

by Fritz Ruoss

FED1+, 5, 6, 7, 17: Production Drawing German/English

Production drawing in dual language German/English can be generated for compression springs now (View, Print, CAD DXF/IGES).

The screenshot shows the FED1+ software interface with a production drawing of a compression spring. The drawing includes three illustrations: 1. Spring ends lined up and ground (selected), 2. Spring ends lined up, and 3. Spring ends lined up, forged and ground. The drawing shows a spring with 7 active coils and a total of 9 coils. The length is indicated as $\geq 9,89$. The software window title is "FED1+ Compression Spring Software to EN 13906-1 - 0.fed". The menu bar includes File, Edit, View, CAD, STEP, STL, Database, Document, OLE, and Help.

D	1	Anzahl der federnden Windungen No. of active coils	n = 7,00	
		Gesamtanzahl der Windungen Total no. of coils	nt = 9,00	
	2	Windungsrichtung Direction of coils	rechts (right) <input type="radio"/> links (left) <input type="radio"/>	
	3	Entgraten der Federenden Deburring of spring ends	nicht (no) <input type="radio"/> innen (inside) <input type="radio"/> aussen (outside) <input type="radio"/>	
C	4	Arbeitsweg (working path, stroke)	sh = 10 mm	
	5	Lastspielfrequenz (stress cycle frequency)	f = 1 Hz	
	6	Arbeitstemperaturbereich von/bis Range of working temperature	0 .. 100 °C	
B	7	Draht- oder Staboberfläche Wire or rod surface	gezogen (drawn) <input checked="" type="radio"/> gewalzt (rolled) <input type="radio"/> spitzenlos geschliffen (tipless ground) <input type="radio"/> Feder kugelgestrahlt (shot blasted) <input type="radio"/>	
	8	Oberflächenschutz (Surface Protection) : geölt		
	9	Material: EN 10270-1-SH Pat.gez.Federstahldraht (ISO 8458-2-SH) Zul.Schubspann.(adm.shear stress) tau perm = 1334 MPa Schubmodul (shear modulus) G = 82000 MPa		
	10	Zul. Abweichungen (Perm. Deviations) nach (according to) EN 15800 Gütegrad (Quality Class)		DIN 2096
			1 2 3	
		De, Di	<input type="radio"/> <input checked="" type="radio"/> <input type="radio"/>	<input type="radio"/>
		L0	<input type="radio"/> <input checked="" type="radio"/> <input type="radio"/>	<input type="radio"/>
		F1	<input type="radio"/> <input checked="" type="radio"/> <input type="radio"/>	<input type="radio"/>
		F2	<input type="radio"/> <input checked="" type="radio"/> <input type="radio"/>	<input type="radio"/>
		e1	<input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/>
		e2	<input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/>
		d	T4 - EN10218-2	
	11	Fertigungsausgleich (manufact.tol.)	durch (by) :	
		a) wenn 1 Federkraft und 1 Länge vorgegeben if 1 spring force and 1 spring length specified	L0	<input type="radio"/>
		b) wenn 1 Federkraft, 1 Länge und L0 vorgeg. if 1 spring force, 1 length and L0 specified	n and d	<input type="radio"/>
			n and De, Di	<input type="radio"/>
		c) wenn 2 Federkräfte und 2 Längen vorgeg. if 2 forces and 2 spring lengths are specified	L0, n and d	<input type="radio"/>
			L0, n and De, Di	<input type="radio"/>
	12	Setzlänge Ls = 10,00 mm Setting length Prüffedern setzen (Set test springs) ! übrige Federn set <input type="radio"/> gesetzt Remaining springs not set <input checked="" type="radio"/> ungesetzt liefern	Ungesetzt zu liefernde Federn dürfen länger sein als L0. Springs to be supplied not set may be longer than L0	

FED3+: 3D Centerline as STEP file

Centerline of torsion spring can be generated as STEP file to the loaded into CAD.

FED9,10,13,14,15,16: Incoloy A-286

Incoloy A-286 (spring temper and spring temper + aged) has been added in the material database fed9wst.dbf.

FED1+, 5, 6, 7, 17: Production Drawing International DE,EN,FR,IT,SV,PT,ES,NL
 Production drawing of compression spring can now be generated in German, English, French, Italian, Swedish, Spanish, Portugues and Dutch language.

FED1+ Compression Spring Software to EN 13906-1 - 0.fed

File Edit View CAD STEP STL Database Document OLE Help

Illustr. 1. Extremos de muelle juntas y amolados
 Illustr. 2. Extremos juntas
 Illustr. 3. Extremos de muelle juntas, forjadas y amolados

1	No. de espiras act.	n = 7,00
	No. total de espiras	nt = 9,00
2	Sentido de arrollado	derecho <input type="radio"/> izquierdo <input type="radio"/>
3	Desbarbar los extremos	no <input type="radio"/> interior <input type="radio"/> exterior <input type="radio"/>
4	Carrera	sh = 10 mm
5	Frecuencia de cargas altern.	f = 1 Hz
6	Temperatura de trabajo	0 .. 100 °C
7	Superficie de alambre	Trefilado <input checked="" type="radio"/> Laminado <input type="radio"/> Rectificado <input type="radio"/> Muelle perdigonado <input type="radio"/>
8	Protec.superficie: geölt	
9	Material: EN 10270-1-SH spring steel wire pat. drawn (ISO 8458-2-SH)	

10	Desviaciones admisibles según EN 15800 calidad				DIN 2096
		1	2	3	
	De, Di	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	L0	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	F1	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	F2	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	e1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	e2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	d	T4 - EN10218-2			
11	Tolerancia fabricación		por:		
	a) Si existen prescripciones sobre la carga del muelle y su largo		L0 <input type="radio"/>		
	b) Si existen prescripciones sobre la carga del muelle, si largo y L0		n y d <input type="radio"/>		
			n y De, Di <input type="radio"/>		
	c) Si existen prescripciones de dos cargas del muelle y sus largos correspondientes		L0, n y d <input type="radio"/>		
			L0, n y De, Di <input type="radio"/>		
12	Long. asentado Ls = 10,00 mm		Los muelles que no son asentados pueden ser		

At "View -> Production drawing International" you can choose the desired drawing language.

