Intro to Vehicle Construction Materials
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## Contents

Introduction..............................................................................................................................7  
Obligations To The Customer And Liability..........................................................................7  
Intro to Construction Materials...............................................................................................11  
Steel....................................................................................................................................11  
Aluminum And Magnesium................................................................................................14  
Plastics And Carbon Fiber.................................................................................................. 18  
Collision Energy Management............................................................................................22
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Introduction
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Obligations To The Customer And Liability

The Collision Repair Industry has an obligation to correctly repair the customer's vehicle. Collision repairs must be performed using:

- recommended or tested procedures from vehicle makers, I-CAR, and other research and testing organizations.
- quality replacement parts and materials.
- repair processes and parts as written and agreed upon in the repair order.
- If items on the repair agreement are not consistent with the repair order, it can be considered fraud.

Performing proper collision repairs requires using parts and procedures that keep remaining warranties intact. Collision repairs must restore:

- safety.
- structural integrity.
- durability.
- performance.
- fit.

Throughout the damage analysis and repair process the repairer and insurer must: communicate with each other.

- maintain constant communication with the customer.
- be in agreement with each other and the customer on how repairs will be performed.
- inform the customer of any changes in the repair plan from the original repair agreement, and explain the changes and why they have to be made.

To reduce liability:

- make sure that all repairs are performed thoroughly, correctly and as listed in damage report.
- follow proper procedures.
- use quality replacement parts and materials.
- have documentation of required repairs with detailed record keeping available for customers.
Technicians are considered the experts and are expected to be knowledgeable on how to perform a quality repair.

Keeping thorough records includes more than recording the date, mileage, and pre-existing damage. Record keeping also includes: making sure all notes are legible.

• verifying the repairs that were made or not made.
• having the customer sign a waiver for repairs that they do not want performed. Repairers must determine their liability on not repairing safety systems such as restraint and anti-lock brake systems.
• keeping computer printouts or worksheets on file showing wheel alignment readings or vehicle dimensions before and after repairs.
• keeping scan tool printouts and records of computer codes for airbag, anti-lock brake, emission, and powertrain control module (PCM) systems. attaching the OEM or other tested procedure printout to the vehicle repair order.
• keeping receipts for all sublet work performed.

Liability insurance that covers the repair facility may not always cover all damages. For example:

• the policy may not cover faulty repairs, leaving liability responsibility completely on the facility.
• a shop owner may find that repair facility liability coverage may not cover the full amount awarded in a lawsuit. The shop owner would have to pay the difference.
Intro to Construction Materials
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Steel

Learning objectives for this module include:

- explaining steel strengths and characteristics.
- identifying various types of steel used in vehicle construction.
- explaining some of the forming processes used for steel used in vehicle construction.
- identifying considerations when working with steel parts.

Various strengths of steel are used in the construction of this vehicle structure.

Vehicle makers use several types of materials to build a vehicle. The most common construction material is steel. Characteristics and strengths of steel include that:

- steel is a ferrous metal. A magnet will be attracted to a ferrous metal.
- all steels are alloys that contain a combination of iron, which is the primary metal, and carbon, which is the primary hardening element.

As carbon content increases, hardness and strength increase.
- in the collision repair industry, steel part strengths are identified with tensile strength. Tensile strength is the amount of force necessary to tear a piece of steel apart. The amount of strength is typically measured in megapascals (MPa). One MPa is equal to 145 pounds per square inch.

The black parts shown here are made from mild steel.

There are various types of steel used in vehicle construction. Types of steel include:

- mild steel. Mild steel is the lowest strength steel used in vehicle construction and is easily formed. Examples where mild steel is used include some outer body panels. These steels are typically less than 270 MPa in strength.
- high-strength steel (HSS). HSS describes types of steel made to have higher strength than mild steel. Examples where HSS is used include some vehicle structural
parts. These steels are typically more than 270 MPa in strength.

- ultra-high-strength steel (UHSS). UHSS describes types of steel made to have higher strength than HSS. Examples where UHSS is used include some vehicle structural reinforcement parts, and bumper reinforcements. UHSS parts are typically more than 700 MPa in strength.

Some specific steel types that may be found in vehicle construction include:

- boron-alloyed steel. Boron-alloyed steel is basically a carbon steel that has a small amount of boron added to it that makes it exceptionally hard.
- dual-phase (DP) steel. DP steel is high strength, and has good formability. It has a higher energy-absorbing property than HSS.
- transformation induced plasticity (TRIP) steels. Like DP steel, TRIP steel has a higher energy-absorbing property than HSS.

