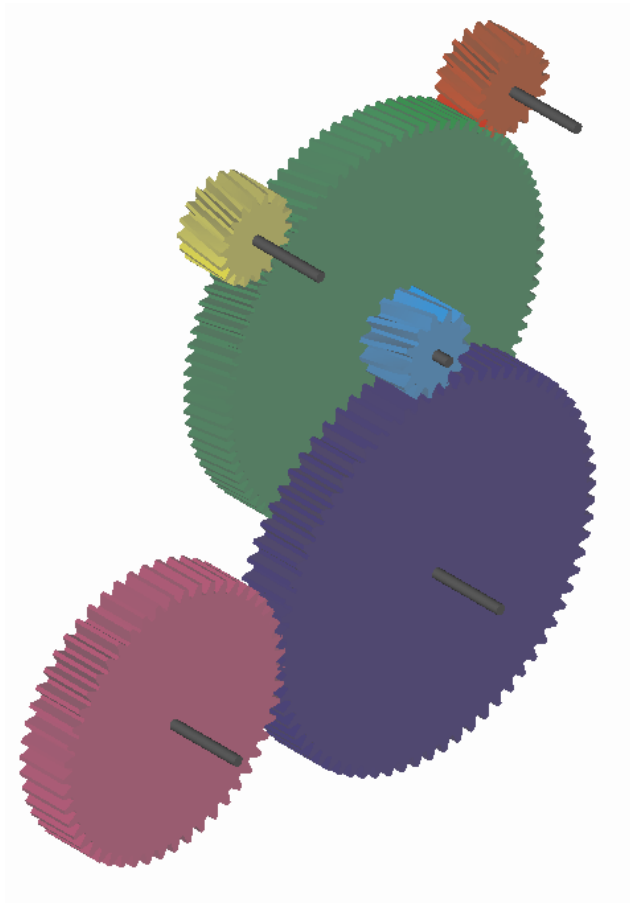


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Multiple Meshing on Gears in KISSsys



Multiple meshing points in one gear

1 Description

Multiple meshing on a gear can be taken into account with the variations of factors from the calculation standards. The factors are the number of the load cycles and the alternating bending coefficient (Kwb).

KISSsys does provide calculation elements for common planetary gear stages only. So the multiple meshing of the planets is not a problem in this case. But how should a gear stage with three gears in a row or a gear with two pinions be modelled, because single gear pair calculation module is used to do the calculation in both cases?

2 Solution

2.1 Factor Kwb

The tooth root strength is sized for dynamic load. In special cases, however, the tooth root has to cope with alternating bending stresses, (e.g. the planet gear in a planetary gear train). In this case, the coefficient has to be reduced from 1.0 to 0.7 (according ISO, DIN or AGMA). Niemann recommends for plastics, 0.8 for laminated fabric and 0.667 for PA (nylon) and POM (Polyacetal).

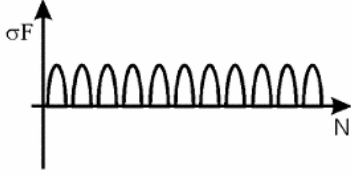
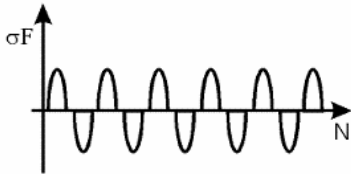
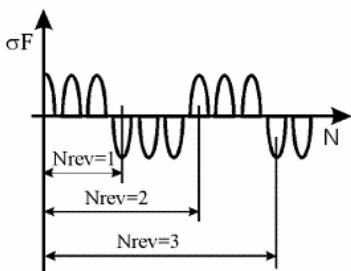
Operating Mode	Operating Factor YA	Load Direction
Pulsating	1	
Alternating	0.7	
Oscillating	$0.85 - 0.15 \cdot \frac{\lg N_{rev}}{6}$ $(1 \leq N_{rev} \leq 10^6)$ 0.7 $(N_{rev} > 10^6)$	

Figure 2.1-1 Kwb for different load directions

2.2 Number of Load Cycles

KISSsoft calculates the number of load cycles by speed and demanded service life. In case of a gear driven by two pinions, the tooth is used two times per rotation. KISSsoft provides also a possibility to enter the number of load cycles per revolution.

