Static Force Analysis of a Spring damper System Using Adams Software

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Abstract – The spring-damper system is modelled and simulated in this paper using MSC Adams software. Analyzing the static equilibrium force produced in a spring-damper attached to a rigid body is the goal. Using constraints to limit motion and applying gravity in the negative Y direction, a mechanical model was constructed in Adams/view. The system was simulated after the required mass attributes were assigned and a translation joint was added. To verify the accuracy of the model, the static equilibrium force derived from the simulation was contrasted with analytically computed values.

Key Words: MSC software , Adams/view, static equilibrium, spring-damper system, simulation, analytical approach,

1.INTRODUCTION TO MSC SOFTWARE :

The behavior of many, especially complex mechanical systems, tends to raise problems to design and analyze regarding its internal working for different scenarios simulations is required. For example: suspension systems, satellite mechanisms, or even heavy machinery where volumetric rotations or translations of several components happen, an engineers tool kit tends to need some predictive and motion analyzing add-ons. MSC Adams is one of the prevalent multibody dynamics packages which facilitate the simulation of such mechanical systems. It aims to aid designers and testers of mechanical systems by providing virtual models that can step a close reality behaviour of the moving parts, thus avoiding the cost and risk of physical testing prototypes.

1.1 ADAMS/VIEW :

The purpose of this article is to create a functional model of the centric crank mechanism in Adams/View software, and then conduct a thorough analysis of its kinematics. Our team is responsible for modeling the crank mechanism in adams/view software. The subsequent phase involves running a simulation with various parameters to analyze its kinematics. Finally, the information collected during this process is compared and assessed. The fast-paced evolution leads to a significant rise in demands for quicker production with higher precision at the lowest possible cost. This is linked to the increasing needs of customers, the ever-changing market, and primarily by globalization. In order to meet the growing demands for faster and more efficient problem-solving, new methods must be developed. The rapid advancement of computer technology facilitated the creation of various types of simulation software. By using computer simulations, we can solve a wide range of very challenging dynamic tasks. A computer model is created using mathematical analysis, ensuring that it possesses the characteristics of a real object. Because the created model shares the same attributes as the real object, the computer simulation produces the same outcomes as the actual simulation model. This computer simulation is more cost-effective and can be easily repeated with adjusted model parameters. We can replicate the same model in different settings and with different external factors at the same cost, which is not feasible with a real model. One of the benefits of using a computer simulation model is that it is virtual, meaning it cannot be physically damaged and can be used for multiple simulations.

1.2 INTRODUCTION TO SPRING DAMPER SYSTEM :

A vibration signature refers to the unique vibration frequency spectrum that is characteristic of a specific equipment component or system at a particular moment, under specific operating conditions. The damper system can accurately detect the vibration signature of a spring-mass-damper system with both free and forced dampers, regardless of the viscosity of the fluid used. This is because there is minimal loss of data during the inspection process. This enables a substantial amount of intricate examination. Nevertheless, one of the drawbacks is that there is often an overwhelming amount of data, making it challenging to identify clear and fault diagnoses. Dr. Paul Young's research shed light on the various elements that comprise an oscillating mechanical system and how they influence the characteristics of the system. The commonly recognized techniques for reducing vibrations in industrial equipment involve force reduction, mass addition, tuning, isolation, and the use of dampers. Andrew K. Costain and Michael Robichaud have briefly discussed each method, and provided practical examples of how they can be applied. They have determined that damping effectively controls vibration at or near resonance by dissipating energy as heat.

2. LITERATURE REVIEW :

Spring-damper systems are extensively studied due to their widespread use in modeling dynamic behaviors in mechanical and control systems. Sharma et al. conducted simulations of spring-mass-damper systems within the

Simulink environment, highlighting how such models can be extended to include vibration absorbers for more effective dynamic control. Their findings suggest better integration between primary and absorber masses enhances performance.

Bhargav Kumar and Himanshu Yadav designed and analyzed an experimental setup of a spring-mass-damper system. Their research showed that increasing the system's mass led to a decrease in natural frequency, a trend verified both experimentally and theoretically.

