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Experimental Stress Analysis

Simulation Model of Car Seat and Its Verification Using Platform with Six Degrees of Freedom

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Abstract: The aim of this paper is to describe simulation model of car seat in MSC.ADAMS/View software. This model will be used for parameter adjusting of dynamic absorber, which will be mounted to car seat in future. The major theme of paper is to adjust parameters of simulation model and compare this model with measurement on real seat.

Keywords: Simulation, MSC.ADAMS, Measurement, Vibration

1. Introduction

Car seats are usually used not only in vehicles, but also in other machines, like excavators, loaders, etc. Therefore excitation of car seats by vibrations in general directions is quite common. For example seats in bucket excavators are excited with vibrations of approximately the same intensity in all three directions (longitudinal, lateral and vertical). In the next we will be engaged in car seat with scissors mechanism.

2. Car Seat Description

Scissors mechanism used in seat construction is very suitable for vibration reducing in vertical direction. But, as mentioned above, seats with this mechanism are often used in machines which excite seat in horizontal directions.

Horizontal vibrations can be very negative for fatigue of individual parts of scissors mechanism resulting in initiation of clearances between parts of mechanism. Another bad influence of horizontal vibrations is increasing passive resistances (friction especially) in seat mechanism. Generally, quite big passive resistances occur in the seat mechanism during its movement. In case of scissors mechanism the character of passive resistances is dry friction especially. This friction causes a quite big damping of vertical seat movement no matter damper is mounted.

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3. Simulation Model of Car Seat

Simulation model of seat was created in MSC.ADAMS/View software. Model geometry was imported from Catia software. Model consists from several parts connected together by kinematical and force attachments (joints). Masses of particular seat parts were weighed from real seat. Inertia moments of individual parts were got from Catia software from their masses and real geometry. Model is shown on Fig. 1.

Fig. 1. Model of seat in MSC.ADAMS/View software.

For simulation model is important implementation of dry friction. To determine suitable mathematical description of dry friction, we have to compare seat behaviour during motion in vertical direction with measurement on real seat.

4. Measurement of Car Seat

Measurement of car seat behaviour was realized in Hydrodynamic laboratory of Technical University of Liberec in Liberec - Doubí. Car seat was mounted to special equipment - platform with six degrees of freedom (see e.g. [1]). This platform is able to excite seat in general direction. By this way it´s able to reproduce signal measured on real machine also. Platform with seat is shown on Fig. 2 and Fig. 3. Car seat was weight down by mass of 80 kg.

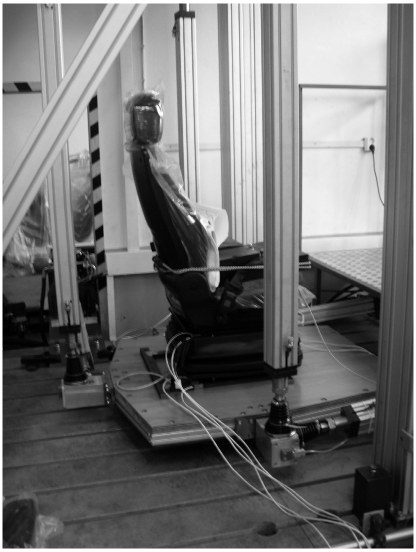

Fig. 2. Car seat on platform with six degrees of freedom.

Fig. 3. Car seat with passive loading.

Car seat was excited by set of up and down steps of various amplitudes in vertical direction. The first it was started with step up of amplitude 20 mm and it was continued with step down of the same amplitude. Then the seat was excited by step up and down of amplitudes 30 mm, 40 mm and 50 mm. The length of step was 0.15 s. Two sets of measurement were realized in all - with and without damper in seat mechanism.

The four values were measured - platform desk acceleration, acceleration of upper part of seat mechanism, platform desk position and position of upper parts of the mechanism (see Fig. 4). All signal were measured in vertical direction.

