Analyzing Silicone Rubber Spacers for Automotive Engine Control Modules

Delphi

Automotive Electronics

USA

ANSYS® Structural™

Overview

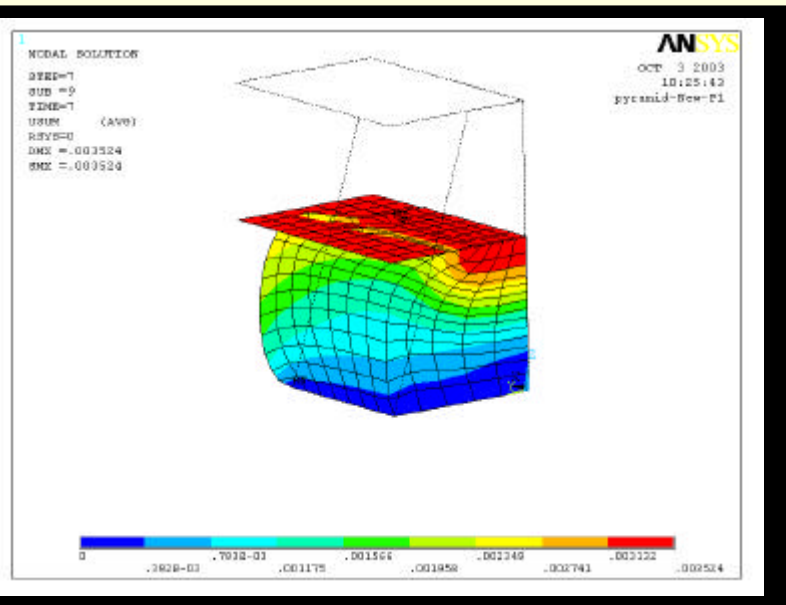
Delphi is a world leader in mobile electronics and transportation components and systems technology.The firm conducts business operations through various subsidiaries worldwide and has headquarters in Troy, Michigan, Paris, Tokyo and São Paulo, Brazil. Delphi's two business sectors – Dynamics, Propulsion, Thermal and Interior Sector and Electronics and Safety Sector – provide comprehensive product solutions to complex customer needs.

The company's integrated systems and modules are designed to help simplify vehicle manufacturers' processes. Delphi is positioned as a single-point solution partner to meet automotive challenges in today's ever-changing global market. Overall, the firm has approximately 186,000 employees and operates 172 wholly owned manufacturing sites, 42 joint ventures, 53 customer centers and sales offices and 34 technical centers in 41 countries. In addition, the Delphi Electronics and Safety division produces about 1 million integrated circuits each day, making it one of the largest in-house manufacturers of customer ICs in the United States.

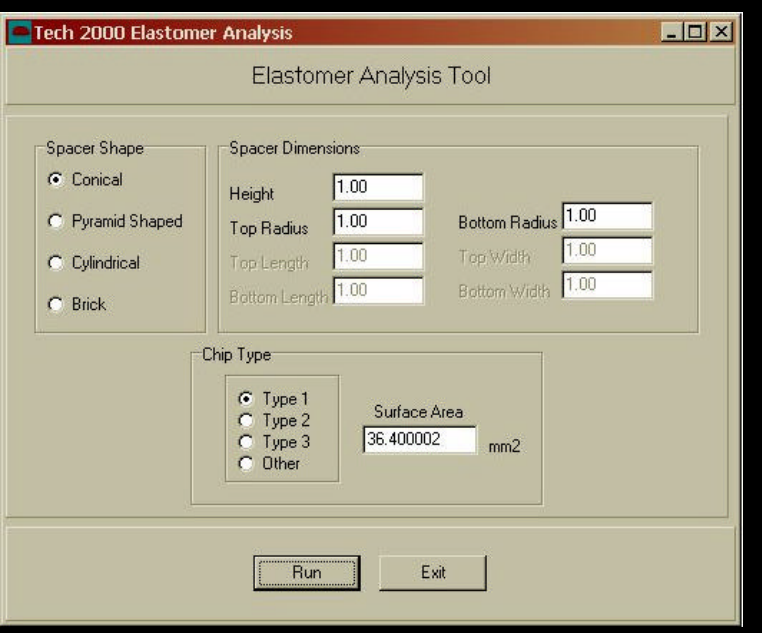
Testimonial

"ANSYS has proven to be a highly effective tool in determining the force-deflection data for the elastomer spacers in ECMs. This saves time and improves design accuracy. Moreover, being able to integrate simulation technology into the product development process through the automated analysis tool enables engineers to more routinely utilize FEA in continually improving product quality."

Fereydoon Dadkhah
Sr. Mechanical Engineer
Mechanical Analysis and Simulation
Delphi Electronics and Safety



Deformed shape of spacer analyzed with ANSYS



Automated tool allows engineers not experienced in FEA to analyze elastomer spacers

Challenge

Silicone rubber spacers in the shape of truncated cones are used in automotive electronic applications to ensure thermal or electrical contact between different components. In one such application, the cones are used in engine control modules (ECMs) to press the integrated circuit (IC) against metal heat sinks to provide a conduction heat transfer path to adequately cool the circuitry.

Determining the force exerted by the spacer is critical to the design of the module. Insufficient force would not adequately cool the IC or properly secure it, resulting in premature failure due to overheating or excessive shock and vibration. On the other hand, the force cannot be set too high because of constraints in the ECM housing and printed-circuit board.

Solution

ANSYS Structural accurately represented the elastomer material so spacers could be designed to provide an optimal force against the circuit board. Mooney-Rivlin material constants for the FEA model were derived from experimentation, where spacer samples were compressed and resulting force-deflection curves derived through curve-fitting commands and macros in ANSYS.

FEA models were developed and validated by reproducing the measured data with very good accuracy. These FEA models were then used to accurately predict force-deflection curves for new spacers as well as establish curves for spacers already in use. ANSYS contact elements were particularly useful in these models to represent surface-to-surface contact between the spacer and PCB.

Benefits

Predicted the force-deflection for the compressed spacers in less time and with greater accuracy than previous methods of linear estimation. As a result, engineers can develop optimal designs that extend the life of ECMs in harsh environmental conditions present in automotive applications.

ANSYS Parametric Design Language (APDL) was developed to model the spacers as well as to extract FEA results data of interest to product engineers and present this information in tabular form. Once the scripts were tested, a C++ graphical user interface was developed to collect the dimensional data from a product engineer and to execute the model. This automated tool thus allows product engineers – without any experience in FEA tools – to use the power of the technology.