

KISSsoft, FEM gear body deformation and it's influence on the LTCA

Application and use of DPK module

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SHARING KNOWLEDGE

1 Document information

1.1 Document change record

Revision	Date	Author	Comments
0	5.3.2017	HD	Original document

1.2 Table of content

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1.3 References

[1] KISSsoft release 03-2017A

2 Data preparation

2.1 KISSsys model

See file THE-KSS-AS-1711-00-KISSsys-model.ks, use with release 03-2017A or later.

There, a simple one stage gearbox is modelled. The model is perfectly symmetrical such that a symmetrical load distribution of over the face width will result as long as no influence of the (asymmetrical) gear body is considered. Note that even the power input and power output through couplings is located in the middle of the shaft in order to achieve symmetry even if this is not a realistic, practical design.



2.2 Exported gear file

From the above KISSsys model, a gear pair file is exported: THE-KSS-AS-1711-00-Gearpair.Z12 Note that some parameters of the gear body (web thickness and gear rim thickness) is already defiend in tab "Basic data", button "Details".

K Define details of geo	metry	/			×
		Gear 1		Gear 2	
Drawing number		z1(z1z2)]	z2(z1z2)	
Rim thickness coefficient	SR.	3.5000	•	3.5000	۲
Inner diameter	dı	33.1100]0	256.1060	🔾 mm 📋
Inner diameter of gear rim	dы	0.0000]	0.0000	mm 📋
Web thickness factor	b₅/b	0.2000	•	0.2000	۲
Web thickness	b _s	12.0000]0	12.0000	🔾 mm 📋
Toothing runout		None 🔹]	None 🔻	- 21
				ОК	Cancel

Note below gear data

Basic data	Reference profile	Т	olerances	Rating	Factors	Σ Con	itact analysis						
Geometry													
Normal mod	dule	mn			4.0000	mm	+			Gear 1	Gear 2	[Details
Pressure an	ngle at normal section	an			20.0000	•	\Leftrightarrow	Number of teeth	z [17	74		
Gear 1			spur gear		•		ىل	Facewidth	b [60.0000	60.0000	mm	+
Helix angle	at reference circle	β			0.0000	•	$\stackrel{1}{\checkmark}$	Profile shift coefficient	x* [0.4266	-0.1715		↔
Center dist	ance	а			183.0000] mm 🗹	+	Quality (DIN 3961)	Q [6	6		ىل.

2.3 Creating the gear body stiffness matrix

See file THE-KSS-AS-1711-00-Gear-body-stiffness.K16

Start KISSsoft module "DPK". Set the flags as shown below. Press "..." and import the gear data for the pinion (gear 1 in gear pair 1). Set mesh density to "medium":

Gear body deformation		
Geometry		
Use factors		
Read data from file		
File	S-1711-00-Gearpair.Z12	
Number of gear pair	1 •	
Number of gear	1 -	
Mesh density FE model	medium 🔻	

Enter geometry that will result in a soft (so that we see an effect in the results) and asymmetrical gear body:

ocomeo j							
Use factors				Rim thickness	SR1	4.0000	mn
Read data from file				Rim thickness	SR ₂	4.0000	mn
File		-AS-1711-00-Gearpair.Z12		 Hub thickness	h.	4 0000	mn
Number of gear pair		1 -					
Number of gear pair		-		Hub thickness	hz	4.0000	mn
Number of gear		1 •		Web thickness	b _s	12.0000	mn
Mesh density FE model		medium 👻		Recess width	k1	5.0000	mn
Facewidth	ь	60.0000	mm	Recess width	k-	24	mn
Hub width	bn	60.0000	mm			- 1	
Operating pitch diameter	dw	68.3736	mm				
Shaft diameter	dsh	33.1100	mm				
Normal module	mn	4.0000	mm				

Select the gear body material, activate the below flag and define an output path for the *.resu (that is the stiffness matrix) file:

Material			
Gear body deformatio	18CrNiMo7-6, Case-carburized steel, case-hardened	•	+
Load			
Generate the stiff	less matrix		
Stiffness matrix file	D:/HP/10-KSS/13-Release-2017/DPK/THE-KSS-AS-1711-00-Stiffness-matrix.resu		

I recommend to save the file before running the calculation.

Run the calculation by pressing "F5" or \sum .