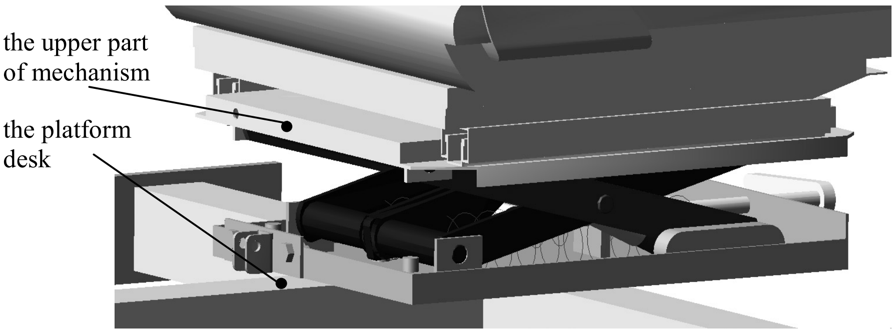

Fig. 4. Measured points on platform and seat mechanism.

On the Fig. 5 platform desk step up of amplitude 40 mm and position of upper part of seat mechanism without damper is shown.

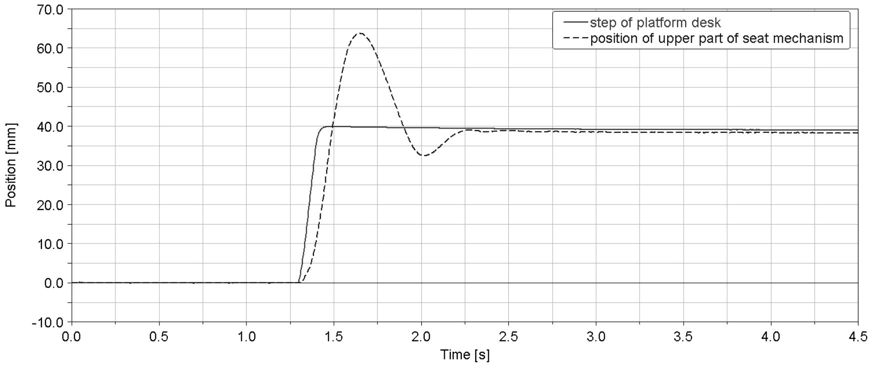

Fig. 5. Measured points on platform and seat mechanism.

From Fig. 5 follow quite higher damping value of seat mechanism without damper. The main reason of this are high values of frictions in revolute and sliding joints.

5. Mathematical Description of Friction in Simulation Model

MSC.ADAMS/View software allows a lot of possibilities how to describe mathematical functions. At the first we tried to describe dry friction by step function. Amplitude of this function changed mark according to a mark of relative velocity between desk and the upper part of mechanism. Results from the step function wasn´t satisfactory.

Therefore a new description of dry friction was proposed - by arc tan function:

$$F = a \cdot \arctan\left(b \cdot v_r\right), \tag{1}$$

where F is a force actuating against of seat movement,

a, b are constants,

v_r is relative velocity between platform desk and seat.

This description is quite better with a view to behaviour of car seat. Now setting up a and b parameters by comparing simulation and measurement results is needed.

6. Comparison of simulation and measurement results

On next figures are shown differences between simulated and real movement of upper part of seat mechanism during exciting by steps of various amplitudes. Y axis of graphs shows vertical position of platform desk and seat.

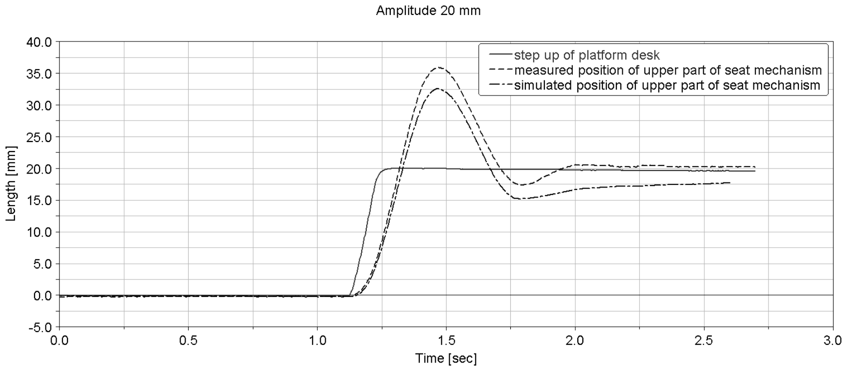

Fig. 6. Simulated and measured results comparing, platform desk excited by step up of amplitude 20 mm.

