KISSsoft AG - +41 55 254 20 50
Uetzikon 4 - +41 55 254 20 51
8634 Hombrechtikon - info@KISSsoft.AG
Switzerland - www.KISSsoft.AG

Centrifugal force definition for the planet pin

1 Description

1.1 Task

One of the very important aspects, especially for the planetary gearbox design, is to take into account the centrifugal forces for the planet pin bearings. In some cases these forces can have a big influence for the bearing lifetime.
Because this is not automatically considered in the KISSsys, user needs to "manually" add this component in to the model. This can be done by adding a "kSysCentricalLoad" in the model and giving a formula for the force component calculation.

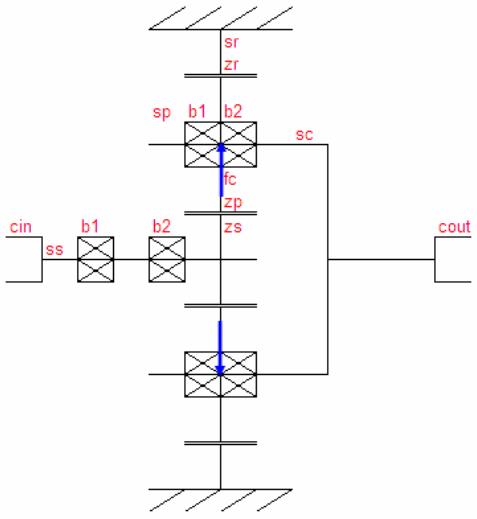

Figure 1.1-1 Schematic of the simple planetary gearbox

1.2 Force definition

This centrifugal force is due the planet carrier rotation and because planet gears are on the planet carrier, there is a force due the mass of the gears, the center distance and the speed of the carrier, which creates an extra force on the bearings additional to the meshing forces. E.g. following diagram shows how the force is dependent of the carrier speed. (mass of planet gear = 1 kg, a = 50 mm)

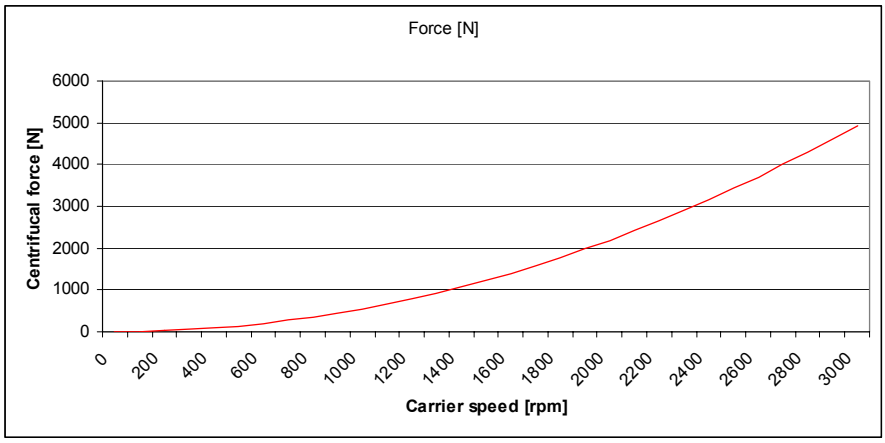

Figure 1.2-1 Centrifucal force

2 Building up a model

2.1 Create a model

Start to build up model as any KISSsys model. Plan your model first and then start with adding first "kSysGroup". Add all needed machine components. Model the planet carrier and put the planet pin under the carrier. Add also extra force component to the pin to be able to consider centrifugal load.

