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SOME PROBLEMS OF CAR SEATS MEASUREMENT ON TESTING BOARD WITH SIX DEGREES OF FREEDOM

PROBLEMATIKA MĚŘENÍ SEDAČEK NA PLOŠINĚ SE ŠESTI STUPNI VOLNOSTI

Abstract

The aim of this project is to describe preparing for measurement on special machinery – a platform with six degrees of freedom. In the first part we will refer about eigenvalues and eigenmodes verification (simulation and measurement). In the second part of this entry we will focused on process of transmission of measured data to the testing desk.

Abstrakt

V tomto příspěvku bychom rádi popsali přípravu, která probíhá před započetím měření na speciálním zařízení – plošině se šesti stupni volnosti. V první části příspěvku popisujeme simulační a experimentální ověření vlastních tvarů a vlastních frekvencí zařízení. V druhé části se zaměřujeme na problematiku převodu měřených dat na pohyb zkušební desky.

1 INTRODUCTION

The unique machinery was developed in Technical University of Liberec – a platform with six degrees of freedom. Kinematical excitation of the examined subject in general direction is realized by this machinery. The platform should be mainly used to measure the influence of vibration on a human body and to develop and design a new car seat spring loading. It was necessary to take into consideration these two opposite requirements during the construction of the machinery – its proper dynamical stiffness and limitations resulting from laboratory building stability.

2 CONSTRUCTION STIFFNESS REQUIREMENTS – MODAL ANALYSIS

The excitation frequencies likely to occur during experiments are supposed to range up to 15 Hz. In compliance with preliminary computations the lowest platform eigenvalue was 18 Hz. It was expected that the lowest eigenvalue would be changed due to adjustments carried out when supporting the platform.

2.1 Platform description

Concrete block with a cast-iron anchorage plate is used as the fundament of the platform. This block had to be set-up on rubber pads in terms of the force transferred to the base. The frame of the platform is made from aluminium ITEM profiles.

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The platform is equipped by six hydraulic cylinders INOVA (max. lifting 200 mm, max. force 25 kN), servo-operated valves REXROTH, sensors of position and force. Linear motors are fitted to the testing desk by ball joints. Further details – please see [2].

2.2 Dynamical models of platform and simulations

Two models of the platform were created in MSC.ADAMS software. The flexible frame of the first model platform was created in Ansys software (beam intersections were simplified) and consequently exported to MSC.ADAMS. The frame of the second model was created directly in MSC.ADAMS software by discrete beams. The intersection characteristics (used for flexible joints) were provided by its producer.

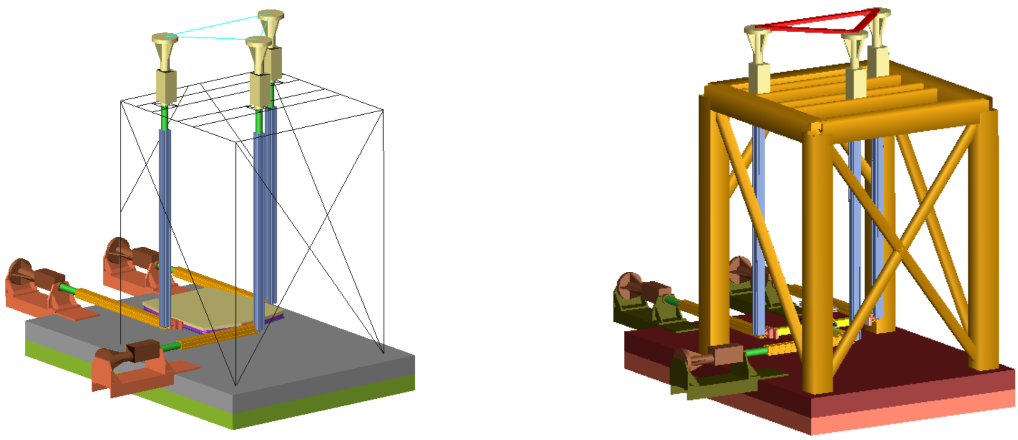

Fig. 1 Two models of platform in MSC.ADAMS software

Modal analysis results were the same for the first seven eigenvalues. For future computations the second model (with discrete frame) was selected. It is better according the length of time the computations take.

Tab. 1 The first eight eigenvalues of platform with six degrees of freedom

Eigenvalue No.	Eigenvalue [Hz]	Eigenvalue No.	Eigenvalue [Hz]
1.	11.6	5.	28.3
2.	11.7	6.	35.5
3.	13.7	7.	70.3
4.	26.8	8.	71.3

According to our presumptions, the values of the first three eigenvalues are too low. However, eigenmodes of the first eigenvalues are attached to the movement of the platform standing on rubber pads. This movement plays an important role in next three eigenmodes also. If we simulate the same model without being equipped with rubber pads (we consider a rigid connection between the platform and the building) we will get fully acceptable results in table 2. For further details please see [1].

