November 10, 2003

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Technical Information For The Collision Industry

Aluminum/Steel Construction Of The BMW 5 Series

The most interesting characteristic about the 2004 BMW 5 Series, from a collision repair perspective, is its construction. The front-end structure from the cowl forward is all-aluminum, while the rest of the vehicle's structure is steel. The front portion of the lower rails is aluminum; the portion of the lower rails under the floor pan is steel. A rear portion of the upper rails is steel, however the rest of the upper rails are made of aluminum. The floor pan and the lower portion of the A-pillars are steel, both joined to an aluminum cowl panel.

The first questions that come to mind are why and how. Why make only the front-end structure out of aluminum? How is aluminum and steel joined while avoiding galvanic corrosion?

The "why" can be answered by considering that an aluminum structure can be just as strong as a comparable steel structure with about one-third less weight. The aluminum front assembly allows the new 5 Series to be slightly longer, wider, and taller than previous model years but still weighs about 20 kg (44 lb) less (see Figure 1). With the front structure made of aluminum, there is almost a near equal weight distribution between the front and rear of the vehicle. Also, with the rear half made out of conventional steel, there's better repairability, necessary for a high volume production vehicle.

When bare aluminum joins with bare steel, contact or galvanic corrosion can result. Where aluminum meets steel in the 5 Series main structure, the joints are made using adhesives and rivets, a process known as rivet-bonding. Everywhere aluminum and steel come together, the adhesive protrudes at least one millimeter outside the joints. This helps ensure that direct contact between bare steel and aluminum is completely avoided. The steel panels are also galvanized and the aluminum panels are treated with a titanium/zircon coating designed to both hinder oxidation and enhance the adhesive bonding surface. After construction, the entire vehicle is also subjected to a phosphate bath and E-coat.

Aluminum part construction used for vehicles is either stamped, extruded, or cast, and the 5 Series uses each of these in the front-end structure. The strut tower/apron assemblies are cast construction. The inner part of the lower rails (engine carriers) are extruded construction, while the outer portion is stamped. The upper cowl panel is extruded and hydroformed. The upper rails and cowl panels are stamped. The alloys are 5000 and 6000 series.

Besides the front structure, the driveshaft, suspension system, engine mounting brackets, transmission crossmember, rear subframe, and several exterior panels are also aluminum.

Figure 1 – The structure on the 2004 BMW 5 Series is aluminum from the cowl forward and the rest conventional steel.

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BMW of North America is holding training programs at the collision repair facilities of its BMW Centers so that collision damage to the aluminum structure and exterior panels can be repaired.

REPAIR PROCESSES

The aluminum front section, which is available as a complete assembly, is originally assembled with coated steel self-piercing rivets and adhesive. Repairs are made using coated steel blind rivets and adhesive. This is because the installation of self-piercing rivets requires a dedicated tool that isn't readily available. Also required is two-sided flange access that is not always available during repairs. The blind rivets can only be ordered from BMW, and there is a specific adhesive.

The recommended process for removing the self-piercing rivets during repairs is a unique process in itself, involving a special stud welding tool and blind rivet gun to pull the rivets out. Where access prohibits this process, the rivets can be drilled out from either side, or ground down on the backside. The stud weld pulling method begins by grinding the rivet heads to bare steel. A special stud welder is then used to weld on stainless steel studs to each rivet head. A special blind rivet gun is used to pull out the rivet. Think of the process of installing a blind rivet, how the gun pulls on the mandrel of the rivet to compress the head before cutting the mandrel off flush with the head. This is how the blind rivet gun is used with the stainless steel stud to pull out the self-piercing rivet. The high pulling force that is required to do this is why most blind rivet guns will not work. The blind rivets are installed in the resulting holes, using the same blind rivet gun. BMW holds the patent on the stud welder and rivet extractor and are only available through BMW dealers.

Preparation of the flanges for adhesive is done with a Pyrosil® (flame) kit (see Figure 2). This is the same process used on the 2004 Jaguar XJ. The flame is applied to the flange. While the flange is still warm, adhesive primer is applied. After allowing the primer to dry, adhesive is applied.

Extruded sections and cast parts, which show any sign of visible or measurable deformation, are replaced, and not straightened. This includes the front lower rails, because the inner part of the lower rails are extrusions.

There is a lower front rail service part available for partial replacement of the rail, forward of the front axle. The procedure for attaching this part to the existing rail is unique. The aluminum lower rail section is cut and fitted to the existing rail, just like any sectioning procedure. But instead of welding the section in place, it is bonded, using two insert-like "repair elements." Screws, installed in the repair elements, are turned to form a tight fit. The screws are removed after the adhesive has cured and the screw holes sealed with a PVC sealing compound.

CONCLUSION

Vehicle makers have been taking different approaches when using aluminum for structural parts. The 2004 BMW 5 Series is no exception with its unique aluminum/steel construction. The vehicle requires specific repair procedures and equipment, usually only available for BMW dealerships.

More information on vehicle maker requirements for repair of aluminum structures can be found in three new I-CAR programs that will be available soon: Structural Straightening Aluminum, Structural Aluminum Design And Repair Processes, and Structural Aluminum Repair Processes.

Figure 2 – The Pyrosil® (flame) kit is used to prep flanges for adhesive application.