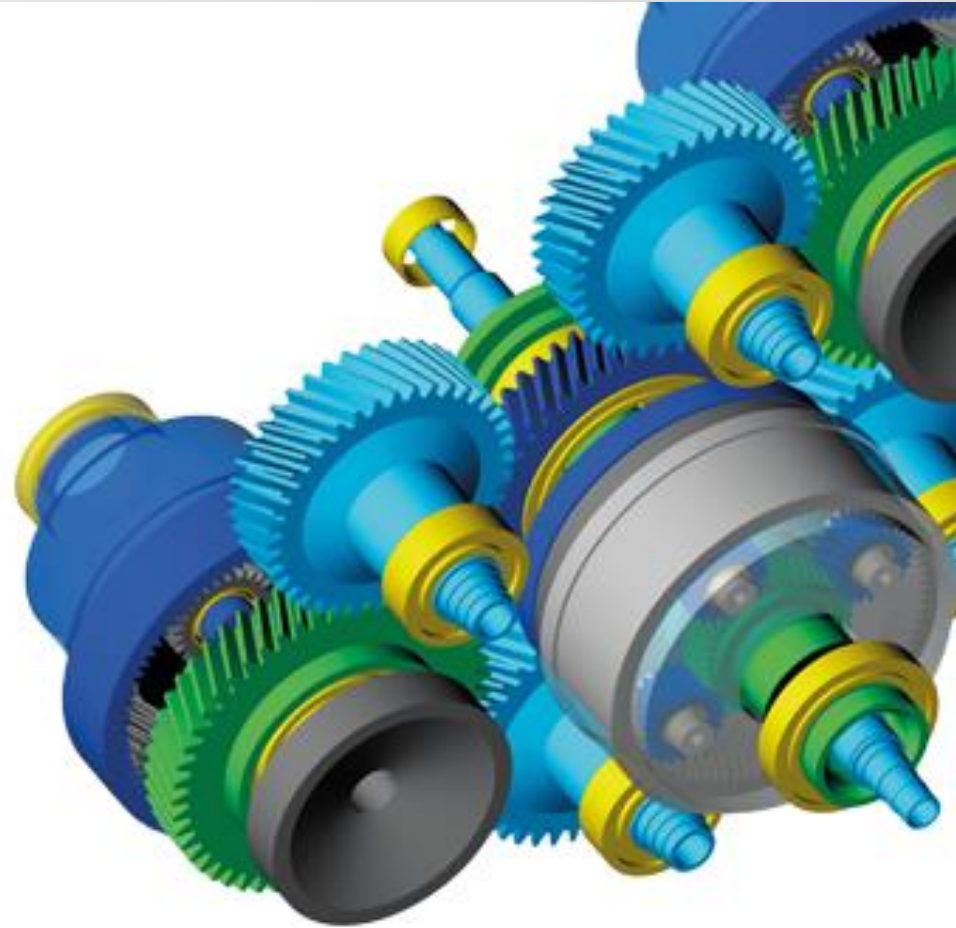


KISSsoft

Reseller Meeting 2017 - Bevel Gear Modification Sizing

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KISSsoft AG



Where is the Modification Sizing used / What for ?

Layout Process of a Gear Set

STAGE I

- Define Raw Dimensions
- a (center distance), b (face width)



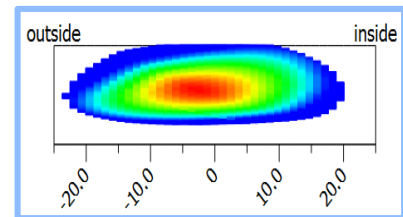
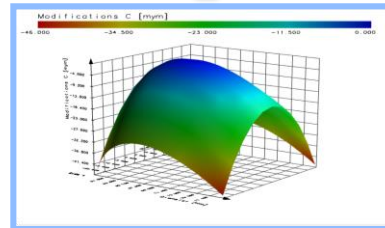
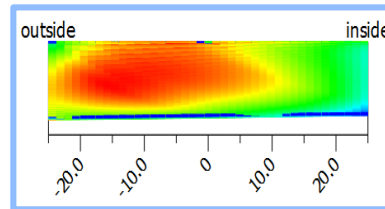
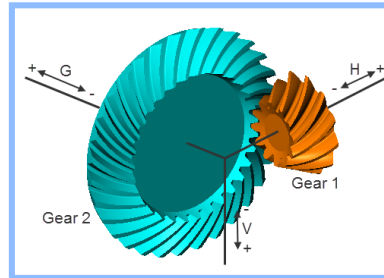
STAGE II

- Define Macro Geometry
- m_n , z , α , β , x , h_{aP} , h_{fP} , ...



