Low Volume Vehicle Technical Association (inc)

INFORMATION SHEET

 # 03 - 2023 (October 2023)

Helping New Zealanders Build & Modify Safe Vehicles

LVVTA CLASSIC CAR RETRO-FIT SEATBELT STRUCTURE
Modern Seatbelts for Old Vehicles

Introduction

The purpose of this Information Sheet is to introduce a new 'Classic Car Retro-fit Seatbelt Structure' which has been designed by LVVTA to enable modern inertia reel lap and diagonal seatbelts to be fitted to the front seating positions of old cars (in particular, pre-1970 pillarless and convertible cars), without the intrusive look of a shoulder belt hanging down from the roof.

The Retro-fit Seatbelt Structure is not something that can be purchased as a finished unit because the dimensions and floor shapes vary from car to car, and so the structure has been designed as a DIY build and installation. It has been tested, and will meet LVV certification requirements if the build and installation process in this Information Sheet is followed.

This Information Sheet provides:

- background information about the need for modern seatbelts in old vehicles; and
- details about the testing processes applied to ensure the structure is safe and compliant; and
- a step-by-step guide to enable any competent home car builder or modifier to build and install the structure in their home garage.

Contents

Old Cars, Unsafe Seatbelts

Old Cars Don't Crash Well

There's a popular misconception that our beloved old cars – especially our '50s and '60s American vehicles – are safe because they're big. Mass helps, but it's not enough. These vehicles were never designed with crashworthiness in mind. They don't incorporate sophisticated crash-management characteristics like high-strength steels and clever design to ensure the occupant compartment doesn't deform in an impact, and they don't incorporate crush zones to absorb impact energy and thereby reduce the decelerative forces on the occupants. What this means, quite simply, is that they won't perform well in highway-speed crashes.

The reality however, is that most crashes occur at low speeds, and this is where the real tragedy occurs.

Lap-belts - Might as Well Have No Seatbelt at All

Most cars manufactured before the late 1960s were fitted either with lap-only seatbelts, or no seatbelts at all. Many people feel safe in a car with a lap seatbelt, but unsafe in a car with no seatbelt at all. But, there's an important message for those people; which is that there's a good argument to say that you're possibly no safer with a lap seatbelt than you are with no seatbelt at all. This is because wearing a lap belt restrains your hips in the seat and almost ensures that all of the impact energy from the crash is concentrated across your upper torso and head - the parts that matter the most. With no seatbelt at all, that energy will be distributed throughout your whole body, possibly reducing the impact energy on the most important parts.

Deaths in Survivable Accidents

LVVTA staff have seen, first-hand, as we've assisted the Serious Crash Unit teams over the years in assessing several old cars in fatal and serious injury crashes, that occupants – drivers especially – are being killed in low speed crashes which should be completely survivable. In recent years we've inspected three classic cars which have been involved in entirely survivable low speed crashes, where, in each case, the driver has died. In all three cases, the driver would have survived (and in two cases most likely wouldn't have even been injured) if a lap and diagonal seatbelt had been worn.

The difference between life and death in these sad events has been, quite simply, the type of seatbelt fitted to the vehicle. Drivers have died because the lap-only seatbelt they were wearing allowed their upper torso and head to be flung forward, making sudden and hard contact with the steering wheel, causing serious chest and head injuries.

These drivers should have climbed out of the car and walked away. In one case, the crash damage was so light that the car could have been repaired with a weekend's work.

Why Not Fit Lap and Diagonal Seatbelts?

The lap and diagonal seatbelts that would have saved these drivers can sometimes be retro-fitted to old cars, but not in all cases. Typically, the diagonal part of a lap and diagonal seatbelt is attached to the B-pillar (the part that the front doors close against), which is fine if your car has a B-pillar, and the B-pillar is strong enough and big enough to have an upper seatbelt anchorage attached to it.

In some old cars however, you can't physically attach an upper seatbelt anchorage to the B-pillar because there isn't the room to fit the anchorage, or because the B-pillar isn't strong enough.

In the case of pillarless cars, there's nothing there to attach the anchorage to, so that's not an option. One option for pillarless cars might be to attach the upper seatbelt anchorage up into the edge of the roof, but in some cases the roof just isn't strong enough - these old cars were never designed to have big crash loads applied to this part of their bodyshell. Even if the roof is up to it however, often the owner isn't. A lot of classic car enthusiasts love the smooth and elegant lines of a pillarless design, be it a two-door or a four-door car - and can't bring themselves to lessen the visual appeal of the car's body style by having a seatbelt hanging down from the roof, visible through the side window opening. The anchorage is often too high in these situations, so a 'dropper' has to be fitted, making everything look even worse.

And in the case of a convertible, of course, there's nowhere practical to fit an upper anchorage even if you did want to. Most attempts will result in the belts getting in the way of rear seat passengers getting in and out.

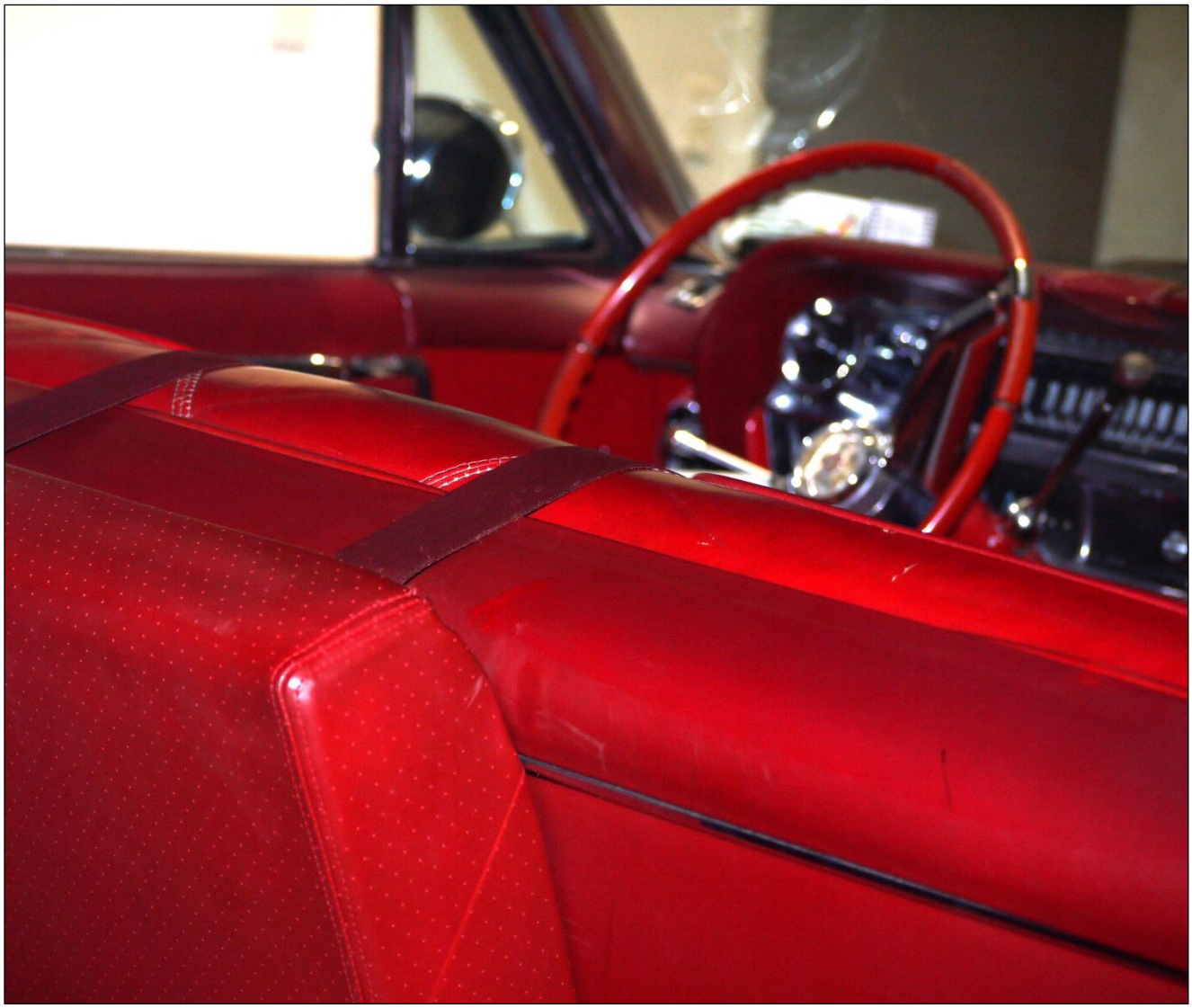
A lot of very old vehicles - particularly those built in the 1920s through to the 1940s, have the B-pillar positioned so far forward that an upper seatbelt anchorage could not operate correctly, because the anchorage is further forward than the seat back.

As a result of understanding these shortcomings, and seeing first-hand over the years what happens when these old cars are involved in crashes, LVVTA staff have thought about ways of improving the safety of old cars when they're involved in an accident, especially in low-speed crashes that should be entirely survivable.

The New LVVTA Classic Car Retro-fit Seatbelt Structure

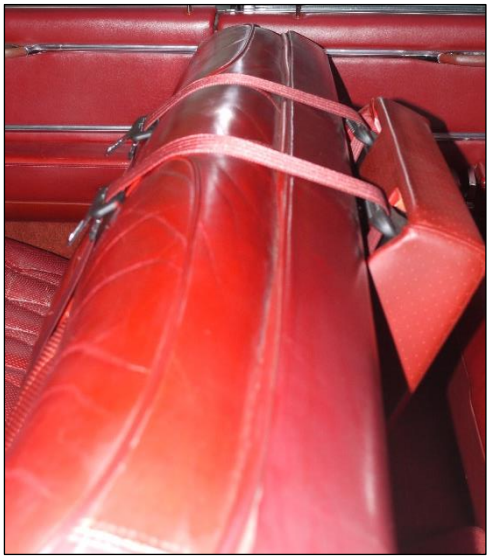
Now You Can Fit Modern Lap and Diagonal Seatbelts

LVVTA has developed a retro-fit solution that will provide a modern lap and diagonal seatbelt system for pillarless, convertible, and old vehicles, which mounts to the driveshaft tunnel and floor immediately behind the front seats. The LVVTA Classic Car Retro-fit Seatbelt Structure (let's just call it the Retro-fit Seatbelt Structure) will provide the driver and front seat passenger with modern inertia-reel lap and diagonal seatbelts, which are comfortable, safe, and almost out of sight. With some good upholstery work, the seatbelt structure will be hidden from view and will blend in with the car's upholstery.



The Retro-fit Seatbelt Structure can't be purchased off the shelf as every vehicle type will have slight differences, such as seatback height, seatback angle, and driveshaft tunnel shape, and so the solution has been designed as a DIY build and install project.

The Retro-fit Seatbelt Structure meets LVVTA's stringent safety requirements. It has been computer-modelled and had simulated crash loadings applied via Finite Element Analysis (FEA), and it has also been physically load-tested simulating an actual severe crash situation. So, you'll be hugely increasing your safety, and increasing your chances of surviving an accident by building and installing one. The Retro-fit Seatbelt Structure could make the difference between surviving a 'survivable accident', or not.



Rather than the conventional method of 'belt on the outside and buckle in the centre', the Retro-fit Seatbelt Structure operates on the 'belt in the centre & buckle on the outside' configuration. It might seem unusually orientated, but it's been done by some vehicle manufacturers over the years, and it's actually just the same as sitting in the centre rear seating position in many modern vehicles. And from a physics and safety perspective the 'centre-to-outside' configuration makes no difference.

