A Methodology for Evaluating the Performance of Material Models Under Biaxial Loads

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Traditionally, product testing was done on physical prototypes. This approach is both expensive and slows down the product development process. For this reason, companies are transitioning to testing by doing simulations, most commonly finite elements analysis. In order to obtain reliable results from the simulations, accurate material models are needed. In this thesis project, conducted at IKEA of Sweden, a methodology for evaluating the performance of material models during biaxial loads using a punch test is developed with the aim to help further strengthen IKEA's simulation capabilities.

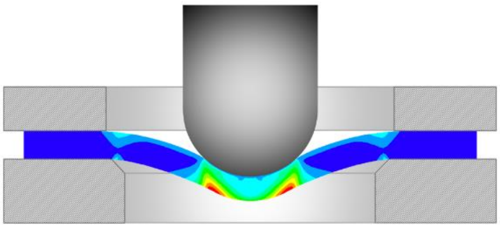

Figure 1. An illustration of a punch test. [1]

In a punch test, a striker is punched through a test specimen until failure (see Figure 1) which induces a biaxial stress state on the material. Many materials exhibit different behavior when exposed to multiaxial loads, compared to uniaxial which are induced by for instance classical tensile tests. To enable the punch testing in this thesis project, a physical test jig (see Figure 2) is designed using a concept development process and then used in combination with existing equipment at IKEA Test Lab. Results from the experiment are acquired using digital image correlation.

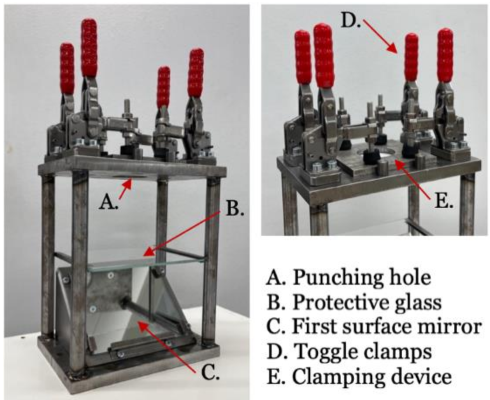

Figure 2. The test jig.

The evaluation of material models is done by executing identical punch tests, one in a simulation and one in a physical experiment, and then comparing the results from the two. The material model that is to be evaluated is used in the simulation and a specimen of the corresponding material in the physical test. The more the results resemble each other, the more accurate the material model is considered to be.

An initial analysis is done by comparing the two force-displacement curves. Further, a field analysis is done where the local displacements and strains are compared. These comparisons result in a number of graphs and figures where the differences between the simulation and the experiment are illustrated. The results can be used to calibrate, evaluate and compare different material models. In addition, the material behavior can be analyzed qualitatively, which may reveal interesting details about its properties. Lastly, it can reveal in which deformation range the material model performs best.

[1] D. E. Altstadt, "*The Small Punch Test*". HZDR. Available: https://www.hzdr.de/db/Cms?pOid=13993&pNid=2708 (2023.01.06)