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Individual wheel braking as a method for increasing velocity of articulated vehicles

ALEKSANDER SKURJAT[1*], ANDRZEJ KOSIARA[2]

1. Wroclaw University of Science and Technology, Department of Mechanical Engineering, Department of Off-Road Machine and Vehicle Engineering, Wybrzeże Wyspiańskiego 27, 50-370, Wroclaw, [0000-0002-3780-1691]

2. Wroclaw University of Science and Technology, Department of Mechanical Engineering, Department of Off-Road Machine and Vehicle Engineering, Wybrzeże Wyspiańskiego 27, 50-370, Wroclaw, [0000-0001-6870-5961]

* Presenting Author

Abstract: Increasing higher and higher velocities of articulated wheeled vehicles requires finding a new methods for stabilizing oscillations in articulated joint. It allows to achieve more in-line path of a vehicle. In the paper, a method for individual wheel braking is proposed and tested in computer simulations. Control algorithm allows for braking from 1 up to 3 wheels for increasing damping and reducing oscillations amplitude in articulation joint. A method for calculating braking torque is presented. Author proposed and compared signals obtained from vehicle angular acceleration and angle in the articulated joint to engage or disengage braking of wheel(s). Several methods are presented in the paper, allowing for faster damping of oscillations and reduction of amplitudes through the use of a brake system. The tests were carried out for 2 different simulation models (different vehicles). Several methods are presented - variants of the system operation. Simulations shows that proposed control algorithms allows to increase damping and decrease oscillation amplitude.

Keywords: articulated vehicle, braking system, control system, snaking, lateral stability, vehicles path

1. Introduction

The rapid development of the automotive industry has contributed to an increase in the number of vehicles reaching higher and higher speeds and moving on public roads. For this reason, safety while driving has become an extremely important factor when designing new earth-working machines and vehicles moving on the streets. Most systems improving safety can be seen in passenger car designs. These include active braking, acceleration slip control, power steering, steering traction control and many others. It should be noted that such systems are not used in earth-working machines and the location of the tool, e.g. an excavator bucket or loader in the event of a pedestrian collision can be extremely dangerous. Increasing the speed of earth-working vehicles is desirable because it brings great economic benefits. One of the phenomena that prevent these machines from moving at speeds in excess of 50 km/h is the phenomenon of snaking. This phenomena can be considered as a spontaneous undesirable by driver vehicle path change [1, 2, 3]. A method for reducing snaking phenomenon is not well designed for articulated vehicles. When vehicles with articulated steering are in motion,

oscillation between the front and rear frames is often generated due to the low stiffness of the hydraulic system. Low damping value and forcing from the ground make the oscillations persist for a long time. Several methods are presented in the paper, allowing for faster damping of oscillations and reduction of amplitudes through the use of a brake system. The tests were carried out for 2 different simulation models (different vehicles). Several methods are presented - variants of the system operation.

2. Results and Discussion

Results obtained from simulations for different braking control signal and braking mode are presented in Fig. 1.

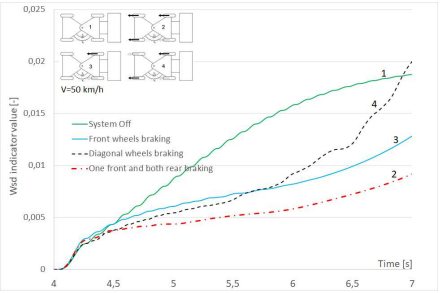

Fig. 1. W_{sd} indicator value and vehicle trajectory for different braking control system. Velocity V=50 km/h

The systems eliminate the phenomenon of snaking by braking at least one wheel contribute to a significant increase in motion stability. It is a solution that can be easily applied to almost all wheeled vehicles. It can be seen that the further development of the steering system should include increasing the energy efficiency of its operation. For this purpose, an algorithm should be developed that, based on control signals, will in a short time automatically select the method and number of braked wheels. An important issue is also the economy of the applied system and the determination of the typical braking time of the wheels on a given typical road. The increase in fuel consumption and wear when this system is used should be considered.

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