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MARCH 2022

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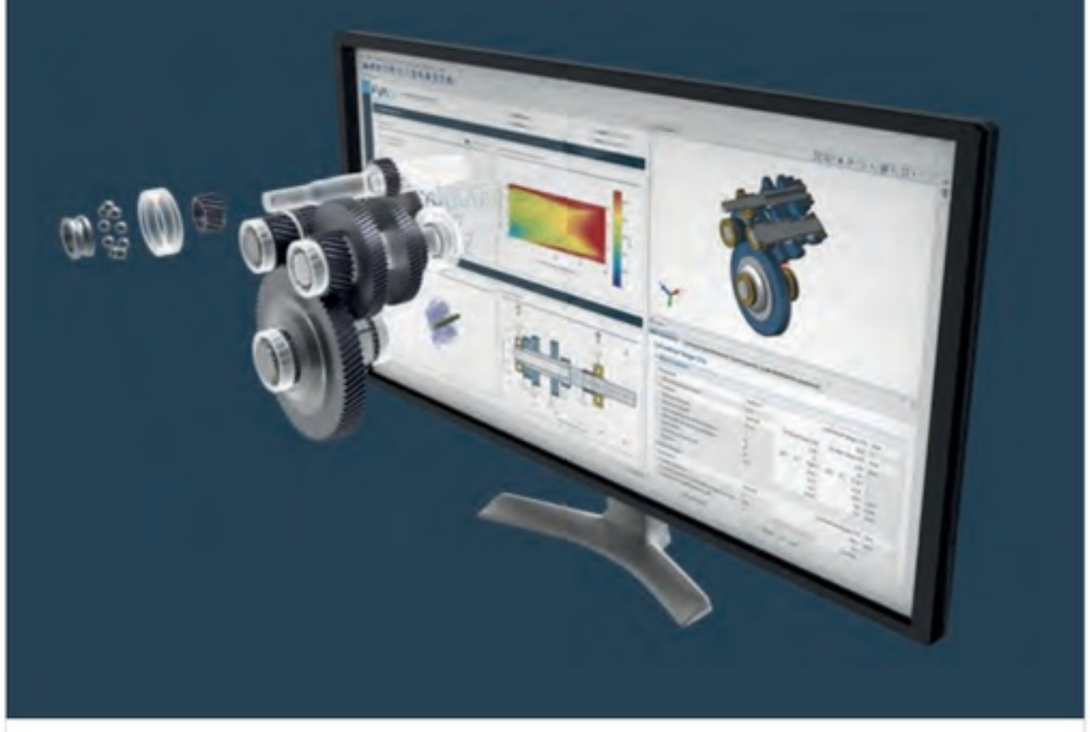

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# Drive system development

## A simulation tool enables fast calculation of the influence of the gear wheel body on transverse load and pressure distribution


To increase the power density of a gear unit it is important to detect extraneous material reserves and cut them to the necessary level. This requires knowledge of the influencing factors on the gear unit and the resulting loads.

The FVA-Workbench is designed to make it easy to calculate the influence of the wheel body on the longitudinal load distribution and determine a suitable modification. The following example looks at a two-stage reduction gearbox to demonstrate the influence on the local load and pressure distribution.

The FVA-Workbench is a manufacturer-neutral simulation tool for complete drive systems. It can reliably calculate load capacities, acoustic properties and losses. The influence of the gear body has been enhanced in the new FVA-Workbench 7.0. The stiffness is now determined in a preliminary calculation using a static reduction, which is then available for all subsequent calculations. This has no noticeable effect on the calculation time.

The reduction gearbox is used to determine the influence of the wheel body on the gear by comparing the results of various geometries with different rim widths. Additional bores are added for further weight reduction. These bores are positioned so that they are directly under the gear mesh in the calculation. This is a worst-case scenario that maximizes the influence of the wheel body.

Different wheel body rim widths between 5mm (17% of the total width) and 25mm (full disc wheel) are evaluated. The results of FVA's evaluation are shown in Figure 1. The graph shows that the rim width has a considerable influence on the stiffness of the gear.

