Rear Suspension Radius Rod Geometry

Introduction:

During the two previous rounds of LVV Certifier training sessions (late 2010 and early 2011), one of the points of technical discussion LVVTA had with the LVV Certifiers was 'ladder bars' - a term given to a particular type of radius rod, that in some circumstances can create incorrect suspension geometry and bind. This Information Sheet summarises the outcome of the good feed-back and general concensus of those discussions LVVTA had with LVV Certifiers throughout the country, together with the like-minded view of the LVVTA Technical Advisory Committee.

The Information Sheet also provides an overview of how such radius rods are to be treated by the LVV Certifiers until such time as the Suspension Chapter of the Car Construction Manual has been next amended.

It is important to note that this information sheet focuses only on rear suspensions, as the use of the type of radius rod systems covered within this information sheet as they apply to front axles is dealt with separately within the Suspension Chapter of the NZ Car Construction Manual.

Types of radius rods in question:

Radius rods should always be designed and fixed so as to maintain correct geometric operation during full suspension extension and compression. There are three types of radius rods that have been traditionally fitted to modified and scratch-built vehicles, where maintaining correct geometry is very difficult, if not impossible. These three systems are as follows:

- One system is 'split radius rods', which is a term given, usually to 1920s through 1940s Ford-based cars and pick-ups, where the OE radius rods that originally triangulated from the diff housing into a central pivot point on the chassis, are opened out, or 'split' and connected to the vehicle's chassis side-rails. These rods, once split, run more or less parallel to the chassis, as opposed to (approximately) 45 degrees inwards.

- Another system is known as 'hairpin radius rods', which are tubular aftermarket rods that operate in the same way as original split radius rods. Again, the hairpin radius rods, or 'hairpins' run (more or less) parallel to the chassis. In some vehicle/diff combinations, there is more 'taper' or inward angle than on others.

- The last system is known as 'ladder bars', which are an aftermarket (or usually custom-built) style of radius rod, that looks a bit like a ladder due to their reinforced tubular design. Again, in some vehicle/diff combinations, there is more 'taper' or inward angle than on others.

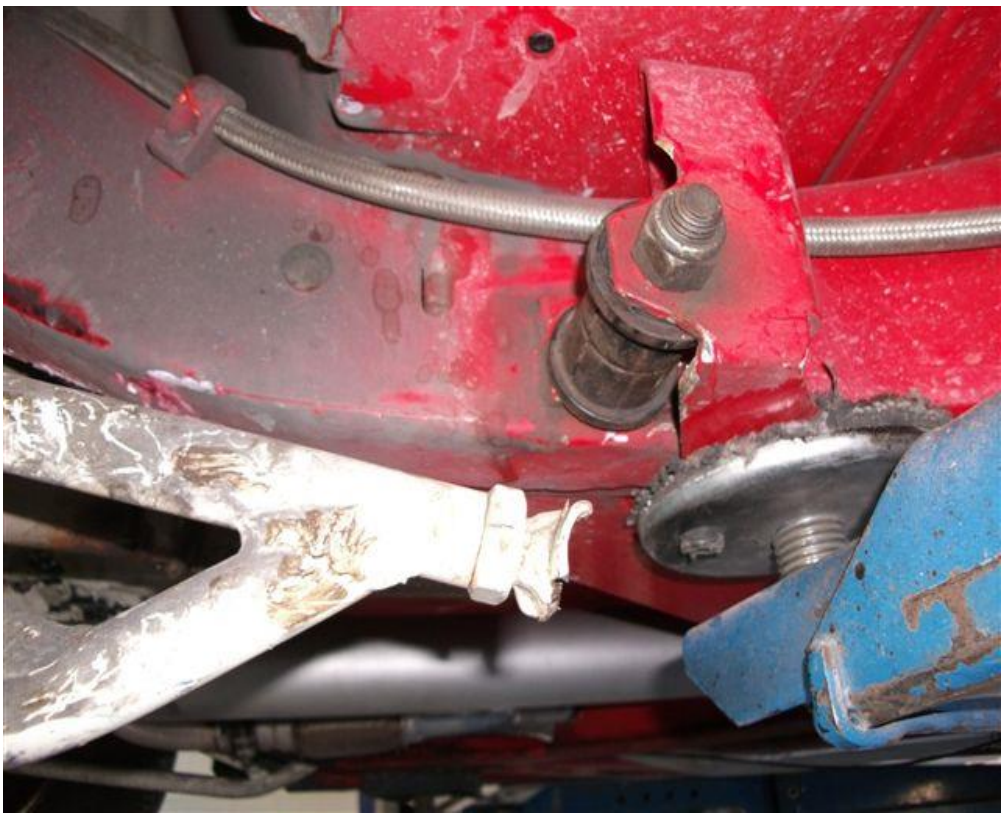
The common theme to all three designs is that they are all solidly fixed to the top and bottom of the diff housing, and pivot from the sides of the chassis.

