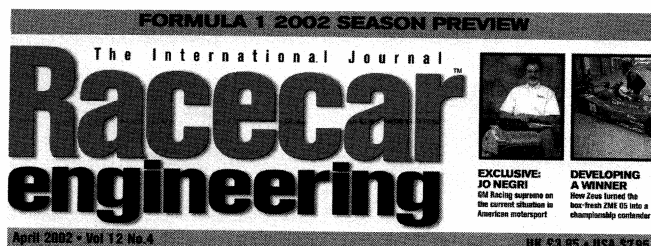


In Rod We Trust

We look at rod end bearings and ask just why it's so important not to overlook the part they play



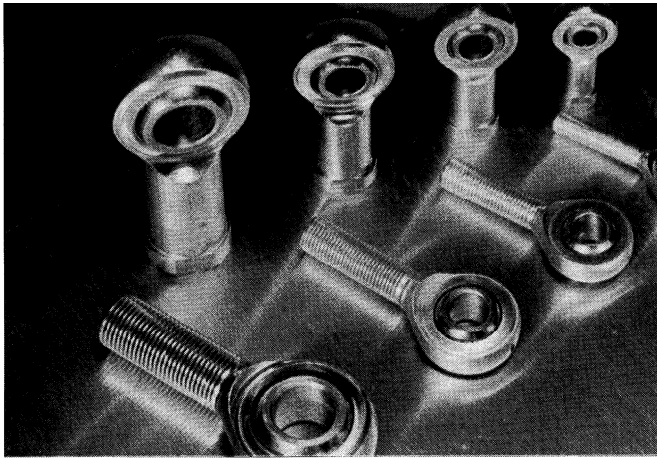
Words | Tim Beynon

Taking anything for granted in motorsport is a mistake, cut corners and you will, inevitably, be caught out in the end. You wouldn't risk the life of a driver by fitting a bargain basement harness, even if it looks as good as a top of the range one, so why then do so many 'professionals' seem to overlook, or underestimate, the importance of rod end bearings? The truth of the matter is that these vital components connect the suspension to the frame, or the wheels to the steering, and a failure in one could have catastrophic consequences. Can you really afford to cut this particular corner?

Rod ends – a definition

In short, rod ends are bearings. They are spherical plain bearings that are installed into female or male rod connectors, made up of a ball machined with a through hole that rotates within a race.

There are two basic categories of rod ends for racecars, commercial, or economy grade rod ends, and three-piece precision →



Care should be taken when choosing male or female rod ends; take a good look at the machining and shake to test for rattles – the fit should be snug

rod ends. The economy versions come in many different guises but as a rule you should only be using fully swaged two-piece rod ends if you go for the economy grade option. These two-piece units have good radial and axial strength as the body is swaged around the ball so that the race that the ball rides on is actually part of the steel body. Other types of economy grade rod ends that can be found in racing applications include those made with injection moulded plastic races, or with races made from one or two pieces of brass. These raceways have very low compressive strength relative to even the basic steel alloys, and hence poor durability.

The three-piece precision rod ends – or 'aircraft style' rod ends as they are sometimes called – are much more intricate. With these a race insert is separately formed around the ball and this insert is then staked into a body. This allows for a closer and more precise fit between ball and race.

Different materials can be used in the construction of these precision bearings in order to best suit the particular application for which they are

the bodies can also be constructed from aluminium or even titanium.

Some rod ends come with a teflon lining which allows them to be self-lubricating, this is beneficial as oiling or greasing can increase the amount of wear due to dirt being attracted to the lubricant and working its way between the ball and the race. A teflon liner does not suffer from the same problem and so wears to a lesser extent, it consists of a fabric carrier component (for compressive strength), a teflon component for lubricity and various bonding resins. Lubrication is provided through the transfer of Teflon from the liner onto the ball as the ball moves in operation. Incidentally a good teflon liner will have a compressive strength of up to 60,000psi and should not be confused with lesser virgin teflon which can only withstand 10,000psi. Finally, the liner eliminates the clearance between the ball and race, giving a snug, tight bearing fit.

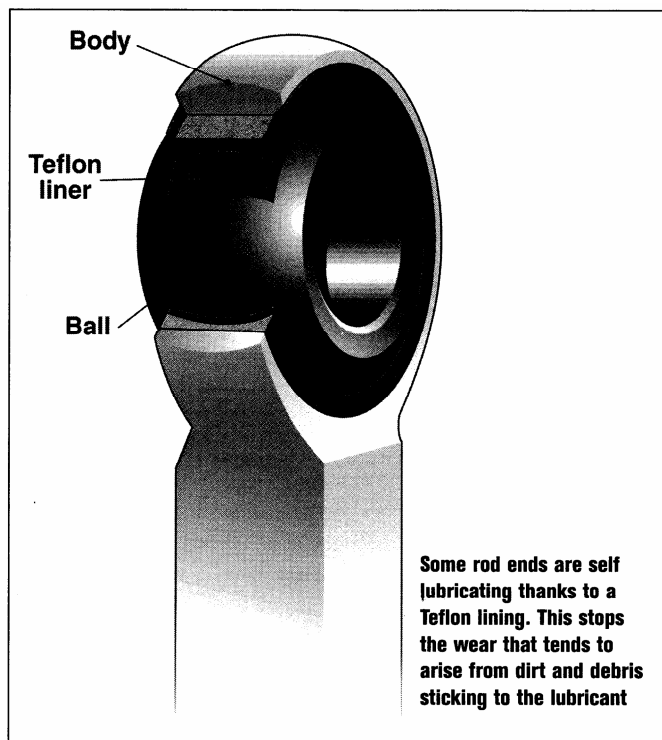
Choosing rod ends

Rod ends are limited to how much each can be misaligned before the sphere binds in the housing. It is therefore critical that the angle of misalignment is carefully considered when choosing rod ends as all are different and, if you were to choose any that exceed the recommended angles of misalignment, then they could wear down prematurely. It is therefore well worth measuring the angles on your car for which the rod end will be required and cross referring this figure with those quoted in a rod end catalogue. You may well find that the most expensive rod end is not actually the best one for your particular needs, in fact the opposite could be the case, it all depends on your requirements.

