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Two Approaches to the Simulations of City Bus Driving Tests

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Abstract: The Triple Hybrid Hydrogen Bus project comprises research and development, implementation and a test operation of a city bus with hybrid electric propulsion using hydrogen fuel cells. The mass distribution and the total bus mass are rather different from common buses. This is, among others, the reason for investigating the bus driving stability. In order to obtain a tool for dynamic analysis, multibody models of the bus were created. Verification of multibody models was performed based on the comparison of simulation results and experimental measurements focused on handling behaviour of the bus. To perform the simulations two approaches were used: the initial position of the bus multibody model at the beginning of the simulation of the manoeuvre depends on the bus motion trajectory and the initial position of the bus multibody model at the beginning of the simulation of the manoeuvre is set an equilibrium position.

Introduction

The TriHyBus (abbreviation of the Triple Hybrid Hydrogen Bus) project comprises research and development, implementation and a test operation of a 12-meter city bus (see Fig. 1) with a hybrid electric propulsion using hydrogen fuel cells.

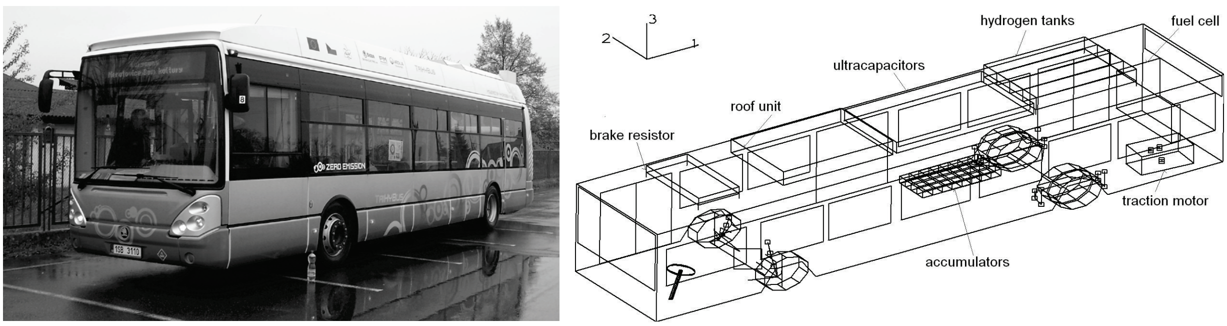

Fig. 1: TriHyBus at experimental tests and visualization of the TriHyBus multibody model in the *alaska 2.3* simulation tool

The mass distribution and the total bus mass differ from those at common buses. This is, among others, the reason for investigating the bus driving stability [1]. In order to obtain a tool for dynamic analysis multibody models of the bus were created using the *alaska* simulation tool. The aim of the simulations with the verified TriHyBus multibody models is the calculation of courses of kinematic and dynamic quantities giving information about the investigated properties of the vehicle at selected operational situations.

Testing manoeuvre and simulation results

Testing manoeuvres focused on the driving stability of the TriHyBus were performed with an empty real bus in the Řípská parking place in Mělník (Czech Republic) in November 2012 [1].

In this paper results from experimental measurements and computer simulations of the severe double lane change manoeuvre according to ISO 3888-1, Test Drive No. 6, are given.

The simulation of the test drive starts when the real TriHyBus reaches the speed of 15 km/h and ends when the real bus speed is lower than 15 km/h (simulating the vehicle starting with zero speed should cause certain problems when comparing the results [1]). In [1] there was presented the approach to the simulations, at which the initial position of the bus multibody model at the beginning of the simulation of the manoeuvre depended on the bus motion trajectory. Comparing the results from the experimental measurements and the simulations presented in [1], it is evident that a certain coincidence of results exists, but it is not perfect (especially time histories of relative deflections of the air springs – see Fig. 2). In order to improve coincidence of results from the experimental measurements and the simulations further approach to the simulations was tested: the initial position of the bus multibody model at the beginning of the simulation of the manoeuvre was set an equilibrium position (the bus body roll angle and the bus body yaw angle, which were measured during the test drive in the moment of the real TriHyBus achieving the speed of 15 km/h, were introduced as initial conditions).

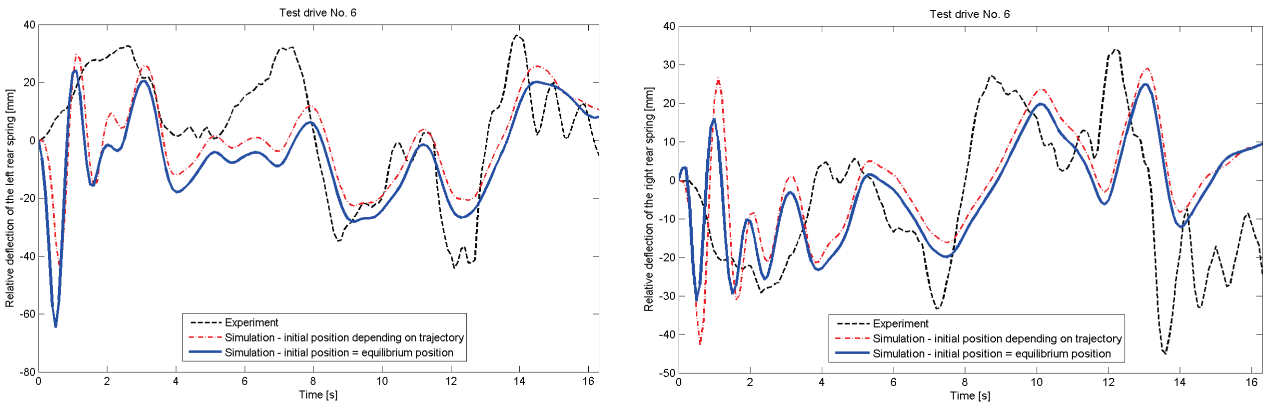

Fig. 2: Time histories of relative displacement of the left and right air springs before the rear axle

Conclusions

From the results given in Fig. 2 it is evident, that neither the configuration, in which the initial position of the bus multibody model at the beginning of the simulation of the manoeuvre was set an equilibrium position, had proved useful.

As it has been stated in [1], the ignorance of the actual air pressure in air springs of the TriHyBus suspension has the most significant impact on correlating experimental measurements and simulation results (it is the source of "unsuccessful" using the configuration, in which the initial position of the bus multibody model was the equilibrium one, among others).

Further testing manoeuvres with the real TriHyBus were performed in the year 2014. Time histories of air pressure in the air springs were measured, in addition to the monitored quantities measured at testing manoeuvres in November 2012. After processing the measured data it will be possible to improve the existing bus multibody models. The characteristics of air springs in the bus multibody models will not be only functional dependent of the forces acting on the springs and the spring deflections, but in addition they will be considered to be functionally dependent on the pressure of the air springs.

References

[1] P. Polach, J. Václavík, Investigation of Lateral Dynamics of Triple Hybrid Hydrogen Bus, in: Z. Dimitrovová, J. R. de Almeida, R. Gonçalves (Eds.), Proceedings of 11th International Conference on Vibration Problems, Associação Portuguesa de Mecânica Teórica, Aplicada e Computacional, Lisbon, 2013, USB flash drive.