Keeping up with repair techniques

In this issue of PanelTalk we present two articles about working with ultra-high-strength steels.

The first article was originally published in May 2004, the second article is an update published in August 2005. Both articles are still relevant and by presenting them separately it helps to illustrate how changes and developments are taking place in the industry. This emphasises the need to keep up with the current surge of technical advancements in vehicle manufacturing and repair methods with ongoing training and upskilling. I-CAR NZ is meeting this demand with a range of courses outlined elsewhere in this edition of Paneltalk.

WORKING WITH BORON STEEL

May 2004 -It could be called the "most ultra" of the ultra-high-strength steels. Boron steel may be a dream material for vehicle makers, but to the collision industry it can be challenging. To some collision repair technicians, the title of this article doesn't make much sense, since the words "working with" and "boron steel" don't seem to go together. But boron steel can be worked with, short of straightening. It can be welded just like any other steel, and it can be cut if the right tools are used. We also found that it can be drilled, given the right bit and procedure.

The type of boron steel used on vehicles today has extremely high strength. The boron steel used on Volvo cars has a yield point of about 1,350–1,400 N/mm2 (196,000–203,000 psi). That's about four times stronger than average high-strength steel. But the process used to make it that strong takes away some of the steel's workability properties, such as being able to straighten it.

Do Not Straighten Boron Steel

Boron steel cannot be straightened because of the extremely high heat used when it is being formed. When boron steel is damaged in a collision, work hardening makes it too brittle to be restored to its original state. Attempts to straighten a boron steel part will usually result in a cracked part. The use of heat may allow the part to be straightened without cracking, but heat destroys the strength of the part. The only solution is to replace the part.

That same heating process doesn't allow boron steel to be galvanized. The galvanizing process can't take the high heat when the steel is being formed, and trying to apply a galvanized coating after the part is shaped would require heating the part, which would destroy the strength.

Boron Steel Applications

For now, boron steel is found primarily on European vehicles, such as the dash panel on the 2002 Porsche Cayenne SUV, the safety bar around the rear seats on the

2003 Porsche Boxster, the door guard beams on the 2003 Porsche 911 Carrera, and the inner B-pillars on the 2003 Mercedes-Benz E Class. Volvo probably uses boron steel the most. Boron is used on the bumper reinforcements and door guard beams on the 2004 Volvo S40 sedan and 2005 V50 station wagon. The 2003 Volvo XC90 SUV has several applications of boron steel, including the inner B-pillars, the roof bow between the B-pillars, the inner rear body panel, and the rear bumper reinforcement. The 1999–2004 S80, and the 2001–2004 V70 and S60 also have boron steel inner rear body panels and rear bumper reinforcements. There are allowable sectioning cut lines on these bumper reinforcements, and on the inner rear body panel on the XC90. So how is this done?

Cutting Boron Steel

Volvo recommends cutting boron steel with a cutoff wheel (see Figure 1) or a plasma-arc torch. A reciprocating saw should not be used. Boron steel will remove the teeth on a reciprocating saw blade. We had success using a 75 mm (3”) cutoff disk on a section of an XC90 rear body panel. A plasma-arc torch is only used for rough cutting. There are some plasma-arc torches available that can be easily set to only penetrate one panel thickness, leaving the inner panel intact. That feature is handy for cutting around spot welds on boron steel.

Drilling Boron Steel

It’s trying to drill spot welds out of boron steel where many technicians have had the most frustration. One way to avoid drilling into boron steel is to drill through the lower strength, softer steel that the boron part is attached to. The restriction that this method has is that the backside of the flange must be accessible to drill.

We tried different bits and methods to drill directly into boron steel. Even very durable drill bits are dulled after a drilling a series of holes in boron steel, and the bits are expensive. We tried a bi-metal titanium carbide bit. Look at the close-up photo in Figure 2. A couple of attempts at drilling into boron steel cracked the carbide insert. Attempts using a cobalt or regular high speed steel drill bit just dulled the bit. We also tried the two-drill bit method of drilling a pilot hole with a small bit and following with a larger bit. The bits got dull just as fast. Applying oil did not help. The oil seemed to not allow the metal shavings to come off the bit fast enough.

