Helical cylindrical torsion spring made of round wires a bars [in]

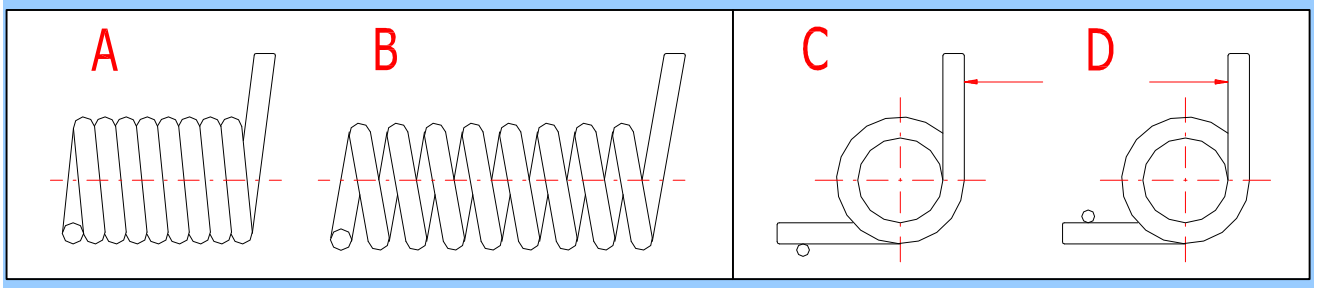
i Calculation without errors.

ii ☐ Project information

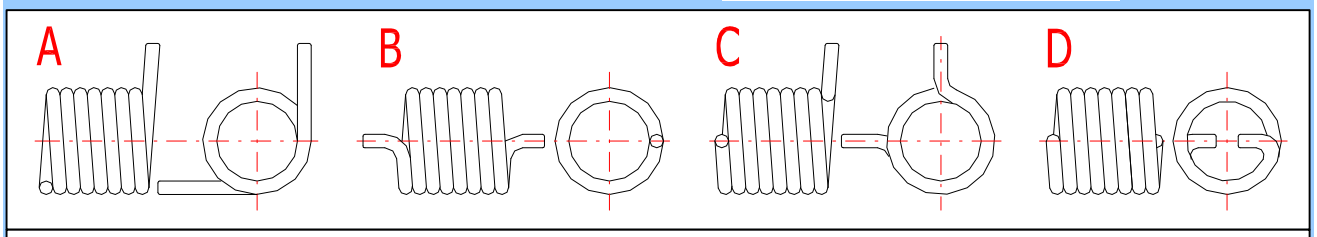
? **Input parameters section**

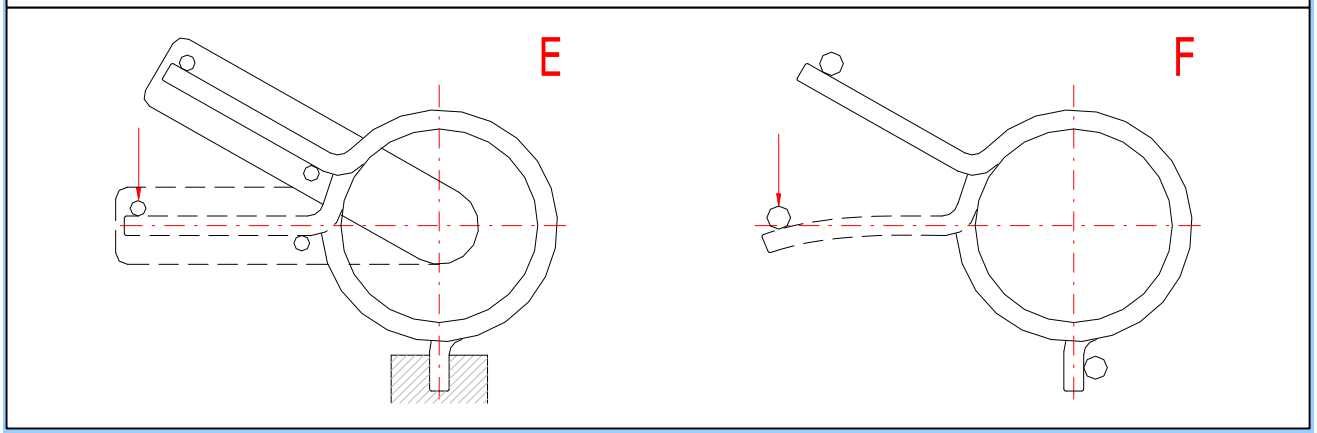
1.0 ☑ **Selection of load conditions, spring operational and production parameters.**

