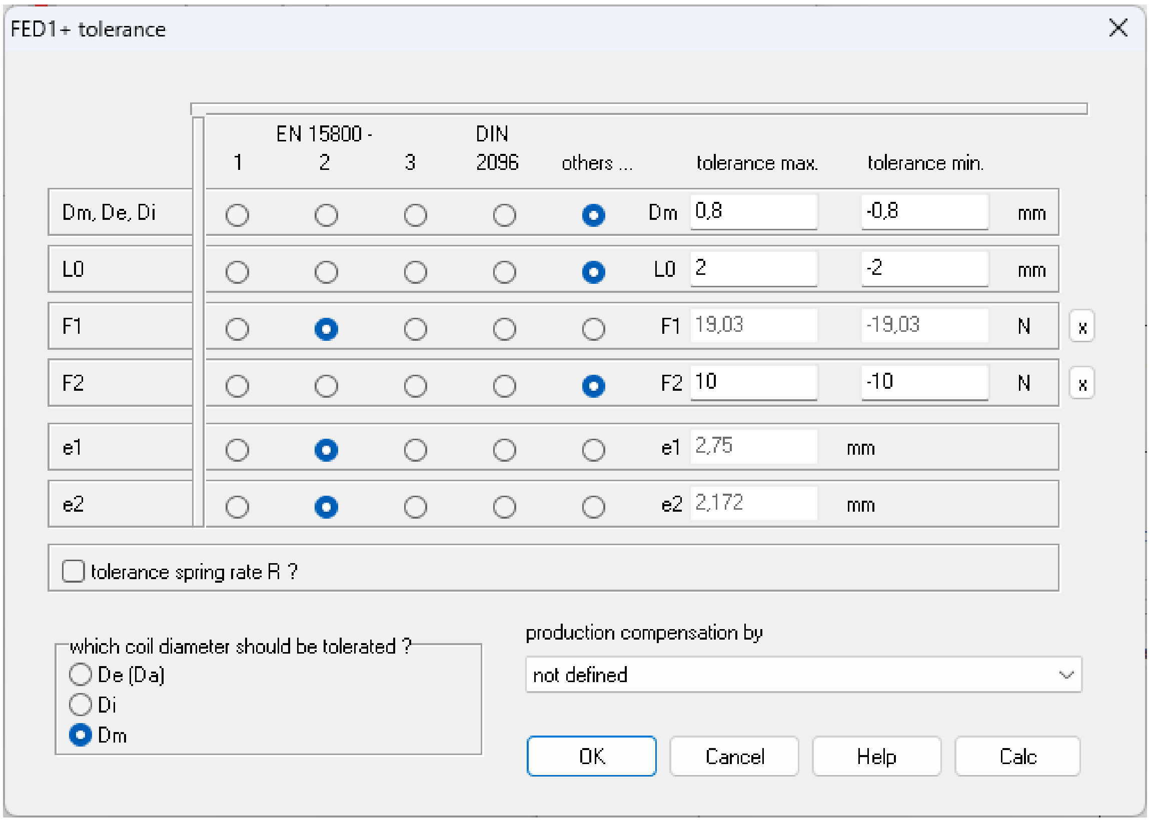
Unlike helical tension springs and helical compression springs, the calculation changes if you swap width and height:

MAIN DIMENSIONS

Wire shape			**rectangular**
Wire width	**b**	**mm**	**3 ± 0,02**
Wire height	**h**	**mm**	**1 ± 0,02**
Area moment of inertia	**Ix**	**mm4**	**2,25**
Reference wire diameter	**d ref**	**mm**	**2,602**

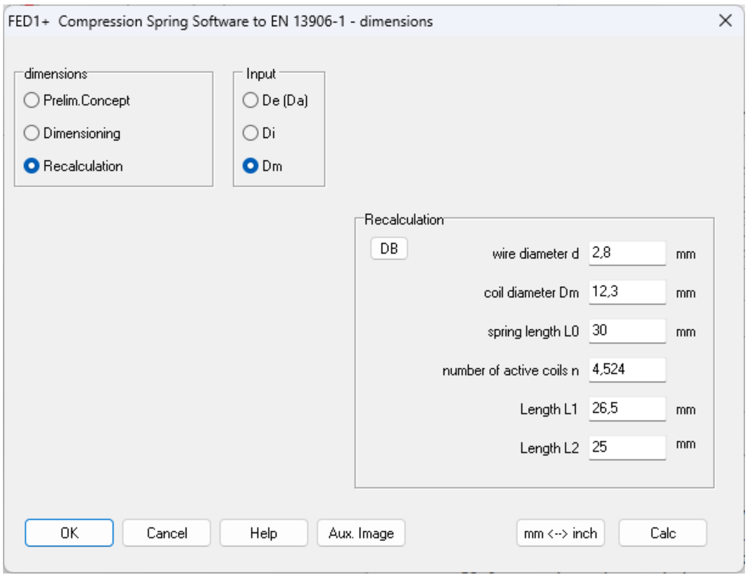
FED1+: Spring load F1 or F2 without tolerance

If you do not want to display tolerances for the spring force F1 or F2 in the production drawing, delete the upper and lower tolerances or set both to 0. To do this, you must first select "other tolerances". Because this is a bit complicated, there are new "x" buttons for F1 and F2 to do this procedure in one step.



