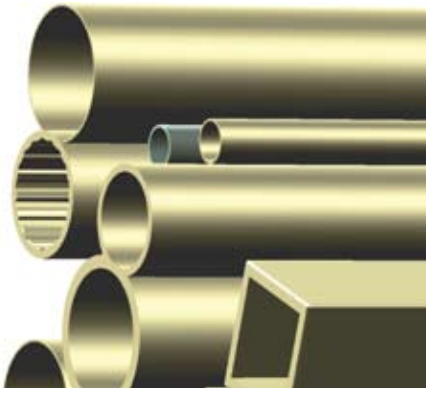
Mg Showcase

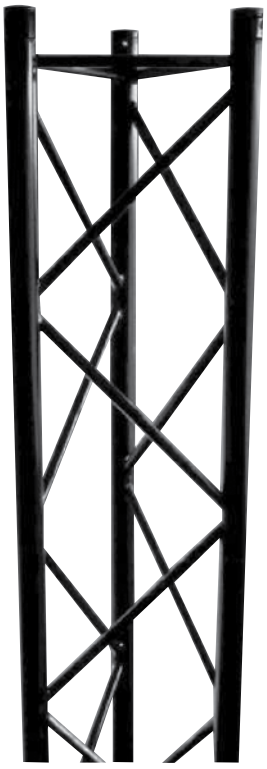
Magnesium Extrusions Optimize Lightweight Strength

Magnesium is increasingly chosen by design engineers as the lightweight metal option that retains rigidity and strength needed for structural applications. Magnesium alloy extrusions offer the structural strength benefits of their aluminum counterparts at a 25 to 30 percent weight savings. Lowering weight directly impacts transportation and energy costs, manpower needed for assembly and use, and load requirements for structure supports. Extruded magnesium alloys offer high mechanical strength and performance while being the easiest structural metal to machine, giving manufacturers better ways to design innovative products for highly competitive markets.



Magnesium is extruded in a wide array of solid, hollow and semi-hollow profiles, offering structural design options at lower weight than aluminum. © Photo courtesy of E12 Magnesium Corp. Used with permission.

Magnesium Trusses Give a Command Performance



Morgo Magnesium Ltd., Zutphen, The Netherlands, makes extruded magnesium tubes to produce truss structures that are used in theaters to house lighting and sound system equipment. Using magnesium allows Morgo to design these truss towers at 25 percent less weight than with aluminum. The truss system's connectors are also turned from extruded magnesium fullbar. This wider magnesium truss structure achieves the same strength and stiffness with less weight than a narrower design in aluminum.

Morgo Magnesium CEO Mark Wemmenhove outlines the truss design's advantages: "Lower weight reduces our costs to transport the components. The truss construction is much easier to build, which is an important factor in Europe where strict labor laws limit the weight an employee may carry. In many theaters, truss towers are connected to the ceiling to house lighting, speakers and sound equipment in boxes. The maximum ceiling load is a critical specification; in some cases, you can use more equipment and cables on these trusses before you reach the maximum ceiling load."

The finished truss structure dimensions are 3000 millimeters (mm) long, by 500mm wide on each side. Morgo Magnesium extrudes the magnesium tubing and does full production of the truss sections including the milling, turning, sawing, and welding. A special chrome-free pre-treatment is done, and a powder-coat paint finish is applied to the truss tubing.

This super-light, yet structurally strong extruded magnesium tube truss tower is fastened to theater ceilings to house and protect sensitive lighting and sound equipment. © Photo courtesy of Morgo Magnesium Ltd. Used with permission.

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Magnesium's structural properties make it a durable choice for this industrial ladder. © Photo courtesy of Morgo Magnesium Ltd. Used with permission.

Magnesium Ladders are Heavy-Duty Standard Equipment

Morgo Magnesium fabricates heavy-duty industrial ladders from extruded magnesium profiles that are designed to support a maximum load 150 kilograms. Substantial weight reduction is achieved using a slightly wider extrusion profile without making thicker tubing. The total ladder including all components is 30 percent lighter than a comparable aluminum ladder. The magnesium profiles are sawed and milled in-house. Pre-treatment and painting are done after extrusion, prior to assembly with special rivets.