STAGE III

- Define Micro Geometry
- Tooth flank modifications

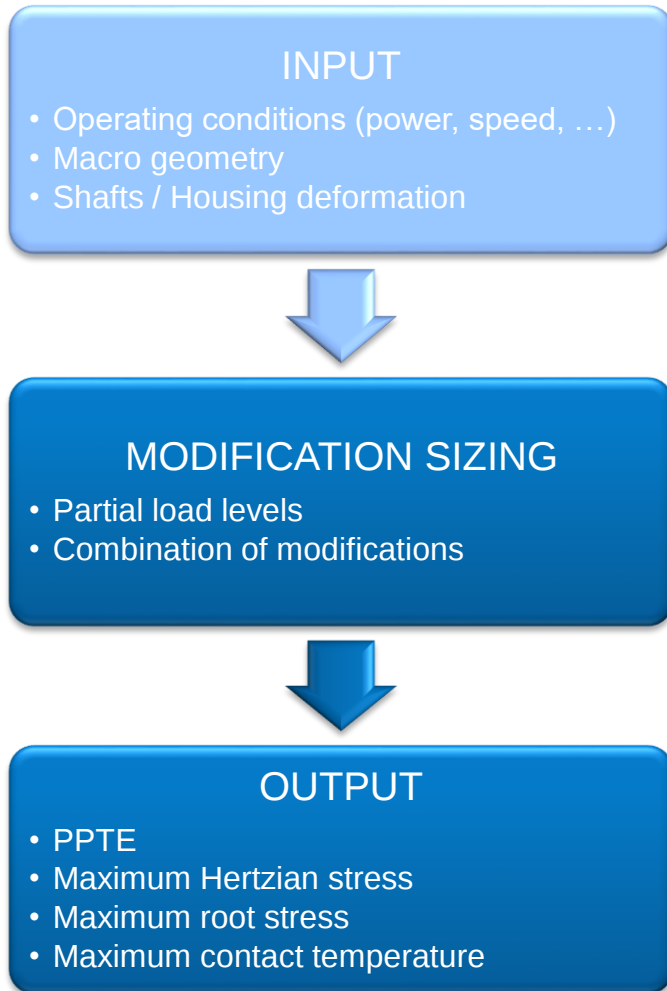


TARGETS

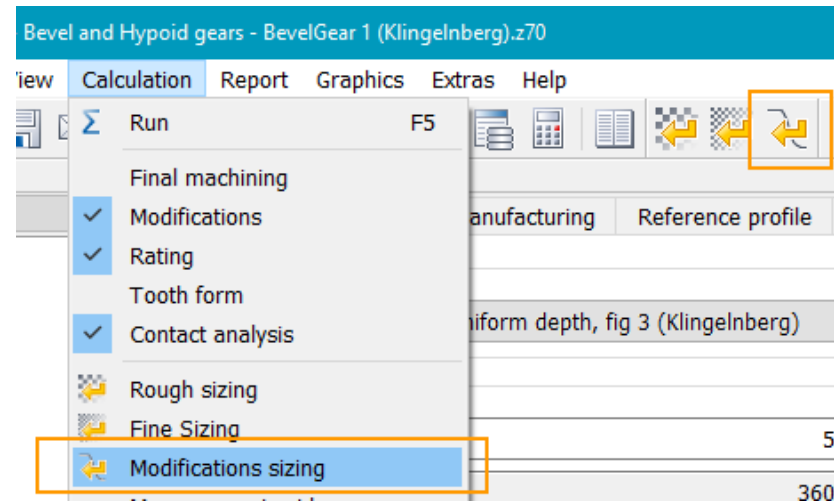
- Optimal load distribution
- Manufacturing error compensation
- Lower noise, vibration, loss, ...
- Higher safety of scuffing, (micro)pitting, ...

Where is the Modification Sizing used / What for ?

Modification Sizing Process



- Select Calculation > Modifications sizing or Click the sizing icon



- Main calculation should be consistent

CONSISTENT

Where is the Modification Sizing used / What for ?

- Settings in contact analysis tab are used (except the partial load settings)

Basic data Manufacturing Reference profile Tolerances Modifications Rating Factors **Contact analysis**

Contact data

Gear 1 - Gear 2

Coefficient of friction μ 0.0500

Axis alignment

Axis alignment...

