

## **All Aluminum- C7 Corvette Chassis (w/C6 & C7 weld repair info) Plus, Added Info About The C8 Corvette Aluminum Frame**



The new C7 Stingray employs an all aluminum frame. In the Z06 the main hydroformed frame was a single section and had to employ a compromised uniform wall thickness front to rear. The C7 all aluminum frame is made from 10 castings, 38 extrusions, 76 stampings, and 3 hydroformed parts. The center section of the perimeter frame is still hydroformed but of a thickness

selected just for that section's strength requirements. It is connected to a casting containing the properly located threads for suspension and front cradle cross member attachment. Extending from the casting, to the front, is a lighter weight extrusion and structural member that is designed to crush in a crash. The windshield frame and firewall support are made of a number of separate pieces joined together to make a ridged assembly. The frame is 57% stiffer and 100 pounds lighter than the previous C6 corvette steel frame.

### **Joining The Pieces**

GM invented and patented a new resistance spot welding process employing 439 of these welds to join frame members. Unlike some sheet metal joining where extra spot welds can be used to compensate for quality variations, the C7 frame welds must be of high, consistent quality. They mention Laser welds are used in the tunnel assembly consisting of 37 segments totaling 71 feet of weld.

### **Conventional MIG Welds Are Also Used:**

Viewing a bare chassis, with running gear, at Laguna Seca in August 2013 showed numerous, more conventional MIG welds were used to join the various sections. Some were very uniform and most probably made with an arc welding robot. MIG welding requires the use of a wire, feed through a MIG gun, where an arc is formed between the tip of the wire and the workpiece. The arc melts the filler wire and base material, so the weld appearance is much different than a Laser weld, which generally does not employ a filler metal.

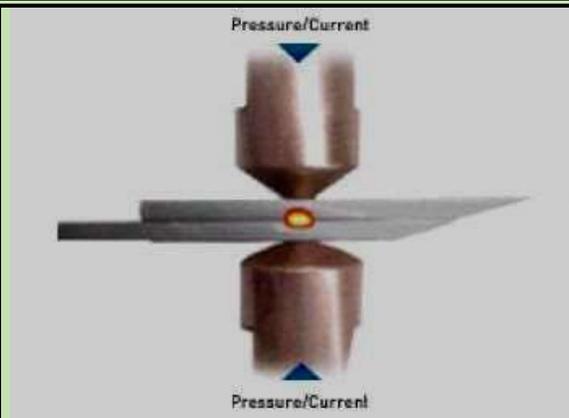
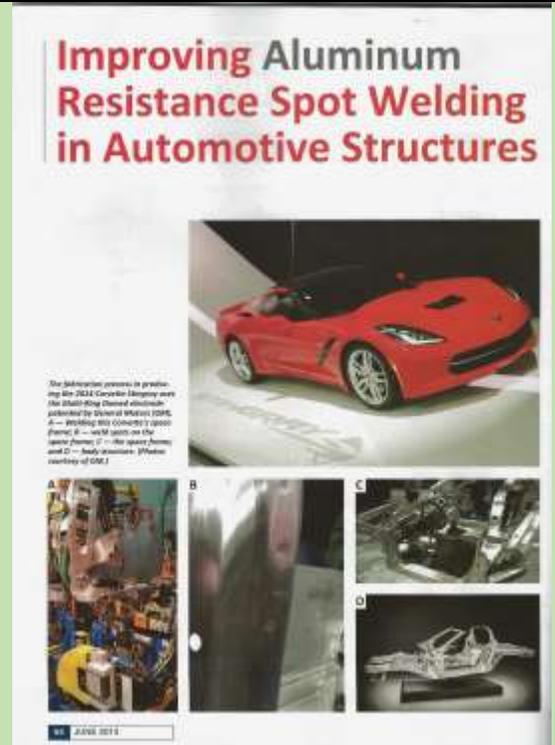
In addition to the robotic MIG welds, it appears some weld joints were made with a manual MIG welder, similar to those commonly used by a body shop or home hobbyist. However, from the weld size, the MIG welders employed were probably of 350 amps or higher capacity and may have been of the Pulsed MIG type.

## Photo Sequence Shows Some of The C7 Frame Welds

Photo right is the first page of a technical paper written by GM engineers and published in the June 2013 issue of the American Welding Societies monthly Welding Journal.

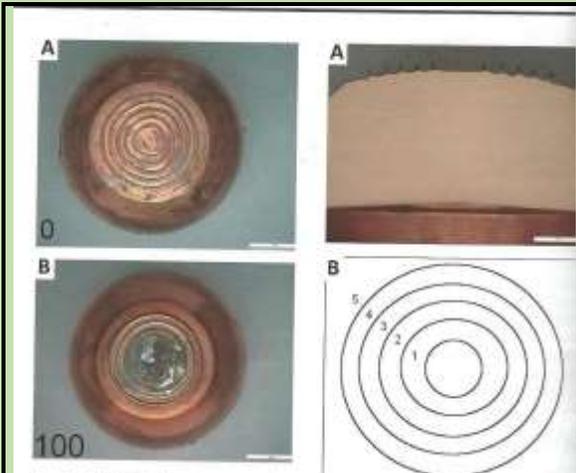
It describes the development of the procedures and patented spot-welding electrodes required for the 439 structural resistance welds used to join the various parts of the C7 aluminum frame.

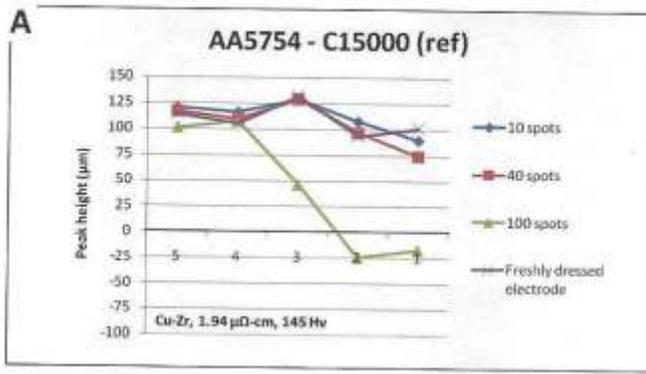
They discuss the major problem encountered when spot welding aluminum. The oxide layer on an aluminum sheet prevents consistent current passage and causes aluminum to be mixed with the surface of the copper alloy electrode, degrading its performance as welds are made. This causes inconsistent weld quality



Resistance spot welds are made between two sheets of material to be joined and copper alloy electrodes. The electrodes press the material being joined together with high force. A very high current is passed through the material for a short time that causes the small area in contact beneath the electrodes to melt and join together.

The GM solution to the aluminum spot welding problem was to put rounded raised concentric rings on the copper alloy electrode face. When these electrodes are pressed into the aluminum sheet, they distort the surface breaking up the brittle oxide surface film. This allows sufficient and consistent current passage to make repetitive, quality welds. They evaluated various tip materials to minimize wear of these peak areas.





Welds were made in common automotive aluminum alloy sheets, and various composition copper tip materials. They used about 1000 pounds pressure and 28,000 amps for 0.150 seconds. They measured the height of the electrode peaks with various alloy tips after a number of spot welds were made. This chart shows that two tip materials (#'s 4 & 5) kept their raised heights even after 100 spot welds. Two behaved poorly after exceeding 40 spot welds.

The researchers also analyzed the chemistry of the peak area tip surface utilizing a Scanning Electron Microscope. This defined the elements on the surface. This allowed them to define why some alloys caused more wear. They found that a layer of aluminum and an aluminum intermetallic compound formed on the electrode created a brittle layer that generated more heat. Eventually this brittle layer broke off causing pits in the tip surface. By selecting the proper electrode alloy this pitting phenomenon was minimized.

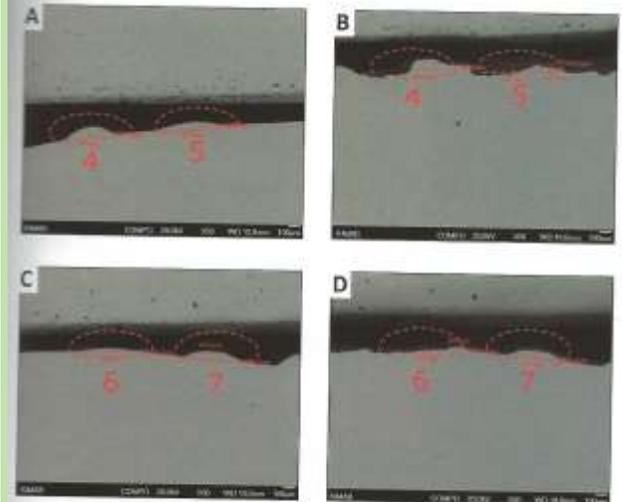


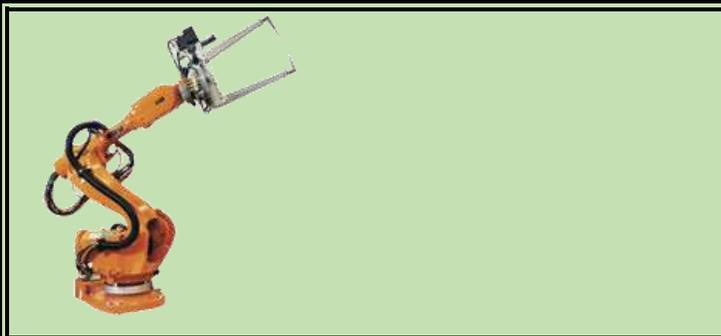
Fig. 8 — SEM images after welding AA6111-T4 with electrode C15760. A — Peaks 4 and 5 after 40 welds; B — peaks 4 and 5 after 100 welds; C — peaks 6 and 7 after 40 welds; D — peaks 6 and 7 after 100 welds.