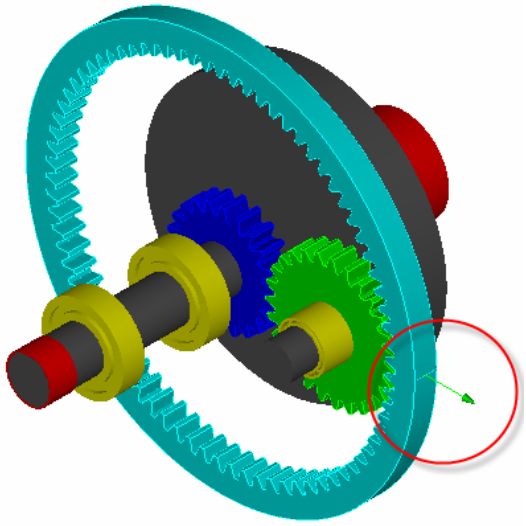

Figure 2.1-1 Planetary gearbox with centrifugal force

After the model is created and geometry data created for the component user need to also define formulas to calculate the centrifugal force due to the carrier rotation. Following steps are needed to create formulas.

3 Adding new variables

3.1 Material density

Planet gear mass is needed for the force calculation, if fixed value is not wanted to be used mass can be calculated from the gear properties. Add a variable “rho” to the gear component (planet, “zp”) to transfer material density from the calculation

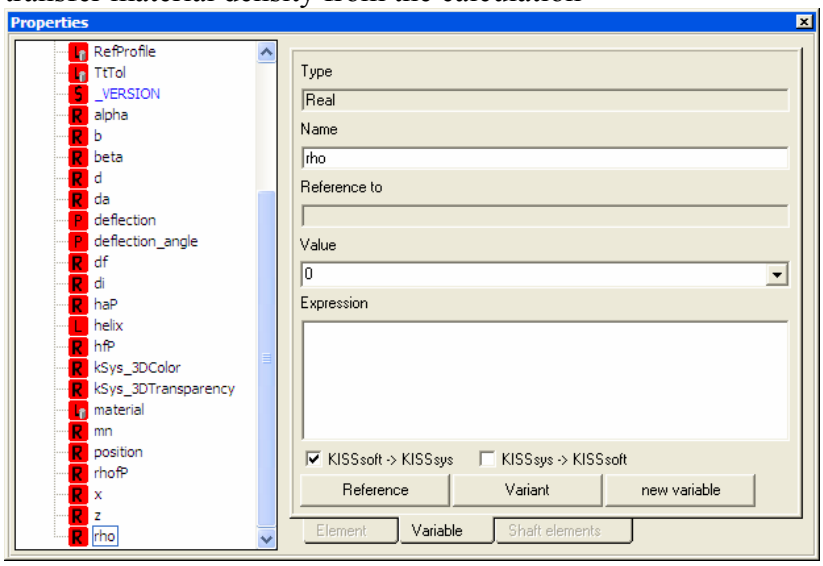

Figure 3.1-1 Add variable for the material density

3.2 “TranslationTable”

For the planet calculation module create a variable “TranslationTable” and define variable “rho” to be transferred. “TranslationTable” definition is as follows [[“variable”,”value from calculation”]].

“variable” is the name of the new variable where to save the transferred value.

“value from calculation” is the expression of the variable that is transferred from the calculation results, find name and definition of the variables from the corresponding report template *.rpt, which are saved in KISSsoft installation directory. See more detailed instructions of the “TranslationTable” usage from the file “ins-007-02-TranslationTable.pdf”.