What we found does work with some success is a titanium drill bit (see Figure 3) combined with slow speed. We used an air drill with a maximum freewheeling speed of 490 rpm (see Figure 4). That’s much slower than the average 1,800 rpm of spot-weld removal drills. With this setup, we drilled several holes in boron steel without dulling or breaking the bit. This is not a promise that you would not have to replace these bits far more than a regular spot welding drill bit on regular steel.

Welding Boron Steel

One process where boron steel is worker-friendly is welding. The low alloy and impurity content make the steel resistant to hot cracking, so the welding process is not difficult. Either the GMA (MIG) welding process or squeeze-type resistance spot welding

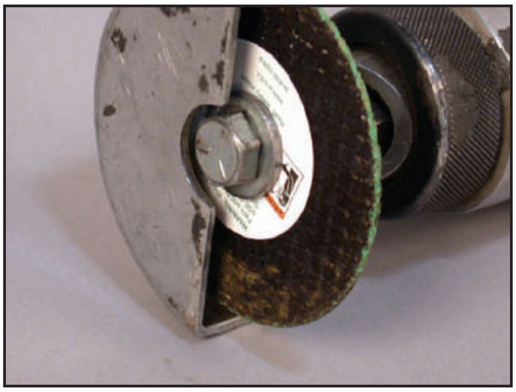

Figure 1–A cutoff wheel such as this is effective for cutting boron steel.

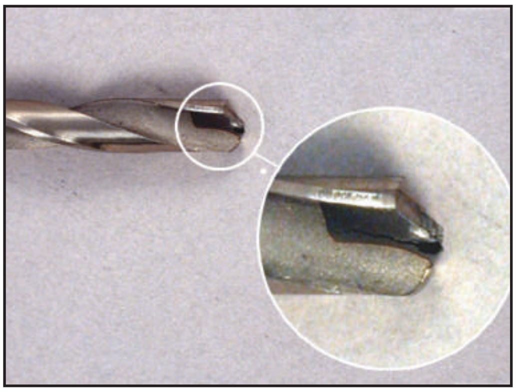

Figure 2–Trying to drill boron steel using a drill bit with a carbide insert resulted in cracking the insert, no matter what speed was used.

Figure 3–A titanium drill bit such as this worked on boron steel.

Figure 4–This special 490 rpm air drill motor was essential for drilling out spot welds from boron steel.

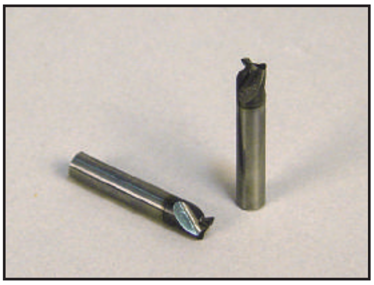

Figure 1 - A triple-fluted tungsten carbide bit effectively removes spot welds from UHSS alloyed with boron.

Figure 2 - A pneumatic C-clamp-style drill applies adequate pressure to the cutting bit.

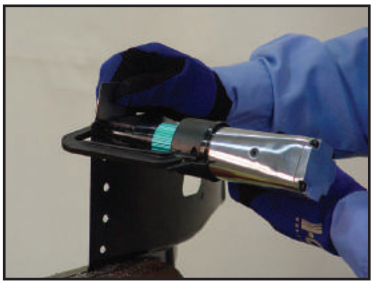

Figure 3 - A C-clamp-style spot weld drill is also effective for making plug weld holes in a UHSS part.

Figure 4 - Plasma-arc cutting equipment can be used to cut around the spot weld.

Figure 5 - A pulling plate welded to a part made from UHSS alloyed with boron is used to remove indirect damage.

Figure 6 - This spot welder pulses to preheat the metal before making the weld.

can be used. Resistance spot welding is typically preferred because there is minimal damage from heat effect.

Corrosion Protection Important

One major concern with thin, strong steels is that corrosion protection is even more critical to maintain vehicle strength. This is especially important with boron steel, since boron steel is not galvanized during manufacture.