FED1+ Compression Spring Software to EN 13906-1 - 0.fed

File Edit View CAD STEP STL Database Document OLE Help

Figura 1. Extremidades da mola estendidas e retificadas
 Figura 2. Extremidades da mola estendid.
 Figura 3. Extremidades da mola estendidas, forjadas e retificadas

1	No. de espiras ativas	n = 7,00
	No. total de espiras	nt = 9,00
2	Direcao das espiras	direita <input type="radio"/> esquerda <input type="radio"/>
3	rebarba das extremidades da mola	nao <input type="radio"/> interno <input type="radio"/> externo <input type="radio"/>
4	Curso de trabalho (deslocamento)	sh = 10 mm
5	Frequencia de ciclos de tensao	f = 1 Hz
6	faixa de temperatura de trabalho	0 .. 100 °C
7	laminado ou Superficie redonda	trefilado <input checked="" type="radio"/> rolada <input type="radio"/> retificado sem cantos vivos <input type="radio"/> mola jateada com esferas de aco <input type="radio"/>
8	Protecao de superficie: geölt	
9	Material: EN 10270-1-SH	

10	Desvios admissíveis conforme EN 15800 Classe de qualidade				DIN 2096
		1	2	3	
	De, Di	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	L0	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	F1	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	F2	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	e1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	e2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	d	T4 - EN10218-2			
11	Tolerancia de fabricacao		por:		
	a) se a forza da mola e o comprimento da mola sao especificados		L0 <input type="radio"/>		
	b) se a forza da mola, o comprimento da mola e L0 sao especificados		n e d <input type="radio"/>		
			n e De, Di <input type="radio"/>		
	c) se duas forcas de mola e os comprimentos da mola sao especificados		L0, n e d <input type="radio"/>		
			L0, n e De, Di <input type="radio"/>		
12	Long. asentado Ls = 10,00 mm		Miles comentários		

FED2+: Production drawing International DE,EN,FR,IT,SV,ES,NL

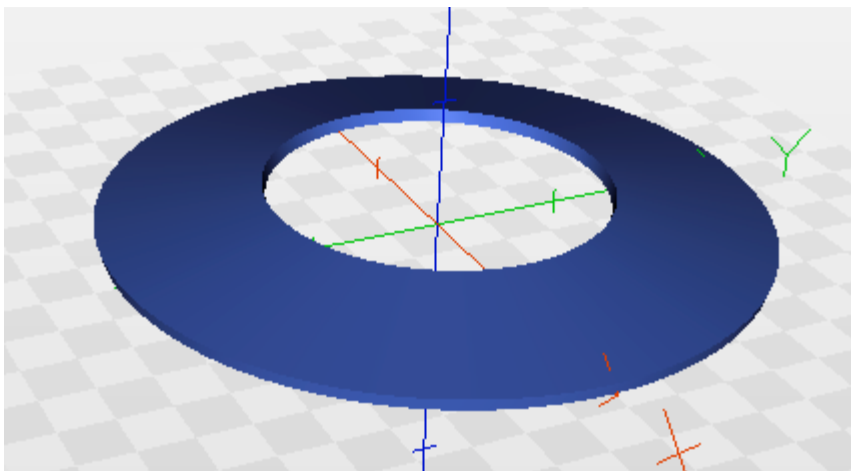
Production drawing of extension springs can now be generated in German, English, French, Italian, Swedish, Spanish and Dutch language.

The screenshot shows the FED2+ software interface with a technical drawing of an extension spring and a data entry table. The drawing includes dimensions: $D_m = 8,8 \pm 0$, $L_0 = 46,13 \pm 1,1$, $L_1 = 55,99$, $L_2 = 69,19$, $L_n = 95,24$, sh , $(L = 756\text{mm})$, and $(P = 1,2\text{mm})$. Below the drawing is a table with the following data:

1	Nombre de spires utiles	$n = 26,1$	10	Déviation admissible selon DIN 2097		
2	Sens d'enroulement	droite <input type="radio"/> gauche <input type="radio"/>	Grade			
3	Type et dimensions des deux boucles	Boucles selon EN 13906-2:2013, Fig. A.2 Boucle resp. ouvert, boucle déplacée position à $39 \pm 31,4$ degré (sens d'une vis à droite)		1	2	3
4	Course du travail	$sh = 13,2 \text{ mm}$	De, Di, (Dm)	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
5	Fréquence de charges	$f = 5 \frac{1}{s}$	L0	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
6	Température de travail	$0 \dots 100 \text{ }^\circ\text{C}$	F0	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
7	Surface de fil	tréfilé <input checked="" type="radio"/> laminé <input type="radio"/> grenailage <input type="radio"/>	F1 .. Fn	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
8	Traitement de surface:		Orient. oeillets	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
9	Matériau: EN 10270-3-1 A568		Déport oeillet	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
			Diamètre d en fil	selon le demi-produit utilisé DIN 2076 C		
			11	Compromis de fabrication		valeurs libres
				a) une force du ressort et la longueur correspondante et L0	F0 et D (De, Di) <input type="radio"/>	
				b) une force de ressort et la longueur correspondante et F0	L0 et d <input type="radio"/>	
					L0 et D (De, Di) <input type="radio"/>	

FED4: STL Disk Spring

Disk spring can be generated as 3D STL model now.



FED1+,2+,3+,5,6,7,8,11,17: "OTEVA 91 not nitrided" modified

Strength properties for Goodman diagram of OTEVA 91 (VD-SiCrVMo) were too low in not nitrided state, because data strength values were based on $d=1$ instead to $d=3.85\text{mm}$. Data in fedwst.dbf have been corrected. Thanks to Mr. Gaedtke of HAWE Hydraulik for his hint.

FED1+,2+,3+,5,6,7,8,11,17: OTEVA 74 SC, OTEVA 76 SC, OTEVA 96 SC

3 new OTEVA valve spring wires have been added to the fedwst.dbf spring wire database:

OTEVA 74 SC is an oil tempered SiCr-alloyed valve spring wire, shaved. Tensile strength and fatigue resistance is equal with OTEVA 75 SC (VD-SiCrV), but until 200°C only.

OTEVA 76 SC is an oil tempered SiCrVNi-alloyed valve spring wire, shaved. Tensile strength and fatigue resistance is the same as OTEVA 75 SC (VD-SiCrV)

