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DESIGN PARAMETRES INFLUENCE ON DYNAMIC LOADING OF VEHICLE TRACK

M. Chalupa, J. Veverka*

Summary: *The paper describes possible design of vehicle track computation model and basic testing step of dynamic loading simulation of the track. The computational model is built for computational simulating system MSC. ADAMS, Tracked Vehicle Toolkit. The full model consists of all parts of real vehicle undercarriage design.*

1. Introduction

The paper describes design of computational model of the vehicle track and undercarriage of the track vehicle. The paper is introducing possible modeling method of selected type of vehicle track and some results of simulating computer modeling of dynamical loading of vehicle track by vehicle running.

The mathematical model is built for computational system MSC.ADAMS.TVT, version 8.0 that is used for the computational modelling. The aim of the work is to carry out the composition of a computational model not only of the caterpillar track but also the general vehicle dynamic properties and to suggest ways of other use of this mathematic model for computational simulation experiments to find out the essential information about individual undercarriage parts behaviour during the vehicle drive. Main task of the work is to define main possibilities of track vehicle directional improvement by simultaneous increase of maximum speed vehicle. It is used for collecting of undercarriage design parameters with whatsoever influence on vehicle directional improvement.

They were done basic simulating calculations sooner. They look for influence changes reaction forces supporting rollers axes in relation on changes of track links weight, changes of driving sprocket diameters and initial tension of track. Nowadays it is known, this design parameters have big influence on dynamical loading of some undercarriage parts. We will analyze this influences in full calculations in next.

What changes of needed torque moment on sprocket wheel can be in relation on changes of driving sprocket diameter is described in next text.

doc.Ing. Milan Chalupa, CSc.: UO Brno, Kounicova 65, 612 00 Brno, tel.+fax: +420 973 44 3 420,
E-mail: milan.chalupa@unob.cz.
Ing. Josef Veverka, Ph.D., MSC.Software s.r.o., Příkop 4, 602 00 Brno, tel. +420 545 176 106,
E-mail: josef.veverka@mscsoftware.com .

2. Computational model description

The computational system MSC.ADAMS.TVT, version 8.0 is used for the computational modelling. This system can be used for the analysis of kinetic and dynamic characteristics of the modelling mechanic system and its animation.

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

2.1 Geometrical part of computational model

Geometrical computational model consists of basic parts of vehicle undercarriage movable organs.

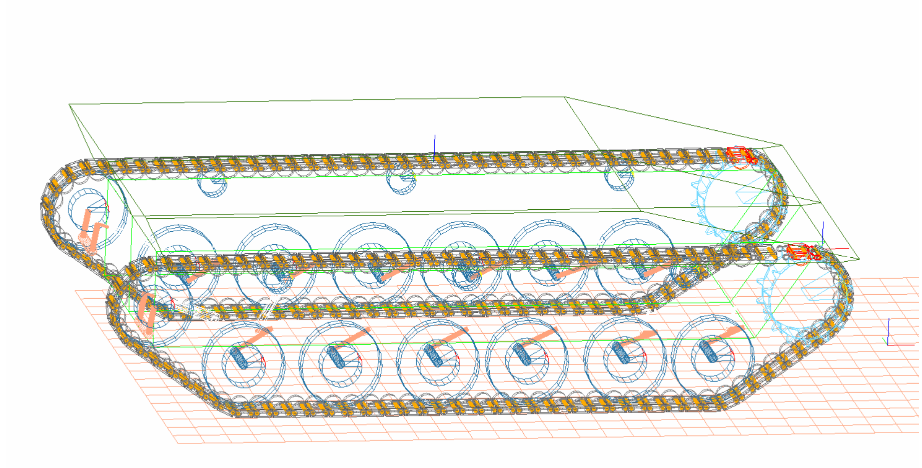


Fig.1: Geometrical part of computational model

There are (Fig. 1) road wheels, supporting rollers, driving sprocket (Fig. 2), idle wheel and track line on which individual track links are connected by a couplings. They are defined by components with right geometrical shape. The main here is to keep of contact flat aspect.

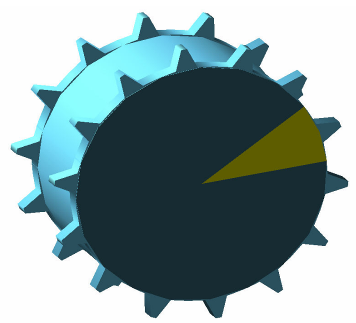


Fig. 2: Geometrical model of sprocket wheel

The main parts of track link is body (Fig. 3) with two guiding detents and two connected eyes with pins, couplings and retaining screws. The number of track links is 84 in one track.

