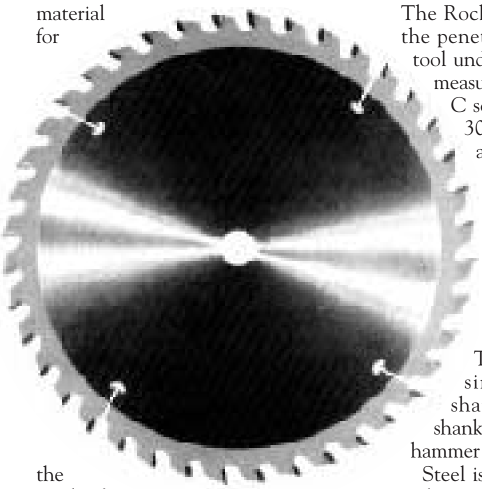
CHOOSING STEEL TOOLS

The right temper, carbon content, and alloys determine whether your steel tools and blades are up to the task

by Lewis Lorini

Next to wood, steel is the most ubiquitous material on a construction site. From saw blades and chisels to hammers and an assortment of nail pullers and screwdrivers, steel dangles from every tool belt.

At first glance, all that steel seems to be about the same — cold, hard, and rusty. But like the tools themselves, the steel used for each implement is designed to do a specific job. For instance, the kind of steel needed to make a quality hammer would not be the best choice of material for the tooth of a saw blade. And likewise, the tungsten carbide that seemingly holds its edge forever on a saw blade would be a disaster (and an expensive one at that) if used for a pry bar.



Making Steel

The manufacture of all steel begins with the smelting process where iron ore is cooked at a very high temperature with a flux, commonly limestone, to separate the iron from impurities. The iron is further heated to remove some of the carbon, which is when it turns into steel. Tool steel is iron that has a carbon content between .4% and 1.5%. Steel with less than .4% carbon is difficult to harden, while steel with more than 1.5% carbon loses much of its malleability. Iron with more than 2% carbon content is cast iron.

The carbon content of steel, as well as its heat treatment, affects its "hardness" and "toughness." In steel, toughness is defined as the ability to withstand shock without shattering. Hardness is the resistance of the material to abrasion or penetration. Hardness is often expressed as a measurement on the Rockwell C scale. The Rockwell test involves measuring the penetration of a diamond-pointed tool under a specific load. A diamond measures 100 HRC on the Rockwell C scale, while mild steel is about 30 HRC. A file, for instance, is about 65 HRC, which is about the hardness limit for steel with a 1% carbon content.

Often, the toolmaker is balancing hardness and toughness. For instance, the steel at the edge of a chisel is often tempered to be harder than the shank, which is tougher. That is a good combination, since the hard edge will stay sharp longer, while the tougher shank will better absorb shocks from hammer blows.

Steel is usually delivered to the toolmaker in a fully annealed state (achieved by heating and slowly cooling it), which is relatively soft. It stays in that condition until the toolmaker fashions it either by drop forging, milling, or grinding. Once the shape of the tool is achieved, it is tempered or hardened. Tempering involves heating the steel to a specific temperature, then cooling it quickly in water or oil.

The intricacy of a tool's shape and requirements for the tool generally dictate the manufacturing method. Drop forging is the most common process used to make construction tools. Drop forging involves heating a blank to about 2,000°, where it becomes malleable, and shaping it between a pair of dies. Forging metal, as done by blacksmiths, also involves heating a blank and hammering it into a particular shape.

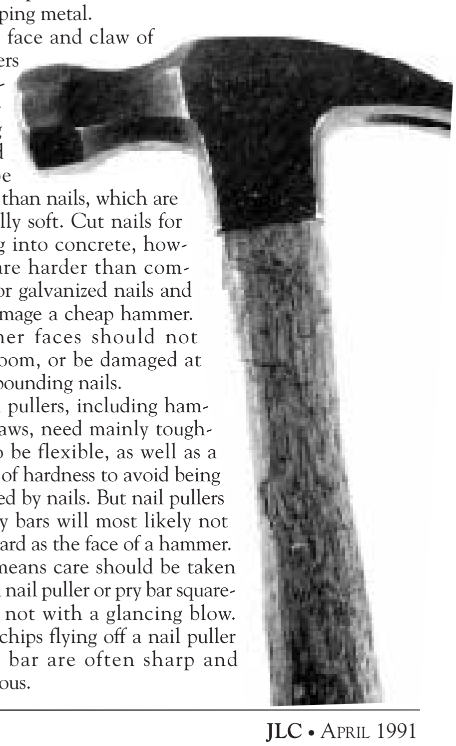
Grinding and milling usually occur in the final stages of the manufacturing process to remove relatively small amounts of material or give a tool its finish.

Tools for Pounding and Prying

Quality hammers, nail pullers, and pry bars are generally drop forged and made of reasonably hard carbon steel that is designed with toughness in mind.

