Keeping up with new construction methods and repair techniques

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In this edition of PanelTalk we again look at new body construction methods and in particular the concept of tailor-welded blanks.

Because we in the collision repair industry can't be expected to know how each and every model vehicle is constructed, this I-CAR Advantage article gives a general overview of how and why this method of construction is used, as well as where there is a likelihood of laser welded joints.

Remember this will not be the same for every vehicle but is to make you aware that future analysis of damage and the correct repair method may be required when developing a repair plan. Any doubt check with the manufacturer's repair recommendations.

TAILOR-WELDED BLANKS

Decmeber 6, 2004 - The concept of "tailored blanking" for vehicle body structures was one of the many brainstorms during the development of the Ultralight Steel Autobody (ULSAB) project (see " Ultralight Steel Auto Body " (904 K) in the July-August 1998 issue and " Ultralight Steel Consortium Update " (1.3 M) in the March/April 2001 issue of the Advantage Online). The ULSAB never became a production vehicle itself, but the individual engineering ideas have been mainstreamed into many production vehicles. These include the use of different strengths of high-strength steels, hydroforming, and tailor-welded blanks.

Definition

A "tailor-welded blank" is one part made up of different strengths or thicknesses of steel, joined at the factory usually by a laser weld.

Imagine being given the task of designing a front upper rail from a flat, blank sheet of steel. You have a weight limit and you want to make the last half of the rail, up to where it's joined to the cowl panel, twice as strong as the front half. You determine that this is essential to protect the passenger compartment. Adding lateral stiffeners, or protruded ribs along the length, wouldn't provide the strength you need. So you decide to weld another layer of steel along the inside, in the form of a reinforcement, but find that adds too much weight. You could join different steels, but that would add a flange halfway into the part, a potential weak spot exactly where you need strength.

The solution that the ULSAB consortium came up with was to lay out two different sheets of steel, one for the front part of the rail and one for the rear. Have the steel toward the rear twice as strong or thick than the other sheet. Then stamp the front and rear half of the rail separately, and join the halves together with a near seamless laser weld. ULSAB used this concept on several parts, including the entire outer uniside (see Figure 1). Several of the parts were comprised of three different types of steel in the same part, such as the outer and inner front rails (see Figure 2). Using this method, parts could be "tailor made" for the purpose they served.

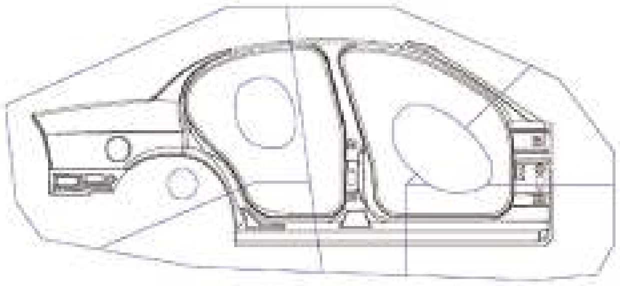

Figure 1 - The uniside on the ULSAB is joined with six laser welds where different types of steel come together. (Courtesy of the International Iron and Steel Institute)

Advantages

The main advantage of a tailor-welded blank is the opportunity to place the optimum steel thicknesses and strengths where they're needed the most. A laser weld is the next best thing to having no seam at all, so there's little concern about where in the part the seam or seams occur.

The weight savings, with no reinforcements, has

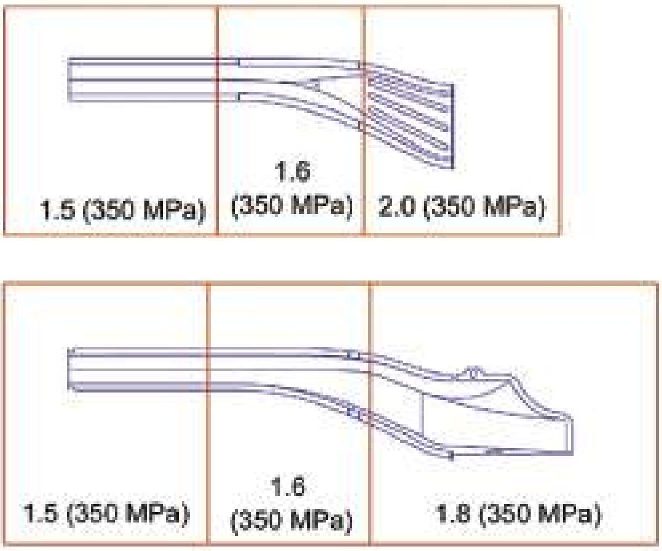

Figure 2 - The upper and lower rails are made of three strengths of high-strength steel. (Courtesy of the International Iron and Steel Institute)

Figure 3 - The upper front rail, or side member, on the Volvo S40 is a two-part tailor-welded blank.

already been mentioned. Attaching reinforcements is another step in the manufacturing process, so there's a production savings as well as a reduction in the number of parts.

Also, there's no overlap joint. The only other way to add another strength or thickness of steel to the same part is to overlap the steels, but that introduces the possibility of corrosion in the seam, requiring another production step to seal the seam. After a collision, the areas that are going to show the most fatigue are the seams, especially in a part like a rail that is designed to absorb and transfer collision energy. That brings up another disadvantage of an overlap joint: overlaps don't allow collision energy to flow as easily through a part.

Laser Welds

Although laser welding is not the only method used to make a tailor-welded blank, all of the tailor-welded blanks on the ULSAB were laser welded. This is because compared to the other methods, laser welds make the cleanest, most precise joint. The precise, high-intensity weld makes a very narrow weld zone. There is almost no impact on the corrosion resistance when coated material is used. In many cases, the parts are moved relative to a fixed laser beam, rather than moving the laser across the joint. This allows the joint to be non-linear. Additionally, it doesn't have to be in a straight line.