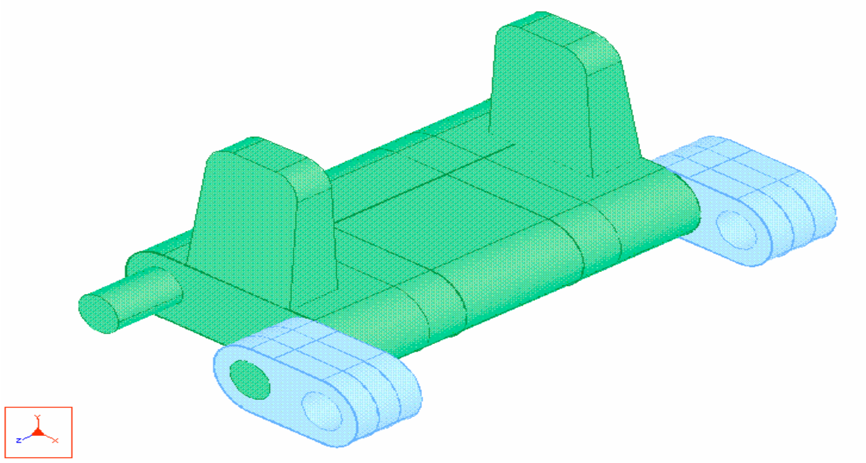


Fig. 3: Geometrical model of track link and connecting clip

Levers, torsion bars and shock absorbers are defined as simplified shape components, as without contact components. This type of components is generated from offer of universal track vehicles undercarriage components. They are defined by input date 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 are impact and frictional forces individual undercarriage parts defined in the way so that the whole model resembles the reality as much as possible.This contact forces are described in Adams System by impact force:

$$F = -k'(q - q_0)^n - c\dot{q}$$

Where: q-q_0 penetration of bodes in contact
k … contact stiffness
c … absorbing
$\dot{q}$ … 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 (Fig.4) as well.

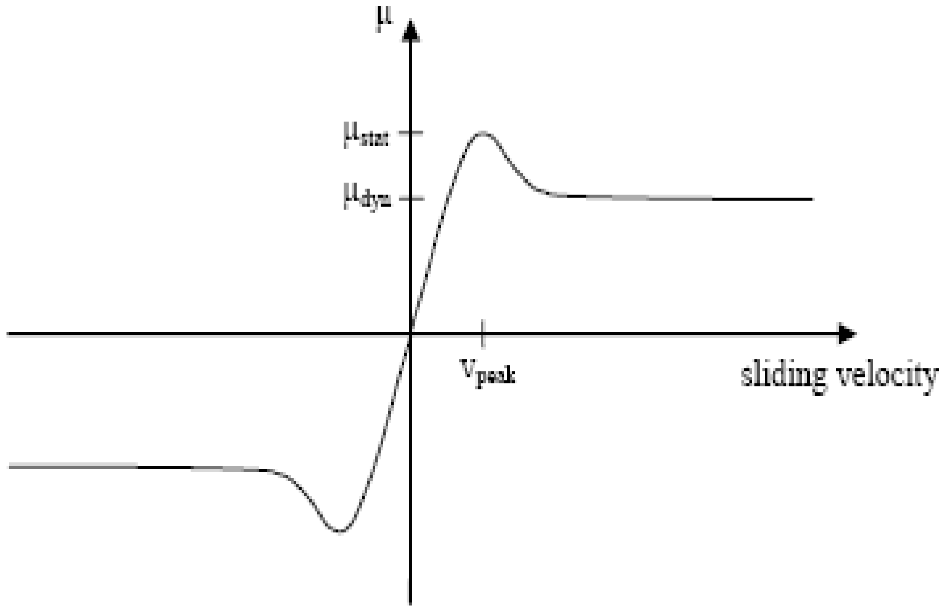


Fig. 4: Course of fiction coefficient

Kde: μ_{stat} … static friction coefficient
μ_{dyn} … dynamic friction coefficient

3. Simulating calculation description

The aim of the simulating calculation is the determination of change influence of specific constructive parameters of the vehicle track (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) which are determined especially by intensity changes of the reaction force of the carrying elements of track links bodies.

