KISSsoft 03/2012 – Tutorial 15

Bevel gears
Contents

1  Starting KISSsoft...................................................................................................................................... 3
   1.1  Starting the software....................................................................................................................... 3
   1.2  Starting the calculation module ...................................................................................................... 3
2  Analyzing bevel and hypoid gears ........................................................................................................... 4
   2.1  Differential bevel gears ................................................................................................................... 4
   2.2  Calculating geometry in KISSsoft ................................................................................................... 4
   2.3  Calculation of static strength ......................................................................................................... 5
   2.4  Inputting an existing set of bevel gears from a Gleason data sheet ............................................. 6
   2.5  Dimensioning a bevel gear set with "Rough sizing" ........................................................................ 7
   2.6  Optimizing macro geometry "Fine Sizing" .................................................................................... 8
   2.7  Gleason spiral bevel gear and hypoid gear .................................................................................... 10
      2.7.1  Gleason, 5-section method ...................................................................................................... 10
      2.7.2  Gleason, duplex methods ....................................................................................................... 12
      2.7.3  Gleason, face hobbing .......................................................................................................... 14
   2.8  Klingelnberg cyclo-palloid ............................................................................................................. 15
   2.9  Klingelnberg palloid .................................................................................................................... 16
3  3D Model of a Bevel Gear with Spiral Teeth .......................................................................................... 18
   3.1  Creating a 3D Model ...................................................................................................................... 18
   3.2  Contact line check and entering modifications ............................................................................ 19
1 Starting KISSsoft

1.1 Starting the software

You can call KISSsoft as soon as the software has been installed and activated. Usually you start the program by clicking "Start→Program Files→KISSsoft 03-2012→KISSsoft". This opens the following KISSsoft user interface:

Figure 1. Starting KISSsoft, initial window

1.2 Starting the calculation module

Start the "Bevel and Hypoid gears" calculation module by double-clicking the corresponding entry in the "Modules" window in the top left-hand corner of the main window.

Figure 2. Selecting the "Bevel and hypoid gears" calculation module from the "Modules" window
2 Analyzing bevel and hypoid gears

There are various different types of bevel gears, and every design has special features that must be taken into consideration. This tutorial describes these various designs and provides information about how they can be analyzed in the KISSsoft system.

2.1 Differential bevel gears

Differential bevel gears are usually straight toothed. For manufacturing reasons, their construction is usually very different from the theoretical design. Therefore, we recommend you use a different approach to analyze an existing set of bevel gears from a drawing.

The drawings for differential bevel gears often contain very little theoretical data. Usually, the drawing does not show a theoretical outer tip diameter $d_{ae}$ or an outer reference diameter $d_e$. Instead it shows the finished outer diameter, so the outer reference diameter must be estimated. It is also often not clear whether the module is the middle or outer module. However, this can be checked quite easily with $m_n = d_e/z$. The transverse and normal modules are identical because the gear is straight toothed.

2.2 Calculating geometry in KISSsoft

1. In the "Basic data"→ "Geometry" tab select the "Standard, fig 2 (Tip, Pitch and Root apex NOT in one point)" option. This type allows you to input tip and root angles (see Figure 3).

   ![Figure 3. Selecting "Standard, fig 2" type](image)

2. Input "Reference diameter gear 2 (outside)" or "Normal module (in middle)" according to the drawing. If the values are not specified on the drawing, use the graphics on the drawing to determine them.

3. Input the "Pressure angle" and "Number of teeth" in accordance with the drawing. "Helix angle gear 2 (middle)" is zero.

4. Input the "Facewidth". If the facewidth is not predefined, you must measure it on the drawing. Here, use the reference cone length.

5. Input the "Profile shift coefficient" and "Tooth thickness modification factor" = 0.

6. Before you can input the "Tip and root angle gear 2", you must first run the calculation with $\sum$ or press "F5" to calculate the reference cone angle. Right-click on "Convert" $\sum$ to input the tip and root angle. Then click "Calculate" to calculate the tooth angle and include this in the calculation (see Figure 4).
7. You do not need to input any data in the "Manufacturing" tab because this data will be ignored.

