An implicit and explicit solver for contact problems

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Introduction

The interaction of rolling tyres with road surfaces is one of the major contributions to road traffic noise. In order to reduce tyre/road noise, accurate (numerical) prediction models are needed. These models are developed in the current project.

Contact algorithm

The contact between tyre and road is one of the most important aspects in the model. A new contact solver has been developed and has been successfully applied in an implicit and explicit three-dimensional finite element scheme [1]. In the solver there is no need for contact elements or contact parameters. The finite element model is valid for large translations and rotations. Different material models and friction models can be used. The major advantage is the possibility to use multigrid to speed up the algorithm.

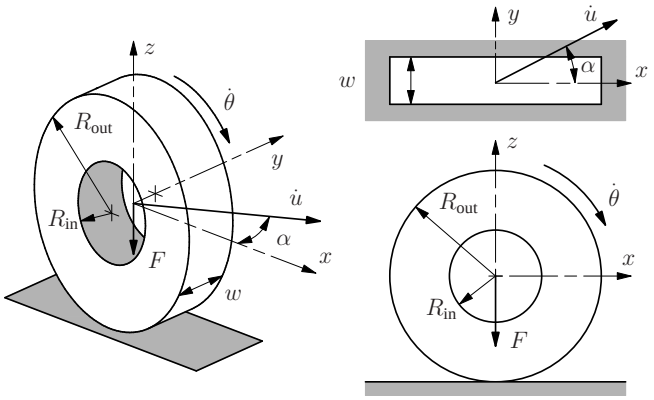
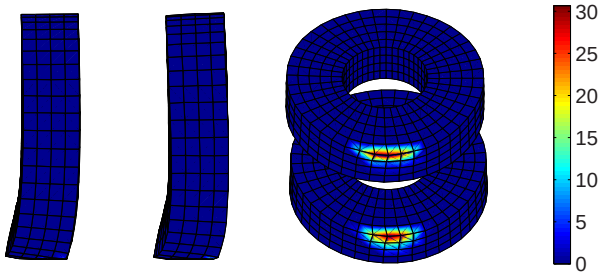


Figure 1 : The small test tyre.

Numerical example

Small rubber tyres are used to measure the skid, traction, and wear resistance of rubber compounds (see figure 1, where $R_{\text{out}} = 39$ mm, $R_{\text{in}} = 17$ mm, and $w = 17.5$ mm). The tyres are rolling on a rotating disk, where the speed, slip angle, load and surface of the disk can be changed. The disk is assumed to be rigid. A basic Coulomb friction model is used. The small tyres are modelled statically and dynamically.

The results of the contact solver are compared with the solvers in the finite element package Abaqus. In one example the rim axle is forced to translate with velocity $\dot{u} = 2.59$ m/s and forced to rotate with $\dot{\theta} = 70$ rad/s. Figure 2 shows the tyre in a deformed shape after 0.1 s. The tyre is rolling in clockwise direction to the right. The results are in good agreement with Abaqus/Explicit. The contact solver is very robust at large slip angles. The longer calculation times are still a major drawback, since multigrid is not applied yet.



a Deformed shape for explicit solver (right) and Abaqus/Explicit. *b Shear force in N for explicit solver (above) and Abaqus/Explicit*

Figure 2 : Deformed shape of the tyre during clockwise rolling under a 45 degree slip angle.

Conclusions and future work

An implicit and explicit solver for contact problems has successfully been developed. Numerical examples show the working, the robustness and the potential of the algorithm. Future research aims at an experimental study on the contact zone with a special focus on the shear forces.

References

1. Schutte, J.H., Wijnant, Y.H. and de Boer (2010) An implicit and explicit solver for contact problems. In *Proceedings of ISMA2010*, Leuven, Belgium.

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