Technical Whitepaper: Reparability

Introduction

As aluminum use continues to rise in the auto industry, so does the need for understanding and applying "best practices" when repairing automotive aluminum components.

A review of both the similarities - and differences - encountered during the repair of aluminum panels compared with those of traditional materials shows that working with aluminum is not difficult; it is merely different.

In fact:

- Some procedures for working with aluminum are easier than with conventional materials
- The majority of tools for working aluminum are similar to those for working conventional materials
- The skills necessary for working aluminum can be learned as easily as the skills required for other materials
- Repair costs are not very different from those of traditional materials
- There are programs currently in place and new programs under development that offer training for repair of aluminum panels

The Body Repair Industry

Throughout the past century, body repair shop practices, tools and techniques have been developed to work mainly with automotive steels. As the auto industry looks to the future, however, it is increasingly turning to aluminum as the material of choice for use in automotive body structures and closure panels. As a result, there are a number of repair shops nationwide that are acquiring an expertise in aluminum repair, and their numbers are growing each year.

In fact, comprehensive programs are being put in place that address aluminum's different characteristics. The development and implementation of repair instructions for specific aluminum vehicles has been led by the manufacturers.

The InterIndustry Conference on Auto Repair (I-CAR)* and others from the auto insurance and repair equipment supply industries have worked side-by-side with experts from the aluminum industry to develop training guides for correct repair of aluminum panels. A nationwide training program which began in 1996; technicians who have attended these programs say working with aluminum is different but not difficult.

Tools: Adapted or Developed for Aluminum

Tools for working with aluminum are generally similar to those used for working with steel. However, good practice dictates the same tools should not be used on both metals because of cross-contamination. This causes problems with welding, finishing and potential bimetallic corrosion.

Files, sanding discs and other associated equipment are as effective when working with aluminum as with other metals. Cutting and general working of aluminum is much easier than steel, and the techniques involved are similar to those used in wood-cutting. Reciprocating saws and band saws - both with high blade speeds – are normally used.

The Use of Heat for Metal Straightening

When an aluminum part is damaged, the deformed area is work-hardened (strengthened). Pulling on the part to straighten it will deform undamaged areas, which have not been work-hardened, before correcting the damaged area. Local heating of the damaged area will temporarily soften the heated area so that the damaged area can be corrected. The Aluminum Association provides information on the effects of elevated temperatures on material properties and recommendations for the use of heat for straightening.

A technique known as heat-shrinking can be used to take dents out of aluminum skin panels. When the area around a dent is heated with a torch, the stresses generated by restraining the metal that wants to expand cause the dent to be pushed out.

Another difference between heated aluminum and steel is that aluminum does not change color, even at its melting point. Therefore, it is important to use temperature indicators to keep track of the metal temperature during working. Heat can be used in cases where a technician needs to disassemble an adhesive-bonded joint. As long as the temperature is kept within the recommended range, using heat will soften the adhesive and enable the joint to be chiseled open with less mechanical damage and no long-term effects on material properties.

Joining Methods Traditional: Conventional Gas Metal Arc (GMA) Welding

The most common method used for welding common metals is inert gas (or GMA) welding. Aluminum lends itself very well to this type of welding. Virtually all repair shops possess MIG welders. The more powerful and adaptable machines, required by aluminum, are beginning to penetrate many of the larger repair shops. Lap and fillet welds, butt welds with a backing added for the repair, and MIG plug welds are all approved for replacing other joining methods, as well as to repair original MIG welded joints.

The Bonding Advantage

Aluminum panels have been bonded together with adhesives in the aircraft industry for decades. This type of structural bond yields exceptionally strong and reliable joints that also improve the rigidity of the final assembly, particularly for stamped sheet auto bodies.

Automotive engineers designing for precise handling and the quiet, solid feel of a high-quality automobile consider high stiffness very important.

Using a suitable surface pretreatment, adhesive-bonded aluminum joints can be repaired without any sacrifice in strength or stiffness and will outlive a normally protected steel structure in most situations.

Semi-structural bonding is used widely in steel and aluminum bodies in areas such as hood hem flanges and roof panel joints. Equivalent bonding products are available for all these applications and new repair adhesives have been developed to bond joints that were spot-welded in the original assembly.

Riveting

A wide range of coated steel and aluminum stem (pop) rivets are available for every type of application including high loads and severe corrosion conditions. A conventional countersunk aluminum rivet may be used for flanges that require a flush surface on both sides. Precision drills are available for standard rivet sizes and assembly is straightforward once the parts have been aligned. The tools required for riveting are inexpensive and simple to use.

Equipment for automated punch riveting is not suitable for repair workshops, but tools for removing this type of rivet are becoming available. Vehicle manufacturers will specify a generic or proprietary fastener, which can be used to replace these rivets and spot welds.

Spot Welding

Production spot welds can be neatly removed with a conventional spot weld cutter by adjusting the drill depth to cut through only the damaged part. The equipment used for spot welding aluminum in production is too large and powerful for the repair workshop. An alternative joining method is generally recommended.

Refinishing

Aluminum panels are finished in the same way as conventional materials, including the use of body fillers. All the major paint suppliers offer aftermarket paint repair systems, which include products designed and tested for specific materials (aluminum, steel, galvanized steel, SMC, etc.). Whatever the material, the supplier will warrantee the quality of the finish provided that the products and procedures for their complete system are used. Most procedures are standard for all the suppliers and the finish systems are warranted as long as directions are followed.

Costs

There are few fundamental differences between the repair of steel and aluminum panels and the average repair shop can be outfitted relatively easily for both. The difference between the material costs of steel and aluminum are insignificant in comparison to the cost of replacement parts.

For an experienced technician, the labor time required for aluminum repair is equivalent to that required for steel. To gain appropriate experience, the first step is training. Such training is rapidly spreading, and those who complete instruction are more valued assets to their employers.

As the aluminum content of vehicles increases, more and more repair facilities will learn to better accommodate aluminum-intensive vehicles (AIVs). As AIVs come into the marketplace, repair shops will react - as they always have - to economic pressures and equip themselves to handle damage repairs, much like they did several years ago to adjust to the universal changeover to computer engine controls.

As for insurance costs, premiums for AIVs today are no higher than for equal-value steel vehicles. Listed below is a range of yearly insurance costs of five comparable luxury vehicles in the Washington, DC area for a middle-aged driver:

1999 Vehicle Insurance Costs

- Audi A8 $444-$498 (Aluminum-intensive)
- BMW 740i $642-$720 (Traditional steel)
- Mercedes-Benz E420 $534-$588 (Traditional steel)
- Land Rover Discovery $512-$590 (Aluminum-skin panels)
- Chevy Tahoe $489-$533 (Traditional steel)

These figures reflect the fact that insurance costs are based on the value of the vehicle. Moreover, the quality and cost of repair is based on the experience and training of the person doing the work.

Conclusion

When comparing the relative ease and costs of repairing aluminum and steel, it is clear that aluminum is not more difficult; it is just different. Different techniques are required, as is a clear understanding of the differences between steel and aluminum alloys and how these differences affect the repair process. Such understanding is readily available, as are the necessary specialized tools for proper repair of aluminum. As for training, I-CAR programs have been in existence for several years, and the manufacturers and suppliers are making available the necessary instructional materials to assimilate the repair of aluminum into everyday shop practices.

As the use of automotive aluminum continues to climb due to its performance, safety and environmental advantages, its repair will become as commonplace and routine as that of traditional materials.