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Non-smooth nonlinear model of suspension system based on piecewise linear luz(…) and tar(…) projections

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Abstract: Strong nonlinear phenomena are attributes of suspension systems of vehicles operated at high dynamic loads and high speeds. The causes of these phenomena are dry friction and clearance in the mechanisms, detachment of the wheel from the roadway, impact on the bumper element, etc. Therefore detailed descriptions of vehicle "vertical dynamics" should express these non-smooth nonlinearities, also in the case their structural physical models are discrete mechanical systems with only several masses. Modeling of strong nonlinear phenomena can be based on a piecewise linear approach. For simplification mathematical description of such phenomena special piecewise linear luz(…) and tar(…) projections have been proposed and elaborated by Żardecki. These projections have surprisingly simple mathematical apparatus which enable analytical operations (eg. reductions) for differential and algebraic equations and inclusions with non-smooth nonlinearities. They also simplify numerical simulations. Applications of this method due to modeling of car steering systems with inclusion freeplay and stick-slip processes have been reported in several authors' papers. This paper presents a "quarter-car" mathematical model of suspension system based on the luz(…) and tar(…) projections as well as results of simulation investigations of vertical non-linear dynamic of the car's wheel on uneven road at high speed.

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