Tata Motors

Door seal behavior prediction and enhancement

The MSC team worked hand in hand with the Tata Motors team to proactively sort out issues and find quick solutions.

Established in 1945, Mumbai headquartered Tata Motors Limited is a multinational automotive manufacturing company that delivers over 9,000,000 vehicles per annum. Its range of products includes passenger cars, trucks, vans, coaches, buses, sports cars and military vehicles.

Tata Motors owns the English premium car maker, Jaguar Land Rover (JLR), and the South Korean commercial vehicle manufacturer, Tata Daewoo. The company has several auto manufacturing and assembly plants in six locations across India, as well as in Argentina, South Africa, Great Britain and Thailand. It also has R&D centres in India, South Korea, the UK and Italy.

Figure 1: Door assembly in automobiles

Challenge

When designing automobiles, the automotive seal has an important function to play. It seals the interior of the vehicle from the environment. Therefore, it not only needs to be functional, but there needs to some cohesion with the body design of the vehicle. Poor door seal system design can cause water leakage, wind noise, hard opening or closing of doors, and other issues that impair customer satisfaction. Moreover, improper design of the seal can make it difficult to install on the body panel. Therefore, the design rationality and manufacturing process are important for the functionality and performance of the sealing system.

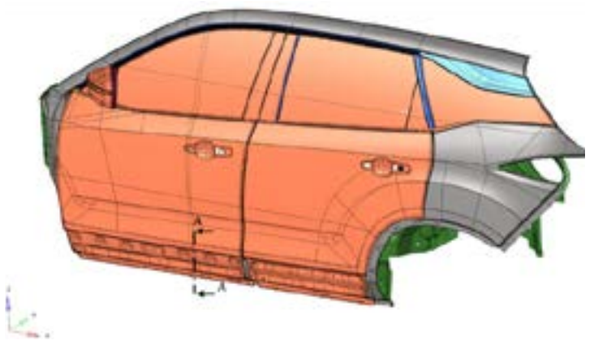
However, the door sealing system comes with several design and manufacturing variables. It is difficult to precisely confirm the individual quantitative effect on the functionalities of these variables at early design stages. Therefore, computer-based simulation of the door sealing system is more practical since it is cost and time-efficient and also helps isolate critical factors.

Digital simulation of rubber sealing is both a complex and scalable problem. This is due to the unique properties of rubber, which is highly nonlinear and nearly incompressible. Besides, sealing simulation also needs to capture contact (self-contact) and geometric non-linearity.

The existing solver was proving to be ineffective since there were several challenges and convergence difficulties.

Solution

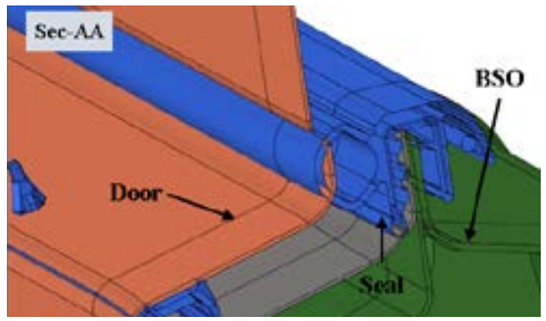
Marc possesses specially formulated elements, material models and automated contact analysis procedures to evaluate elastomers.

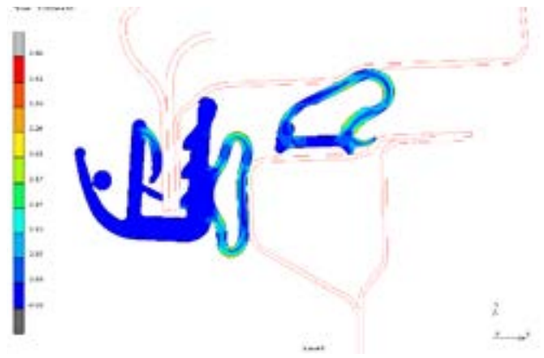


Therefore, Tata Motors decided to use Marc to overcome the rubber seal simulation difficulties.

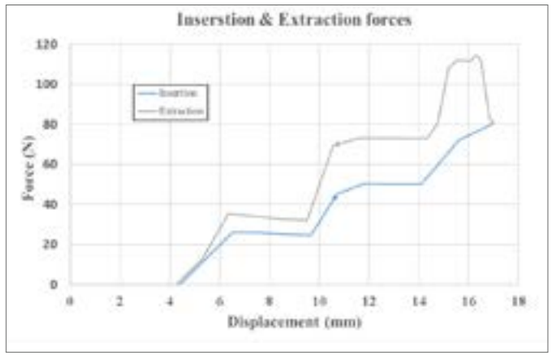
Marc is useful to predict the performance of the door seal during door opening and closing events. Based on the confidence of the above simulations, further studies are performed to evaluate the sensitivity of other parameters of the seal such as seal thickness, bulb diameter, gaps between mating surfaces and material properties.

Next, the seal assembly sequence is captured in the simulation. The Marc simulation result provided key insights on seal deformation, contact length, closing effort, CLD curve and installation forces of seal on the body panel. These parameters are important since they influence various functions of door seal performance.





Key highlights:
Product: Marc and Adams
Industry: Automobile
Benefits:
Co-simulation by coupling simulation environments in Marc and Adams



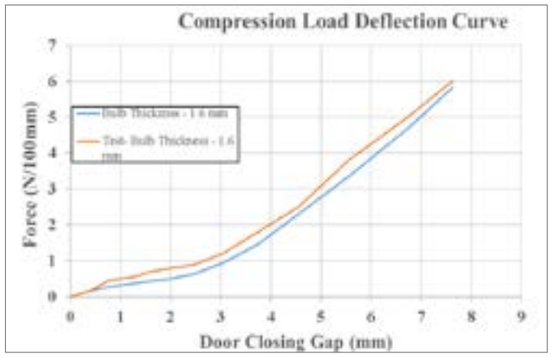


Figure 2: Door seal simulation results

Benefits

There was found to be good agreement between the analysis result and physical test data when the numbers were compared. These results helped establish the impact of the major parameters with respect to predicting water leakage, wind noise, and opening/closing efforts. Getting these insights at an early design stage helped reduce the cost and shorten the product development time.

With Marc, the team was able to complete the simulation four times faster (see Table 1) and at least double the existing simulation productivity.

The MSC team worked hand in hand with the Tata Motors team to proactively sort out issues and find quick solutions. Overall, the team was able to meet the set program development cycle timelines.

In the future too, the team intends to use a similar approach for door sealing system design. The same will so extend to the simulation of other aggregates such as window GRM and sunroof weather-strip.

	Existing Solver	MSC Marc	% Difference
Model Set Up Time	120 Min	30 Min	75
Wall Clock Time (Solution Time)	35 Min	10 Min	71
Total time	155 min	40 min	72

Table 1: Door seal simulation times with our existing solver versus Marc

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

MSC Software, part of Hexagon's Manufacturing Intelligence division, is one of the ten original software companies and a global leader in helping product manufacturers to advance their engineering methods with simulation software and services. Learn more at mscsoftware.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

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