LVVTA has designed the system so that any competent car modifier or builder can build the system in their home garage, by following a set of specifications supplied by LVVTA in this Information Sheet.

What Will It Cost?

We've worked with a friend in the industry, Ian Vibert and the team at Metcon Engineering in Wellington, to provide a 'kit' of steel parts, which will give the builder every piece of steel he needs, cut to size. This will simplify the process and reduce the cost.

The cost of the steel kit is (at the time of the release of this Information Sheet) $287.50. There is two-to-three hours of welding involved, so that might cost another $300. Two seatbelts with doubler plates and Monel rivets will be around $400. After that, it's just your time to build and install the structure, some welding materials, the cost of the upholstery to cover it, and the cost of LVV certification. (All costs are GST-inclusive).

If you have to pay someone to build the frame and install it all, the cost will of course be higher - perhaps $2000 - $3000 – that ramps up the cost, but you'll probably spend more than that on your ignition system, and this spend could save your life or a family member's life.

Things to Keep in Mind…

There are a number of things that should be considered before and during the build and installation of the Retro-fit Seatbelt Structure.

<u>Using the Information Sheet</u>

- Over time, this Information Sheet may be refined and improved, so always go to LVVTA's website to ensure you're working from the most up-to-date version.
- Read and understand the whole procedure before you start. Lots of elements of the build and installation are dependent on each other, so get your head around every step before you start, and keep looking ahead.

<u>Limitations of this Information Sheet</u>

- It is possible that there will be some vehicles which cannot be easily retro-fitted with this system. The suitability of the vehicle structure and its materials, especially in relation to driveshaft tunnel shape, needs to be considered before starting the project.

- The target vehicles are typically those with normal height bench seats (as most pre-1970 vehicles are equipped with) and vehicles with low-back bucket seats. The Retro-fit Seatbelt Structure is unlikely to work with any vehicles fitted with high-back bucket seats.
- This procedure cannot teach every aspect of good engineering practice involved in the build and installation, and so expert guidance should be sought by non-engineers or novice builders as you go, in order to ensure that a high quality, safe, and well-engineered end-product is achieved.
- The build and installation procedure provided in this Information Sheet must be treated as a 'recipe', which cannot be varied from. This is because the components, and the build and installation process, is a tested system, and any variances could cause the structure to no longer perform as tested. Therefore, no variances can be made to any component sizes or specifications shown in this procedure, without written approval from LVVTA.
- This procedure, using the specified 40 x 40 x 4 mm Square Hollow Section (SHS) material, requires the height of the Main Support Bar (Part B) to be limited to 515 mm (or 555 mm with the Seatbelt Running Loop Bar [Part D] attached). This tested system should work for most vehicles. If more height is required, it is possible to vary - subject to case-by-case approval from LVVTA - the specification to use 50 x 50 x 6 mm SHS. This material will allow a maximum height of 590 mm (or 630 mm with the Seatbelt Running Loop Bar [Part D] attached) to be used.

Welding and LVV Certification

- A home-builder can tack-weld the various components together, but the final welding must be undertaken by a suitably skilled and experienced welder using appropriately-rated welding equipment. Evidence must be provided to the LVV Certifier that the person who undertook the welding is a suitably skilled and experienced welder using appropriately-rated welding equipment.
- The building and installation of the Retro-fit Seatbelt Structure must be overseen and approved by a Low Volume Vehicle Certifier (LVV Certifier) to ensure that the procedure contained in this Information Sheet has been met, and that the system is safe and compliant. Make sure you engage an LVV Certifier at the outset, to confirm that the system is suitable for your vehicle, and to keep an eye on things during the build and installation process.

Helpful Tips

- The vehicle's floor and tunnel must be in sound structural condition, with no corrosion or poor repairs.
- Make sure the front seat is positioned as far rearward as you'll ever want it to go, because once the Retro-fit Seatbelt Structure is in place, the seat won't be able to go any further back.
- Installation of rear seatbelts in a vehicle fitted with a Retro-fit Seatbelt Structure is not mandatory, however, LVVTA recommends the installation of lap and diagonal seatbelts in all rear seating positions. It's a relatively easy process for most vehicles.

Feedback

- Designing the Retro-fit Seatbelt Structure, and developing this procedure, have both been complex projects. We're well aware that there could be ways of improving the procedure for future users, so we'd appreciate any feedback from those of you who build and install a Retro-fit Seatbelt Structure. Let's know how you go, what problems you experienced, and how we could make the procedure better for others into the future.

Disclaimer

- Every effort has been made to design a simple, affordable, and achievable Retro-fit Seatbelt System that will keep users safer in a collision. However, there are a huge number of variables associated with structural differences from vehicle to vehicle, and different crash-loads that could be applied. Because of these variables, LVVTA cannot guarantee any outcomes, however there can be no doubt that the occupants of a vehicle fitted with a fully-tested system that provides modern inertia reel lap and diagonal seatbelts will be vastly safer in any type of crash situation than those wearing lap seatbelts or no seatbelts.

Sourcing the Components

The image below shows all of the parts and materials that will be required for the construction and installation of the Retro-fit Seatbelt Structure.

Steel Kit

Every piece of steel necessary to build a Retro-fit Seatbelt Structure can be purchased as a 'Steel Kit' from Metcon Engineering in Wellington. Each piece of steel that is of a variable length (depending on vehicle specifics) is over-cut, so the Steel Kit should suit any vehicle. The cost of the steel kit (as of the date of the release of this Information Sheet) is $287.50 (inc GST). Metcon can be contacted at kat@metalcon.co.nz, or phone (04) 499-2494

Each piece of steel is detailed in Table 1. (Note that the seatbelts, seatbelt bolts, and seatbelt anchorage doubler plates [as shown in the photograph below] do not come with the Steel Kit).

Table 1: Parts and Materials			
A	Top Tunnel Plate	50 mm wide x 12 mm thick mild steel flat bar	1 piece, 800 mm long
B	Main Support Bar	40 x 40 x 4 mm mild steel SHS	1 piece, 515 mm long
C	Under Tunnel Mounting Plates	100 x 150 x 3 mm mild steel plate	4 pieces
D	Seatbelt Running Loop Bar	40 x 40 x 4 mm mild steel SHS	1 piece, 400 mm long
E	Main Support Bar Gusset	40 x 40 x 4 mm mild steel SHS	1 piece, 150 mm long
F	Side Tunnel Plates	70 x 250 x 3 mm mild steel plate	2 pieces
G	Inside Tunnel Mounting Plates	80 x 50 x 3 mm mild steel plate	6 pieces
H	Side Support Bars	25 x 25 x 3 mm mild steel SHS	2 pieces, 400 mm long
I	Seatbelt Retractor Mount	20 mm bar (drilled and tapped to 7/16 UNF)	2 pieces, 25 mm long
J	Upper Connection Gusset	150 x 100 x 3 mm plate (taper cut to 35 mm)	1 piece
K	Lower Connection Gusset	180 x 150 x 3 mm plate (taper cut to 75 mm)	1 piece
L	Seatbelt Retractor Mount Gusset	30 x 25 x 3 mm	2 pieces
M	Seatbelts, stalks, & mounting bolts	As supplied by seatbelt supplier	2 x sets
N	Under Tunnel/Running Loop nuts	As supplied	6 pieces
O	Inside Tunnel & Under Tunnel bolts	As supplied	10 pieces

Seatbelts and Attachment Components

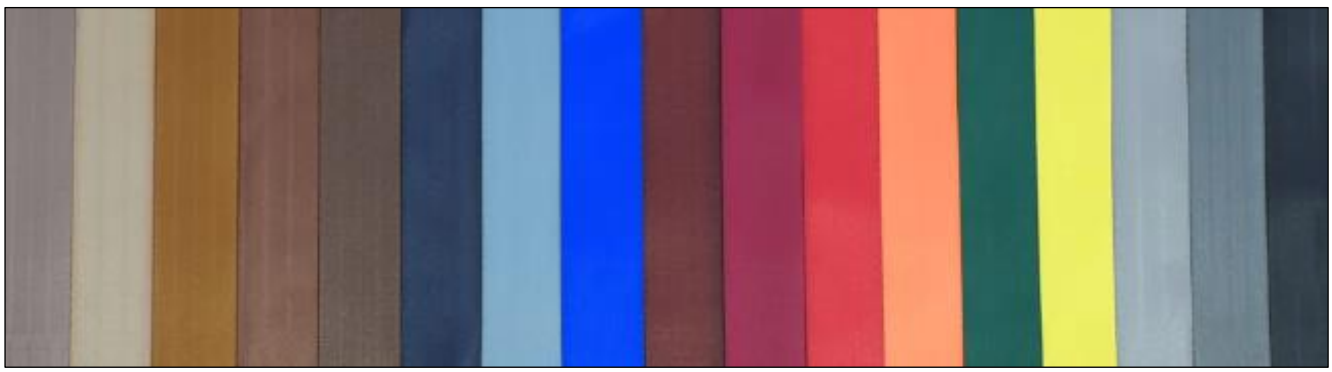
Seatbelts

Seatbelts can be sourced from anywhere providing they are of an approved type and meet an approved standard. The seatbelt orientation is '90/90' (meaning the seatbelts are designed for a 90 degree fore-aft and 90 degree left-right orientation).

LVVTA recommends Seatbelt Sales NZ Ltd as a seatbelt supplier, partly because of the great range of colours that they can provide, as shown below.

Their colour range is well-suited to classic vehicles, and they were able to provide seatbelts that were a great match for the blood red colour of the subject 1964 Cadillac's interior.

Seatbelt Sales NZ can be contacted at *info@seatbeltsales.co.nz* or freephone (0508) 58-00-00.



Doubler Plates

Seatbelt anchorage 'doubler plates' (Part G) are standard 80 x 50 x 3 mm doubler plates, which can also be purchased from Seatbelt Sales NZ.

Monel Rivets

The rivets must be 3.2 mm Monel rivets ('Monel' is a high-strength material), which can also be purchased from Seatbelt Sales NZ.

High-density Energy-absorbing Foam

We recommend the use of 12 mm thick FIA Orange Energy Absorbing Foam, which is available from Racetech in Wellington. This material is what David Black and his team at Racetech use in the race seats they build for various motorsport series around the world, including V8 Supercars. The material comes in sheets measuring 180 x 380 mm, and you'll most likely need two sheets. The approximate cost for these sheets is $95 per sheet.

To purchase this material, contact Racetech at *sales@racetech.co.nz* The part number for this material is RT-FOAMEC-5012.

Tools Required

Here's all the tools you'll need to build and install the Retro-fit Seatbelt Structure, other than the welder and associated welding equipment, and a rivet gun. Everything here will be in the garage of most competent home builders and modifiers. We haven't provided a table detailing what they all are - if we have to explain what the tools are, then you definitely need to get someone else to build it for you!

Building the Retro-fit Seatbelt Structure

In this section, we'll go through the process of building and installing the Retro-fit Seatbelt Structure step-by-step. The build and installation happens together (rather than building it, and then thinking about installing it) because the main structure has to be rigidly fixed to the vehicle as the rest of the supporting components are added to it.

Master-fabricator Sheldon Currington of 'Bad Seed Ltd' has been involved throughout the whole design and development of this project, and he's seen here doing the build.

Connecting the Top Tunnel Plate and Main Support Bar

The Top Tunnel Plate (Part A), and the Main Support Bar (Part B), are the two most important components of the system.

At right, Sheldon holds the two components in position to show the basis of the system.

