KISSsoft Exercise 4

Bevel Gear 04

EPG and contact analysis of a Face Milling bevel gear set

1 Purpose of exercise

In this exercise, we will learn about:
- EPG displacements within KISSsys
- Contact analysis and tooth flank modifications

2 Task

Open the KISSsys file "BevelHelicalPlanetaryGearbox.ks" from the folder „Open examples".

2.1 Step 1: Add the template for displacements

Add the template in the KISSsys model. Check the contact pattern under load including the EPG values.

2.2 Step 2: Optimization of tooth contact pattern

Add modifications as follows:

The **profile crowning** is applied with 0.005 * mean normal module, applied on pinion and ring gear. Use the diameter-centered profile crowning.

The **lengthwise crowning** is applied with b2 / 1000, on pinion only. Check the contact pattern position and Hertzian pressure.

Make **further optimization** by reduced crowning but vary spiral angle and pressure angle to optimize the contact pattern position. Again, check the bevel gearset regarding contact pattern and Hertzian pressure.
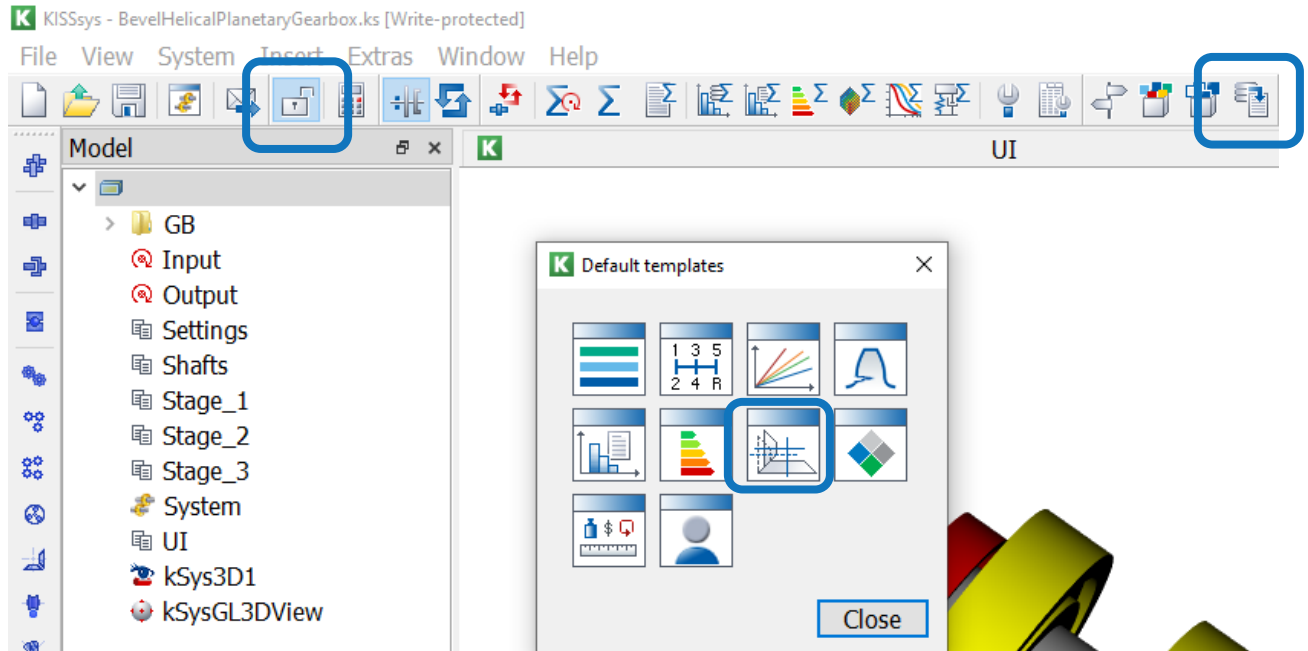
2.3 Step 2: Contact pattern under light load

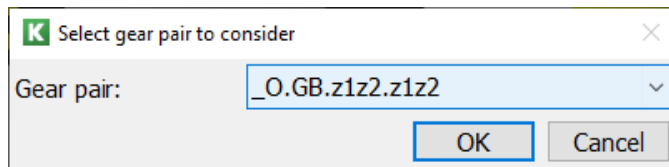For the quality control, check and document the contact pattern under light load.

