Weight-Saving ZF Technology for the Chassis

- Alternative materials as well as new designs and production methods save weight
- ZF has been manufacturing lightweight components in volume production for many years
- Increased use of fiber-reinforced plastics

Lightweight design is a key technology when it comes to reducing vehicle energy consumption. For the passenger car chassis, ZF Friedrichshafen AG has opted in favor of several, mutually complementing solutions: Engineering focuses on the structural optimization of components and the integration of functions. In addition, alternative materials, such as aluminum, carbon fiber-reinforced plastic (CRP) or glass-reinforced plastic (GRP) are used, and advanced production procedures are applied. Thus, the technology company reduces the weight of control arms, tie rods, suspension struts, dampers and entire axle systems.

Weight reduction in the passenger car chassis is not only an important aspect in electric vehicles where reduced weight results in an increased range and thus greater acceptance, saving weight on board has advantages in all vehicles. Fuel consumption and, in parallel, CO₂ emissions are consequently reduced in conventionally motorized passenger cars as well. At the same time, lower unsprung masses lead to greater driving dynamics and more comfort and safety. Gigantic evolutionary leaps can be made thanks to intelligent lightweight design.

Several ways to reach a target
Thus, for a single product, ZF is pooling various measures and methods for weight optimization in chassis technology. In this context, the materials used play a crucial role, such as the correct material mix. In addition to aluminum and high-strength steels, ZF increasingly uses a material mix of fiber-reinforced plastics (FRP). When designing components with this material mix, ZF engineers have to strike new paths in order to optimally harness the
maximum fiber characteristics and adapt the direction of fiber to the corresponding loads and stresses. The production-oriented component design, in conjunction with the integration of functions and structural optimization, again saves material and weight which in turn makes the approach an essential element of lightweight engineering.

For the integration of functions, several components or component functions are merged into one. Today, integrated products are already offered in the ZF portfolio. Additional lightweight potential results from the integration of functions in conjunction with alternative materials or new production methods.

**ZF lightweight technology in volume production**

Frequently ZF’s lightweight products, which range from individual chassis components to the entire axle system, feature single components that combine several lightweight measures. Even comparably low weight reductions of individual, smaller passenger car components add up for the whole vehicle and may result in significant weight savings.

SMiCA (Sheet Metal integrated Control Arm) proves that ZF is already offering mature lightweight solutions. The control arm requires no rivets or screw connections and is therefore up to 23 percent lighter than conventional sheet metal control arms. Moreover, it requires less installation space and allows for more flexibility when designing the chassis.

With the start of volume production of a lightweight brake pedal made from fiber-reinforced composite materials and injection molding, ZF outlines how about 50 percent weight can be saved compared to a standard steel brake pedal—without compromising load-carrying capacities. Fiber-reinforced composites are continuous, fiber-reinforced thermoplastics that boast extremely high material strength and rigidity and are fully recyclable.
A lightweight damper with aluminum outer tube has already been manufactured in volume production for some years. Close to volume production, on the other hand, are the ZF lightweight damper in aluminum lightweight design and the ZF lightweight suspension strut in steel lightweight design. With the aluminum lightweight damper for the rear axle, which is a monotube damper in aluminum/plastic hybrid design, it is possible to achieve weight savings of up to 25 percent. The steel lightweight suspension strut for the front axle includes both a hybrid spring plate made from steel/plastic and a hollow piston rod as well as outer tubes with varying wall strengths. The material is reinforced where it is required by the function, the other areas of the outer tube are kept as thin as possible. This results in a weight reduction of up to 20 percent.

The weight reduction in the aluminum lightweight damper as well as the steel lightweight suspension strut would not be achieved without the innovative jointing technologies that are successfully applied here.

**Lightweight design one step further**

However, the lightweight expertise of ZF does not end with the products that are mature or close to volume production today. With numerous concepts, ZF takes weight reduction in the passenger car chassis even further.

