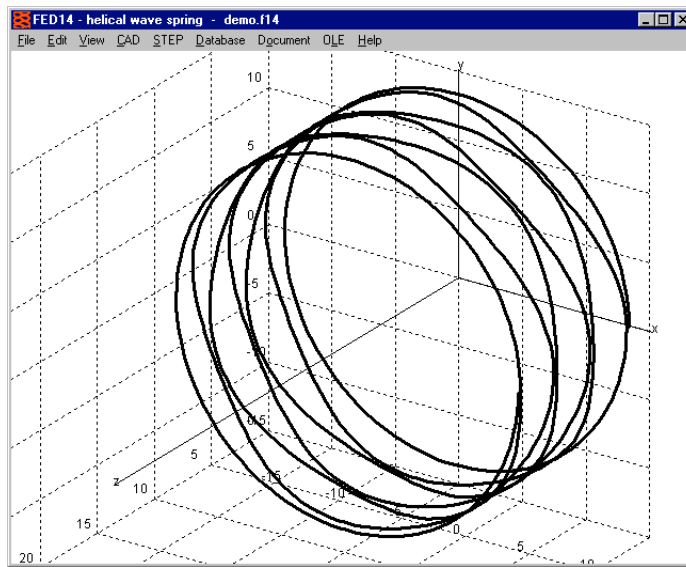


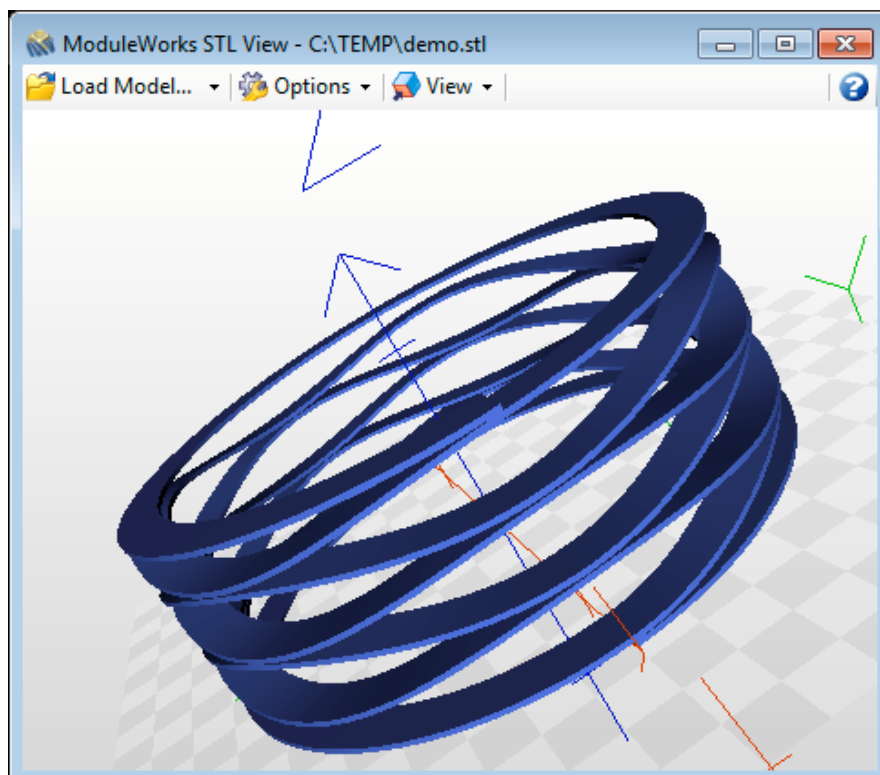
by Fritz Ruoss

FED14: 3D Centerline of Helical Wave Spring

3D centerline of helical wave spring can now be generated as 3D drawing to be exported into CAD as DXF, IGES, STEP or TXT file.

FED14: STL Export

A 3D model of the helical wave spring can be generated as STL file.



FED1+: Temperature Table

	44,4°C	20°C	0°C	100°C
<i>G [MPa]</i>	76677	77200	77629	75484
<i>F1 [N]</i>	41,82	42,1	42,34	41,17
<i>F2 [N]</i>	483,3	486,6	489,3	475,8
<i>R [N/mm]</i>	11,62	11,70	11,76	11,44

A table with spring properties for four different temperatures can be shown now at View -> Temperature -> Table:

- operating temperature
- 20°C
- temperature "from" (Edit -> Production drawing)
- temperature "to" (Edit -> Production drawing)

Table includes temperature-dependent data shear module G, spring loads F1, F2, as well as F1,48h and F2,48h after relaxation, and spring rate R.

Quick4 view includes the temperature table, if operating temperature is different than 20°C.

Quick3 view, from now on shows spring load F2,48h only if springs "not set" or "free" was selected at "Edit -> Production Drawing". If the compression spring was pre-set, remaining relaxation is much lower than calculated, and therefore no longer listed in Quick3 and Quick4 view.

