A comparative study of materials models for solid and laminated birch wood over wide ranges of strain, strain-rate and temperature

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Wood as an engineering material shows benefits like high specific strength and stiffness in fibre direction, low cost and a wide availability. It shows a low failure strain under tensile loading but a high ductility and energy absorbing capability under compression both in and across the fibre direction. This high energy absorbing capability makes it an interesting material for automotive applications especially for crash relevant components. In order to use wood in automotive applications it has to be describable within a numerical simulation over wide ranges of strain, strain-rate and temperature.

Within this study various material models in the explicit FEM code LS-Dyna (e.g. Mat058, Mat126 or Mat157) complemented by orthotropic damage models (e.g. eGISSMO) were compared w.r.t. their capability of describing birch wood in a numerical crash setting. The material data were established employing a universal testing machine and a Split-Hopkinson bar. The characterisation tests covered a comprehensive range of loads (tension, compression, shear and bending), temperatures (-40°C, +20°C, +80°C), loading-rates (up to 1100 s-1) and specimens (solid and laminated birch wood).

The study shows that readily available material models combined with orthotropic damage models in LS-DYNA can sufficiently well describe the rather complex material-behaviour, in terms of anisotropy, as well as load- and temperature-dependencies. However, some simplifications and trade-offs regarding the elastic properties as well as the softening and hardening behaviour have to be taken into account in order to simulate all considered load cases with one material setting, respectively. The advantages and disadvantages of the individual modelling approaches are discussed, and the performance is showcased in use-cases, like a side-impact beam.

**REFERENCES**

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