One example is the concept of a lightweight suspension strut and knuckle module. For this component, ZF uses a material mix of FRP, aluminum and high-strength steels. The ZF concept allows for weight savings of up to 40 percent and thus almost cuts the weight in half compared to conventional steel designs.

The development of a passenger car rear axle with a wheel-guiding transverse spring made of glass-fiber-reinforced plastics underpins ZF's expertise to also manufacture complete axle systems from lightweight materials. Here, weight reductions of up to 15 percent compared with a conventional steel rear axle is not the only
advantage: In contrast to the complex multilink concept, a single component – the wheel guiding transverse spring – takes on the tasks of wheel guidance as well as bounce and roll suspension. This component integration reduces the complexity of the axle, makes its installation much easier for OEM, and also saves installation space. In addition, fewer components mean even less weight.

At the ZF Composites Tech Center in Schweinfurt, Germany, the company specifically develops process technologies for the volume production of FRP materials in order to pave the way for the maturity of many lightweight concepts.

Captions:
1.) Lightweight design by integrating functions: The innovative SMiCA (Sheet Metal integrated Control Arm) requires no jointing material.
2.) The lightweight damper with aluminum outer tube has already been manufactured in volume production for some years. It is used in various M models by BMW, for example.
3.) The lightweight suspension strut and knuckle module only weigh half of conventional steel suspension struts.
4.) The wheel guiding transverse spring (green) takes on steering and suspension functions (bounce & roll damping) in the ZF lightweight axle.

Photos: ZF
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ZF is a worldwide leading technology company in driveline and chassis technology with 122 production companies in 26 countries. In 2014, the Group will presumably achieve a sales figure of more than €18 billion with about 72,000 employees. In order to continue to be successful with innovative products, ZF annually invests about 5 percent of its sales (2014: around €890 million) in research and development. ZF is one of the ten largest automotive suppliers worldwide.

In 2015, the company will celebrate its centennial. Originally named Zahnradfabrik GmbH, ZF was founded in Friedrichshafen in 1915 by Luftschiffbau Zeppelin GmbH among others. In its early years, the company developed, tested and manufactured aircraft transmissions. After 1919, the company’s focus shifted to the automotive and commercial vehicle industry under Alfred Graf von Soden-Fraunhofen, the first general manager and later head of the company. In this sector, the company registered numerous patents for innovative transmission technology and established itself once and for all as a major technology supplier. ZF grew outside of Europe in 1958 with a location in Brazil, launching a globalization drive that still continues. In addition, through product innovations and acquisitions, ZF constantly expanded its range of expertise. In 1984, ZF acquired the majority share in Lemförder Metallwaren & Co. KG, a move that extended the product portfolio to include chassis technology. In 2001, ZF took over the former Mannesmann Sachs AG to strengthen its value added product offering with driveline and chassis components. It adopted the current name of ZF Friedrichshafen AG in 1992. Today’s product range includes driveline and chassis technology such as transmissions, driveline and chassis components, as well as complete axle systems and modules. ZF products are used in passenger cars, commercial vehicles, construction and agricultural machinery, rail vehicles and marine applications. The company also focuses on the wind power and electronic components business. In addition, ZF Services represents the company on the international aftermarket. In 2014, ZF announced its intention to acquire U.S. automotive supplier TRW.

The shareholders of ZF Friedrichshafen AG are the Zeppelin Foundation, administered by the City of Friedrichshafen, holding a share of 93.8 percent, and
the Dr. Jürgen and Irmgard Ulderup Foundation, Lemförde, with 6.2 percent.

"Motion and Mobility," ZF’s tagline, clearly states the company’s core mission: Right from its foundation, ZF has developed and manufactured innovative products for all people around the globe who want to move things reliably, comfortably and safely all while experiencing the ultimate in efficient mobility. Quality, technological leadership and innovative power have always defined the company’s identity – today as much as ever.

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