

Detroit **MATERIALS**



Light Weighting With Advanced High Strength Steel Castings

Detroit Materials designs the strongest commercially available low alloy wrought steel

By Pedro Guillen and Nick Moroz

Light Weighting With Advanced High Strength Steel Casting

Lightweighting is now a major trend in the transportation space, especially as it pertains to commercial vehicle. Mass reduction is a priority for heavy duty and off-highway vehicle manufacturers. The mass reduction of vehicle systems improves fuel economy and increases vehicle cargo capacity thus improving operational efficiency of the vehicle operator, increasing revenue potential.

The U.S Department of Energy 2013 industry workshop report "Trucks and Heavy-Duty Vehicles Technical Requirements and Gaps for Lightweight and Propulsion Materials" highlighted industry's perspective on material requirements for trucks and heavy-duty vehicles. Key personnel from commercial vehicle OEMs and suppliers supported the workshop. The report suggests the value of lightweighting for commercial vehicle to be at \$3.5 per pound.

Detroit Materials (DM) has developed the strongest commercially available wrought low alloy steel to address vehicle lightweighting demands, particularly for drivetrain and suspension components. Detroit Materials introduces a series of uniquely thin wall castable steels providing unmatched cost competitive weight savings solutions.

Mechanical Properties and Cost Comparatives

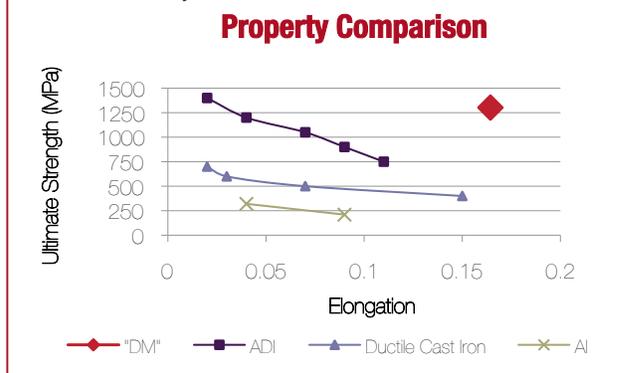
Commercial vehicle manufacturers are investigating low-density materials, such as aluminum, carbon fiber and other composite materials to reduce component weight by displacing steels. These materials can

provide optimal solutions for specific applications where packaging space or cost is not an issue.

“Detroit Materials has produced the strongest commercially available low alloy wrought steel”

These low-density materials severely limit design options and component application due to extreme tradeoffs between material density, strength, ductility, modulus, stiffness and cost.

DM Steel provides the best combination of strength and ductility of commonly used high performance cast materials such as ADIs, Ductile Cast Irons and Aluminum Alloys.



Important material property considerations for heavy truck cast components are high tensile strength, high elongation, and the ability to cast thin wall sections and complex geometries.

Typical materials for suspension and drivetrain cast components are aluminum alloys, ductile cast iron and Austempered Ductile Iron (ADI).

DM Steels offers the performance advantages of an exotic-alloy steel with the ability to cast thin wall section and complex geometries.

Aluminums, such alloy A356 T6, allow for the successful casting of thin wall sections. Still, aluminums are low-strength materials with limited ductility, especially as compared to ferrous castings. Ferrous castings, such as ADI and ductile iron, offer acceptable elongation but only at strengths below 750 and 500MPa. When requiring tensile strengths above 1000 MPa and elongations above 12% only DM delivers.

“DM steel offers the performance advantages of an exotic-alloy steel with the ability to cast thin wall section and complex geometries.

In order to gauge the true lightweighting potential of a material, specific strength (strength per unit volume) and specific strength per dollar provide a real material comparisons. Materials should be evaluated on performance per cost basis, not weight per cost basis. Comparisons of specific strength are far more accurate, particularly when comparing ultra-high strength materials, and by this metric DM steels stand above the competition.

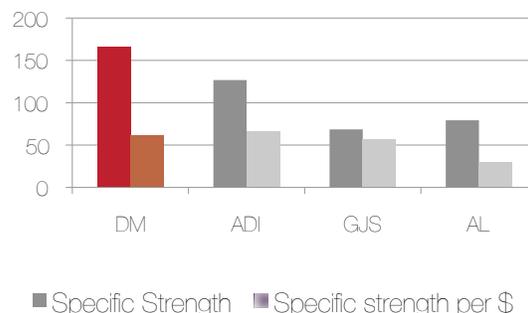
In addition to our steel excellent properties the steel exhibits very good fluidity allowing for the casting of sub 3mm wall sections and complex shapes.

Conclusion

DM steel offers the performance advantages of exotic-alloy steels (**1300MPa UTS, 16% Elongation**) with the ability to cast thin wall section (**3mm wall**) and complex geometries at comparable cost per performance than ADI and GJS ductile irons.