3 Solution

3.1 Step 1: Add the template for displacements

Activate the Administrator button in KISSsys. Click the top level of the model and add the template for 'BevelGearDisplacements'.



Select the gear pair 'z1z2'.

Calculate the EPG values and check the results in the template.

	A	B	C	D	E
1	**SETTINGS**				
2	Presentation	Draw deflection lines	no		
3		Deflection scale	1000		Setup model
4		Type	Gleason (EPG)		Calculate
5	Load on	Drive Side			Export deflection
6					
7	**RESULTS**				
8	Shaft results at middle of facewidth	x	y	z	
9	Pinion displacement [mm]	-0.017425	-0.01673	0.084894	
10	Pinion rotation [deg]	0.025713	0.12699	0.0095413	
11	Wheel displacement [mm]	0.012718	0.010231	-0.062957	
12	Wheel rotation [deg]	-0.0070735	0.00084374	0.0013128	
13					
14	**Bevel gear displacements**	E [mm]	P [mm]	G [mm]	Alpha [deg]
15	**Total**	-0.20929	0.03144	-0.033977	0.0082285
16	Pinion	-0.15707	0.01673	-0.044208	0.0095413
17	Wheel	-0.052224	0.01471	0.010231	-0.0013128

Open the bevel gear calculation in KISSsys.

Model
- GB
  - Line
  - cpccpp
  - s1
  - s2
 - z1z2
    - z1z2
  - z3z4
  - zpzr
  - zszp
  - zszpzr
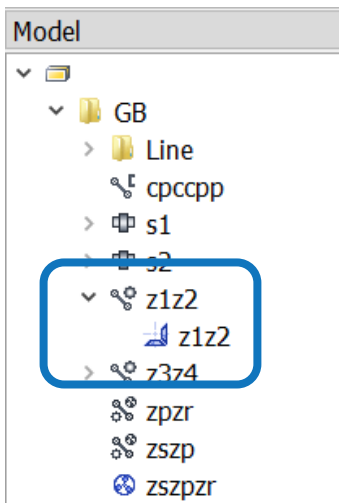
Open the tab contact analysis and open the window 'Axis alignment…' and change the settings for shaft calculation to 'Treated as in defined in shaft calculation'.
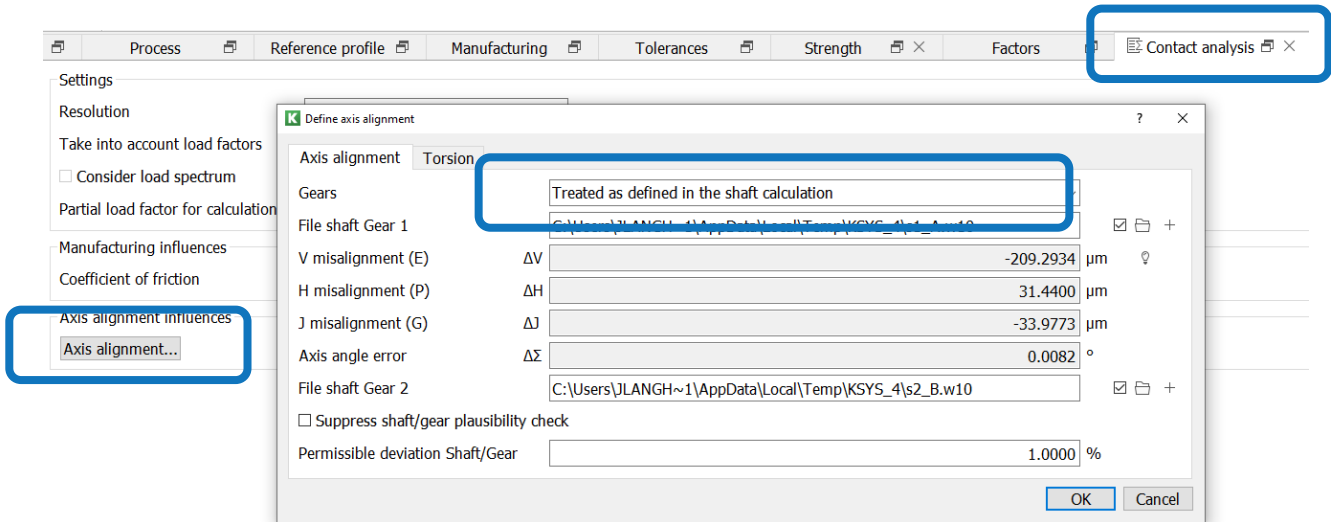
For the calculation of contact analysis, unclick the checkbox for shafts. Herewith, the misalignments are used directly.