Contact analysis

Accuracy of calculation medium

Partial load for calculation w_t 100.0000 % ☐ Consider load spectrum

☐ Load distribution calculated with: $K_t \cdot K_A \cdot T_{nom} / s$, Axis alignment calculated with: $K_t \cdot K_A$

- Set the proper accuracy of calculation to reduce the computation time
- Shaft / Housing deformation can be included from Axis alignment window

K Define axis alignment

Axis alignment Torsion

Gears Gears mounted by interference fit, with stiffness according to ISO 6336-1

File shaft Gear 1 Pinion shaft for BevelGear 6a (Straight, Fig 1).W10

V misalignment (E) ΔV 67.7336 μm

H misalignment (P) ΔH -17.7926 μm

J misalignment (G) ΔJ 8.4944 μm

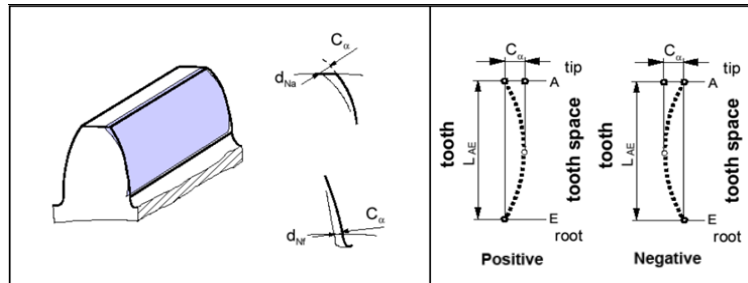
Shaft angle deviation $\Delta \Sigma$ 0.0000 °

File shaft Gear 2 Gear shaft for BevelGear 6a (Straight, Fig 1).W10

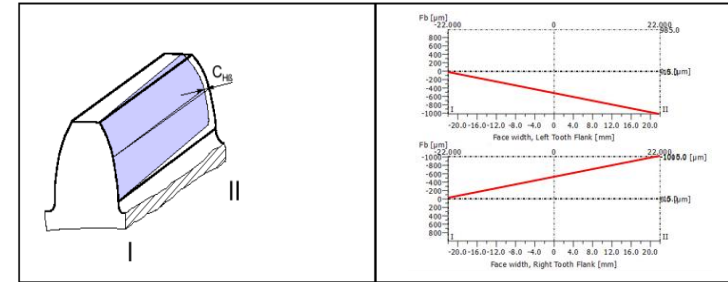
OK Cancel

Available Modification Types for Bevel Gear

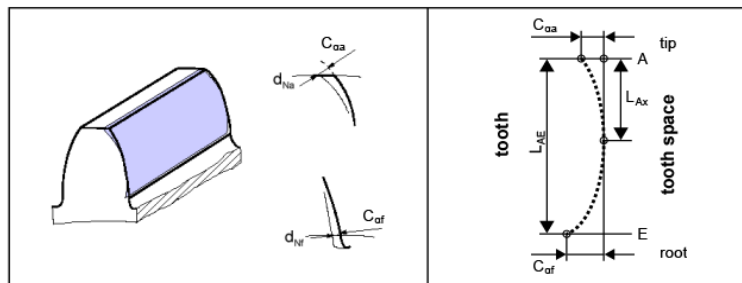
- Profile crowning (Barreling)



- Helix angle modification (conical)

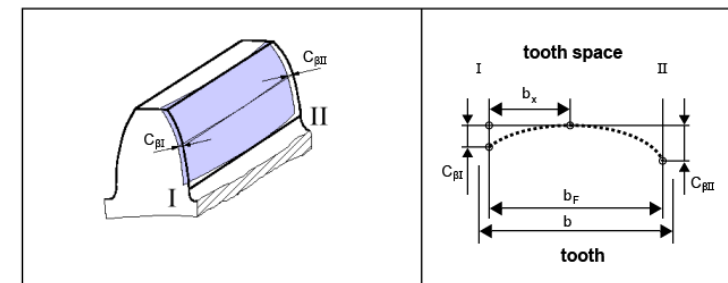


- Eccentric profile crowning



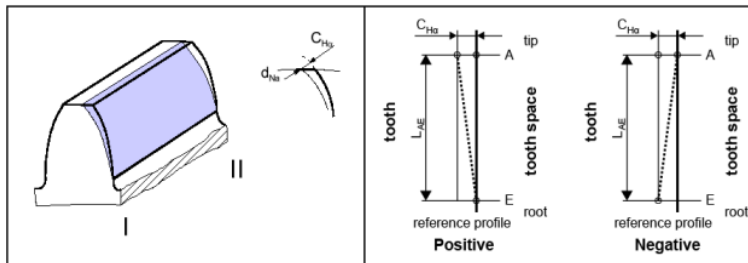
Factor 1	Factor 2
$L_{Ax} = (d_A - d_x) / (d_A - d_E)$	C_{aa} / C_{af}

