Fundamentals Of Collision Repair Program 1

Textbook

I-CAR®

IMPORTANT NOTICE

This material provides general directions for collision damage repair using tested, effective procedures. Following them will help assure the reliability of the repair.

I-CAR cannot accept responsibility for any individual repair, nor can it warrant to the quality of such repair. Anyone who departs from the instructions in this program must first establish that neither personal safety nor the integrity of the repair of the vehicle is compromised by the choice of methods, tools, or supplies.

I-CAR does not endorse or recommend any brands or makes of vehicles, repair equipment and supplies or other products. The appearance of various makes and brand names in any I-CAR material is purely coincidental and is based on the availability of those products at the time of production.

All recommendations presented in this program are based upon research programs or upon tests conducted by laboratories, manufacturers, or selected collision repair facilities. If performed as outlined, these recommendations will provide the basis for a thorough, professional repair.

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Topic A. Vehicle Designs

The three main types of vehicle construction include unibody, space frame, body-over-frame.

A-3 Unibody vehicles are designed to direct collision energy around the passenger compartment by using collapse zones.

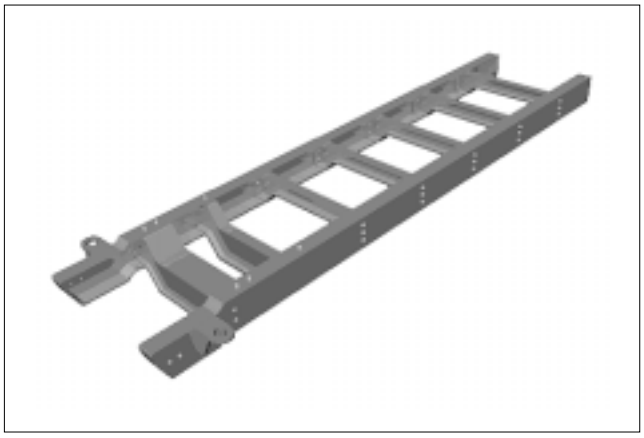
A unibody, or unitized body vehicle has multiple sheet metal parts welded together to form a single unit. It is built with its engine crossmember and suspension parts mounted directly to the body.
A unibody vehicle is dependent on correct structural alignment and integrity for proper steering and suspension alignment. It also controls collision forces through designed-in kick-up areas, bends, and collapse zones (crush zones) such as dimples, holes, and slots.

A-4 Saturn vehicles have a space frame design.

A space frame is similar to a unibody and has a lightweight metal, or metal and composite structure. It is designed to meet federal crash standards without outer cosmetic body panels attached, unlike a unibody. The outer panels are attached with adhesives, mechanical fasteners, or both.

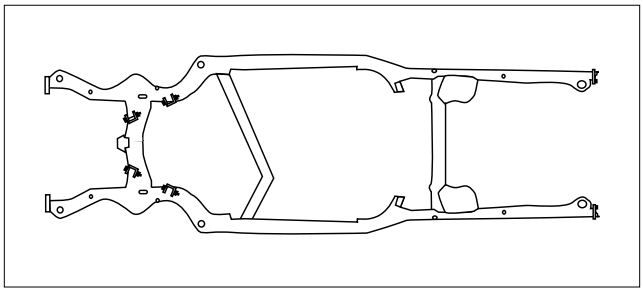
A-5 Some frames are now being designed with crush zones similar to unibodys.

Body-over-frame vehicles have an independent frame with a separate body bolted to the frame. Frame vehicles also have engine, drivetrain, and suspension parts mounted to the frame. Two main types of frame designs include ladder and perimeter.



A-6 Ladder frames have several riveted crossmembers that give the frame its ladder-like appearance.

A ladder frame has riveted and/or welded crossmembers. Depending on vehicle design, ladder frames may not be dependent on the body for strength. Ladder frame vehicles have a higher center of gravity compared to perimeter frame vehicles.