Calculate the contact analysis and check the Hertzian Pressure and contact pattern under load for ring gear, under 'Graphics - Contact analysis – Forces and stresses - Contact pattern on tooth flank – Gear 2'.
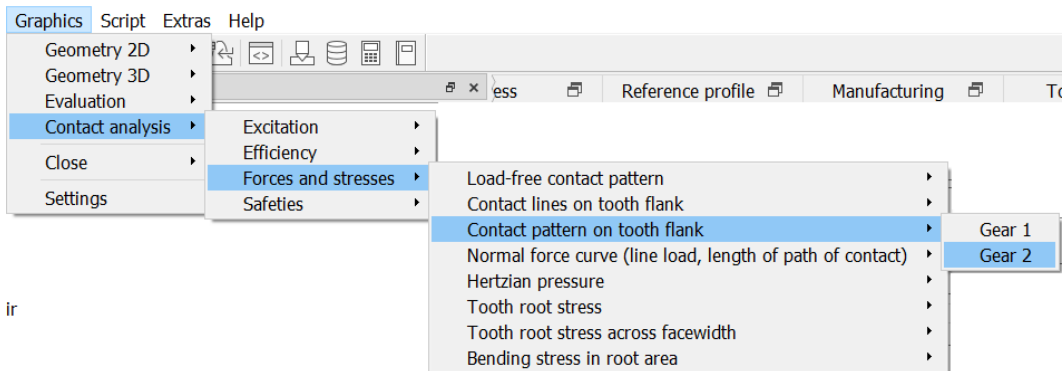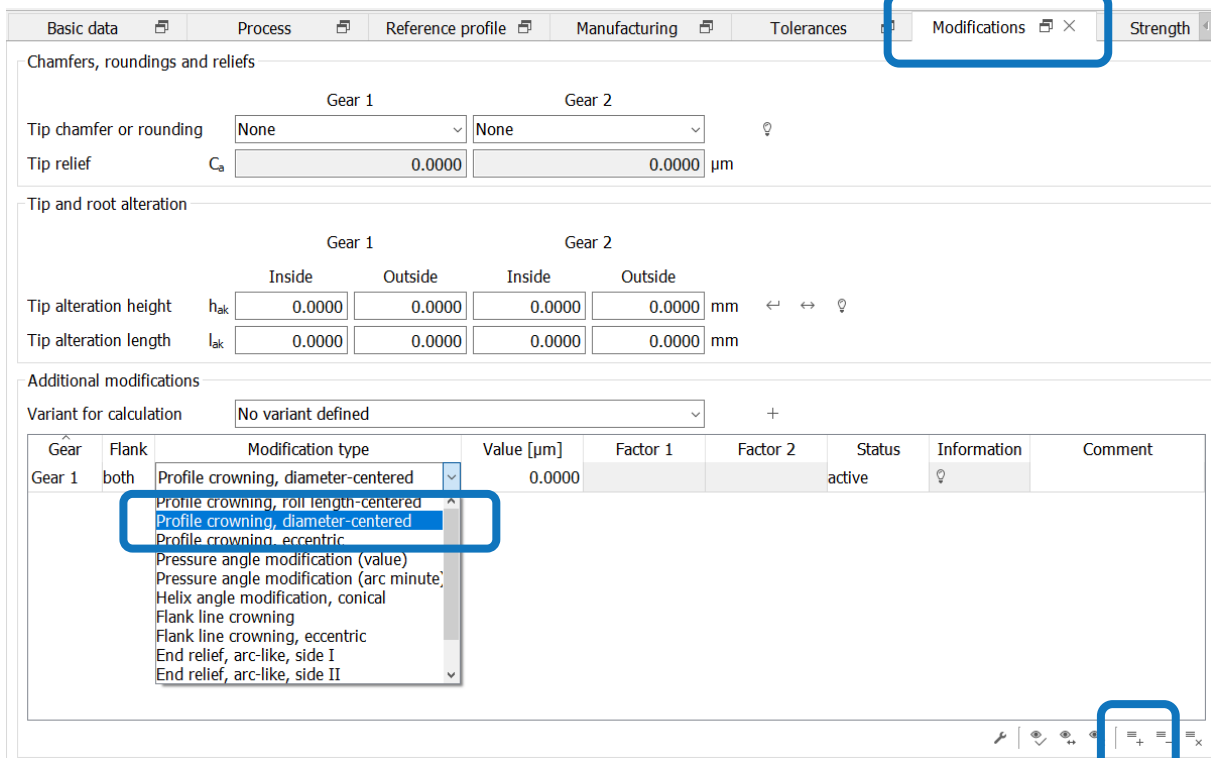

