Understanding Structural Damage on Today's Vehicles

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PART 2 OF 3: SIDE IMPACT COMPONENTS

In last month's column, we talked about the understanding of collision-related structural damage and how to diagnose the damage to the frontal components. This month, we will discuss the understanding and diagnosing of the structural side components of a vehicle and how they manage the applied force in a collision event. Today's vehicles are designed to absorb a certain amount of side collision energy (or collision pulse), and then transfer that pulse up and over, and down and under the passenger compartment for the safety of the occupants. The questions associated with damage diagnosis and repair are, "How does this happen?" and, "What are the effects on the associated components?"

The biggest culprit in poor side-impact damage assessment is the lack of measuring the distance from the B-Pillar on the damaged side to the undamaged side of the vehicle when compared to the vehicle dimensions (OEM, ALLDATA information or three-dimensional measuring equipment). Measuring the distance between the B-Pillars can give the damage assessors (estimators and adjustors) a visual indicator of how much impact force the vehicle absorbed. The major problem with most B-Pillars is that they are a multi-layer structure with inner and outer panels of typically High Strength Steel (HSS) and an inner reinforcement comprised of some sort of Ultra High Strength Steel/Advanced High Strength Steel/Extra High Strength Steel (UHSS/AHSS/EHSS). Depending on the manufacturer's terminology, they will call this substrate UsiBOR, UHSS, AHSS or EHSS (Martinsitic or Boron alloyed steel). It is imperative that the damage assessor knows the tensile (psi) strength (usually specified in Mega-Pascals [MPa]) of the substrate, due to the amount of overlapping strength ratings and substrate terminology utilized by OEMs. The OEM or ALLDATA information will provide this information in the construction materials section of their websites. Often, a vehicle B-Pillar will show little or no evidence of movement until the pillar is measured. Many professionals are misled by the operation of the closure panels (doors) and assume that misalignment of the closure panels are the damage to the panels themselves and not the supporting structure.

Damage may be hidden deep inside the structure of the vehicle, which can be a major issue that may cause a multitude of problems. A repair that was assumed to be low-cost and take a day or so can easily turn into an eight-to-15-day repair and cost upwards of thousands of dollars due to the UHSS pillar reinforcement. There are two major reasons why this happens: A lack of knowledge of what occurs in a collision event and how the vehicle reacts, and laziness.

Hopefully, the following explanations of how the side components of a vehicle react to the applied forces in a collision event will help assist damage assessors to better understand what they need to do to fully view the damage sustained by the vehicle components as a system. Let's look at the side components and how they react in collision events.

Front and Rear Door Shells, Intrusion Beams and Trim Panels

Front and rear door shells (door shells) can be constructed from HSS, High Strength Low Alloy (HSLA), Dual Phase (DP) steel or any combination through the use of tailor-welded blanks. The Ford F-150 is an example of a tailor-welded blank door shell. Some manufacturers are using aluminum door shells (5000 or 6000 series, Infiniti M and FX), in some rare cases, magnesium (Mercedes Benz CL Class) and even carbon fiber plastic (Corvette ZR1 and Mercedes Benz SLR). Regardless of the type of door shell substrate utilized by the OEM, the door shell is basically the housing for the intrusion beam. Intrusion beams are constructed of UHSS, AHSS, EHSS, UsiBOR or structural aluminum (6000 or 7000 series) and can either be bolted or welded to the door shell. Intrusion beams perform two very important duties: The first is assisting in transferring the crash pulse to the pillars; the second is to strengthen the pillars by stabilizing the door opening until all of the crash pulse has dissipated.

During a collision, the applied force moves through the door assembly. The intrusion beam starts to transfer the collision pulse outward towards the pillars. As the pulse travels across the intrusion beam, the beam may start to deform inwardly depending on the amount of applied force. As the beam deforms inward and forces the door shell to move inward, the design of the door trim panel becomes important. Door trim panels are constructed from fiberboard or plastic with a thin foam pad (cushioning) covered by leather, cloth or some combination. This is done so that during a collision event, the occupants impact a "soft" object. What many technicians do not know is that the foam block found on the backside of the trim panel, and even the shape of the panel, plays an important role in assisting the transfer of the collision pulse. As the door shell moves inward, the trim panel – through the shape of the panel and the foam blocks – starts to come into contact with the seat assembly. The seat assembly then starts to assist in the transfer of the crash energy (see explanation below).

B-Pillars

B-pillars are generally constructed with an outer panel and inner panel made from Mild Steel/Baked Hardened Steel (MS/BHS), High Strength Steel (HSS) or aluminum (5000 series) that sandwich an inner reinforcement. The outer and inner panels are pressed in three basic ways: Tailor-rolled blank, tailor-welded blank or a single-layer panel. One example of advanced engineering design is the 2011 Audi A8, which is an aluminum-intensive vehicle with an EHSS (Martinsite) inner B-Pillar reinforcement. Most of today's OEMs are utilizing tailor-rolled or tailor-welded blanks for B-Pillars. They are utilizing this design to allow small crush zones along the length of the pillar to slow down the crash pulse, before transferring the pulse to the roof assembly. To ensure that the crash pulse does not intrude into the passenger compartment, the OEMs are utilizing a thin (but very strong) substrate made from either Martinsitic or Boron alloyed steel. This material resists the energy from the crash and attempts to transfer it around the passenger compartment to the other side of the vehicle through the roof panel crossmembers.