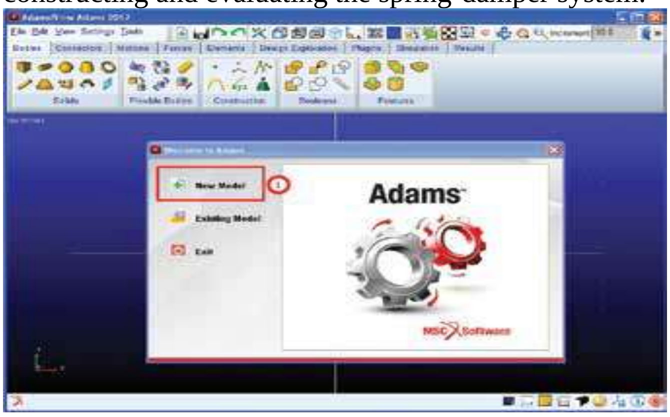
In another study, Yuan and Tan from Nanyang Technological University modeled contact dynamics using virtual springs and dampers to simulate impact behaviors, including rigid and plastic contacts. Their work emphasized the importance of accurately defining parameters like damping and stiffness, and proposed that dynamic tests are essential to refine simulation accuracy.

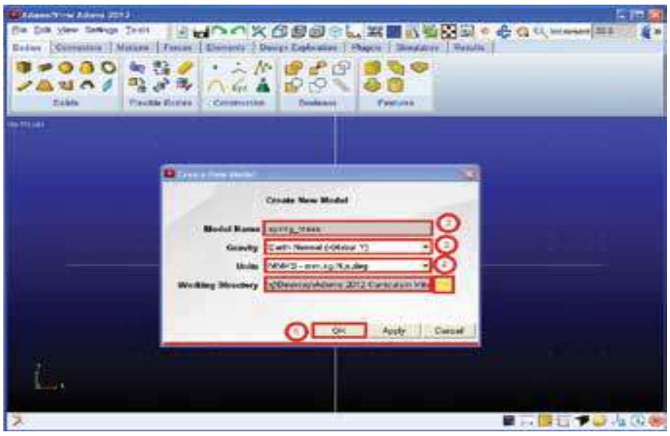
These studies collectively demonstrate the value of spring-damper models in both academic and industrial applications, providing a foundation for further simulations like the one conducted in this work using MSC Adams software.

3.MODEL CONSTRUCTION AND SIMULATION PROCEDURE :

Step 1. Model setup in Adams/view :

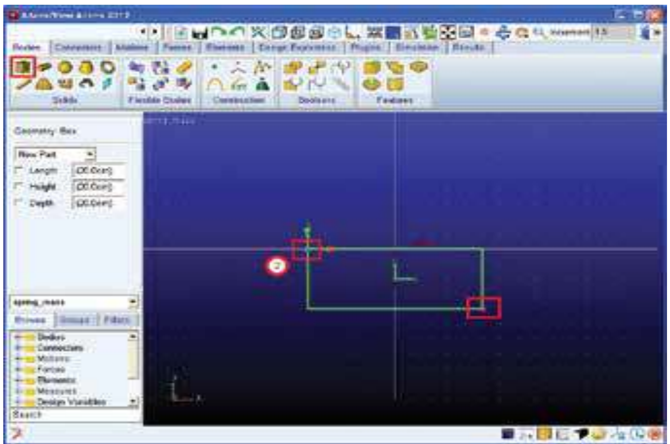
To initiate, a fresh project was established in the Adams/view environment. The model was called spring_mass , and gravity was directed downwards in the negative y-direction to mimic the effects of Earth's gravity. The unit system was set up to measure in millimeters, kilograms, newtons, and seconds to maintain consistency with the mechanical parameters examined in the study. These initial settings laid the groundwork for constructing and evaluating the spring-damper system.