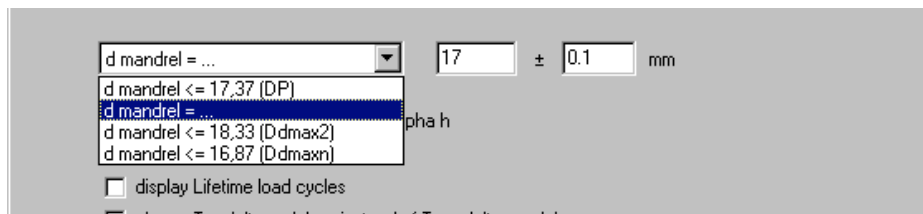
FED3+: Diameter of Mandrel and Bore

According to DIN 2194, test mandrel diameter DP is calculated. Maximum diameter of mandrel and minimum diameter of bore had been calculated according to this formula, too. Now, max mandrel and min bore diameter are calculated without 5% buffer, but with wire diameter tolerance.

$Dd_{max2} = Di_2 - AD - Ad$ (mandrel until alpha2) and $Dd_{maxn} = Di_n - AD - Ad$ (mandrel until alpha n)

$DH_{min} = De + AD + Ad$ (bore)

As alternative, you can enter mandrel diameter with tolerance at Edit->Production Drawing". List of available pre-settings was enlarged: select between $Dd \leq DP$, $Dd \leq Dd_{max2}$, $Dd \leq Dd_{maxn}$, or with “..” input mandrel diameter and tolerance.



FED4: Spring rate of packed disk springs

In FED4 you can calculate disk springs as well as disk spring packages. For number of spring packages $i > 1$, spring loads were calculated correct, but spring rate remained unchanged, this was corrected now (i = number of spring packs, n = disk springs per pack):

Spring load of spring pack compared with single spring: $F = F_i * n$

Spring rate: $R = R_i * n / i$

Spring Work: $W = W_i * n * i$

Thanks to Mr. Erhardt of Hilti for the hint.

TR1: Quick Input for Girder Calculation

In a new Quick Input dialogue window you now can enter all dimensions, load, material and bearing data.

TR1 - Girder Calculation - Quick Input

Draft: drawing name: drawing number:

drawing name 2:

line 1: Application Example

line 2:

profile Dimensions

	y [mm]	z [mm]	phi °
1	0,00	-33,00	0
2	1,33	-33,00	82,05
3	6,98	-28,09	0
4	9,82	-7,76	-82,05
5	15,47	-2,85	0
6	124,53	-2,85	-82,05
7	130,18	-7,76	0
8	133,02	-28,09	82,05
9	138,67	-33,00	0
10	140,00	-33,00	0
11	140,00	33,00	0
12	138,67	33,00	82,05

length girder: 1200 mm

material: AlMg5F32

elastic modulus E: 70000 MPa

shear modulus G: 27000 MPa

density: 2,7 kg/dm³

radial load Fr

	F [N]	x [mm]	Text
1	1800	1180	F 1
2	1000	1180	

constant path load q

	q [N/mm]	x1 [mm]	x2 [mm]	Text
1	10	330	1030	

bending moment Mb

	Mb [Nm]	x [mm]	Text
1	91	1180	

axial load Fx

	Fx [N]	x [mm]	Text
1	1300	1180	

bearing

bearing type: fixed clamping

bearing positions: x: 0 mm

spring rate: R: N/mm

force introduction angle: w: °

roller pitch line diameter: dw: mm

Calculation Method:

Reset:

OK Cancel Help Text Aux. Image mm <-> inch Calc

Calculation successful without error messages

ZAR2: Quick Input for Spiral Bevel Gears (Klingelnberg Cyclopalloide)

New Quick Input allows input of all dimensions, tolerances, assembly dimensions, material, drive data, lubrication and strength calculation data in only one dialogue window now.

ZAR2 - Bevel Gear Design Quick Input

Drawing: Quick 3

gear 1: Drawing name: Pinion, Drawing number: 000000, Drawing name 2:

gear 2: Drawing name: Gear, Drawing number: 000000, Drawing name 2:

Material gear 1: 17CrNiMo6, Sigma-FE: 620 MPa, Sigma-Hlim: 1300 MPa, HB: 650, E: 210000 MPa, mu: 0,3, rho: 7,85 kg/dm3, Case-hardening steel (Eh), case-hardened (Eh)

Material gear 2: 42CrMo4, Sigma-FE: 500 MPa, Sigma-Hlim: 1000 MPa, HB: 500, E: 210000 MPa, mu: 0,3, rho: 7,85 kg/dm3, Heat-treatable steel (V), flame-hardened (IF)

