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Vibration of Mechanical System Using MSC Adams Software

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Abstract This article numerically solves vertical oscillating of mechanical system of vehicle by kinematic excitation. When simulating in program MSC Adams, 3D model without gravity impact was taken into consideration. Three-dimensional model of mechanical system was replaced by simple solid table. The result of the work is creation of complex instruction of vertical vibration in program MSD Adams/View that is intended for didactic purposes.

Keywords: *MSC Adams, step, simulation, vibration, multi-body model*

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1. Introduction

For the solution of vertical oscillation of mechanical system the simulation program MSC Adams (Automatic Dynamic Analysis of Mechanical Systems), so called Multi-body system was used. Multi-body system is a system in which the model is not described by kinetic equations. This model is made up of basic geometrical bodies that need to have properties of real object assigned (position, weight, stiffness, forces, moments, joints). Simulation program is able to draw up mathematical description out of modeled geometry automatically [1].

It is computing software for modeling and simulation of bound mechanical systems composed of firm and also elastic elements that are interconnected by various types of kinematic bonds in the whole. They make it possible to implement static, kinematic and dynamic analysis of proposed models and also optimize and verify their mathematical models. The program enables dynamical solution of mechanical systems by numerical calculations. The whole system is composed of many modules. Additional module Adams/View is the tool for fast and easy creation of model and for the simulation. Generated model can be saved in system Adams/View and directly numerically solved by some task without manual generating of solver input file and inducing solver. Module Adams/PostProcessor functions as the means for processing of acquired characteristics from simulation [2].

2. Solution of Mechanical System Vertical Vibration

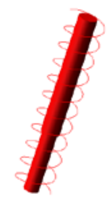
Three-dimensional model of vehicle mechanical system is replaced by simple solid table, which is flexibly laying on four springs and damper [3].

The system is kinematically excited by function Step (Figure 2). The gravity was not taken into consideration when simulating model. The gravitational acceleration is deactivated by function Settings, Gravity. Before simulation is launched, the measure of displacement, velocity and acceleration of centre of gravity of table in direction Z, the measure of force in spring C and the measure of depicting kinematic excitation are created. After the simulation in module Adams/PostProcessor there are all the quantities of every body in model available, also without defining measure.

Very important part is selection of units. In this case it is MKS - m, kg, N, s, deg.

In the Table 1 there are structural elements of model with parameters.

Table 1. Model bodies with parameters

		
Table	Spring and damper	Base
Dimension [m]: 1,2x0,8x0,04 Mass [kg]: 2000	Length [m]: 0,38 Stiffness coefficient [N.m^{-1}]: 50000 Damping coefficient [N.m^{-1}.s]: 500	Dimension [m]: 0,08x0,08x0,01

In the Table 2 there are functions with description which will be applied to modeling mechanical system in module Adams/View.

Table 2. Functions description in Adams/View

Function	Description
Construction Geometry: Marker	Auxiliary coordinate system for joints definition, action of the forces
Rigid Body: Box	Contains structural elements of model
Connector: Translational Spring-Damper	Modeling springs
Applied Force: Force	Defining load
Joint: Fixed	Fixed joint creation
Joint: Translational	Translational joint creation
Position: Reposition objects relative to view coordinates	Changing position (displacement, rotation) of bodies
Interactive Simulation Controls	Launching simulation
Plotting	Depicting courses, creating animation
Entity color	Selecting colors of objects
Render	Visual representation of model

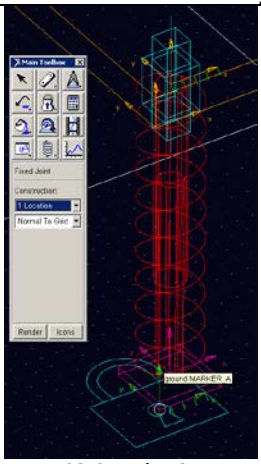
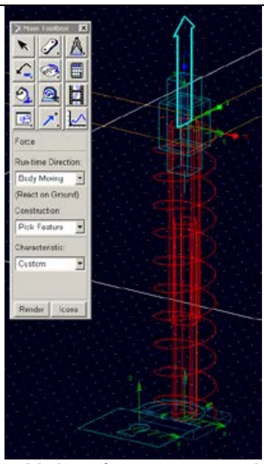
The next step is construction of structural items – markers (Table 3). The label is for example A1 – marker A on table, A2 – marker A on base. They serve to model springs and place bases.