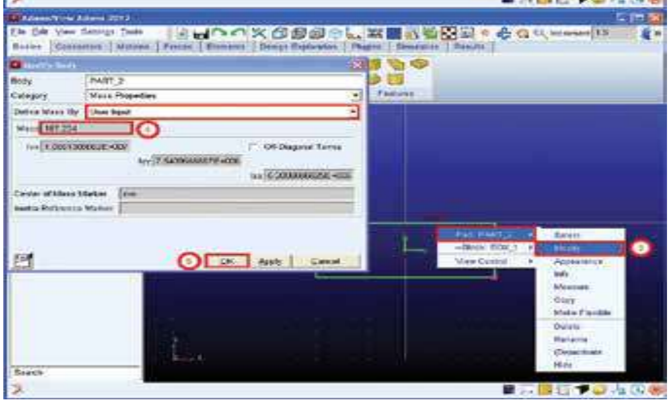




Step 2. Creating the rigid body :

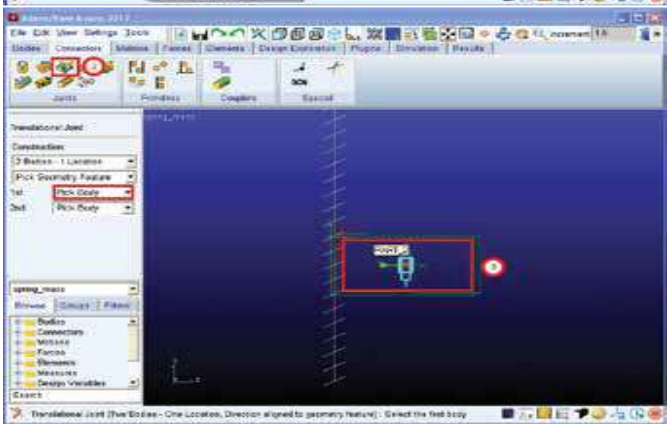
The simulation environment included a rigid body to represent the object connected to the spring-damper system. A box-shaped component was chosen as the geometry, and it was assigned a mass of 187.224 kg. This mass value represents the weight of the object being simulated, taking into account the force of gravity. Although the shape and size of the box were not crucial for the analysis, it was essential for using physical constraints and loads.