The heavy 12 mm thick Top Tunnel Plate (Part A) - a piece of 50 x 12 mm mild steel flat bar 800 mm long - will be fixed to the top of the driveshaft tunnel. Attached to it will be the Main Support Bar (Part B) - a piece of 40 x 40 x 4 mm mild steel square hollow section (SHS), which is what will support the finished structure that the two inertia-reel lap and diagonal seatbelts will be fixed on to. The angle of the Main Support Bar (Part B) will be parallel to the angle of the back of the front seat (which will differ from vehicle to vehicle).

Note that the finished length of the Main Support Bar (Part B) must not exceed 515 mm.

The Top Tunnel Plate (Part A) must extend rearward from the Main Support Bar (Part B) by between 55% and 65% of the height of the Main Support Bar (Part B). This is a tested formula which can't be varied from.

The first step is to sit the Top Tunnel Plate (Part A) centred on the top of the driveshaft tunnel. These are usually straight sections of the vehicle floor, and it will be unusual for the Top Tunnel Plate (Part A) not to sit flat on the top of the driveshaft tunnel. The Top Tunnel Plate (Part A) must conform closely to the shape of the tunnel, so changes to the shape of either the Top Tunnel Plate (Part A), or the vehicle tunnel, may be necessary. Using packers to create a good mating surface is better than reshaping the tunnel.

In the photo on the previous page, the Top Tunnel Plate (Part A) is sitting in position, with the place marked (with an X) where the Main Support Bar (Part B) will connect to it.

The Top Tunnel Plate (Part A) must be fixed to the driveshaft tunnel with not less than four in-line fixing points; two in front and two behind where the Main Support Bar (Part B) will sit. The engineers chalk crosses (in the photo below) denote where the fixing point holes will be drilled.

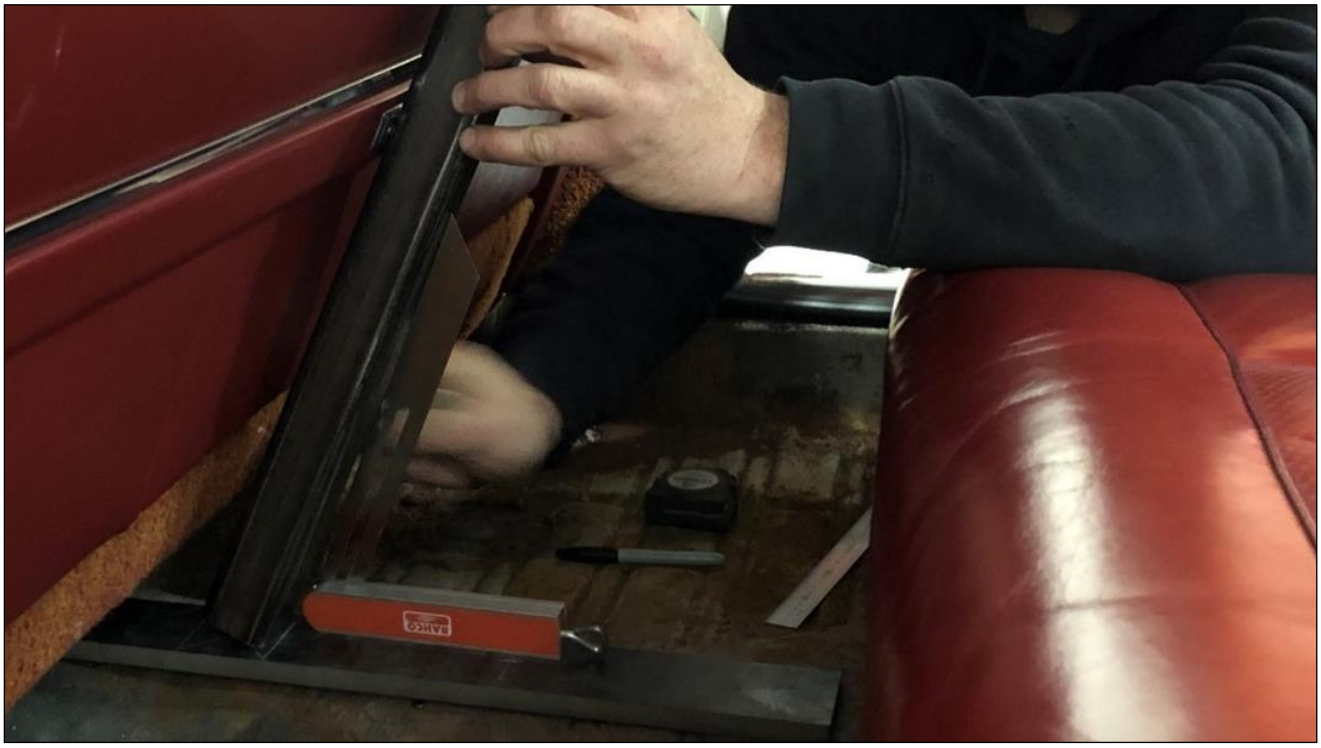
The two fixing points forward of the Main Support Bar (Part B) should be positioned more-or-less equidistantly between the Main Support Bar (Part B) and the forward-most end of the Top Tunnel Plate (Part A).

Of the two fixing points rearward of the Main Support Bar (Part B), one fixing point must be positioned as closely to the rear-most end of the Top Tunnel Plate (Part A) as practical (however not less than one hole width from the end), and the second fixing point must be positioned half-way between the rear-most fixing point and the Main Support Bar (Part B).

With the fixing points of the Top Tunnel Plate (Part A) determined, the Main Support Bar (Part B) can be attached to the Top Tunnel Plate (Part A).

Make sure that the front seat is positioned as far rearward as it's ever likely to be, because once the Retro-fit Seatbelt Structure is in place, you won't be able to move the seat back any further. Adjusting the seat forward from this position won't cause any problems.

Also, keep a gap between the seatback and the structure, as a seat can flex to some extent during use.



In the photo on the previous page, Sheldon uses his eye and a ruler to determine the angle of the Main Support Bar (Part B), and then uses a Bevel to 'set' the angle. With the fore-aft position and the angle now known, the two sections can now come out, be prepared, and tack-welded together.

At this early stage, don't trim the top of the Main Support Bar (Part B) below 515 mm - leave it over-length for now.

The Top Tunnel Plate (Part A) is drilled in the four places with a 1/2" or 12 mm drill bit, for the 7/16" UNF seatbelt bolts which will be used to connect the Top Tunnel Plate (Part A) to the driveshaft tunnel.

At the same time, the rest of the Top Tunnel Plate (Part A) needs to be prepared (as shown in photo at right) which consists of providing a radius of 10 mm on each corner, chamfering all edges, and deburring the drilled holes. The radius and chamfers reduce the likelihood of the Top Tunnel Plate (Part A) punching through the vehicle floor during an impact (like a can-opener), and deburring the drilled holes provides clearance for the internal radius under the bolt heads.

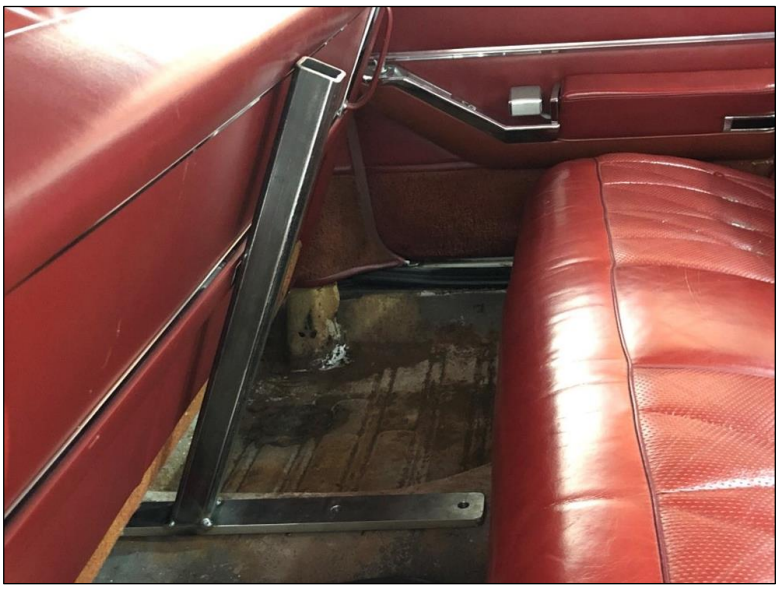
Another little point to remember is that when you're lifting steel structures and components in and out of a classic car, the smoother the edges are, the less likely you are to inadvertently rip your interior.

The photo below shows the Main Support Bar (Part B) tack-welded to the Top Tunnel Plate (Part A), and then checked back in the vehicle to ensure that the Main Support Bar (Part B) sits nice and parallel to the seatback, as intended.

An important point to note, as we touch on welding for the first time in this procedure, is that the home builder can do the whole job of building and installing the structure, except for the final welding. Welding the 4 mm thick Main Support Bar (Part B) to the 12 mm thick Top Tunnel Plate (Part A) is a job for an expert welder, so while the competent home builder/modifier can tack everything in place, the final welding must be done by a highly-skilled welder using appropriately-rated welding equipment.

Attaching the Top Tunnel Plate and Main Support Bar to the Driveshaft Tunnel

The drilled and prepared assembly of Top Tunnel Plate (Part A) and Main Support Bar (Part B) can now be put in its exact centred and aligned position (as shown in the photo at right), and the driveshaft tunnel can be drilled in the four places in readiness for bolting the assembly to it. The reason we're going to bolt it properly to the tunnel now (rather than completing the build of the structure and then installing it) is to ensure that the assembly is properly pulled into position before continuing its construction. Pulling it up tightly against the tunnel can slightly alter the position and angle, compared to just sitting in place, and so adjustments may be required before it's all sitting perfectly.



The Under Tunnel Mounting Plates (Part C) - 3 mm mild steel plate - are the plates that sit on the underside of the driveshaft tunnel to clamp the Top Tunnel Plate (Part A) to the driveshaft tunnel. The minimum size requirement for the Under Tunnel Mounting Plates (Part C) is 100 x 150 x 3 mm for each mounting plate. The Under Tunnel Mounting Plates (Part C) must have a radius of not less than 5 mm on each corner, and must have all edges chamfered (as shown in photo at right).

The Under Tunnel Mounting Plates (Part C) must be drilled in the centre with a 1/2" or 12 mm drill bit, for the 7/16" UNF seatbelt bolt which will be used to clamp the Top Tunnel Plate (Part A) through the driveshaft tunnel to the Under Tunnel Mounting Plates (Part C). A 7/16" UNF nut (as shown in the photo above) must be tack-welded to one side of the plate (the side facing away from the tunnel surface) to enable the nut to remain with the Under Tunnel Mounting Plates (Part C) while the bolts are being fitted and removed.

The photo below shows what the Top Tunnel Plate (Part A) and one of the Under Tunnel Mounting Plates (Part C) (if you were to follow the minimum allowable specification) would look like without the driveshaft tunnel positioned in between them. What isn't shown here is that the Under Tunnel Mounting Plates (Part C) must be 'shaped' to conform to the shape of the underside of the driveshaft tunnel.

While the 100 x 150 x 3 mm Under Tunnel Mounting Plates (Part C) shown on the previous page are the minimum permissible size, spreading the impact load (in the event of a crash) as much as possible is always desirable, and so if you can see a way of increasing the 'footprint' of the Under Tunnel Mounting Plate (Part C), go for it. In this case, we opted for (shown at bottom of this page) two very much larger Under Tunnel Mounting Plates (Part C) rather than the four minimum spec ones shown above. We did this because the two larger mounting plates substantially exceed the total combined area of the recommended Under Tunnel Mounting Plates (Part C) and therefore dramatically increased the clamping area, and it was also easier to get everything into position in the subject vehicle.