Dimensions

Pre-dimensioning

Rot. speed n1: 1000 1/min

Rated torque T1: 5000 Nm

Rated power P: 523,6 kW

Gear axis angle summa: 90 deg

Gear ratio u=n1/n2: 6

Pitch circle diameter d02: 760 mm

Facewidth b: 110 mm

Normal module mn: 10,5 mm

Helix angle Bm: 29,5 deg

Pinion no. of teeth z1: 9

Number of teeth z2: 54

Assembly dimension tB1: 382,4 mm

Auxiliary plane distance tH1: 107,8 mm

borehole diameter dB1: 0 mm

Assembly dimension tB2: 100,6 mm

Auxiliary plane distance tH2: 25,07 mm

borehole diameter dB2: 0 mm

Gear quality acc. DIN: 5

Rot speed, Torque, Rated power

z2/z1 = 54 / 9 = 6

gear 1: Rot. speed n: 1000 1/min, Rated torque T: 5000 Nm, Rated power P: 523,6 kW

gear 2: Rot. speed n: 166,7 1/min, Rated torque T: 30000 Nm, Rated power P: 523,6 kW

Calculation method: accord DIN 3991

Strength

gear 1: Tooth contacts per/rotation e: 1, no. of load reversions/period Np: 0, Average peak-to-valley height Tooth flank RzZ: 5 µm, Average peak-to-valley height Tooth root RzY: 5 µm

gear 2: Tooth contacts per/rotation e: 1, no. of load reversions/period Np: 0, Average peak-to-valley height Tooth flank RzZ: 5 µm, Average peak-to-valley height Tooth root RzY: 5 µm

Oil working temperature: 50 °C, Oil viscosity at 40°C: 80 mm²/s, Visko... °C

application factor: KA H: 1, KA F: 1, KA S: 1, KA: ?

Lubrication: Immersion lubrication, Manufacture: finished cut, drive: 1 drives 2, Bearing: both double-sided

application: Aeroplane, Tooth relief Ca: 0 µm

OK Cancel Help Text Aux. Image mm <-> inch Calc

Error: gear ratio!
Warning: SH < 1.0! [0,32]
Warning: SH < 1.0! [0,71]

ZAR2, ZAR6: View Strength Calculation with Formulae and Factors

Similar as in ZAR1+, in ZAR2 and ZAR6 a new screen was created with essential formulas, factors and results of strength calculation according to DIN 3991.

ZAR2 - Bevel Gear Design - DEMO.r12

File Edit View CAD Database Document OLE Help

CALCULATION METHOD: accord. DIN 3991

	gear 1	gear 2
Sigma-FG = SigmaFE * YdrelT * YrelT * YK * YA	MPa 610	492
Sigma-F0 = Fmt * (beF * mmm) * YFa * YSa * Yk * Yeps * YK	MPa 217	253
Sigma-F = Sigma-F0 * KA * Kv * KF * KFalfa	MPa 343	400
SF = Sigma-FG / Sigma-F	SF 1,777	1,229
Sigma-H0 = ZH * ZE * Zeps * Zb * ZK * sqrt(Fmt * (dvl * beHY) * (uv + 1) * Yuv)	MPa	950
Sigma-HG = SigmaHlim * ZL * Zv * ZR * ZX	MPa 1102	848
Sigma-H = ZB * Sigma-H0 * sqrt(KA * Kv * KH * KHalfa)	MPa 1194	1194
SH = Sigma-HG / Sigma-H	SH 0,923	0,710
theta flaE = mueB * Km * XBe * Xal.be * (KA * Kv * KB * KBalfa * KBgamma * Fmt * beHY) * (3/4) * vmt * (1/2) * jav * 1/4 * 1 / (X * D * X * Ca)	°C	208
theta flainE = thetaflaE * Xeps	°C	70
theta int = thetaM + C2 * theta flainE	°C	204
theta intS = thetaM + C2 * Xv * theta flainE	°C	239
SintS = theta int S / theta int	SintS	1,174

K FACTORS	Y	gear 1	gear 2
KA H	1,00		
KA F	1,00		
KA S	1,00	2,043	2,346
Kv	1,01	1,997	2,028
KH-beta	1,50		0,754
KF-beta	1,50		0,753
KB-beta	1,50		1,000
KF-alfa	1,04	1,000	1,000
KH-alfa	1,04	1,041	1,041
KB-alfa	1,04	0,946	0,946
KB-gamma	1,24		

Z FACTORS	gear 1	gear 2
ZH	2,23	
ZB	1,00	
ZE	1,92	
Z eps.	0,92	
Z beta	0,93	
ZL * Zv * ZR	0,85	
ZK	0,85	

drive	gear 1	gear 2
P	kW 523,800	523,800
T	Nm 5000,0	30000,1
n	1/min 1000	166,7

Dimensions	gear 1	gear 2
z	9	54
zv	9,1	328,5
x	0,550	-0,550
delta	9,46	80,54

Dimensions	gear 1	gear 2
summa	*	90,0
alpha	*	20,0
betaM	*	29,5
b	mm	110,0
u	mm	6,000
m0	mm	10,500
mmm	mm	10,500
Rm	mm	330,24
Re	mm	395,24
Ri	mm	275,24