The conditions of the track loading in these calculations can be described in the way that the specific vehicle track parameters will be determined gradually with changes during which it will be possible to reach sufficient result changes of the examined quantities of the track qualities calculations in the way so that clear evaluation of examined quantities could be carried out and their basic influences could be determined.

It is evident that the results of simulation computations have proved the assumption that by constructional parameters changes of undercarriage parts is possible to improve dynamical behaviour of some parts of track vehicle undercarriage and optimise dynamic properties when is the vehicle in motion.

4. Implementation of simulating calculations

Simulating calculation is watching the influence of driving sprocket diameter change on needed twist moment of driving sprocket.

The input data and information for influence finding of driving sprocket diameter:

- vehicle velocity 40 km/h
- horizontal plane
- geometry of model Fig. 1, 2 a 3
- models ADAMS/AVT : diameter R1, R2, R3
- start velocity 11.11 m/s
- geometry of vehicle real design parameters

They were given three types of driving sprockets.

Driving sprocket 1 – R1 with 13 catch detents.

Driving sprocket 2 – R2 with 14 catch detents – real design.

Driving sprocket 3 – R3 with 15 catch detents.

5. Results of simulating calculations

Computational simulation calculations was realized with using of computation model that is to see on the figure No 5.

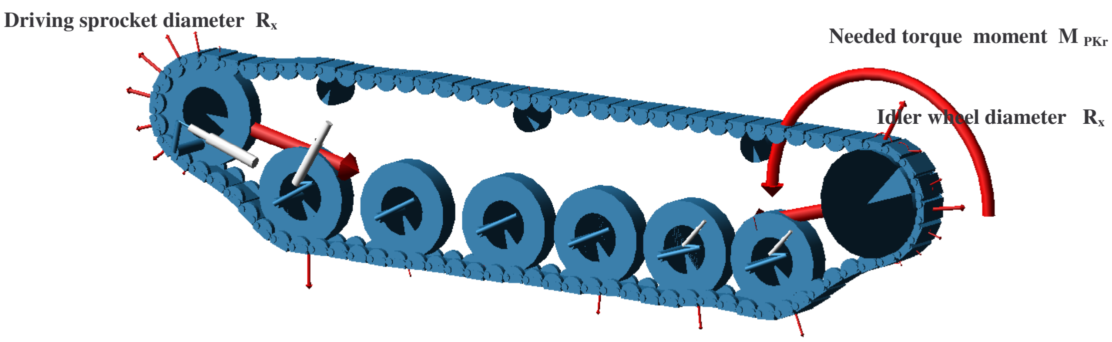


Fig. 5: Geometrical model of influence of driving sprocket diameter

Next printout of calculated results is given in figure No 6. It is the influence of driving sprocket diameter values changes on the needed torque moment values changes of driving sprocket.