FED1+: Recalculation at File\New

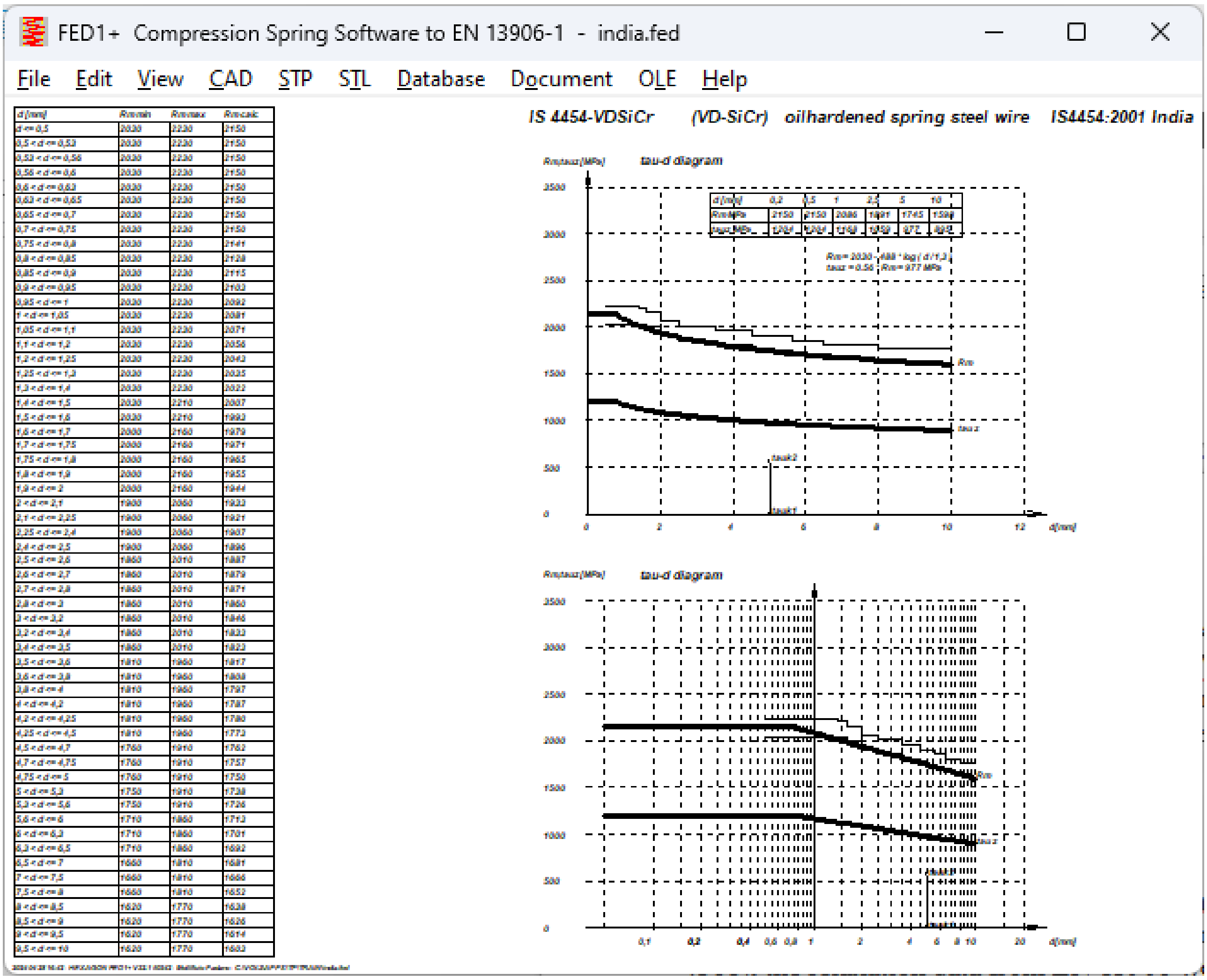
In version 32.0 the calculation process has been further optimized; the calculation now runs a little faster. Unfortunately, an input window was overlooked. If you do not use the quick entry and not "Edit\Recalculation", but "File\New" or "Edit\New", there is this window:



Unfortunately in V32.0 the number of active coils is not taken over immediately, an error message appears: Fatal: sc <=0! Please click on the "Calc" button twice and everything will be calculated.

FED1+,2+,3+,5,6,7,8,17: VDSiCr to IS 4454

At a customer's request, a valve spring wire VDSiCr according to the Indian standard IS 4454 was added to the material database. It differs from EN 10270-2 in that the minimum tensile strength and therefore also tauperm is approx. 50 MPa lower. The stresses in the Goodman diagram for this material were also reduced by this amount.



FED1+,2+,3+,5,6,7,8,17: Relaxation data for VDFI materials

For the materials with new Goodman diagrams from VDFI (FDSiCr, VDSiCr, VDSiCrV, DH, 4310, 4568), the relaxation data from EN 13906 were adopted, as well as the heat treatment data for 4310 and 4568.

SR1 Tip: Tightening torque MA

In SR1 the tightening torque MA max, min, nom is calculated and output. MA nom is the average torque to be set on the tightening tool. But which tightening torque should be specified on drawings and work instructions? That's not an easy question to answer because VDI 2230 always specifies the maximum tightening torque MA max. There is no MA max,min,nom in VDI 2230. There is only MA. And MA refers to the maximum permissible preload force FMzul. So if you specify “tightening torque MA according to VDI 2230” in the drawing, you must use MA,max from SR1. If you instead want to specify the average value as a setting value on the tightening tool, please first make sure that you have defined friction tolerances. If you subsequently enter friction tolerances, MA,min and MA,nom increase, MA,max remains the same. The factor alphaA takes into account the sum of the tolerances from friction and tightening torque.

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