Case Study: **Mahindra Two Wheelers**

Adams Multibody Dynamics Simulations Help Bring Two Wheelers to Market 7-21 Weeks Faster

Overview

In the past, the design of new two wheeler models at Mahindra was based on building prototypes and driving them on a test track. The limitations of this approach were that prototypes took an average of five weeks to build and had to be run for about two weeks to evaluate component durability. A major improvement came when test rigs were introduced and used to recreate the conditions of the test track using automated equipment that eliminated the need for a driver and could be operated 24X7. This approach saved time, however, a complete vehicle prototype iteration was still required for each major design change.

Riding two wheeler on test track

Simulation of bump rig test with Adams MBD model

"The number of prototypes required to bring a new two wheeler to market has been reduced from 4 or 5 in the past to 2 or 3 now. The time to build and test a new prototype is about 7 weeks so the company has been able to bring new two wheels to market at least 7 to 21 weeks faster than was possible in the past"

Mihir Bhambri, CAE MBD analyst, Mahindra 2 wheelers

Challenge

Mahindra's engineering management wanted to bring new two wheeler designs to market faster. The company wanted to use computer simulation to evaluate the kinematics of the vehicle and calculate loads for individual components that could be exported to finite element analysis (FEA) software for stress analysis. Another desired option was to use a flexible body in the dynamics simulation so that stress at critical locations could be determined directly. Achieving these goals required a multibody dynamics (MBD) software package that could accurately predict the behavior of the two wheeler on the test track.

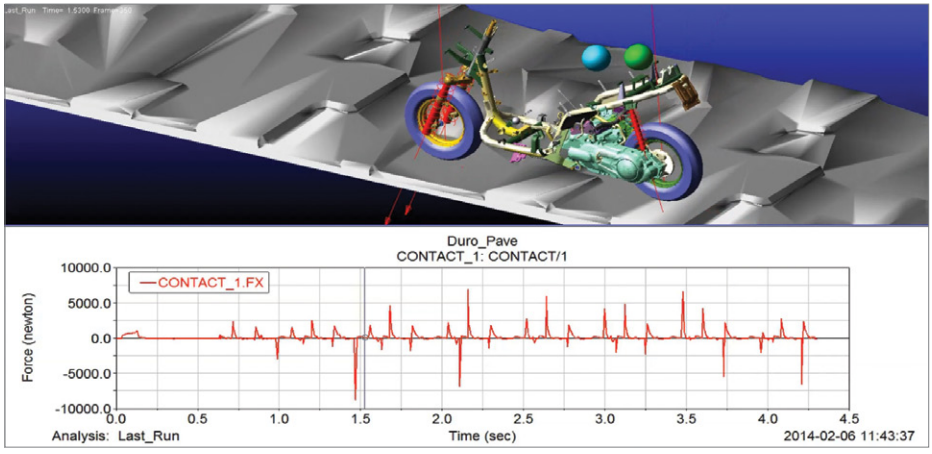
Solution/Validation

Mahindra selected MSC Software's Adams, the most widely used MBD software for over three decades. MSC Software is the world leader in both MBD and FEA software. Speaking the language of both domains gives MSC the capability to develop the rich data transfer required to fully integrate them. Mahindra has evolved a new virtual testing design process that uses Adams to simulate the performance of new designs and accurately predict their performance prior to the prototype phase.

The new process begins when designers create the initial concept design of a new two wheeler using computer aided design software. Engineers import the design into Adams and create an MBD model by defining connectivity, mass properties, forces and the dynamics input and output of the two wheeler. Rigid bodies are typically used at this stage except on components with multiple joints where flexible bodies are used to avoid redundancies.

The simulation provides detailed information on the behavior of every aspect of the two wheeler that is included in the model. This information is often used by engineers to understand the reasons why one design performed better than another. It's important to note that simulation provides much more diagnostic information than can be obtained from physical testing which is limited by the relatively small number of sensors that can be positioned on the two wheeler.