The joint can't be duplicated in the field. And in that precise location where a different strength or thickness of steel is chosen to start is not a good place to make a repair joint anyway. Besides, it would be difficult to set a GMA (MIG) welder to weld a butt joint joining two different thicknesses of steel. For those reasons, sectioning joints on tailor-welded blanks are usually recommended away from the laser weld locations.

Application Examples

It is very possible that you have worked with tailor-welded blanks and were not aware of it. Tailor-welded blanks are used quite extensively today, and the laser welds may be difficult to see.

The outer upper rail replacement part fitted up in Figure 3 (from the 2005 Volvo S40) has a laser weld about one third ahead of the cowl panel. Volvo calls the steel

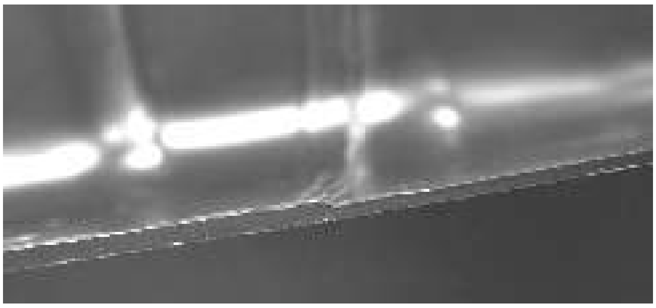

Figure 4 - The thicker steel on the left is extra-high-strength steel.

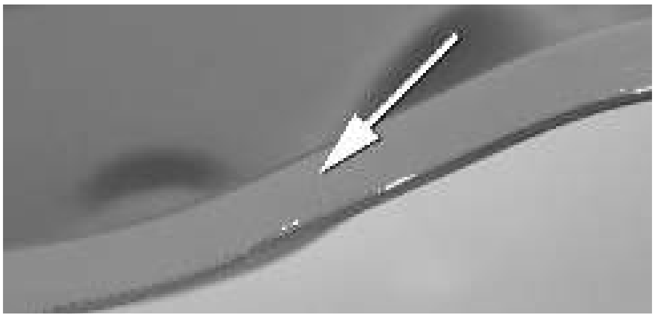

Figure 5 - This joint shows no difference in thickness between the steels.

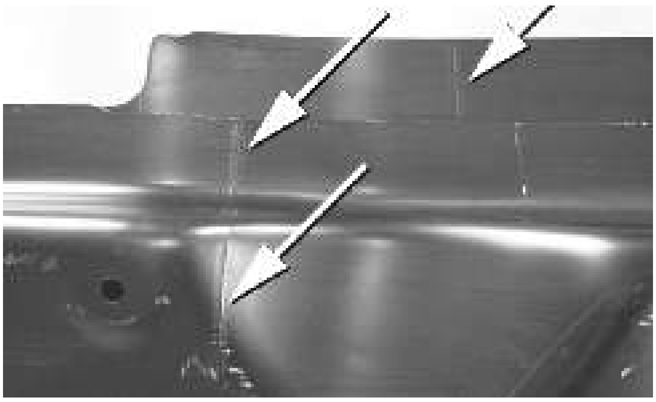

Figure 6 - Laser welds on this lower rail or side member show offset joints between the inner and outer halves.

Figure 7 - High-strength and extra-high-strength steels are joined at the lower portion of this inner B-pillar.

forward of the laser weld high-strength steel and the steel rearward of the laser weld extra-high-strength steel. The extra-high-strength steel is twice as strong as the high-strength steel. Viewing the part from the edge in Figure 4, you can see that the extra-high-strength steel is also twice as thick.

A closeup of the inner lower rail on that same vehicle is shown in Figure 5. The laser weld also joins high-strength steel and extra-high-strength steel, but this time there is no difference in thickness. The inner rail also has a reinforcement, so this is still an option with tailor-welded blanks. When the inner and outer rails are clamped together, shown in Figure 6, it can be seen that the laser welds are offset.

Side-impact protection provides another role for tailor-welded blanks. The laser weld joint on the inner B-pillar in Figure 7 is near the bottom of the pillar, just above where the pillar flares out as it joins the rocker panel (also on the Volvo S40). The close-up in Figure 8 shows that the steel gets thicker from that joint upward. There is also a reinforcement in the inner B-pillar.

Figure 8 - The thicker, higher strength steel is above the laser-welded joint in this example.

The center pillar on the 2004 Ford F-150 also uses a tailor-welded blank (see Figure 9). On this pillar (see Figure 10), the thicker steel is to the bottom of the laser weld, where the extra strength is needed on trucks.

Figure 9 - The center pillar on this Ford F-150 uses a tailor-welded blank.

Conclusion

Thanks to a brainstorm of steel engineers several years ago, vehicle makers have a designing tool that meets several demands of today's vehicles. Tailor-welded blanks allow combining different strengths of steel in one part without adding complications at the joints. Watch for this design method to be used more with each model year.

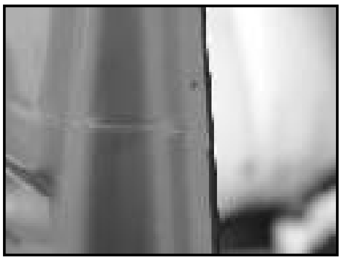

Figure 10 - On this B-pillar, the thicker and stronger steel is below the laser weld.

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