

OIL SOAKED WOOD BEARINGS

HOW TO MAKE THEM AND HOW THEY PERFORM

Introduction

The purpose of this Technical Brief is to provide some background information for both constructors and designers who wish to use wood bearings. The type of wood to use, its treatment, lubrication, and expected performance will be discussed.

Some advantages of oil-soaked wood bearings

- Made from locally available materials.
- Made by local craftsmen with woodworking skills.
- Easily assembled.
- Do not require lubrication or maintenance.
- Operate under dirty conditions.
- Easily inspected for wear.
- Quickly repaired or replaced.
- Can provide a temporary means of repairing a more sophisticated production bearing.
- Require low tolerance on both the shafts and the housings.

Choice of wood

The composition of wood is very complex, but in simple terms it consists of fibrous material bound together with a glue-like substance, water, resins, and oils.

Initial Selection

D. A. Atkinson (1972) stated that one of the essential characteristics to look for in the choice of wood is hardness.

- The harder the bearing surface, the less the deformation and the smaller the coefficient of friction.
- The harder the bearing surface, the lower the rate of wear.
- The harder the bearing surface, the less likely it is to breakdown prematurely, singe, and ultimately burn.
- The harder the bearing surface the greater its strength.

It is also worth noting that generally, the harder the wood, the greater its weight and the more difficult it is to work.

The oiliness of the wood is a particularly important consideration when the bearings are unlikely (or not intended) to receive lubrication during their service. Practical indicators that assist the identification of timbers which may have good self-lubricating properties are:

- they are easily polished
- they do not react with acids
- they are difficult to impregnate with preservatives
- glue does not easily stick to them

Other considerations

High moisture content causes a reduction in hardness and results in greater wear. For most applications low moisture content is preferred and excess moisture must be removed to prevent subsequent shrinkage especially if the bearing is to be used as a bush.

The hardest wood is to be found in the main trunk just below the first branch.

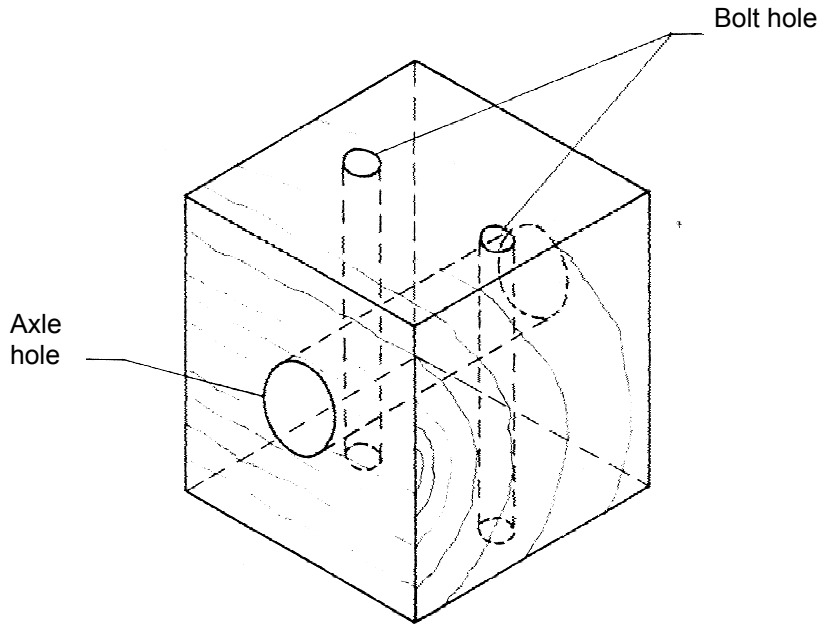


Figure 1: One-piece block bearing

Grain direction should be considered, and if possible advantage taken of the close grain to provide hardness at the wearing surface.

The piece of timber selected for the bearing should be free from cracks. Some suitable timbers are listed in Table 1.

- "Greasy" woods Lignum vi tae (Guaiacum officinale)
- Tallowood (Eucaliptus microcorys)
- Teak (Tectona grandis)
- Blackbutt (Eucaliptus pilularis)
- Other woods Poon (Calophyllum tomentosum)
- Hornbeam (Carpinus betulus)
- Degame (Calycophyllum carididissimum)
- Boxwood (Phyllostylon brasiliense)
- Pear (pyrus communis)
- Oak (Quercus robur)
- Camphorwood (Dryobalanops aromatica)

Table 1: Suitable timbers

If the timber is not of the self-lubricating variety (or of doubtful self-lubricating characteristics) it can be soaked in oil to minimise the need for subsequent lubrication. It is important to have dry wood to assist maximum absorption of oil.

Construction

The following notes relate to experience gained in the field manufacture and testing of three types of wood bearing. All were of the oil-soaked variety.

