Examining The Latest Advancements In The Use Of Aluminum Extrusion In Lightweighting
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Rob Nelson
Director of Sales, US
rob.nelson@almag.com
www.almag.com

Joe Gibson
Vice President, Business Development
jgibson@taberextrusions.com
www.taberextrusions.com
While Aluminum has had a long steady increase in auto usage, extrusion – particularly extruded shapes – is only recently gaining momentum.

Source: The Aluminum Association, Ducker Worldwide
### INTRODUCTION

Structural applications are expected to drive Extrusion use

#### Aluminum Extrusion Pounds per Vehicle

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
<th>2012</th>
<th>2017</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shapes</td>
<td>Interiors, Seats, Trim, Sunroof, Others</td>
<td>1</td>
<td>1.2</td>
<td>2</td>
</tr>
<tr>
<td>Shapes</td>
<td>Exterior</td>
<td>3</td>
<td>3.2</td>
<td>4</td>
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<td>Bumpers</td>
<td>4</td>
<td>5.5</td>
<td>6</td>
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<tr>
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<td>Body Structures</td>
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<td>4</td>
<td>17</td>
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<tr>
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<td>Steering &amp; Brakes</td>
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<td>3</td>
<td>4</td>
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<tr>
<td>Tube</td>
<td>Drive Shafts</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Rod &amp; Bar</td>
<td>Transmission</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
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<td>Mounts</td>
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<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Tube</td>
<td>Heat Exchangers</td>
<td>5.3</td>
<td>5.3</td>
<td>5.5</td>
</tr>
<tr>
<td>Shapes</td>
<td>Suspension / Links / Chassis</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25.3</td>
<td>31.7</td>
<td>49.5</td>
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</table>

**Incr. in #/yr* %**

<p>| | | | | |</p>
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<thead>
<tr>
<th></th>
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<td>15mm</td>
<td>67%</td>
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<tr>
<td>15mm</td>
<td>25%</td>
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<td></td>
</tr>
<tr>
<td>9mm</td>
<td>9%</td>
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<tr>
<td>234mm</td>
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<td>18mm</td>
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<tr>
<td>18mm</td>
<td>50%</td>
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<td>318mm</td>
<td></td>
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</tbody>
</table>

Source: Ducker Worldwide
INTRODUCTION

Engineers are increasingly familiar with the key extrusion design variables:

1. Alloy selection and modification
2. Geometry, or Profile Shape
3. Tolerances
4. Fabrication/Joining
Since 1953, ALMAG has built a reputation as an industry leader in extruding complex, thin-walled, high-visual, custom aluminum extrusions.

Pushing the limits of industry standards, ALMAG provides 4 pillars of service; DESIGN, EXTRUDE, FABRICATE and FINISH.

PRIMARY INDUSTRIES – Automotive, Healthcare, Lighting and Office Furniture.

ISO 9001 – 2008 Certified
Brampton Ontario is ALMAG's primary manufacturing and distribution location. Now more than 100 times its original size, Brampton encompasses 3 buildings with a total size of 175,000 square feet.

Ardmore Alabama, our 30,000 square foot facility was established in 2011 and primarily services fabrication and warehousing for key ALMAG Customers.

North American Distribution.
EXTRUSION PRESS
CAPABILITIES
FABRICATION & FINISHING

- PUNCHING
- PIERCING
- CNC MACHINING
- BENDING
- WELDING
- FORMING
- ADHESIVE BONDING
- ALODINING
- E-COATING
- POLISHING
- BRITE DIP
- ANODIZING
- WET PAINT
- POWDER COAT

Window Application 0.0185" Wall
Lighting Application 17:1 Tongue Ratio
Shade Application
Roll up Fire Truck Door - High Visual
Store Fixture
Lighting Application
COMPLEX SHAPES

Die and Extrusion technology is evolving

- Multiple hollows
- “Put the material where it is required”
- Thin wall
TIGHT TOLERANCE

Extruders know what is required
Standard vs Precision Tolerances
Stronger alloys without compromising tolerance
The Circuit™

Gear Traction Drive (GTD)

- All wheel drive and all wheel control
- 250hp Electric Motor controls each wheel
- Circularity
- Concentricity
- Hole Dimensions
HIGH VISUAL and LIGHTWEIGHT

• 1/3 the weight of Steel
• Features can be optimized
• Achieve excellent surface finish without secondary processing
• Many different coating applications
LIGHT BAR

- Complex bending operation
- Convex plain
- Thermal shedding allows maximum lumen output for off-road racing/driving
- Bend into heat sink
Extrusion is stretch bent over a form

Material – 6360 T6

Increased Thermal Conductivity
Good Machining
Tight tolerances
About Taber

Part of National Material, LP.