Table 3. Markers coordinates

	Coordinate [m]		
	X	Y	Z
Marker_A1	-0,4	-0,34	0,38
Marker_A2	-0,4	-0,34	0
Marker_B1	-0,4	0,34	0,38
Marker_B2	-0,4	0,34	0
Marker_C1	0,68	0,34	0,38
Marker_C2	0,68	0,34	0
Marker_D1	0,68	-0,34	0,38
Marker_D2	0,68	-0,34	0

In Table 4 there is fixed joint Joint: Fixed from ground applied, also translational joint Joint: Translational is applied between table and ground. Using function Applied Force: Force, Run-time Direction – Body Moving a Construction – Pick Feature, the force named Excitation_by_obstacle with origin in marker Marker_D1 is defined in Table 4 figure on the right. Subsequently magnitude of the force is given in box Modify Force, clicking on Function Builder as in Figure 2.

Table 4. Addition of joints and excitation to model

	
Establishing fixed joint	Establishing force – excitation by obstacle

Entry of model excitation by obstacle using the function Step (Figure 1) in Function Builder is as follows: STEP (time, t0, y0, t1, y1) + STEP (time, t2, y0, t3, -y1).

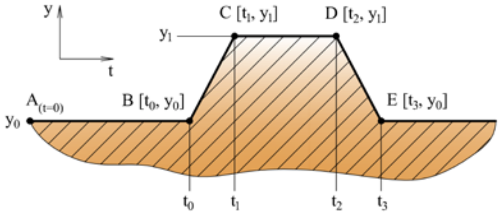


Figure 1. Defining function STEP

The shape of obstacle (Figure 2) in this calculation is given by function that will be entered into Define a runtime function. Preview of the function will be launched by Plot.

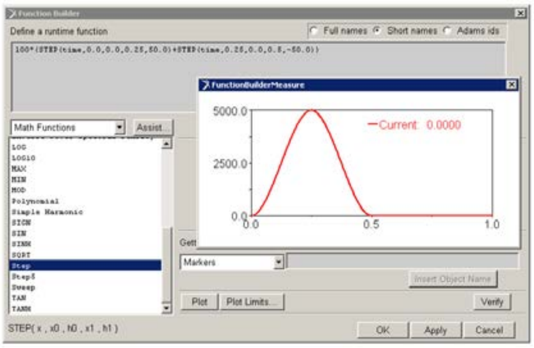
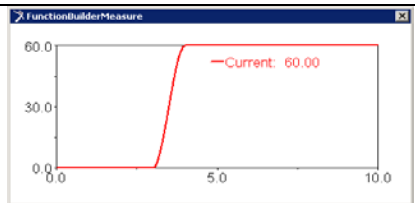
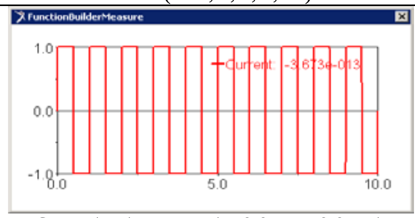
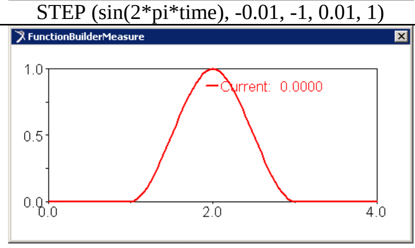
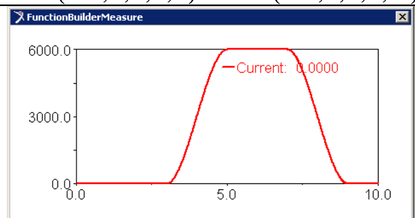


