Advanced High-Strength Steel 101

As automakers develop the next generation of vehicles, they’re seeking lightweight material innovations to meet evolving regulatory requirements, such as the Corporate Average Fuel Economy (CAFE) regulations in the United States. The steel industry is meeting this need through the development of new advanced high-strength steel (AHSS) grades, whose unique metallurgical properties and processing methods enable the automotive industry to meet current and future industry fuel, emissions and safety requirements, while keeping cost down.

About AHSS:

• A new generation of steel grades that provide extremely high strength and formability, which together facilitate mass reduction in vehicles. AHSS are materials whose properties are engineered by precisely controlling melting, heating and cooling processes in steel plants today.

• Each type or grade has unique microstructural features, which allow vehicle designers to use each steel where it might be best employed to meet performance demands.

• Categorized in three ways:
  
  o First-generation AHSS are ferritic and include dual phase (DP), ferritic-bainitic (FB), complex phase (CP), martensitic (MS), transformation-induced plasticity (TRIP) and hot-formed (HF). They offer improved formability over a wide range of tensile strengths compared to conventional high-strength steels;

  o Second-generation AHSS are austenitic and include twinning-induced plasticity (TWIP). They are extremely strong and formable, and can be used to provide extraordinary mass reduction for difficult-to-form parts; and

  o Third-generation AHSS are under development and expected to be ferritic or multi-phased steels with enhanced strength and formability compared to first generation AHSS.

• Used in an increasing number of automotive parts, enabling engineers to meet difficult safety, efficiency, emissions, manufacturability, durability, quality and cost requirements.

Evolution of AHSS:

- Use of AHSS has grown tremendously in the last 15 years as a result of the increased demand for vehicle crashworthiness, mass reduction and cost effectiveness.

- The global steel industry has been dedicated to researching and developing new AHSS grades and design methods through engineering projects such as UltraLight Steel Auto Body-Advanced Vehicle Concepts (2002) and FutureSteelVehicle (2011) (FSV).

- Research has enabled AHSS and its manufacturing process to continually evolve:
  - AHSS grades are becoming increasingly stronger and more formable (some are five times stronger than their predecessors and have produced parts 25 to 35 percent lighter than previous steel parts);
  - Manufacturers have developed methods, such as tailor rolling and tailor welding, to avoid unnecessary or redundant mass in vehicle structures by enabling engineers to place the strength exactly where needed;
  - Due to steel research under FSV, engineers have use of new design methods which can optimize multiple parameters. For example, the ability to simultaneously select the best combinations of strength, thickness and part geometry, as well as cost and carbon footprint; and
  - According to the FSV project, new grades offer increased mass reduction for the body-in-white (BIW) that is on par with the mass reduction potential of aluminum.

- Independent automotive studies predict 50 percent of the average BIW will be converted to AHSS in this decade; proposed CAFE regulations have the potential to further boost AHSS use.

Future of AHSS:

- The steel industry is committed to the automotive market. The range of organizations working to advance AHSS includes steel companies, universities, national labs, customers and suppliers. Steel companies invest hundreds of millions of dollars annually in the capital equipment for the production of AHSS.

- Research, emphasizing joining and forming of AHSS, enables increased use of optimized lightweight assemblies.

- Future initiatives include communicating the advantages of AHSS to the many stakeholders who benefit from its use, and developing and fostering broad partnerships for the future growth and acceptance of AHSS.

# # #