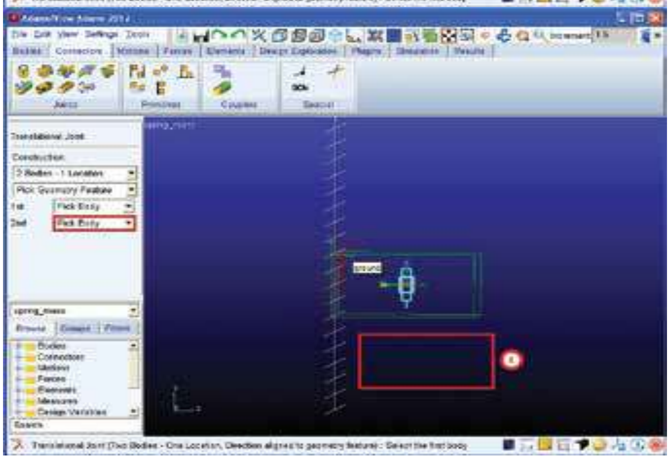


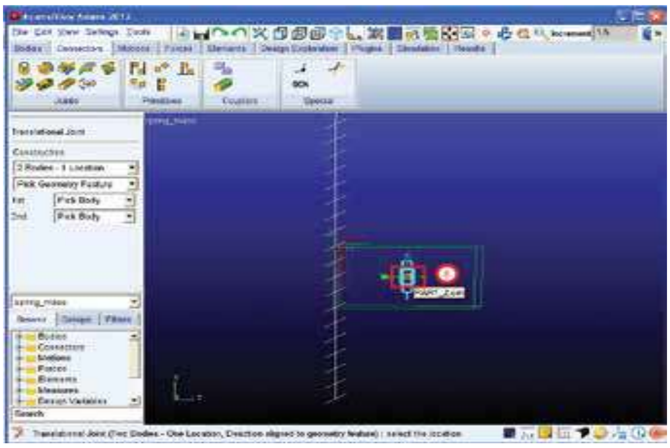


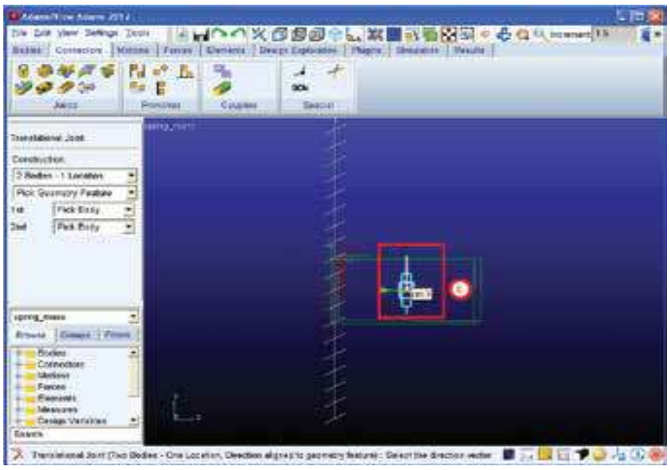
Step 3. Applying motion constraints :

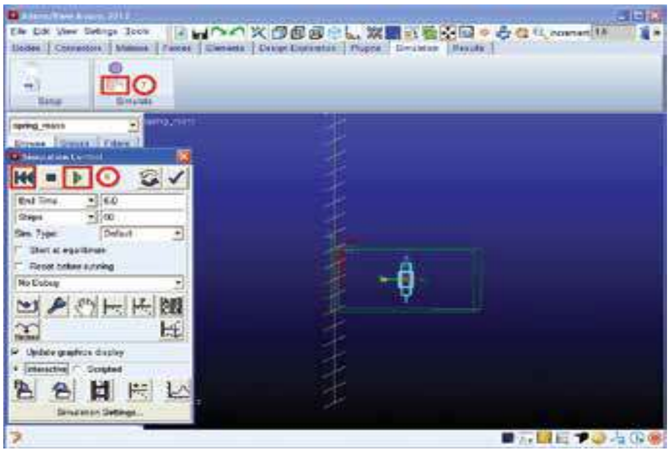
To restrict the movement of the rigid body to only the vertical (y) direction, a translational joint was employed. This joint limited the box's movement to a single axis, imitating the motion of a mass attached to a spring, moving vertically. Prior to attaching the joint, the model was repositioned to ensure precise placement and alignment along the intended axis. The translational joint was established between the rigid body and the fixed ground reference, facilitating linear motion necessary for static force analysis.





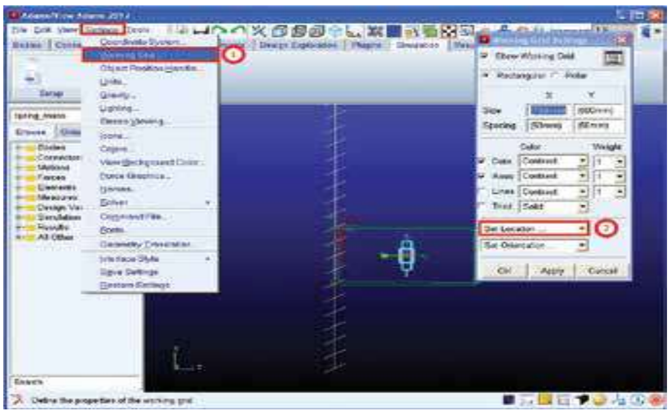


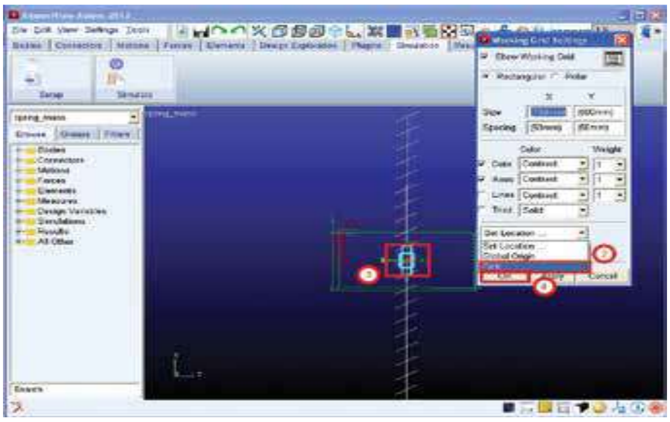




Step 4. Aligning the working grid :

