Stainless steel makes for lightweight tailgate

AK Steel commissioned Altair Engineering Inc. to design a lightweight, stainless steel tailgate that would be easier to open, more resistant to dent and corrosion damage, and as good as or better in performance than current production-carbon steel tailgates. A new design resulted in a 38% weight reduction over the carbon steel tailgate and a more cost-effective solution to aluminum or other alternative lightweight materials.

Stainless steel is well known for its ability to resist corrosion, and many variations have a strength-to-weight ratio three times that of low-carbon steels. Other advantages include good formability, enhanced dent resistance, and better durability performance. In addition, manufacturing costs generally less than that for other lightweight materials.

Stainless steel is already being successfully used in automotive exhaust systems, safety restraint systems, fuel and brake components, bus frames, and truck trailer rear frames. Potential automotive applications include closures, bumpers, control arms, engine cradles, and crossmembers.

The optimized stainless steel tailgate design from Altair uses Nitronic 30 stainless steel, a nitrogen-strengthened

According to Altair, stainless steel performs better than regular steel in several ways.
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Material innovations

A conceptual stainless steel design was developed to meet all of the requirements. Nitronic 30 offers not only enhanced corrosion resistance but also a unique combination of high strength and elongation. Nitronic 30 offers good formability, toughness, and energy-absorbing characteristics to the design.

All optimization analyses were performed using Altair Optistruct and were based on standard structural loads representing tailgate durability and functionality requirements. Using gauge optimization, engineers identified tailgate components that were most sensitive to loads. Suitable gauges then were established.

Topology optimization was used to identify the primary structural load paths within the inner panel. A design space was defined within the inner panel, and material was redistributed to increase load-bearing capability. The process resulted in a new shape for the stainless steel tailgate inner panel to improve the overall stiffness. Combined with the good mechanical properties of Nitronic 30, structural optimization methods resulted in a new lightweight tailgate concept that met all of the requirements.

For validation, the structural performance of the stainless steel design was compared with that of the existing carbon steel design using finite element methods.

To ensure manufacturing feasibility of this concept, metal-forming simulations were conducted on both the inner and outer panels using Altair’s Hyperform analysis software.

For cost and weight comparisons, Altair looked at a high-strength aluminum 6000-series alloy and the drawing-quality cold-rolled grades of low-carbon steel. The

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stainless steel design is 15 lb (6.8 kg) lighter than the low-carbon steel design and costs $20 more for a cost impact to mass reduction ratio of $1.33/lb. The aluminum design is 19 lb (8.6 kg) lighter than the low-carbon steel design but costs twice as much ($50) for a cost impact to mass reduction ratio of $2.63/lb.

The additional 4 lb (1.8 kg) of mass savings realized with the aluminum design has a cost penalty of approximately $30 per part over the stainless steel design. This translates to a cost impact of $7.50/lb for additional mass saved with aluminum.

Under normal use, tailgates are exposed to the corrosive elements and subjected to rough handling, which leads to paint abrasion and scuffing. Tailgates are often not replaced after being damaged if they are still functional, so stainless steel should lengthen the life of tailgates, arguably the most abused closure panel. The lightweight tailgate also lowers lift and closing effort. Additionally, most of the structural body repair practices prevalent in the industry are applicable to stainless steel.

Ticona is material witness to Jaguar XJ success

Celstran long fiber-reinforced thermoplastic (LFRT) from Ticona is being used in the door modules and the grille-opening reinforcement (GOR) of the new Jaguar XJ.

Use of Celstran LFRT in Jaguar cars is part of a growing trend in automotive design, according to Ticona. There are three main reasons for that, the company says. First, molded parts made from Celstran LFRT have a framework of long glass or carbon fibers for good dimensional stability and mechanical properties. Second, when properly designed, parts made from the material perform as well as metal parts and have obvious weight savings compared to steel. Third, components made from Celstran LFRT facilitate use of modular technology by enabling component integration, leading to easier assembly and manufacturing cost advantages.

With Celstran LFRT materials, nearly all semi-crystalline and amorphous thermoplastics may be used (e.g., Hostaform or Celcon acetal copolymer and Fortron polyphenylene sulfide). In this way, the specific advantages of these technical polymers—such as the inherent flame resistance of Fortron PPS—can be exploited.