The concentric rings that form on the spot weld can be seen clearly in these two spot welds on the frame photographed at Laguna Seca.

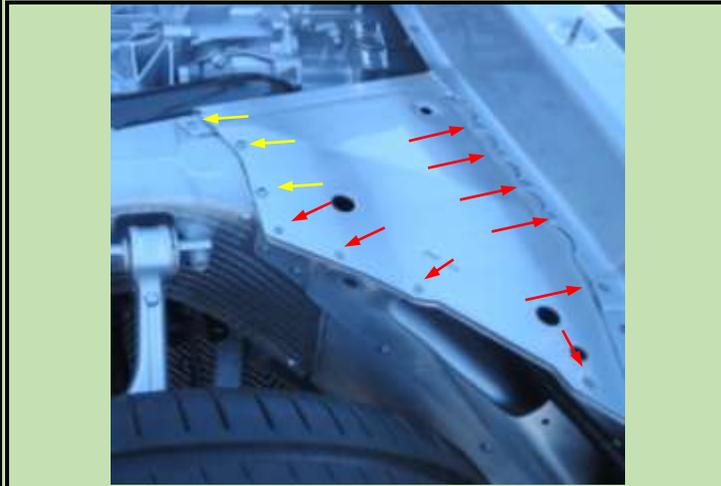
Surprisingly there were few finished welds shown in the technical paper and none showed as clearly as in the photographs we took at Laguna Seca!

As mentioned, GM reported that there are 439 such spot welds employed to join sections of the C7 frame.



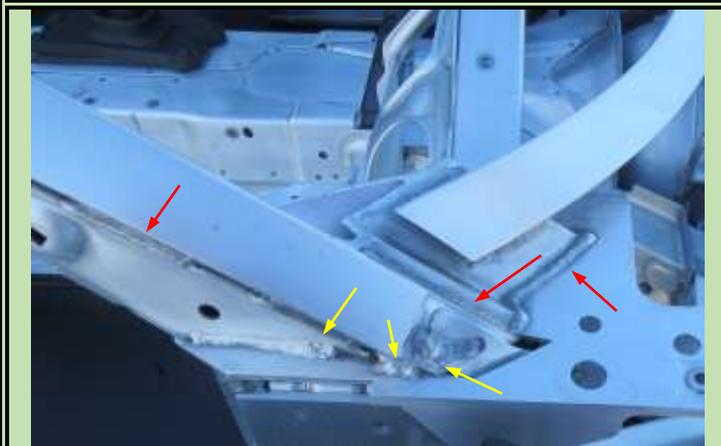


Resistance spot welders made in automotive production are often attached to robots and welds are programmed by a process computer when the parts are held in place by a fixture.



There are a number of resistance spot welds joining this reinforcing plate to the rear C7 frame (shown with red arrows.)

There are many mechanical fasteners also employed for various joints (shown in yellow.) GM reports there are 188 Flowdrill-machined fasteners used with a structural adhesive. A high-speed drill extrudes the frame material to create a strong, integral collar that is tapped for screw-type fasteners.



There are many MIG welds used in the joining of the chassis parts. In fact, looking at the linear length of joints made with each joining processes, MIG welding is the largest. Most all welds appear to be made with a MIG welding robot since they are very uniform and welding speed was very consistence (red arrows.) Perhaps only for this prototype frame, some welds appear to be made with a semi-automatic process where a welder moved the MIG gun along the joint and maintained the gun to work gap (possibly those shown with yellow arrows.)



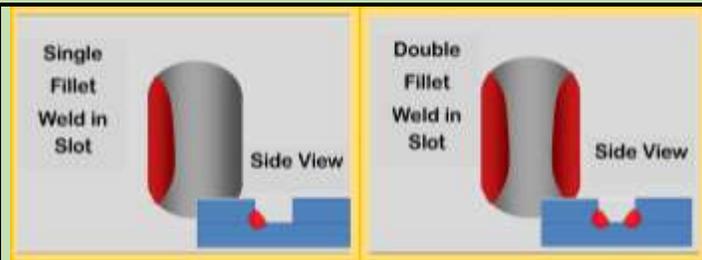
These MIG welds also appear to be made with a MIG welding robot. They are uniform and the crater in one was filled preventing a crack in the depressed end (red arrow.) This can be easily accomplished with a robot by stopping the travel and if needed by tapering the current down before stopping the arc for a short time.

Most MIG welds in the frame at Laguna Seca were of excellent visual quality. The lap fillet welds attaching the top bracket are an example (red arrows.)

However the fillet weld attaching the reinforcing bracket to the perimeter frame and cross member is too concave (a slightly convex to flat weld is desired) and it cracked in the throat (yellow arrow.)

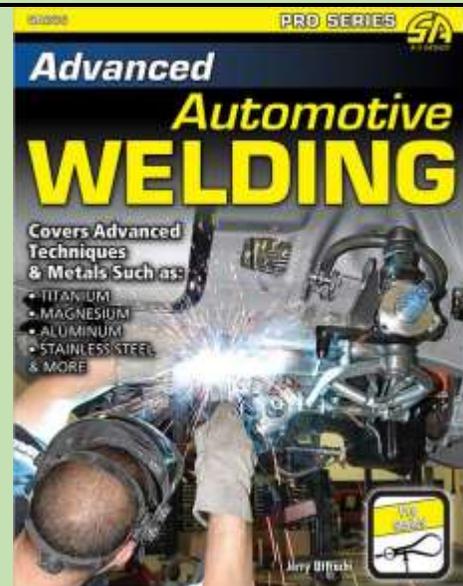


Two interesting welds were found on the front frame. These are called fillet slot welds (red arrows.) They allow a larger weld to be made than a conventional MIG spot weld or MIG plug weld. Two slots were machined in the bracket and lap fillet welds made on one side. This assures penetration is made into the main member. Lap fillet welds were used to join the top of the bracket (yellow arrows.)