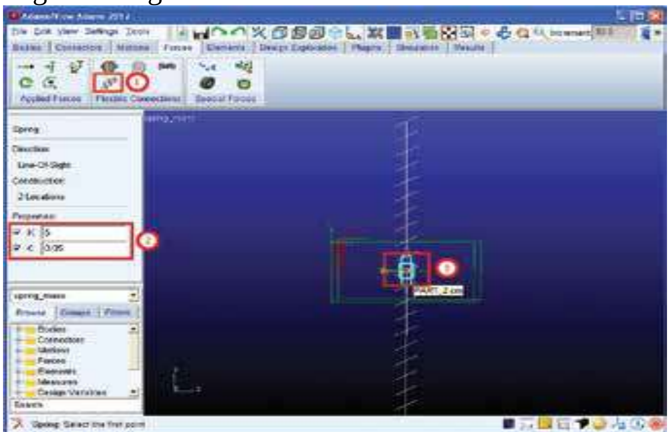
To ensure accurate placement of simulation elements like the spring-damper, the working grid was adjusted to the center of mass (cm) of the rigid body. This alignment guaranteed that all subsequent components, such as constraints and measurement markers, would be correctly positioned and aligned with the system's motion path.

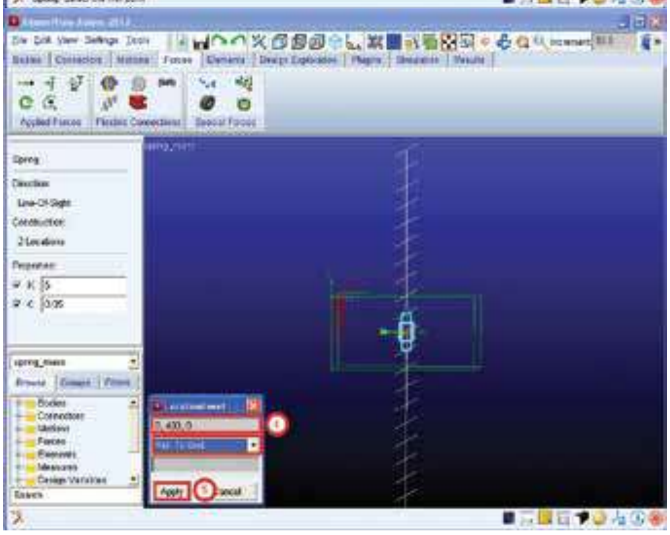




Step 5. Inserting the spring-damper element :

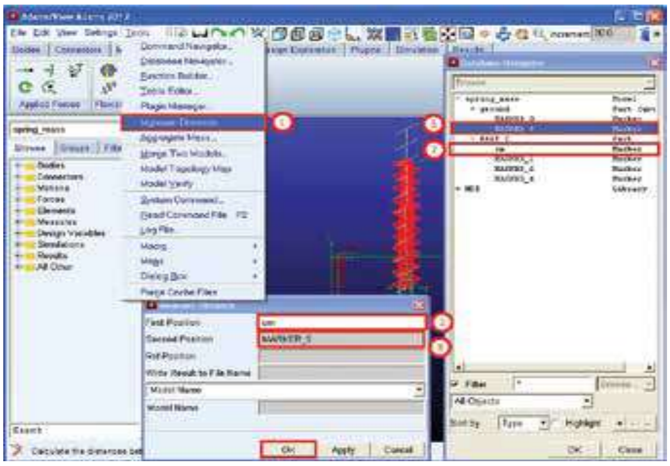
A predetermined spring-damper component was incorporated between the rigid body and a stationary point on the ground. The spring's stiffness was set at 5 n/mm, and the damping coefficient was determined to be 0.05 ns/mm. These values reflect the physical attributes of the system being examined. The positioning was meticulously planned to ensure that one end of the spring-damper was attached to the body's center of mass, while the other end was securely connected to a fixed point aligned along the vertical axis.