It shows a clear stress concentration on the toe side.
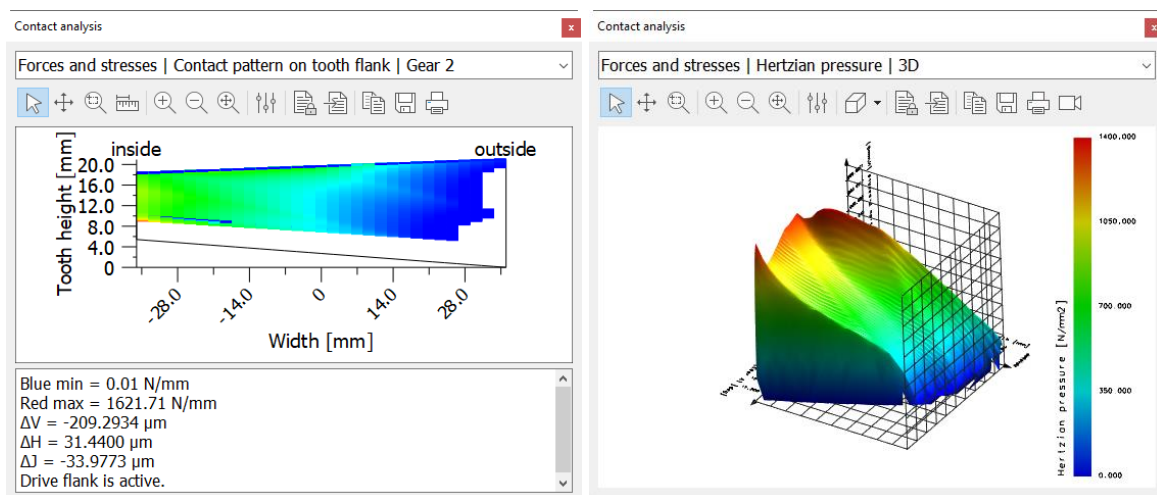
See file Exercise-Bevel-04-contact_analysis_en-de-v2200-jl-public_Step-1.z70

3.2 Step 2: Optimization of tooth contact pattern

Open the tab 'Modifications' and add profile crowning, <u>diameter-centered</u> for pinion and ring gear.

Recommendation: HB = 0.005 * normal module = 0.005 * 7.5 mm = 38 μm

Add <u>lengthwise crowning</u> for pinion.

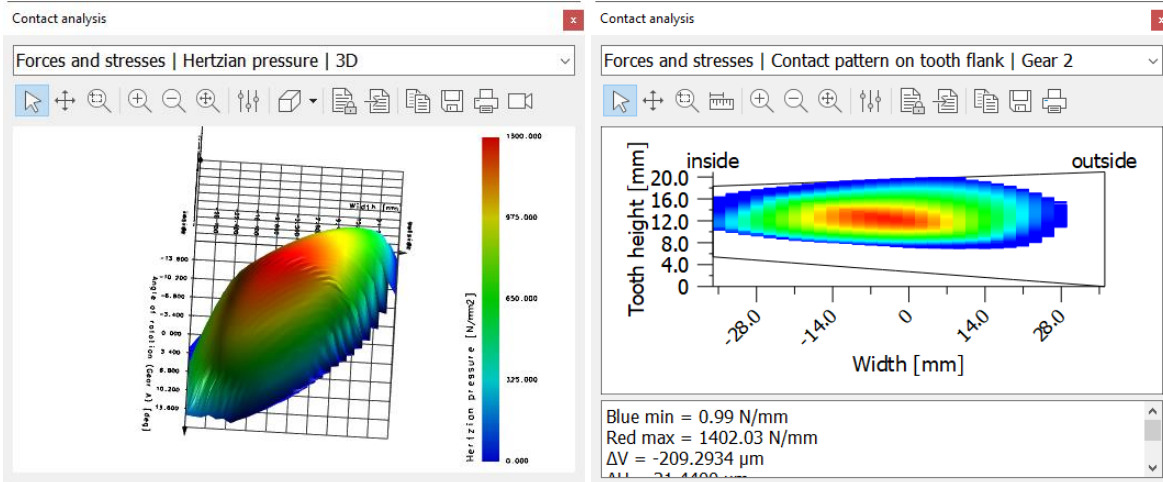Recommendation: LB = b2 / 1000 = 72 / 1000 = 0.050 mm = 72 μm