2.3 Constraints

Modelling planetary gear stages in KISSsys requires special constraints “kSysPlanetGearConstraint” and it therefore requires no further settings. For the above mentioned problems, the constraint for this kind of problem stays the same as the constraint for a simple two stage gearbox “kSysGearPairConstraint”. For one gear stage with three gears you will need two constraints. Constraints 1 and 2 when two pinions are driving one gear and constraints 3 and 4 for idle gear.

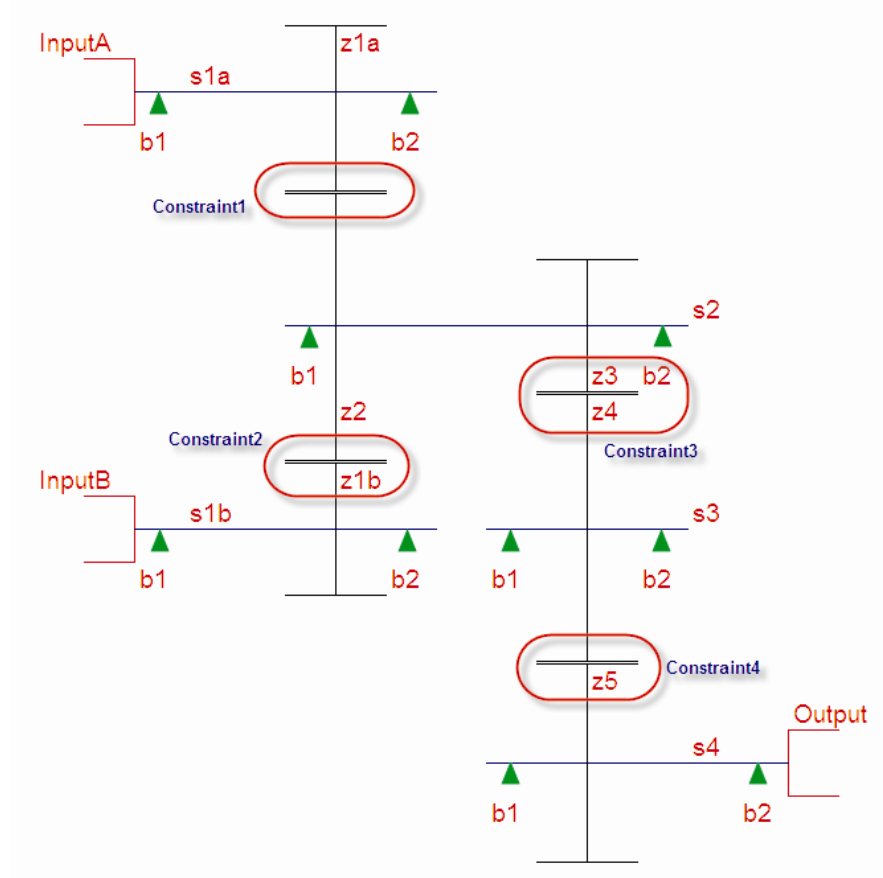


Figure 1 Three gears in a row and gear with two driving pinions

The combinations of elements for those constraints vary between a gear stage with three gears in a row and a gear with two driving pinions:

For three gears in a row:

Constraint between	Element 1	Element 2
$z3z4$	$z3$	$z4$
$z4z5$	$z4$	$z5$

For gear with two driving pinions:

Constraint	Element 1	Element 2
$z1az2$	$z1a$	$z2$
$z1bz2$	$z1b$	$z2$

2.4 Calculation-Elements

There are now two constraints on the gears, where we can apply two elements of type “HelicalGearPair”. Without doing anything, the gears are calculated as they would be simple gear

stages with two gears. Therefore the above mentioned factors have to be modified properly. The modification of the factors is done as follows:

2.4.1 Three Gears in a Row

In order to change Kwb (middle gear of the three gears in row), proceed as follows:

1. Open the “S”-Mask of the gear which has alternating tooth bending
2. Click on “Influence value” behind the field alternating bending coefficient
3. Change the value of Kwb from 1 to 0.7

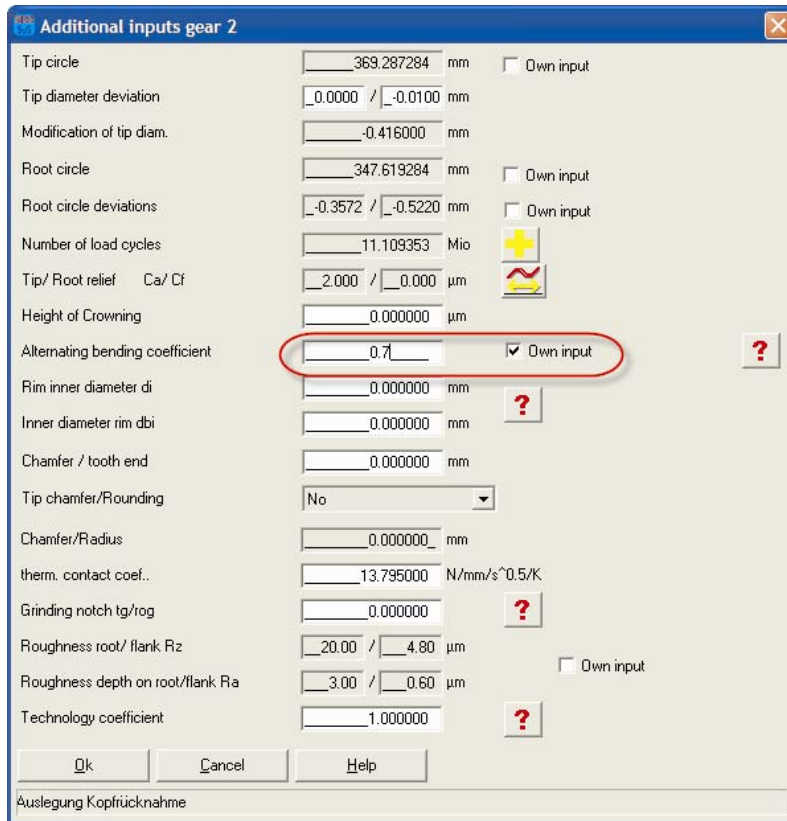


Figure 2.4-1 Setting up kwb

2.4.2 Two Pinions Driving one Gear

To change the number of load cycles per revolution is needed when two pinions are driving a same gear. Adjustment for that can be done as follows.

1. Open the properties for the calculation module and look for the variable “NLValue1” or “NLValue2” depending on if gear 1 or 2 has to contacts.
2. Delete existing expression and add flag to transfer data from KISSsoft – KISSsys if you want to modify value from KISSsoft module.
3. Type in new number of cycles per revolution directly in KISSsys or
4. Open the calculation module to do the modification in KISSsoft
5. Open the “S”-mask of the gear with teeth doing more than one cycle per revolution:
6. Click on the +Button behind the field “Load cycles”
7. Activate and enter “Load cycles per revolution” (2 for a gear with 2 driving pinions)