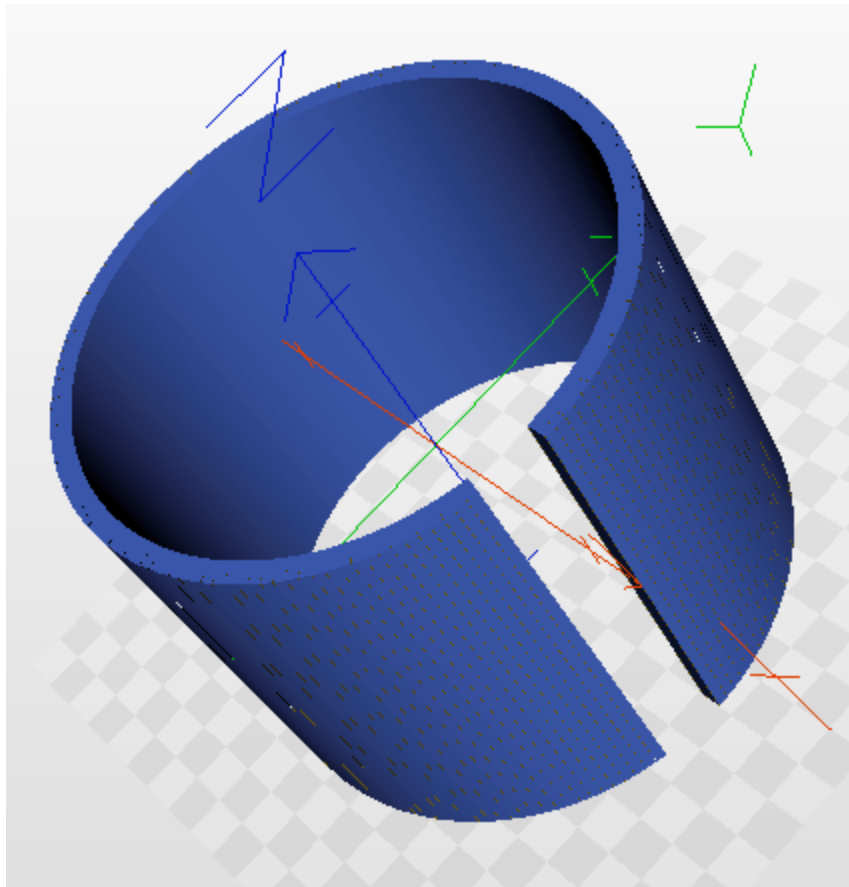
OTEVA 96 SC is an oil tempered SiCrVMo-alloyed valve spring wire, shaved. Tensile strength and fatigue resistance is the same as OTEVA 90 SC (VD-SiCrVMo)

The strength properties of OTEVA 90, 91, 96 are the same.

We have no relaxation charts for the OTEVA materials. In the data sheets there are such, but for preset springs only. Relaxation chart in data sheet shows that there is no further relaxation if working temperature is below 100°C .

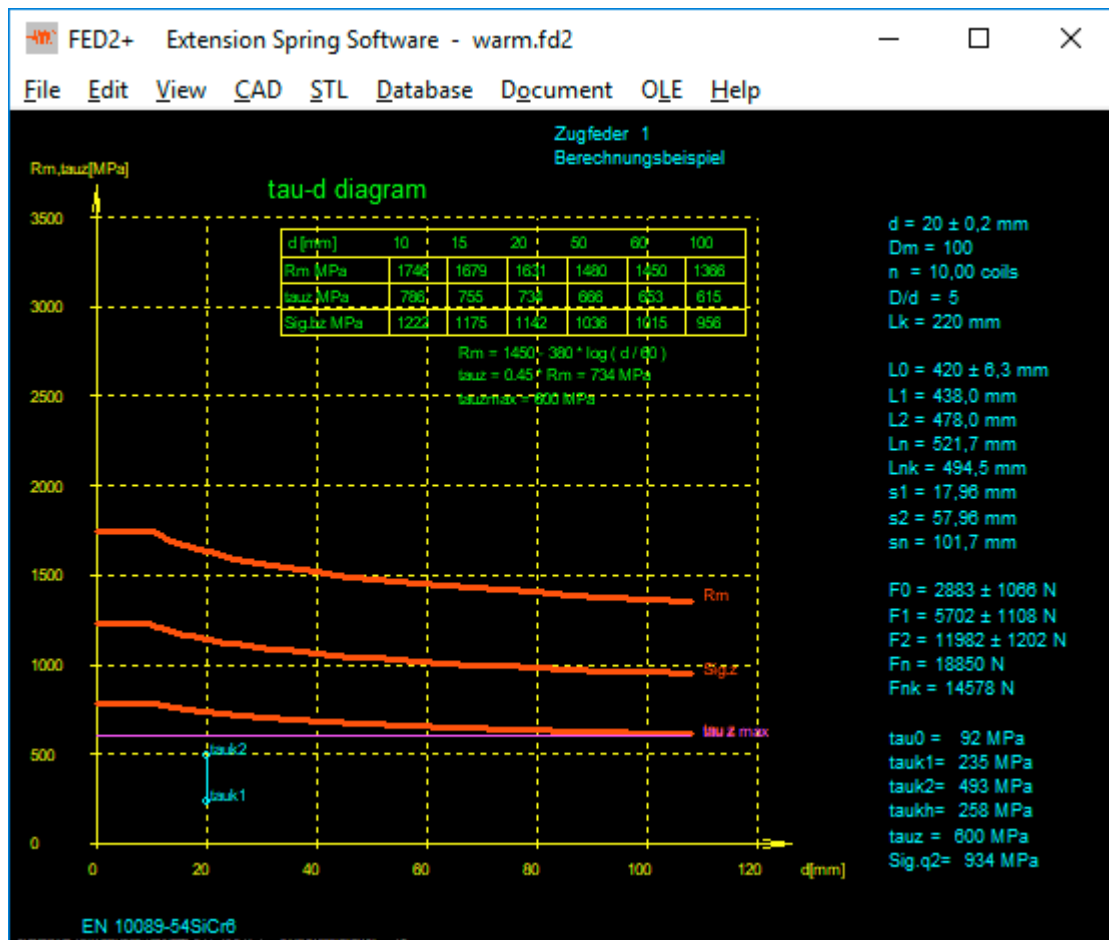
FED11: STL Model

FED11 generates a 3D model of the calculated spring lock or bushing as STL file now.