- Crowning / Eccentric crowning

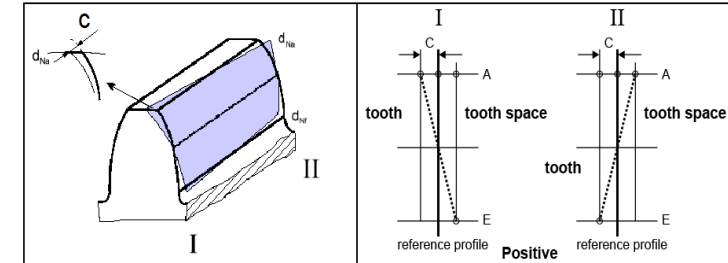


Factor 1	Factor 2
b_x / b_F	$C_{\beta II} / C_{\beta I}$

- Pressure angle modification



- Twist



Usage of 'Modification sizing' tool to find optimum design

The screenshot shows the 'Modifications sizing' window with the following components and annotations:

- Conditions I** tab is selected.
- Partial load area for the calculation with:**
 - Min.:** 50
 - Max.:** 100.0000 %
 - Number of steps:** 6
 - Annotation:** Set the range and steps of partial load
 - Find optimal modification for a specific load level
 - Find robust modification for variable loads
- Options:**
 - ☒ Cross-vary value and factor 1/2
 - ☒ Only calculate shaft deformation once for each partial load
 - Annotation:** Set the partial / full combination of the modification values with factors
 - Annotation:** Assume shaft deformation is linearly proportional to the load
- Base modifications (are not varied):**

No.	Gear	Flank	Type of modification	Value [μm]	Factor 1	Factor 2	Comment
1	Gear 1	both	Profile crowning (barreling)	15.0000			
1	Gear 1	both	Crowning	30.0000			
1	Gear 2	both	Profile crowning (barreling)	15.0000			

 - Annotation:** Base modification to compare and to measure the improvements of the results
- Buttons:**
 - Import modifications from the main window to the base modification** (Up arrow icon)
 - Add / Remove the base modifications** (+, -, X icons)
 - Annotation:** Set contents details of the report
- Report length:** Short form
- Buttons:** Accept, Delete, Report, Calculate, Cancel

Usage of 'Modification sizing' tool to find optimum design

K Modifications sizing

Conditions I Conditions II Results Graphic I Graphic II

No.	Gear	Synchronize	Flank	Type of modification	Number of steps	Value (min)	Value (max)	Factor 1 (min)	Factor 1 (max)
1	Gear 1	1 both		Profile crowning (barreling)	3	10.0000	20.0000		
2	Gear 1	2 both		Crowning	3	20.0000	40.0000		
3	Gear 2	3 both		Profile crowning (barreling)	3	10.0000	20.0000		

Trial values = [10, 15, 20]

K Warning

Attention:
The number of possible solutions, and therefore also the time required to calculate them depends on:
-number of partial loads
-number of modification steps

-number of modifications to be varied, with or without cross variations

The calculation will generate 168 solutions.
Do you want to continue?

Yes No

6 partial load steps
1 base modification
3 modification types
3 value steps for each modification type

$6 * [1 + 3 * 3 * 3] = 168$

Report length Short form Accept Delete Report Calculate Cancel

Usage of 'Modification sizing' tool to find optimum design

The screenshot shows the 'Modifications sizing' window with the following table:

No.	Gear	Type of modification	Numb	Value (min)	Value (max)	Factor 1 (min)	Factor 1 (max)	Factor 2 (min)	Factor 2 (max)
1	Gear 1	Eccentric profile crowning	3	10.0000	20.0000	0.4000	0.6000	0.9000	1.1000
2	Gear 1	Eccentric crowning	3	20.0000	40.0000	0.3000	0.5000	0.4000	0.6000

Below the table, three ranges are indicated with arrows:

- [20, 30, 40]
- [0.3, 0.4, 0.5]
- [0.4, 0.5, 0.6]

A warning dialog box is displayed with the following text:

Warning

Attention:
The number of possible solutions, and therefore also the time required to calculate them depends on:

- number of partial loads
- number of modification steps
- number of modifications to be varied, with or without cross variations

The calculation will generate **4380 solutions.** Do you want to continue?