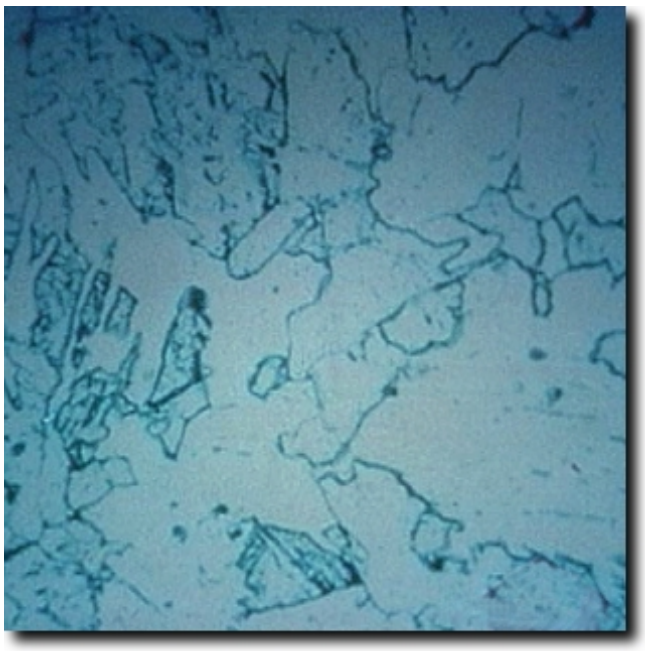


A-7 Perimeter frames provide a more car-like ride compared to ladder-frame vehicles.

Perimeter frames have riveted and welded crossmembers and work with the body to provide rigidity. Torque boxes are used to join the side rails to the front and rear frame sections. Torque boxes are multi-layered and often used for anchoring during collision repairs. Like ladder frames, perimeter frames use kick-up areas to position the suspension at proper height. Lastly, perimeter frames have a passenger compartment which has a lower center of gravity than ladder-frame vehicles.

Many trucks and sport utility vehicles have frames similar to the perimeter frames used on full-frame passenger cars rather than the ladder-type frames typically associated with trucks. These types of frames provide a more car-like ride and lower ride height to allow easier entry and exit from the vehicle.

Topic B. Types Of Vehicle Construction Material

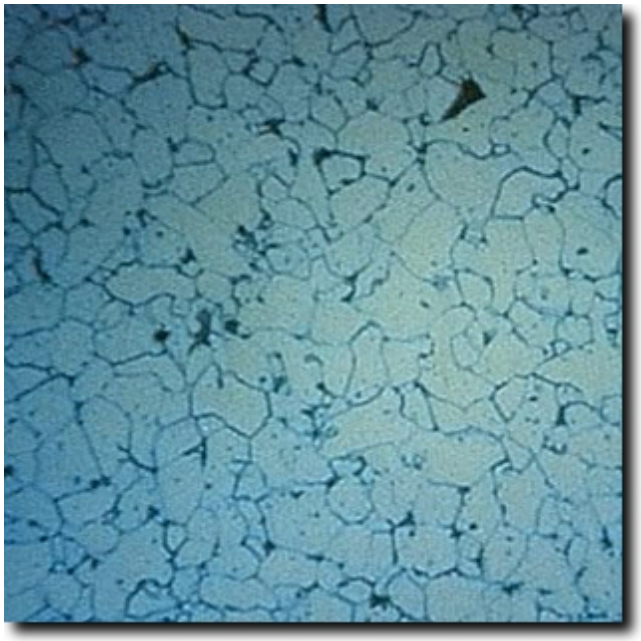


B-1 The grain pattern in mild steel is larger than high-strength steel or ultra-high strength steel, allowing it to be worked with minimal damage.

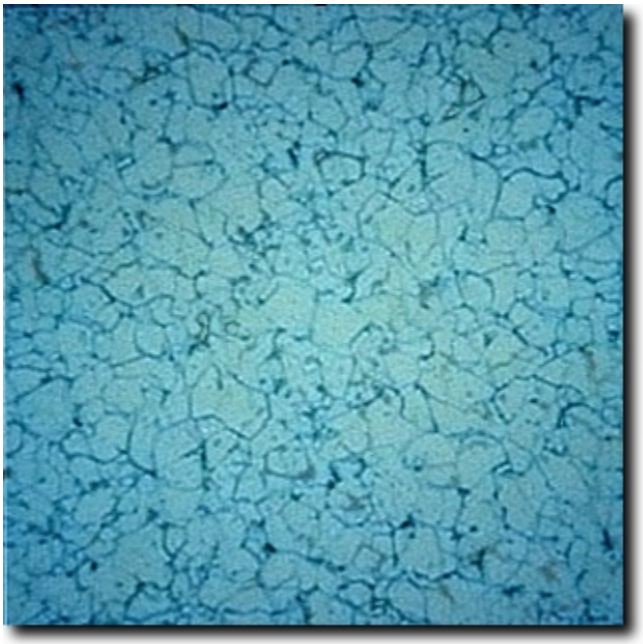
Vehicle makers use several different types of materials to construct a vehicle. These include steel, aluminum, plastic, laminates, or a combination of these materials.

