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DYNAMIC LOADING OF VEHICLE TRACK SIMULATION

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Abstract: *The article describes design of vehicle track computation model and basic testing step of dynamic loading simulation of the track. The model is built for computational simulating system MSC. ADAMS, TVT. Computational model intended for MSC computational system is built from geometrical and contact computational part. The aim of the simulating calculation is the determination of change influence of specific vehicle track constructive parameters (curve track geometry or track preloading) on changes of examined qualities of the vehicle track link (reaction force against motion, minimal track link speed and medium track speed). The results of simulating calculations are given by using of mentioned model. The full model consists of all parts of real vehicle undercarriage design. The computing result sample comes out as one of many possible cases. The influence of changes of all parameters on the needed torque changes of driving sprocket is displayed in the article. Further research plans are described in the article as well.*

Keywords: ***Dynamic properties, testing, computational simulation.***

1. Introduction

The paper is introducing possible modeling method of selected type of vehicle track (Vlach, 2001) and some results of simulating computer modeling of dynamic loading of vehicle track by vehicle running (Vlach, 2003).

The work described in the article has been performed in order to solve the requirement for analyzing the problem of not good course holding of specific track vehicle when driven at a speed exceeding 65 km.h^{-1} (Chalupa, 2007). It is possible to find out the reasons of this effect and propose possibilities of its elimination. It would be useful to propose possible design changes, which would make safe improvement maximum vehicle speed at the same time (Chalupa, 2009).

Main task of the work now is to define main possibilities of track vehicle course holding improvement by simultaneous increase of maximum speed vehicle. As a first step, the simulation is used for colleting of undercarriage design parameters under influence of different vehicle course holding conditions and increasing maximum speed. The basic simulating calculations are done already it this part of work. The purpose of these preliminary simulations is to monitor the influence of changes in supporting axes reaction forces in relation with changes of track links weight and initial tension of track. Such changes can influence vehicle course holding. It is well known that design parameters have relevant influence on dynamic loading of some undercarriage parts. The complete calculation of this influence is subject of the second part presented work.

2. Computational model and simulating results description

The PC computational system MSC.ADAMS.AVT, version 8.0 (Adams, 2003) is used for the computational modelling. This system can be used for the analysis and synthesis of kinetic and dynamic characteristics of the modelling mechanic system and its animation.

Computational model intended for MSC computational system is built from two basic parts. They are geometrical and contact computational parts of model.

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2.1. Geometrical part of computational model

Geometrical computational model consists of basic parts of vehicle undercarriage, movable parts and the main parts of the track link. These parts are defined by components with right geometrical shape. The critical aspect at this point is to keep flat contact.

The parts of suspension are defined as simplified shape components, such as without contact components. This type of components is generated from offer of universal track vehicles undercarriage components. They are defined by input data as basic design dimensions, weight, moment of inertia, stiffness, absorbing and number of parts.

2.2. Contact part of computational model

Contact computational model consists of impact and frictional forces system. To guarantee the highest accuracy and practicality, the impact and frictional forces of individual undercarriage parts are defined in such way, that the whole model resembles the reality as much as possible. These contact forces are described in Adams System by impact force:

$$F = -k\,(q - q_0)^{\,n} - c\,q` \tag{1}$$

where: q-q_0..penetration of bodies in contact,
k … contact stiffness,
c … absorbing,
$q`$ …sliding velocity of bodies in contact,
n … exponent n = 1.5 by using of Hertz theory.

Contact model is described by characteristic of influence sliding velocity on friction coefficient as well.

2.3. Simulating calculation description

The aim of the simulating calculation is the determination of change influence of specific vehicle track constructive parameters (curve track geometry or track preloading) on changes of examined qualities of the vehicle track link (reaction force against motion, minimal track link speed and medium track speed). These are determined especially by intensity changes of the reaction force of the carrying elements of track links bodies.

It is evident that the results of simulation computations have proven the assumption that by means of changes in constructional parameters of undercarriage parts it is possible to improve dynamic behaviour of some parts of track vehicle undercarriage and optimize dynamic properties of the vehicle in motion.

2.4. Implementation of simulating calculations

Simulating calculation is quantifying the influence of ten parameters on needed torque of driving sprocket on supporting rollers axes reaction forces.