8. To perform the calculation, click or press "F5". Create and open the report by clicking or press "F6". You can then compare the results in the report with the default data on the drawing, for example the angle (see Figure 5).

Figure 5. Bevel gear calculation report, section 1, tooth geometry

2.3 Calculation of static strength

Differential bevel gears are normally calculated with static load because they usually operate in static applications. The static calculation only takes root fracture due to bending into account.

1. In "Rating" -> "Calculation method", select the "Differential, static calculation" calculation method (see Figure 6).

2. Input performance/torque/rotation data using the default values.

3. Differential bevel gears are normally used with several strands. Check and input the "Number of strands" under "Rating" -> "Details". The default value is 2, because this is the most common situation.

4. To perform the calculation, click or press "F5". Create and open the report by clicking or press "F6".
2.4 Inputting an existing set of bevel gears from a Gleason data sheet

To analyze an existing set of bevel gears (with spiral toothing) using drawings or Gleason data sheets ("Gleason dimension sheets"), follow this procedure.

Bevel gear drawings and the Gleason dimension sheet usually contain precise, comprehensive information about intermeshing. In KISSsoft, use the "Conversion from GLEASON data sheets" utility screen to input this data. The data you require \( m_{te2} \) (or \( d_{te2} \)), \( \beta_{m1} \), \( \Sigma \), \( a_v \), \( r_{cb} \), \( z_1 \), \( z_2 \), \( b \), \( d_{ae} \), \( h_e \), \( \delta_a \).

1. In "Basic data" → "Geometry" select the "Constant slot width" or "Modified slot width" type (see Figure 7).

![Figure 7. Selecting "constant slot width" type or "modified slot width" type](image)

2. Click on "Convert" to the right of the Geometry field and input the data (see Figure 8 and Figure 9).

![Figure 8. Conversion from GLEASON data sheets](image)
Unfortunately, the cutter tip cutter radius is often not specified on the drawings. However, this value is usually present on Gleason data sheets.

3. Click on "Calculate" and check the calculated values, then click "Accept" to transfer them into the main input screen.

4. To perform the calculation, click \( \sum \) or press "F5". Create and open the report by clicking \( \text{Report} \) or press "F6".

### 2.5 Dimensioning a bevel gear set with "Rough sizing"

You can use the "Rough sizing" function to dimension a new bevel gear set. Rough sizing uses formulae defined at Klingelnberg (in accordance with the Klingelnberg "Bevel gear" book), no matter which calculation method you select (ISO, DIN, AGMA, Klingelnberg).

**Important note:**
This calculation process is designed for bevel offset gears without offset and with a pressure angle of 20°. Other conditions in the main input screen are ignored. Despite that, Rough sizing can also be used for other bevel gears and supplies good initial values for further developments.

1. In "Basic data" \( \rightarrow \) "Geometry", select the required type (standard, Klingelnberg, Gleason).
2. Then input the power data and the required calculation standard in the "Rating" tab (see Figure 10).
3. Then select Rough sizing by either clicking "Calculation" → "Rough sizing" or clicking on .
4. Input the data as required (see Figure 11).
   - Face width to normal module ratio: 8…12
     Values closer to 8 result in higher modules and resistance to bending, and values closer to 12 lead to smaller modules and a higher contact ratio
   - Ratio of length of reference cone to tooth width: \( \text{Re/b} = 3.5 \).
     To avoid manufacturing problems using standard machines, the ratio should not be less than 3.
   - Helix angle: usually in the range 20° to 35° for the bevel gear (Gear 2)

5. Click "Calculate" to calculate the values.
6. If the calculated data is not output as you would like, (for example, the reference diameter bevel gear is too large), you can predefine the value by setting the input flag and clicking "Calculate" again.
7. Click "Accept" to transfer the data to the main KISSsoft input screen.

### 2.6 Optimizing macro geometry "Fine Sizing"

The KISSsoft Fine Sizing module enables you to optimize and existing gear set by varying the macro geometry values and automatically calculating these combinations. The Fine Sizing module can be used to analyze both bevel and hypoid gears.

