Optimizing bearings in door hinges

NICO KORNEGOOR, BSC. INDUSTRIAL DESIGN ENGINEERING, UNIVERSITY OF TWENTE, THE NETHERLANDS

Public Summary

Themans is a developer of hinges, locks and other items related to doors and windows. Under the brand name of S^2 Safe & Secure, Themans focusses on hinges and door fittings. Most modern hinges use sliding bearings in between the knots of the hinges. The goal of this assignment is to research possible improvements to these bearings. This is beneficial as the current sliding bearing hinges meet all the standards set by the industry, but the bearing wear can still be improved. Most of the market has adopted two bearings per knot while Themans uses one bearing per knot.

An in-depth analysis of the problem was performed by examining the bearings of hinges that went through durability testing and by simulating the forces that act on the hinges in SolidWorks. For these simulations, two types of use situations were created. Regular use was simulated as a door hung in its hinges without moving. Extreme use cases exist of a door hitting a wall or door stopper. These excessive forces apply a peak load on the hinges and thus the bearings.

To further examine the loads in the hinges, a testing device was designed using loadcells. The device was designed to have loadcells individually measure the forces per hinge. The long term goal of this testing device is to find the optimal location for the hinges to reach an optimal distribution of horizontal forces in the hinges, but also to find the effect of door closers and door dimensions. The results show too much variance to estimate ideal hinge locations. The results do clearly show that the current industry standard for hanging door hinges is far from optimal as the lowest hinge is loaded much more than the other three hinges.

With a clear view of the problem, literature research on sliding bearings, friction, materials and material wear was performed. Applied theories on sliding bearing design can be applied directly to design some of the dimensions of the hinge. Literature research on material wear has shown that the roughness of the counter surface is one of the most critical factors influencing material wear. Literature shows that POM is an excellent material for sliding bearings, as long as the counter surface is smooth, which is currently not the case. Instead of changing the material of the bearing, the focus of the design improvements is to create a smooth counter surface as this will yield the best results.

Using the hinge as the counter surface of the bearing would keep the non-obtrusive look of the Ultimaxx hinge. Production processes capable of creating the required smoothes were examined, and the geometry of the sliding bearing was finetuned to create a balance between surface area and ease of assembling. Other approaches to reach the same goal were also explored. This included adding new parts to the hinges to act as the counter surface of the bearings. The project resulted in 3 improved designs focussed on decreasing the wear of the bearings. While literature research shows that the changes made will improve the durability of the hinge, the quantity of this improvement is impossible to estimate. It is, therefore advised to create a small scale durability test using prototypes.