A further point to consider is whether or not the rod end you choose will be strong enough for your application. However, the whole issue of strength is not a straightforward one with rod ends as the different manufacturers have different methods of measuring strength in radial static load capacity and axial static load capacity. In general, the radial static load capacity listed in catalogues refers to a load that applied once will cause failure. Operating loads should have a factor of safety applied



Rod ends are used in a variety of applications and they are worked extremely hard, so if you are buying used be sure to check the second hand bearing against a new example and try to find out where it was used previously. That said, with components as vital as these it is best to buy new and buy the best



to them relative to the catalogue load ratings. It is therefore important that you double check your own figures and those quoted by the manufacturer when making your choice. Note that, in certain instances, you might find the more expensive three-piece rod ends can actually be weaker than their two-piece equivalents.

The uncertainty surrounding the quoted static figures, however, makes it even more important to calculate the dynamic rating required in order to ensure that the rod end will withstand the conditions within which it will be operating. This figure is based on the PV value (the load in psi multiplied by the surface speed in fpm). It can be calculated using the following formula:

$$PV = WN/12L$$

This is where W = load in lb; N = rotational speed, RPM and L = bearing length, in

With the figure gained from running this equation and, depending on the material they are made from, rod ends can be separated into three ranges of PV values. Your calculated figure should therefore not exceed the following limits:

- Hard steel on bearing bronze: 50,000psi-fpm
- Hard steel on soft steel: 10,000 - 15,000psi-fpm
- Bronze or steel on filled nylon: 8000psi-fpm

It is worth noting that, as well as the PV limit, the strength of the oil lubricating film also limits the maximum dynamic load and the compressive strength of the bearing elements. In general, the maximum load on the projected bearing area of a metal-to-metal bearing should be no more than 4000psi. Finally, you should also remember to measure the pressure limit of the bearing.

Judging quality

Judging just how good or bad the quality of your rod end bearing is is a relatively simple task. As long as you ask yourself the right sort of questions as you are inspecting the rod end.

Firstly, take a close look at the machine work that has gone into the rod end. Look at and feel of the race, is it smooth or rough? Same again with the ball, smooth or rough? In both cases, the smoother the better. If you are looking at a non-Teflon lined rod end give it a shake to judge the clearance and the preciseness of the fit, does it rattle or does the bearing

stick in the race? If it seems to fit snugly and precisely, without sticking, then it should be fine. If a Teflon liner is present look closely, check if the liner is whole or whether there are gaps and pieces missing from it? It should be one continuous, obvious, well fitting liner.

Don't forget to find out what the rod end and the ball bearings have been made of, if they were made from a high-grade precision material or not? Also, were they made by a reputable manufacturer that has invested in its engineering, research and development? As with anything in racing and life, you get what you pay for.

When things go wrong

Failures will happen and when they do many people refer to the rod end 'beating out.' By this they usually mean one of two things. Firstly they could be referring to when low strength 'self lubricating' liners get deformed, notably where the races are made of molded nylon or other plastic, possibly with Teflon added. These rod end races usually have a compressive strength of only 15,000psi making the race susceptible to deformation before any visible damage to the body can be seen. The same is true for brass race bearings.

Secondly 'beating out' could refer to when a proper liner has become detached from the race itself, thus causing a failure. The self-lubricating nature of the liner means that it may not bond strongly with the race. If this happens then, under high load, each time the bearing becomes misaligned, pieces of the liner will be ripped off until, eventually, there is little or nothing left of it. You are then left with a rod end with far too much clearance and it's just a matter of time before it fails.

However, not all rod ends with Teflon liners are destined to suffer this fate. The American government, among its various bearing requirements, sets specifications for bond strength and, if your rod end supplier, meets these mil specs then his/her Teflon rod ends should be fine.

As a rule a faulty or damaged rod end is a useless rod end, it is simply not worth, or indeed safe, to attempt to tighten up a worn rod end or patch up an accident damaged one. If you are unsure, after an accident, as to whether or not a rod end has been damaged always get it checked visually for any deformations, or indeed crack tested.

Buying used

On the whole it is not worth buying used rod ends because, when you do, you will have no idea how they have been used, or indeed for how long they have been used before you came along.

However, judging the amount of wear on a used bearing is certainly possible. One good place to start is by comparing your used rod end with a brand new rod end. Hold the shank of the joint and shake it around, if it rattles then the clearance is probably too great and it's worn out. One further tell-tale sign to look out for with Teflon lined rod ends is an absence of play either axially or radially remembering that a zero clearance fit is one of the benefits of the liner.

It is also, however, worth considering the fatigue life of a rod end. The body of a rod end can fail either due to a massive overload, such as in an accident, or due to natural metal fatigue which is altogether much more difficult to spot. A rod end may look fine but it may still be on the edge of a fatigue related failure, so it is vital that you find out how it has been used in the past and where on the car it had been fitted.

The latter point here is important because rod ends can be loaded in a variety of different ways, all of which have differing effects on its fatigue life. On a suspension push rod, or pull rod, they can be loaded in straight tension or compression, for example. While on a tie or radius rod they could have a straight-line reversing load. When used as a ball joint they can have bending loads applied to the shank or, indeed, a rod end can be subjected to a number of different loads in different directions. So be sure you know just how the bearing was used.