The calculation should complete with:

K Info	rmation ×		
The stiffness matrix was saved successful			
	ОК		

The *.resu file should look like this:

TextPad - D:\HP\10-KSS\13-Releas	ie-2017\DPK\THE-KSS-AS-1711-00-Stiffness-matrix.resu — 🗆 🗙
Datei Bearbeiten Suchen An	isicht Extras Makros Konfiguration Fenster Hilfe
0 🗃 🖬 🗐 🖨 🖪 🕷 🕅	🖻 💼 🗠 🗠 🛲 🖬 😂 🆤 🕼 🚱 🛠 🏟 👁 📭 🔹 🗤 🕨 🎼 Inkrementelle Suche 🔱 🕆
Dateiliste 4 ×	THE-KSS-AS-1711-00-Stiffness-ma ×
THE-KSS-AS-1711-00-Stiffness-matr	
	<i><iniast> VOUS UTILISEZ UNE VIEILLE VERSION DE CODE_ASTER. EN MESTTANT A JOUR VOTRE VERSION, VOUS BENEFICIEREZ DES DENNIERES AMELIORATIONS APPORTEES AU CODE DEFUIS 15 MOIS. SI VOUS AVEZ DES DEVELOPPENENTS FRIVES, VOUS RISQUEZ D'AVOIR UN TRAVALL IMPORTANT DE REINGENIERIE SI VOUS NE SUUVEZ PAS LES MISES À JOUR.</iniast></i>
	CODE_ASTER VERSION DE DEVELOPPEMENT 1
	VERSION SEQUENTIELLE
	COPYRIGHT EDF-R&D 1991 - 2010
	EXECUTION DU : VE-05-MAI -2017 16:53
	PLATE-FORME : LAPTOP-HP
	NB MAX PROC OpenMP: 1
😋 Expl 🚰 Datei 🖉 Textb	۲ ۲
Suchergebnis	ŧ,
Suchergebnis 🔛 Programmausga	abe
Drücken Sie F1 für Hilfe.	1 1 Lesen ÜB Block Sync Aufz UF

See file THE-KSS-AS-1711-00-Stiffness-matrix.resu

2.4 Checking the FEM body calculated

To see the geometry / FEM mesh, press 💴 . Salome will open, press 💴



Click on @



3 Import

3.1 Import in KISSsys

Go back to KISSsys. Open shaft model of pinion shaft. Import the *.resu file into the shaft editor:

Z	T	1	i k		
x	Y		Ę	4	
	Elements-editor				
	Read data from file				· · · · ·
(☑ Take stiffness matrix	into account			
	File name	D:/HP/10-KSS/13-Release-2017/DPK	/THE-KSS-AS-1711-00-Stiffness	matrix.resu	
	Take into account for	Ce center point official			1
1	Label	z1(z1z2)			
	Position of cylindrical gea	r on shaft	У	100.0000 mm	
	Position of cylindrical gea	r in dlobal svstem	Y	100.0000 mm	

3.2 Contact analysis with consideration of gear body deformation

Now, close the above shaft model and go to the gear calculation.

Check that the shaft calculations are linked to the gear pair calculation as shown below:

				_	_	_	
iears	Cons	ider gears as mass and as	stiffness	•			
ake into account partial loa	d From	shaft calculation		-			
		Konstant	Proportional (1000.	00 Nm)			
haft Gear 1 file 🛛 🤇	C:\U	sers\HP\AppData\Local\Te	mp\KSYS_0\s1_calc_A.w10			•	•
leviation error of axis	fza	0.00	00	0.0000	μm	and the second se	l
nclination error of axis	f.	0.00	00	0.0000	μm	1	i.
haft Gear 2 file	C:\U	sers\HP\AppData\Local\Te	mp\KSYS_0\s2_calc_B.w10			4	•

And neglect any torsional effects:

•
•

Run the contact analysis. You will find the below stress distribution:



3.3 Contact analysis without of gear body deformation

Go back to the shaft calculation of the pinion shaft and deactivate the flag:



Close the KISSsoft shaft file and go back to the gear pair file. Run the contact analysis again to find:



3.4 Assessment

In the calculation without influence of the gear body, we find – as expected – a symmetrical load distribution. We find that – due to the bending of the two shafts and because no crowning is applied – there is more load on the outer sides of the face width.

If we consider the gear body deformation, we see a "rippling" effect. This is because the FEM mesh is not fine enough in the gear body deformation calculation (the programmers are aware of this). Also, we see that on side II, where the gear body is soft, there is less load.

So, the results are as expected.

The usage of this module is not yet as it should be and the programmers are aware that the usability should be improved. However, in principle, the module DPK can be used for detailed analysis.