Depending on the intended use, hammers range in hardness on the Rockwell C scale from 40 to 50 HRC for the typical framing hammer to about 55 HRC for a ball-peen hammer that is intended for shaping metal.

The face and claw of hammers for carpentering need only be harder than nails, which are generally soft. Cut nails for driving into concrete, however, are harder than commons or galvanized nails and can damage a cheap hammer. Hammer faces should not mushroom, or be damaged at all by pounding nails.



Nail pullers, including hammer claws, need mainly toughness to be flexible, as well as a degree of hardness to avoid being damaged by nails. But nail pullers and pry bars will most likely not be as hard as the face of a hammer. That means care should be taken to hit a nail puller or pry bar squarely and not with a glancing blow. Metal chips flying off a nail puller or pry bar are often sharp and dangerous.

Hold That Edge

In addition to pounding and prying, steel tools are also important for cutting. And circular saw blades are clearly the most common application of cutting tool technology on the job site.

Plain steel blades are usually made of a high-carbon steel that holds an edge well under normal conditions, but will easily lose temper and sharpness if abused. Run a steel blade through thick material until a whiff of smoke drifts out of the kerf, and you can kiss that blade goodbye, at least until it can be resharpened. The same is true if you hear the familiar whine of a blade hitting a nail.

But when it comes to the cutting edge, so to speak, of the blade technology, the only word to know is carbide. Carbide is much harder than tool steel because, instead of iron, it contains tungsten and carbon grains bonded together with cobalt. It is the hardness of carbide that enables it to cut through nails without losing its edge. However, carbide is brittle and may chip.

Ordinary tungsten-carbide blades, which have been available for nearly 20 years, hold an edge much longer and withstand more abuse than steel blades. But in the past few years, several companies have introduced new carbide formulations that last up to ten times longer than standard tungsten carbide.

Understanding the secret to the increased edge-holding ability of these blades requires an understanding of how blades get dull in the first place. It was commonly believed that the main reason an edge dulled was abrasion. Research, however, has shown that the real degraders of sharp edges are high-temperature chemical reactions of oxidation or corrosion.

That corrosive chemical reaction depends on the tremendous heat created during cutting. Since the blade is encased in the kerf, that heat has nowhere to go but into the blade.

The solution found by some companies was to change the composition of the carbide. The new long-lasting blades add other alloys to the cobalt that typically bond the tungsten and carbide grains. The additional elements act to raise the temperature needed to kick off the corrosive chemical reaction.

While it has been known for years that corrosion dulls blades, it was not until a few years ago that blade manufacturers found ways to add the necessary alloying elements without substantially increasing the cost.

Although in a particular price range there is no visible difference between carbides, generally the smoother the finish on the carbide teeth and more uniform the braising, the better the blade. The smooth finish not only indicates better workmanship, but also helps limit high-temperature corrosion.

Carbide blades, however, must be sent to a professional for sharpening on a diamond-encrusted grinding wheel. Although a tiresome process, a steel blade can be effectively sharpened on site with a file.

Jigsaw and reciprocating saw blades are also available in low-tech and hi-tech versions. The traditional material used to make these flexible but not very hard blades is spring steel, which is also used for handsaws. Bimetal blades for these saws, however, combine the best qualities of two different steels.

Bimetal blades have high-speed steel (HSS) edges welded with a special process to spring steel, which creates a blade that has a hard edge and the toughness to withstand substantial shock. HSS is carbon steel treated with an element, usually tungsten, that permits it to withstand higher temperatures than plain carbon steel before losing its temper. The HSS on these blades is often M2, which also contains molybdenum, chromium, and vanadium, and is more heat resistant than tungsten HSS.

Boring and Driving

Drill bits are another common category of cutting tool on the job site. Typically wood boring bits, including auger bits and spade bits, are made of high-carbon steel and heat-treated to about 40 HRC. That process is sufficient for most drilling applications, such as boring through 2x4s or plywood. Twist drills intended to drill through metal, however, should be HSS. Most HSS twist drills are stamped "HSS" at the shank. Plain carbon steel bits usually don't say anything.

Once the hole is drilled, you might want to turn a screw. Since screws, like nails, are relatively soft, screwdriver tips do not need to be especially hard. However, the screwdrivers that commonly fill the dollar bin at the hardware store are not worth half that price. Often a cheap screwdriver is made of low-carbon steel that can barely be hardened and will mushroom the first time it faces any resistance.

Very expensive screwdrivers are also usually not worth the price mainly because the increased cost is not for a better grade of steel but for a better handle or other cosmetic feature. Generally, a mid-priced screwdriver is the most practical choice.

Paying the Right Price

With the competition in the marketplace, price is often a pretty good indicator of the quality of material used to make a particular tool.

And while it is always a pleasure to own and use the best tool available, when it comes to steel, the price you have to pay may be hard to justify. With saw blades, chisels, and even hammers, the best tool available may not be the best value. As a woodworker friend of mine is fond of saying, putting a $100 saw blade on a $300 table saw is like putting perfume on a pig. ■

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