The problem:

The problem with all three radius rod designs referred to above is that when the bars are rigidly mounted to the diff housing and there is no triangulation (ie they run more or less parallel to the chassis), the suspension will not work as it should and the axle will bind.

This system effectively turns the diff housing into a giant anti-sway bar. When suspension loads are repeatedly applied to a system that cannot freely move through the necessary range of compression and extension, the loads are likely to eventually cause a failure. (Although we're not talking front suspensions within this information sheet, the same outcome occurs whether you're talking about a diff housing or a tubular front axle.)

Types of failure that LVVTA people have seen first-hand over the years are radius rod brackets fracturing (or even being torn completely off the diff housing), fracturing of the diff housing (sometimes the first signs of this has been diff oil leaking from axle housings), and failure of the rod end at the chassis.



Pictured to the left is the remains of a failed rod end, still attached to the ladder bar. The vehicle in question is a 'worst-case scenario', in that it had everything going against it; - heavy vehicle, a lot of suspension travel (due to airbags), short ladder bars, and minimal bush compliance. The most likely reason that the bars were so short is that the builder decided to use the front OE leaf spring hanger mounts on the chassis as forward attachment points for the ladder bars. The bar's failure caused a (non-injury) accident.

Current requirements:

Contained within LVV Standard 195-00 (Suspension Systems), and the Suspension Chapter of the Car Construction Manual, is the following requirement (relevant section thereof underlined):

"Low volume vehicles which have undergone significant changes to the suspension system must feature no abnormal suspension geometry, and be aligned so as to provide satisfactory handling characteristics, and ensure against excessively shortened tyre life."

'Normal' suspension geometry means, within the context of this discussion, suspension that will extend and compress throughout the range of travel available to the shock absorber and spring without any interference

or binding, particularly binding to such an extent that high levels of stress may be applied to the diff housing or any inter-related component.

Tapered or semi-tapered radius rods may work:

Where hairpin radius rods, split radius rods, or ladder bars are used, they should ideally taper inwards toward the centre of the vehicle. This way, the diff housing will pivot at the centre and the suspension will operate correctly. Even if the rods don't meet at the vehicle centre like old OE Ford systems, some inward angle of the bars may make a big difference.

Semi-tapered radius rods may still allow unimpeded suspension travel, provided that:

- the bushes used at the chassis end have a lot of compliance in them to assist with articulation of the joints; and
- the vehicle in question has minimal suspension travel; and
- the radius rods are of sufficient length.

Assessment of suspension operation:

A correctly designed radius rod style suspension system will allow each side of a diff housing to be raised and lowered by simple lifting by hand, provided that the shock absorber and spring (and anti-sway bar) is disconnected.

In the event that an LVV Certifier is presented with a vehicle that features a style of radius rod suspension, that due to its design, may possibly bind the diff housing (and this will include any parallel or semi-parallel radius rod, hairpin, or ladder bar), the LVV Certifier must ensure that such a system is safe. To ensure that the consistent safety of such systems, LVVTA requires LVV Certifiers, effective immediately, to physically test the functionality of such suspension systems, by applying the following assessment process.

The LVV Certifier must:

- raise the vehicle, support the chassis, and support the centre of the diff housing with a floor-jack or similar; and
- disconnect or remove the springs and shock absorbers (and anti-sway bar); and
- simply (by hand) lift and lower one wheel and tyre assembly on either side of the diff housing, and establish that each side of the diff housing can easily swing up and down sufficiently to indicate that the suspension will operate normally, without impeding the suspension's operation or binding any of the components against each other.

With the springs and shocks removed in a suspension system that is geometrically correct, the diff housing will virtually 'teeter' on the jack and each side of the diff housing will be able to be moved up or down with ease.

If the diff housing is 'locked' by the radius rods, or is binding before a reasonable amount of suspension travel is attained, the system cannot be used in its present condition.

Note that the only area of concern in regards to suspension operation is 'available travel', or the full range of travel where the actual suspension system would normally operate within. If bind occurs beyond the normal range of suspension extension and compression, this is not an issue.

Finally:

If any assistance in the use of this Information Sheet is required, please contact the LVVTA office on (04) 238 4343.