1. You can either input the data of an existing gear set or have the software calculate its dimensions with the rough sizing functions. For this tutorial, import the "BevelGear 2 (Hypoid gear)" example file.
2. Then either select Fine Sizing under "Calculation" → "Fine Sizing" or click on .
3. The software should now perform an optimization run with the same gear size. Input the values (see Figure 12). Click "Calculate". If the "Termination: maximal no of solutions exceeded." message appears, input 1000 in the "Maximal no of solutions" field.

**Note:**
If all the parameters have been altered, we recommend you only calculate between 2 and 4 values for each parameter to prevent too many combinations being calculated.

![Figure 12. Data entered for the fine sizing of a hypoid gear](image)

The results are then listed in the "**Results**" tab. Click the right-hand mouse button to either display or hide these parameters. The columns can be shifted to the left and to the right so you can arrange the most interesting parameters in the way that suits your requirements. Simply click on a column header to sort these solutions by that particular parameter.

In the "**Graphics**" tab you can compare the solutions as graphics. We recommend that you set the X and Y axes with the required result parameters, such as, for example, "Minimum root safety", "Efficiency" or "Axial force Gear 1". For the color scale we recommend you select an input parameter from the "Conditions I" tab, such as, for example, "Helix angle Gear 2 Middle" or "Offset" (see Figure 13).
You can then enter the input parameters again with smaller steppings and value ranges and rerun the fine sizing calculation until you are satisfied with the way the macro geometry has been optimized.

2.7 Gleason spiral bevel gear and hypoid gear

Gleason bevel gears are usually manufactured in a single part process (face milling). Due to their arc-shaped tooth length form, these gears can be ground after being heat treated. In the automobile industry, bevel gears are also lapped. However, Gleason also uses a continual hobbing process (face hobbing).

In the examples that follow, dimensioning has already been performed using Rough sizing so that the majority of the required data is already present (see section 2.5). For this reason only the specific entries for each method are described. However, if Rough sizing has not already been performed, you must input all the values manually.

2.7.1 Gleason, 5-section method

1. In "Basic data"→ "Geometry" select the "Modified slot width" type (see Figure 14). The pinion space width changes due to the different machine settings for each flank.
2. Input the "pressure angle".

3. Click on the **"Plus"** button to the right of "Pressure angle". Under **"Additional data hypoid gears"** you can input values for the "Nominal pressure angle" and the "Influencing factor limit pressure angle" (usually 1 for "Modified slot width"). If an offset (hypoid gear) is predefined, the influencing factor of the "generated and effective contact angle" is included in the calculation.

4. Input the "spiral direction" for the pinion.

5. Click on the **"Plus"** button to the right of "Helix angle". Then go to **"Additional data for spiral teeth"** and enable spiral toothing. If the Rough sizing function was used, spiral toothing is active.

6. You can either input the **"Profile shift coefficient"** manually or click the Sizing button to calculate it automatically. If the KISSsoft software determines an undercut, the profile shift coefficient is set to prevent undercut. All the other criteria (optimal specific sliding, etc.) are listed in the report and can be entered manually.

7. Use the predefined data to input the "Offset" for a hypoid gear.

8. In the **"Manufacturing"** tab, select **"Face milling"** as the manufacturing process and then input the "Cutter radius". We recommend you use the sizing function to the right of the "Cutter radius" input field to get a suggested value for the minimum cutter tip size (in accordance with Klingelnberg "Bevel gears", page 70) and then enter the cutter tip radius that was actually used, from Production. Click the right-hand mouse button to select the unit "inch": this is usually used for Gleason cutters (see Figure 15).

A warning message appears if the cutter head radius is smaller than the recommendation. This is because the meshing may not be correct for practical applications (see Figure 16).
The cone length (for hypoid gears) and the outer and inner spiral angles are affected by the cutter tip radius. KISSsoft therefore checks whether the values are suitable.

9. The "Basic data" is where you define the addendum and dedendum angle. We recommend you use the sizing function if you are sizing a new gear. As the angles are affected by the cutter head radius, the reference profile, and the profile shift, you must run the sizing function again if you want to change one of these values at a later point in time (see Figure 17).