Tab.2 The first eigenvalues of the platform with a rigid connection to the building

Eigenvalue No.	Eigenvalue [Hz]	Eigenvalue No.	Eigenvalue [Hz]
1.	11.6	5.	28.3
2.	11.7	6.	35.5

2.3 Measurement

For modal shape measurement were chosen measure points according to figure 2.

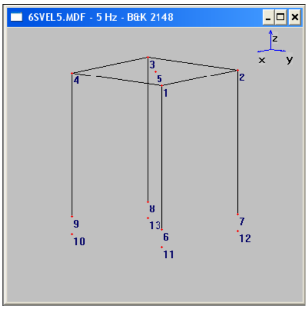

Fig. 2 The point grid for modal shape measurement

The measurement of modal shapes was performed with three modes of exciting signals. These modes correspond with supposed excitement during the platform operating:

- harmonic exciting signal with the amplitude of 2 mm and frequency 5 Hz in X or Y direction of the coordinate system – passive weight of 250 kg,
- harmonic exciting signal with the amplitude of 5 mm and frequency 5 Hz in Z direction of the coordinate system – passive weight of 250 kg.

Results of measurement:

- Points 10, 11, 12 and 13 are placed near the rubber pads –their oscillations demonstrate the pads influence on the compliance of the platform behavior.
- The values of frame deformations during measurement were 0.02 mm maximally. According to the platform proportions (2.9 m height and 3.2 m length) these deformations can be considered as insignificant.
- No important element reaching the eigenvalues (especially low ones) was identified. The situation proved almost no influence of the eigenvalues on the accuracy of the measurement achieved within required weight and excitement conditions.

3 PLATFORM CONTROL

The process of transmission of measured data to the testing bed has three principal steps solved by using principles of matrix 3D kinematics.

In the first step, platform motion corresponding to the given measured data must be expressed in terms of local platform reference point position vector components and three spherical angles. From the mathematical point of view, we have to solve six ordinal differential equations of the second order. Its solution is done in the given time range with periodic boundary conditions.

In the second step, from the resulting periodic motion of the platform, corresponding motions of the test facility driving linear hydraulic motors are computed.

In the third step, complete motion of the platform must be inspected from security point of view. All possible positions of the platform must be in secure distance from other system parts. Limited strokes of the driving linear motors must also be taken into the account. The angles in the spherical joints between the platform and the linear motor rods must be in the set-up limited range. These requirements are observed in the program.

The only logical conclusion is that not every given experimental data are reproducible in the testing bed. So, any measured data should be filtered in advance from this point of view, using the developed program.

4 TRANSMISSION SOFTWARE VERIFICATION MEASUREMENT

Transmission software verification was performed for one testing point. We chose the course of its position and acceleration coordinates and transformed them to a data file for linear motors actuating. Three accelerometers and two position sensors were placed at the measure point. Two position sensors were used because joining three sensors to one point could distort the measurement when considering the dimensions of the joint eyes. The first measurement of its position was performed in a longitudinal and lateral direction, the second in longitudinal and vertical direction. Then both measurements were synchronized by the measurement in a longitudinal direction.

Next picture compares the measure point acceleration in a longitudinal direction. The red line is the simulation result; the blue one describes its assumed course (input function for the transmission software).

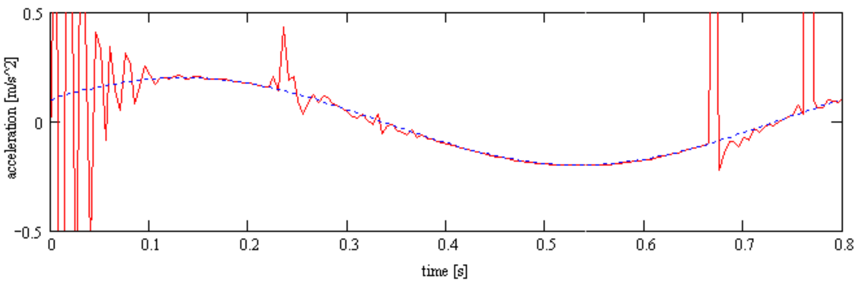

Fig. 3 Comparison of assumed and MSC.ADAMS simulated acceleration course.

The result of the comparison is correspondence between both courses. Red line peaks are evoked by numerical instability of the computation. The measurement results are not satisfactory at present time. It is caused by a bad calibration of the position sensors in linear motors. The comparison of both discussed above courses and measurements will be presented at the conference.

5 CONCLUSIONS

The platform is planned to be moved to the building of a new laboratory in a few year time. Its fitting to a concrete fundament in a sand bed is currently being prepared. This arrangement is supposed to increase the stiffness and damping characteristics of the platform construction. As it can be seen from the above mentioned, the machinery is possible to be used to perform any experiments without distortion of the results caused by inappropriate dynamic reactions of the platform until its replacement to the building of the new laboratory.

6 ACKNOWLEDGMENTS

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