DM Steel provides the highest specific strength of common chassis and drivetrain casting materials, at a comparable performance per dollar than ADI and cast iron.

Common Casting Material Comparison



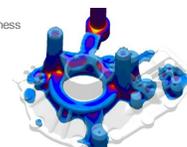
This is a truly remarkable result that can offer superb lightweighting options for many casting applications. Detroit Materials steel is stronger and more ductile than any other commercial low alloy casting material, ferrous or otherwise.

Case Study – Thin Wall Steel Casting

Detroit Materials delivers AHSS wrought steel capable of 3 mm wall with tensile strength over 1300MPa/190ksi and 16% elongation



- ❑ **Problem**
 - ❑ Current steels are difficult to cast requiring 6 to 12 mm sections
 - ❑ **Challenge:** Cast 3mm wall section parts with ultra high strength materials
- ❑ **Approach**
 - ❑ Refine proprietary chemistry and heat cycle to achieve required fluidity
 - ❑ Complete solidification simulation to optimize casting process
- ❑ **Solution**
 - ❑ DM Thin Wall Casting
 - ❑ Sound Casting
 - ❑ Complex section transition
 - ❑ 3mm-25mm section thickness
 - ❑ sharp isolated corners
 - ❑ Mechanical Properties (ave.)
 - ❑ UTS 1300 MPa
 - ❑ YS 1049 MPa
 - ❑ Elongation 16.4%



DM Wrought

General Product Description

- DM Steels are wrought materials available for demanding applications.

Mechanical Properties

	YS (MPa)	UTS (MPa)	EI (%)	Modulus (MPa)	HRC
DM 800-15	469	809	15	228,190	12
DM 1300-16	1049	1302	16.4	229,246	35

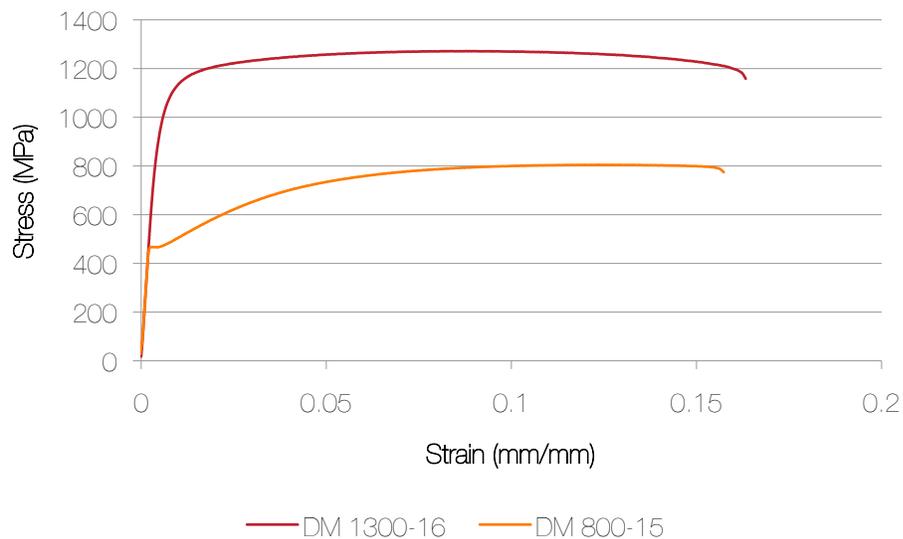
Mechanical Testing

- Brinell hardness test according to ASTM E10 on each heat.
- Charpy impact test according to ASTM E23 on each heat.
- Tensile test according to ASTM E8 on each heat.

Delivery Condition

- The delivery condition is annealed and/or proprietary heat-treated.

Mechanical Data



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Detroit Materials' business is to commercialize next generation materials.

Founded in 2013 on the with the sole purpose of develop and commercialize ultrahigh performance materials.

Who we work with

We work with OEM and Tier 1s interested in ultra high strength materials. We work with Foundries interested in seeking differentiating materials looking to improve financial return.

What we do

We provide companies with lightweighting and high wear solutions.

Investor Relations

Detroit Materials is a venture-backed company, with support of Detroit Innovate—an early stage venture fund in southeast Michigan. DM is to complete pilots for commercial vehicle military and mining applications.

Validation is expected to last until December 2014 and the pilots to commence between Q4 2014 and Q1 2015. Additionally, DM has been awarded a Phase I NSF Advanced Materials grant. The DM team is seeking Strategic Partners to deploy pilot programs. If interested in learning more, please email Pedro Guillen at pjg@detroitmaterials.com.

Detroit Materials, Inc

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