![Figure 17. Sizing function for addendum and dedendum angle](image)

10. In the "Reference profile" tab select a suitable reference profile or click on "Own Input". The recommended tip clearance factor for a "Modified slot width" is 0.3 (in accordance with Klingelnberg "Bevel gears", page 72), so you should input 1.3/0.3/1 manually.

11. In the "Rating" tab select the required "Calculation method" (ISO, DIN, AGMA:, VDI, etc.) and input the torque, speed and/or load spectra.

12. In the "Basic data" tab, under Materials, manufacturing types and lubrication", select the "For generated gears" or "Made by form cutting" settings to influence the tooth thickness at the root. As a rule of thumb, for conversions $i>2.5$ the "Made by form cutting" process is selected for bevel gears because they can be manufactured more quickly with this process. The pinion is always generated. (see Figure 18).

![Figure 18. "For generated gears" and "Made by form cutting" manufacturing types](image)

13. In the "Tolerances" tab, select tooth thickness deviation "ISO23509" to ensure the flank clearance and the appropriate tooth thickness allowance can be set automatically in accordance with the module. The "No backlash" option is also often selected because the clearance value is not set until the gear is assembled by changing the assembly dimensions.

14. To perform the calculation, click $\sum$ or press "F5". Create and open the report by clicking $\text{Report}$ or press "F6".

**2.7.2 Gleason, duplex methods**

1. In "Basic data"→ "Geometry" select the "Modified slot width" type (see Figure 19). The pinion has a constant space width because both flanks are created in the same manufacturing run.
2. Input the "pressure angle".

3. Click on the "Plus" button to the right of "Pressure angle". Under "Additional data hypoid gears" you can input values for the "Nominal pressure angle" and the "Influencing factor limit pressure angle" (usually 0.5 for "Constant slot width"). If an offset (hypoid gear) is predefined, the influencing factor of the "generated and effective contact angle" is included in the calculation.

4. Input the "spiral direction" for the pinion.

5. Click on the "Plus" button to the right of "Helix angle". Then go to "Additional data for spiral teeth" and enable spiral toothing. If the Rough sizing function was used, spiral toothing is active.

6. Use the predefined data to input the "Offset" for a hypoid gear.

7. You can either input the "Profile shift coefficient" manually or click the Sizing button to calculate it automatically. If the KISSsoft software determines an undercut, the profile shift coefficient is set to prevent undercut. All the other criteria (optimal specific sliding, etc.) are listed in the report and can be entered manually.

8. Under "Manufacturing", select "Face milling" as the manufacturing process and then input the "Cutter radius". We recommend you use the sizing function to the right of the "Cutter radius" input field to get a suggested value for the minimum cutter tip size (in accordance with Klingelnberg "Bevel gears", page 70) and then enter the cutter tip radius that was actually used, from Production. Click the right-hand mouse button to select the unit "inch": this is usually used for Gleason cutters (see Figure 20).

A warning message appears if the cutter head radius is smaller than the recommendation. This is because the meshing may not be correct for practical applications (see Figure 21).
Figure 21. Warning if the cutter radius is smaller than the recommendation

The cone length (for hypoid gears) and the outer and inner spiral angles are affected by the cutter tip radius. KISSsoft therefore checks whether the values are suitable.

9. In the "Reference profile" tab, select a suitable reference profile or click on "Own Input". The recommended tip clearance factor for a "Constant slot width" is 0.35 (in accordance with Klingelnberg "Bevel gears", page 72), so you should input 1.35/0.3/1 manually.

10. In the "Rating" tab, select the required "Calculation method" (ISO, DIN, AGMA; VDI, etc.) and input the torque, speed and/or load spectra.

11. In the "Basic data" tab, under "Materials, manufacturing types and lubrication", select the "For generated gears" or "Made by form cutting" settings to influence the tooth thickness at the root. As a rule of thumb, for conversions $i>2.5$ the "Made by form cutting" process is selected for bevel gears because they can be manufactured more quickly with this process. The pinion is always generated. (see Figure 22).