Rocker Panels

Rocker panels are constructed similarly to B-Pillars, but are meant to perform a different role during a collision event. Like B-Pillars, rocker panels can be constructed of different strengths of steel with extra strength through the utilization of the reinforcements of either EHSS or aluminum, in both steel and aluminum-intensive vehicles. If the applied collision force is to the middle of the B-Pillar, some of the crash energy is transferred to the rocker panel; if the applied force is lower on the B-Pillar, even more of this energy is transferred to the rocker panel.

The rocker panel is designed to transfer the crash energy longitudinally across the component as opposed to the B-Pillar that transfers the crash pulse vertically up the component. As the rocker panel deforms inward, the panel reinforcement is designed to slow the intrusion by forcing the crash energy to dissipate longitudinally to the ends of the reinforcement and then transfer, in part, to the floor crossmembers (see explanation below).

Floor Crossmembers and Floor Center Tunnel

The floor crossmembers are designed to transfer the crash force to the center tunnel of the floor in an attempt to further redirect the energy. The floor crossmembers are assisted by the seat assemblies and can be constructed from MS, HSS or UHSS with a low MPa strength. Many OEMs design their center floor tunnels with longitudinal crush zones that allow the tunnel to deform laterally. Volvo vehicles are one example.

Roof Crossmembers and Sunroof Assemblies

Roof crossmembers are designed to transfer the crash pulse from the B-Pillar to the other side of the vehicle, in an attempt to further dissipate the crash pulse. The floor crossmembers are assisted by the sunroof assemblies and can be constructed from MS, HSS or UHSS with a low MPa strength.

Structurally-Bonded Glass

The windshield and backlight (rear glass) are bonded to the front and rear of the "greenhouse" structure (A-Pillars, Roof Panel and Quarter Panel flanges) with structural urethane adhesive, which generally has a lap sheer strength of 650 psi to 1500 psi. Structurally-bonded glass assists in the transfer of the crash energy to the opposite side of the vehicle from the point of impact, and resists twisting of the vehicle.

Front and Rear Seat Assemblies

Many OEM front-seat assemblies are constructed with EHSS cross bars to resist the crash pulse from the door assemblies and B-Pillars, and transfer that pulse to the center floor tunnel. Many OEM rear-seat assemblies are constructed with EHSS cross bars that resist the crash pulse and transfer that pulse to the opposite side of the vehicle. One example is the Volvo XC90, which utilizes a bolt-in lower rear seat frame made from AHSS.

As you can see, the side structural components on a vehicle are specifically designed and constructed to respond in a particular manner during a collision event. It is paramount that damage assessors understand how the vehicle reacts to the applied force in a collision event, so that they can inspect the vehicle for direct impact and collateral damage. Think of the vehicle as an assembly line where each component has a specific job, with one component taking over when the forward component completes its job. Each component is working for the protection of the occupants.

Now that we have explained what side components actually do in a collision event, you may be asking yourself, "How do I diagnose the sustained damage?" In our other articles where we explained how to diagnose damage, we mentioned the following processes:

- Remove the door trim panels, the A, B, C or D-Pillar trim panels and, in some cases, the headliner. The removal of these panels will allow access to many of the side structural components that were hidden, and damage might be under the panels. Looking into the access areas in the panels might reveal deformity of the inner reinforcements.

- Start your inspection at the opposite side of the point of impact by checking the operation of the doors. This will assist you in discovering any collateral damage first.

- Check all panel gaps for proper gap distance. Gap tolerances can be obtained by the OEM websites or from ALLDATA Collision.

- Check the operation of all other closure panels.

- Check the position of all four wheels to determine if the collision energy caused collateral damage to the suspension components or a change in wheelbase from the applied force to the side of the vehicle. Remember that a vehicle impact on the side may cause the wheelbase to get shorter on the side of the impact when compared to the undamaged side. This is because the vehicle "got shorter" in the rocker panel area on the side that was struck.

- Obtain the vehicle dimensions from the OEM website or ALLDATA Collision and a tram gauge. Take some comparative measurements to determine if there is any structural misalignment. The most important area to check is the door striker area to determine the width of the vehicle. If there is, then the vehicle should be placed on a lift and electronically measured.

- Break the vehicle into sub-systems or family units, and inspect each family member to determine if any sustained damage. Only after each family member is inspected can you move to the next family.

- Sometimes, the removal of the front seat assemblies, center console and carpet will reveal damage to the floor pan crossmembers and center tunnel.

We hope this article has helped the industry to better understand how today's vehicles with advanced substrates absorb, transfer, control and sustain damage from the applied force during a collision event. Feel free to contact us if you have any questions.

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