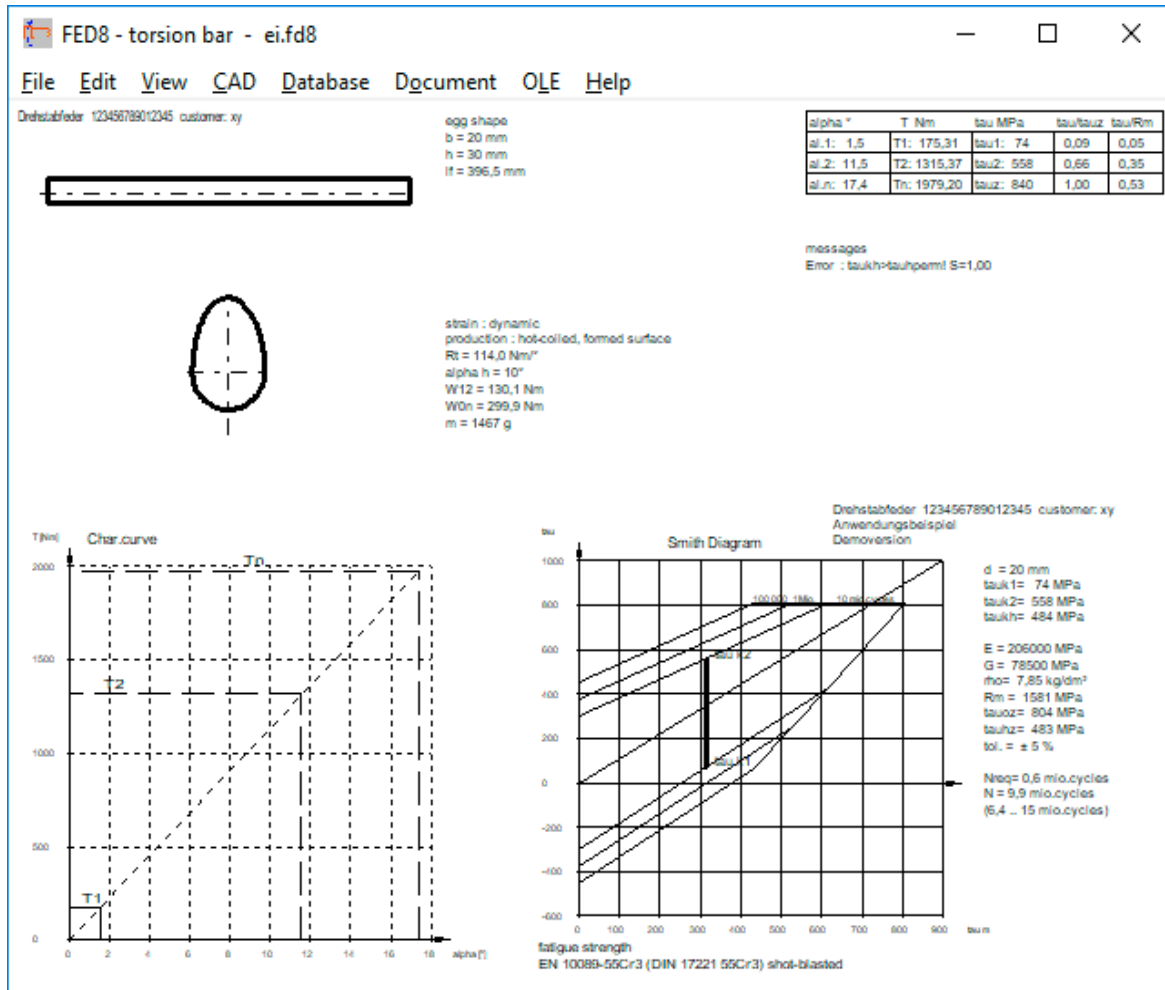
FED1+,2+,3+,5,6,7,8,11,17: Hot-rolled spring material to EN 10089

In EN standards there are 2 sources for the permissible shear stress of hot-formed compression springs: in EN 13906-1 (10.1.2) there is a diagram for τ_{zul} depending on the wire or rod diameter, but irrespective of the material. EN 10089 includes min/max tensile strength of various materials, but irrespective of the diameter. The program calculates $\tau_{zul} = 840 - 250 \cdot \log(d/20)$, derived from the diagram in EN 13906, and $\tau_{zul} = 0.56 \cdot R_m$ to EN 10089. The smaller of the two values is used for calculation. Since this is usually the value of the EN 13906, the values from the database remain virtually ignored. Nevertheless, the material database FEDWST.DBF has now been modified that the tensile strength R_m depends on the diameter of the wire or rod. In adaptation to the diagram from EN 13906, R_{mmin} applies to $d = 60\text{mm}$ and R_{mmax} for $D \leq 10\text{mm}$. In the τ - d diagram, the curve for τ_{zulmax} is now additionally drawn in accordance with EN 13906 (if hot formed springs only). In the previous version, it was not possible to see where the value τ_{zul} comes from. For 38Si7 and 51CrV4, the curves are almost identical, whereas for materials of higher strength (e.g. 60SiCr7) the τ_{zul} curve from the database is significantly higher than the τ_{zulmax} curve according to EN 13906. In a later version, maybe we could add an option to ignore the permissible shear stress according to EN 13906 and use the higher value from the database instead, if there are reliable facts. I would be happy to accept suggestions and measured values from you.



For tension springs, $\tau_{zulmax} = 600 \text{ MPa}$ is indicated for hot formed springs according to EN 13906, irrespective of wire or rod diameter. Else, $\tau_{zul} = 0.45 R_m$ should be used for tension springs according to EN 13906. FED2+ uses the smaller value of 600 MPa and $0.45 R_m$. In most cases, $0.45 R_m$ is larger than 600 MPa , so the permissible shear stress for most hot-formed tension springs is $\tau_{zul} = 600 \text{ MPa}$.

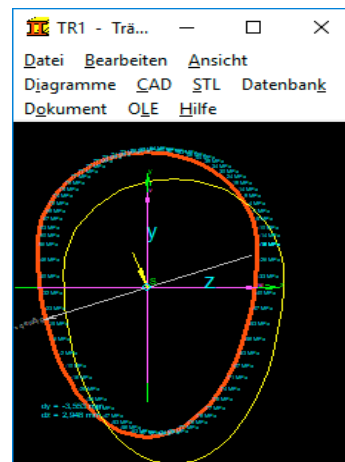
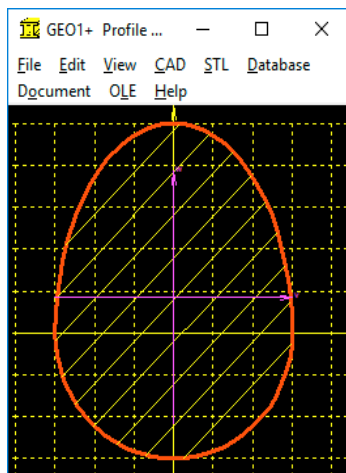
FED8: Torsion bar in egg shape



An egg-shaped cross-section is composed of a semicircle and a half ellipse. Thus also the mass moment of inertia and the polar area moment of inertia is calculated, as the sum of half circle and half ellipse. However, this is just an approximation.

