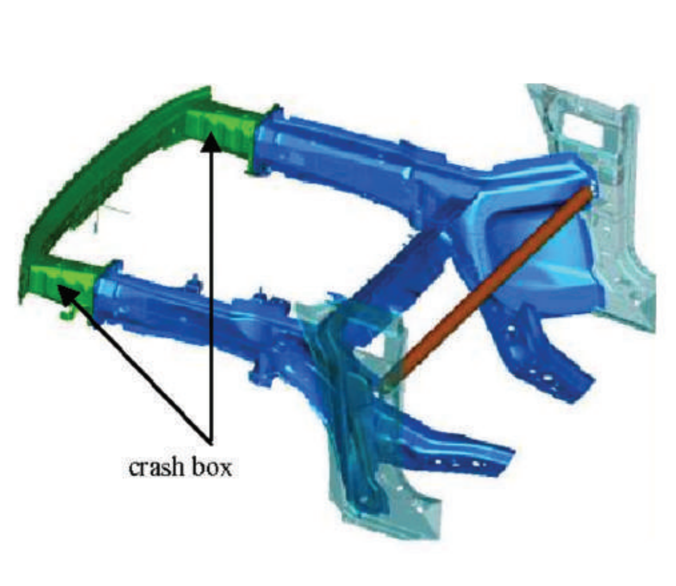
TECHNICAL REPORT

I-CAR NEW ZEALAND

AUTO BODY TECHNOLOGIES:

UNDERSTANDING "COLLISION ENERGY MANAGEMENT (CEM)" -



I-CAR NZ have recently been involved in determining whether a repair method completed by a collision repairer was "fit for purpose", or in contradiction of the vehicle-makers recommendations. Regardless of the outcome of that particular repair procedure, it did highlight that there are some discrepancies in how technicians and industry experts alike, interpret OEM information, as presented in both course material and the applicable Body Repair Manual (BRM) – especially under the general information section(s).

Collision Energy Management systems (CEM), that feature HSS / AHSS, composites and aluminium to name a few, describe both **Energy Absorption** & **Energy Transfer**

To help to clarify the essential differences between "Collision Energy Absorption" and "Collision Energy Transfer", it is important to understand that unibody structures (and to a lesser extent, full frames chassis configurations) have always been based on the engineering principle of "**Finite Load Paths**".

This is where individual stamped, pressed and cast parts are configured and connected together in such a way as to create torsional strength and rigidity within the overall structure, without creating stress points or fatigue fracture zones, and avoid weak or compromised areas in undesirable locations. These detailed structures are developed and applied by vehicle-makers, via teams of highly qualified engineers, with calculations and modelling concepts that are very mathematical in nature.

Obviously, as technologies and materials diversity has increased, so too has the ability to create vehicle structures that are stronger, lighter - and crucial to crash management, substantially more predictable in the way that the overall structure behaves when subjected to different impact parameters.

As previously stated, load paths are created by utilising the correct materials in the right positions, as well as applying appropriate welding or joining techniques, and perhaps a little misunderstood, the use of shapes or profiles stamped into the individual components – Adding further confusion is the fact that newer structural design principals and ideologies for the Body In White (BIW) are often referenced when determining a correct repair procedure for previous generation (older) vehicle collision repairs.

You are not alone if you are thinking that this is all starting to get a little difficult to understand, especially when there may be a difference of opinion about developing and implementing a repair plan on a vehicle that may not have all of the appropriate information available.

While each and every repair scenario should be evaluated on an individual basis, there are a number pitfalls that estimators, technicians and assessors alike can fall into when identifying the extent of the damage and the appropriate repair plan –

- There are **NO** hard and fast rules around the types and/or combinations of steels vehicle – makers use in the both the unibody or chassis frame, but generally speaking, older models/platforms use substantially lower tensile strength metals, with more individual parts to be joined together.
- Accordingly, direct damage is more substantial and intrusive on older platforms with a dramatic reduction in “Energy Transfer”, when compared to a similar impact on newer generation vehicles.
- Ridges, profiles, convolutions and swage lines identified in many structural components do not necessarily confirm that these areas are “Crush Zones” - as already stated, often these features form part of the “Load Path”.
- In further support of profiles being used as “stiffeners”, we only need to look to reinforcements and inner X members where there is substantial use of convolutions / swage lines to create complex, rigid structures.
- Apart from the amount of collision energy sustained, the **DIRECTION** of impact will also determine how structural parts deform / behave.
- The **LOCATION** of any convolutions / profiles are also a good indicator of what functions the particular component will be performing – Crush zone areas are, in most instances located at the very front portion of the chassis rail **(FRONTAL)** or at the very rear of the chassis rail **(REAR)** – in both instances, these are directly behind the bumper fascias and are often incorporated into the crash beam(s).

Frontal impacts are globally the most common type of collision event that occurs – accordingly this is where we find the most abundant use of **Collision Energy Management** features – correspondingly, this is also where we find more complex **Load Path** scenarios.