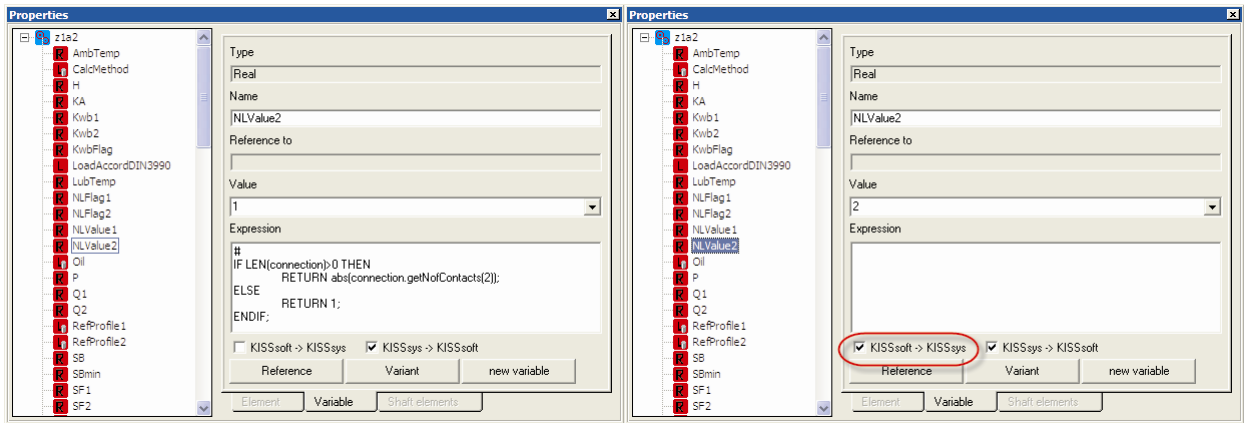


Figure 2.4-2 Modifications for the load cycle definition. Left; Delete default expression from the NLValue definition. Right; Write new number and activate flag “KISSsoft-KISSsys”

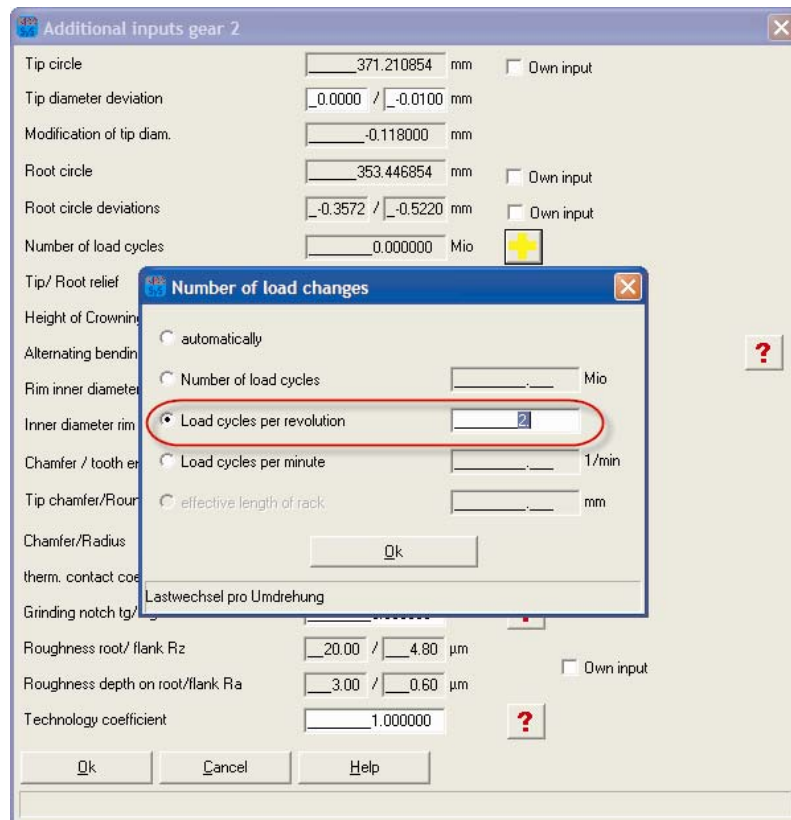


Figure 2.4-3 Setting up a number of load cycles in KISSsoft module

Hint: If the power from the pinions driving the gear is equal, it does not make sense to calculate pinion and gear two times.

2.5 Results

The most difficult part, as for every engineering work, is the interpretation of the results. As you have two calculation elements in your model you get more results than you really need. You receive four results and really need two of them (one for the tooth root and one for the flank). Looking at the minimum of the safety factors would be on the very safe side. We recommend to look at both results and to decide which one to take.