1.1	**Working cycle operational parameters**			
1.2	Method of loading		Fatig loading	
1.3	Working temperature	T	200,0	[° F]
1.4	Working environment		Non corrosive	
1.5	Method of stress curvature correction		Correction by Wahl	
1.6	**Spring design**			
1.7	Spring type		A ... Close-wound spring	
1.8	Direction of spring loading		C ... In coiling direction	
1.9	Surface treatment		Shot peened springs	
1.10	Direction of coil winding		Right	



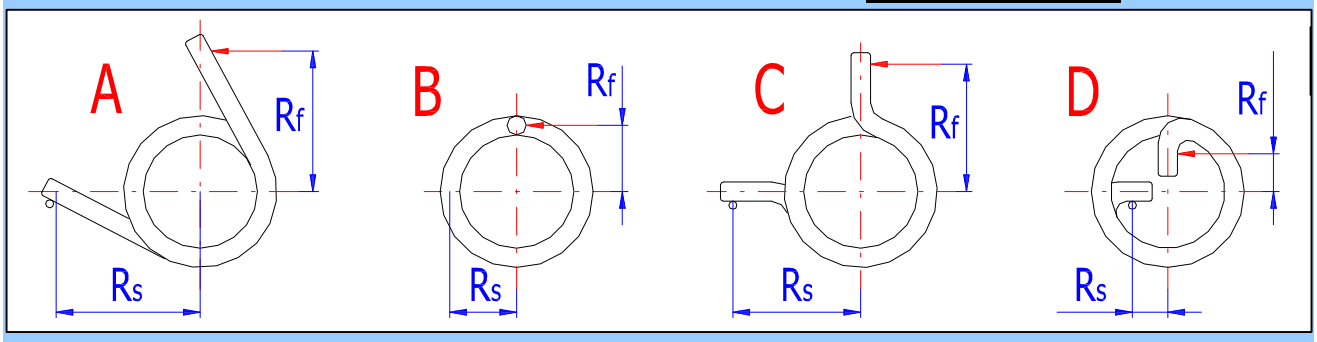
1.11	**Design of working leg**		
1.12	Type of leg	A ... Straight tangential leg	
1.13	Method of fixing the leg	E ... Fixed clamped leg	
1.14	**Design of support leg**		
1.15	Type of leg	A ... Straight tangential leg	
1.16	Method of fixing the leg	E ... Fixed clamped leg	



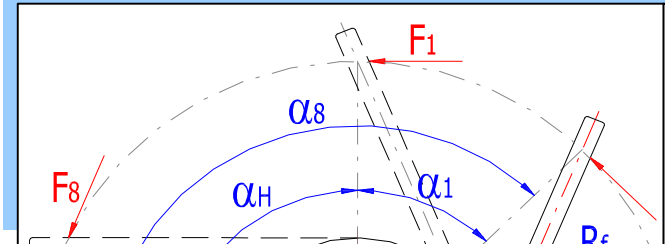


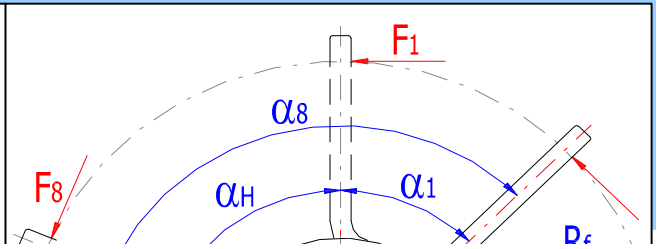
1.17	**Static loaded spring**		
1.18	Operational loading mode	Light service	