MATERIAL	gear 1	gear 2
material	17CrNiMo8	42CrMo4
Sig.Hlim	MPa 1300	1000
Sigma FE	MPa 620	500
Sig.Flim	MPa 310	250
Tempering:	case-hard.	flame-hard.
Brinell	HB 650	500
E	MPa 210000	210000
mue	0,30	0,30
rho	kg/dm3 7,85	7,85

FORCES	gear 1	gear 2
Fmt	N 92096	92096
Fa Z	N 57741	29423
Fa S	N -45077	46560
Fr Z	N 29423	57741
Fr S	N 46560	-45077

epsilon	gear 1	gear 2
eps.v.alpha	1,173	
eps.v.beta	1,398	
eps.v.gamma	2,569	

K, Y, Z	gear 1	gear 2
vmt	m/s 5,885	
Rz Z	µm 5,0	5,0
Rz Y	µm 5,0	5,0
mue40	mm²/s 80	

Z	gear 1	gear 2
beH	mm 93,50	
dvl	mm 110,08	
uv	36,000	
ZX	1,00	1,00

X	gear 1	gear 2
drive	1 drives 2	
v40	mm²/s 80,0	
th.Oil	°C 50,0	
T1T	Nm 300,0	
publication:	Immersion lubrication	
Ca	µm 0,80	
Ceff	µm 53,38	
X S	1,00	
Xeps.	0,34	
XM	50,00	
XBE	0,56	
Xal.be.	0,99	
XQ	1,00	
XCa	1,00	
mueB	0,07	
thetaM	°C 99,0	
thetaMT	°C 149,0	
thetaflaint	°C 70,0	
thetaflaintT	°C 80,3	
XvHelt	1,00	
C2	1,5	
av	2036,5	

Application example for demo version
Pinion 000000
Gear 000000

error messages
gear ratio !
Warning: SH < 1.0 ! (0,92)
Warning: SH < 1.0 ! (0,71)

ZAR6: Quick Input for Bevel Gear Design

Enter all dimensions, tolerances, assembly data, material, drive data and data for strength calculation in only one dialogue window.

ZAR6 - Bevel Gear Design Quick Input

gear 1 Drawing name: Ritzel Drawing number: 23.57-1 Drawing name 2: Drawing number 2: Drawing name 2: gear 2 Drawing name: Rad Drawing number: 23.57-2 Drawing name 2: Drawing number 2: Drawing name 2:

Basic rack: Addendum hA/mm: 1, 1 Dedendum hF/mm: 1,25, 1,25

helical geared Gear axis angle summa: 90 Pressure angle alpha: 20

Text 1: Decker Maschinenelemente Aufgaben Text 2: Aufgabe 23.57

gear 1 Assembly dimension tB1: 212,1 mm Auxiliary plane distance tH1: 53,4 mm borehole diameter dB1: 22 mm gear 2 Assembly dimension tB2: 121 mm Auxiliary plane distance tH2: 29,17 mm borehole diameter dB2: 29 mm

gear1 (dv = 188,6) Gear quality DIN 3965: 5 xH-thickness tolerance Tsn (DIN 3967): 25 xH-thickness deviation Asne (DIN 3967): e Asne: -0,056 Asni: -0,106 mm gear2 (dv = 831,7) Gear quality DIN 3965: 5 xH-thickness tolerance Tsn (DIN 3967): 25 xH-thickness deviation Asne (DIN 3967): e Asne: 0,1 Asni: 0,18 mm

Material gear 1: 42CrMo4V (1.7225) Sigma-FE: 770 MPa Sigma-Hlim: 1070 MPa HB: 550 E: 210000 MPa mu: 0,3 rho: 7,85 kg/dm3 Heat-treatable steel (V) gas-nitrided (NT) Material gear 2: 15MnCr5N (1.7131) Sigma-FE: 650 MPa Sigma-Hlim: 770 MPa HB: 560 E: 210000 MPa mu: 0,3 rho: 7,85 kg/dm3 Case-hardening steel (EH) nitrocar. (NV)

Re-calculation: Number of teeth z1: 20 z2: 42 Facewidth b: 60 mm Helix angle beta: 20 Profile shift coeff. x1: 0 Tooth thckn. alteration fact. xs1: 0

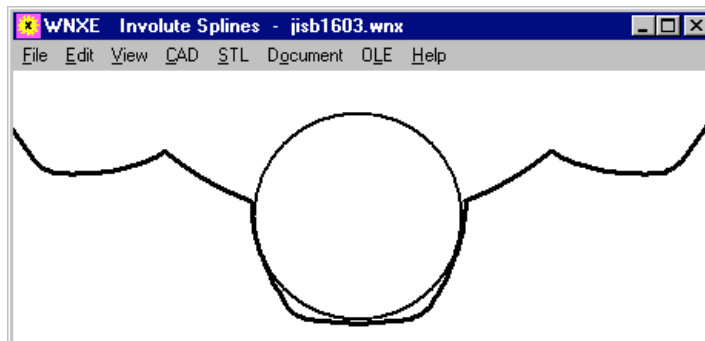
Strength: e, np? Tooth contacts per/rotation e: 1, 1 no. of load reversions/period Np: 0, 0 Average peak-to-valley height Tooth flank RzZ: 12, 12 Average peak-to-valley height Tooth root RzY: 20, 20 Oil working temperature: 80 °C Oil viscosity at 40°C: 150 mm²/s application factor KA H: 1 KA F: 1 KA S: 1,25 Manufacture: drive Bearing lapped 1 drives 2 one double-sided, one cantilever Lubrication: Immersion lubrication application: Industry Tooth relief Ca: 0