The magnesium ladder is manufactured to be bigger than standard ladders for heavy-duty use in factories and on building and construction sites. Workers rely on magnesium's structural strength to support themselves and their tools and equipment through strenuous daily use on the job. Strength and durability in a ladder of this type not only gets the job done, but offers a stable structure that supports workers safely.

Workers rely on extruded magnesium ladders to safely handle heavy load requirements while retaining lightweight portability. © Photo courtesy of Morgo Magnesium Ltd. Used with permission.

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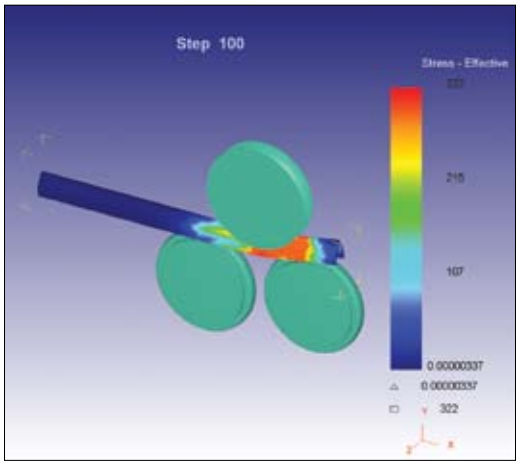
Green Revolution: Magnesium Extrusions are Recyclable and Eco-Conscious

Fully recyclable extruded magnesium bicycle wheel rims allow manufacturers to produce an eco-friendly bike without sacrificing strength or lighter weight. © Photo courtesy of E12 Corporation. Used with permission.

As featured in *Mg Showcase Issue #4*, magnesium alloy extrusions are the norm for making cutting-edge bicycle wheel rims that are stronger and lighter than the competition. In Taiwan, the E12 Magnesium Corp. extrudes proprietary magnesium wheel rims for top bike manufacturers.

E12 CEO Mondher Latiri says, "E12 and our customers are intensely focused on producing superior and affordable products with a genuine concern for the environment. It is no longer sufficient to just produce bike components that are stronger and lighter, they must also be greener and more affordable. Magnesium fits the bill on all counts! Meeting this environmental challenge and consumer expectations requires us to invest in and develop our extrusion capability using the latest advances in magnesium metallurgy and process technologies."



This simulation shows stress and strain rates during rim extrusion. © Graphics courtesy of E12 Magnesium Corp. Used with permission.

Extruded Magnesium Bicycle Stem Stays the Course

Morgo Magnesium produces an extruded magnesium bicycle stem containing a multitude of complex machining, which connects the bike's front fork to the handle bars. After extrusion, the stem is milled, drilled and tapped for use on racing and mountain bikes.

The solid magnesium bicycle stem extrusion is machined out of magnesium alloy AZ80, and then receives a pre-treatment and a ceramic paint layer prior to assembly. © Photo courtesy of Morgo Magnesium Ltd. Used with permission.

The magnesium stem extrusion, located between the fork and handlebars, is critical to absorbing vibrations at the front of the bike for a smoother ride and better control. © Photo courtesy of Morgo Magnesium Ltd. Used with permission.

According to Wemmenhove, the stem's stiffness and high damping capacity are the key benefits of using magnesium: "Overall stiffness, plus the stiffness-to-weight ratio (STW) and reduced weight for this part are much better than for carbon stems. Magnesium has a very high damping capacity, incomparable among other materials."

The finished magnesium stem extrusion is available in various sizes in 10mm increments from 80mm to 140mm. Because magnesium alloy extrusions have a low modulus of elasticity, they absorb energy elastically. The rigid, high-strength magnesium bike stem extrusion, with its superior vibration dampening, is critical to bike performance on rough terrain. The magnesium stem's lighter weight makes the bike easier to steer and control.