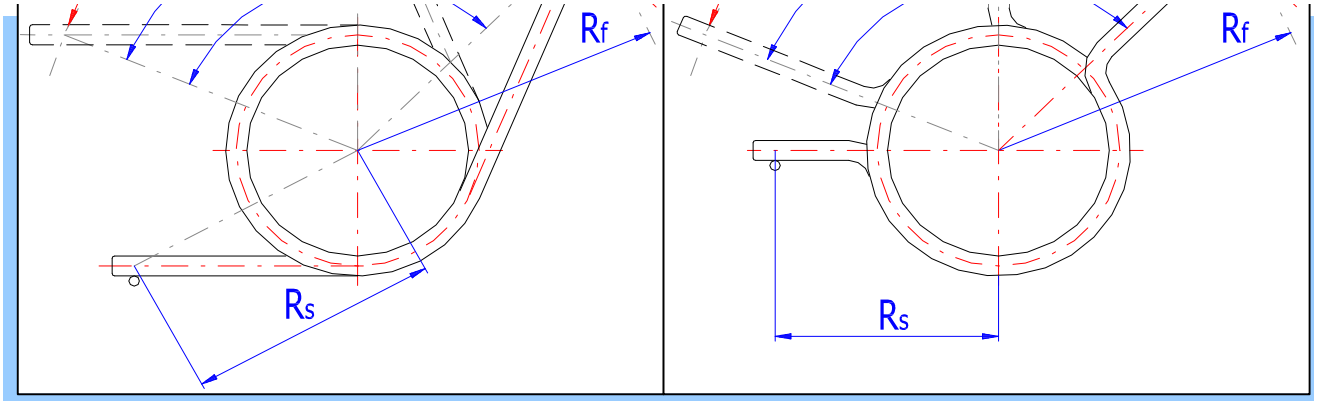
1.19	Desired level of safety	s_s	1,00		
1.20	**Fatig loaded spring**				
1.21	Operational loading mode		Continuous loading		
1.22	Desired spring service life in thousands of cycles	N	Infinite life		
1.23	Desired level of safety	s_f	1,30		
2.0	☑ **Options of spring material.**				
2.1	Production method :		Cold formed springs		
2.2	Spring material :		Hard drawn steel wire ASTM A227		
2.3	**Field of use of the selected material**				
2.4	Suitability for fatigue load		Insufficient		
2.5	Relative strength		Medium		
2.6	Corrosion resistance		Insufficient		
2.7	Max. operational temperature		250		[° F]
2.8	Delivered wire diameters		0,031 - 0,625		[in]
2.9	**Mechanical and physical properties of the material**				
2.10	Modulus of elasticity in tension	E_{20}	28700		[ksi]
2.11	Modulus of elasticity at operational temperature	E	28043		[ksi]
2.12	Density	ρ	490		[lb/ft^3]
2.13	**Strength characteristics of the material**				
2.14	Ultimate tensile strength	S_u	175		[ksi]
2.15	Permissible bending stress	σ_A	122,5		[ksi]
2.16	Endurance limit in bending	σ_e	70		[ksi]
2.17	Endurance limit by finite life	σ_f	70		[ksi]
3.0	☑ **Spring design.**				
3.1	**Force arms**			Deviat. [%]	
3.2	Arm of working force	R_f	1,500	10,0	[in]
3.3	Arm of supporting force	R_s	1,500	10,0	[in]



3.4	**Desired moments of the working cycle**				
3.5	Maximum working moment	M_8	20,0	10,0	[lb ft]
3.6	Minimum working moment	M_1	10,0	30,0	[lb ft]
3.7	**Desired angular deflections of spring working leg**				
3.8	◉ Leg angular deflection of fully loaded spring	α_8	120,0	10,0	[°]
3.9	○ Angle of working stroke	α_H	60	50	[°]
3.10	Leg angular deflection of preloaded spring	α_1	60	59	[°]







3.11	**Filters of the designed solution**			
3.12	☐ Maximum permissible spring outer diameter	D_{emax}	5,000	[in]
3.13	☐ Minimum permissible spring inner diameter	D_{imin}	1,000	[in]
3.14	☐ Maximum permissible length of coiled section	L_{Kmax}	10,000	[in]
3.15	Permissible division of the number of active coils		1/10	
3.16	Permissible exceeding of spring limit dimensions		0,0	[%]
3.17	Perform a preliminary check of loading of the spring legs		Yes	
3.18	Keep to the required level of safety with the strength check		Yes	
3.19	Quality criterion		Combined	
3.20	Number of design iteration		Medium	
3.21	**Options of solutions**			
3.22	Sort design result by		Qualities of solutions	
3.23	Run design calculation			