Error: Warning: epsvbeta < 1

OK Cancel Help Aux. Image mm <-> inch Calc

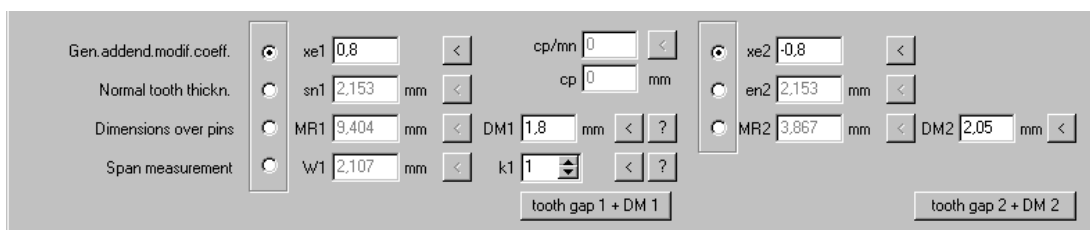
ZAR1+, ZAR5, ZAR7, ZAR8: Measuring circle drawn according to xe settings

Measuring circle in tooth gap drawing was drawn in tolerance center until now, as this is the default setting. If you modified tooth drawing by means of profile shift coefficient x_e , position of measure circle remained unchanged. But now, dimensions over balls/pins are calculated for the actual setting and measuring circle is drawn equivalent to this setting.



ZAR1+, ZARXP, ZAR1W, WN2+, WN4, WN5, WN10, WNXE: Button „Tooth gap + DM“

A new button "tooth gap + DM" in the input window draws tooth gap with measuring circle in the background window. So you can easily test different ball and pin diameters. The suggested value according to DIN 3960 is not always suitable for gears with small tooth height (involute splines), calculated diameter must be checked. By means of the drawing you can evaluate if a flattened pin or ball must be used.

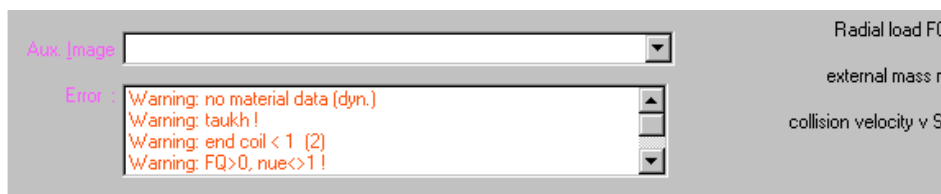


ZARXP, WNXE: Minimum and Maximum values of Dimensions over Pins or Balls

Input of dimension over pins/balls for iterative calculation of profile shift coefficient x_e was improved in ZARXP and WNXE. Allowed input zone for internal gears and splines was enlarged, and if overriding allowed zone you get error messages $MR > MR_{max}$, $MR < MR_{min}$, $MK > MK_{max}$, $MK < MK_{min}$. Please consider negative signs if you calculate internal gears (-2 is smaller than -1).

FED1+, SR1+, WL1+, FED10: Error Box in Quick Input Window

New box with error messages at Quick Input: Click into error message to get description and remedy displayed as hint.



ZAR1+, ZAR1W, ZARXP: Profile drawn continuous

By inserting teeth as block into the drawing, gear wheels not always were drawn in one curve. This cannot be seen in the drawing, but if you convert the profile drawing into CNC code this can be used without optimization now. By means of our DXFMAN software, tooth profile can be converted into one polyline, to be used in GEO1+ for example to calculate area, mass and area moments of inertia.

ZAR1W: Quick Input

ZAR1W calculates dimensions and tolerances of one gear wheel. Other as in ZAR1+, in ZAR1W you calculate one gear wheel, no gear pair. No center distance, no strength calculation. ZAR1W is well suited for gear manufacturers, few input data are enough to get all dimensions and a profile drawing. New in ZAR1W is Quick Input with all input data in one dialogue window. With „Calc“ button or „Enter“ key, gear wheel is recalculated and result graphic is actualized in the background window.