Another type of steel used for certain parts by some vehicle makers is laminated steel. Laminated steel:

- has two outer layers of steel with an inner polymer (plastic like) layer.
- is primarily used for noise, vibration, and harshness control, as the polymer layer absorbs any sound waves that are passing through the metal.

Some examples where laminated steel is used include the cowl panel on some vehicles, and the seat storage tubs for some minivans. The cowl (also referred to as the firewall) is the panel forward of the instrument panel that separates the engine compartment from the passenger compartment.
Video: Steel Part Forming

Steel Part Forming
Steel parts are formed using a variety of methods. Some forming processes include stamping, hydroforming, tailor-welded, and tailor-rolled blanks.

When stamping is used, a piece of sheet metal is placed in between two dies, and a press forces the metal into the shape of the dies using extreme pressure. A die is a form used in the manufacturing process to shape the sheet metal into a part.

Tailor-rolled blanks are different thicknesses of the same strength steel in the same part. During the manufacturing process, the roller increases pressure in areas of the sheet steel where thinner metal is desired and decreases pressure for areas where thicker metal is desired.

A tailor-welded blank is a panel that has dissimilar thicknesses or metal alloys. It is laser-welded together to form one continuous piece.

The strength of a steel part can be affected by exposure to high temperature.

There are various considerations when working with steel parts. Some of these include:

- heat affect. The strength of a steel part can be adversely affected by heat. If a steel part is exposed to high temperature, the strength of the metal may be altered. This is critical with HSS because excessive heat can weaken high-strength steel.
- work hardening. Work hardening occurs when steel is bent from being formed, damaged, or straightened. Work hardening causes the metal to become harder and stronger, but also more brittle. Severe work hardening results in cracking.
- deformation. Deformation is caused by a collision or impact. Deformation is an area where the metal is bent out of its original shape. Deformation hardens the metal, making it more resistant to straightening.
- elasticity. Elasticity is the ability of a material to regain its original shape after a deflecting force has
been removed. Mild steel has very little elasticity compared to HSS.

- plasticity. Plasticity is the ability of a material to be bent or formed when sufficient force is applied. Generally, plasticity is considered the opposite of elasticity. Mild steel typically has a higher degree of plasticity compared to HSS.

Topics discussed in this module included:
- explaining steel strengths and characteristics.
- identifying various types of steel used in vehicle construction.
- explaining some of the forming processes used for steel used in vehicle construction.
- identifying considerations when working with steel parts.

Aluminum And Magnesium

Learning objectives for this module include:

- identifying properties and characteristics of aluminum.
- identifying where aluminum parts are used in vehicle construction.
- explaining considerations when working on aluminum parts.
- identifying properties and characteristics of magnesium.
- identifying where magnesium parts are used in vehicle construction.
- explaining considerations when working on magnesium parts.

Aluminum is used for outer body and structural parts on the vehicle shown here.

Aluminum is a strong, lightweight metal used in vehicle construction to help reduce vehicle weight. Aluminum is:

- used for various parts of a vehicle.
- used in various strengths depending on the function of the part. Aluminum may have different alloys to alter the strength and other characteristics.
- corrosion resistant. Aluminum forms a sacrificial oxide coating that bonds to and protects the aluminum from corroding. It is a self-healing coating. If the oxide is removed, it will begin to reform almost immediately.
Video: Aluminum Part Forming

Aluminum Part Forming
Aluminum can be easily formed into multiple shapes during production. Aluminum parts are formed using a variety of methods, which include stampings, castings, and extrusions.

Pressing or stamping an aluminum sheet in a die forms stampings. Aluminum stampings are typically used for exterior body panels, such as fenders, hoods, and doors.

Pouring molten aluminum into a mold and allowing it to cool forms an aluminum casting. Cast-aluminum parts are typically used for structural applications such as a suspension mounting location.

Forcing a solid piece of aluminum, that has been softened with heat, through a die forms extrusions. Extruded aluminum parts, such as this, are typically used for structural applications.

Identifying if a part is aluminum is important for making repair or replace determinations. Identification can be done by:

- using a magnet. Aluminum is a nonferrous metal. A magnet will not be attracted to an aluminum panel.
- referring to the vehicle maker service information. Aluminum parts may be identified in the service manual.