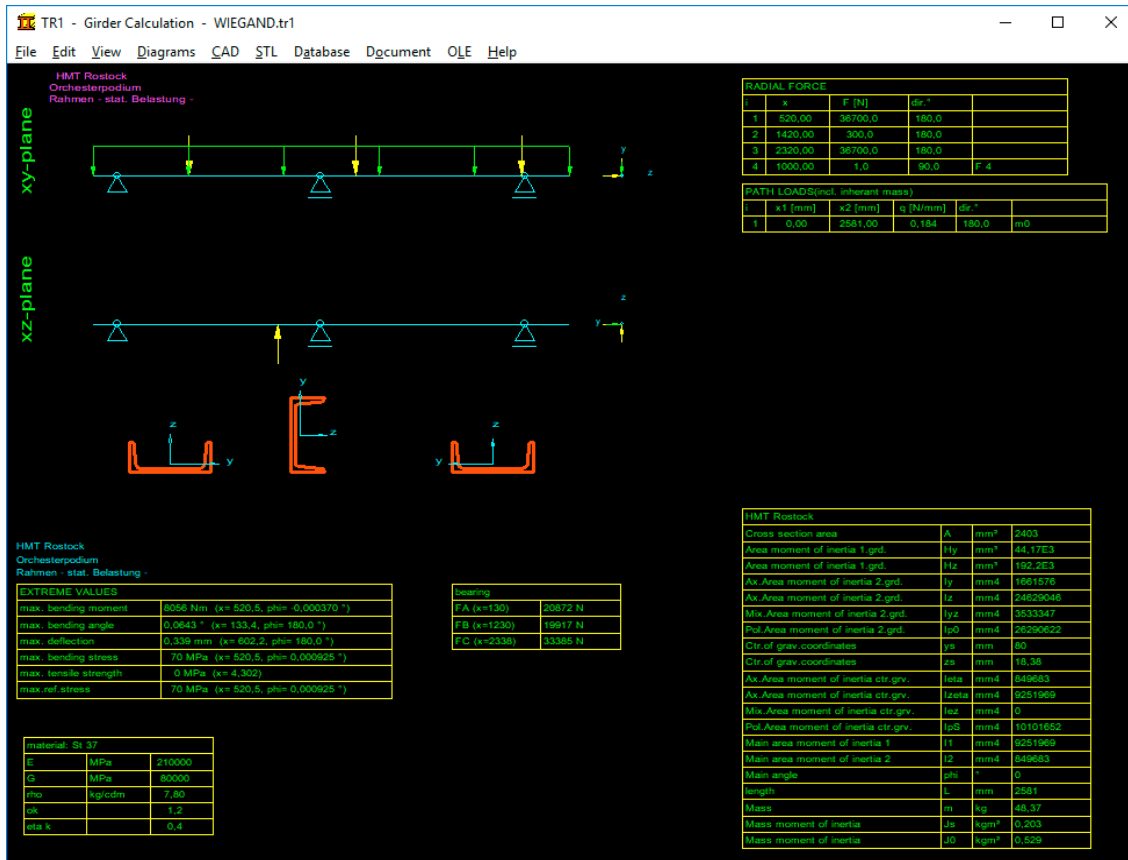
GEO1+, TR1: Ellipse and Egg-shape

Generating of ellipse and egg-shape has been added in GEO1+ and TR1. GEO1+ calculates area moment of inertia, center of gravity and mass moment of inertia. TR1 additionally calculates bending curve and bending stress of the special shaped girder.



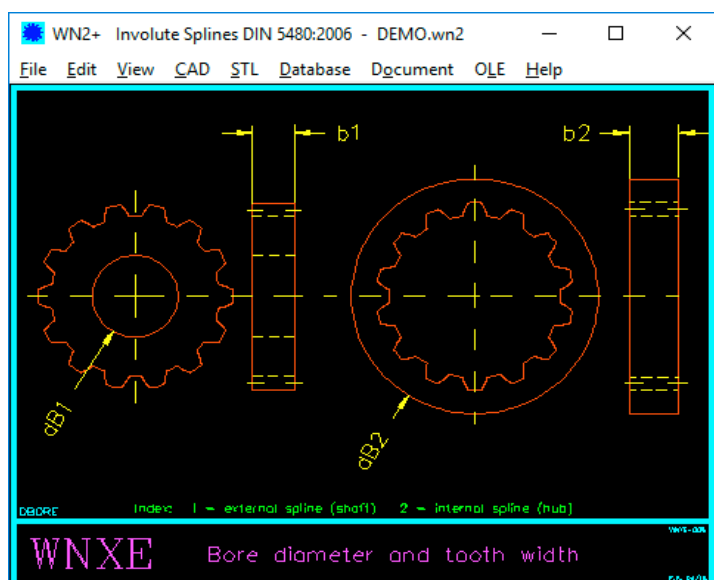
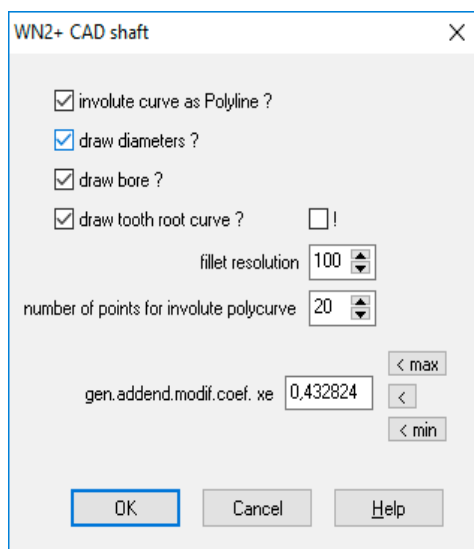
TR1: Quick3 and Quick4 View

Quick3 View and Quick4 View has been added to girder software TR1 with drawings of cross-section, bedding and loads, tables with input data and calculation results, altogether on one screen.



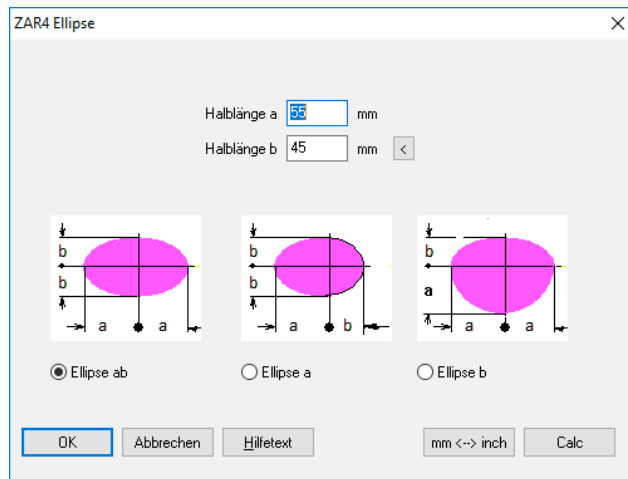
WN2+: Configure drawing with/without bore

If the tooth profile is used for conversion into a CNC program or for wire eroding, the drawing must be displayed without a bore hole. On the other hand, if you want to create an STL model on the 3D printer, you need the drawing with bore hole. For internal gearing, the bore hole diameter d_B means the outer diameter of the hub (negative sign). There is also a new help picture, this one now belongs to WN2, 4, 5, 6, 7, 8, 9, 10, WNXE, WNXP, ZAR1 +, 4, 5, 7, 8, ZARXP, ZAR1W.



ZAR4, GEO4: Half ellipse (Egg shape)

At ellipse gear input, you now also can generate an egg-shape gear composed by a half ellipse over 180° and a semicircle. Three types can be generated: Full ellipse, half ellipse with small radius semicircle, and half ellipse with large radius semicircle.



ZAR4 – center distance shift for flank clearance

Unlike round gears, the backlash is not adjusted by a flank tolerance, but by the center distance in the case of noncircular gears. Therefore you can now enter a center distance. This must be slightly larger (backlash/tan alpha) than the calculated center distance. In gear drawing and gear animation, the modified center distance is used now instead of the calculated zero-backlash center distance.

ZAR4 – DXF Import

The pitch curve of a noncircular gear wheel can be imported as a polyline in DXF format. If the polyline contains arcs, they are now taken in 1° increments.