Product Offering:

- Carbon and Electrical Steel Processing and Distribution
- Stainless and Alloys
- Raw Material Trading and Distribution
- Aluminum Extrusion & Fabrication
- Other Operations

Customers:

- Boeing
- Rolls Royce
- General Dynamics
- BAE Systems
- Northrop Grumman
- Tesla
- Lockheed Martin
- Toyota
- Honda
- Ford
- Eaton
- Chrysler
- Powerware
- John Deere
- Valmont
- Emerson
- Pratt & Whitney
- ALUMINUM EXTRUDERS COUNCIL
About Taber

Taber Extrusions (Russellville, Arkansas and Gulfport, Mississippi)

- Casthouse
- 3 Extrusion Presses: 1800 ton to 8600 ton
  - Rounds: 7”, 9”, 11”, 16”, 20”
  - Rectangular: 10” x 28”
- 2XXX, 5XXX, 6XXX and 7XXX alloy series
- Various Fabrication and Value Added Manufacturing Processes
About Taber

Typical Products

- Wide & Heavy Profiles
- Marine Grade 5000 Series
- Armor Grade 5000 Series
- Various Extruded 5000 Series Components
# 5XXX Alloys

While 6xxx and 7xxx are frequently used in Auto applications, we’ll explore 5xxx.

<table>
<thead>
<tr>
<th>Series</th>
<th>Major Alloying Elements and Alloy Characteristics</th>
</tr>
</thead>
</table>
| 1000 Series | **Minimum 99% Aluminum**  
High corrosion resistance. Excellent finish ability. Easily joined by all methods. Low strength, poor machinability. Excellent workability.  
High electrical conductivity. |
| 2000 Series | **Copper**  
| 3000 Series | **Manganese**  
Low to medium strength. Good corrosion resistance. Poor machinability. Good workability. |
| 4000 Series | **Silicon**  
Not available as extruded products |
| 5000 Series | **Magnesium**  
Low to moderate strength. Excellent marine corrosion resistance. Very good weld ability. |
| 6000 Series | **Magnesium & Silicon**  
| 7000 Series | **Zinc**  

**Today’s Focus**
5XXX Alloys

5XXX Alloys used at Russellville and Gulfport plants

<table>
<thead>
<tr>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>5456</td>
</tr>
<tr>
<td>5454</td>
</tr>
<tr>
<td>5086</td>
</tr>
<tr>
<td>5083</td>
</tr>
</tbody>
</table>

Composition as Max unless shown as a range.

- 5XXX series alloys are **non-heat-treatable**, and derive their strength from addition of Mg (up to 6 wt.%) Mn (up to 1 wt.%) and Cr (up to 0.2 wt.%).
  - Mg – corrosion resistance
  - Strength – added by cold working the material
- Most widely used shipyard alloys are 5086, 5083 and 5456 for excellent combination of strength, corrosion resistance and weld ability.
- Excellent Mechanical Properties after welding, and better corrosion with high strength in 5456 are extensively used in marine grade application.
5XXX Alloys

Extrusion Versus Rolled Plate: 5083 Series

- Similar Mechanical properties
  - Standard Rolled or Plate
    - 5083 H131: 335 MPa UTS ; 250 MPa yield – 8% min elongation.
    - 5083 H116: 317 MPa UTS ; 230 MPa yield - 17% min. elongation
  - Extrusion:

<table>
<thead>
<tr>
<th>5XXX alloy/ Temper Mechanical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>5083-O</td>
</tr>
<tr>
<td>5083-H111</td>
</tr>
<tr>
<td>5083-H112</td>
</tr>
<tr>
<td>5083 Cl I</td>
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</tbody>
</table>

- Benefits of Extrusions versus Rolled Products
  - Material Savings-Near next shape versus standard rolled shapes
  - Increased Productivity of machining or downstream manufacturing operations
  - Tooling is less expensive and has shorter leadtimes
5XXX Alloys & Laser Welding

The Process

- Laser beam generator
- Beam-directing optics to transport the beam to the work and focus it to the required spot size and power density
- Workstation containing work piece handling equipment that may feature manual or automatic loading and unloading

Advantages of Laser Welding with 5083

- The process exhibits good repeatability; is easy to automate.
  - Typical travel speeds for production laser welding processes range from 40 to 400 inches per minute (IMP)
- The deep penetration characteristic of laser welds usually allows single-pass welding and generally does not use filler material.
- A high-power laser welding assembly system allows the manufacturer to join similar and dissimilar materials, and stocks of different thickness that results in a high integrity weld with minimal heat affected zones (HAZs).
  - The high travel speeds used in laser welding minimize diffusion of heat into the surrounding metal. Therefore, heat affected zones (HAZs) are narrow, and because the laser welding process uses minimum heat input, distortion is maintained at a minimum.

Fig 1: Possible quality problems in fusion welds

- Courtesy: fig 1 Robert Dean