Figure 22. "For generated gears" and "Made by form cutting" manufacturing types

12. In the "Tolerances" tab, select tooth thickness deviation "ISO23509" to ensure the flank clearance and the appropriate tooth thickness allowance can be set automatically in accordance with the module. The "No backlash" option is also often selected because the clearance value is not set until the gear is assembled by changing the assembly dimensions.

13. To perform the calculation, click or press "F5". Create and open the report by clicking or press "F6".

2.7.3 Gleason, face hobbing

If the Gleason face hobbing method is to be used (i.e. Triac, Pentac FH), we recommend you use the Klingelnberg method (see Figure 23).

Figure 23. Selecting the "Uniform depth, fig 3 (Klingelnberg)" type
2.8 Klingelnberg cyclo-palloid

The cyclo-palloid procedure is a continuous hobbing process (face hobbing). The bevel gears have a uniform depth. Cyclo-palloid bevel gears are often used for small series industrial gears or large bevel gear sets.

In the examples that follow, dimensioning has already been performed using Rough sizing so that the majority of the required data is already present (see section 2.5). For this reason only the specific entries for each method are described. However, if Rough sizing has not already been performed, you must input all the values manually.

1. In "Basic data" → "System data", select the "Uniform depth, Fig 3 (Klingelnberg)" type (see Figure 24).

2. Input the "pressure angle".

3. Click on the "Plus" button to the right of "Pressure angle". Under "Additional data hypoid gears", you can input values for the "Nominal pressure angle" and the "Influencing factor limit pressure angle" (usually 0 for the cyclo-palloid procedure). If an offset (hypoid gear) is predefined, the influencing factor of the "generated and effective contact angle" is included in the calculation.

4. Input the "spiral direction" for the pinion.

5. Click on the "Plus" button to the right of "Helix angle". Then go to "Additional data for spiral teeth" and enable spiral toothing. If the Rough sizing function was used, spiral toothing is active.

6. Use the predefined data to input the "Offset" for a hypoid gear.

7. You can either input the "Profile shift coefficient" manually or click the Sizing button to calculate it automatically. If the KISSsoft software determines an undercut, the profile shift coefficient is set to prevent undercut. All the other criteria (optimal specific sliding, etc.) are listed in the report and can be entered manually.

8. If necessary, input "Angle modification gear 1".

9. Under "Manufacturing", select "Face hobbing" as the manufacturing process, and enter the "Cutter radius" and the "Number of tools blade groups". We recommend you use the sizing function to the right of the "Cutter radius" input field to get a suggested value for the minimum cutter tip size (in accordance with Klingelnberg "Bevel gears", page 70) and then enter the cutter tip radius that was actually used, from Production. As an alternative, you can transfer the cutter tip from the "List of Klingelnberg machines" if the checkbox is active (see Figure 25).
In addition, the system displays a warning message if the milling tip radius is smaller than the recommended value. This is because the meshing may not be correct for a practical application (see Figure 26).

The cone length (for hypoid gears) and the outer and inner spiral angles are affected by the cutter tip radius. KISSsoft therefore checks whether the values are suitable.

10. In the "Reference profile" tab, select a suitable reference profile or click on "Own Input". The recommended tip clearance factor for a "Cyclo-palloid procedure" is 0.25 (in accordance with Klingelnberg "Bevel gears", page 72), and can be selected in the list with "1.25/0.3/1 CYCLOPALLOID".

11. In the "Strength" tab, select the required "Calculation method" (Klingelnberg 3028 or 3029, ISO, DIN, AGMA, VDI, etc.) and input the torque, speed and/or load spectra.

12. In the "Basic data" tab, under "Material, manufacturing types and lubrication", the "Generating process" is selected automatically because cyclo-palloid gears are always generated (see Figure 27)

13. In the "Tolerances" tab, select "No backlash" because the clearance value is not set until the gear is assembled by changing the assembly dimensions.

14. To perform the calculation, click \(\text{Calculate} \) or press "F5". Create and open the report by clicking \(\text{Create report} \) or press "F6".