Galvanic corrosion can appear as a white ash-like residue on aluminum.
Aluminum is susceptible to galvanic corrosion. Galvanic corrosion:

- occurs when dissimilar metals come in contact along with the presence of an electrolyte, such as moisture. If a bare aluminum panel comes in contact with a bare steel fastener, and there is moisture present, the aluminum may corrode at a faster rate than the steel fastener.
- can be avoided by using coated fasteners, or non-metal washers or gaskets between the dissimilar metals.

Shown is a cracked aluminum body panel.

Considerations when working with aluminum parts include that when aluminum is bent, it wants to stay in that shape. This may limit the ability to be straightened back to the original shape. Aluminum:

- stampings are typically more repairable than castings or extrusions. This does not mean, however, that they can always be repaired.
- extrusions have limited repairability.
- castings are not repairable.
- has rapid heat transfer properties. Heat will spread rather than stay concentrated in a small area. Unlike steel, aluminum has no color change when heated to indicate that the surface temperature is rising.
- dust in high concentrations can be highly combustible and explosive. Clean up of aluminum dust/metal shavings should be done using a broom and dustpan, or a special explosion-proof vacuum dust collection system.

Shown here is a cast magnesium part.

Magnesium is a type of metal used in vehicle construction for various parts. Magnesium:

- is a lightweight material. It is lighter and stronger than some steel, and is typically used where weight has to be reduced, but the strength must be maintained.
• is nonferrous. A magnet will not be attracted to a magnesium part.
• parts have good noise, vibration, and harshness dampening characteristics.
• parts are typically made from castings. Pouring molten magnesium into a mold and allowing it to cool forms a magnesium casting.

Magnesium is used for various parts. Some examples include:

• structural parts.
• engine and suspension parts.
• roof frames.
• liftgate and door frames.
• seat frames.
• steering wheels.

Considerations when working with magnesium parts include that:

• unless otherwise specified by the vehicle maker, cast magnesium parts are typically not repaired, and may require replacement if damaged.
• magnesium parts are typically attached using mechanical fasteners. Vehicle makers may have specific attachment requirements for magnesium parts to help prevent corrosion when it is attached to a dissimilar metal.
• magnesium dust is flammable and can ignite. However, the likelihood of fire is minimal with parts because heat dissipates quickly on magnesium.

Topics discussed in this module included:

• properties and characteristics of aluminum.
- where aluminum parts are used in vehicle construction.
- considerations when working on aluminum parts.
- properties and characteristics of magnesium.
- where magnesium parts are used in vehicle construction.
- considerations when working on magnesium parts.

**Plastics And Carbon Fiber**

Learning objectives for this module include:

- identifying where plastic parts are used in vehicle construction.
- identifying properties and characteristics of plastic.
- identifying where carbon fiber parts are used in vehicle construction.
- identifying properties and characteristics of carbon fiber.
- explaining plastic type identification.
- explaining considerations when working on plastic and carbon fiber parts.

**Video: Plastic Use**

Plastics are lightweight materials used in vehicle construction for various parts. Some examples where plastics may be used include front and rear bumper covers, grilles, mirrors, and interior and exterior trim panels.

The grille and bumper cover on this vehicle are both plastic.

Depending on the part, the type of plastic used may be flexible or rigid. The two general classifications of plastics include:

- thermoplastics. Thermoplastic parts are formed by melting pellets, forcing the molten solution into a mold, and then cooling. Thermoplastics are commonly
used for making flexible parts such as front and rear bumper covers.
- thermoset plastics. Thermoset plastic parts are permanently shaped when formed and cannot be heated and reshaped. Thermoset plastics are commonly used for making rigid parts such as grilles and outer mirror housings.

Some plastics may be reinforced with fibers. These may be called fiber-reinforced plastics, or composites. The primary function of the fibers is to provide strength and stiffness. Fiber-reinforced plastic:

- parts are usually considered a rigid part,
- can be identified by fibers or strands visible in the damaged area. Fiber matting may also be visible on the backside of the part.

There are various types of fiber-reinforced plastic used for vehicle part construction. One example is carbon fiber-reinforced composite, more commonly called carbon fiber.

Shown is a carbon fiber fender from a Corvette ZR1.

Carbon fiber is high cost to manufacture and large carbon fiber parts are generally found on luxury and high-performance vehicles. Carbon fiber may be used for almost any part of a vehicle. Some examples where carbon fiber is used include:

- hoods.
- fenders.
- door panels.
- roof panels.
- floors and underbody panels.
- interior and exterior trim parts.
Shown is a visible weave carbon fiber roof panel on a Corvette ZR1.