Bump rig test duplicates test track



Rough Road Riding Test using Adams

Key Highlights:

Product: Adams

Industry: Automotive

Benefits:

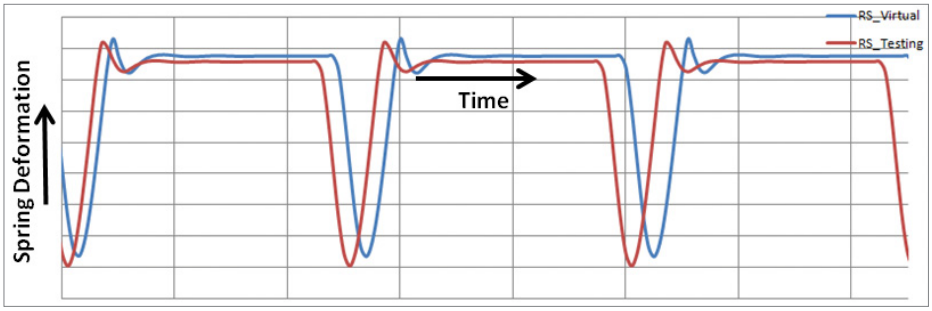
- Simulation provides much more diagnostic information than can be obtained from physical testing
- Engineers perform parametric analyses to investigate the influence of design variables such as the location of hard points on accelerations
- Excellent correlation between simulation and measurements on suspension systems
- The number of prototypes required to bring a new two wheeler to market has been reduced from 4 or 5 in the past to 2 or 3 now
- Adams bring new two wheels to market at least 7 to 21 weeks faster than was possible in the past

While the multibody dynamics model is being created, the company also builds a rough prototype for use in validating the model. The prototype is run on a test rig and engineers compare maximum, minimum and root mean square (RMS) loads on critical components for the prototype and model. The loads predicted by the model normally match those measured on the prototype within 10%. When this level of accuracy is achieved, the model is considered validated and used to drive the design process from that point forward.

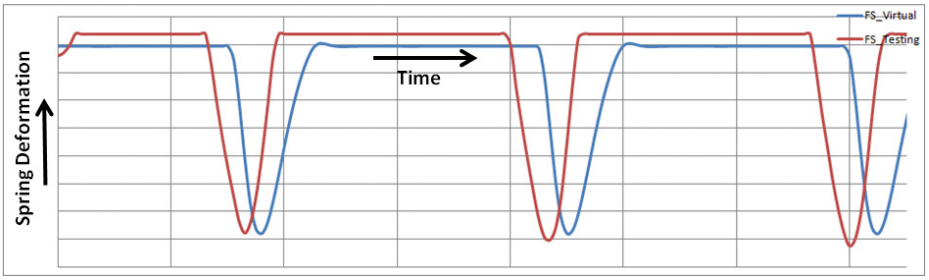
Engineers then utilize the MBD model to make improvements on the initial conceptual design. Their primary focus is controlling acceleration levels at hard points such as where the engine attaches to the frame. Accelerations at these points are important because they generate load and fatigue.

Engineers perform parametric analyses to investigate the influence of design variables such as the location of hard points on accelerations. Engineers identify the combination of values of the design variables that reduce accelerations and loads to minimum values. The design optimization process typically takes three days including defining the model variables and constraints and results interpretation. The loads on key components predicted by the Adams analysis are passed to the durability team who uses these loads as input for FEA.

Engineers then ask the opinion of the stylists and manufacturing engineers to determine whether the optimum values are desirable and feasible and make changes if needed. This consultation process takes another two weeks on average. The next step is to modify the prototype to match the final design as determined by simulation. Road testing is then performed on the prototype. If a component fails prematurely, the components are examined to determine the cause of the failure and changes are made to the design. In the vast majority of new products, the design developed during the simulation process works fine and is used as the final design. The final preproduction model is then built from scratch and given to test drivers and customers to evaluate if there are any concerns on the rough road and handling test. If changes are needed, engineers modify the design and use the MBD model to recheck the loads.



Correlation between MBD simulation and testing on rear suspension



Correlation between MBD simulation and testing on front suspension

Results

Basing the design process on simulation rather than testing provides substantial time and cost savings. The largest savings come from being able to evaluate alternative designs without having to build a prototype. The number of prototypes required to bring a new two wheeler to market has been reduced from 4 or 5 in the past to 2 or 3 now. The time to build and test a new prototype is about 7 weeks so the company has been able to bring new two wheels to market at least 7 to 21 weeks faster than was possible in the past.

About Mahindra

Founded in 1945 as a steel trading company, Mahindra entered automotive manufacturing in 1947 to bring the Willys Jeep onto Indian roads. Over the years, the company has diversified into many new businesses. Today it has US $16.7 billion in revenues and more than 180,000 employees in over 100 countries. The Mahindra Two Wheelers Ltd. product line includes the Centuro and Pantero motorcycles and Rodeo RZ, Duro DZ and Flyte scooters.

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