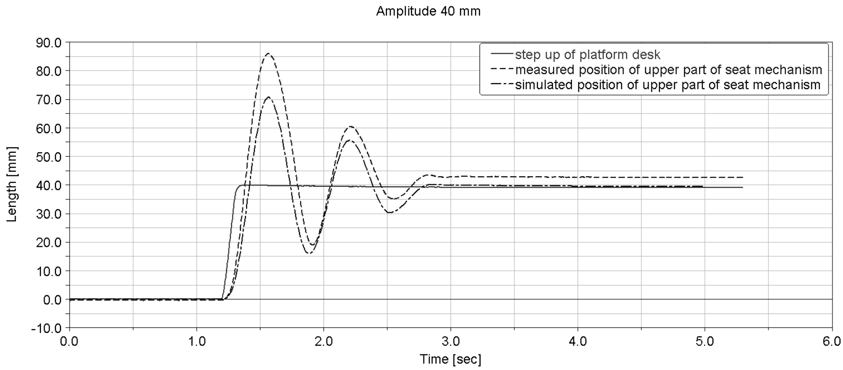

Fig. 7. Simulated and measured results comparing, platform desk excited by step up of amplitude 40 mm.

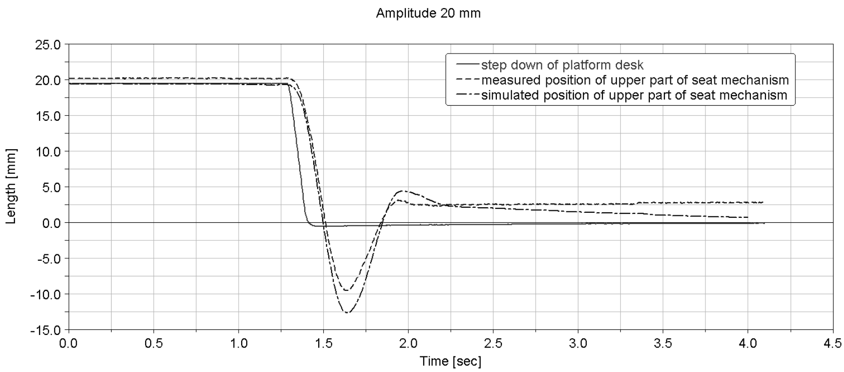

Fig. 8. Simulated and measured results comparing, platform desk excited by step down of amplitude 20 mm.

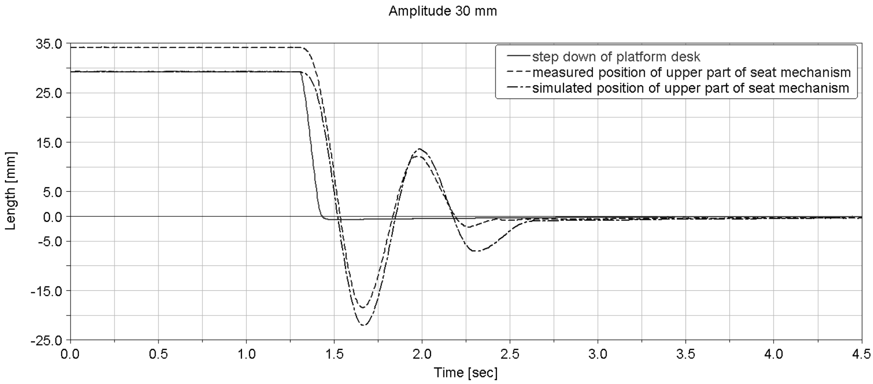

Fig. 9. Simulated and measured results comparing, platform desk excited by step down of amplitude 30 mm.

From figures above follows, that results for some amplitudes are more different, but generally we can say, that simulation model with dry friction (1) and upper results is satisfactory for our purposes.

7. Conclusion

The aim of this project was to create suitable simulation model of car seat. This model will be used in future for setting parameters of dynamic absorber which will be mounted to car seat. For this purposes the results from simulation car seat model is satisfactory.

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References

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