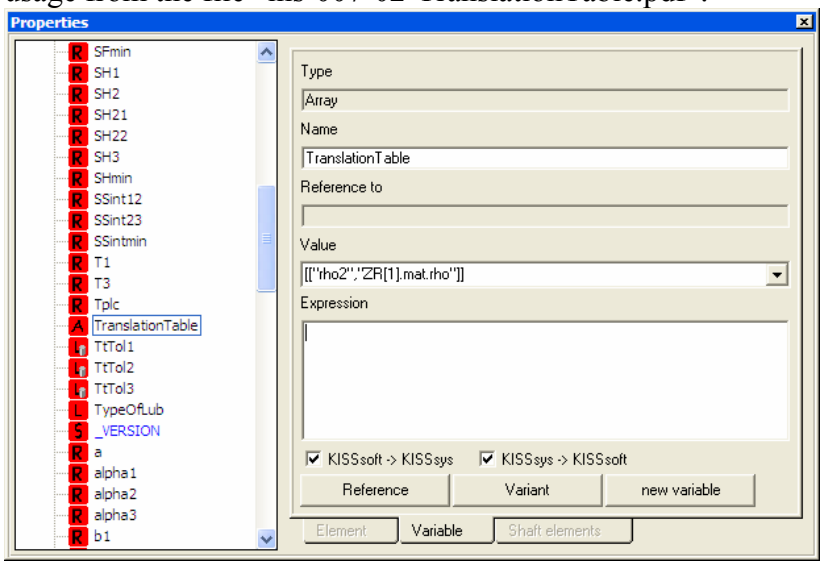

Figure 3.2-1 Add "TranslationTable" for the calculation

Create also a new variable “rho2” where to transfer the density of the gear and make it reference to the gear “rho”.

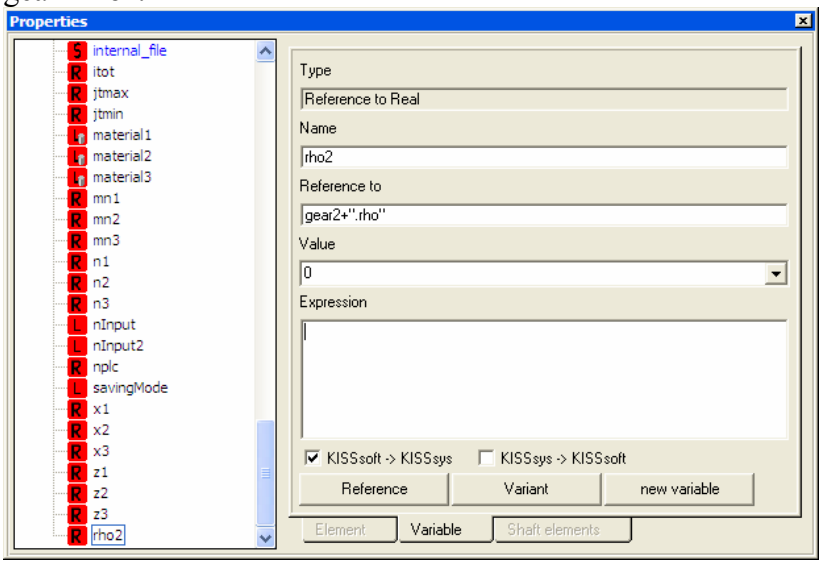

Figure 3.2-2 Create variable to save new value

4 Variables with formulas

4.1 Calculate gear mass

Define mass of the planet gear $m = (b * \pi * \frac{(\frac{d - df}{2} - di)^2}{4} * \rho$. This also requires a new variable “mass” to be defined.