Carbon fiber parts are a combination of a polymer and carbon fibers. The carbon fibers are the reinforcing substance. Carbon fibers are made from carbon atoms, which are joined together to form long fiber strands. These fibers are very strong and lightweight. Carbon fiber:

- parts are reinforced through the use of bi-directional woven carbon fiber cloth. Carbon fiber cloth is manufactured in various weave patterns. The patterns may be visible on some panels.
- may be used for almost any part of a vehicle.
- parts are similar to fiberglass parts in appearance when painted.
- parts are very strong and lightweight. The strength of some carbon fiber parts may be equal to or greater than some aluminum or steel parts.

Video: Plastic Type Identification

Plastic Type Identification
In the repair process, plastic parts need to be identified to ensure the appropriate materials and procedures are used.

The best way to identify a plastic part is to use the International Organization for Standardization, or ISO code. Most plastic items will have an ISO code on them. ISO codes are a standard set of letter codes that identifies the plastic.

The ISO code on a plastic part may be molded into the backside of the part or a non-visible area. The location is not consistent from vehicle to vehicle or even part to part. The part may need to be removed to access the code.
Some vehicle makers may have recommended procedures for making plastic repairs.

Some considerations when repairing plastic parts include that:

- adhesive may be used to bond damaged pieces together.
- some plastics may be welded using a plastic welding process.
- some plastics may require an adhesion promoter before adhesives, fillers, and paint coatings can be applied.
- broken mounting tabs may be repaired or re-created.
- fiber-reinforced plastics typically require special repair procedures and repair materials. These can only be repaired using adhesives.
- some plastic parts may be textured. These are difficult to duplicate and typically replaced rather than repaired.
- some plastic parts should not be repaired, such as pressurized plastic fuel tanks and cooling system surge tanks.

Considerations when working on carbon fiber parts include that:

- damage may not be visible from the front side of the part. This may require access from the backside to make repair or replace decisions.
- some vehicle makers may not allow repairs to some carbon fiber parts.

Topics discussed in this module included:

- where plastic parts are used in vehicle construction.
- properties and characteristics of plastic.
- where carbon fiber parts are used in vehicle construction.
- properties and characteristics of carbon fiber.
- plastic type identification.
- considerations when working on plastic and carbon fiber parts.
Collision Energy Management

Learning objectives for this module include:

- identifying different build designs of vehicles.
- explaining parts that absorb collision energy.
- explaining parts and areas of a vehicle that transfer collision energy.
- explaining how collision energy travels through a vehicle during different types of collisions.
- explaining why different steel is used in vehicle construction.
- explaining the difference between a tailor-welded part and a tailor-rolled part.
- describing the function of a vehicle collapse zone.
- explaining how the restraint system works with the structure to protect occupants.

A unibody vehicle:

- is a unitized structure that is built by attaching multiple parts of sheet metal to create a structure that creates a safety cage around the occupants.
- controls collision energy with crush zones, kick-up areas, and different types and strengths of steel or aluminum. Some parts have designed-in dimples, holes, and slots that cause the part to crumple in a collision. Other parts are rigid, but are designed to "kick up" and redirect collision energy around the passenger compartment.

Some unibody vehicles use the quarter panels and roof to add strength to the unitized vehicle structure. A space frame vehicle is a metal or composite unitized structure. Space frames are less dependent on outer body panels for structural integrity.

A space frame is built similar to a cage used in a racecar. This design is intended to provide safety for the passengers in frontal, side, and rear collisions.
Full-frame or body-over-frame vehicles use a separate frame assembly that is attached to the body structure.

Body-over-frame designs are vehicles that use an independent frame with a separate unitized structure bolted to the frame. Body-over-frame vehicles may also be referred to as full-frame vehicles.

The three sections of a vehicle or frame serve different functions.

Each vehicle is designed with three main areas, the front, rear, and center section.

Each section of the vehicle has a specific function to perform during a collision. The front and rear areas are designed to initially collapse and absorb collision energy.

Unlike the front and rear sections of the vehicle, the center section, or passenger compartment is not designed to collapse. For the center section, collision energy is transferred around it and remains intact. This provides a safe area for the occupants.

The extent of the amount of collision energy being absorbed or transferred by the vehicle varies with the severity and direction of the impact.