ZAR1W - Involute Gear Dimensions Quick Input

Display: []
 Aux. Image: []
 Error: Calculation successful without error messages

Text 1: Application Example
 Text 2: ZAR1W Demo
 Drawing name: Helical Gear
 Drawing number: 0000002
 Drawing name 2: []

Dimensions

Pressure angle alpha: 20 deg.
 Helix angle beta: 9 deg.
 Normal module mn: 6.5 mm (3.908 1/in)
 Number of teeth z: 58 +/-
 Facewidth b: 88 mm
 Profile shift coeff. x: 0.57 < x min < x05
 tip reduction:
 kmn: 0 mm
 da: 401.903 mm
 tooth alignment: free
 borehole dB: 0 mm

Basic rack

self-defined...
 Database
 Protuberance
 chamfer
 haPO/mn: 1.25
 hiPO/mn: 1
 raPO/mn: 0.25
 rfPO/mn: 0.3

Gear quality

Gear quality: DIN 3961 6
 tooth-thickness tolerance Tsn (DIN 3967): 25
 tooth-thickn.deviation Asne (DIN 3967): e
 Asne: -0.075 Asni: -0.135 mm (d = 381.7)
 Machining allowance q: 0 + 0 mm

measurement

No. of teeth measured k: 8
 Ball and pin diameters DM: 12 mm
 tooth gap + DM

OK Cancel Help Aux. Image mm <-> inch Calc

ZAR1W: Additional Table in Quick4 View

Two tables with additional dimensions (nominal/min/max) have been added to Quick4 View.

ZAR1W - Involute Gear Dimensions - HIGHTOOT.z1w

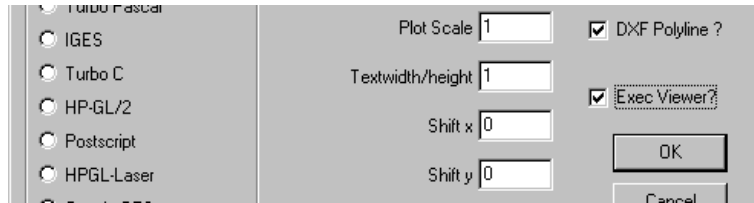
File Edit View CAD STL Database Document OLE Help

span measure W/ min 41,491 41,281

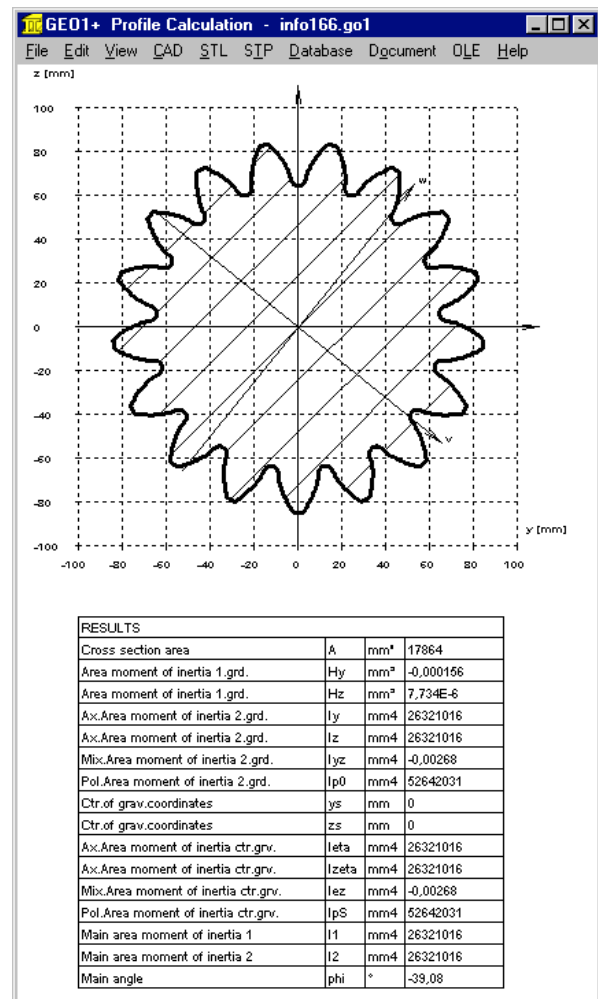
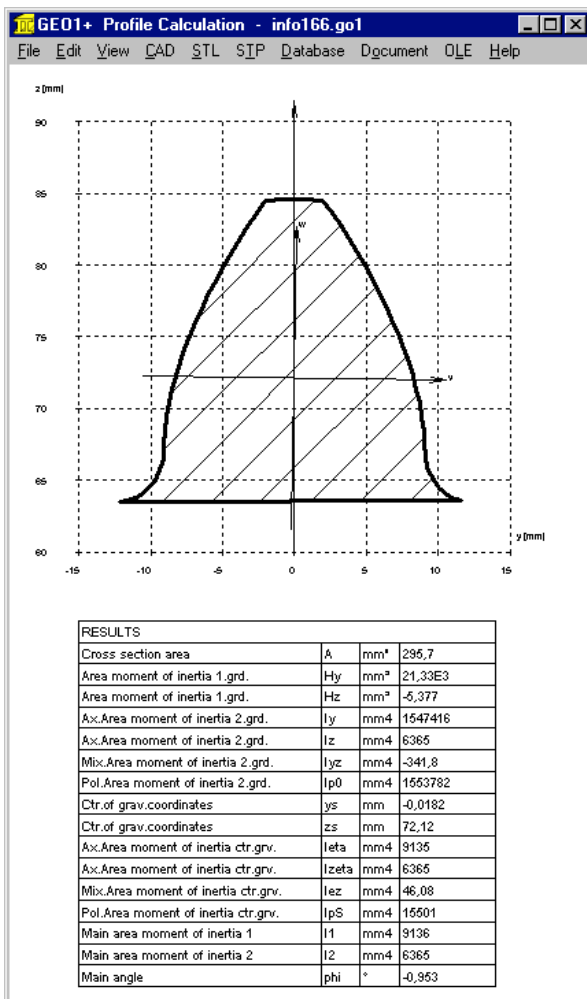
	nom	min	max
Asn	0,000	-0,059	-0,019
sn	3,479	3,420	3,460
st	4,017	3,949	3,995
san	1,282	0,827	1,257
sat	1,481	0,955	1,451
xe	0,20000	0,15436	0,18530
q	0,086	0,086	0,172
xev	0,20000	0,32497	0,46464
dw	95,775	95,755	95,794
df	88,002	88,515	89,087
dFf	90,871	90,762	90,836
da	101,920	100,122	100,694
dFa		99,707	100,694
h	5,803	5,517	6,090

