Verification of a Tractor Gearbox

KISSsoft AG
Frauwis 1
CH-8634 Hombrechtikon
www.KISSsoft.ch
Verification of a Tractor Gearbox

Part I, Introduction
Objective

1. Tractor transmission should be verified using load spectra as input
2. Strength critical parts have to be identified
3. Positive experience / know-how with existing transmission to be used

Cost effective, parametrised calculations of strength and lifetime of the transmission components are required
Objective

Design verification of tractor transmission

- Parametric studies on system level, sensitivity analysis
- Very flexible model in case of design changes
- Knowledge database, benchmarks
- Permits detection of weak parts or fatal load steps

Parameterized KISSsys Model
Verification of a Tractor Gearbox

Idea

- Analysis of the existing transmission using several load cases and a load spectra allows comparison for experience
- Results of these analysis are used as benchmark results
- The KISSsys model may be used in future as a knowledge database
## Scope of the Calculations

<table>
<thead>
<tr>
<th></th>
<th>Gears ISO6336 AGMA2001 DIN3990</th>
<th>Shafts DIN743</th>
<th>Bearings ISO281</th>
<th>Shaft-hub connections DIN7190 DIN …</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculation with nominal load</td>
<td>Lifetimes and safety factors</td>
<td>Safety factors, finite life</td>
<td>Lifetime, static safety</td>
<td>Safety factors</td>
</tr>
<tr>
<td>Calculation with load spectra</td>
<td>Lifetimes and safety factors</td>
<td>Safety factors for each step individually</td>
<td>Lifetime</td>
<td>Worst case analysis</td>
</tr>
</tbody>
</table>
Verification of a Tractor Gearbox

Part II, Description of Transmission and Model
Current Design of Transmission, Schematics

- F, R: Forward, reverse
- M, LL, H: Medium, low and high speed range
- PTO: Power take off (not modelled)
- 1, 2, 3, 4: Speeds
- 2WD / 4WD
- Total 24 speeds

Power distribution: Front: 38%, Rear: 62%
KISSsys allows for modelling of:
• Gear pairs
• Chains of gears
• Couplings
• Idlers
• Superimposed shafts
• Statically over determined shaft supports
• Power split
• Kinematics constraints
Verification of a Tractor Gearbox

KISSsys Model of Current Design, Overview

Tree structure
Results
3D Representation
Schematics
Load Spectra
Messages
Current Design, Details

Production drawings for all elements were provided

Corresponding KISSsoft files needed to be generated

Verification of a Tractor Gearbox
Verification of a Tractor Gearbox

Part III, Details of KISSsys Model
Verification of a Tractor Gearbox

Representation According to Speed Settings

Speeds: R,3,M,4WD

Speeds: F,1,H,2WD
1. Couplings can be closed/opened
2. Gear forces have to be applied on the main shafts

The reaction forces off the change gear parts define the action forces on the main shafts
Load Definition

Add load spectra into KISSsys table

Import load spectra as *.txt file with “;” as separator (Excel)

Definition of load settings, input of nominal load
Positioning

Positions provided by Manufacturer

3D Representation with coordinate system

Positioning Dialog in KISSsys

Verification of a Tractor Gearbox
Verification of a Tractor Gearbox

Part IV, Results and conclusion
Results

User defined representation of most important results

Verification of a Tractor Gearbox
Results

Gear stage data in predefined tables

Lifetime for each load step exported to Excel

Includes detailed KISSsoft reports
Conclusion

Using a parameterized model of a complete transmission modeled in KISSsoft / KISSsys
Strength / lifetime verification using load spectra is performed
Results were compared to experience / field results
To use results as benchmark for further calculations
In the sense of a knowledge database