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DYNAMIC BEHAVIOUR OF LOCOMOTIVE WITH AXLE-MOUNTED TRACTION MOTORS

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Abstract: *Especially in case of locomotives for freight operation, nose-suspended traction motors are usually used nowadays. This solution of traction drive is simple and relatively cheap; however, because of bearing of the traction motors directly on the axles, this solution contributes to increase the unsprung masses with all negative influences on dynamic interaction between the rail vehicle and the track, as well. Therefore, this paper deals with influence of nose-suspended traction drive of a locomotive on the dynamic interaction between the vehicle and the track. By means of simulations, dynamic behaviour of the locomotive with axle-mounted traction motors is compared with dynamic behaviour of a locomotive equipped with fully suspended traction drive.*

Keywords: ***Nose-suspended traction motor, dynamic interaction vehicle–track, simulations.***

In framework of solving of R&D project "TIP" of the Ministry of Industry and Trade of the Czech Republic in years 2010–2012, Jan Perner Transport Faculty of the University of Pardubice co-operates with company CZ LOKO, a.s. at research and development of a new locomotive Class 744.0. Among others, computer simulations of dynamic behaviour of the locomotive are realized at Detached Branch of the Jan Perner Transport Faculty in Česká Třebová. This work deals with dynamic interaction between the locomotive, which is equipped with axle-mounted nose-suspended traction motors, and the track. By means of simulations, dynamic effects of run of the locomotive equipped with nose-suspended traction motors are compared with a locomotive with fully suspended traction drive.

The locomotive Class 744.0 is a four-axled diesel-electric locomotive for shunting as well as track service which is equipped with new two-axled CZ LOKO bogies (Kopal, 2009). The locomotive can be produced in various versions with a power of 800–1500 kW and maximum speed up to 120 km/h. Total weight of a standard-gauged version of the locomotive can range from 64 up to 90 t. Besides the standard-gauged version, a broad-gauged version, which is designed according to the GOST standards, is being prepared for the track gauge 1520 mm. Nowadays a prototype of the standard-gauged version of the locomotive 744.001 is tested in framework of its authorisation process.

For purposes of computer simulations of dynamic behaviour of the locomotive, an original program system "SJKV" for multi-body simulations was used; for detailed description of this system see the paper (Zelenka, 2009). A new version of the system named "SJKV-Lok744" was created. This modification allows investigation of dynamic behaviour of the standard- as well as broad-gauged version of the locomotive; see also the paper (Kohout et al., 2011), for example.

In framework of this work, two different alternatives of dynamic model of the locomotive were created. The first variant represents the locomotive Class 744.0 with a total weight of 80 t equipped with the nose-suspended traction motors. The second one represents an imaginary locomotive which has the same parameters (total weight, masses and inertia moments of the bodies, characteristics of joints etc.) as the Class 744.0, but it is equipped with some kind of fully suspended traction drive. Therefore, mass of the traction motors does not increase the share of unsprung masses in this case. Simulations of the vehicle run on straight tracks with three various conditions of quality of the track geometry were performed at speeds from range of 80 up to 160 km/h. In all cases, conditions of wheel/rail contact geometry and the friction coefficient in wheel/rail contact were identical.

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Because the share of unsprung masses influences above all the "vertical dynamics" (i.e. the dynamics of wheel forces), especially these forces were observed at the simulations and statistically processed consequently. In case of considered locomotives, the static wheel force (static load) has a value of 98.1 kN. At the assessment, standard deviations of wheel forces were computed from their filtered time histories. The obtained results show that the dynamics of wheel forces depends strongly on quality of the track geometry as well as on vehicle speed. A difference between the locomotives with nose-suspended traction motors and with fully suspended traction drive is more significant with increasing speed, as well. In fig. 1 there are shown then so-called expected values of maximum wheel forces computed according to the European standard EN 14363 which confirm these statements.

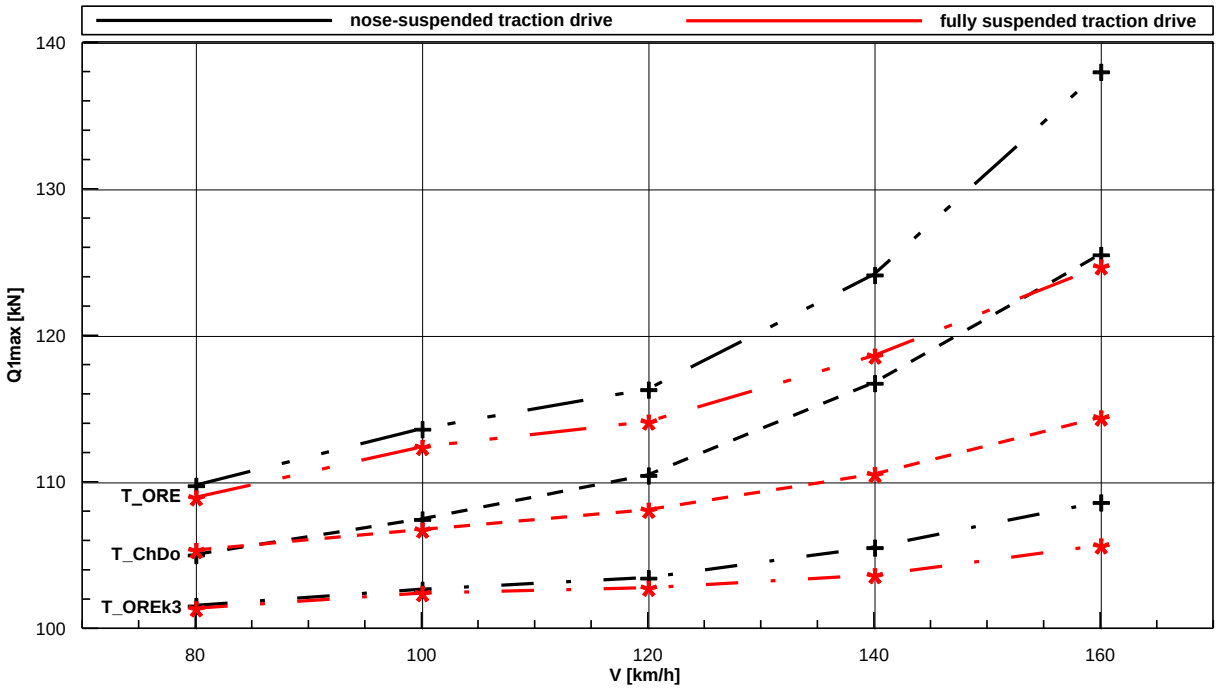

Fig. 1 Expected maximum values of wheel force for both alternatives of the locomotive with total weight of 80 t in dependency on vehicle speed on tracks with various quality of the track geometry.

On the basis of fig. 1 it is possible to state that the difference between the dynamic effects of the locomotive equipped with nose-suspended motors and the locomotive with fully suspended traction drive becomes to be more significant with increasing speed. Especially in case of worse quality of the track geometry, this difference is considerable at speeds higher than approximately 120 km/h, although a limit value of the maximum wheel force according to the EN 14363 was not exceeded in any case. On the basis of performed simulations it is possible to say that similar differences from the point of view of "lateral dynamics" also exist but its assessment is more complicated…

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