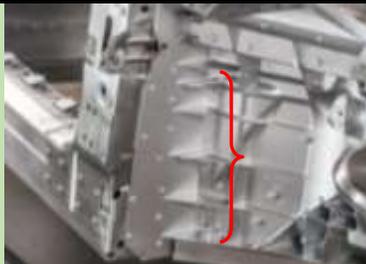
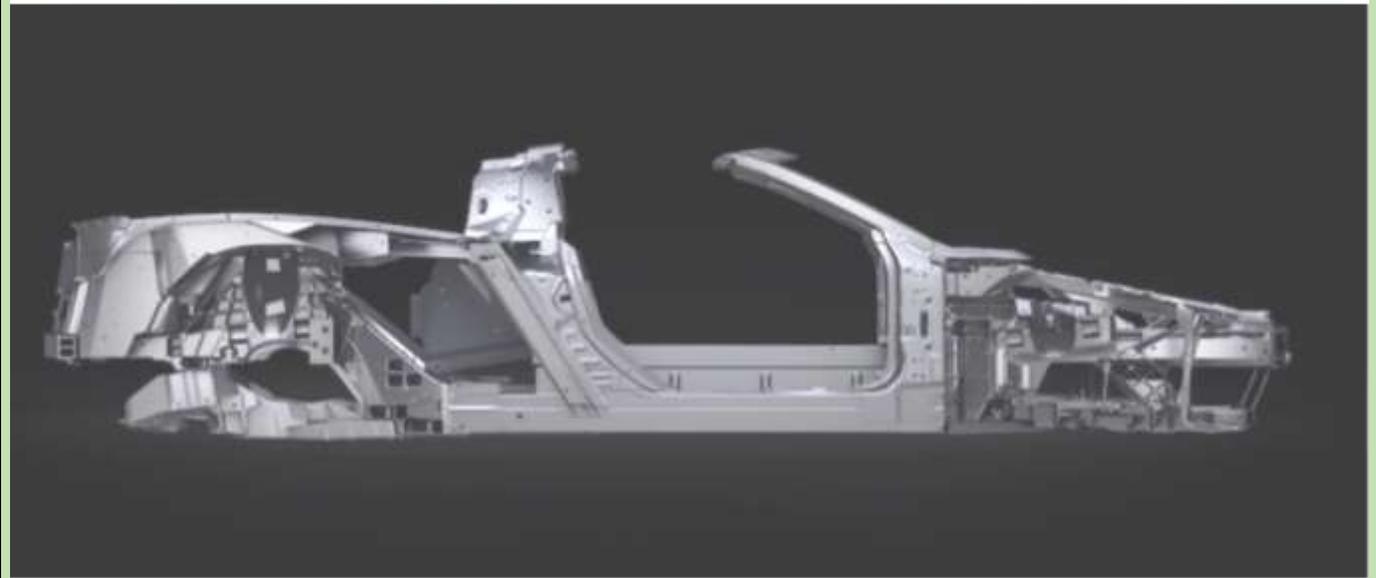
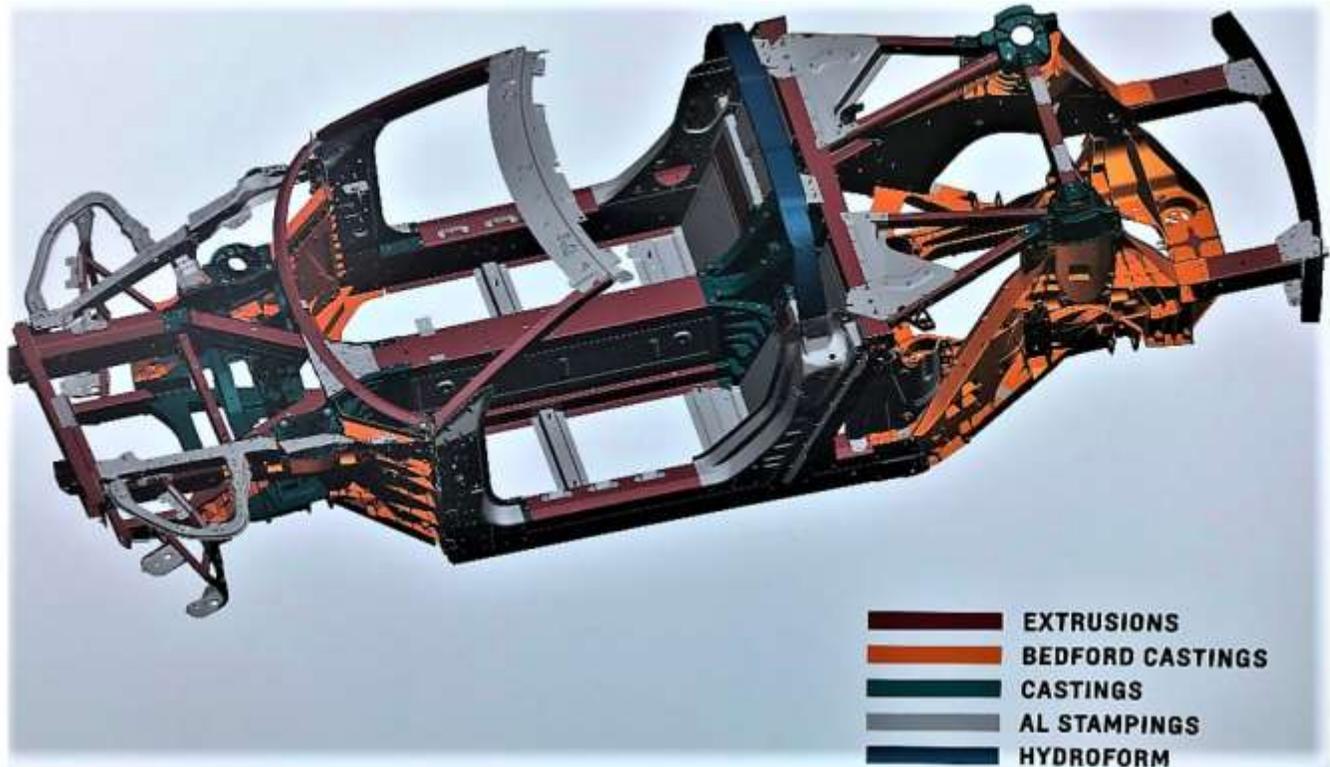
Of interest, this partial slot weld joint was defined in a book I wrote for CarTech last year, entitled *Advanced Automotive Welding*. The book mostly discusses welding Street Rods and Race Cars, as well as important weld quality and metalurgical issues.

I authered this CarTech 2012 published book that is 176 pages and has 450 high quality pictures with 50 to 80 word captions. It covers all arc welding processes used for joining carbon steel, Chrome Moly steel, aluminum, stainless steel, titanium and magnesium materials. Welding techniques employed for the material thicknesses used in automotive constrution are discussed. There is an example of a weld repair on an aluminum Z06 Corvette frame that applifies what is covered in a GM body repair manual. A few pics from the book are shown below in the section of C7 Weld Repair. Similar procedureds are used for the C8 but more bolting and replacing rivets versus welding.

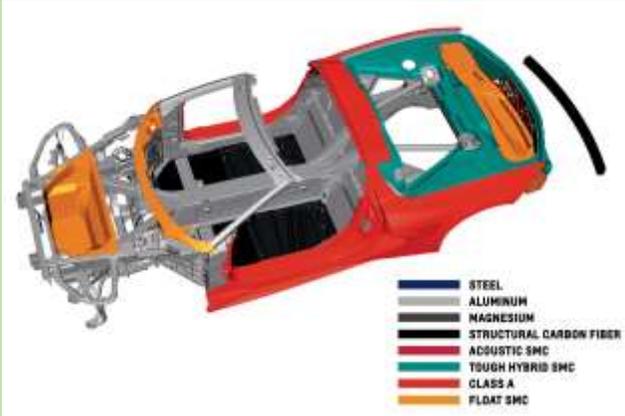


## C8 Aluminum Frame

GM changed the construction method for the C8 from the in-house mostly welded C7 fabricated aluminum to include many large (some smaller) castings and joining with many more rivets, bolts, Flow Drill Screws and adhesives.



Some of the castings include multiple very thin gusset supports making a very rigid structure (Red.) GM spent a lot of money developing an expensive large mold aluminum production method- WHY?



Tadge Juechter describes the six largest castings that make up the main structure—castings that GM names the “Bedford Six” after the location where they’re built: Bedford, Indiana—as “enormous.”

Juechter said, the castings minimize the number of joints reducing mass, and increasing stiffness. They are the key to making this the stiffest Corvette in history, *which in turns contributes to great driving dynamics!* The C8 is 10 % stiffer than that of the outgoing C7.

Tadge also said in an interview that he was very scared about having a 60% rear heavy car as he came from a Porsche family. His Dad, a military pilot, drove his to the limit. He was well aware of the “Oversteer Issue,” *similar to the Corvair!* However, he also said it took decades for Porsche, who had the same issue for them to solve the issue. He said for the C8 they had to get it right the first time and they did.

In another interview he said you cannot have the chassis acting like an “Undamped Spring.” Having a modified 1967 Corvair knew Chevy did several things to help the “oversteer issue” with its 60% rear weight. They required the front tires pressure to be 16 psi to promote some “Understeer” in a high “g” turn. They also specified rear toe-in of ¼ inch to 3/8 inches. I had mine set for 3/8-inch toe-in! Yep a “cheap form of rear steer” as in a high “g” turn the heavily loaded outside rear tire “steering” to counter the skid. He also said they examined a number of ME cars to understand what is required for great handling (*as Porsche has ben able to achieve with a ~64% rear heavy car.*)

**How My Speculation:** Since Tadge mentioned 1) chassis stiffness, 2) in today’s world they were not going to use a “trick” like large rear toe-in and 3) his comment about the chassis can’t act like an Undamped Spring. I’m assuming a very ridged chassis with the suspension acting very predicable in high “g” situations is part of the secret.

Porsche uses unibody construction, so body panels add to the overall stiffness. The Corvette must get all the “Stiffness” in the Chassis.

So, is the rigidity to the Chassis and the suspension mounting points a key to solving the Oversteer issue? Probably.

*BTW, with my 1967 modified Corvair Plus 1 wheels and performance tires, using 3/8-inch rear toe-in, still had to learn to handle a rear skid if going to fast for a turn. Had to turn the opposite as you would in a FE car, or you’d be off the road in less than a second- rear first. Had less than a second to react, in fact like a dirt track racer had to anticipate the issue! Most drivers don’t know how, and it took practice!*



A fun way to discuss what Tadge must have faced “selling the ME” and the new chassis construction is this hypothetical dialog with the GM CFO in ~2013, when he said in the Autoline Interview they were designing the C8:

**GM CFO at a ~2013 hypothetical meeting with Tadge:** *OK Tadge you convinced Mary and the Board with that Pratt & Miller engineering study showing a ME and 60% rear weight was needed to improve the Corvette performance. Although Zora tried with prototypes and persuasion, he could not do that. BUT why are there high cost issues your team specified like having to make a*

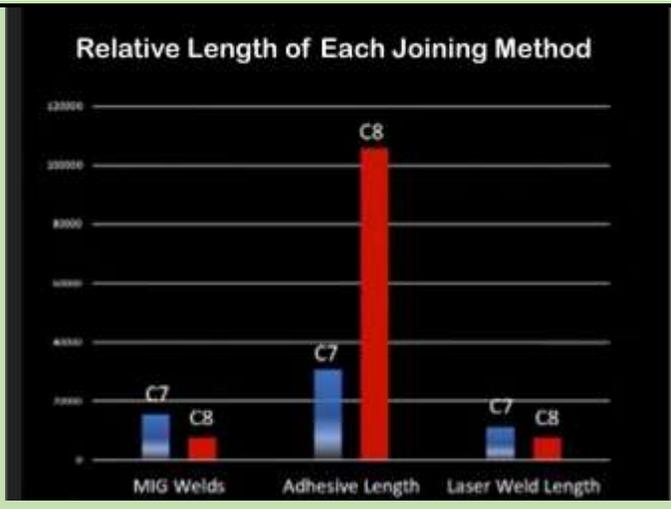
*large investment in an unproven cast frame technology? And that frame must be higher and larger because you decided we can't use the low-cost composite springs we have for years. Heck I was happy with the Tier 1 supplier providing the C6 frames BUT NO, the Corvette Team insisted we build it in Bowling Green! Did you not have a clue when no supplier would bid those large castings it could be expensive and difficult to produce ourselves?*