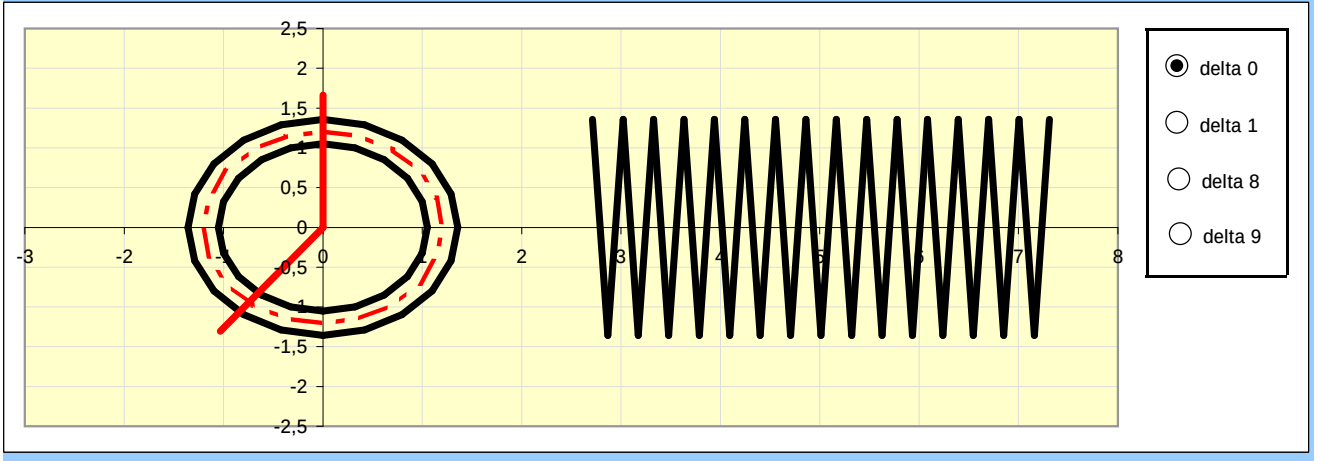
3.24

ID	D	D_e	D_i	d	n	δ_0	α_1	α_8	R_f	M_1	M_8	σ_8	s_s	s_f	m	quality
1.	2.408	2.714	2.101	0.3065	15.40	142	72.5	118.7	1.510	11.0	18.0	76	1.45	1.31	2.546	1.17

Results section

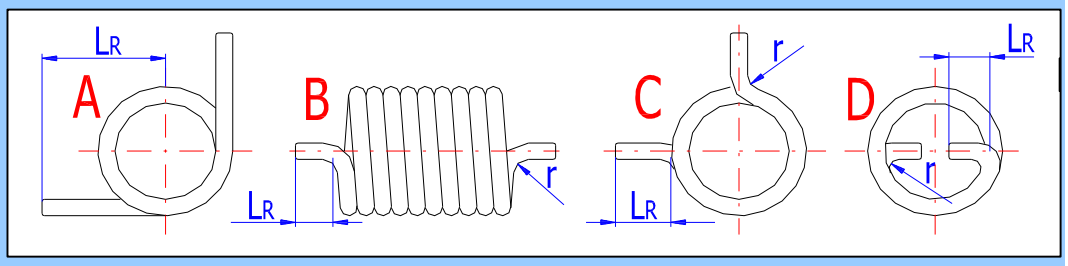
4.0 ☑ **Summarized list of designed spring parameters.**

