Adjusting Tapered Roller Bearings

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THE QUESTION

What Are the Best Methods to Adjust Tapered Roller Bearings?

Expert Response Provided by: Norm Parker, Technical Specialist – Driveline Bearings, GM Milford Proving Grounds

One of the most popular discussions around tapered roller bearings (TRBs) involves methods for adjusting or preloading. We are always looking for ways to increase preload accuracy, reduce manufacturing complexity and improve serviceability. We will review some common methods while highlighting a few benefits and drawbacks of each.

There are two different buckets we can throw preloading methods into; one we will call a "direct" method and the other, "indirect." The end goal of preloading is to have a net axial load on the bearing while at rest. The "direct" method either directly measures the axial force on the bearing during preload or measures the axial displacement based on a known displacement vs. force chart to make a shim selection. The "indirect" method uses a measured relationship between the axial load placed on the bearing and the torque needed to rotate it. For this method the preload will be set by measuring the rotating torque of the bearings as an indirect way of measuring the axial preload.

Direct Method

Many people may more readily recognize the direct method as a solid spacer and shim arrangement. In this method the housing and bearing dimensions are measured and a shim size is calculated to give a desired dimensional offset or interference. This is considered a direct method because the bearing is being displaced by a known value, which directly correlates to an axial preload with very little variation.

This method can be extremely accurate (but still only as accurate as the shim thickness increments and tolerances) or about as accurate as an indirect method. If we need high accuracy, each housing and bearing can be measured prior to installation and the appropriate shim will be selected to reach the desired interference for the bearing set. If less accuracy is needed, the direct measurements can be skipped and the assembly will rely solely on the tolerances of the mating components. This is usually only recommended where some endplay is desired and can be verified after assembly. Trying to preload solely based on tolerances will almost certainly result in some over-preloaded sets which will produce early failures.

Figure 1 Solid spacer and shim pack.

Indirect Method

Many TRB applications are set up through the indirect method of measuring the assembled turning torque of the bearing set. Wheel bearings, pinions for axles and PTUs, final drives and others are set up using this method.

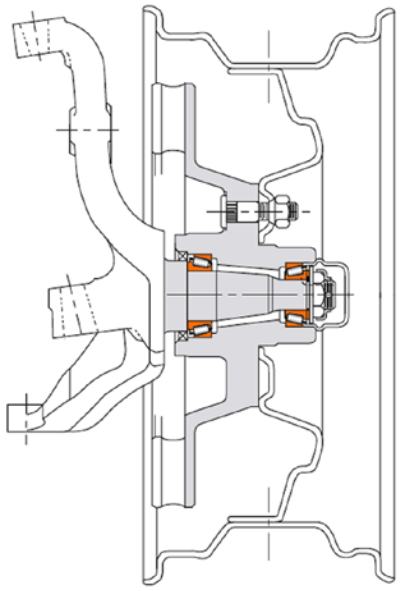

Figure 2 Wheel ends set up through tightening the bearing nut.

The indirect method is less accurate than the direct method because the torque vs. preload relationship is less accurate than axial displacement vs. preload relationship. You could easily expect a 20% scatter for preload ranges with this method. However, for high production and serviceability, this is often a manageable tradeoff. The indirect method may or may not use some type of elastic or collapsible spacer between the bearings as a means of adding resistance to the preloading process in an effort to avoid over-preloading and sometimes increase the nut torque if a prevailing torque requirement is needed.

Just as with the direct method, we can add or remove accuracy to this system as needed. If higher precision is needed, the individual bearings can be measured for torque and then set up. This removes the bearing-to-

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Figure 3 Timken AP bearing arrangement.

bearing torque variation and makes for a very accurate system.

Purchased Assemblies

In a perfect world, we could utilize the many variations of paired assemblies that are already preloaded or matched sets that utilize ground shim arrangements that assemble to hit the perfect preload every time. Often, our unique assemblies can't accommodate these nice, premium products and we have to set the preload in the factory.

Conclusion

Clearly, there is no "best" method for preloading bearings. The method is usually selected based on what is possible with the bearing arrangement, the surrounding componentry, available resources, budget, manpower, factory capability and serviceability. We can adjust our needed accuracy by measuring each individual bearing or rely on statistical deviation.

Usually, the system architecture will push you into a method. If a bearing tightening nut is possible, this is usually desired because it is an adjustable, easy-to-use system. However, inside a manual transmission or power takeoff unit, there is no external access and the only option is to measure and shim.

Figure 4 ILjin Gen 2 hub unit.

In certain applications where failure is not permissible or the system is not available to reliably set the preload, we may be pushed into purchasing an assembled bearing arrangement. Today, automotive front wheel hubs are almost exclusively assembled, preloaded, bolt-on units. This can be a costly upgrade, but sometimes, considering the cost of failure, this may be the best option available. *(See p. 38 for Parker's "Tapered Rolling Bearing Application Guide.")* **PTE**

Norm Parker is the bearing technical specialist for the driveline division at General Motors LLC, located onsite at the Milford (MI) Proving Grounds. With his bachelor and master degrees in mechanical engineering from Oakland University (Rochester, Michigan), Parker has developed a keen, diversified interest in the academic, commercial and engineering aspects of the bearing industry.