The ten parameters tested are:

1. Radius of driving wheel,
2. Radius of tightening wheels,
3. Initial tension track,
4. Track link weight,
5. Stiffness of connection plugs track link,
6. Resistance against turning of clutches plugs track link,
7. Geometry of the driving rib,
8. Bearing rollers weight,
9. Radiuses of bearing roller,
10 Stiffness of assessment base in bearing rollers.

The input data and information for simulations and general influence quantifying: vehicle of 40 km/h, horizontal plane - 0°, geometry of model for ADAMS/AVT.

Simulation calculations were realized with use of computation model displayed in Fig. 1.

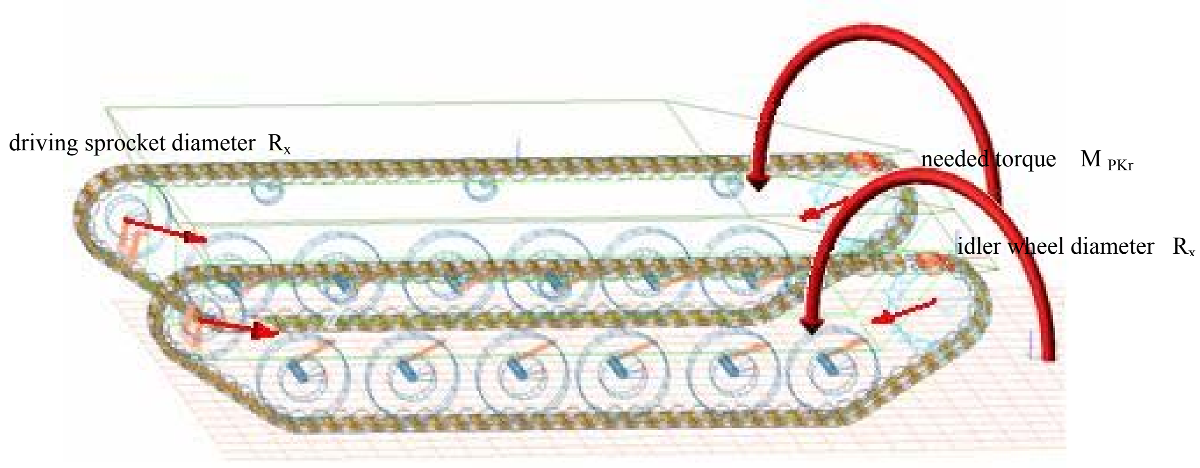

Fig. 1: Geometrical model for testing of influence of all parameters.

2.5. Results of simulating calculations

The results of performed basic simulating calculations shown the big influences of changes of

- Track links weight,
- Initial tension of track,
- Radius of driving wheel,
- Geometry of grip rib of track link

on supporting rollers axes reaction forces. It is clear that these design parameters have big influence on dynamic loading of some undercarriage parts and therefore a maximum speed of vehicle. The same influences of changes of needed torque on sprocket wheel in relation with changes of driving sprocket diameter were approved as well. This parameter influences vehicle course holding and improves maximum speed of the vehicle. This phenomenon will be the subject of our forthcoming research when full calculation will be performed.

3. Further research plans

Application of second-rate simulation collection will be performed hereafter to assemble of approximation relation y_o of influence monitored parameters R_x, F_{pr}, $k_{p,}$ and m_x. This further research plan consists of three steps:

1. Composite plan simulations assembly for four parameters,
2. Implementation of 24 simulations calculations, and
3. Assessment of regression function.

4. Conclusion

The paper describes one of the possible ways of design and creating the computational model of real track vehicle movement mechanism in software environment MSC.ADAMS.AVT. Vehicle track design and recommendation for upgrading simulating mathematical model is emphasized. The objective is to create computation simulation for the purpose of finding the basic information on track component parts and undercarriage performance of moving track vehicle.

It is obvious from the contents of the article that our research conducted and described up to now is an introduction only to problems of vehicle track dynamic properties computational modelling, which seems to be the only viable way of track dynamic properties analysis of moving track vehicle. On the grounds of these analysis outcomes it will be possible to state which constructional changes will lead to objective accomplishment.

This objective can be defined as a track vehicle directional improvement by simultaneous maximum speed increase, simulated apart from other factors, not only on optimization of track construction, but also on the whole track kinetic and suspension arrangement of track vehicle undercarriage mechanism.

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