The most used construction material is steel. The three most common types include mild steel, high-strength steel, and ultra high-strength steel.

Mild steel, which is typically used for structural parts, is easily formed and generally easy to work with. While this type of steel is less sensitive to heat than high-strength steel, it may increase in strength when it is formed or kinked.



B-2 The grain pattern for high strength steel is much closer together than mild steel.

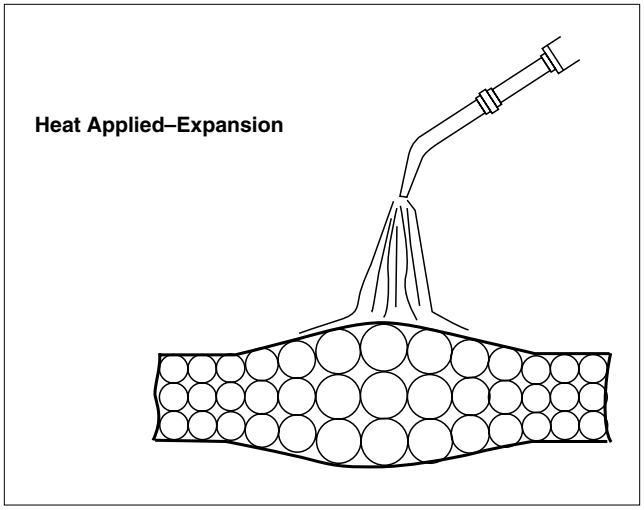


B-3 The grain pattern from UHSS is even closer together than HSS. It is this closeness that gives the steel its increased strength.

High-strength steel (HSS) describes a type of steel that has higher strength than mild steel. It is usually used in thinner gauges, which reduces vehicle weight, resulting in improved fuel economy. It also increases the strength of load-carrying structural parts.

HSS is more heat sensitive than mild steel. This typically requires HSS part to be straightened cold. Another type of HSS can be high-strength, low-alloy steel (HSLA). HSLA fills the gap between HSS and UHSS.

Ultra high-strength steel (UHSS) strength is destroyed by heat and parts are usually replaced if damaged. HSS is used for door intrusion beams and many bumper reinforcements.



B-4 Heating the steel expands the grain pattern and reduces the strength of the steel.

Because the strength of a steel part can be affected by applying heat, most vehicle makers recommend cold straightening, heat is only used as a last resort, if at all. Specific guidelines are typically provided by the vehicle maker for heating steel during repairs.

If heat is applied at too high a temperature, or for too long, the strength of the metal will be reduced. The point where fine-grained steel changes to coarse-grain steel is called the critical temperature.

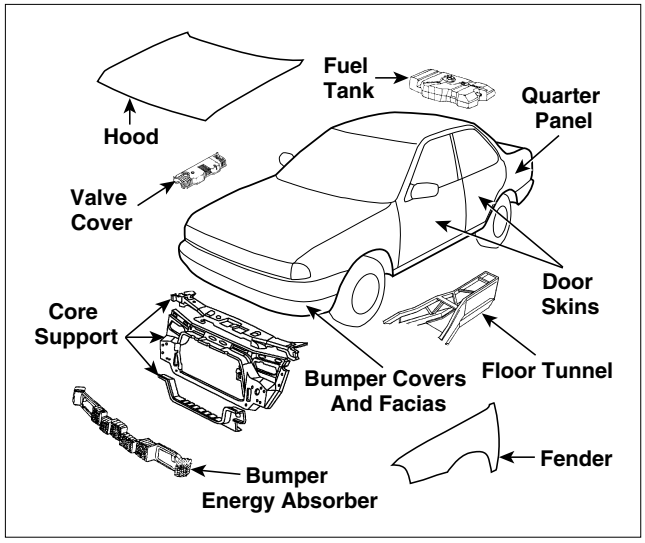
If metal is heated past the critical temperature, the grains get larger and the strength of the steel is reduced.

B-5 Applying heat can reduce the strength of metal temporarily while straightening methods are applied.