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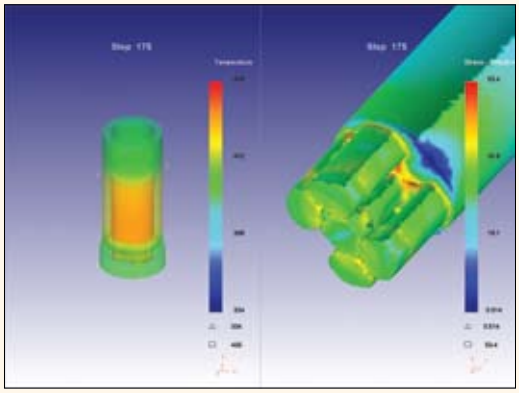
A Closer Look: Magnesium Extrusion

The magnesium extrusion experts at Morgo Magnesium Ltd., The Netherlands, use a process to extrude magnesium alloys that is similar to aluminum extrusion. Magnesium alloys ZM21 and AZ31 allow the highest extrusion speed, whereas alloys such as AZ80, ZK60 and WE54 require an extrusion speed that is up to ten times slower. Morgo utilizes direct extrusion without a lubricant, heating cylindrical ingots to 300°- 400° Celsius and pressing them through dies with manifold cross-sections.

This method of magnesium extrusion achieves the non-porous microstructures with clean metallic surfaces that are critical for high-tech materials and specialized customer requirements. Extruding with magnesium alloys allows an expanded level of design freedom, incorporating special shapes and cross-sections that maximize magnesium's ductile capabilities. Solid extruded profiles are separated into full rods, flatbars and shapes without embedded planes, while hollow extrusions include one or more enclosed cavities or bay regions. To prepare magnesium extrusions for use as structural components, extrusions may undergo stretching and special heat treatments that maximize strength properties beyond their initial fabrication state.

The minimum wall thickness for small to medium-sized magnesium profiles is determined by the alloy used. For example, magnesium alloy ZM21 reaches a minimum wall thickness of about 1mm. In a complex magnesium extrusion, wall thickness in a multi-wall extrusion with ribs, flanges, bosses, slits, and indentations are incorporated into a new design in order to optimize the product's mechanical properties. Custom, standard and seamless extruded tubing, bars, rods, and multi-void hollow shapes are available in circle sizes ranging from 15mm to 360mm.



Simulation of the magnesium hot extrusion process. © Graphic courtesy of E12 Magnesium Corp. Used with permission.

"Extruding with some magnesium alloys is possible using standard aluminum extrusion dies with a minimal amount of die corrections, making magnesium extrusion an economical option. Optimal die value is achieved by investing in only one die for extruding in both aluminum and magnesium," notes Morgo CEO, Mark Wemmenhove.

At E12 Magnesium Corporation, CEO Latiri emphasizes that magnesium alloys are as easy to use for the extrusion process as seven-series aluminum alloys, and offer comparable strength-to-weight ratio to justify any added cost compared to 6-series aluminum alloys. "The distinction is even more relevant where weight reductions and low inertia are key design criteria. Carbon composites, while attractive on paper are not recyclable and do not offer the design precision and manufacturing flexibility that is readily available with magnesium."

Solid, hollow and semi-hollow magnesium alloy extrusions are available in many sizes and finishes. © Photo courtesy of E12 Magnesium Corp. Used with permission.

E12 Corp. is able to achieve tight tolerances in its extrusions without sacrificing productivity. According to Latiri, magnesium may be extruded to yield specific mechanical properties as a function of the alloying elements, process parameters and thermal treatment. Magnesium extrusions achieve a fine-grained structure with good elongation that has the ability to improve structural strength by more than 30 percent above standard ASTM International specifications. Another characteristic of magnesium extrusions is their consistently good surface finish.

Latiri recognizes the importance of magnesium as a catalyst for innovation, "At E12, we believe strongly in magnesium's potential as an extrusion alloy for structural applications. We work in partnership with our customers, trying new ideas to achieve design performance and added value. The work we've done so far across a broad range of applications and industries has met or exceeded expectations. At E12, magnesium extrusions as light as 50 grams per meter have been produced for mission-critical aerospace applications."

Magnesium alloy extrusions are increasingly being specified for automotive, transportation, electronics, aerospace, and general engineering applications. Magnesium has the ability to combine high strength and lighter weight with the design versatility of the extrusion process, providing a platform that will shape and drive groundbreaking product designs and manufacturing innovations.

To learn more about the benefits of designing products with magnesium, contact the
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