alpha	17°30'
alpha t	20°0'19"
beta	30°
beta b	28°28'50"
pn	6,440
pt	7,437
pbt	6,988
pet	6,988
pen	6,142

HPGL-Manager, DXF-Manager: DXF Polyline



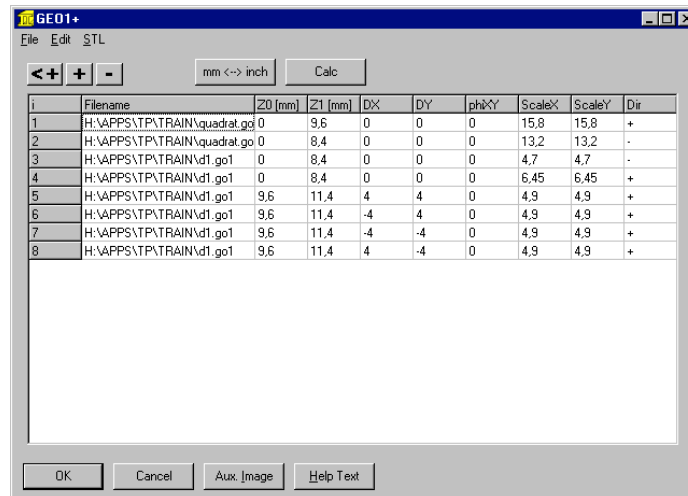
For conversion of a profile drawing into DXF you can set a new Option “DXF Polyline?” to create a dxf drawing which consists of only one drawing element, one polyline. Of course, this makes sense only if the drawing is a continuous profile, a gear profile drawing of ZAR1+ for example, where a teeth is defined as block and inserted z times. By conversion from DXF into DXF, blocks are removed and tooth profile drawn as one polyline. Example applications: convert into CNC track, or load into CAD and extrude as 3D body, or import with GEO1+ for calculation of area and area moments of inertia. If you import a gear wheel DXF file of ZAR1+ into GEO1+, one teeth will be loaded and calculated. If you convert the file by means of DXFMAN and "DXF Polyline?" option, you can import the complete gear wheel profile into GEO1+.



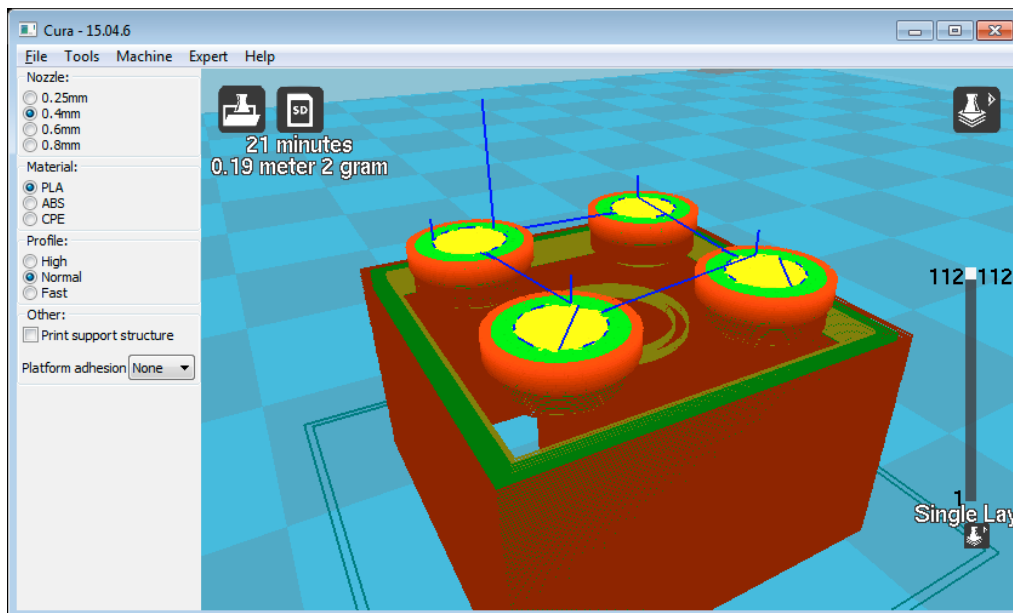
GEO1+: Mirror and Copy

By button „Transform.“, profile coordinates can be moved, turned, mirrored and direction inverted. A new option „Mirror and Copy“ has been added.. This eases input of symmetric profiles. Design a half of the profile, 2nd half "mirror and copy".