When using heat for stress relieving, refer to the body repair or service manual to determine if heat can be applied. If heat is allowed, follow the vehicle maker's recommendations for time and temperatures. Heating time is cumulative. This means that the metal can only be heated for the total time given. It cannot be reheated after the total time has been reached.

B-6 Temperature indicators are designed to change color when a specific temperature range has been reached.

Temperature indicators are used to help a repair technician determine the temperature of a part when it is being heated. Temperature indicators are available as heat sticks, thermal paints, and thermal labels. They come in a variety of temperature ranges and are available at most welding supply stores.



B-7 Plastic use has increased over the past years and can be found in many areas of vehicle construction.

To reduce vehicle weight, many vehicle makers are increasing the use of plastic in vehicle construction. The average amount of plastic used in vehicles in 1999 was 163 kg (360 lbs) with expectations that this figure will rise considerably over the next 10 years.

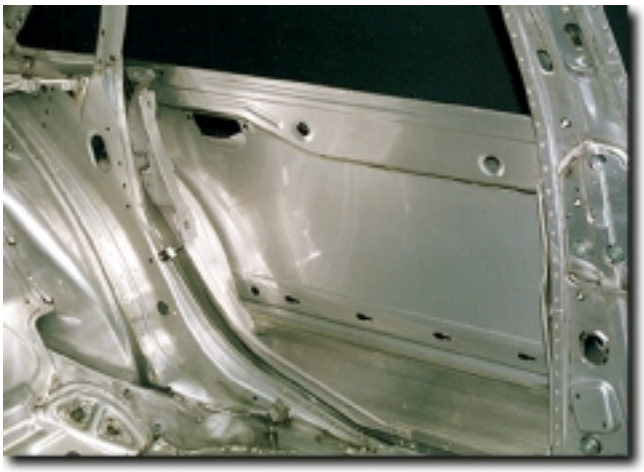
Some examples of where plastics are currently used include:

- bumper covers.
- trim.
- springs.
- bumper energy absorbers.
- upper radiator core supports.
- exterior body panels.
- fuel tanks.

Research is being conducted to see if plastics can be used for:

- windows.
- structural parts.
- lower control arms.
- frame rail reinforcements.

With the increasing use of plastic, it is important for technicians and appraisers to be aware of the special techniques required to diagnose damage and repair plastics.

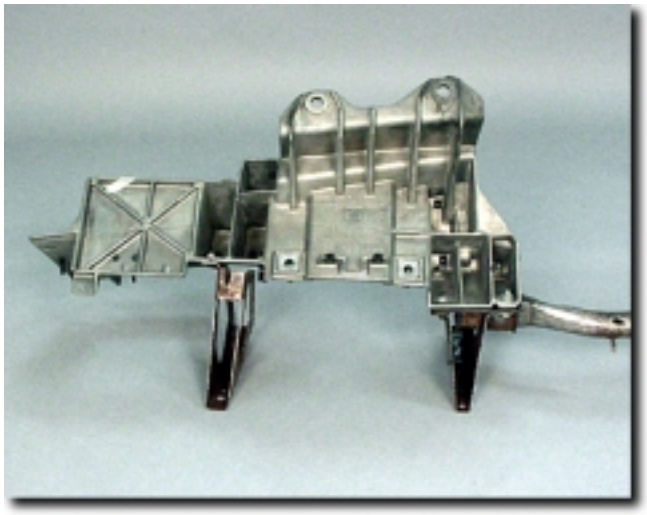


B-8 Aluminum can be a difficult material to repair if the specific aluminum type is not known.

Aluminum alloy is used in a variety of areas including both structural and non-structural parts. These parts are made using the following processes:

- Stamped, for sheet metal
- Extruded, for structural parts
- Cast, for engine parts

Like steel, aluminum alloy is available in different strengths. The different strengths are used in different areas of the vehicle depending on its potential use. Knowing the type of aluminum is important for the technician to make an appropriate repair. For example, when welding aluminum, the technician needs to know the type of aluminum so the appropriate welding wire can be chosen. Using the wrong wire can lead to poor weld quality or even weld failure.