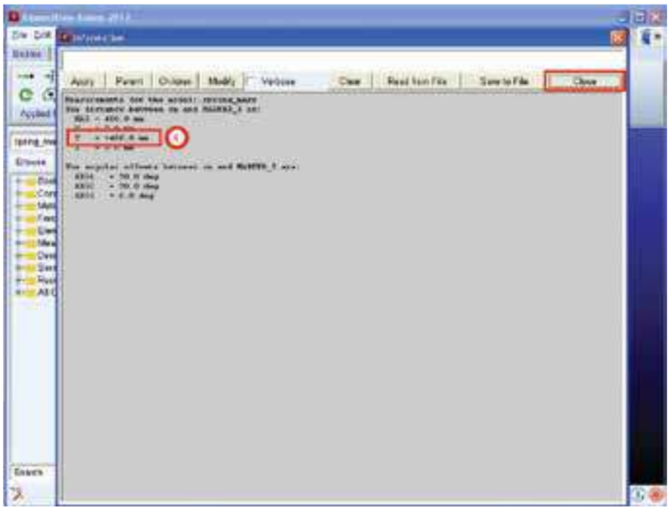




Step 6. Measuring the Spring-Damper Displacement :

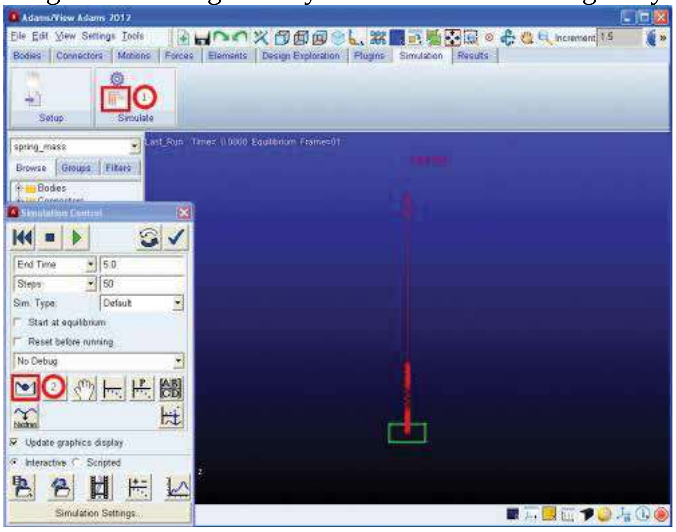
To analyze the static performance of the spring-damper system, the displacement between the two ends of the spring was measured. This was done by identifying the center of mass of the rigid body as one reference point, and the fixed connection point on the ground as the second. Using the measurement tools available in ADAMS/View, the vertical distance (along the Y-axis) between these two points was recorded. This value represents the elongation or compression of the spring under the applied load and is a critical factor in verifying the force results from the simulation.





Step 7. Static force analysis in the Spring-damper :

After setting up the system, a simulation was conducted to calculate the equilibrium force generated by the spring-damper. The static equilibrium analysis tool in Adams/view was utilized, and force visualization settings were activated to present numerical force values on the simulation model. After running the simulation, the spring-damper was observed to generate a restoring force of approximately 1836.04 newtons, which balanced the weight of the rigid body under the force of gravity.



Analytical Solution – Verify the Results by Calculating the Analytical Solution :

• The block's mass is 187.224 kg.

• Therefore, to balance the force of gravity, the spring damper must generate:

• 187.224 kg * 9806.65 mm/s2 = 1836.04 N

• The results produced by Adams View are the same as the hand calculated answer.

4.REFERENCES :

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5. CONCLUSIONS :

The analysis of the static behavior of a spring-damper system was accomplished using msc adams/view software. By creating a virtual model with specific mass, gravity, and constraints, the simulation offered precise information about the system's balance and stability. The simulation outcomes demonstrated a spring force that aligned with the analytically derived value, validating the effectiveness of both the modeling approach and the software configuration. This showcases the efficiency of Adams/view in examining mechanical systems and confirming theoretical outcomes. The approach described in this study can be expanded to investigate the dynamic responses and behavior of more intricate vibration isolation systems in future research endeavors.

6.BIOGRAPHIES :

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