**Tadge:** *That very ridged frame is needed to avoid Oversteer issues with a 60% rear heavy car. Remember the history of even the non-swing axle 1965 and later, Corvair? It took Porsche decades to eliminate the issue and a very ridged frame is needed so the chassis is not acting like an "undamped spring." That changes suspension movement in an unplanned way. We don't have their unit body rigidity, so we need a stiffer frame.*

*As far as using coilovers over composite springs, we need low center of gravity in the rear. In the front you know we will have to meet that 2012 federal government dictated mpg for sports cars outlined in that 1174-page published report that requires achieving about 40 mpg in 2025 and starting with significant improvements ~5 years sooner. Europe is planning similar low CO<sub>2</sub>/km maximum requirements. We're planning a FWD hybrid as our best option and that composite spring is in the way. We are in no position to plan a high performance EV to offset lower mpg to get the Corvette Family, as defined in that report, to ~40 mpg.*

*Also Porsche announced last year (2012) they are producing the 918 Spider hybrid that gets over 65 mpg! Looks like they are planning hybrids and EV's. We believe that Ferrari announced no standard shifts even in their FE models for the same planned hybrid reason. They face similar reduced CO<sub>2</sub> emissions requirements in Europe.*

*We will also need a computer-controlled transmission to make a high mileage hybrid viable. It must be a high performance DCT for Corvette enthusiasts and NOT that 10 speed "slushbox" we developed with Ford that some of your bean counters said we should have integrated into a transaxle instead of using a sub supplier! Yep that will cost more as well.*



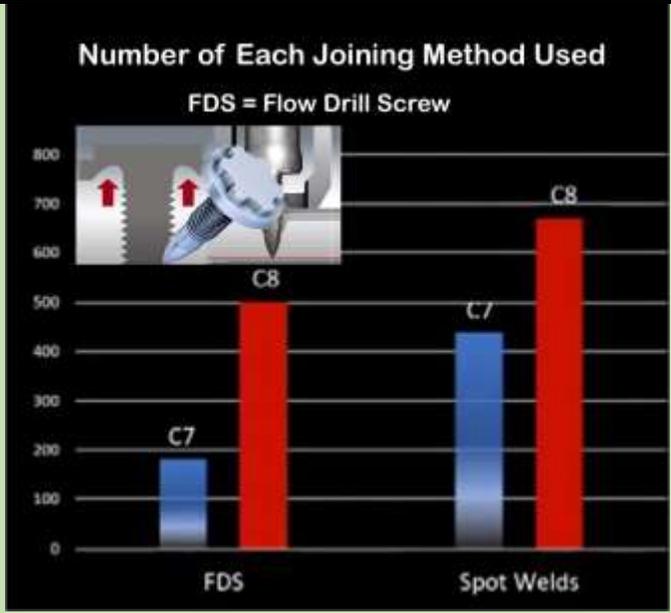
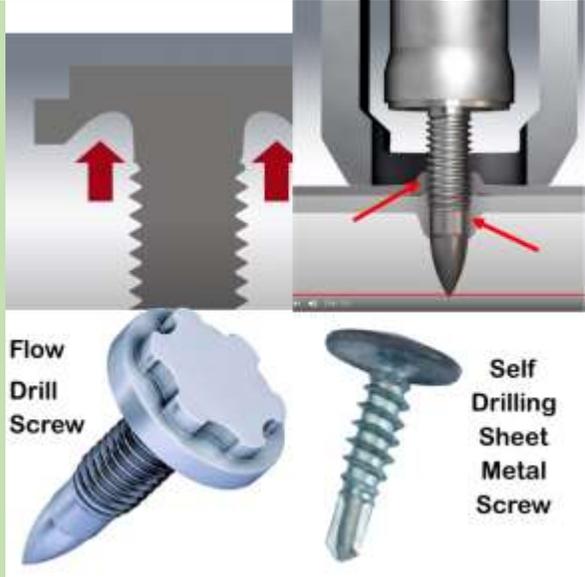
This graph gives a perspective on the changes in construction methods from C7 to C8. It presents the relative lengths of joining method from C7 to C8.

Note there is ~60% less MIG welds; about 1/3 less Laser welds and almost 4 times the length of adhesives employed.

Overall, where adhesive length was about twice MIG and Laser weld length in the C7, it's about 80% of the joining length in the C8.

The next two joining method comparisons require an explanation of one, called FDS. These are Flow Drill Screws. The difference between a FDS and a self-drilling sheet metal screw is the extrusion of the materials above and below the surface. That increases the screw holding surface by over twice the amount of area.

Note a recess is required in the FDS head for the material that flows room to extrude upward.



Note for the C8 over 3 times the number of FDS are used than the C7. The use of castings also reduced the number of spot welds.

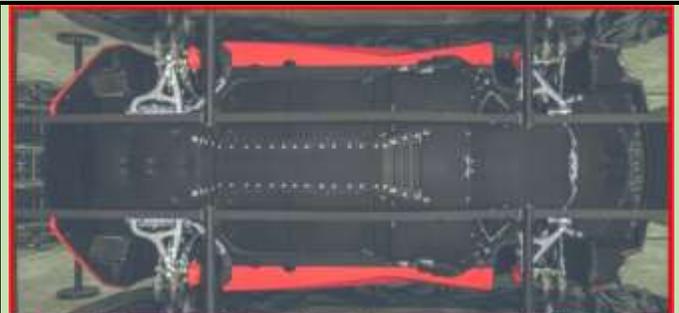
Bolts and rivets were not mentioned in the overview of C8 construction the plant manger covered at the May Corvette Bash. But they are also used.

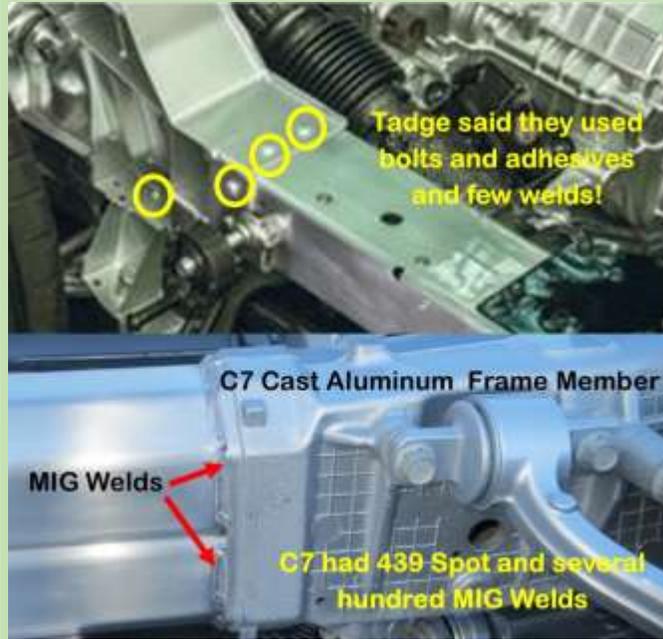


Some additional pictures of the C8 Chassis. Note, compared to the C7 etc. FE Corvettes that used transverse leaf springs there are high chassis supports for the coilovers.

Note in the top pic they used a complete “belly pan” to cover on the bottom. It directs air over a smooth surface that reduces turbulence and therefore drag over suspension and engine/transmission members. Those shiny bots in the center hold a 5mm aluminum plate that makes a strong box structure with the large center support tunnel.

Pics lower right, show the many thin “gussets” that are placed in the thin wall castings. They add to the extra chassis rigidity without having to weld in gussets. Welding would add to distortion from the heat, a possible reason the total Pulsed MIG welds for the C7.





Tadge said they used bolts and adhesives and few welds!

C7 Cast Aluminum Frame Member

MIG Welds

C7 had 439 Spot and several hundred MIG Welds

Top pic shows some bolts, rivets or FDSs used in the C8 chassis assembly. The bottom pic shows the more welded frame construction used for the C7. Many welds were made with MIG welding robots in Bowling Green.

The Corvette team probably evaluated a more welded chassis using the existing C7 welded construction before deciding on the large (and small) casting approach. Tadge only mentioned in the Autoline 1-hour interview that welding causes distortion. That is true. Assume they found that the use of many gussets to get increased stiffness would cause a lot of distortion and residual stresses if welding was used as the primary joining method.