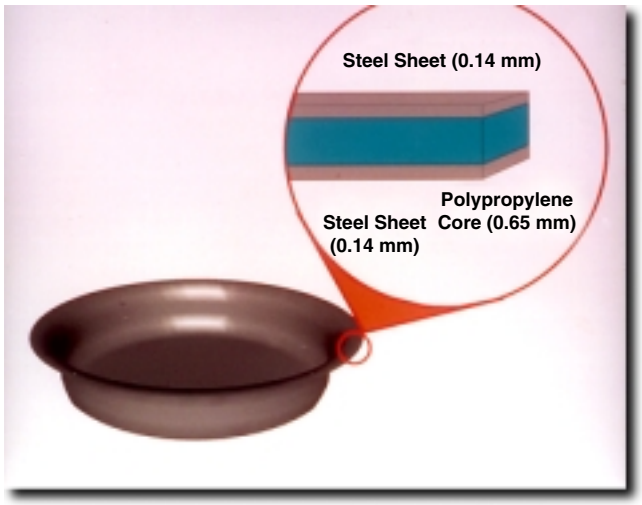


B-9 Magnesium is a very strong but brittle metal that is used in specific areas of the vehicle such as the instrument panel support bracket.

Some vehicle makers use magnesium for support brackets for the instrument panel or for miscellaneous panels in the vehicle structure. Typically, magnesium is used where weight has to be reduced but the strength of the vehicle must be maintained.

Magnesium is difficult to repair. Therefore, if a magnesium part is damaged it is typically replaced.

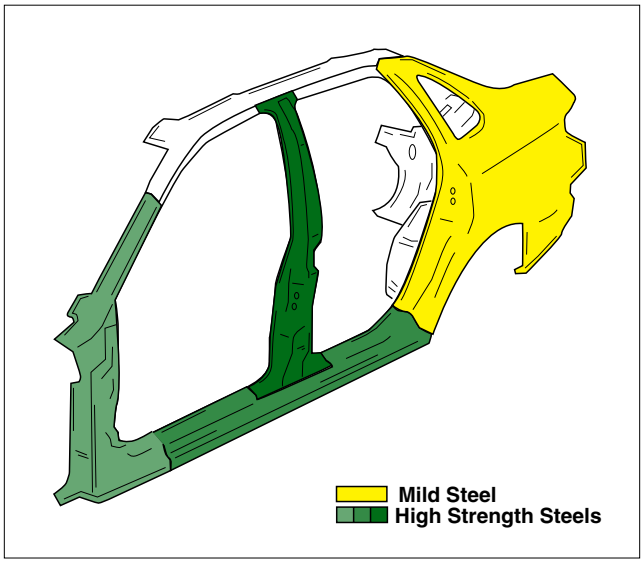
Do not heat or weld magnesium panels. Magnesium panels are flammable and will ignite if exposed to extensive heat. Extinguishing magnesium fires require a Type D fire extinguisher.



B-10 One weight-savings material design is sandwiching a polypropylene core between thin-gauge steel. A weight savings of 50% is possible compared to solid sheet metal.

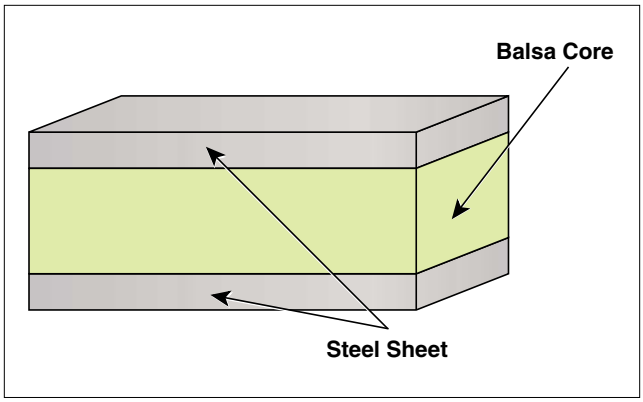
As use of plastic and aluminum continue to increase, the steel industry has worked on reducing the weight of their product to compete with these materials. Some solutions to decrease the weight of steel autobodies include tailor-welded blanks and steel sandwiched parts.

Using these designs, the vehicles not only meet the weight requirements but are less expensive to assemble than today's average vehicle due to the reduced number of parts.



B-11 Tailor-welded blanks are made by laser welding different thicknesses and different strengths of steel into one sheet.