4.1 Refresh results from the selected spring design

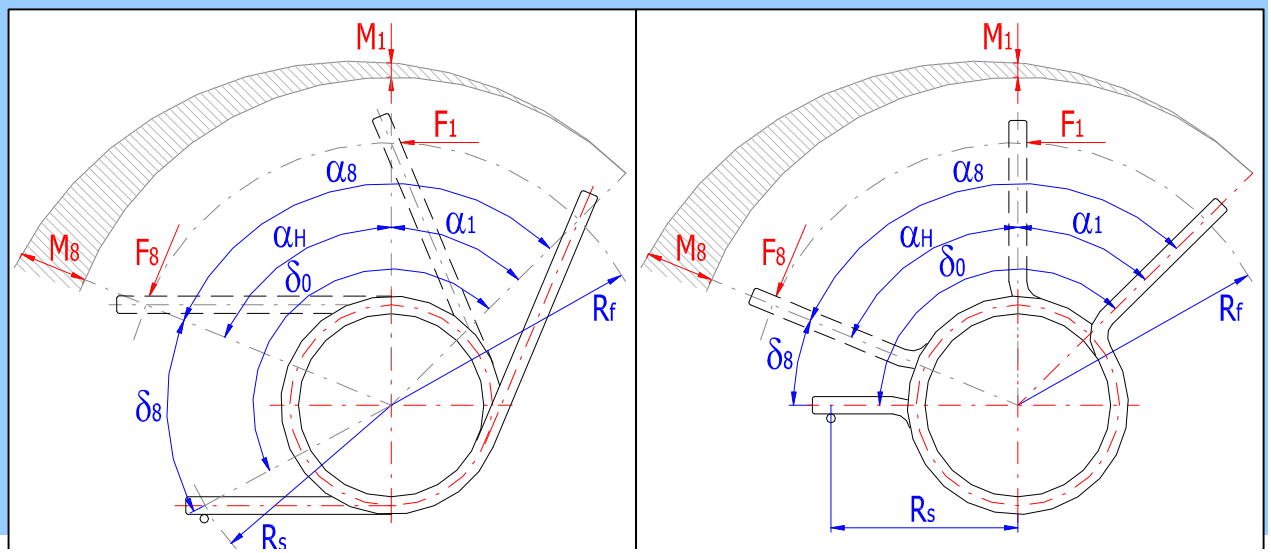


4.2	**Spring loading**				
4.3	Arm of working / supporting force	R_f / R_s	1,5103	1,5103	[in]
4.4	Minimum / maximum working moment	M_1 / M_8	11,000	18,000	[lb ft]
4.5	Minimum / maximum working force	F_1 / F_8	87,40	143,02	[lb]
4.6	**Spring dimensions**				
4.7	Mean spring diameter	D	2,4076		[in]
4.8	Recommended limits of wire diameter	d_{min} / d_{max}	0,1505	0,6019	[in]
4.9	Wire diameter	d	0,3065		[in]
4.10	Outer / inner spring diameter	D_e / D_i	2,7141	2,1011	[in]

4.11	Spring index	c	7,86		
4.12	Number of active coils	n	15,4		
4.13	Angle between legs in a free state	δ_0	141,7		[°]
4.14	Theoretic length of coiled section	L_K	5,0266		[in]
4.15	Pitch between coils of free spring	t	0,3065		[in]
4.16	**Dimensions of spring legs**				
4.17	Length of working / supporting leg	L_{R1} / L_{R2}	1,530	1,530	[in]
4.18	Bending radius on the working / supporting leg	r_1 / r_2	0,000	0,000	[in]