Reminded when we sponsored Richard Petty Race Team for 15 years- see next:



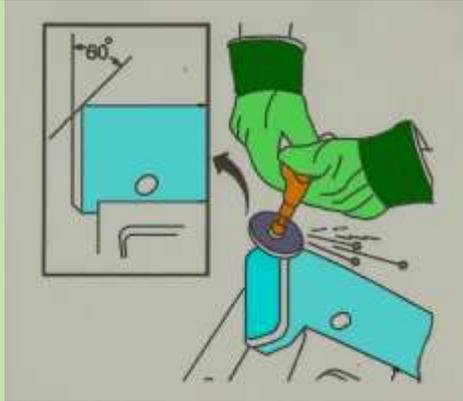
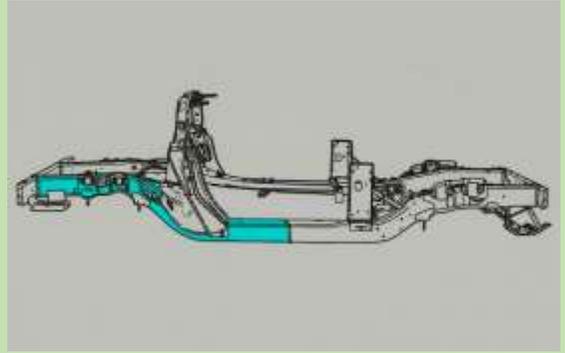
Sponsored Richard Petty for over 15 years. One question discussed was why some race car chassis performed better than others. Mentioned the frame weld sequence and different residual stresses that relieve during a race causing minor frame movement, were no doubt a factor.

Left: Some additional chassis pics.



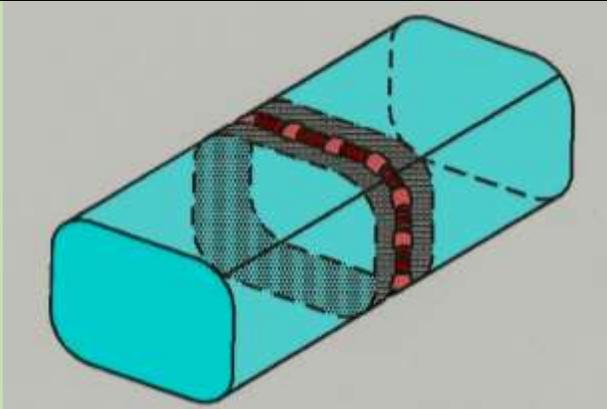
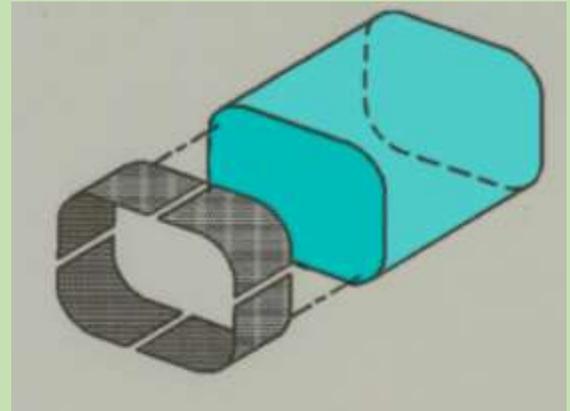
## Repair of a C6 Z06 Aluminum Frame (Taken from above pictured book)

Unlike the C7 frame rail, made of many pieces welded together, the C6 Aluminum frame rail is one piece hydroformed aluminum. The repair requires buying a complete frame rail and cutting out the bent frame section and a piece from the new frame to match.



Then the remaining old frame and the new frame section are beveled with a grinder to form a gapped single V joint. Note GM specifies grinding at a 60-degree angle that will make a 120-degree included angle, a lot of weld metal to fill, requiring several weld passes.

They suggest an interesting way to make a backing member to put behind the gapped, wide angle, single bevel joint. They suggest cutting a 2-inch-long section from the new frame and cutting it in 4 pieces as shown. Each section is inserted into one end to be welded about 1 inch and tack weld in place. Then the replacement frame section inserted over the backing pieces leaving the thickness of the material as a gap. In the case of the C6 Z06 frame that is  $3/16$  inches.

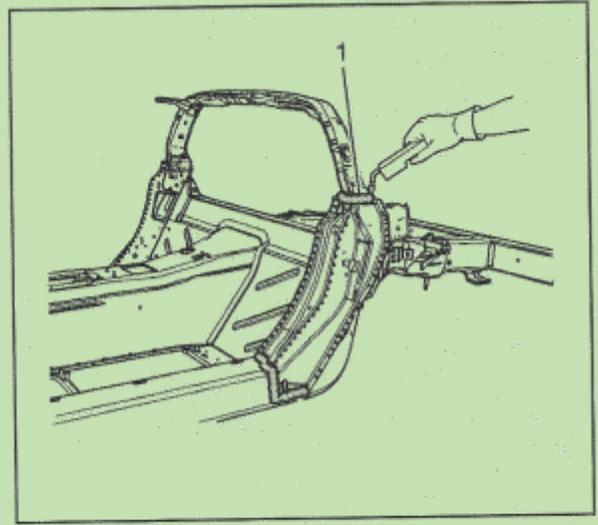


GM specifies a root pass and a separate cover pass. They also specify welding for 2 minutes and letting the weld cool for 2 minutes no doubt to help preserve some of the strength of the base material.

## Weld Repair Procedures From 2014 Service Manual

Of Interest are some of the weld procedures suggested for repairing the 2014 Aluminum frame. They suggest removing the defective frame pieces by cutting or grinding out the welds and recommend welding the new parts back.

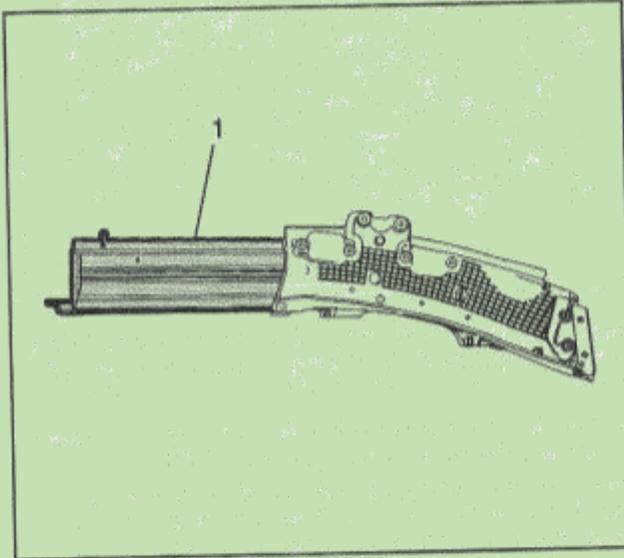
They specify using 5554 alloy welding wire versus the 5356 alloy recommended for the C6 Z06 aluminum frame. Alloy 5554 produces about the same strength but is less crack resist. However, GM no doubt did the required tests and found it was most compatible with the alloys being welded. Follow their advice!



1864579

**Note:** Recommended wire alloy is 5554 and wire size is 0.035. The shielding gas is 100 percent Argon.

6. Using a PULSED-MIG (P-MIG) or Resistance Welder, weld the lock pillar to the structure duplicating the factory welds (1).



3450343

9. Remove the damaged section of frame rail. Cut the welds around the perimeter using a cut off wheel or equivalent tool. Grind off the remaining weld from the casting.

**Note:** Recommend wire alloy is 5554 and wire size is .035. The shielding gas is 100 percent Argon. A two minute cooling down period is recommended for every 2 minutes or 100 mm (4 in) of welding.

**Note:** Use a stainless steel brush to remove the oxide layer prior to welding.

4. Using a PULSED-MIG (P-MIG) welder, weld the front frame rail to the cast rail section duplicating the factory welds.

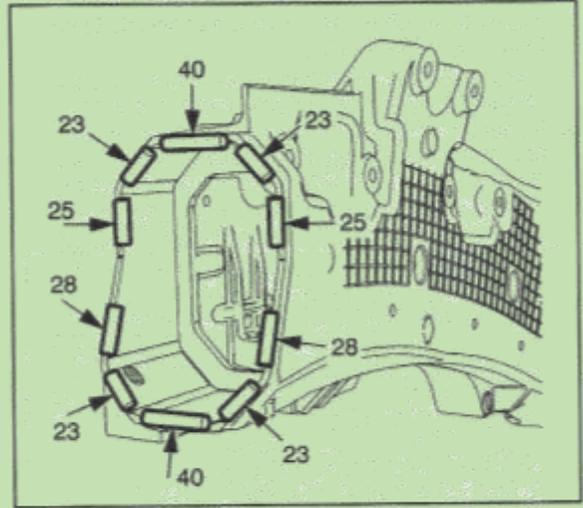
Another very interesting recommendation is specifying the use of a Pulsed MIG Welder. These are not inexpensive devices you can pick up at Harbor Freight! Today they are easier to use than in the past, but they cost in the range of \$5000 and up! Not the welder you would find in most shops, nor would the average welder (let alone a body shop technician) know how to set it up or use it!

