

COMPARISON OF THE PHYSICAL AND EMPIRICAL APPROACH TO MODELLING OF QUASISTATIC ENVELOPING PROPERTIES OF THE TRACTOR TIRE

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ABSTRACT: Vibration properties of agricultural tractors are important indicator of their overall performances. Most important excitation source comes from pronounced short-wavelength road undulations, which are typical for unprepared off-road terrains generally dealt with by tractors. Low-pass geometric filtering of road profile done by tire thereby defines effective vibration input. Appropriate tire model that is able to account for this phenomenon is needed in order to optimize tractor vibration properties in early stage of development, by means of computer aided simulations with virtual prototype. To reduce tire model complexity and therefore improve simulation speed, yet achieving satisfactory accuracy, one possible approach is to separate tire model into two parts, one describing tire enveloping properties on the short-wavelength road input and the other one for tire elasticity with single-point contact. Enveloping model thereby generates effective excitation for contact point. In this paper two quasi-static tire enveloping models were derived. One of them is physically based and the other one is novel empirical model. Performances of both models are represented and compared with one another as well as with results of the physical experiment. Good agreement with experimental data is achieved in both cases. It was concluded that, in view of computational efficiency, empirical model manifested supremacy over physical model while the other one achieved greater flexibility regarding variations of influential parameters.

KEY WORDS: tractor vibrations, tire model, tire enveloping properties

POREĐENJE FIZIČKOG I EMPIRIJSKOG PRISTUPA MODELIRANJU KVAZISTATIČKIH ENVELOPNIH KARAKTERISTIKA PNEUMATIKA TRAKTORA

REZIME: Vibracione karakteristike poljoprivrednih traktora su važan pokazatelj njihovih ukupnih performansi. Najvažniji izvor su neravnine puta male talasne dužine, koje su tipične za nekategorisane puteve i vanputne podloge karakteristične za traktore. Pneumatik vrši nisko propusno filtriranje profila puta i to je značajna vibraciona pobuda. Odgovarajući model pneumatika koji je u stanju da objasni ovaj fenomen je potreban u cilju optimizacije vibracionih karakteristika traktora u ranoj fazi razvoja, pomoću računskih simulacija na virtuelnim prototipu. Radi smanjenja složenosti modela pneumatika i poboljšanja brzine simulacije, i postizanja zadovoljavajuće tačnosti, jedan od mogućih pristupa je da se model pneumatika razdvoji na dva dela: jedan koji opisuje karakteristike envelope pneumatika izloženog neravninama kratkih talasnih dužina i drugi koji opisuje elastičnost pneumatika sa kontaktom i tački. Model envelope generiše efektivnu pobudu u tački. U ovom radu su prikazana dva razvijena kvazistatička modela pneumatika. Jedan od njih je fizički, a drugi

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je empirijski model. Performanse oba modela su predstavljene i upoređene jedne sa drugima kao i sa rezultatima fizičkog eksperimenta. Dobro slaganje sa eksperimentalnim podacima je ostvareno u oba slučaja. Zaključeno je da, s obzirom na računsku efikasnost, empirijski modeli manifestuje bolje karakteristike fizičkog modela, dok drugi daje bolje mogućnosti za variranje uticajnih parametara.

KLJUČNE REČI: vibracije traktora, model pneumatika, karakteristike envelope pneumatika