Buttons: Yes, No

Report length: Short form

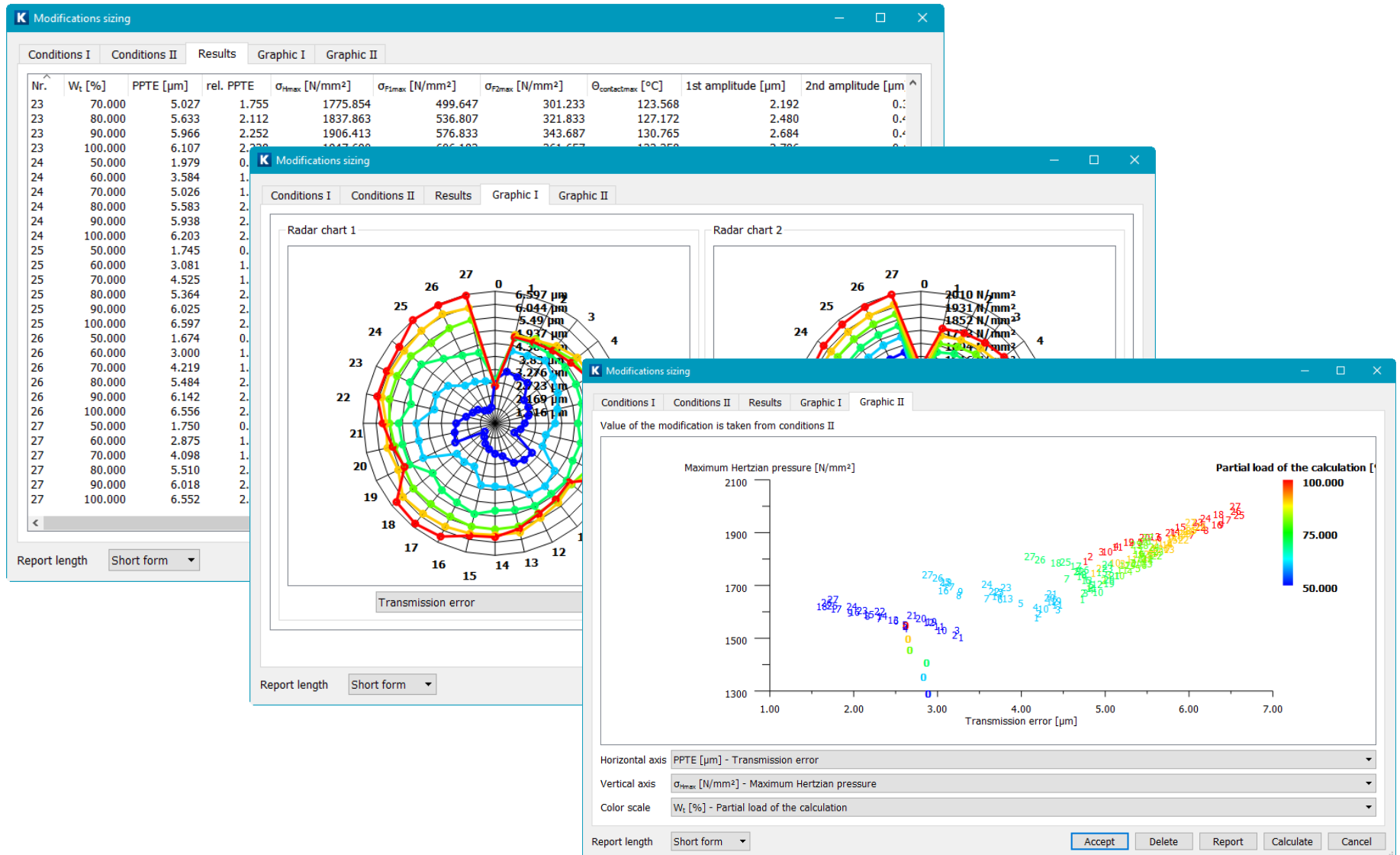
Buttons: Accept, Delete, Report, Calculate, Cancel

6 partial load steps
1 base modification
2 modification types
3 value steps for each modification type
3 factor 1 steps for each modification type
3 factor 2 steps for each modification type

with Cross-vary of values and factor 1/2
 $6 * [1 + (3 * 3 * 3) * (3 * 3 * 3)] = 4380$

without Cross-vary of values and factor 1/2
 $6 * [1 + 3 * 3] = 60$

Usage of 'Modification sizing' tool to find optimum design



Thank you very much!
Any Questions?

KISSsoft AG
Reseller Meeting
April 2017