### 2.9 Klingelnberg palloid

The palloid procedure is a continuous hobbing process. The bevel gears have a uniform depth. Palloid bevel gears are often used for smaller bevel gear sets (up to module 6mm).

In the examples that follow, dimensioning has already been performed using **Rough sizing** so that the majority of the required data is already present (see section 2.5). For this reason only the specific entries for each method are described. However, if **Rough sizing** has not already been performed, you must input all the values manually.

1. In "Basic data" \(\rightarrow\) "Geometry", select the "Uniform depth, fig 3 (Klingelnberg)" type (see Figure 28).
2. In the "Rating" tab, select either the "Klingelnberg palloid 3025" or "Klingelnberg palloid 3026" calculation method (see Figure 29).

3. Input the "pressure angle".

4. Click on the "Plus" button to the right of "Pressure angle". Under "Additional data hypoid gears", you can input values for the "Nominal pressure angle" and the "Influencing factor limit pressure angle" (usually 0 for a palloid procedure). If an offset (hypoid gear) is predefined, the influencing factor of the "generated and effective contact angle" is included in the calculation.

5. Input the "spiral direction" for the pinion.

6. Click on the "Plus" button to the right of "Helix angle". Then go to "Additional data for spiral teeth" and enable spiral toothing. If the Rough sizing function was used, spiral toothing is active.

7. Use the predefined data to input the "Offset" for a hypoid gear.

8. You can either input the "Profile shift coefficient" manually or click the Sizing button to calculate it automatically. If the KISSsoft software determines an undercut, the profile shift coefficient is set to prevent undercut. All the other criteria (optimal specific sliding, etc.) are listed in the report and can be entered manually.

9. If necessary, input "Angle modification gear 1".

10. The "Face hobbing" manufacturing process is already selected in the "Manufacturing" tab. Input the "Cutter cutting length" and "Cutters small diameter" tool data. Click the information button to display a table that lists the standard palloid cutters. However, you can also input data for special milling cutters (see Figure 30).
In addition, the system displays a warning message if the palloid milling cutter is too small to be able to mill the gear (see Figure 31).

11. In the "Reference profile" tab, select a suitable reference profile or click on "Own Input". The recommended tip clearance factor for a "Palloid procedure" is 0.3 (in accordance with Klingelnberg "Bevel gears", page 72), and can be selected in the list with "1.3/0.38/1 PALLOID".

12. In the "Tolerances" tab, select "No backlash" because the clearance value is not set until the gear is assembled by changing the assembly dimensions.

13. To perform the calculation, click \(\sum\) or press "F5". Create and open the report by clicking \(\text{Report}\) or press "F6".

3 3D Model of a Bevel Gear with Spiral Teeth

Straight-, helical- and spiral-toothed bevel gears can be given flank modifications and output in STEP format. Below you will find details of how to create, check and output a bevel gear.

Click on the "Examples" tab and import the "BevelGear 1 (Klingelnberg)" file. Then click on "File \(\rightarrow\) Save as..." to save it to a specific directory. In the "Tolerances" tab, change the tooth thickness allowance to "No backlash". This not only simplifies subsequent processing but also corresponds to the procedure used to create a gear using standardized cutter radiuses. In this case, the clearance is usually set by adjusting the bevel gear assembly dimension (G-displacement).

3.1 Creating a 3D Model

1. Input these values under "Module specific settings \(\rightarrow\) Generation of 3D":

   Number of sections across the facewidth: 11
   Modeling operation tolerance: 1 \(\mu\)m
   Rendering quality: 5 \(\mu\)m
   The "Constant root rounding radius along the facewidth" and "Constant protuberance along the facewidth" options

2. Then display the 3D model under "Graphics \(\rightarrow\) 3D geometry \(\rightarrow\) Tooth system" (see Figure 32):
TIP: After you perform the calculation (by pressing F5) it may happen that the **graphics window appears in the background**. To change this, simply minimize the KISSsoft program and then maximize it again.