**Note,** in this pic it defines the need to use a stainless steel brush to clean the material prior to welding.



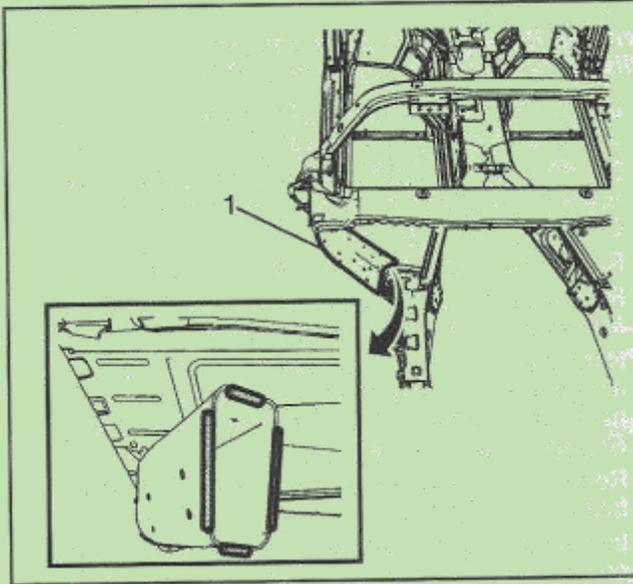
The above pic and text define the need to use a stainless steel brush. It is critical that the brush be dedicated to welding aluminum! This goes for any aluminum welding. If the brush is used on any steel, small pieces of iron can get transferred to the aluminum causing weld defects. Aluminum also oxidized very rapidly. Aluminum oxide has a very high melting point and a molten aluminum weld cannot wet into the oxide. It must be removed, preferably just before welding.

In this pic, they are welding a frame rail to the cast frame member. Note they are recommending using the original short spaced welds. Note they specify letting the weld cool for 2 minutes for every two minutes of welding to help retain the base material properties.



Note: If no trace of the original welds is present, follow the pattern specified for welding the rail to the cast rail section.

Note: Recommend wire alloy is 5554 and wire size is .035. The shielding gas is 100 percent Argon. A two minute cooling down period is recommended for every 2 minutes or 100 mm (4 in) of welding.



Note: Recommended wire alloy is 5554 and wire size is 1 mm (0.035 in). The shielding gas is 100 percent Argon.

3. Using a P-MIG welder, stitch weld the cast rail section (1) to the center rail duplicating the factory welds.

Note for all welds they recommend 100% Argon shielding. When welding aluminum you cannot use the common shielding gas used for MIG welding steel that contains from 8 to 25% CO<sub>2</sub> (which for steel welding is needed to have a more stable arc and increase weld penetration.)

Only two choices for welding aluminum, Argon or a mixture of Argon and Helium. It must be totally inert.

Note they have a metric conversion error! 1 mm diameter MIG wire is actually 0.040 in. and not 0.035 in.. Of interest in the US steel MIG welding wire is not sold in a 0.040-inch (1 mm) size but it is for Aluminum! Which one are they specifying? Suggest finding a Collision Repair Manual or check with GM!

## Unusual Failure of a 2017 Grand Sport Causes Forum Comments, Many Incorrect!

A forum member posted pictures of an unusual failure. He drove over a very large rock (bolder!) It cracked in an undercarriage member. Appears minor and compared to welding on critical frame members does not appear, to me, to be a difficult repair! The insurance company totaled the car!

Panic comments started by some forum members stating the car would be unsafe and now could GM make a car that fails that easy?



The owner posted other pictures that put the crack and member location in perspective.

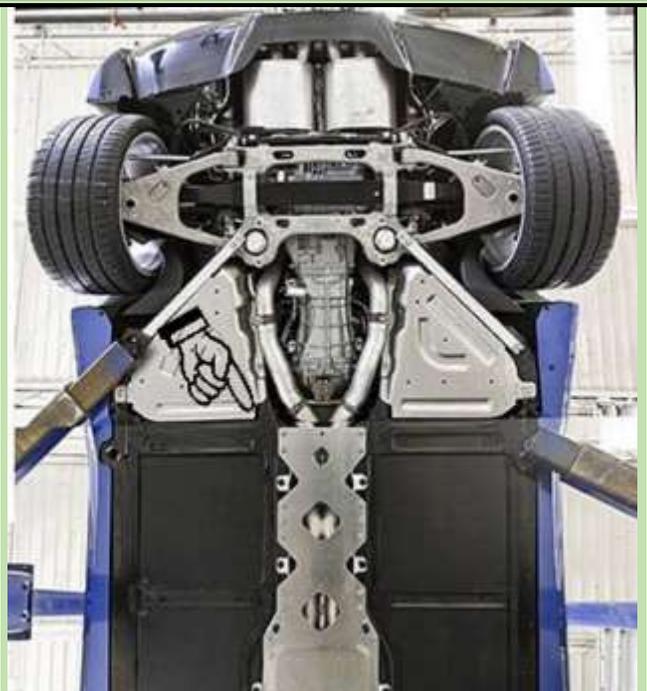
In this large view shows the crack and an exhaust pipe in the upper right. It helps define that this member's main function may be a transmission support.

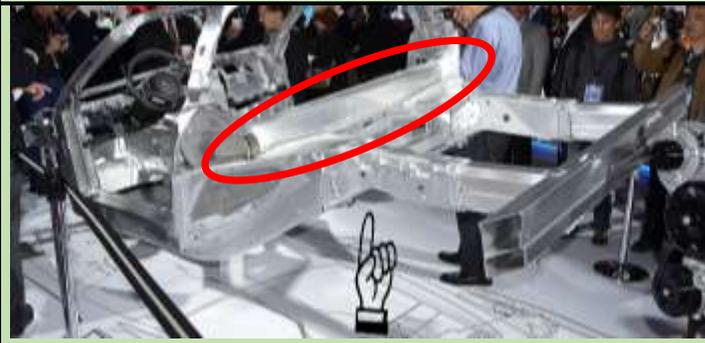
About a week after the pics were posted got a call from CarTech about possibly writing another book, so investigate this issue.

An owner posted this picture and included a finger pointing to the location. Notice this structural member does not go straight across from one large perimeter structural member to the other. It dips down (or up depending on your perspective) to go around the large exhaust pipes. It appears to be primarily a transmission support member.

However, the Insurance Company totaled the car and had it listed with a \$75,000 value needing \$7600 repairs.

IMO and that of some other forum members, it's a small dollar repair by a good welder! I'd use TIG but a none hi-frequency stabilized modern, variable frequency AC inverter and be sure the battery cables were removed!

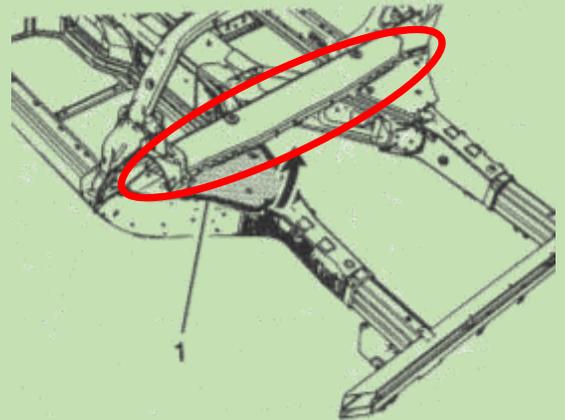




The Insurance company said the part was available and apparently found it would cost \$7600 to repair.

It appears GM may not have a repair procedure because 1) it's not a critical structural member and 2) they can't be expected to have every failure covered!

What is interesting, the main structural member in this area is covered in the repair procedure with their "remove and reweld approach!" This member does tie both sides of the perimeter frame together and is a large box type structure. Again, reinforces that this unusual failure was not covered by allowing a simple repair only by their standard, "remove and replace" approach. To access it would probably require removing rear composite tub that is glued to the frame etc. Perhaps must more to access. Not cheap!