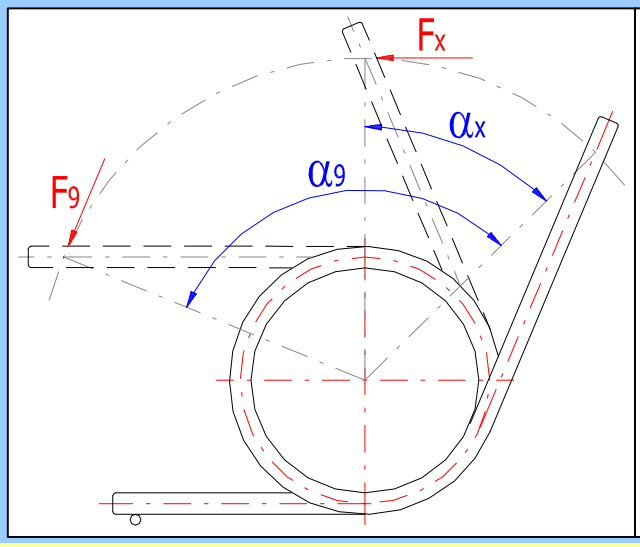
4.19	**Parameters of preloaded spring**				
4.20	Angular deflections of working leg / corrected	α_1 / α_{1c}	72,52	72,52	[°]
4.21	Angle between spring legs	δ_1	69,2		[°]
4.22	Spring stress	σ_1	46,70		[ksi]
4.23	**Parameters of fully loaded spring**				
4.24	Angular deflections of working leg / corrected	α_8 / α_{8c}	118,67	118,67	[°]
4.25	Angle between spring legs	δ_8	23,0		[°]
4.26	Angle of spring working stroke	α_H	46,15		[°]
4.27	Spring stress	σ_8	76,41		[ksi]
4.28	Max. outer / min. inner spring diameter	D_{e8} / D_{i8}	2,7141	2,0506	[in]
4.29	Maximum theoretic length of coiled section	L_{K8}	5,1276		[in]
4.30	**Parameters of spring limit state**				
4.31	Spring limit loading	F_9 / M_9	207,5	26,1	[lb] / [lb ft]
4.32	Angular deflections of working leg / corrected	α_9 / α_{9c}	172,20	172,20	[°]
4.33	Angle between spring legs	δ_9	-30,5		[°]
4.34	**Spring mechanical and physical properties**				
4.35	Torque spring rate	k	1,82		[lb in/°]
4.36	Spring deformation energy	W_8	18,64		[ft lb]
4.37	Developed wire length	l	121,7		[in]
4.38	Spring weight	m	2,546		[lb]

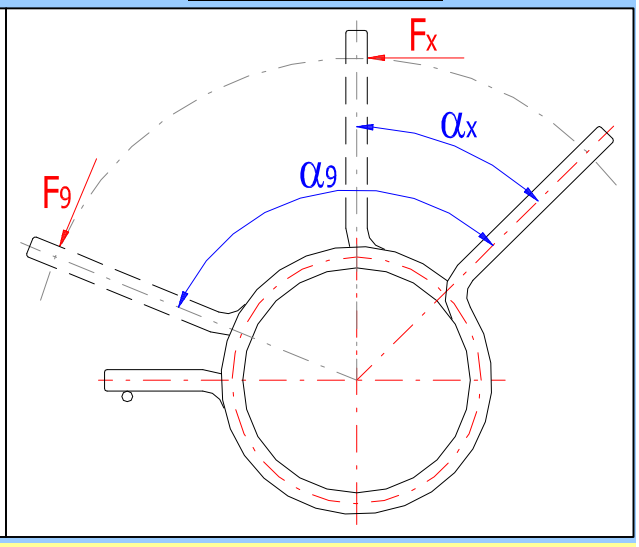


4.39	**Spring strength check**				
4.40	Curvature correction factor	K_s	1,1048		
4.41	Corrected stress of fully loaded spring	σ_{8C}	84,42		[ksi]
4.42	Permissible bending stress	σ_A	122,5		[ksi]
4.43	Level of safety		1,451		
4.49	**Strength check of a spring exposed to fatigue loading**				
4.50	Corrected stress in spring coils	σ_{8C}	84,42		
4.51	Corrected stress on leg at the point of bending	σ_{8r}	84,42		[ksi]
4.52	Max. fatigue strength for the given loading	σ_{max}	110,5		[ksi]
4.53	Level of safety		1,309		

5.0 ☑ Parameters of designed spring for specific working load.

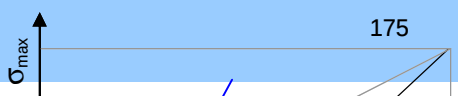
5.1	**Spring parameters for the given working loading**				
5.2	Spring loading	M_x / F_x	15,00	119,2	[lb ft] / [lb]
5.3	Angular deflections of working leg / corrected	α_x / α_{xc}	98,89	98,89	[°]
5.4	Angle between spring legs	δ_x	42,8		[°]
5.5	Spring stress	σ_x	63,68		[ksi]
5.6	**Spring parameters for the given angular leg deflection**				
5.7	Angular deflections of working leg	α_x	100,0		[°]
5.8	Angle between spring legs	δ_x	41,7		[°]
5.9	Spring produced force / moment	F_x / M_x	120,5	15,17	[lb] / [lb ft]
5.10	Spring stress	σ_x	64,39		[ksi]