Some sheets of steel are made up of a combination of a variety of types of steel. These types of sheets are called tailor-welded blanks. Tailor-welded blanks are made by laser welding together different strengths and possibly thicknesses of steel into one sheet. When the sheet is stamped into a specified design, different areas of the part are now of different strengths and thicknesses. This eliminates the need for flanges, reduces the number of spot welds by ⅓, and reduces vehicle weight.

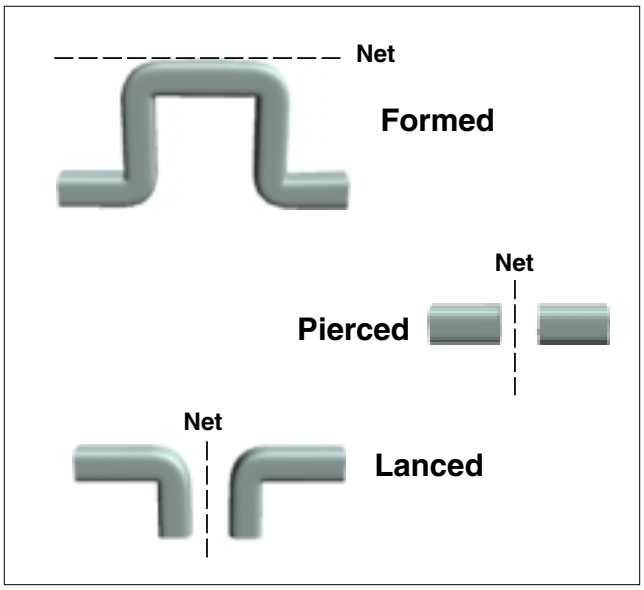


B-12 Instead of a polyproplene core, some steel sandwich designs use a balsa core.

Another weight-reducing method of construction is sandwiching a polypropylene core between two thin steel skins. This steel sandwich is used on the instrument panel insert and the spare tire tub on some vehicles. Weight savings of up to 50% are possible compared to a solid sheet metal.

Some vehicles have a layer of balsa wood sandwiched by composite material. This creates light, stiff panels that provide good sound deadening capabilities and reduce vibration.

Topic C. Manufacturing Processes



C-1 These types of reference points are used to locate outer body panels on unibody vehicles.

Some methods of manufacturing structural parts may affect service parts and how a vehicle is repaired. These methods include:

- the net build process.
- hydroforming.
- adhesive bonding.

Net build is a manufacturing process designed to accurately locate outer body panels on unibody and space-frame vehicles.

To do this, reference points are formed on the body during manufacturing. The body panels are aligned with these reference points during vehicle assembly.

The reference points used to align panels are "coined" into the vehicle's structure. Coining is the process of stamping metal under high pressure to alter the surface of a part. Three types of coined surfaces include formed, pierced, and lanced.

Formed areas are flat, raised, or depressed areas in the panel. Formed reference points are often also pierced or lanced. A pierced area is where a panel is punched, leaving a hole. Lancing is a piercing process. However, the areas around punched holes are stretched so the metal forms a thread surface for fasteners.

C-2 These coined surfaces are used to align panels on the vehicle structure.

Coined surfaces are usually not provided in replacement parts, and may require extra steps during the repair process to compensate for parts without a coined surface. These steps may include measuring to locate where the reference point should be. Shims may need to be added, adhesive-backed washers may be placed at formed locations, or holes drilled at pierced and lanced locations.

Another method used to compensate for parts without a coined surface is to temporarily position the part on the vehicle to determine where to drill mounting holes. It may be necessary to test fit parts such as a strut into a strut tower, an axle trailing arm onto a rear rail bracket, or a fender onto an upper rail.

C-3 Hydroforming creates seamless, one-piece structure, such as this engine cradle, from a steel sheet or tube.

Hydroforming is a process that uses hydraulic pressure to create a seamless, one-piece structure from a steel tube. The tube is first bent and pre-formed, then the fluid pressure molds the final shape. Because the part is molded instead of stamped, the part thickness is more uniform. Also, hydroforming is a cold-working process, increasing the effective yield strength of the steel. Some parts that are hydroformed include:

- A-pillars.
- front rails.
- roof panels.
- roof rails.
- full frame rails.

Because there is a reduction in the number of flanges on a vehicle, corrosion becomes less of a concern.

Hydroformed rails may be sectioned depending on the vehicle maker's recommendations.

