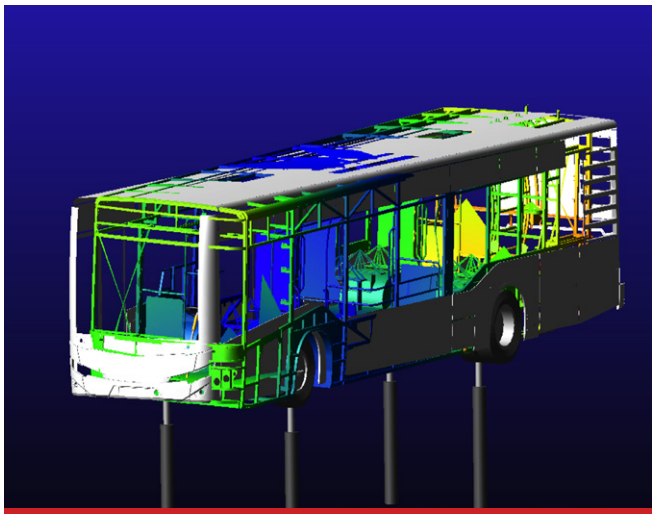
Case Study: **Anadolu Isuzu**

Adams Helps Reduce Time and Cost of the Fatigue Test

Based on an interview with: Emre SERT, R&D Engineer/ Vehicle Dynamics Engineer for Anadolu Isuzu
Sertaç Dileroğlu, Senior R&D Engineer/ Test Engineer for Anadolu Isuzu

Overview

Andolu Isuzu's new 12 meter long bus, called the Citiport, is equipped with a ZF 6-speed full automatic transmission and a 6 cylinder common rail turbo diesel Cummins engine that produces 283 horsepower at 2100 rpm. The bus can be configured to hold up to 103 people. A wheelchair ramp and kneeling system simplify entry and exit for passengers with disabilities. The bus uses an independent air suspension powered by an electric or engine-driven air pump or compressor. This compressor pumps the air into a flexible bellows made from textile-reinforced rubber. The air pressure inflates the bellows, and raises the chassis from the axle. There are two air suspensions in the front of the bus and four in the rear.



Adams/Car model of Citiport bus

“We selected Adams/Car software to simulate static and dynamic testing because of its high level of computational capability and detailed animation capability.”

Emre Sert, Research and Development Engineer for Anadolu Isuzu

Challenge

Anadolu Isuzu engineers were tasked with the challenge of optimizing the design of the suspension in order to improve the ride, handling and safety of the bus as well as ensuring the fatigue performance of suspension, chassis and body components. In the past, the suspension was designed by building prototypes and running them through benchmarks such as the lane change test. The durability of components was evaluated by using an instrumented vehicle to collect road load data and then using this data as input to accelerated testing on a four poster test rig to evaluate the individual components. Four poster test rigs consist of four hydraulic actuators that are each attached to one wheel of the vehicle. The actuators move to simulate the accelerations exerted by the road on the wheels. The problem with the traditional method is that it is very time-consuming and expensive to build prototypes and run physical testing programs. Management asked the engineering team to develop a simulation model that would accurately predict the performance of various design alternatives from a ride and handling perspective and also provide the ability to evaluate component fatigue life.

Solution

“We selected Adams/Car software to simulate static and dynamic testing because of its high level of computational capability and detailed animation capability,” said Emre Sert, Research and Development Engineer for Anadolu Isuzu. Anadolu Isuzu engineers started with a computer aided design (CAD) model of the bus. The suspension system was modeled with rubber bushings, bump stop/rebound stop elements, anti-roll bars, shock absorbers, leaf springs, and other elements. Attachment points were taken from the CAD model. Nonlinear parameters such as the damping characteristics of the shock absorbers, spring stiffness and damping and torsional characteristics of the bushings were taken from test results provided by suppliers and input to the Adams/Car model.

The tire supplier provided Pacejka’s Magic Formula parameters that were used in the Adams/Car tire model. The steering system was modeled with a two gear housing. Other subsystems including the engine, brakes, chassis and body were modeled based on their geometry and nonlinear characteristics. The inertial properties of the virtual vehicle including the center of gravity, mass and inertia were defined to match the actual vehicle.

Adams/Car was used to perform maneuvers with the model including driving over a bump and double lane change. The same maneuvers were performed with an early prototype of the vehicle that matched the simulation model. While the actual vehicle performed the test maneuver, vertical accelerations and displacements were measured on the wheel hubs. These test