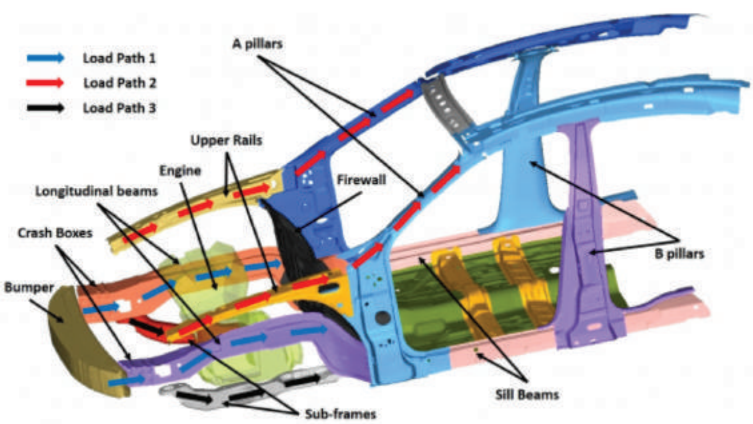


Figure 1.2: Load paths of vehicle frontal structure

LOAD PATH 1: Bumper beams - Crash boxes - Longitudinal beams

• **LOAD PATH 2:** Upper rails/reinforcements (hood ledge) - A pillars

• **LOAD PATH 3:** Sub-frames & cradles - Sill beams/reinforcements

The components in all three paths, besides creating stiffness / strength, are designed to either **absorb** or **transfer** impact energy and are often a combination of both features.

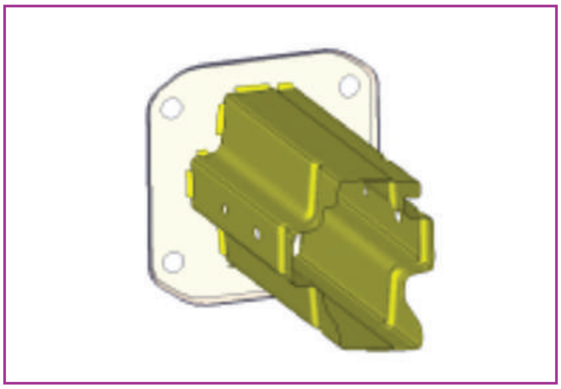
LOAD PATH 1 : (Crash beams, crush boxes and chassis members), can typically be required to absorb up to 50% of the total crash energy – but that can vary widely dependent on the impact angle / direction.

LOAD PATH 2 : (Upper rails/reinforcements) are connected directly to the A pillar / screen pillar to create a definitive load path and increase rigidity. Modern designs now incorporate the door hinges and intrusion beams in load path calculations.

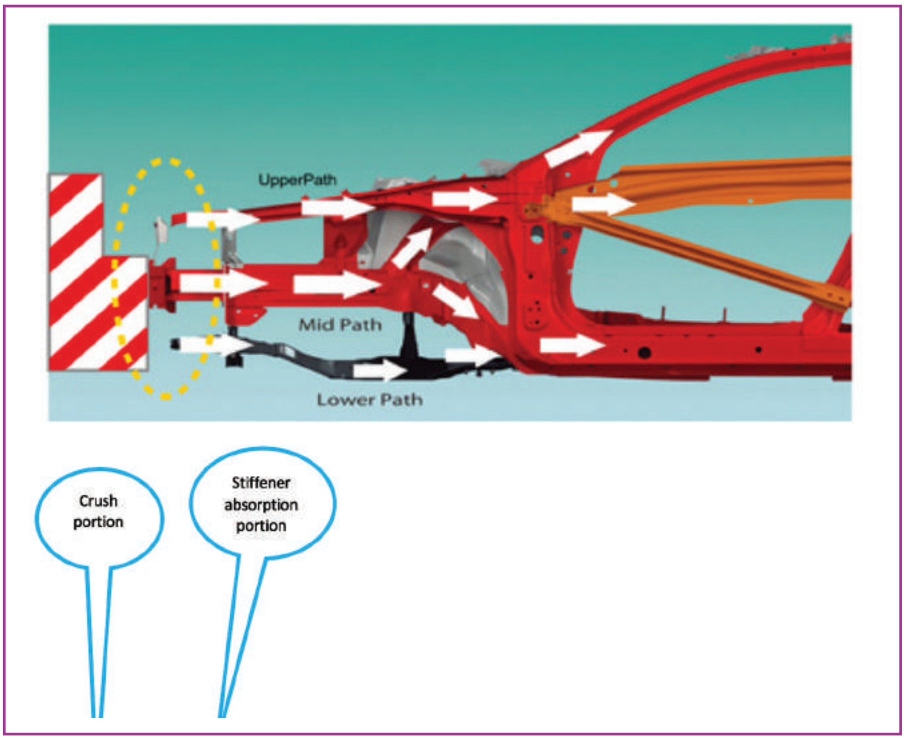
LOAD PATH 3 : (Subframes / sill beams) In the lower load path, we observe that torsional strength and stiffness is achieved by the load being directed though to the rear section of the front chassis rails where they migrate into the floor pan, and via torque boxes, into the sill / rocker areas.