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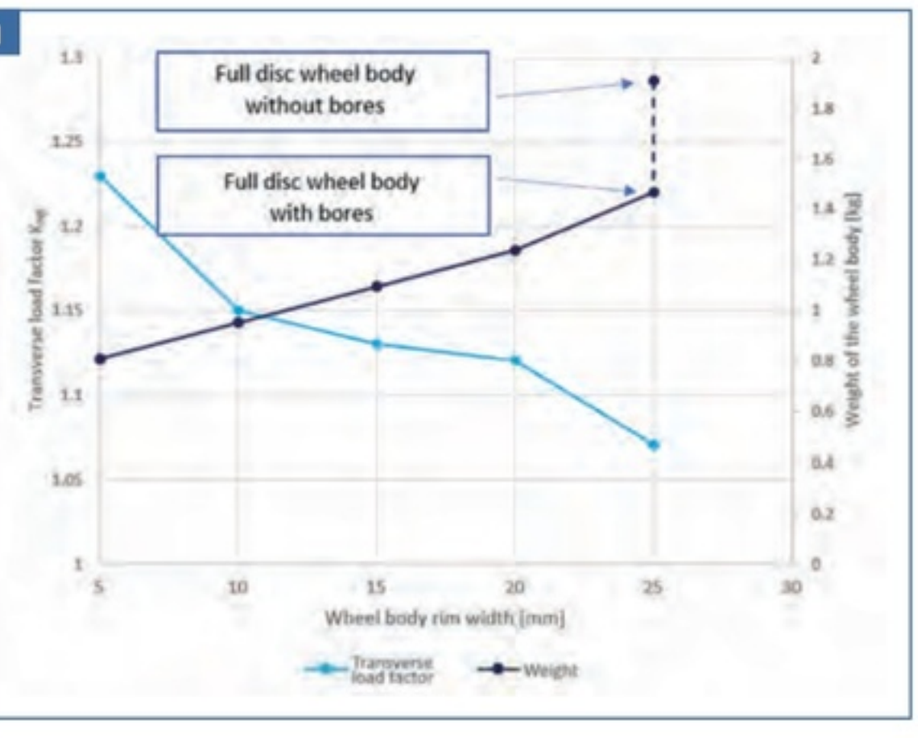


**1.** Weight and transverse load factor $K_{H\beta}$ over the rim width of the gear

**2.** Evaluation showing tooth contact changes

| Rim width | Weight (kg) | Transverse load factor ($K_{H\beta}$) | Max pressure (N/mm²) |
|---|---|---|---|
| 25 | 1.91 | 1.07 | 1473.92 |
| 25 | 1.47 | 1.07 | 1611.69 |
| 20 | 1.24 | 1.12 | 1706.46 |
| 15 | 1.1 | 1.13 | 1899.43 |
| 10 | 0.9 | 1.15 | 2188.90 |
| 5 | 0.8 | 1.23 | 3171.81 |

The gear tilt can be seen in the longitudinal load distribution and the plot of the transverse load factor $K_{H\beta}$. The dark blue line shows the weight of the gear. As is to be expected, the weight increases linearly with the width of the rim.

### ANALYSIS RESULTS

This evaluation shows that the transverse load factor decreases rapidly as the rim width increases. In the simulation, no difference could be observed between a full disc wheel body and a machined-out wheel body with a rim width of 20mm. However, there are strong deviations, which must be considered in the modification. The changes to the tooth contact are shown in Figure 2. It can be seen that moderate rim widths have only a slight influence on the transverse load factor.

The gear is designed so that the maximum sustainable pressure of 1,500N/mm² is not exceeded. However, with smaller rim widths, additional tilting from the wheel body leads to overloading of the gear and increased local pressure.

The calculated tilt can be compensated for with additional helix angle modifications, which can easily be calculated with the FVA-Workbench. Complex optimizations are not required.

It is relatively easy to increase the power density of a gear unit by using a small rim with bores. With the FVA-Workbench's One-Click FEM feature, even beginners can perform reliable FE calculations and take bores into account thanks to a quick and easy calculation process. With this method, notable gearbox weight savings can be achieved. However, it also leads to a considerably softer design. The FVA-Workbench calculates the resulting deformations and suggests suitable gear modifications. This ensures an optimal design.

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