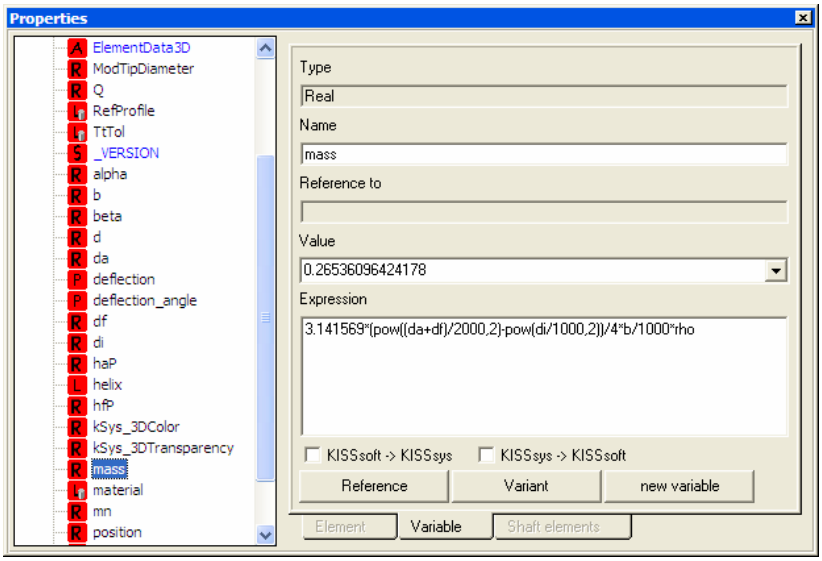

Figure 4.1-1 Mass definition of the gear

4.2 Calculate centrifugal force

Define centrifugal force $f = m * r * \omega^2$. If angle position between sun and planet is defined, then force value must be separated to x and z directions according to the angle keeping force to be defined directly outwards.

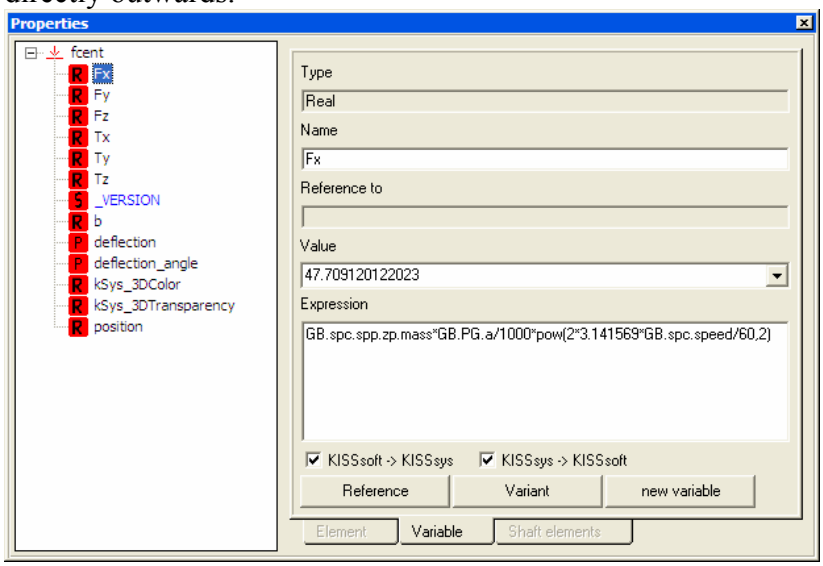

Figure 4.2-1 Define formula for the force

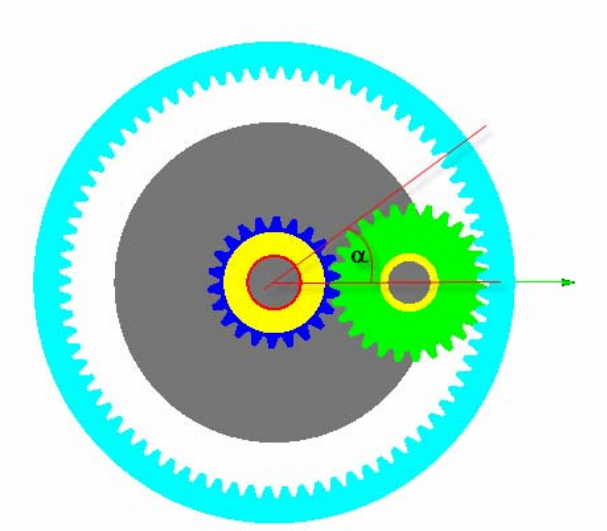

Figure 4.2-2 Angle of contact in planet gears

If value for the angle α is given then the force formula is defined in the x and z directions.
Fx = $f = m * r * \omega^2 * \cos(\alpha)$ and Fz = $f = m * r * \omega^2 * \sin(\alpha)$

Force value can be shown in 3DView with green arrow. See instruction of the force activation from the file “ins-010-02-Graphical-elements.pdf”.