It should be noted at this point that the subject vehicle is a 1964 Cadillac Sedan de Ville, chosen because it features the unusual General Motors 'X-chassis' design (rather than the more conventional 'Perimeter chassis' design). The X-chassis made the Cadillac an ideal subject vehicle because the X-chassis is the worst-case scenario for fitting up the Retro-fit Seatbelt Structure, making getting the plates in place difficult, however not impossible. We managed to do the installation without even removing the exhaust system or letting body mounts go. Installing this system into a vehicle with a conventional perimeter-style chassis is a piece of cake by comparison.

The photo below shows what our larger two-plate Under Tunnel Mounting Plates (Part C) looked like on the underside - again, imagining what it would look like without a driveshaft tunnel positioned in between the Top Tunnel Plate (Part A) and Main Support Bar (Part B) assembly, and the Under Tunnel Mounting Plates (Part C).

With the holes for the Top Tunnel Plate (Part A) already drilled through the driveshaft tunnel, the Under Tunnel Mounting Plates (Part C) can be slipped up into position on the underside of the driveshaft tunnel, as shown above, to support the Top Tunnel Plate (Part A).

This will involve (because of the tight space between the X-chassis and the floor and tunnel) a combination of clever technique, brute force, and some swearing. But it is do-able. You'll also need someone up top inside the car to feed the bolts through to capture the Under Tunnel Mounting Plates (Part C) as you wriggle them up and into position. If you're struggling to manoeuvre the Under Tunnel Mounting Plates (Part C) into place, letting the body mounts go on one side and gently jacking the body slightly will make it a whole lot easier.

Once the Under Tunnel Mounting Plates (Part C) are in position, use 7/16" UNF bolts to pull them up firmly against the driveshaft tunnel.

Then, as shown at right, drill through the driveshaft tunnel and the Under Tunnel Mounting Plates (Part C) together, using a 3.2 mm to 3.5 mm drill bit, and rivet the Under Tunnel Mounting Plates (Part C) to the driveshaft tunnel with a minimum of four 3.2 mm Monel rivets per plate.

The rivets will ensure that the Under Tunnel Mounting Plates (Part C) remain in place as the Retro-fit Seatbelt Structure is bolted in and out of the vehicle - which will happen a few times during the construction and installation process. (Note that the rivets must be located beyond where the Top Tunnel Bar (Part A) sits, so that when the bar is bolted in position it is not resting against the rivet heads.)

The photo at right shows the basic assembly bolted down through the driveshaft tunnel into the Under Tunnel Mounting Plates (Part C). The basic assembly (Parts A, B, and C) is now locked into place, and sitting rigidly.

The rivets holding the Under Tunnel Mounting Plates (Part C) in place are visible just to the left and behind the Top Tunnel Plate (Part A).

Attaching the Seatbelt Running Loop Bar

With the basic assembly firmly bolted into place, the next step is (as shown at right) to position and attach the Seatbelt Running Loop Bar (Part D) made from 40 x 40 x 4 mm mild steel SHS. This is the part of the Retro-fit Seatbelt Structure that the seatbelt running loops attach to, and this bar determines where the shoulder straps (diagonals) sit.

There are four important things to consider here:

- the 'permitted area' which is about ensuring that the location of the seatbelt running loops is correct; and
- ensuring that the diagonal section of the seatbelt sits comfortably across the shoulder; and

- getting the height of the Seatbelt Running Loop Bar (Part D) bang-on so that the bar doesn't sit any higher than it needs to (from a visual stand-point); and
- that there is sufficient clearance so that the seatbelt webbing doesn't rub against the seat.

The top of the Main Support Bar (Part B), which the Seatbelt Running Loop Bar (Part D) will be attached to, should be positioned (as shown below) on the same plane as the top of the seatback. In other words, if you sat a straight edge across the top of the seatback, the Seatbelt Running Loop Bar (Part D) should tuck up nicely against the straight edge. This will get the upper seatbelt anchorages in the right place, and the finished installation will look clean and discreet.

The upper seatbelt anchorage 'permitted area' is shown in Diagram 1 on the following page. An upper seatbelt anchorage will fall within the 'permitted area' as long as the top of the shoulder (within the range of normal-height people) is close to the top of the height of the seat, and the Seatbelt Running Loop Bar (Part D) is more-or less parallel to the top of the seatback.

Before trimming the top of the Main Support Bar (Part B) to its final height of (maximum) 515 mm, hold the Seatbelt Running Loop Bar (Part D) into position, have someone sit in the front seat, and then check that the top face of the Seatbelt Running Loop Bar (Part D) falls within the shaded area in Diagram 2 on the following page.

Also check that the total height of the combination of the Main Support Bar (Part B) and the Seatbelt Running Loop Bar (Part D) is no higher from the Top Tunnel Plate (Part A) than 555 mm - this must be measured along the Main Support Bar (Part B), not vertically.

Once this positioning is determined, the top of the Main Support Bar (Part B) can be trimmed to its final correct height (remember, maximum of 515 mm), and the Running Loop Bar (Part D) can be tack-welded to the Main Support Bar (Part B).

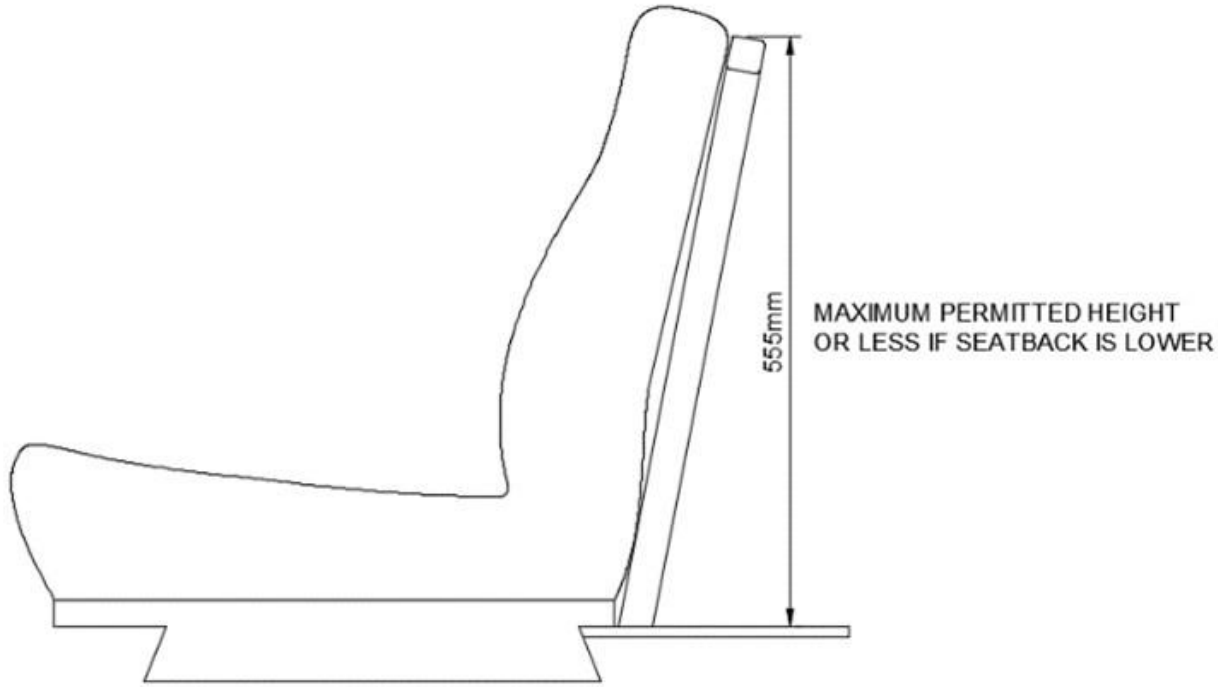


Diagram 1

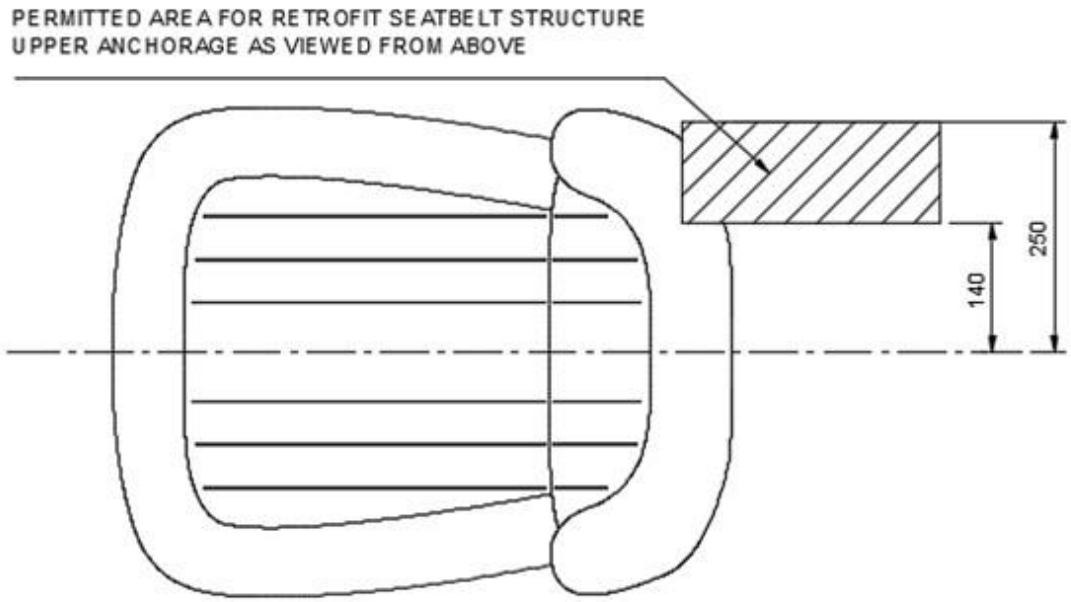


Diagram 2

Making the Seatbelt Running Loop Mounts

The 'width-wise' positioning of the seatbelt running loops is determined by a combination of the upper seatbelt anchorage 'permitted area' (see Diagram 2), and what feels right when the seatbelt is positioned over the shoulder.

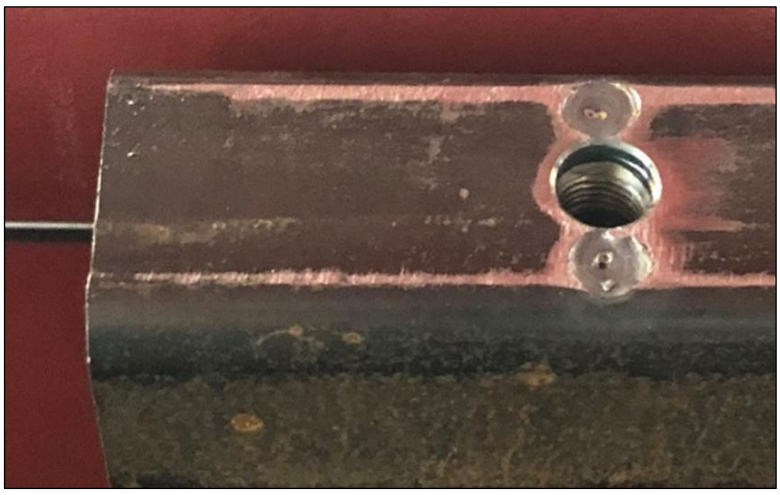
This 'width-wise' positioning aspect is, simply, that the upper anchorage (running loop in this case) must be no further away width-wise from the centreline of the wearer than 250 mm, and no closer width-wise to the centreline of the wearer than 140 mm (see Diagram 2).

