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MATERIAL INPUT FOR TIRE SIMULATION

Computational modeling of tires by Finite Element Method allows solving of various ways of loading. It is possible deal with static tire models if only static load should be applied (a car stands, the target is to determine deformation conditions of inflated tires loaded by the vertical force) or dynamic tire models, which will represent real states of tires during car such as tire impact on the specific barrier at a certain car speed.

It is important to experimentally determine material parameters used for the description of each individual part of tire-casings for computational modeling of tires [1]. E.g. material parameters as the modulus of elasticity and Poisson ratio describe the textile fiber [2]. For the description of elastomer parts of tire-casings there are used several material models of the viscoelastic behavior of the material – constitutive models, the Mooney-Rivlin (MR) modelis the most commonly used.To determine ofMRparameters, it is necessary to carry out the tensile test for elastomer samples by standar-dISO 37 [3].

Next way, MR parameters can be determined on the basis of the Shore A hardness. The procedure is such that the Shore A hardness (it is expressed as A in equations) is converted to the elastic modulus E [MPa] or shear modulus$G$ [MPa] andthen MR parameters are determinedfrom the modulus.Following equations can be used conversion of the mentioned hardness:

- Gent equation [4]:

$$E = \frac{0.0981 \cdot (56 + 7.62336 \cdot A)}{0.137505 \cdot (254 - 2.54 \cdot A)}; \quad (1)$$

- equation [5]:

$$E = \exp(0.0235 \cdot A - 0.6403); \quad (2)$$

- equation [6], but the elastic modulus is expressed in [psi]:

$$E = 11.427 \cdot A - 0.4445 \cdot A^2 + 0.0071 \cdot A^3; \quad (3)$$

- Batterman/Köhler equation[7] is based on expression dependence between shear modulus and Shore A hardness:

ж (4)

These equations can lead to different results of moduli for the same Shore A hardness.

Mooney-Rivlin parameters, such as C_{10} and C_{01} [MPa] are calculated according to:

$$G = 2 \cdot \left(C_{10} + C_{01} \right), \tag{5}$$

where $C_{01} = (\text{from } 0.2 \text{ to } 0.25) \cdot C_{10}$.

The parameter of incompressibility (d) [MPa^{-1}] can be calculated as:

$$d = \frac{2 \cdot (1 - 2\nu)}{C_{10} \cdot (5\nu - 2) + C_{01} \cdot (11\nu - 5)}, \tag{6}$$

where ν [-]is Poisson's ratio, which has values close to 0.5 for incompressible elastomers and it is commonly considered to be 0.4995 for better convergence of calculations.

The moduli of elasticity of composite structures of tire-casings such as steel-cord belt [8] are needed as material input to tire computation models too. The moduli are determined on the basis of the statical tensile and bend tests [1] and they can be used for verification analyses between tests and computational modeling of structure parts of tire-casings. Also specific low-cyclic tensile tests of tire textile carcass [9] are also important for obtaining material parameters too.

LITERATURE

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