Metal carrier plates in the door modules were replaced with Celstran LFRT in both the front and rear doors, allowing use of modular technology and assembly. The carrier plates in the door module component measure 1000 x 700 mm (39.4 x 27.6 in) and have a mass of about 1.7 kg (3.7 lb). Functional elements such as internal door openers and speakers are directly built into the door modules. Automold, working with Ticona engineers, selected Celstran PPGF30 X293-P11/1X (polypropylene matrix reinforced with 30% long glass fibers) for the door module carrier plates. The material has good thermal resistance in the range of -40 to +80°C (-40 to +176°F), high dimensional stability, good insulation characteristics, and high tensile strength. The door modules serve as water barriers and provide extra tensile rigidity to the entire door assemblies.

Ticona aided design, development, and evaluation work with finite element analyses (FEA), mold-flow analyses, and various strength tests. Product development work from the first drafts to prototypes took 24 months to complete. This involved extensive material tests and design improvements resulting in reduced component depth. In addition, tooling costs were significantly reduced compared to use of aluminum carrier plates in the door modules.

The GOR is a U-shaped support, 1600 mm (63 in) wide that provides attachment points for, among other things, the vehicle’s lights, radiator grille, bumper, and front wing. Automold selected Celstran PA66GF50-02-P11/14 (nylon 6/6 matrix reinforced with 50% long glass fibers) for this application. Key GOR requirements included dimensional stability, high-impact strength, and temperature resistance up to 180°C (356°F) in the engine compartment.

As part of the GOR development, its crash behavior was tested. The experience gained then was incorporated into design optimizations. In total, 40 months were invested in development down to the very last detail. Additional tasks included integrating the windshield washer fluid container into the GOR.

This article was written by Gagan Tandon and Sanjaya Fonseka, Altair Engineering Inc.; and John Tack, AK Steel Corp.
RX-8 has ‘shocking’ aluminum hood application

Kobe Steel, Ltd. and Kobe Alcoa Transportation Products, Ltd. are supplying aluminum to Mazda Motor Corporation for use in the all-new 2004 RX-8 sports car’s hood, rear doors, and suspension system.

The aluminum sheet that goes into the outer and inner panels of the hood has good press-forming qualities and high stiffness resulting from bake-hardening after painting, according to the Kobe Steel Group, which developed the material. The inner panel is of a multicone structure, developed by Alcoa. The companies say use of cone-shaped dimples press-formed on the aluminum sheet is another method to improve stiffness. The RX-8 represents the first use of a multicone structure in a domestically produced car.

Mazda has combined the multicone design with its own pedestrian-protection technologies into what it calls the Shock Cone Aluminum Hood. Pedestrian protection is provided via a large amount of space between the hood and the engine.

The aluminum sheet is supplied through Kobe Alcoa Transportation Products, Ltd., a 50/50 Tokyo-based joint venture between Kobe Steel and Alcoa Inc. As an inner door material, aluminum is difficult to form, according to Kobe Steel. The company said its technical support, through proposals for improvements using forming simulation such as FEM analysis, allowed for wide use of the material in the RX-8.

The various aluminum suspension parts are made via forging.

With the RX-8, Mazda is the first automaker to use friction stir welding for aluminum body assemblies, according to the publication Aluminum Now.

Patrick Ponticel

8 Enhanced stiffness and light weight are two advantages an aluminum multicone design, such as this one from the RX-8, has over conventional steel hoods.

Teleflex opts for plastic in adjustable pedal system

United Plastics Group Inc. has designed and manufactured an innovative plastics gear box that will be part of Teleflex Automotive’s adjustable pedal system. United Plastics says its collaboration with Teleflex signifies a growing trend to replace metal or steel gears with plastic ones.

The adjustable pedal system can be used by the driver to move the accelerator, brake, and clutch pedals closer or further away, improving comfort and safety. UPG was selected to help develop a lightweight, robust, and inexpensive gear train for the second generation of Teleflex’s adjustable pedal system.

"Plastic gears and worms have proven to be a superior alternative to metal or machined steel gears not only because they are cost-effective, but because they are quieter in operation, have more design flexibility, and are easier to interface with," said Avtar Kalsi, Senior Engineering Manager for Teleflex.

Patrick Ponticel

9 Teleflex’s second-generation adjustable pedal system uses a plastic gear box.