As well as ensuring that this 'width-wise permitted area' is correct, it's also really important to experiment with the 'feel' of the seatbelt position. Have someone sit in the back of the car behind you while you sit in the front, and have that person move the belt across-wise (left and right) for you, to enable you to find exactly the right spots (for the driver and passenger).

Having the belt sitting in the correct position will determine how comfortable you'll be when wearing the seatbelts. If the belt is too far toward the outside of the car it will rub against your neck; if it's too far toward the centre of the car it could slip off your shoulder. Put the time into getting this right. As an example, on the subject '64 Cadillac, the seatbelt running loops are positioned exactly 290 mm apart.

As shown in the two photos below, to attach the seatbelt running loops, drill a 1/2" or 12 mm hole into each side of the Seatbelt Running Loop Bar (Part D) at the desired location for the 7/16" seatbelt anchorage nut, and debur the drilled holes. Just on the outside of the 1/2" or 12 mm hole, drill an 8 mm hole on each side (above where the body of each side of the nut will sit), to secure the nut to the Seatbelt Running Loop Bar (Part D).

A 7/16" nut is slid inside each end of the Seatbelt Running Loop Bar (Part D), and then pulled up tightly under the 1/2" hole with a sacrificial 7/16" bolt. This bolt will hold the nut in place while a plug-weld is made through each 8 mm hole to permanently attach the nut to the inside of the Seatbelt Running Loop Bar (Part D).



The sacrificial bolt will protect the thread of the nut during the plug-welding process, and will then be thrown away. Don't use too much heat, as you don't want to distort the shape of the nut.

If you've got it right, the seatbelt running loops can now be bolted in place, be free to swivel, and have a minimal amount of clearance just across the top of the seatback.

Adding the Main Support Bar Gusset

The critical connection point between the Top Tunnel Bar (Part A) and the Main Support Bar (Part B) will be a highly-loaded element of the system in an impact. The impact force that a person could apply to this structure during a big crash is in the region of 2 tons of force. This connection point needs to be strengthened by the addition of a Main Support Bar Gusset (Part E) - a piece of 40 x 40 x 4 mm mild steel SHS which is 150 mm long (shown at right).

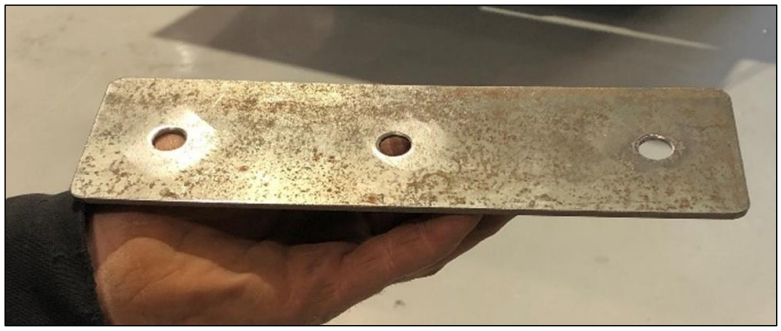
The Main Support Bar Gusset (Part E) should be cut in such a way that a full 40 mm of depth is maintained, while from there a taper-cut is made to extend between 100 mm and the full 150 mm length upwards.

Once fitting neatly, the trimmed Main Support Bar Gusset (Part E) can be tack-welded to the Top Tunnel Plate (Part A) and the Main Support Bar (Part B).

Preparing the Side Tunnel Plates

The Retro-fit Seatbelt Structure, thus far, has good strength in a fore-aft direction, but it now needs some support for any element of loading that the structure might be subjected to in a sideways direction.

This side support starts with another doubler plate system, this time referred to as the Side Tunnel Plates (Part F) - which are pieces of 70 x 3 mm mild steel flat bar, 250 mm long.



The Side Tunnel Plates (Part F) (shown at right) must have a radius of not less than 5 mm on each corner, and must have all edges chamfered.

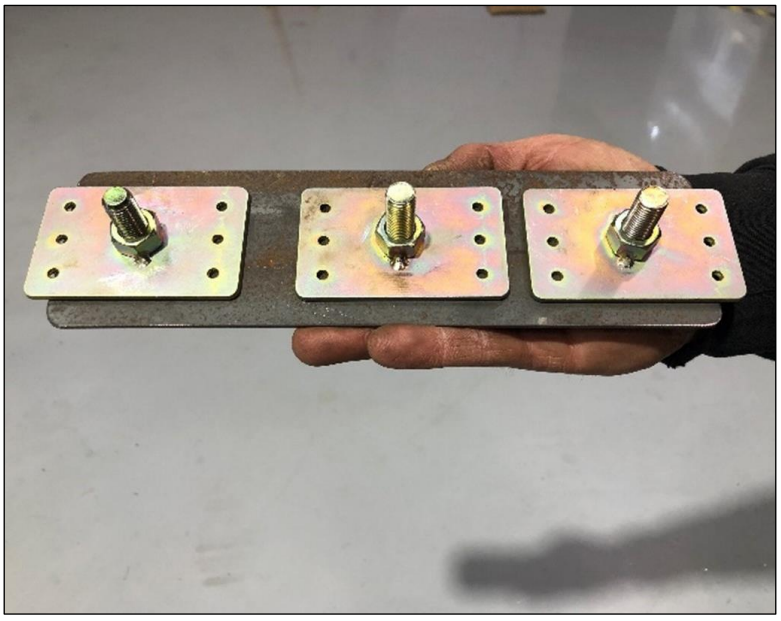
The plates must be drilled along the centreline in three places with a 1/2" or 12 mm drill bit, for the 7/16" UNF seatbelt bolts which will be used to connect the Side Tunnel Plates (Part F) to the sides of the driveshaft tunnel.

These holes must be spaced equidistantly, with the rear-most and forward-most holes drilled as closely to the ends of the Side Tunnel Plates (Part F) as practical (however no closer to the end of the plate than one hole-width). The holes must be deburred.

Attaching the Side Tunnel Plates

The Inside Tunnel Mounting Plates (Part G) - 3 mm mild steel plate - are the plates that sit on the inside of the driveshaft tunnel to clamp the Side Tunnel Plates (Part F) to the sides of the driveshaft tunnel. The minimum size requirement for the Inside Tunnel Mounting Plates (Part G) is 80 x 50 x 3 mm, and they can be regular 80 x 50 x 3 mm seatbelt anchorage 'doubler plates'. The Inside Tunnel Mounting Plates (Part G) must have a radius of not less than 5 mm on each corner, and must have all edges chamfered.

The Inside Tunnel Mounting Plates (Part G) (if not using seatbelt anchorage 'doubler plates') must be drilled in the centre with a 1/2" or 12 mm drill bit, for the 7/16" UNF seatbelt bolts which will be used to clamp the Side Tunnel Plates (Part F) through the sides of the driveshaft tunnel to the Inside Tunnel Mounting Plates (Part G). A 7/16" UNF nut must be tack-welded to one side of the plate to enable the nut to remain with the Inside Tunnel Mounting Plates (Part G) while the bolts are being fitted and removed.



The photos at right show what a Side Tunnel Plate (Part F) and it's associated three Inside Tunnel Mounting Plates (Part G) would look like (if you were to use regular seatbelt anchorage doubler plates) without the driveshaft tunnel positioned in between them. What isn't shown here is that the Inside Tunnel Mounting Plates (Part G) must be 'shaped' to conform to the inside of the driveshaft tunnel.

As with the Under Tunnel Mounting Plates (Part C), spreading the impact energy across a greater 'footprint' is even better, so if you can make a single Inside Tunnel Mounting Plate (Part G) with a total combined area that is greater than the three individual plates, all the better.

It's important to remember throughout the build of the Retro-fit Seatbelt Structure that you want the complete finished structure to tuck in as closely as possible to the back of the front seatback. You don't want it any further back, or any wider, than it needs to be. This is important from a visual viewpoint, and also so that it doesn't use up any more of the rear seat passengers' leg space than necessary.

The Side Tunnel Plates (Part F) must be fitted (on the top-side) of each side of the driveshaft tunnel, located in the region of the intersection point of the Top Tunnel Bar (Part A) and the Main Support Bar (Part B), and as far down the side of the driveshaft tunnel as possible, taking into account that the flattest part of the driveshaft tunnel will be the easiest area to shape the Inside Tunnel Mounting Plates (Part G) against.

Note that the exact position of the Side Tunnel Plates (Part F) cannot be established until the exact position of the Side Support Bars (Part H) has been established, which in turn will be determined by the position of the seatbelt retractors. This is a point at which you'll need to loosely mock-up the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G) until the next steps are figured out.

Once the location of the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Parts G) are established, this (below) is what the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G) look like bolted in place.

Don't rivet the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G) to the driveshaft tunnel yet. This will be done during final assembly.

Adding the Side Support Bars

As a general note, make sure you cover the upholstery and glass well before doing any welding. Sparks, and the damage they bring with them, always seem to go further than you think.

With the Side Tunnel Plate (Part F) and Inside Tunnel Mounting Plates (Part G) in place, you now have something for the Side Support Bars (Part H) to land on. The Side Support Bars (Part H) are pieces of 25 x 25 x 3 mm SHS, 400 mm long (shown below), and they will introduce the required sideways strength to the structure.

The Side Support Bars (Part H) must span a distance of not less than 45 mm of the height of the Side Tunnel Plates (Part F), and extend upwards to connect to the Main Support Bar (Part B) at a point which is no less than 30% of the height of the Main Support Bar (Part B). A connection anywhere from 30% to 50% of the Main Support Bar (Part B) is ideal. The section of the Side Support Bars (Part H) that attaches to the Main Support Bar (Part B) must be taper-cut to enable the greatest possible contact area.

Note however that the exact location of the Side Support Bars (Part H) will be determined by the positioning of the seatbelt retractors. So, you'll need to dummy up the seatbelt retractor position (described further on), in order to establish your Side Support Bar (Part H) position, in order to establish the position of your Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G).

Adding the Seatbelt Retractor Mount

The key to getting everything correctly positioned and functioning well is establishing the position of the Seatbelt Retractor Mount (Part I), shown at right. The Seatbelt Retractor Mount (Part I) is a 25 mm long piece of heavy wall round tube, with an outside diameter of 20 mm, and drilled and tapped to 7/16" UNF to receive a seatbelt anchorage bolt. This is what the seatbelt retractor attaches to.

The Seatbelt Retractor Mount (Part I) must be positioned so that the seatbelt retractor attaches to the structure directly below the seatbelt running loops, however remaining parallel to the seatback. For clarification, the retractor must be directly below the seatbelt running loops when viewed from behind, but not when viewed from above, and the distance between the two seatbelt retractors must be the same as the distance between the two seatbelt running loops.

The Seatbelt Retractor Mount (Part I) must enable the seatbelt retractor to mount vertically (at 90 degrees to horizontal), and the position of the seatbelt retractors must enable the seatbelt to pull and retract vertically, with no twisting of the seatbelt through its movement, and no touching of the webbing against the seat or any other component or bracket.

In the picture above, everything starts coming together:

- the location where the seatbelt retractor must sit (in relation to the seatbelt running loop position) has been established;
- which in turn establishes the position of the Seatbelt Retractor Mount (Part I);
- which in turn establishes the position of the Side Support Bars (Part H);
- which in turn establishes the position of the Side Tunnel Plates (Part F) together with the corresponding Inside Tunnel Mounting Plates (Part G).