Types of bearing

- Bush bearing
- Split-block bearing
- One-piece block bearing

General remarks

H.S.Pearson (1915) has suggested that as a general rule-of-thumb guide to the size of timber needed for the bearing, the axial length of the bearing should be at least twice the shaft diameter. For example, for a 25mm diameter axle, the bearing should be at least 50mm long. In the case of the block bearings, the thickness of bearing material

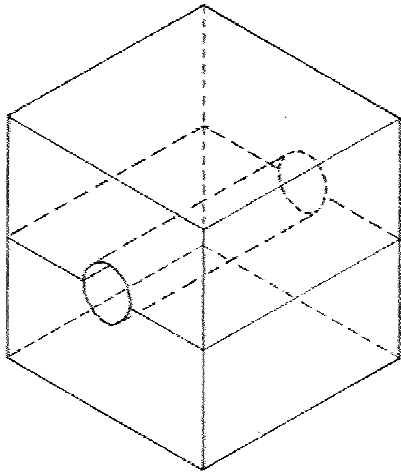


Figure 2: Split-block bearing

The drilling of radial holes for lubrication purposes is only recommended by Pearson for the bush type of bearing. He found that if lubrication holes were drilled in block bearings not only were the bearings weakened but also the holes acted as dirt traps.

The bearing should be located whenever possible in a position where falling dirt will not direct enter the bearing. For example, if the axle is carried in bearings mounted under the floor of a cart instead of a fixed axle with bearings at the hub of the wheel, then dirt falling from the rim of the wheel will not fall directly onto the bearings.

If the bearing is expected to take side-thrust, large flat washers must be used, the one next to the end of the bearing being free to rotate on the shaft. The bearing surface of the shaft should be perfectly round and smooth and polished in appearance.

How to make the bearings

Available timber often has rather doubtful self-lubricating properties and high moisture content. In this instance, a simple procedure for making an oil-soaked bush bearing has been devised by the Industrial Development Center, Zaria in Nigeria. Excess water is removed and subsequent shrinkage prevented.

- Reduce the timber to a square cross section and bore a hole through the centre the same diameter as the journal on which the bearing will be working.
- Place the blocks into a metal container of commercial groundnut oil and keep them submerged by placing a brick on top. Raise the temperature of the oil until the water in the wood is turned into steam -this will give the oil the appearance of boiling vigorously. Maintain the temperature until only single streams of small pin-size bubbles are rising to the surface of the oil. This may take anything from 30 minutes to 2 hours depending on the moisture content of the wood.
- Remove the heat source and leave the blocks in the oil to cool overnight if possible. During this stage the wood will absorb oil. If the temperature of the oil is allowed to get too high after the bubbles have ceased to appear, the wood will change to charcoal and the bearings will be ruined.
- Rebore the centre hole to compensate for any shrinkage that may have taken place.

Be very careful if you need to handle the container whilst it is full of hot oil.

- Place on a mandrel and turn the outside diameter to the required measurement that will give the bush a press fit into the hub.
- Bore four equally spaced holes through the wall of the bush at its mid-point and fill with lubricant. In general terms, the harder the lubricant the better, so animal fat, soap or tallow are preferable although grease is an excellent alternative.

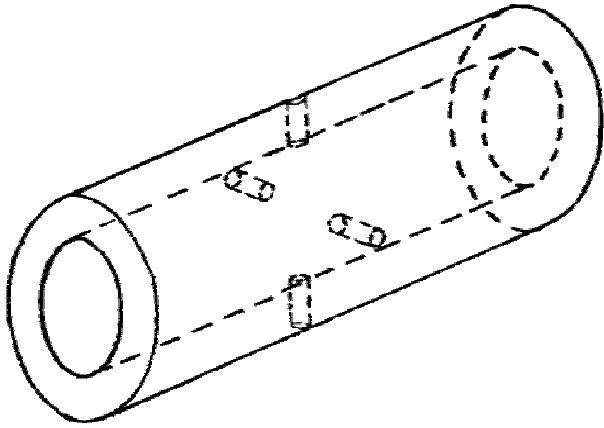


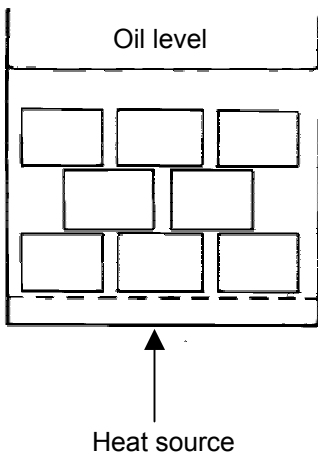
Figure 3: Bush bearing showing the four lubrication holes

The forty bush bearings made and tested at Zaria were 2.5" long by 1.550" outside diameter with a 0.855" bore. They were pressed into 1½" seamless black iron Class C pipe, and turned on a ½" pipe journal. The wood used was mahogany (being the most readily available) and rig tests with a loading of 100 lbs and a speed of 100-200 rev/min indicated sufficient lubrication. These test conditions were chosen to simulate the working forces on a 7" gauge wheel of an ox-drawn plough. Tests performed on bush bearings without the four radial lubrication holes again indicated sufficient lubrication.