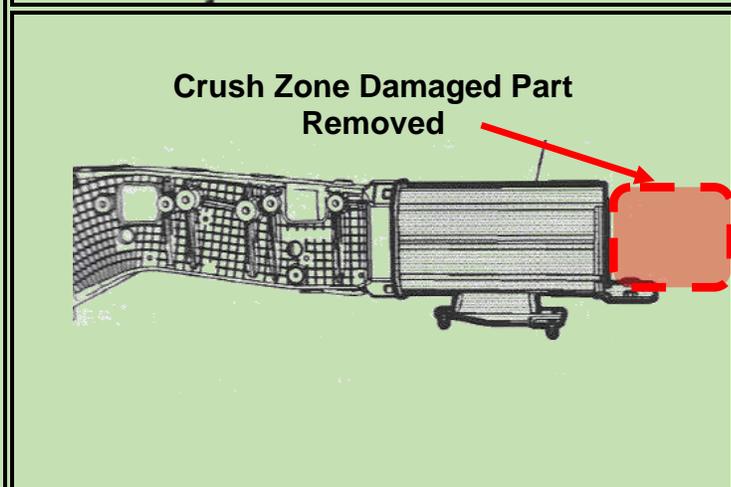
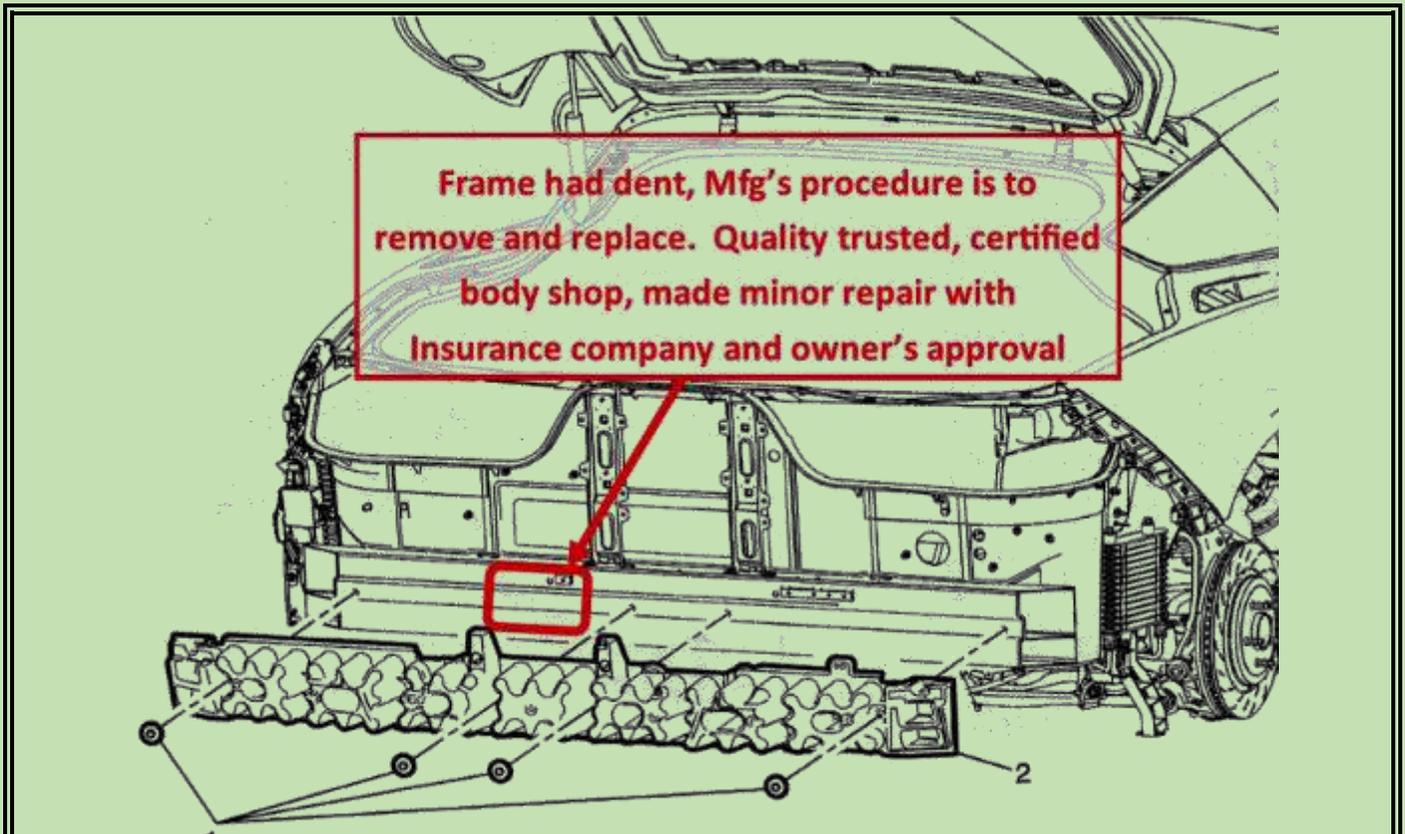
With the call from CarTech re a possible new book and seeing this incident, I decided to interview two body shops that are "certified by the car manufactures to weld aluminum." Both have spent significant money to buy the special Pulsed MIG welder, Self-Piercing Rivet equipment, adhesive application tools, frame alignment jigs and technician training. One bought from the tools from Mercedes and the other from a company called Car-O-Liner, which is a Swedish affiliate of Snap-On.

They both are "certified" by Chevy, Mercedes, BMW and one also Honda that has some aluminum frame components. They are required to only use OEM parts and to follow the manufacturers published procedures (or lose their certification.)

I asked one about welding on the C7 Corvette frame. They had one in the shop with minor side rail damage, but that section is required to be replaced. To gain access required removal of the rear hatch frame and then removal of the whole composite tub that is "glued" to the frame. A PIA and costly!

I asked if they always had to follow the manufacturers procedures and what if there were none for a particular repair? The manager had an interesting example and said: *"Generally we always follow the manufacturer's recommendations, but we had a C7 in with a minor rear end collision. We replaced the rear bumper and foam crash absorbing material, but it only had a minor dent in the aluminum rear cross member. We do enough with the insurance companies that they trust our judgement and they and the owner agreed it would be best to just make a minor repair and not replace the member."* See next page.

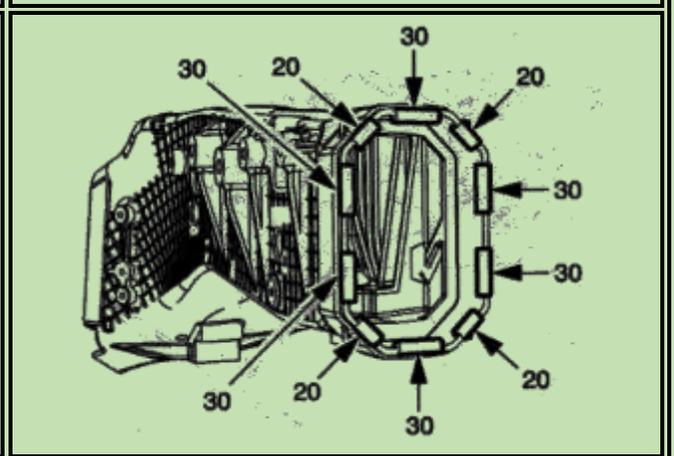
He said if a specific repair is not specified and it was not in a crash zone he would make a recommendation to the insurance company as well as the car owner and is confident it would be accepted.



IMO, the C7 may be easier to repair than the C6, even one with a steel frame! As mentioned above, the C6 had two large hydroformed frame rails and in the case of an accident a new one purchased as one long unit. Then the section needing repair has to be cut from the old frame and a similar section cut from the new frame rail. Then backing plates made from the new frame parts that would be scraped and welded to the old frame. A waste of time, material and effort for a minor crash.

The C7 is made in many parts. The crush zone parts are easily removed by grinding the old welds, inserting a new part and rewelding. If a part is not listed with a repair method, and IF it is not a critical structural member a competent body shop, certified by the manufacturer should be able to use judgement.

(The 4 volume 2014 Service Manual I have, has 35 pages of repairs but is not a complete list.)



## “50” C8, 2017 Grand Sport & 2014 Stingray Mods, Info Available As PDFs:



50 PDFs discuss improvements or info about a C8, 2017 Grand Sport, 2014 Stingray function and/or esthetics. Some are minor and others, like the installing the Rear Diffuser & MGW shifter, include detailed install information.

Below are the PDF's available. Click on picture or Blue PDF link or copy and paste the PDF link (Blue type) into your browser. Or email me at [GUtrachi@aol.com](mailto:GUtrachi@aol.com) and state the title desired, shown in Yellow:

### C8 Install High Wing

How To Remove Rear Bumper- Install Wing  
[http://netwelding.com/C8\\_High\\_Wing.pdf](http://netwelding.com/C8_High_Wing.pdf)



### C8 FWD Hybrid

WFWD Hybrid Provides More Power & MPG  
[http://netwelding.com/C8\\_FWD\\_Hybrid.pdf](http://netwelding.com/C8_FWD_Hybrid.pdf)



### Rusty GS/C7 Muffler

Why the C7 muffler rusts way to turn matte black.  
[http://netwelding.com/Muffler\\_Rust.pdf](http://netwelding.com/Muffler_Rust.pdf)



### Change GS/C7 Oil

WHY change your own oil and C7 Lifting Methods  
[http://netwelding.com/Changing\\_Oil.pdf](http://netwelding.com/Changing_Oil.pdf)



### C7 Carbon Fiber Side Skirts

How to install C7 side skirts with jacking info  
[http://netwelding.com/Side\\_Skirts.pdf](http://netwelding.com/Side_Skirts.pdf)



### C7 Carbon Fiber Splitter w/End Plates

How to install Splitter & Nylon bra fit  
[http://netwelding.com/CF\\_Splitter.pdf](http://netwelding.com/CF_Splitter.pdf)



### C7 Removing GM Plastic Film

How To Remove The Rocker Panel Film  
[http://netwelding.com/Rocker\\_Panel\\_Film.pdf](http://netwelding.com/Rocker_Panel_Film.pdf)



### C8/GS/C7 Mirror Proximity Alarm

Limit switch alarm warns when close to door frame  
[http://netwelding.com/Mirror\\_Proximity\\_Alarm.pdf](http://netwelding.com/Mirror_Proximity_Alarm.pdf)



### **Jacking Pads for C8/GS/C7**

*Manual says Jacking Pads 2 1/2 inch max OD..*  
[http://netwelding.com/Jacking\\_pads.pdf](http://netwelding.com/Jacking_pads.pdf)



### **GS/C7 Radar Power**

*For C7 tapped rear fuse panel. For GS tapped mirror*  
[http://netwelding.com/Radar\\_Detector\\_Power.pdf](http://netwelding.com/Radar_Detector_Power.pdf)



### **GS/C7 Belt Rattle**

*Passenger seat belt rattles against the seat back.*  
[http://netwelding.com/Eliminate\\_Rattle.pdf](http://netwelding.com/Eliminate_Rattle.pdf)



### **Aluminum C8/C7 Chassis & Weld Repair**

*The C7 aluminum chassis. Includes weld repair info.*  
[http://netwelding.com/Aluminum\\_Chassis.pdf](http://netwelding.com/Aluminum_Chassis.pdf)