Apply weld-through primer on bare steel mating flanges, removing the primer from the direct weld area before welding. Take care to not remove the primer from any area beyond the immediate weld area. Apply epoxy primer to the entire parts after welding.

Conclusion

There promises to be more applications of boron steel, along with other types of high-strength steels, in future model years to reduce weight and strengthen the chassis. Perhaps along with the added applications will be more equipment and tool options for working with these strong and brittle materials.

WORKING WITH BORON STEEL - AN UPDATE

August 2005 -In May, 2004, I-CAR produced the preceeding article entitled "Working with Boron Steel." Since then, vehicle makers have continued to increase their use of ultra-high-strength steel (UHSS) alloyed with boron. This has prompted some tool and equipment makers to address a few of the issues related to repairing collision damaged parts made of UHSS alloyed with boron. During research at the I-CAR Tech Centre, some of this equipment has proven effective when drilling, cutting, straightening, and welding UHSS alloyed with boron.

Removing Spot Welds on UHSS Alloyed with Boron

One type of spot weld drill bit has three flutes (see Figure 1). This bit is made from tungsten carbide steel, a material even stronger than UHSS alloyed with boron. When used in combination with a pneumatic C-clamp-style spot weld drill (see Figure 2), this bit effectively removes spot welds. Precision and control of the drill is key to preserving the longevity of the drill bit. A speed of 800-1000 rpm is recommended for removing the spot weld and preventing heat buildup of the bit. Even when used cautiously, the drill bit will become dull after drilling approximately 100 spot welds. The C-clamp-style drill with the tungsten carbide bit is also effective for making plug weld holes in a part made from UHSS alloyed with boron (see Figure 3).

Using plasma arc cutting equipment has also shown some effectiveness, although extensive practice on the technique is required. The technique requires making a circular cut around the spot weld through the outer layer, yet leaving the spot weld and the inner panel intact (see Figure 4). Caution must be used to prevent cutting into the inner panel. Before attempting to cut spot welds on a vehicle, it is helpful to practice on a scrap part to obtain the proper settings of the equipment and to practice the technique. Other methods, including using a cutoff wheel or a die grinder to grind through the weld, have also been proven effective.

Straightening UHSS Alloyed with Boron

The previous article stated that parts made with UHSS alloyed with boron should not be straightened. In some instances, however, it may be necessary to pull on the UHSS part to remove indirect damage from a collision. Due to the extensive strength, straightening should usually be limited to parts that will be either partially or completely replaced (see Figure 5). When straightening parts made from UHSS alloyed with boron, it is crucial that the entire vehicle dimensions are monitored and that the vehicle is visually inspected during the pulling operation. This prevents pulling damage into an undamaged area of the vehicle.

Welding UHSS Alloyed with Boron

As the previous article also stated, UHSS alloyed with boron does weld easily, although there are a few items to consider. To maintain the high strength characteristics of the steel, it is important to limit the heat-affected area in the weld zone. When GMA (MIG) welding UHSS alloyed with boron, a skip/stitch technique should be used, allowing the metal to cool after approximately 13 mm (1/2”) of welding. When using squeeze-type resistance spot welding (STRSW) (see Figure 6), some equipment makers have specific settings for welding UHSS alloyed with boron. These settings pulse the welding output once to preheat the weld zone, and then welds the metal together. This creates a weld with less heat buildup in the weld zone, helping to maintain the strength of the metal.

Conclusion

Vehicle makers are continuing to use UHSS alloyed with boron to reduce vehicle weight while maintaining occupant protection in the event of a collision. Although the metal may be difficult to work with, some product and equipment makers have provided tools and equipment that make it a little less challenging.

These articles first appeared in the I-CAR Advantage Online, which is published and distributed free of charge. I-CAR, the Inter-Industry Conference on Auto Collision Repair, is a not-for-profit international training organization that researches and develops quality technical education programs related to automotive repair. To learn more about I-CAR, and to subscribe to the free publication, visit http://www.i-car.com