Long coils of steel become the small but ever-important elements that hold structural steel buildings and bridges together.

Whole Lotta Bolts

STORY AND PHOTOS BY GEOFF WEISENBERGER

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ST. LOUIS SCREW & BOLT (SLSB) no longer makes screws. But they make plenty of bolts—about 7,500 tons per year.

But in the beginning, they made neither.

The company, which began in 1887, started off making smaller, hot-forged parts such as door hinges. Over the decades, it gradually moved into structural fasteners. And in 2006, it moved from a very old, outdated facility in St. Louis to a 125,000-sq.-ft facility across the Mississippi River in Madison, Ill.

"We went from one loading dock to 15 and from four bolt-makers to 11," says Garland Parker, the facility's general manager.

All bolt manufacturers have their own way of doing things—in terms of equipment, distribution, inventory, testing and packaging—and a recent visit to SLSB provided one example of how the process can work.

The facility produces structural bolts ranging from ½ in. to 1½ in. in diameter for projects worldwide, though approximately 80% of

▲ Steel coil, ready to go.

▼ As it arrives in the machine, it is sheared to length.

▲ Coil being fed into the bolt-maker.

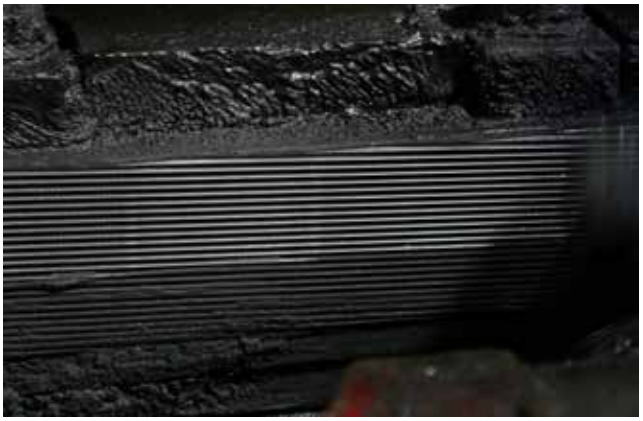
▼ Kick-out tooling helps move the bolts through the forming process.

▲ Shear, shank, head, hex-head.

▼ Bolts are zipped along this die for threading.

▲ In line, waiting for threading.

▼ Completed bolts, ready for heat-treating.



Steel coil, in rolls, waiting to be turned into bolts.

SLSB's business is domestic. (In addition, it is the leading provider of weathering bolts.) For a long time, the company was mostly focused on bridge projects, but in recent years it has targeted buildings, though bridge projects still account for approximately 40% of SLSB's bolts.

The company is also associated with Haydon Bolts and JH Botts, which produce anchor bolts and specialty bolts, and the three entities complement each other's capabilities and assist one another with production as necessary.

Hammering it Out

SLSB's Madison facility is divided into three sections: manufacturing, packaging and inventory. The 42,000-sq.-ft manufacturing portion is where steel coil, ranging from ½ in. to 1½ in. in diameter, is transformed into heavy-hex structural bolts. Bolts are produced and stocked to service fabricators' needs.

The coil, made by domestic producers, arrives in two-ton spindles, which are stored until they are ready for production. It takes several steps to turn coil into bolts, all of which happen in one machine, the boltmaker. The coil is first hung onto a spindle then fed into the machine. From here, the coil is sheared to length then struck by a series of heads. The first compresses a portion of the coil section into a shank—the unthreaded portion of the bolt—the second creates a round head and applies grade and manufacturer's marks and the third cuts the head into a hexagon (the scrap from the cut falls into a bin and is later recycled). It's not the speed with which the heads strike the coil but rather the pressure that's applied: 100 to 700 tons depending on the bolt size. At full speed the heads are a blur, but the machine can be slowed down to get a better glimpse of the process.

From here, the bolts are queued before being threaded. They are spun at a speed of 48 to 120 parts per minute—again, depending on bolt size—through the thread die and come out looking like a final product, though they still need to be heat treated, coated, lubricated and tested.

A hexagonal punch-out, which becomes scrap.

A recent acquisition, this machine will be modified to create structural bolts.

A view of the kick-out tooling from the exterior of the machine.

▲ Shrink-wrapping.

▼ Preparing a bolt for tensile testing.

▲ The custom packaging and staging area.

▼ A break in the root of the thread or transition area is the desired outcome of the wedge tensile test.

The speed at which the bolts are produced depends on the machine; some can create 60 bolts per minute, others can do 90. The number of bolts that can be produced on one die or set of dies also varies. SLSB's manufacturing manager Bill Schuler explains that dies typically break due to improper use or maintenance, and the company retools or replaces them as necessary.

The bolt-making machines themselves also vary based on size, age and setup—and they are built to last. SLSB's oldest bolt-maker dates back to the 1930s and the newest one was manufactured in the 1980s. The company keeps an eye out for when machines come on the market, sometimes even traveling abroad, and assesses them to see if they're worth purchasing for additional production, parts or future use. Older machines are overhauled or modified as necessary for shop use. And this is one area where SLSB is especially lucky to have Schuler around.

"We purchased a machine and brought it to the shop, and Garland asked me what I was thinking," said Schuler. "I told him I could have it up and running in two weeks. He didn't believe me, but two weeks later it was ready to go."

