INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Racing bikes – steel's great comeback?

Advanced steels and frame designs may now be heralding a new age of racing bicycles. A UK-based racing team has brought steel frames back into the professional bicycle racing circuit. These new frames utilize high-strength, molybdenum-alloyed maraging steel.

The 100th running of the Tour de France took place in 2013. The first eighty or so editions were almost exclusively the domain of steel-framed machines. Despite the adoption of new materials such as aluminum, titanium and carbon fiber in the past thirty years, steel may be about to make a comeback thanks to advanced alloying and processing, resulting in astonishing material characteristics. Steel remains the material of choice for many other types of quality bicycles as well, such as mountain and city bikes where durability is of prime importance.

The frame

The frame is the core of any bicycle. Ideally, it is the result of the "perfect marriage" of material and design. However, its performance is a compromise between different, and sometimes conflicting, requirements. The relative importance of each depends on how the bike is to be used. These requirements include torsional stiffness, so the rider's effort isn't wasted in bending the frame sideways as he pedals rather than using that energy to progress forward; vertical stiffness, which if too great will make the ride uncomfortable; weight, aerodynamics, durability and, of course, cost. ›

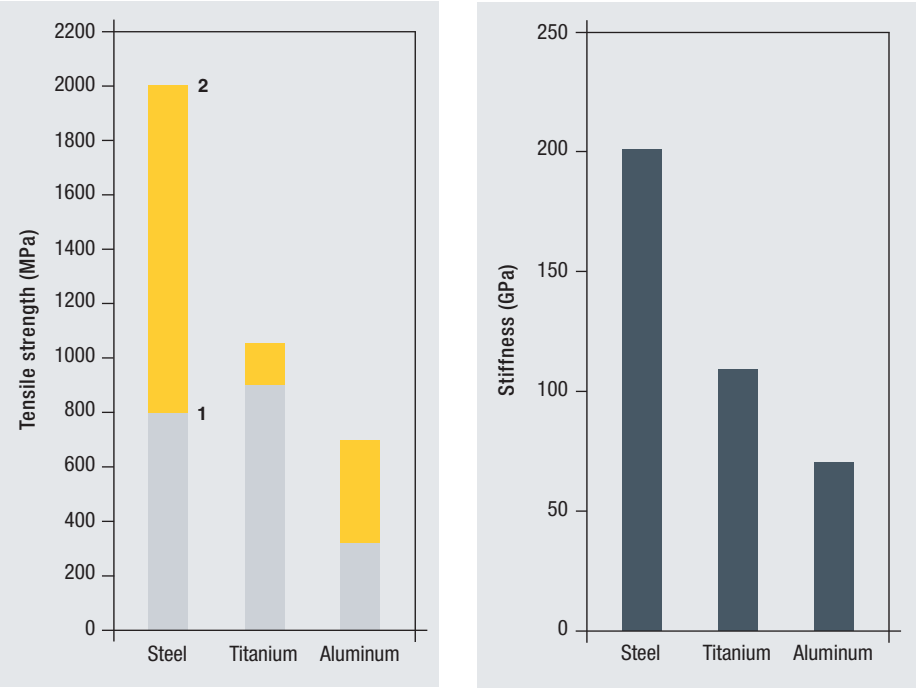
Steel is making a comeback in professional bicycle racing. © Andy Jones/Cycling Weekly

Toward the end of the glory days of steel frames on the European professional circuit (the early to mid-1980s), artisan frame builders were doing great things with design to get the best overall result. Tubes had long been butted, a process whereby the wall thickness is increased where the stresses are greatest, and reduced to save weight where they are low. By the 1980s, tubes were also being produced in “non-circular” shapes to provide asymmetric properties. The builders even adopted internal helical stiffeners so the wall thickness could be further reduced.

Frame material development

In addition to improving the design of the tubes, bicycle makers used various alloys over the years, including molybdenum-containing steels. In steel, molybdenum is beneficial for strength and toughness, as well as for a number of other properties. For the racing cyclist, who has always sought minimum weight to save energy when struggling over mountain passes, higher strength means thinner tube walls. And good toughness means those thinner-walled frames will not break easily.

Developments in steel-frame tubing continue to this day, with specialist frame builders delivering unbelievable works of art with outstanding performance. Through the use of molybdenum and various other alloying elements, combined with sophisticated manufacturing processes, tube manufacturers have now produced a frame material having strengths reaching 2,050 MPa. This is over three times that of the steel used in buildings and bridges. This “maraging steel” gets its exceptional strength from two mechanisms, the well-known martensite reaction and a precipitation-hardening reaction utilizing molybdenum.



Bicycle frame materials with their typical range of tensile strengths in yellow (left) and their stiffness (right). The actual tensile strength depends on the alloy, the cold drawing method and the heat treatment. For steel it ranges from 1) cold-drawn chrome moly steel (1% Cr, 0.2% Mo) to 2) maraging stainless steel (12% Cr, 1% Mo).

This strength is nearly three times that of the strongest aluminum used for bicycle frames, and the alloy’s stiffness is three times that of aluminum. These properties make a wall thickness of less than 0.5 mm, even as low as 0.3 mm (!) possible. Using less material means that, despite its higher density, steel can be used to produce a frame of similar weight as one in aluminum or titanium. Whilst a carbon fiber-reinforced plastic frame may be 15% lighter, it is widely recognised that it is less durable and will not provide the same “ride quality” for the discerning cyclist. Costs vary depending on the quality of the frame, but it is fair to say that steel will generally be the least expensive, and titanium or fiber-reinforced plastic the most expensive option.

The future

Madison Genesis, a UK-based team is currently taking steel back to the professional circuit, working with Reynolds tubing on maraging stainless steel frames with up to 1.25% molybdenum. Being able to compete in the most important event of the year (the Tour of Britain), and a national championship win, have persuaded them to expand their efforts in 2014. So top-end steel, which for so long ruled the roost of professional cycling, returns to the pinnacle of technical development. It is now able to prevail against its more fashionable competitors thanks to the contribution of molybdenum. (Graham Couchman)