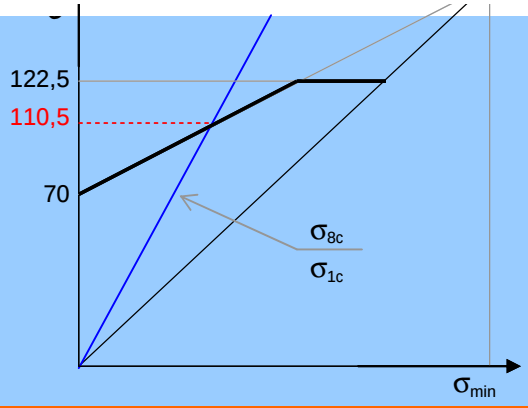




6.0 ☑ Check of loading capacity of a spring exposed to fatigue loading.

6.1	Curvature correction factor	K	1,1048	
6.2	Corrected stress of preloaded spring	σ_{1C}	51,59	[ksi]
6.3	Corrected stress of fully loaded spring	σ_{8C}	84,42	[ksi]
6.4	Ultimate tensile strength	S_u	175	[ksi]
6.5	Permissible bending stress	σ_A	122,5	[ksi]
6.6	Endurance limit in bending	σ_e	70	[ksi]
6.7	Endurance limit by finite life	σ_f	70	[ksi]
6.8	Max. fatigue strength for the given loading	σ_{max}	110,5	[ksi]
6.9	Level of safety		1,309	





Supplements section

7.0 ☑ Spring check calculation.

7.1	Uploading of input data from main calculation					
7.2	**Parameters of working cycle**					
7.3	Arm of working / supporting force	R_f / R_s	1,5103	1,5103	[in]	
7.5	Maximum working moment	M_8	18,00		[lb ft]	
7.4	Maximum working force	F_8	143,0		[lb]	
7.6	Angle of spring working stroke	α_H	46,15		[°]	
7.7	Minimum working loading	F_1 / M_1	87,4	11,0	[lb] / [lb ft]	
7.8	**Spring strength check**					
7.9	Mean spring diameter	D	2,4076		[in]	
7.10	Recommended limits of wire diameter	d_{min} / d_{max}	0,2813	0,6019	[in]	
7.11	Wire diameter / from table	d	0,3065	0,625	[in]	
7.12	Outer / inner spring diameter	D_e / D_i	2,7141	2,1011	[in]	
7.13	Spring index	c	7,86			
7.14	Permissible bending stress	σ_A	122,5		[ksi]	
7.15	Corrected stress in spring coils	σ_{8C}	84,4		[ksi]	
7.16	Bending radius on the working / supporting leg	r_1 / r_2	0,0000	0,0000	[in]	
7.17	Corrected stress on leg at the point of bending	σ_{8r}	84,4		[ksi]	
7.18	Level of safety		1,451			
7.19	**Spring construction**					
7.20	Recommended minimum number of active coils	n_{min}	5,99			
7.21	Number of active coils	n	15,40			
7.22	Angle between legs in a free state	δ_0	141,7		[°]	
7.23	Pitch between coils of free spring	t	0,3065		[in]	
7.24	Theoretic length of coiled section	L_K	5,0266		[in]	
7.25	Working angle of preloaded spring / corrected	α_1 / α_{1c}	72,52	72,52	[°]	
7.26	Working angle of fully loaded spring / corrected	α_8 / α_{8c}	118,67	118,67	[°]	
7.27	Angle between legs for fully loaded spring	δ_8	23,0		[°]	
7.28	Max. outer / min. inner spring diameter	D_{e8} / D_{i8}	2,7141	2,0506	[in]	
7.29	Maximum theoretic length of coiled section	L_{K8}	5,1276		[in]	
7.30	Transfer of solution into main calculation					

8.0 ☑ Calculation of working forces of the spring.