The shop's newest bolt-maker, which it purchased in 2013, is another example.

"The machine weighs 300,000 lb," explains Parker. "It was being used to make auto parts in Michigan, and we modified it to create structural bolts. There were only four of those machines made."

When it comes to nuts, the company purchases these from Unytite, Inc., a domestic leader in the production of structural nuts and key parter to SLSB, Haydon and JH Botts (see the "Hot and Cold" sidebar for more on the nut-making process). SLSB also contracts galvanizing—about 50% of their bolts end up being galvanized—and heat-treating services to other companies as well. (Heat treatment is performed to get the bolts to the proper hardness range; they are heated, quenched in oil and tempered to the specified range.)

In the Keg

After the bolts are produced and sent out for coating, heat treatment and lubrication, they are packaged in the

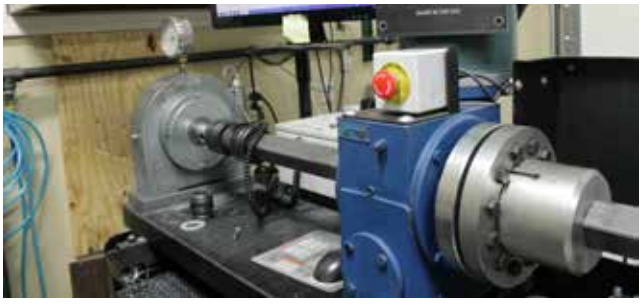
▼ Testing for elongation.

▼ Testing for hardness.

▼ Proof load testing.

▲ A wet saw is used to cut the bolt for testing.

▼ The rotational capacity testing machine.



Hot and Cold

Of course, bolts need nuts (and washers) in order to be useful. Unlike cold-formed bolts, most nuts are hot-formed, and they are typically made from bar as opposed to coil. A bundle of steel is loaded on a bar rack system that automatically feeds the steel into the induction system. The steel is heated to around 2,300 °F, cut to short lengths and forced into a hex die, and then a plain, unthreaded hole is punched; this operation occurs at a rate of about 90 to 175 nuts per hour. The nuts are marked in the forming process, where the punch has the manufacturer's mark and identifying grade. The punch-outs are diverted away from the nuts and are eventually recycled.

From there, the nuts are tumbled in a drum full of shot to remove scale, heat treated to obtain a specific hardness, then threaded or "tapped" on a bent shank-style tap that is about a foot long. One nut pushes the next over the teeth, and the nut at the end of the die falls off as the next nut is pushed on.

Nuts for use on galvanized bolts and tension-control bolts are lubricated, one of the most important facets of fastener assembly performance. Improper lubrication can result in either high pretension and broken bolts, or low pretension.

Currently, SLSB doesn't produce nuts. However, it does store and ship final bolt-nut-washer assemblies from its facility.

▲ Lids are color-coded based on bolt grade and finish.

▲ The facility keeps around 6,000 tons of inventory at all times.

company's signature orange drums, otherwise known as RPKs (rigid polyethylene kegs). All of this happens in the facility's shipping and receiving section, between manufacturing and storage. The RPK lids are color-coded for all grades and finishes of structural bolts—plain, galvanized, weathering, etc. Once the RPKs are sealed, they are put on pallets and shrink-wrapped, ready to be shipped. Garland notes that the system wraps the RPKs vertically, not just horizontally, which provides the added benefit of keeping the labels dry when the drums are stored on a job site.

SLSB accommodates orders of all sizes. Orders are packaged, labeled and shipped not only by job but also by job sequence, so that bolts arrive on-site as needed and don't have to be stored for long periods of time—though storage practices are at the discretion of the building team. And Parker can't stress proper storage enough.

"It's amazing what you'll see out there—bolts being left uncovered, exposed to the elements for months," he says. "There's not much you can do with bolts that were left sitting outside, uncovered through the winter, for example."

Passing the Test(s)

Before shipment, every lot (batch) of bolts needs to be tested per the ASTM standard to which they were manufactured, on various equipment in the lab. All testing machinery is calibrated in-house and also by an outside certification entity on a regular basis, and every bolt can be traced back to the mill.

Perhaps the most dramatic test is the tensile test, which is known as "pulling a bolt." The bolt is placed in the testing device, which pulls it apart until it fails. The bolt passes if it makes it past the appropriate tension (as specified by the ASTM standards) before breaking, and the break needs to occur in the threads. And when it breaks, it's loud—not so much a pop but a BANG—and ear protection is required for those in the vicinity of the testing. As a matter of fact, this test even became too distracting for testing-lab personnel.

"We used to have the tensile test in the lab," says Schuler. "But every time someone would say that they were going to pull a bolt, everyone would stop working and brace for the noise. So we had to move it out of there."

On the Shelf and Out the Door

While orders are produced and distributed on a per-project basis—and each project can involve bolts of different gauges, lengths and diameters—the company also dedicates a portion of its facility to inventory. There's always the possibility of last-minute orders, plus fabrication shops tend to order bolts based on what they know their own equipment is capable of; they might know the required diameters early in a design but not the required length.

It's also a matter of maintaining a status as a go-to source for the customer and being able to accommodate them without delay.

"We like to have whatever the customer needs in stock and ready to ship," says Bill Germuga, the company's sales and marketing manager. "If it's not on the shelf, not only do we risk losing the order, but this could also impact the building team's schedule." ■