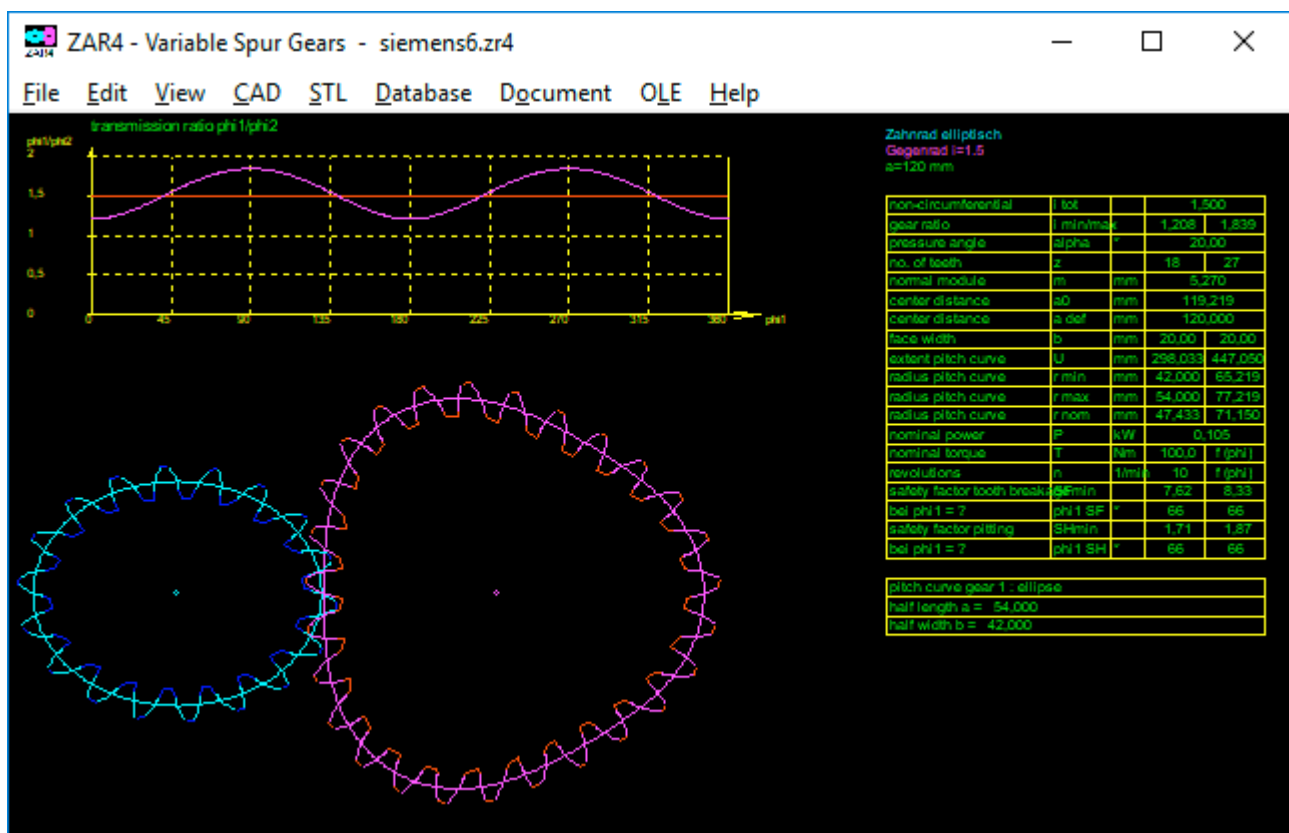
ZAR4 – Printout List

Angle of rotation of gear wheels 1 and 2, radii, transmission ratio, speed and acceleration can now be displayed in 1° increments.

phi1 °	phi2 °	r1 mm	r2 mm	i=r2/r1	v2 1/s	a2 1/s ²
1.0	-0.9	55.00	63.87	1.161	0.00	0.00
2.0	-1.7	54.98	63.88	1.162	0.90	0.00
3.0	-2.6	54.96	63.90	1.163	0.90	-0.04
4.0	-3.4	54.93	63.93	1.164	0.90	-0.05
5.0	-4.3	54.90	63.97	1.165	0.90	-0.07
6.0	-5.2	54.85	64.01	1.167	0.90	-0.08
7.0	-6.0	54.80	64.06	1.169	0.90	-0.10
8.0	-6.9	54.74	64.13	1.171	0.89	-0.11
9.0	-7.7	54.67	64.19	1.174	0.89	-0.12
10.0	-8.6	54.60	64.27	1.177	0.89	-0.14
11.0	-9.4	54.51	64.35	1.181	0.89	-0.15
12.0	-10.3	54.42	64.44	1.184	0.88	-0.16
13.0	-11.1	54.33	64.54	1.188	0.88	-0.17
14.0	-11.9	54.22	64.64	1.192	0.88	-0.19
15.0	-12.8	54.11	64.75	1.197	0.88	-0.20
16.0	-13.6	54.00	64.87	1.201	0.87	-0.21
17.0	-14.4	53.87	64.99	1.206	0.87	-0.22
18.0	-15.3	53.75	65.12	1.212	0.86	-0.22
19.0	-16.1	53.61	65.25	1.217	0.86	-0.23
20.0	-16.9	53.48	65.39	1.223	0.86	-0.24
21.0	-17.7	53.33	65.53	1.229	0.85	-0.25
22.0	-18.5	53.19	65.68	1.235	0.85	-0.25
23.0	-19.3	53.04	65.83	1.241	0.84	-0.26

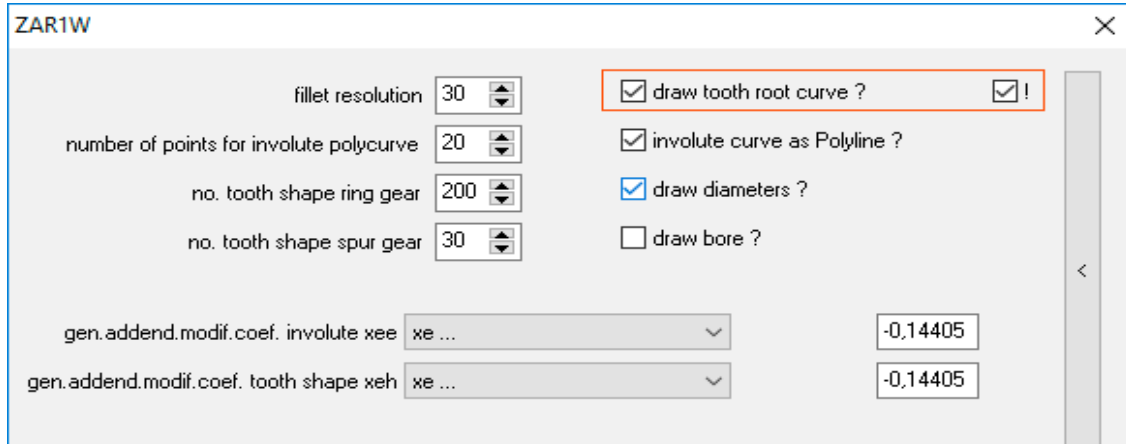
ZAR4: Free transmission ratio for non-circumferential gears

For circulating nonlinear gears, the total transmission ratio must be 1 or 2 or larger integer. If only a sector of the nonlinear gear is used, e.g. for a control lever, then this restriction can be reduced, the total transmission ratio can then have any value. This case can now also be calculated in ZAR4, for this case choose "gear pair non-circumferential" and enter number of teeth of the counterwheel. Tooth profile is not closed at $\phi = 360^\circ$ and matching teeth no longer run together. But there are also exceptions: if the pitch curve of gear 1 is symmetrical, the gear pair is also running if the total transmission ratio is 1.5 or 2.5.