You need to see all of these elements clamped or tacked in place before you can be sure of the final position of all of those components.

Once you can see that everything is in place, working well, and occupying the least amount of space possible, then it's time to:

- mount the Side Tunnel Plates (Part F) together with the corresponding Inside Tunnel Mounting Plates (Part G) into the sides of the driveshaft tunnel; and
- properly tack-weld the Side Support Bars (Part H) to the Side Tunnel Plates (Part F) and the Main Support Bar (Part B); and
- properly tack-weld the Seatbelt Retractor Mount (Part I) to the Side Support Bars (Part H).

At this point - provided the seatbelts operate as you'd expect, and feel comfortable - the design and assembly of the Retro-fit Seatbelt Support Structure is completed and is ready to now remove, fully-weld, and then finally add some additional gussets. You're on the home-run now!

Final Welding and Fitting Gussets

Here, Sheldon shows the Retro-fit Seatbelt Structure out of the car for the second to last time, in its completed form, excepting for final welding and the fitting of some last gussets.

This is the point where home modifiers/builders will take the structure to a skilled welder with the appropriately-rated welding equipment to complete the final welding of the structure.

Ask your welder to try to carry out the welding in such a way as to avoid any twisting of the structure. If the heat from the welding pulls any part of the structure away from its current shape, this will cause extra work to get it to fit and sit correctly again.

Once the full welding process is completed, trial fit the structure back in the car to make sure it still fits nicely before adding the last gussets. If the gussets are added before a trial fit takes place, and it turns out that the structure has to be 'cut and shut' because the structure has twisted during the welding process, removing the last gussets will just add a further layer of time and annoyance.

In this case, Sheldon welded the structure carefully, and was able to connect everything with high-quality welds, carried out incrementally, without introducing any twist to the structure.

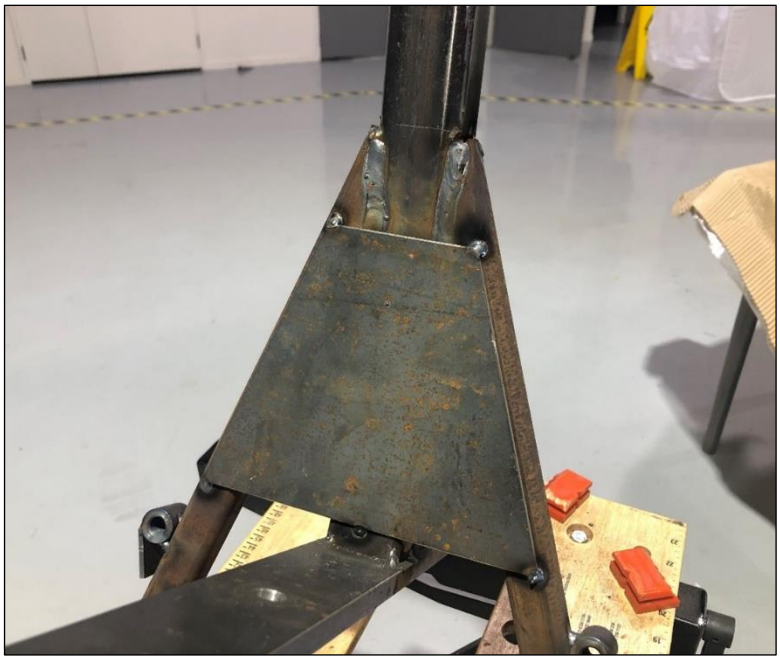
There are four gussets to add to the Retro-fit Seatbelt Structure to give it 'belts and braces' strength.

The first is the Upper Connection Gusset (Part J), which is a piece of 3 mm thick mild steel plate, cut to 150 mm at its widest point, 35 mm at its narrowest point, and 100 mm high (shown at right).

This Upper Connection Gusset (Part J) will provide extra stability for the connection point of the Seatbelt Running Loop Bar (Part D) and the Main Support Bar (Part B), to assist in any twisting or downward loads that might be applied in a crash.

Position the Upper Connection Gusset (Part J) on the back-side of the structure (away from the front seat), so that it spans the full height of the Seatbelt Running Loop Bar (Part D) and the full width of the Main Support Bar (Part B), and then tack-weld the gusset in place.

The second gusset is the Lower Connection Gusset (Part K), which is a piece of 3 mm thick mild steel plate, cut to 180 mm at its widest point, 75 mm at its narrowest point, and 150 mm high (shown at right).



This Lower Connection Gusset (Part K) will provide extra support in keeping the two Side Support Bars (Part H) in their correct relative position during any twisting load that might be applied in a crash.

Position the Lower Connection Gusset (Part K) on the back-side of the structure (away from the front seat), with the top of the gusset positioned at the bottom of the connection point of the Side Support Bars (Part H) and the Main Support Bar (Part B), and then tack-weld the gusset in place.

The third and fourth gussets are the Seatbelt Retractor Mount Gussets (Part L), which are two rectangular pieces of 3 mm thick mild steel plate, cut to whatever measurement is necessary to span the distance from the Seatbelt Retractor Mount (Part I) downwards to the Side Support Bar (Part H).

These Seatbelt Retractor Mount Gussets (Part L), shown on the next page, will provide extra support to keep the Seatbelt Retractor Mount (Part I) in its correct relative position during an upward load that the seatbelt retractor will apply to the mount in a crash. Tack-weld the gussets in place.

The Retro-fit Seatbelt Structure can now go back to the welder for the four gussets to undergo final welding. On the Upper Connection Gusset (Part J) and the Lower Connection Gusset (Part K), stitch-welding is all that is required.

Final Installation

Once the welder has performed his final bit of magic on the last gussets, the structure should be cleaned and painted, and then bolted in for the final time. Note that all parts, including all mounting plates, should be cleaned, prepared, and painted to protect it all against corrosion into the future.

It's time to install the structure for the final time. After the Side Tunnel Plates (Part F) and the Inside Tunnel Mounting Plates (Part G) are bolted into position, the final installation job is to drill through the Side Tunnel Plates (Part F), the driveshaft tunnel, and the Inside Tunnel Mounting Plates (Part G), in two places per Inside Tunnel Mounting Plate (Part G), using a 3.3 mm to 3.5 mm drill bit. Then rivet the assembly together using 3.2 mm Monel rivets. The Monel rivets add to the strength of the assembly, particularly against a twisting load.

Here's a tip: Although it's not shown in these photos, an even better way to perform the job above is to make the Inside Tunnel Mounting Plates (Part G) taller (top and bottom) than the Side Tunnel Plates (Part F), and then just the Inside Tunnel Mounting Plates (Part G) can be riveted to the driveshaft tunnel. This way, the Inside Tunnel Mounting Plates (Part G) will remain in position if the Side Tunnel Plates (Part F) are removed.

Now is a good time to fit the lower seatbelt anchorages.

Inner Lower Seatbelt Anchorages

The inner anchorage for the lap part of the lap and diagonal seatbelt can just bolt to the factory inner lap anchorage (where the factory buckle would normally attach to) in the vehicle floor.

If the vehicle has never had any factory-fitted lap seatbelts, or lap seatbelt mounts, then a simple and compliant solution is to attach the lower inner end of the lap and diagonal seatbelt to the forward-most of the three holes drilled through the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G).

Outer Lower Seatbelt Anchorages

The outer end of each seatbelt is, in this case, the buckle. Again, the buckle can be attached directly to the factory outer lap mount in the vehicle floor.

If the vehicle has never had any factory-fitted lap seatbelts, or lap seatbelt mounts, then *Chapter 14 Seats, Seatbelts, & Anchorages* of the *NZ Car Construction Manual* should be referred to for full detailed information regarding the positioning and attachment of the outer lower seatbelt anchorages.

The picture at below left shows the Lower Connection Gusset (Part K) after being fully welded across the top, and stitch-welded down the sides.

This picture at below right shows the front seat unbolted and moved forward out of the way to enable final installation.

This picture at right shows (with the front seat still unbolted and moved forward out of the way) the left-side lower inner seatbelt using the forward-most of the three bolts that connect the Side Tunnel Plates (Part F) and Inside Tunnel Mounting Plates (Part G) as its anchorage point. The same is happening on the other side.

The use of the Side Tunnel Plates (Part F) together with the Inside Tunnel Mounting Plates (Part G) make a very strong 'doubler plate' system for securing the lower inner seatbelts to. This system substantially exceeds the minimum requirements for seatbelt anchorages specified in the *NZ Car Construction Manual*, even though crash loads would be 'shared' across the same mounting system that supports the retractor. It's still belts and braces.

The picture at right shows the Retro-fit Seatbelt Structure finished, painted, and installed, with the front seat and carpets back in place.

At this point, the system is completed, fully functional, and will provide both of the front seat occupants of this old 1960s classic car with modern inertia-reel lap and diagonal seatbelts, that will be comfortable, and will function as effectively and safely as any modern vehicle with the same type of seatbelts.

It's a given that these old cars don't perform particularly well in a highway speed crash compared to a modern vehicle, but this system will massively increase the chances of survival, or injury reduction, in a low-speed crash. In fact, there is a high probability that this system could make the difference (for the driver especially) between death, and no injury at all other than some seatbelt bruising.

Protection and Looks

Two Things to Achieve

There are two remaining issues to deal with now that the Retro-fit Seatbelt Structure is built, installed, and operating. The first is to protect the rear seat occupants from the hard surfaces and edges of the structure, and the second is to make it all look nice, and blend into the vehicle's interior.

We'll tick both boxes with the same process.

Protecting the Occupants

The need to provide interior trim over the Retro-fit Seatbelt Structure can be as basic or beautiful as you want it to be, and apart from some protection from the Seatbelt Running Loop Bar immediately behind the front seat occupants, you could have nothing at all. However, if a vehicle being fitted with a Retro-fit Seatbelt Structure has a rear seat (which will, of course, be most vehicles) there will have to be some protection provided for the rear seat occupants. Anyone who is going to the cost and effort of installing one of these Retro-fit Seatbelt Structures will most likely be fitting lap and diagonal seatbelts in the rear (as we've done on the subject '64 Cadillac), so the rear seat occupants will, in general terms be well protected.

However, the presence of the Retro-fit Seatbelt Structure presents a 'leg-strike' risk, and so protection must be provided to ensure that rear seat occupants do not sustain additional foot and leg injuries from contacting the structure in the event of a collision.

This protection for the rear seat passengers is achieved through the design and fitting of a protective cover plate, and the covering of that plate with a high-density energy-absorbing foam. This enables the Retro-fit Seatbelt Structure to meet LVVTA's Interior Impact requirements.