Figure 2. Block Function Bilder

Table 5. Overview of some STEP functions

 STEP (time, 3, 0, 4, 60)
 STEP (sin(2*pi*time), -0.01, -1, 0.01, 1)
 STEP (time, 1, 0, 2, 1) + STEP (time, 2, 0, 3, -1)
 100*(STEP (time, 3, 0, 5, 60) + STEP (time, 7, 0, 9, -60))

For an illustration there is an overview of some defined functions in Function Builder (Table 5).

In the Figure 3 there is model rendering by applying function Render; function Icons turns off icons indication and function Depth – Toogle projection between orthographic and perspective activates perspective view. These tools are placed in Main Toolbox.

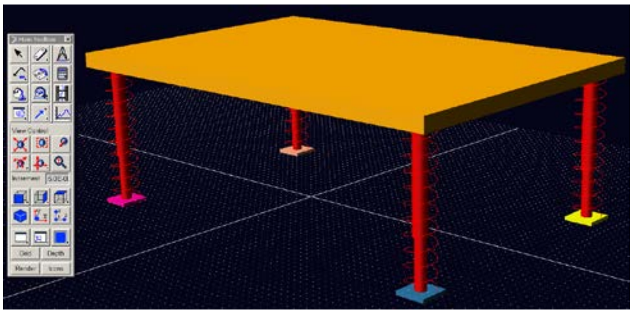


Figure 3. Rendering of model by function Render

The results of shifting mechanical systems simulation are presented in the graphical form and also numerical values are at disposal. One of the options for depicting processes of measured quantities directly in the setting of module Adams/View is by clicking on diagram and confirming function Transfer To Full Plot, the module Adams/PostProcessor with diagram is launched and it is depicted with File, Print (Figure 4 and Figure 5). In this setting (Figure 6) it is possible to edit and save diagrams of formats JPG, PDF. Another option is animation of 3D model by function View, Load Animation (Figure 6). The system performance may be recorded in the form of video file in format AVI.

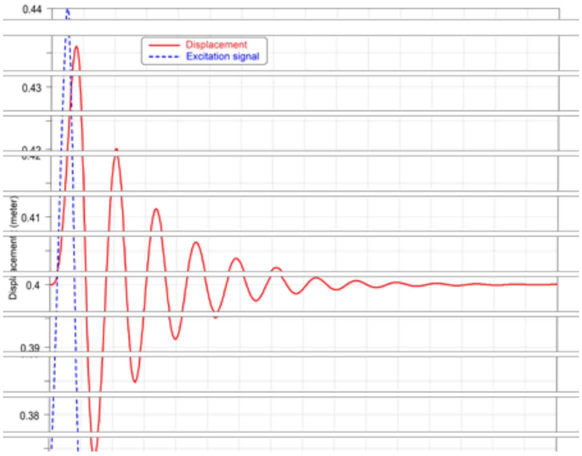


Figure 4. Depicting displacement of the centre of gravity of table and the shape of obstacle