GEO1+: Create 3D STL files from 2D GEO1 Profiles



At “Edit -> 3D Layer” you can select up to 100 GEO1 files and assemble to a 3D body by input of profile height and position. Next you can create a STL file for 3D printing. For a gear wheel with inner internal spline, for example, 2 files are required: gear profile of ZAR1+ or ZAR1W or ZARXP, and inner involute spline profile of WN4 or WNXE. For each GEO1 element, you can define position, scale and direction. This is very practical, so you can work with only few base profiles. For example, a circle with diameter of 1mm can be used for each cylinder and bore, because diameter is entered as scale. With direction “+” as cylinder and inverse direction “-“ as cylindrical bore. Example: Lego block made from only 2 base elements: circle (6x) and square (2x).



SR1: Yield Point at higher temperature

If you enter a working temperature other than reference temperature, SR1 calculates tensile strength R_m , yield point $R_{p0.2}$ and permissible pressure p_G for working temperature from database at "Database\Material\Bolt,Plates\ $R_{p0.2}=f(T)$ ". If the selected material cannot be found in the database, SR1+ uses this formula for approximated calculation of the yield point:

$$R_p(T) = R_p \cdot (1.018 - T/1120)$$

Tensile strength and permissible pressure at temperature are calculated with the same coefficient:

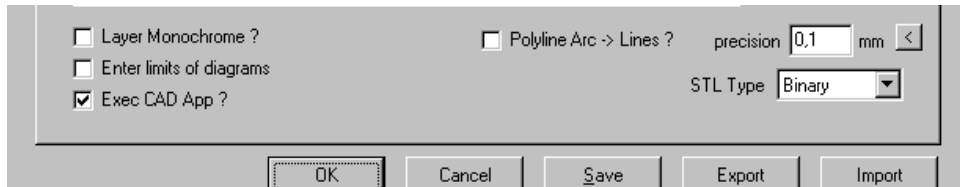
$$R_m(T) = R_{m20} \cdot R_p(T) / R_{p20}$$

$$p_G(T) = p_{G20} \cdot R_p(T) / R_{p20}$$

All Programs: Zoom Screen Graphic with Mouse Wheel

As alternative to keys + and – you now can use mouse wheel to enlarge or reduce size of screen graphic.

Tip: Exec DXF, IGS, STP, STL software directly



If "Exec CAD App" is checked at "File\Settings\CAD\ ", the installed software to edit or view CAD files or STL files is executed to open the generated CAD file. If no application is assigned to the file extension (DXF,IGS,STP,STL), maybe you get an error message such as "cannot open file" or "no certificate". To avoid the error message, uncheck "Exec CAD App?", then save configuration.

At "File\Settings\Directories" you can configure the folder for CAD files.



Tip: Spring Calculations with different shear module

Our spring software calculates with shear module $G=82000\text{MPa}$ for spring wire DM,DH,SM,SH. EN 10270-1 and EN 13906, however, use $G=81500\text{MPa}$. The difference of 0.6% results in an equivalent difference at load and stress. We use $G=82000\text{MPa}$ since decades, because customers claim that these data are exact. To compare results with shear module $G=81500$ according to EN, you have several possibilities:

1. Edit->Material: Select "others..": input $G=81500$
2. Edit->Application: Enter operating temperature $T = 44.4\text{ °C}$ to get $G=81500$
3. Database -> fedwst (Browse): copy record with Edit\Append, then modify G

Option 3 is not recommended: On a later update, your modified database fedwst.dbf may be overwritten, if you do not take care about.

Other materials with deviations to EN standards: spring wire according to EN 13906-2: $G=79500\text{MPa}$. HEXAGON software uses $G=79500$ for FDC, FDCrV and FDSiCr. But shear module G for VDC is a bit higher and for VDCrV and VDSiCr a bit lower.

Tip: Save default settings in NULL file

Your individually preferred materials, tolerances, dimensions, .. can be saved in a NULL file. NULL is the file name.

Example: In SR1, material database mat_p_1.dbf for clamping plates and material 10.9 for bolts and friction coefficients 0.1 should be set by default.

Then start a new calculation, input default data and one clamping plate, then save with file name "null". If you start SR1+ next time, it opens file null.sr1 automatically, if exist.

HEXAGON PRICELIST 2018-01-01

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