8.1	Uploading of input data from main calculation				
8.2	**Parameters of working cycle**				
8.3	Leg angular deflection of fully loaded spring	α_8	118,67	[°]	
8.4	Leg angular deflection of preloaded spring	α_1	72,52	[°]	
8.5	Angle of spring working stroke	α_H	46,15	[°]	
8.6	**Spring dimensions**				

8.7	Mean spring diameter	D	2,4076		[in]
8.8	Wire diameter / from table	d	0,3065	0,625	[in]
8.9	Outer / inner spring diameter	D_e / D_i	2,7141	2,1011	[in]
8.10	Spring index	c	7,86		
8.11	Number of active coils	n	15,40		
8.12	Angle between legs in a free state	δ_0	141,7		[°]
8.13	Pitch between coils of free spring	t	0,3065		[in]
8.14	Theoretic length of coiled section	L_K	5,0266		[in]
8.15	**Dimensions of fully loaded spring**				
8.16	Angle between spring legs	δ_8	23,0		[°]
8.17	Max. outer / min. inner spring diameter	D_{e8} / D_{i8}	2,7141	2,0506	[in]
8.18	Maximum theoretic length of coiled section	L_{K8}	5,1276		[in]
8.19	**Spring loading**				
8.20	Arm of working / supporting force	R_f / R_s	1,5103	1,5103	[in]
8.21	Minimum / maximum working moment	M_1 / M_8	11,00	18,00	[lb ft]
8.22	Minimum / maximum working force	F_1 / F_8	87,4	143,0	[lb]
8.23	**Spring strength check**				
8.24	Corrected stress in spring coils	σ_{8C}	84,4		[ksi]
8.25	Bending radius on the working / supporting leg	r_1 / r_2	0,0000	0,0000	[in]
8.26	Corrected stress on leg at the point of bending	σ_{8r}	84,4		[ksi]
8.27	Permissible bending stress	σ_A	122,5		[ksi]
8.28	Level of safety		1,451		
8.29	Transfer of solution into main calculation				
9.0	☑ **Calculation of working angles of the spring.**				
9.1	Uploading of input data from main calculation				
9.2	**Spring loading**				
9.3	Arm of working / supporting force	R_f / R_s	1,5103	1,5103	[in]
9.4	Minimum / maximum working moment	M_1 / M_8	11,00	18,00	[lb ft]
9.5	Minimum / maximum working force	F_1 / F_8	87,4	143,0	[lb]
9.6	**Spring dimensions**				
9.7	Mean spring diameter	D	2,4076		[in]
9.8	Wire diameter / from table	d	0,3065	0,625	[in]
9.9	Outer / inner spring diameter	D_e / D_i	2,7141	2,1011	[in]
9.10	Spring index	c	7,86		
9.11	Number of active coils	n	15,40		
9.12	Angle between legs in a free state	δ_0	141,7		[°]
9.13	Pitch between coils of free spring	t	0,3065		[in]
9.14	Theoretic length of coiled section	L_K	5,0266		[in]
9.15	**Parameters of working cycle**				
9.16	Working angle of preloaded spring / corrected	α_1 / α_{1c}	72,52	72,52	[°]
9.17	Working angle of fully loaded spring / corrected	α_8 / α_{8c}	118,67	118,67	[°]
9.18	Angle of spring working stroke	α_H	46,15		[°]
9.19	Angle between legs for fully loaded spring	δ_8	23,0		[°]
9.20	Max. outer / min. inner spring diameter	D_{e8} / D_{i8}	2,7141	2,0506	[in]
9.21	Maximum theoretic length of coiled section	L_{K8}	5,1276		[in]
9.22	**Spring strength check**				
9.23	Corrected stress in spring coils	σ_{8C}	84,4		[ksi]
9.24	Bending radius on the working / supporting leg	r_1 / r_2	0,0000	0,0000	[in]
9.25	Corrected stress on leg at the point of bending	σ_{8r}	84,4		[ksi]

9.26	Permissible bending stress	σ_A	122,5	[ksi]
9.27	Level of safety		1,451	
9.28	Transfer of solution into main calculation			

10.0 ☑ **Graphical output, CAD systems**

10.1	2D drawing output to:	DXF File	
10.2	2D Drawing scale	Automatic	
10.3	Angle between spring legs	0,0	
10.4	**Text description (Information for BOM)**		
	Row 1 (BOM attribute 1)	Torsion spring	☑
	Row 2 (BOM attribute 2)	D=2,4076; d=0,3065; n=15,4	
	Row 3 (BOM attribute 3)	Hard drawn steel wire ASTM A227	
10.5	Table of parameters