Protecting the look

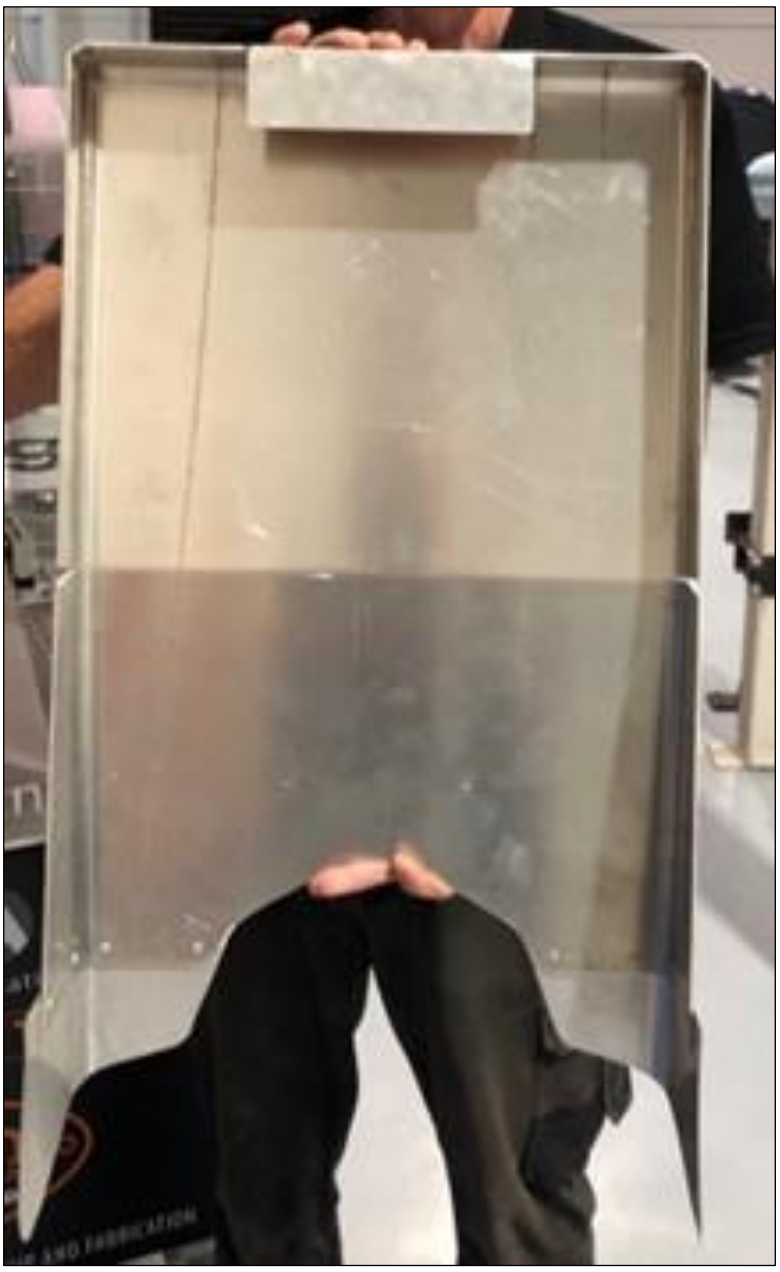
As lovers of beautiful old cars, we're all going to want to make the structure 'disappear' as much as possible, and so chances are that there will be some serious effort put into this by most people who are installing a Retro-fit Seatbelt Structure.

One of the key objectives throughout the whole process of building and installing the Retro-fit Seatbelt Structure is to keep it all as shallow as possible - in other words, tucked in as closely to the seatback as can be achieved. This is to minimise the amount of intrusion into the rear seat leg space, and also to minimise the overall visibility of the Retro-fit Seatbelt Structure. The smaller the structure is, the less obvious it will be. This is similarly true for the covering of the structure.

Aluminium Cover Plate

Dealing with the protection issue and the visual issue can be achieved at the same time, if both aspects are kept in mind right from the start.

For the Cadillac, we folded up an aluminium cover plate (shown at right) that covered the face and sides of the Retro-fit Seatbelt Structure from 2.0 mm aluminium plate. This extends from the floor, and up over the seatbelt running loops.

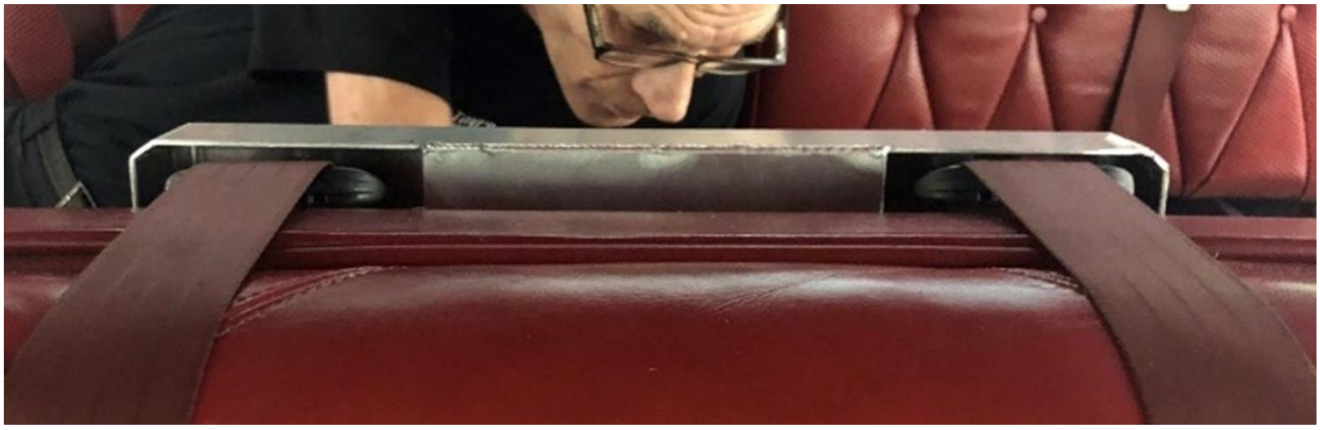


Some fabrication work (requiring a small amount of aluminium welding) took place at the top to achieve some nice curvature of the cover plate, so as to mirror the rounded corners of the factory seat and the rest of the upholstery. We didn't want to introduce any harsh-looking right-angle corners - they would look out of place amidst the soft roundness of the factory interior, and would draw your eye to the cover and the structure instead of disguising it.

Once the basic cover was made, a couple of additional pieces were added. Firstly, a vertical 'filler' tab was welded into the top centre area, which fills in the void between the seatbelts, and also locates the cover at the top. The second addition was a piece at the bottom of each side to neatly fill in the space right down to carpet level. We added the bottom pieces by simply riveting the extra bits in - that might seem a bit on the rough side, but remember that at this point, it's all about the shape, as everything will be covered.

The vertical filler tab makes sense when seen in the picture on the next page, as it cleans up the look of the cover. The opening appears to be bigger than necessary, but remember that the running loops swivel, and the seatbelt has to move sideways as the belt is being pulled on and taken off without making contact with anything around it.

Below, the aluminium cover panel is fitted, and is in the process of being marked for some final trimming. The cover plate is secured to the structure by the vertical filler tab locating it at the top, and two holes have been drilled near the bottom of the cover plate which will correspond with two riv-nuts which have been inserted into the Lower Connection Gusset (Part K). These two fixings will firmly secure the cover in place.



Protective foam

To protect the rear seat occupants, the cover plate must be covered in a layer of high-density energy-absorbing foam, which has an uncompressed thickness of not less than 10 mm. Normal soft foam cannot be used. **We repeat:** normal soft foam **cannot be used.** Foam that is not a very specific high-density energy-absorbing material will not provide the necessary protection in an impact. You can tell the difference between the correct foam and normal foam two ways. One; the correct material is very expensive, and two; you cannot compress the correct material more than 50% with hard thumb pressure.

We used 12 mm thick FIA Orange Energy-absorbing Foam (part number RT-FOAMEC-5012), which we purchased from Racetech in Wellington. If another material is used, it must be of equivalent specification, and must meet the same standards. The material comes in sheets measuring 180 x 380 mm, and we used two sheets in the subject Cadillac.

Toni Wadek of Toni's Auto Interiors in Porirua was chosen to carry out the upholstery work for the '64 Cadillac. Toni does a lot of custom and hot rod work, and handily, is experienced in colouring leather to match any existing interior colour. Accurately matching the leather on the cover plate to the Cadillac's blood red interior was really important. Having glued the 12 mm thick high-density energy-absorbing foam to the cover plate, Toni's showing here how stiff the material is. He's pushing it with his thumb as hard as he can, and he's compressed it by only 30% of its original uncompressed thickness.

Upholstery

In the photos below, the 12 mm thick high-density energy-absorbing foam has been glued to the cover plate, and has had its corners shaped and smoothed (taking care not to reduce the thickness at any point below 10 mm). It's now ready for the leather covering.

At this point, it's over to the owner to upholster the cover plate as they see fit, determined by time, taste, and budget.

In the case of the Cadillac, the factory interior features leather upholstery, in an unusual but attractive shade of blood red. Toni chose some perforated leather with a similar look and feel to the Cadillac's factory material, then coloured the leather to exactly match the blood red colour of the factory Cadillac leather, then finally incorporated some stitching as a final touch to help make it look as 'factory' as one could hope for.

For the owner of the Cadillac, the extra expense to make the final product look right has been well worth it, especially when admirers look inside the car, and don't even notice the presence of the Retro-fit Seatbelt Structure - which happens surprisingly often.

The real pay-off for the owner comes when driving the car; wearing a modern inertia-reel lap and diagonal seatbelt that's comfortable and gives a (fully justified) feeling of added safety really adds to the ride - as does knowing he's keeping friends and family who travel with him safe as well.

Questions

There will be situations where this build and installation procedure doesn't cover a particular situation, or where further information is needed. When this occurs, users of this Information Sheet should contact their LVV Certifier, or contact the LVVTA office directly. We'll all endeavour to help you.

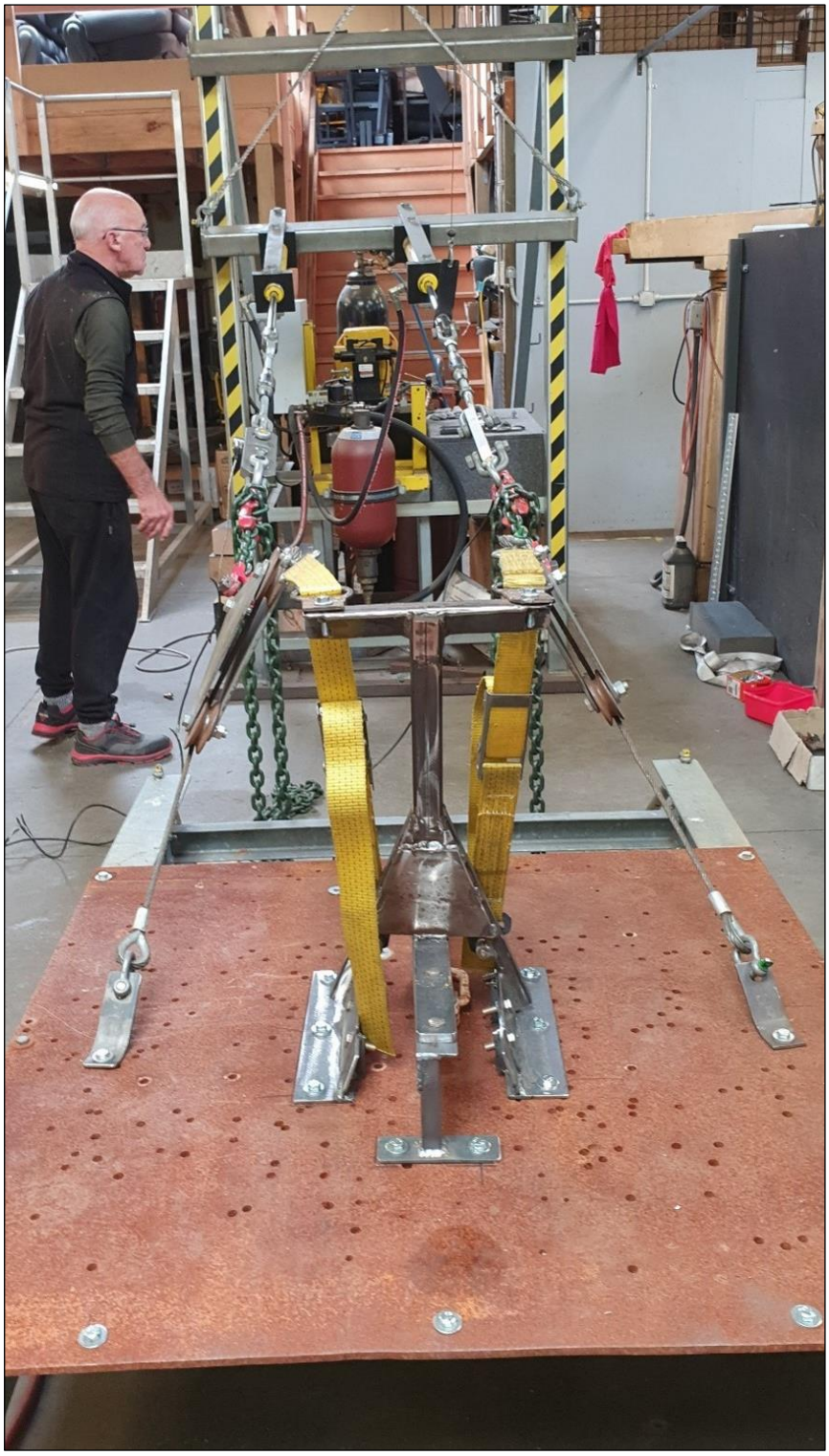
The Test Process

The LVVTA Retro-fit Seatbelt Structure has been tested in two different ways; a physical load-test, and then computer modelling using Finite Element Analysis (FEA).

