

Why is Bearing Alignment Important?

By Victor Wowk, P.E.

Bearing misalignment is the second most common cause of premature bearing failure, after lack of lubrication. Rolling element bearings are misaligned when the faces of the inner ring and the outer ring are not parallel. The inner ring can be crooked on the shaft, or the outer ring can be crooked in the housing. This can be caused by dirt at the precision metal interface, metal burrs, metal galling during mounting interference fits, or sledge-hammer installation. Pillow-block bearings can be misaligned if the support plate is not flat.

Rolling-element bearings have some internal clearance, which is available for thermal expansion and to accommodate some small misalignment between the rings. When this clearance is used up, then we have hard metal against hard metal with high contact forces. The bearing makes noise, it generates temperature, and fails quickly, sometimes as quickly as just a few days or weeks. The vibration symptoms of bearing misalignment are identical to shaft misalignment. In fact, I have not been able to distinguish the two conditions from vibration or acoustic symptoms alone.

Plain, or sleeve, bearings are not as sensitive to misalignment as rolling-element bearings are. This is because the bearing material is soft and will wear in. Misalignment creates edge loading of the shaft on the babbitt, and the high pressure will generate some friction and temperature, but the babbitt will crush down to support the load.

How do we deal with bearing misalignment? There are various design solutions and some practical techniques when fitting bearings.

1. True self-aligning spherical roller bearings are one very good design solution. This is almost a necessity when the support structure for pillow blocks is not a precision machined flat surface, like fans with welded steel angles and channels that the pillow blocks are bolted to.

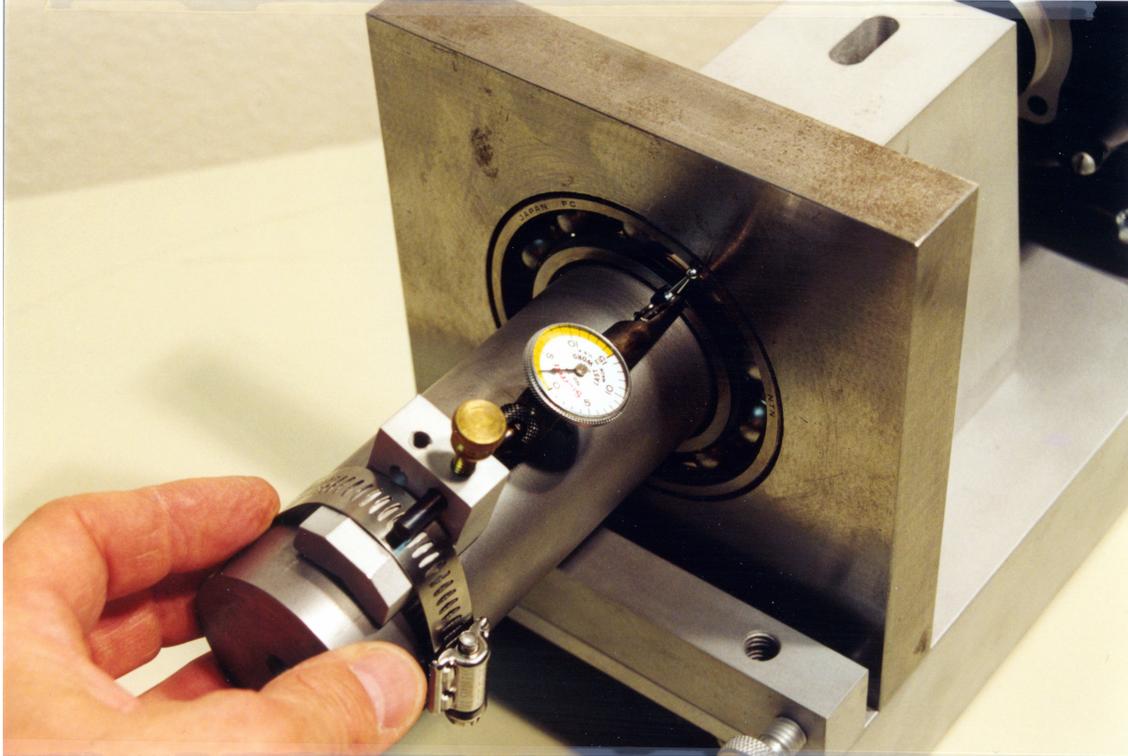
2. Do not use interference fits when designing a shaft or housing. Instead, capture the bearing in position with a loading nut against a square shaft shoulder.

3. When fitting bearings:

- a. Use the minimum amount of force.
- b. Use fixtures and arbors to maintain perpendicularity when pressing bearings cold.
- c. Use heat to expand the bearing and hold it square against a shoulder as it cools and grips the shaft, aligning itself in the process.
- d. Use hydraulic expansion, if the shaft is equipped with proper flow channels.
- e. Measure for bearing alignment after installation and adjust it if necessary.

This measurement is shown in the accompanying figure. A dial indicator is fixtured to the shaft, reading on the outer ring as the shaft is rotated. This measures the perpendicularity of the outer ring face to the shaft axis. The indicator should read less than .001 inch per inch of swing diameter. This number, 1.0 mil per inch, or numbers similar to it, appears in the engineering section of virtually all

bearing manufacturers' catalogs. In the field, after installation, the bearing can be adjusted with a punch and hammer until the dial indicator swings less than 1.0 milliradian (.001 inch/inch). This measurement, by the way, is a lost technology in the maintenance trades. This measurement is illustrated in the *Machinery's Handbook*, which was first published in 1914, but I have never seen mechanics do this in the field. I would like to see this done for every rolling-element bearing installation, if possible, if only to verify good alignment. In my company we do this routinely, and after adjustment, the bearings spin quiet and cool.



Precision machine tool builders are aware of this requirement, because preloaded bearings have no internal clearance remaining to accommodate misalignment. They are very sensitive to temperature and misalignment, so care is done to control both parameters on precision high-speed spindles. In the utility industries, however, controlling bearing alignment is a technology that is not as well practiced as it should be, because it translates directly into uptime.