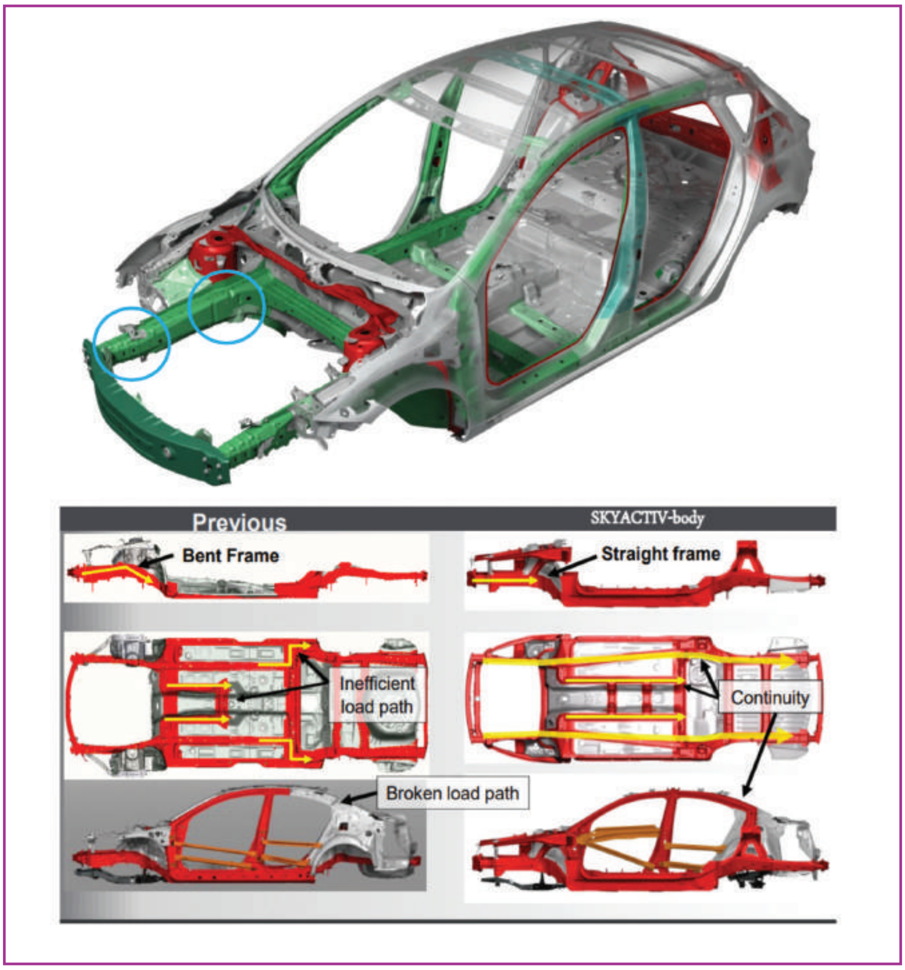
In all instances, the modern approach from vehicle – makers, and their engineers, is to create straighter lines throughout the body structure…

Courtesy of Mazda :-

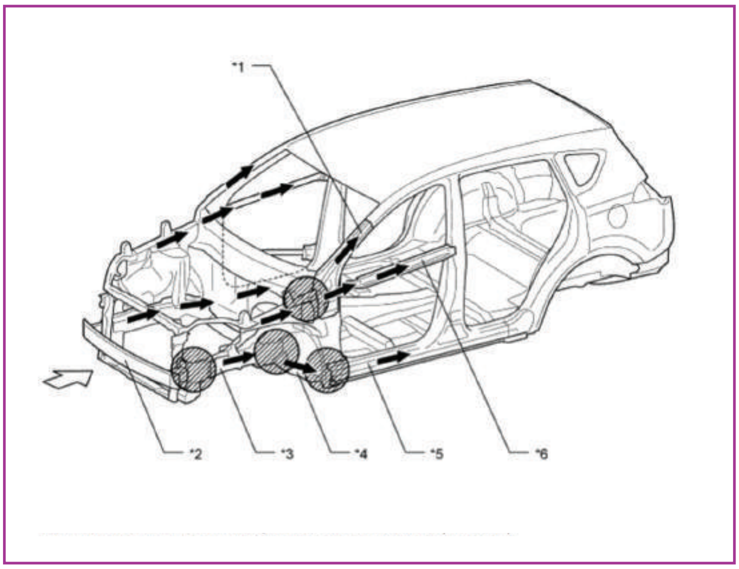


12-point box shape of chassis rails improves rigidity (Skyactiv technology)





Courtesy of Toyota :-



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