### **GS/C7 Ceramic Brake Pads**

*The Z51 has very dusty brakes. These pads help!*  
[http://netwelding.com/Ceramic\\_Pads.pdf](http://netwelding.com/Ceramic_Pads.pdf)



### **GS/C7 License Plate Frame;**

*Must Meet South Carolina Law*  
[http://netwelding.com/License Plate\\_Frame.pdf](http://netwelding.com/License_Plate_Frame.pdf)



### **Manage GS/C7 Spilled Gas & Door Lock**

*Protect when filling gas. Preventing door lock failure.*  
[http://netwelding.com/Manage\\_Spilled\\_Gas.pdf](http://netwelding.com/Manage_Spilled_Gas.pdf)



### **GS/C7 License Plate & Cargo Lights**

*LED license plate light & cargo area bulbs*  
[http://netwelding.com/License\\_Plate\\_Light.pdf](http://netwelding.com/License_Plate_Light.pdf)



### **GS/C7 Rear Cargo Area**

*Rear cargo area storage device and rear protector*  
[http://netwelding.com/Rear\\_Cargo\\_Area.pdf](http://netwelding.com/Rear_Cargo_Area.pdf)



### **GS Rear Diffuser (Fits Any C7)**

*Rear Carbon Flash Composite Diffuser*  
[http://netwelding.com/Rear\\_Diffuser.pdf](http://netwelding.com/Rear_Diffuser.pdf)



### **GS/C7 Door Panel Protector**

*Black plastic protector prevents scuffing of door*  
[http://netwelding.com/Door\\_Panel\\_Protector.pdf](http://netwelding.com/Door_Panel_Protector.pdf)



### **GS/C7 Improved Cup Holder**

*A solution to the cup holder spilling*  
[http://netwelding.com/Improved\\_cup\\_Holder.pdf](http://netwelding.com/Improved_cup_Holder.pdf)



### **GS/C7 Wheel Chatter/Hop**

*Why sharp, low speed turns with cold tires causes the front tires to chatter/hop.*  
[http://netwelding.com/Wheel\\_Chatter.pdf](http://netwelding.com/Wheel_Chatter.pdf)



### **C7 Carbon Fiber Grille Bar**

*Install genuine carbon fiber grille bar overlay*  
[http://netwelding.com/CF\\_Grille\\_Bar.pdf](http://netwelding.com/CF_Grille_Bar.pdf)



### **Jacking a C8/GS/C7 Vette**

*Safely jacking either front only or back & front*

[http://netwelding.com/Jacking\\_A\\_C7.pdf](http://netwelding.com/Jacking_A_C7.pdf)



### **Deer Whistle Installed on GS/C7**

*Do they work? Plus Install Info*

[http://netwelding.com/Deer\\_Whistle.pdf](http://netwelding.com/Deer_Whistle.pdf)



### **Replacing C7 Battery**

*Tricks for installing battery!*

[http://netwelding.com/Battery\\_Issues.pdf](http://netwelding.com/Battery_Issues.pdf)



### **GS/C7 Window Valet**

*Lower Windows With FOB Helps Latch Hatch*

[http://netwelding.com/Hatch\\_Latch.pdf](http://netwelding.com/Hatch_Latch.pdf)



### **C8/GS/C7 Splash Guards**

*GM splash guards. ACS Best Front Guards for GS.*

[http://netwelding.com/Splash\\_Guard.pdf](http://netwelding.com/Splash_Guard.pdf)



### **GS/C7 Blind Spot Mirror**

*Smaller rear and side windows cause C7 blind spots. Small "blind spot mirrors" help*

[http://netwelding.com/Blind\\_Spot.pdf](http://netwelding.com/Blind_Spot.pdf)



### **GS/C7 Skid Pad Protector**

*After the air dam, the aluminum "skid pad" hits*

[http://netwelding.com/Skid\\_Pad\\_Protector.pdf](http://netwelding.com/Skid_Pad_Protector.pdf)



### **GS/C7 Wheel Locks**

*Wheel locks, help protect your expensive wheels.*

[http://netwelding.com/Wheel\\_Locks.pdf](http://netwelding.com/Wheel_Locks.pdf)



### **GS/C7 OnStar Lights**

*Rear view mirror OnStar LED's, at a quick glance, look like a police car flashing light! This is a fix.*

[http://netwelding.com/OnStar\\_Lights.pdf](http://netwelding.com/OnStar_Lights.pdf)



### **GS/C7 Skip Shift Eliminator**

*Skip Shift Eliminator install with suggestions on jacking a C7.*

[http://netwelding.com/Skip\\_shift\\_Eliminator.pdf](http://netwelding.com/Skip_shift_Eliminator.pdf)



### **GS/C7 Catch Can & Clean Oil Separator**

*What is Coking and how to reduce the potential*

[http://netwelding.com/Catch\\_Can.pdf](http://netwelding.com/Catch_Can.pdf)



**GS MGW Flat Stick Shifter**  
*The MGW shifter shortens throw and is more precise*  
[http://netwelding.com/MGW\\_Shifter.pdf](http://netwelding.com/MGW_Shifter.pdf)



**GS/C7 Round Shift Knob**  
*A round shift knob shortens throw on OEM shifter*  
[http://netwelding.com/Shift\\_Knob.pdf](http://netwelding.com/Shift_Knob.pdf)



**GS/C7 Stingray Sill Plate**  
*Stingray sill plate replaces original.*  
[http://netwelding.com/Sill\\_Plate.pdf](http://netwelding.com/Sill_Plate.pdf)



**GS/C7 Nylon Bra**  
*Nylon Bra Stops Bugs. Fits with Stage 3 Winglets*  
[http://netwelding.com/Nylon\\_Bra.pdf](http://netwelding.com/Nylon_Bra.pdf)



**GS/C7 Clutch Fluid Change**  
*Clutch fluid after 3000 miles gets dirty*  
[http://netwelding.com/Clutch\\_Fluid.pdf](http://netwelding.com/Clutch_Fluid.pdf)



**C7 Carbon Fiber Hood Vent**  
*Replaces Plastic Hood Vent*  
[http://netwelding.com/Hood\\_Vent.pdf](http://netwelding.com/Hood_Vent.pdf)



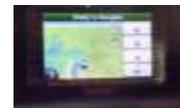
**GS/C7 Cold Air Intake**  
*Low Restriction Air Filter & Duct*  
[http://netwelding.com/Cold\\_Air\\_Intake.pdf](http://netwelding.com/Cold_Air_Intake.pdf)



**GS/C7 Soler Modified Throttle Body**  
*For Improved Throttle Response*  
[http://netwelding.com/Soler\\_Mod\\_TB.pdf](http://netwelding.com/Soler_Mod_TB.pdf)



**Garmin GPS for GS Cubby**  
*Garmin Mounts in GS Cubby & Apple CARPLAY*  
[http://netwelding.com/GPS\\_In\\_Cubby.pdf](http://netwelding.com/GPS_In_Cubby.pdf)



**GS Splitter Stage 3 Winglet**  
*Stage 3 Winglets Integrate with Spats*  
[http://netwelding.com/Stage\\_3\\_Winglets.pdf](http://netwelding.com/Stage_3_Winglets.pdf)



**GS 2LT to 2.5 LT**  
*Red Upper Dash Pad Like 3LT*  
[http://netwelding.com/Red\\_Dash\\_Pad.pdf](http://netwelding.com/Red_Dash_Pad.pdf)



**Jake Emblem/Decals for GS**  
*Jake Symbols Support GS Racing Image*  
[http://netwelding.com/Jake\\_Embblems.pdf](http://netwelding.com/Jake_Embblems.pdf)



**GS Splitter Protector**  
*Scrape Armor Protection for Splitter*  
[http://netwelding.com/Splitter\\_Protectors.pdf](http://netwelding.com/Splitter_Protectors.pdf)



## **GS Engine Compartment Mods**

*Cosmetic Additions in Engine Compartment*  
[http://netwelding.com/Engine\\_Compartment.pdf](http://netwelding.com/Engine_Compartment.pdf)



## **GS Vitesse Throttle Controller: Fits All C7s**

*Adjustable Throttle-by-Wire Control*  
[http://netwelding.com/Throttle\\_Control.pdf](http://netwelding.com/Throttle_Control.pdf)



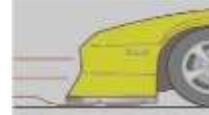
## **Boomy Bass Solution**

*Use Presets to Adjust Bass etc Tone/Balance*  
[http://netwelding.com/Boomy\\_Bass](http://netwelding.com/Boomy_Bass)



## **GS/C7 Air Dam, Functions**

*Why Missing from Z51, Some GS & Z06*  
[http://netwelding.com/Air\\_Dam.pdf](http://netwelding.com/Air_Dam.pdf)



## **Engineering a ProStreet Rod**

*How Our '34 ProStreet Rod Was Designed and Built*  
<http://netwelding.com/Engineering%20Street%20Rod%203-08.pdf>



## **Motorsports Welding Article**

*Wrote a 5 Page Article for AWS March 2018 Journal  
Covers NHRA and NASCAR Chassis Design*  
[http://netwelding.com/Motorsports\\_Welding\\_2018.pdf](http://netwelding.com/Motorsports_Welding_2018.pdf)