Collision energy starts at the point of impact on the vehicle. Vehicle structures are designed to absorb and/or transfer collision energy. These structures are built using crush zones, which are designed in the steel or aluminum. Crush zones are used to collapse or bend in a controlled manner to control collision energy.

In areas of the vehicle structure where collision energy transfer occurs, stronger materials are used that resist bending. These materials transfer collision energy around the structure.
To manage collision energy, reinforcements, different thickness materials, varying material strengths, or a combination of these may be used.

**Video: Understanding Collision Forces**

Understanding Collision Forces
To understand the importance of restoring the integrity of the vehicle structure, it may be helpful to see the advances in safety features over vehicles of 50 years ago. Watch as this 1959 Chevrolet Bel Aire collides with a 2009 Chevrolet Malibu in a 40 mph offset test. In slow motion, take note of the Bel Aire structure. Notice how the door separates from the lock pillar. The windshield separates from the pinchweld, and the front structure on the driver side completely collapses. This view shows the impact from the backside.

From inside the vehicle, notice how the steering column pushes toward the driver. The driver's head impacts the roof structure, and the seat separates from the floor.

Here we see the impact from the driver's side of the Malibu. Note how the vehicle's center section remains intact, including the door, roof panel, and windshield. From inside the Malibu, we see how the driver remains properly positioned. The steering column remains in place, and the properly deploying airbag protects the driver from any contact with the steering wheel.

Advances in vehicle design over the past several decades have created a safer passenger cab, reducing the number of severe injuries and even deaths. Vehicle makers have added crush zones, higher strength steels, and advanced restraint systems to control collision energy and protect the passenger. These must be restored as originally designed to ensure they react similarly in a subsequent collision.

**Ford Mustang**

Collision energy is absorbed between the rear bumper and the fuel tank.

There are general parts on a vehicle that are important to its collision energy-absorbing characteristics. These parts are located away from the passenger compartment on both the front and rear of the vehicle. As a general rule, the further away a part is from the passenger compartment, the more it will collapse.
and absorb collision energy. Parts that are closer to the passenger compartment are generally designed to transfer collision energy.

Some parts that typically are used for absorbing collision energy include, but are not limited to, bumper assemblies, crush caps, and frame rail ends.

Some parts are designed to absorb the inertial energy of the passengers. Inertial energy occurs from passengers and other objects inside the vehicle continuing their momentum after the vehicle has stopped. These parts include the:

- seats. Seat backs are designed to move rearward during a rear collision. This is done so the occupant can ride down the rear collision energy forces.
- floors.
- steering wheel and steering column.
- instrument panel.
- airbags, as they are used to control the inertial energy from the occupant as they move forward toward the steering wheel and dash.

**Video: Comparative Crash Damage**

![Comparative Crash Damage Video](image)

Comparative Crash Damage

It’s important to understand that today’s vehicles have changed. If you look at the vehicles from ten years ago they look very similar, but the structures react differently in a collision. Now more than ever high-strength steels and ultra-high-strength steels are being used throughout the vehicle. One way to see what difference that makes is to watch a crash test video.

As you watch the energy transferring through the structure of the Buick LeSabre, notice the windshield area and the door gaps. The passenger compartment has some deformation. Now watch both the windshield and door gap areas again on the Buick Lucerne and compare the damage between the two. You can see the collision energy following a similar load path, but it does not deform the passenger compartment as much. This gives the occupants more protection.
Rear collision energy follows the rear rails up to the center section of the vehicle.

Similar to a front-end impact, when a rear impact occurs, the outer end of the rear frame rails will collapse to a specific location. At this point, the vehicle structure will transfer collision energy to the front of the vehicle.

Collision Energy Absorbing Seats
Using this energy-absorbing seat, let's see how it functions to absorb rear collision energy. This type of seat is designed to support the occupant and reduce the chance of injury during a rear collision.

During a rear collision, part of the seat hinge assembly moves rearward. This moves the seat back assembly up. When the seat is at the full up position, and if the rear impact forces are severe enough, the seat hinge continues to deform and the seat back tilts rearward. As the hinge moves up, the seat back tilts. A seat that has deformed to absorb collision energy may appear to be reclined too far back, or appear to have an excessive gap between the seat back and the seat cushion. On the left is a seat following a rear collision, and on the right is an undamaged seat assembly.

Following the collapse of a part, collision energy follows specific paths around the vehicle.