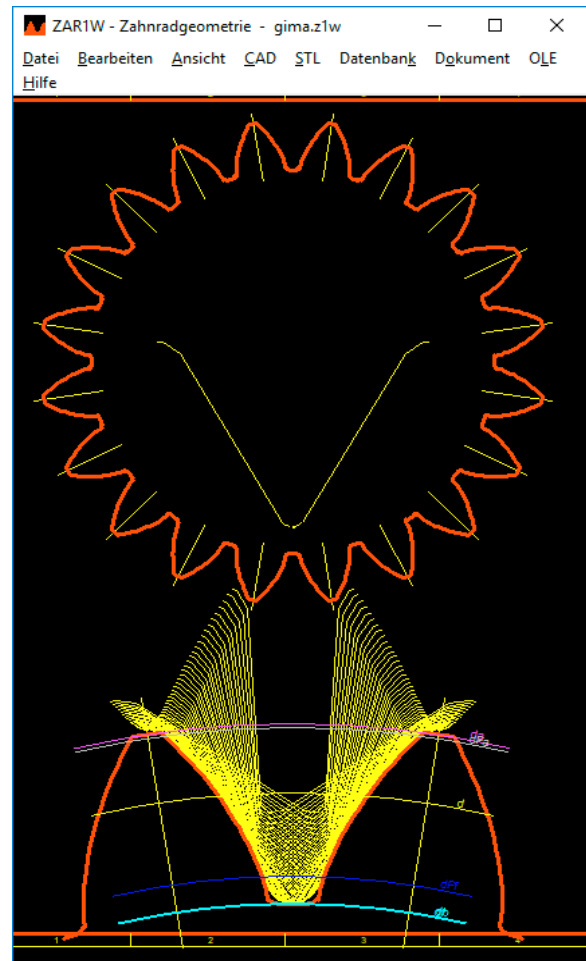
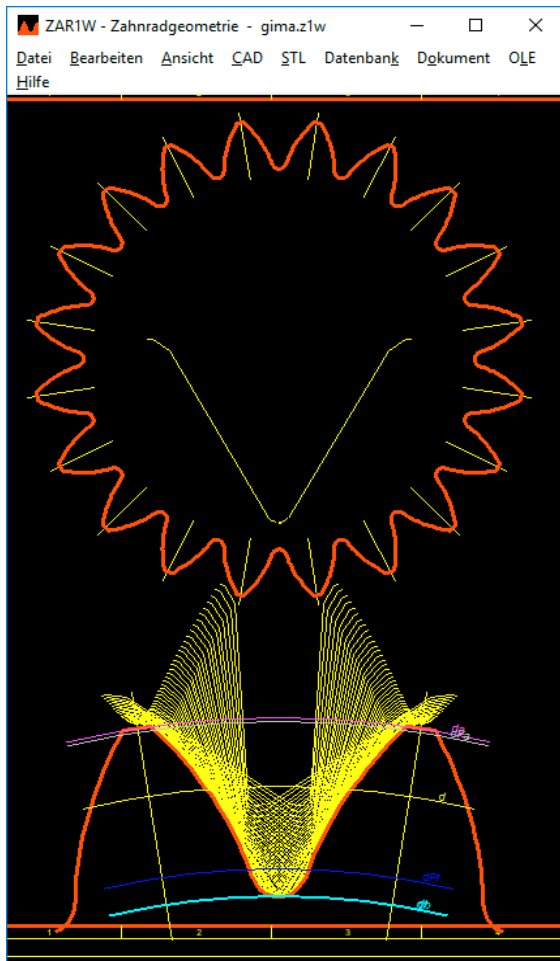


See calculation for elliptic driving wheel with generated counter wheel for total transmission ratio of 1.5.

ZAR1+, ZAR1W: Draw tooth root fillet trochoide settings

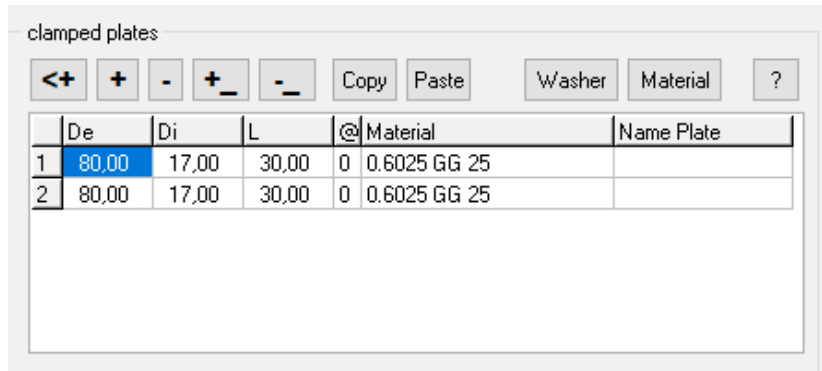


If the option "Draw tooth root curve" is set under "CAD-> Settings", then the trochoide curve generated by cutting tool will be drawn in case of undercut. Without undercut, fillet of the cutting tool is drawn. In rare cases (for "lace" gearing tools with a low frontal tooth width) there is a gap between the cutting tool shape (yellow) and the tooth fillet curve (red) in this drawing. For this case there is now a second checkbox (!) on the right, then a trochoide curve is always drawn. However, this option is not suitable as a permanent setting because, for example, involute splines according to DIN 5480 are drawn with a spike. Sometimes (but not always) helps in this case to increase the fillet resolution setting.



FED1+,6,7,10,WL1+,GEO1+,2,4,SR1+,TOL1,TR1,WN1,ZAR4: Improved Input Tables

For tables for entering shaft sections at WL1 +, spring sections at FED6 and FED7, clamping plates at SR1 +, dimensions for GEO1 +, GEO2, GEO4, ZAR4, TR1, WN1, there are improvements to insert and delete rows, and export/import with Excel.



