DURABILITY EVALUATION USING 6 DEGREE OF FREEDOM MULTI AXIAL ROAD SIMULATOR

INTRODUCTION

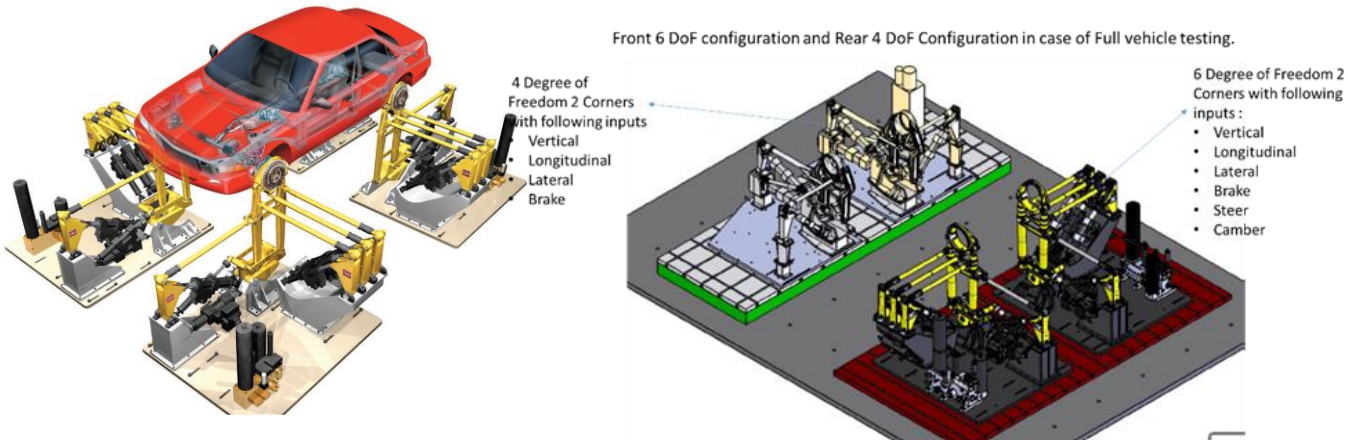
As a part of vehicle development cycle it is necessary to have laboratory testing methods of vehicle and its sub parts to ensure product validation before other aggregates are developed. Relying completely on road trials will consume a lot of time and result in extended PV cycle. Thus in order to evaluate complete vehicle and reduce the PV cycle, we need to simulate real-world operating conditions and characterize the performance of the specimen in a controlled laboratory environment. Multi Degree-Of-Freedom (DOF) testing is used across many industries, usually to characterize complex components or structures. The full-car road simulator is the ultimate complete car and component test rig for front and rear axle fatigue testing, full car stiffness tests and analysis of suspension sub systems.

The 6DOF Road Simulator system provides six-degree-of-freedom, first of its kind in public domain in India, control of forces and motions in its 12 channel configuration is the full complement of hardware and controls necessary at each vehicle spindle to provide:

(1) Vertical translation;
(2) Lateral translation;
(3) Longitudinal translation;
(4) Brake/drive torque;
(5) Camber moment; and
(6) Steer moment.

Three lateral struts each connected to independent actuators work together to provide lateral force control and also the steer and camber moment control.

By utilizing proven linkage-coupled technology with independent actuation, the 6DOF Road Simulator system enables accurate replication of the true multiaxial stress state of vehicle subsystems and components at any instant in time to simulate the complex nonlinear events required for meaningful durability road simulation.



TEST CONFIGURATIONS

The 329 6 DOF Road Simulation System is used to induce a variety of "road" input conditions on a test vehicle in the laboratory. This system can be operated in a variety of modes, the most common being an inertially reacted full floating body whereby all of the inputs are reacted by the inertia of the vehicle. This set-up is very useful for a whole vehicle durability test which encompasses the body, body mounted components, and the suspension.

Floating Body (20 channels) – This full-vehicle test provides the most accurate overall stress distribution in the complete vehicle structure for non-maneuvering events. The vehicle body is allowed to float, and all loads are reacted by its inertia.

Fixed Body (12 channels) – This single-axle test produces accurate loads in the vehicle suspension, and allows simulation of maneuvering events (braking and cornering) along with rough road simulation. The vehicle body is grounded, or the suspension can be mounted into a fixed reaction frame.

Semi-Floating Body (12+1 channels) – This single-axle test produces accurate loads in the vehicle suspension and a portion of the vehicle body. One axle is grounded through a yaw or yaw-twist fixture while the body is allowed to float. Simulation of braking events is also possible in this configuration.

System Specifications for the 6 Degree of Freedom Road Simulator

	Vertical	Longitudinal	Lateral	Steer	Brake	Camber
Max. Operating Frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Spindle Force/Moment	63 kN	29.5 kN	20 kN	6.9 kN-m	4.0 kN-m	9.6 kN- m
Spindle Displacement	380 mm	392 mm	258 mm	16^o	32^0	16^o

APPLICATIONS

The 6DOF Road Simulator system brings the track testing into the laboratory. It offers advanced capabilities for passenger cars that offers six-degree-of-freedom control for evaluation of following systems and Subsystems

- ✓ Suspension assembly
- ✓ Suspension to Vehicle body interface
- ✓ Vehicle Body
- ✓ Body-mounted components (mirrors, fuel tanks, battery mounts etc.)
- ✓ Interior parts (seats, IP, steering column etc.)

With the 6DOF Road Simulator system uses the data acquired using the Wheel Force Transducers to simulate the forces and moments on the rig. The rig along with its high speed and accuracy digital controllers and complete simulation software enables:

- ➢ Accurate reproduction of dynamic tire loading
- ➢ Accurate load distribution in the specimen
- ➢ Accurate load input vectors

- Uncontrolled responses are eliminated, resulting in:
  - ✓ Faster system convergence
  - ✓ Superior correlation from remote transducers
  - ✓ No need to make judgment calls on uncontrolled channels

Six-degree-of-freedom control at the spindle means that you can run your simulations without compromising the assumptions that typically govern four and five degree of freedom simulations.

With six degrees of freedom:

- You can achieve force relationships/ fixed moments even for quasi-static testing. This is because vehicle tire rolling radius and input load offset will vary dynamically during road events.
- The acceleration of offset tire/wheel inertia will not generate dynamic spindle moments on the road, and uncontrolled simulator moment loads will be correct.
- A rigid body spindle housing with six control inputs will reliably generate frequency-dependent loads at the spindle. This will eliminate phase angles between spindle forces and moments.

ADVANTAGES OF THE 6DOF ROAD SIMULATOR

- Improved Testing Capabilities – It improves simulation correlation for durability testing, provides greater available range of brake clearance, and reduces the possibility of interference with smaller wheel housings due to the straight vertical struts.
- More Reliable & Accurate Results – The uncertainty due to lesser control channels available in 4 & 5 DOF system gets eliminated resulting in more accurate and reliable results.
- Time and Cost savings – It provides more complete simulation information for modeling, analysis, design and virtual testing because it reproduces all multiaxial spindle loads with greater accuracy. It also eliminates uncontrolled responses, resulting in faster system convergence and reducing the simulation time.
- Testing in Initial Phase – Suspension & Steering Assembly, Vehicle body to mounting interface can be tested at initial design phase.
- With integration of 6 DOF front corners with 4 DOF rear corners in SDL – ARAI it will become the only full vehicle road load simulation facility for Public Domain in India. Facility will be available for all OEMs and Vehicle Manufacturers.