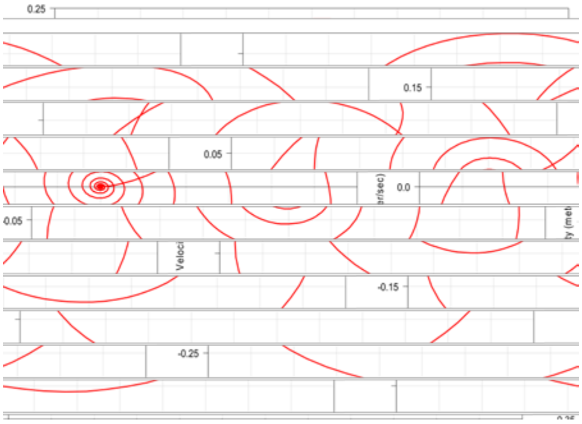


Figure 5. Dependency of velocity – acceleration

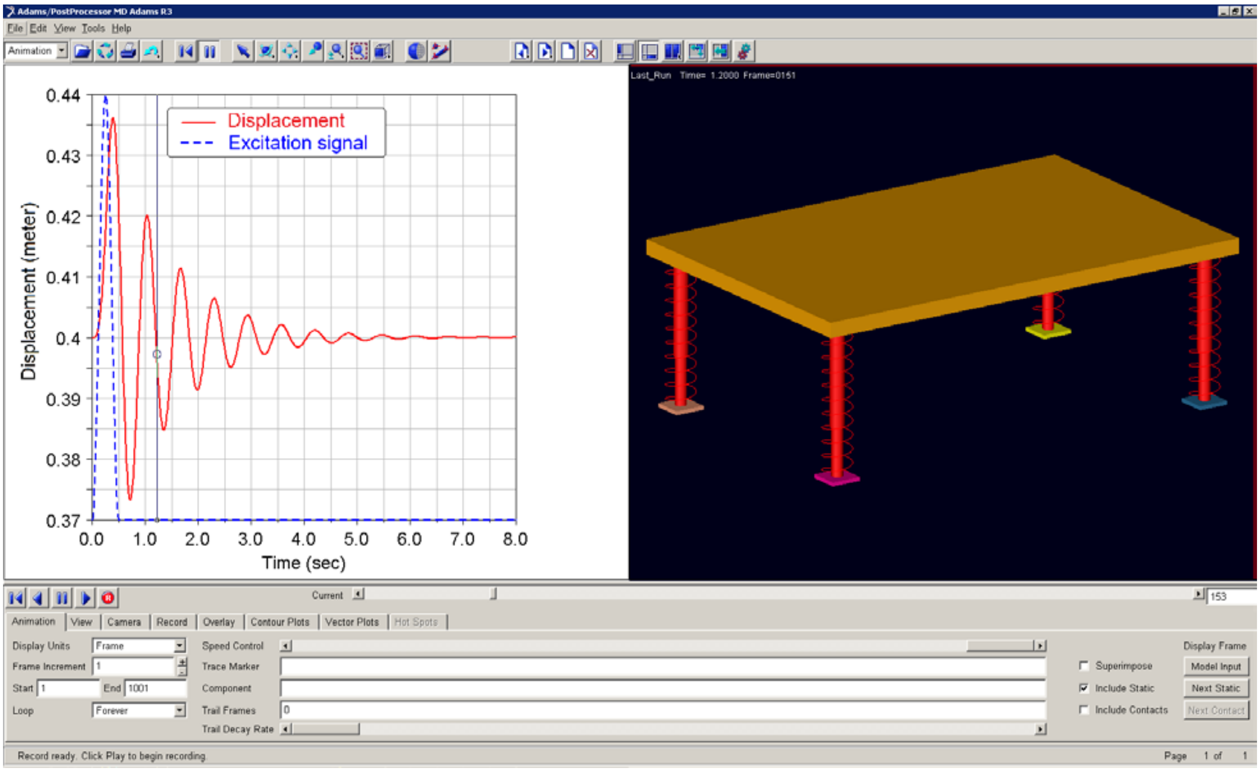


Figure 6. Model animation

3. Conclusion

As an illustration, there is methodology of one-mass system calculation. Simulation in the program MSC

Adams is not so time-consuming, but the knowledge from the area of statics, kinematics and dynamics is needed for creating models. Gravity impact on 3D model was not taken into consideration. It will be the contents of other author's works.

Acknowledgement

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