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Ankündigung eines Gastvortrages

zum Thema

Numerical solution of non-linear steady rolling contact problems for radial tires

Termin: **Mittwoch, 20. Januar 2010, 16:00 Uhr**

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Abstracts of the report

The report is devoted to the numerical solution of steady rolling contact problems for radial tire modelled by a three-layer geometrically non-linear shell [1, 2]. Three basic contact problems are considered:

- The problem of frictionless contact of an immovable tire quasistatically loaded with a vertical force Q_z;
- The problem of tire straight-line steady rolling with dry friction in contact;
- The problem of tire steady cornering performance with specified cornering angles.

In all this cases contact surfaces modelling the road are considered to be absolutely rigid, and their shapes are specified analytically allowing to model not only planes but also slightly sloping curvilinear surfaces such as tire drums.

In order to properly model the inner radial tire structure for the case of large displacements, two kinds of finite elements were developed:

- 8–nodes (24 degrees of freedom) finite element with membrane approach to carcass and breaker;

- 18-nodes (90 degrees of freedom) finite element with two Timoshenko shells modelling carcass and breaker layers.

Each of this elements includes a third non-compressible streak layer and an elastic outer protector layer. Efforts for the elimination of FE-locking in carcass, breaker and streak had been undertaken.

First the contact problem is considered as the basis for solution of two remaining problems. It had been demonstrated that the solution of the contact problem for the shell with an outer Winkler layer is equivalent to usage of the penalty method with a physically determined penalty parameter. This makes tangential stiffness matrix to be positive defined and gives possibility to use an advanced solution techniques like Cholesky method what considerably reduces solution time.

To determine the contact area which is unknown at the beginning, three-level iteration method based on [3] were developed. An outer level of iteration has been introduced to enhance convergence for the problems with friction (second and third problems in the above list). To determine initial estimate correctly discrete method of continuation of loading parameters (inner pressure, contact surface position etc) had been used.

The second problem considered in the report deals with *straight-line steady-state rolling* of radial tire. In the case of Coulomb friction in the contact, tire contact area is divided into two zones: sticking zone and the sliding zone depending on friction law inequality. Sliding in contact makes it necessary to develop a special solution method because the general two-level iteration scheme gives no solution in this case.

The *third problem* of tire *steady-state cornering performance* covers the case of steady rolling with given cornering angle θ. In this solution tire contact area becomes fully non-symmetric. To model friction it is proposed to consider Coulomb's friction law in an independent form which considerably simplifies the algorithm of solution.

The results of our solution include contact area, stick/slide zones, contact pressure fields (both normal and tangential), displacements of tire's points, strain-stress state of inner tire elements and integral properties such as vertical load Q_z, lateral force Q_y, cornering coefficient $k_y=Q_y/\theta$ and others. Verification of solutions had been accomplished using the materials of experiments for the following tire models: car tires 175/70R13 [4], 185/65R14 and truck tire 10.00R20.

References

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