Physical Load-testing

Firstly, the Retro-fit Seatbelt Structure was physically load-tested in a testing facility. The test equipment used was at Jackson Enterprises in South Auckland, and involved fixing the structure to a rigid frame, and applying typical test loads for upper and lower seatbelt anchorages (based on international standards) to the structure.

The photo at right shows the Retro-fit Seatbelt Structure fixed to the test-bed, and the testing equipment being prepared to apply the test-load to the structure.



The specified test-loads were applied to each seatbelt anchorage, via body blocks, in accordance with UNECE Regulation No. 14.07.

The structure performed well during the application of the load-test, and showed a very small amount of bending; just a slight deformation of the Top Tunnel Plate (Part A).

After the primary load-test was carried out, an additional load-test was performed on just one set of anchorages to simulate a single occupant, which would have the effect of applying a twisting load, as the structure wouldn't be loaded equally as it is with two positions tested simultaneously.

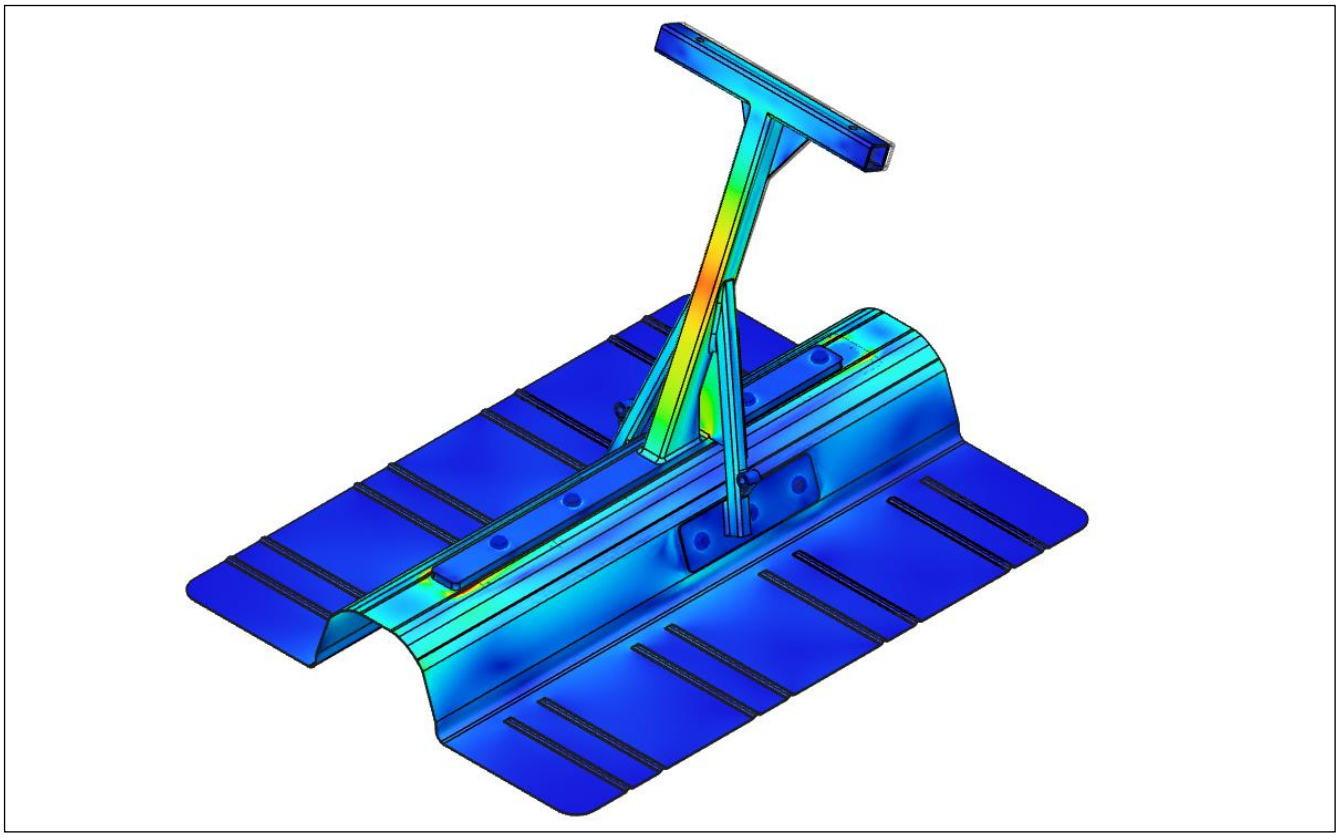
Again, the Retro-fit Seatbelt Structure passed the load-test with flying colours, giving us added confidence that no failure, or even major deformation, occurred after testing it a second time.

Computer-modelling and Finite Element Analysis

This physical testing process at the test facility proved the strength of the Retro-fit Seatbelt Structure, but didn't take into account the outcome of loading the Retro-fit Seatbelt Structure in combination with a typical vehicle floor and tunnel structure, as the test facility used a rigid steel plate platform.

To enable a vehicle floor attachment system to be simulated, LVVTA's Engineer Dylan Mathieson created a 3D computer model of the Retro-fit Seatbelt Structure, mounted to a (very conservative strength-wise) floor and tunnel section (shown at right), ensuring that the connection of the structure to the floor exactly mirrored the design shown in this Information Sheet. Dylan then applied the test-loads, again following international standards, to the structure and floor, using Finite Element Analysis (FEA). This is the coloured image shown below. FEA is a tool used to simulate a test-load, and the colouring system shows the level of stress applied.

The strong blue shows no or little stress, and the stress increases through the colours until quite high stress loads are shown in the warmer yellow/orange/red colour range. The FEA process showed that the floor section coped with the test-loads well, and the seatbelt loads sustained by the structure itself mirrored those of the physical load-test conducted at Jackson Enterprise's test facility.



Acknowledgements

A big thanks to:

- Peter Coster of Connett Engineering in New Plymouth who has designed his own retro-fit seatbelt system for his '56 Chevrolet, and who kindly allowed us to review all of his engineering data associated with his system, and to incorporate some of his ideas into the LVVTA design.
- Sheldon Currington of Bad Seed Ltd for provided the fabrication work to build the prototypes and the final version, and for chipping in with great ideas to improve the build and installation processes.
- Peter Jackson of Jackson Enterprises in Auckland for providing the test facility for the physical load-testing of the structure.
- Thomas Breinhorst of Thomas Engineers for overseeing the physical load-testing process at Jackson Enterprises.
- Ian Vibert and the team at Metcon Engineering in Wellington for working with us to create the 'Steel Kit', and for being their usual clever and helpful selves.
- Toni Wadek of Toni's Auto Interiors in Porirua City for carrying out the upholstery work to make it all look nice.

A Personal Note from Tony Johnson, CEO of LVVTA.

After 30-something years working in this vehicle safety environment, I've become well aware of the shortcomings, safety-wise, of these old vehicles that we all love so much, and that's probably made me a lot more risk averse than most old car enthusiasts. During that time we've helped the NZ Police Serious Crash Unit with the inspection and assessment process of pretty well every old, unusual, modified, or scratch-built vehicle that's ever been involved in a fatal or serious injury accident - and if I haven't see these outcomes first-hand, my colleague Justin Hansen has, and so I learn about them all. By the nature of our technical standards development work, every day during these past three and a half decades has revolved around 'what if?', 'what if?', and more 'what if?' So, I can't help but ask questions about how to make these old cars safer.

Over this time I've seen several cases where someone has been driving their much-loved classic car, something has gone wrong, and they've become involved in a low speed and completely survivable crash. But they haven't survived. In each case, these car enthusiasts should have got out of the car, and walked around to the other guy who drove into them, and given the driver some insight into how they feel about having their pride and joy damaged. But instead, of doing that, they've died, because they weren't wearing a seatbelt, or they were wearing a lap seatbelt (which is little better than no seatbelt), and they sustained massive chest injuries against the steering wheel.

And so over the years I've told my car-car buddies about this, and try to talk them into putting modern lap and diagonal seatbelts into their old cars. They say no, because they don't like the look of seatbelts hanging down through the window opening of their pillarless car, or they don't want the hassle of diagonal seatbelts being in the way of people getting in and out of the back. I say to them "so, ok, you're prepared to chance it, but what about your wife and your kids? Are you happy risking their life, or their good looks, just to avoid the look of seatbelts?" If I had a dollar for every time I've had this debate, and achieved nothing except for annoying my friends, I'd probably have another old car in my garage.

So, sick of the conversions and the excuses, one thing led to another, and I decided there must be a way to help other people who love old cars but don't like the unescapable look that diagonal seatbelts present. This end result has come from a lot of thinking, a lot of talking, and a lot of trial and error in the LVVTA workshop. I'd like to pay a special thanks to LVVTA workmate Ken McAdam (who like me, isn't a formally-trained engineer) for encouraging me to pursue the idea, and helping me to figure it out. Between us, armed with some common-sense and a practical approach, Ken and I talked and thought about this over a long period of time. We figured this system out, had it tested, and it works. I've now driven my '64 Cadillac over many miles, and as well as making me feel safer, and making my occupants feel safer, I also know there's a good chance it could make the difference between life and death in a crash.

This Retro-fit Seatbelt Structure project has been heavily supported by the whole LVVTA team all the way through, from encouragement of the concept, ideas as we figured it out, to pitching in with physical help - I'm very grateful to them all.

I hope this idea, and this how-to procedure, will help some car enthusiasts to adopt the system. And I also hope that the wives and partners of all the car guys out there will recognise the benefits of this when their guys don't, and remind their car guy husbands and partners that they're now officially out of excuses to not fit decent seatbelts into their old cars.

Over time, if enough people adopt it, this Retro-fit Seatbelt System will genuinely save lives.

FOR FURTHER INFORMATION PLEASE CONTACT YOUR LVV CERTIFIER, OR LVVTA.