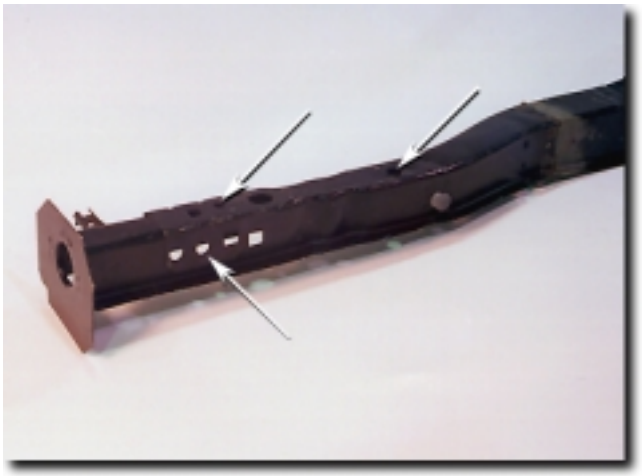
C-4 There is an increase in the used of adhesives to attach panels to the vehicle structure.

During the manufacturing process, some panels are bonded instead of welded to the vehicle structure. The bonding process includes weld-bonding or bonding with fasteners.

Weld-bonding is the process of using OEM spot welds with adhesive to attach panels to the vehicle structure.

Some vehicle makers combine adhesives with mechanical fasteners. The fasteners are designed to hold the panel in place until the adhesive cures.

Topic D. Control And Reference Points



D-1 These points are used to help align the vehicle structure during repair.

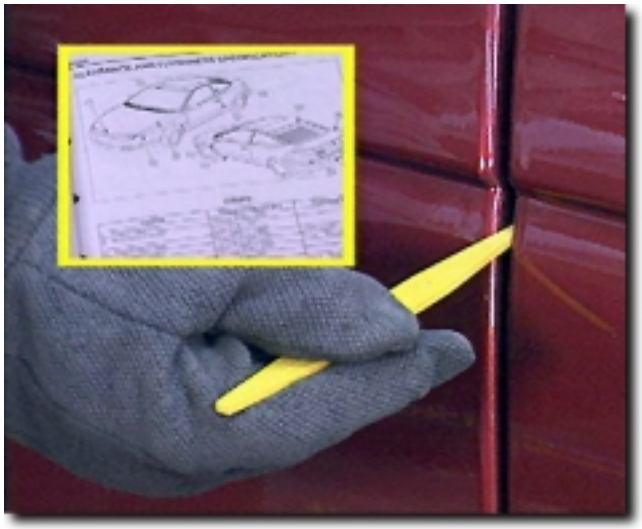
Vehicle makers use control and reference points to properly position parts or assemblies during the manufacturing process. Control points are points on the vehicle structure used to control the dimensional accuracy of the vehicle body during the assembly process. These points may include holes, slots, formed and pierced points.

Control and reference points are also used to measure vehicle dimensions for damage analysis. Reference points can be holes, hardware mounting locations, ball joint locations, and body center marks stamped into the sheet metal on both the underbody and upperbody areas.

D-2 Tram gauges are measuring tools used to make quick checks during damage analysis.

Tram gauges are measuring tools used to make center-to-center measurements of reference holes. Tram gauges have pointer tubes that are inserted securely into the reference holes or centered on the top of fasteners.

These are quick measurements used to check vehicle alignment without mounting the vehicle to a three-dimensional measuring system.



D-3 Production tolerances can be as little as 0 mm or as high as 3 mm depending on the vehicle and vehicle maker.

All high-production vehicles are welded and assembled on an assembly line. They may have variations in dimensions between identical vehicles but all are built within a certain tolerance. Tolerance is the range that a measurement can vary by and still be acceptable. This tolerance may be as low as 0 mm for some vehicle makers.

D-4 Repair tolerance should not be more than 3 mm for the entire vehicle.

When repairing a vehicle, it is important to return it as close to vehicle maker specifications as possible. A structure that is not returned to proper specification may affect suspension angles and alignment, drivetrain alignment, panel fitup, and collision energy management.

The amount of tolerance may vary according to location. For example, a door opening that is 2–3 mm out of alignment may be evident in the door gaps. However, a condition where the trunk floor extension is 2 mm out of alignment may be less of a problem during reassembly.

Areas with very low tolerance include non-adjustable door hinges, uniside construction, non-adjustable suspension mounting locations, and airbag sensor mounting locations.