Vibrations, Wheelbase and Chassis Strength

Additional axle mass limits are available in Australian for 'road-friendly suspensions'. A road-friendly suspension must have a natural frequency that is less than 2 Hz when the axle is at full weight. It must also have a damping rate that is more than 20 per cent of the critical value. Critical damping would occur when there is no overshoot on the first response.

Fortunately good RFS performance is good for both the road and the truck. Truck frames also have a 'natural frequency'. This is called the buffeting frequency and it is illustrated in the diagram at the bottom. Typically it is in the range 6 – 9 Hz. So road vibrations that get through the suspension at this frequency can excite beaming. For reference, a vehicle that encounters road bumps that are 2m apart when it travels at 70 km/h will experience road bumps at 8 Hz.

The stiffer the chassis, the less beaming can occur. Occasionally, a truck has a particularly bad beam tendency and the driver will complain that it jumps around on the road. Beaming tendency is the other consideration when selecting the wheelbase. The rails must be adequately stiff for the longer wheelbases. Good road handling can only occur with a relatively stiff chassis structure because any excessive bends and twists cause the road handling and braking forces at the wheels to vary, which is destabilizing. On trailers and rigid body trucks the stiffness of the body can be a key factor in stiffening up the chassis.

An adequate design for the mechanical attachment of the body to the chassis rails of a truck or a trailer is essential for safety. It also may determine the life expectancy of the chassis rails and affect the roll stability of the vehicle. Some basics follow:

- The diagram on the right shows the three main attachment types. Mounts can be classified as stiff or flexible. Most trucks and trailers need a mix of mount types because the design should avoid sharp changes in torsional and vertical stiffness.

- The art of good design is to gradually change the stiffness to avoid high stress locations that might occur if high loads are applied across dramatic changes of strengths.

- U-bolts are the traditional attachment method. They allow the body to flex sideways because there is limited side stiffness.

- When used on C-section chassis rails, they must have spacer inserts to prevent the rail section being distorted in. Even when tight, a distorted rail will spring on the road and work the (U-bolt loose. U-bolts used alone also allow some rocking backwards and forwards. There must be two diagonal bracing straps used each side to prevent this happening. The rail must be protected against clashes with U-bolts to prevent any crack development.

- Side-plates attach the sub-frame and bolt through the web of the chassis rail. For heavy-duty trucks and trailers, 10 mm thick mild steel is often used with four high-tensile strength bolts through the rail. Side-plates are usually welded onto the sub-frame of the body, which is also usually made from mild steel.

- Welding side-plates onto the high-tensile chassis rails is not advisable because of the danger of heat damage to the rail steel. Furthermore, bolted connections onto the rails allow the body to be removed.

- Protrusion attachment brackets are welded or bolted onto both the sub-frame and the chassis rails. They usually provide an extremely strong mount with no flexibility. A cross-member is built in underneath. Flexibility cannot be tolerated when stabilizer legs are used. As a guide, an attachment point is required about every 1000mm along each side. These need to be positioned to avoid existing features and should be kept away from cross member bolts and axle mounting bolts.

- When the attachment method causes the weight on the body to rest directly on top of the upper chassis rail flange, a protective strip must be used. It is essential that any protrusions on the sub-frame that could apply point-loads onto the rail flange are avoided. Point load or pinch-points will, in time cause the rail flange to crack. Wooden runners have traditionally been used. Urethane spacer strips are a preferred material. Aluminium should not be used as it is likely to suffer corrosion in contact with the steel. Whatever spacing method is used, gradual transitions are necessary. The space between the rear of the cabin and the front of the sub-frame is particularly vulnerable to torsional stress. The body sub-frame tends to give the rear chassis torsional rigidity, and the cabin stiffens up the front. Some flexibility should be provided in the front body mounts to avoid twisting failure behind the cabin.

- The main message is to keep the chassis and body structure reasonably stiff, make transitions of section strength gradual and avoid any point loads or pinch points on the chassis rails. The front mounts should have some compliance.

- A strong rail spacer for C-section rails must be used with U-bolts.

- Chamfering at the end of the subframe is necessary to avoid a pinch point.

- U-bolt attachments allow flexing. High-tensile steel U-bolts must be used.

- Side-plates give a strong attachment with minimal flex. 10mm mild steel is often used. The lower bolt should be below the rail center-line.

- Always use nut retention such as nyloc or spring washers.

- Mounting brackets can be used with a compliant spacer to provide flexibility.

- High-tensile mounting bolts with hardened washers are always needed.