Though a part is designed to transfer collision energy, it will only resist deforming to a certain point. Typical parts on a vehicle that are designed to transfer collision energy include the:

- A-pillar.
- B-pillar.
- roof rails.
- rocker panel or sill.
- crossmembers.
- floor pan reinforcements.
Saab 9-3

From a side impact, collision energy forces follow specific paths within the vehicle structure to limit deformation.

In a side impact, the latest technology incorporates high-strength materials that minimize intrusion into the passenger compartment. The lower portion of the passenger compartment is designed to deform slightly to absorb some collision energy in a controlled manner. However, the remainder of the passenger compartment is designed so that most of the collision energy is transferred across the reinforced roof and floor structure with minimal deformation. This is because vehicles today are built with less space between the passengers and the side of the vehicle.

If soft materials were used in the side structure, the occupants might suffer severe injuries. By using materials such as ultra-high-strength steel (UHSS), there is less side-structure deformation and the collision energy is directed around the passenger compartment.

Vehicle roofs are tested and rated according to how much weight it takes for the roof to crush.

For rollover protection, the Insurance Institute for Highway Safety (IIHS) has set a standard that tests the resistance of the roof to crushing during a rollover. This resistance should equal the weight of four times the weight of the vehicle.

By setting these standards, vehicle makers are building vehicles to higher standards with better rollover protection. To meet these standards, the A-pillars, B-pillars, roof rails, and cross members need to be strengthened for better crush resistance.

This cutaway frame rail shows a hidden reinforcement.

Vehicle structures will use reinforcements in different areas of the vehicle.
Reinforcements may be steel, aluminum, composite, plastic, or nylon.

The primary function of reinforcements used in the vehicle structure is to strengthen the structure in a specific area to keep the part from bending or deforming.

Different elements are added to molten steel to change its properties.

There are a variety of different steels used in automobile production. These steels are categorized as mild, high-strength steel (HSS), and ultra-high strength steel (UHSS). Each material serves different functions depending on where they are used on a vehicle structure.

Mild steel was typically used extensively in the construction of older model vehicles. Parts made of mild steel required this softer material to be thick and heavy because the parts needed to be more robust to offer adequate strength.

High-strength steels were developed to replace some of the mild steel because of strength and also being thinner and lighter. Using this newer material allowed for meeting increased crash protection and fuel economy standards. With a change to the use of lighter and stronger steels, also came parts that are less repairable because of the steel strength.

UHSS was developed to meet even more stringent new government crash and fuel economy requirements.

Toyota Camry

Different features are used to help initiate and control how a part deforms.

Vehicle structures use crush zones located in different areas. Crush zones are locations on the vehicle that collapse in a controlled manner. Depending on the desired outcome, different designs may be used to create a crush zone. These include convolutions, holes, dimples, slots, or reinforcements.
Laser-welded seams are an indicator of a tailor-welded part.

Tailor-welded and tailor-rolled parts are made using an engineering process that combines multiple collision energy management characteristics into a single part. Working around these parts creates challenges because vehicle makers typically do not allow sectioning repairs near the welded or rolled area.

Tailor-welded parts are made by laser welding two different strengths or thicknesses of steel together to form a single part. The varying thicknesses and strengths of a tailor-welded part can be designed to collapse in a predictable manner during a collision. Tailor-welded parts may be used anywhere on a vehicle.

A tailor-rolled part is made by changing the thickness of a piece of metal using a pressurized roller system. This process does not join different types of metal, but only varies the thickness of the metal. Depending on the style and location of the part, the differences in thickness may not be visible.

Audi developed form-hardened steel for parts such as the Q5 B-pillar reinforcement.

Metal can get strength from the forming process. Form-hardened steel provides another option for creating parts with crush zones. This type of steel is created by cooling the part at different rates to create different strengths within a part. The crush zone is the portion of the part with the lowest strength.
Damage to aluminum may cause welds to crack.

To reduce vehicle weight, aluminum is used in a variety of areas or as the main construction material for a vehicle. Benefits of aluminum include its predictable manner during a collision, high strength, and light weight.

Topics discussed in this module included:

- different build designs of vehicles.
- explaining parts that absorb collision energy.
- explaining parts and areas of a vehicle that transfer collision energy.
- how collision energy travels through a vehicle during different types of collisions.
- why different steel is used in vehicle construction.
- the difference between a tailor-welded part and a tailor-rolled part.
- the function of a vehicle collapse zone.
- how the restraint system works with the structure to protect occupants.