Buttons at input tables:

+ : add new row

<+ : add new row and copy data from previous row

- : delete last row

+_ : insert new row at cursor position

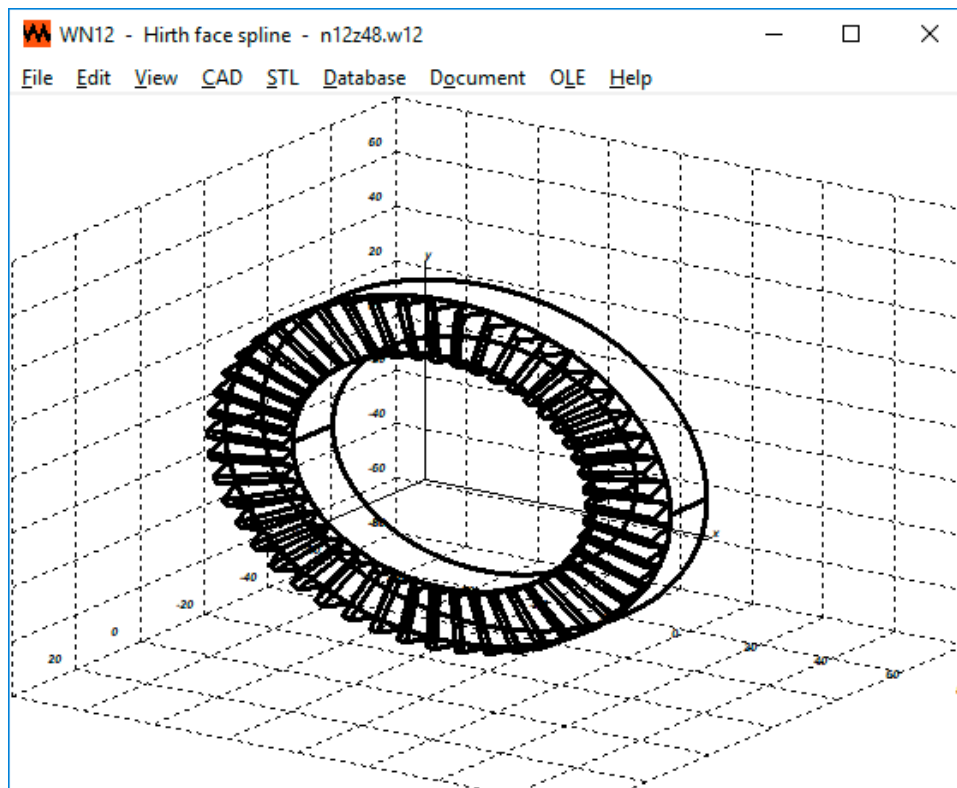
-_ : delete row at cursor position

Copy: copy marked cells into clipboard

Paste: fill cells with clipboard content at cursor position

New buttons are “+_” and “-_”. Tables for large amount of data like dimensions in WL1+, TR1, GEO1+, GEO4, ZAR4, or load spectrum of gear programs additionally got a menu with import/export functions for data exchange with MS-Excel.

WN12 – New Software for Face Splines



The new WN12 software calculates the dimensions of face splines. Outside diameter, inner diameter, teeth, fillet radius and tooth tip clearance and tooth gap angle are input data. WN12 calculates the surface area, surface pressure and safety factor from torque, preload and material data. The tooth drawing is generated by the program and can be exported to CAD. A model of a ring with face spline can be made with 3D printers, WN12 generates an STL file for it. Standard sizes can be selected from the integrated database. Alternatively, the dimensions for self-defined face splines can be entered directly.

N12-D125			
No. of teeth	z		48
Gap angle	gamma	°	60,00
major diameter	De	mm	125,00
minor diameter	Di	mm	85,00
height	hg	mm	16,70
Height until teeth center	hzm	mm	15,00
tooth height exterior	he	mm	4,32
tooth height interior	hi	mm	2,05
tooth height angle	alpha	°	3,23
tooth fillet	r	mm	0,92
tooth tip width	bk	mm	2,13
tip clearance	S	mm	0,92
pressure height exterior	hpe	mm	3,40
torque	Tmax	Nm	1700
Tangential force	Fu	N	32381
axial load	Fa	N	18695
axial preload	Fva	N	14021
area	Az	mm ²	2512
pressure	pmax	MPa	20
material: S235JR (St 37-2)			1.0037
yield strength	Re	MPa	235
load bearing coeff.	klamb.		0,65
Perm. surface pressure	plim	MPa	282
safety plim/pmax	Sp		14,1
Error : Fva < Fa			
Warning: Fva/Fa < 1.8			

Because there is no ISO or DIN standard for face splines, you can display and print out the names and formulas used in WN12.

No. of teeth	z		12
Gap angle	gamma	°	60,00
major diameter	De	mm	30,00
minor diameter	Di	mm	22,00
Height until teeth center	hzm	mm	5,80

torque	Tmax	Nm	80
axial preload	Fva	N	6150
material: S275JRC (St 44-2)			1.0044
yield strength	Re	MPa	275
load bearing coeff.	klamb.		0,75

Symbol	Formula	Result	Unit
beta	beta=gamma/2	30	°
He	He=pi/2/tan(beta)*De/z	6,802	mm
Hi	Hi=pi/2/tan(beta)*Di/z	4,988	mm
Hm	Hm=(He+Hi)/2	5,895	mm
alpha	alpha=arctan(pi/tan(beta)/z)/2	12,20	°
lr	lr=r/sin(beta)	1,2	mm
lrs	lrs=r*(1/sin(beta)-1)+S	1,2	mm
hpe	hpe=He-2*lrs	4,402	mm
hpi	hpi=Hi-2*lrs	2,588	mm
he	he=He-lrs-lr+r	5,002	mm
hi	hi=Hi-lrs-lr+r	5,002	mm
la	la=Hm-2*lrs/cos(beta)	4,036	mm
bk	bk=tan(beta)*2*lrs	1,386	mm
hz	hz=2*hzm	11,60	mm
hg	hg=hzm-lrs+ha/2	11,60	mm
Fu	Fu=4*Tmax/(De+Di)	6154	N
Fa	Fa=Fu*tan(beta)	3553	N
Az	Az=la*(De-Di)/2*z	193,7	mm ²
pmax	pmax=(Fva+Fa)/Az/klambda	66,79	MPa
plim	plim=Re*fh*fs	330	MPa
Sp	Sp=plim/pmax	4,941	

A production drawing with ISO 7200 data field contains profile drawings and tables with dimensions. The drawings can be printed or exported to CAD.

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HEXAGON Industriesoftware GmbH

Stiegelstrasse 8 D-73230 Kirchheim Tel. +49 7021 59578, Fax +49 7021 59986
 Kieler Strasse 1A D-10115 Berlin Mühlstr. 13 D-73272 Neidlingen
 Mobile: +49 163 7342509 E-Mail: info@hexagon.de Web: http://www.hexagon.de