Additional modifications

Variant for calculation: No variant defined   +

Gear	Flank	Modification type	Value [μm]	Factor 1	Factor 2	Status
Gear 1	both	Profile crowning, diameter-centered	38.0000			active
Gear 1	both	Flank line crowning	72.0000	1.0000		active
Gear 2	both	Profile crowning, diameter-centered	38.0000			active

The recommendation values give reasonable results for a contact. In this case, the contact pattern needs some modification in position.

Blue min = 0.99 N/mm
Red max = 1402.03 N/mm
ΔV = -209.2934 μm

To optimize the position, an helix angle modifiation was added.

## Additional modifications

Variant for calculation: No variant defined

Gear	Flank	Modification type	Value [μm]	Factor 1	Factor 2	Status
Gear 1	both	Profile crowning, diameter-centered	38.0000			active
Gear 1	both	Flank line crowning	72.0000	1.0000		active
Gear 1	both	Helix angle modification, conical	-40.0000			active
Gear 2	both	Profile crowning, diameter-centered	38.0000			active
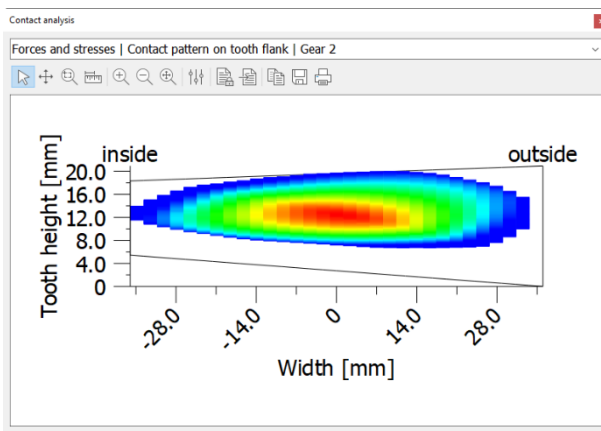
See file Exercise-Bevel-04-contact_analysis_en-de-v2200-jl-public_Step-2.z70

3.3 Step 3: Documentation of contact pattern under light load

The contact pattern for light load is obtained by 1% of the full load. Additionally, the load free contact pattern is available.
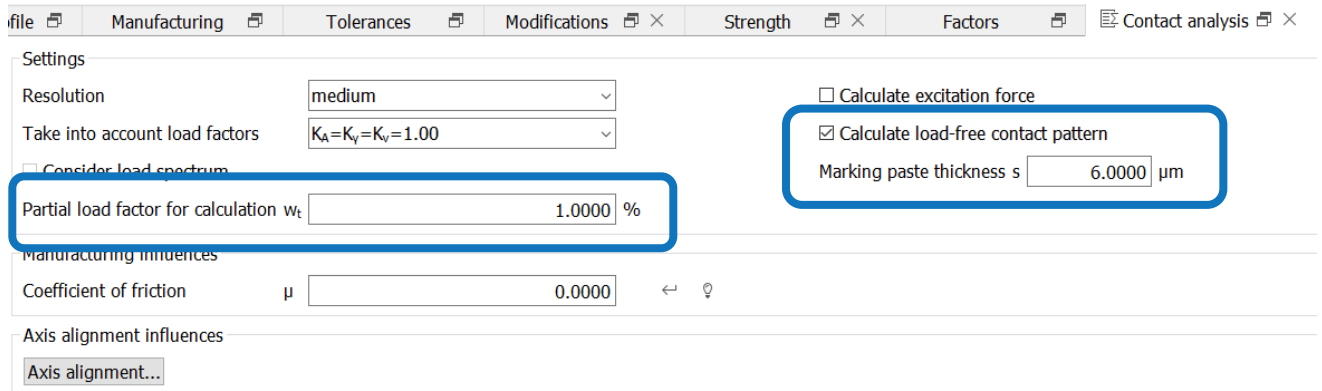
For quality control, the contact pattern positions under light load resp load free are to be checked and reported to the manufacturing department or supplier.