### 3.2 Contact line check and entering modifications

1. Check the contact pattern by changing the model type under "Module specific settings -> 3D generation": Model: Skin model. Repeat the calculation by pressing (F5) to show the models as skin models (see Figure 33).

2. To **Check the tension side contact line** (convex bevel gear) look at the bevel gear from below. To do this, click the right-hand mouse button to position the gear to "View from the bottom".
**TIP:** Rotate the gear so that you can easily see the contact lines at a 5 o'clock position from below. Use the direction keys to move the graphic upwards and to the right and then use the zoom function (+ key).

<table>
<thead>
<tr>
<th>Graphic at a 5 o'clock position</th>
<th>Move with arrow: ← and ↑</th>
<th>Zoom with + key or scroll</th>
</tr>
</thead>
</table>

3. The contact lines on the drive side are represented by the pinion being rotated towards the bevel gear with . To achieve a realistic comparison, make sure that the **amount of contact is not too great**. For example, rolling the bevel gear set over a tester should also only remove a small amount of contact color (see Figure 34).

![Figure 34. Typical contact pattern with tester](image)

**Note:**
The information window inside the "3D geometry" graphic below the model shows which value was used for the "Rotation steps for flank alignment" for the theoretical flank contact. In this case, like for 137.18, a theoretical contact will take place. As a result, the value 138 (and one rotation step) does not achieve contact, but the value 137 (and one rotation step) achieves a minimum penetration. In this case the value 120 is reasonable (see Figure 35).

![Figure 35. Setting the properties](image)

Check the flank contact when rotating the gear with . In a rotation not under load, the contact pattern should not reach the inside and outside edges ("toe" and "heel"). If it does, the gear would react too sensitively to axle misalignments which would lead to edge contact and pressure peaks when operating under load (see Figure 36).
Edge contact under load can be prevented by length corrections and profile crowning flank modifications. Use the pressure angle and helix angle flank modifications to set the position of the contact pattern.

4. The "Modifications" tab is where you input **flank modifications** using the Plus button. In the technical literature ("Bevel gears", by Jan Klingelnberg, page 74) a standard length correction is between b2/250 and b2/600 (for normal misalignment) or b2/350 and b2/800 (for low misalignment). Here, the facewidth b2 is 50mm, so the length correction range lies between 0.200 and 0.084mm (for normal misalignment) or 0.140 to 0.063mm (for low misalignment).

In this case, input a crowning of 140μm for Gear 1 (pinion). Then press F5 to run the calculation on the file again (see Figure 37).

The **definition of the flank side** is seen from the direction of the apex. In the case of the left-hand pinion, the left flank side is the concave side, and consequently the driving side.

5. Check the contact lines again. Now continue as described in points 5 to 7. The contact lines no longer touch the edges when rotated under load. This means the crowning and contact pattern position are therefore technically correct (see Figure 39).
6. In KISSsoft it is possible to use the **VH-Check** to position the contact pattern, and so to determine the sensitivity of the meshing. To do this, enter the position values under Properties (see Figure 40) and follow the instructions in points 5 to 7 to check the contact pattern position.

![Figure 40. VH (EP) Check](image)

For more information about the VH check, please refer to the ISO/TR 10064-6 "Code of inspection practice", for example.

You can change the **cutter head size** to any value: it does not relate to any existing standard series. This makes it easier for you to influence the load-free position behavior. For more information about the effect of the cutter head size, please refer to ISO/TR 22849 "Design recommendations for bevel gears".

7. In the case of a **small number of teeth on the pinion**, it can happen that the teeth become sharp at the tip (tooth inside face, "toe"). Then it is not possible to create the 3D model of the pinion. This information is provided to help you:

- in the **"Modifications"** tab, you can define a tip chamfer on the inside (this is often used in Klingelnberg toothing)
- smaller profile shift on the pinion
- lower tooth tip height on the pinion, by modifying the reference profile data
- smaller facewidth
- Change from face hobbing (constant tooth height, Klingelnberg toothing) to face milling (modified tooth height, Gleason). For more information see also the "BevelGear 5 (Gleason)" example file with a ratio of 8:36.