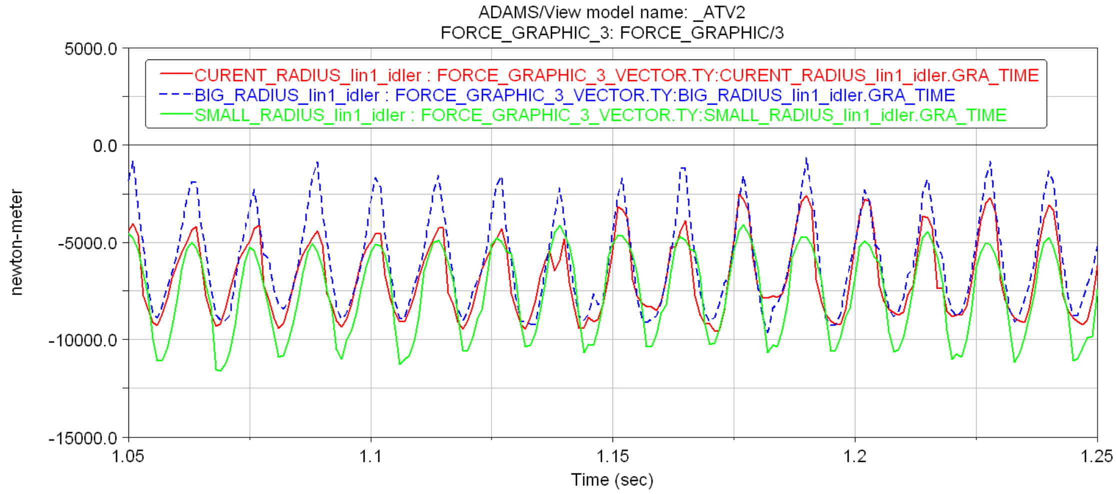
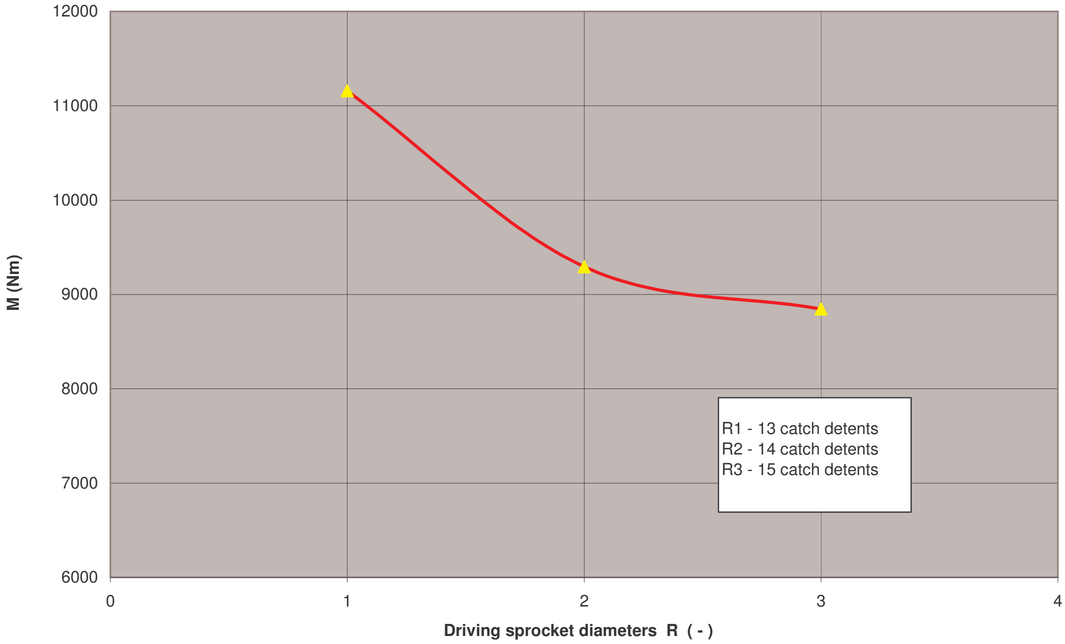


Fig. 6: The values of needed torque moment of driving sprocket

There are very good to see big values changes of needed torque moment effected of driving sprocket diameter changes.

Graph 1: Course of needed torque moment values on driving sprocket diameter



As is to see from Graph No 1, diameter reduction driving sprocket about 15,5 % les causes improvement of needed torque moment value from 9 320 Nm to 11220 Nm. It is about 20,6%. Diameter change driving sprocket about 15,5 % more causes reducing of needed torque moment value from 9 320 Nm to 8 880 Nm , about 4.5 %.

It is possible to say it is the big influence of driving sprocket diameter value changes on needed torque moment values of driving sprocket. It is very interesting and important to realize next analysis of influence of this design parameter in next time.

The results of basic simulating calculations sooner approved big influences of changes reaction forces supporting rollers axes in relation on changes of track links weight, changes of driving sprocket diameters and initial tension of track. It is clear this design parameters have big influence on dynamical loading of some undercarriage parts. The same influence of changes of needed torque moment on sprocket wheel in relation on changes of driving sprocket diameter were approved as well. We will analyze this influences in full calculations in next time.

6. Conclusion

It is described in the paper one of the possible way of real track vehicle movement mechanism computational model setting in MSC.ADAMS.TVT computation system with emphasis on vehicle track design and recommendation for upgrading mathematical model with a view to make the computation simulation attempts for the purpose of finding basic information on track component parts and undercarriage performance when vehicle in motion.

It is obvious from the contents of the article that the research conducted and described up to now is an introduction to problems of vehicle track dynamic properties modelling, which seems to be the only viable way of track dynamic properties analysis when track vehicle in motion. On the grounds of the analysis outcome it will be possible to state which constructional changes will lead to objective accomplishment. This objective can be defined as track vehicle directional improvement at simultaneous maximum speed increase, limited, apart from other things, not only by track construction, but also by the whole track kinetic and suspension track vehicle undercarriage mechanism.

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