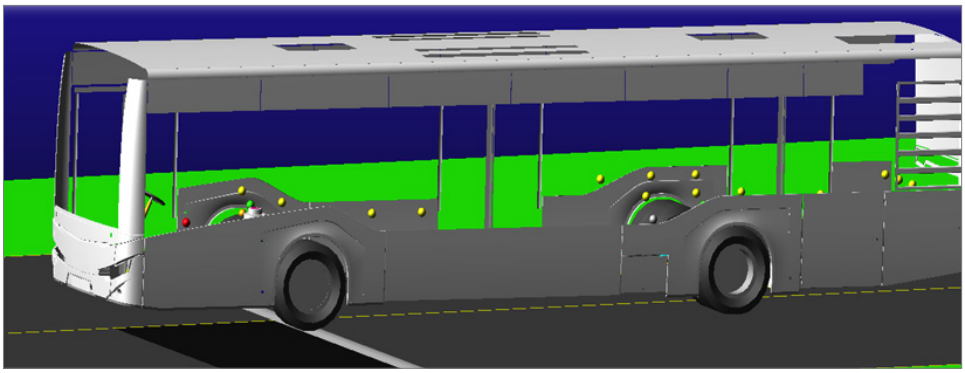
Key Highlights:

Product: Adams

Industry: Automotive

Benefits:

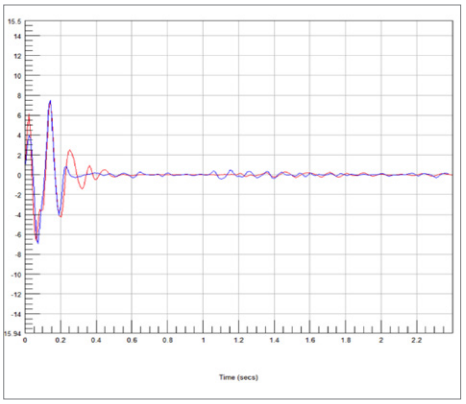
- The optimized suspension design parameters developed in the simulation reduced the rollover risk by 8.37%
- Simulation also reduced the time required to bring the new product to market, which is a major success
- The predictions of the simulation model closely matched the results of actual measurements



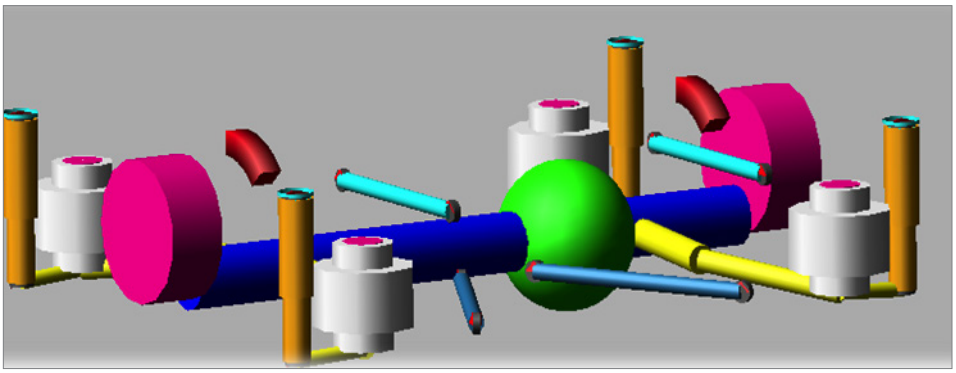
Adams/Car simulation of bump test

Physical test for driving over a bump

Citiport bus



Comparison of acceleration in virtual and actual bus during bump test



Adams/Car model of rear suspension

results were compared with the predictions of the simulation model. The predictions of the simulation model closely matched the results of actual measurements.

"After we validated the model, we began using it to improve the performance of the initial suspension design," Sert said. Anadolu Isuzu engineers used Adams/Insight to create a designed experiment that investigated the effects of suspension design parameters on key performance variables such as rollover risk, handling and ride of the vehicle. In addressing rollover risk, five suspension geometry variables were used as factors and the responses were the suspension roll stiffness and the roll center height, which largely determine the rollover behavior of the vehicle. Adams Insight automatically ran all of the simulation runs needed to explore the design space and provided values for each parameter that deliver optimal performance as defined by the engineers.

"We also used the model to predict component fatigue life as measured by four poster testing," said Sertaç Dileroğlu, Senior R&D Engineer for Anadolu Isuzu. The engineers created a simulation model of the four poster test rig and applied vertical accelerations to the bus model. The model calculated the resulting unit displacement history on the individual components. The unit displacement history was used as input to fatigue analysis in nCode DesignLife software that predicted the fatigue life of the components.

Results/Benefits

With the aid of simulation results, Anadolu Isuzu engineers were able to dramatically improve the initial design concept. For example, the optimized suspension design parameters developed in the simulation reduced the rollover risk by 8.37%. The fatigue life predictions highlighted excessive stress in several body components. These components were redesigned to meet design specifications. "The use of simulation reduced the cost of the product development process because fewer physical prototypes and less physical testing were required," Sert said. "Simulation also reduced the time required to bring the new product to market. The product was introduced about one year ago and has become a major success in the export market."

About Anadolu Isuzu

Anadolu Isuzu is one of the leading medium-sized bus and coach manufacturing companies in Europe whose major shareholders are the Anadolu Group from Turkey, and Isuzu Motors Limited and Itochu Corporation from Japan. The company produces and distributes light duty trucks and midibuses. Since the establishment of the company in 1984, it has built more than 150.000 vehicles. Anadolu Isuzu exports vehicles to 26 countries in three continents. The company has been the midibus export leader in Turkey since 2004.

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