Initial preparation

Saw timber into shape of an oblong block somewhat larger than the outside diameter of the finished bearing to allow for shrinkage and bore being off centre. Bore a hole through centre of block the size of the journal.

Dehydration



Soon after submerging the bearing blocks in hot groundnut oil, many surface bubbles 25mm in diameter, made from a multitude of smaller bubbles will appear on the surface.

As the moisture content of blocks is reduced, the surface bubbles will become smaller in size.

When the surface bubbles are formed from single streams of pin-size bubbles, the dehydration process has gone far enough. Stop heating, and let blocks cool in the oil overnight.

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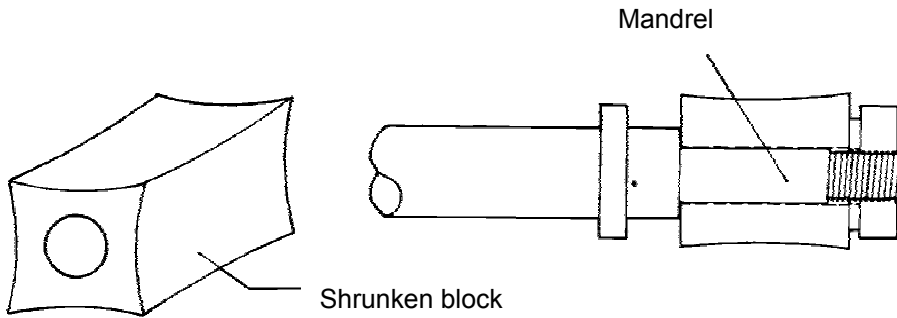


Figure 5: Shrinkage takes place once the blocks have cooled

Finishing

Re-drill centre hole and place shrunken oil-soaked bearing block on mandrel and turn to the desired size.

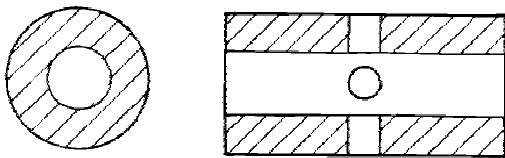


Figure 6: Cross section of the finished oil-soaked wood bearing showing grease reservoir holes.

On heavy equipment such as ox-carts or where it is not possible to push the axle through a bush bearing, the split-block bearing provides a more practical solution. It is simple to fit and replace, and if wear takes place the two halves can be changed around. After further wear, the life of the bearing can be extended by removing a small amount of material from the matching faces. A simple procedure was devised by the GRZ/ITDG Project at the Magoye Regional Research Station in Zambia for the production of such a bearing, again using an oil soaking technique. The timber in this case was teak, and used engine-oil provided a satisfactory alternative to ground nut oil. (Coombs & Pearson, 1974)

- Reduce the timber to a square cross-section and cut length-wise into two halves.
- The two halves of the bearing must be clamped firmly together for the drilling operation. It is most important that the hole for the axle is bored exactly square through the blocks. For the best results an electric powered pillar-drill should be used although a hand powered pillar-drill would be quite satisfactory. If neither of these is available, a jig would have to be made to keep the drill bit in line. After drilling, the two halves should be tied together to keep them in pairs.
- For soaking in oil an old 20-litre (5-gallon) drum is needed. Fill it three-quarters full with used engine-oil and bring to the boil over an open fire. Great care is needed when handling the drum of hot oil. Lift the drum off the fire and carefully place the pairs of bearings into the hot oil. Put a brick on top of the last pair to stop them floating, and leave the drum and contents to cool slowly overnight.

The split-block bearings measured 150mm x 150mm x 15mm with a 38mm diameter bore. They were field tested for reliability by installing them on ox-carts fitted with iron or pneumatic wheels and carrying loads of up to 2 tons. A radial clearance on ODs of these assemblies of about 1mm was found to be essential. If carefully run in at low speeds (ox work), the clearance is increased to 1.5-2.0 mm and the bearing surface attained a highly polished glass-like appearance. Having reached this condition it was round capable of withstanding journeys or a few kilometres at higher speeds (Landrover towing).

A sort pine-wood oil-soaked bearing was tested as an alternative to the hardwood bearing, and this also gave satisfactory performance but might have a shorter life. For lower load, lower speed applications such as the seed-drive mechanism on a small planter, a smaller one-piece oil-soaked block bearing was used measuring 50mm x 50mm x 50mm with a 16mm diameter bore, and this gave satisfactory results, although tests were not extensive.

Performance

The following general points can be concluded.

- The running-in period is of critical importance. It is characterised by a high initial rate of wear whilst smoothing and polishing of the bearing surface takes place, after which wear becomes approximately proportional to time.
- The greater the speed of rotation, the greater the wear, especially during the running-in period.
- The greater the axle loading, the greater the rate of wear.

More specifically, wear is approximately proportional to load, but increases rapidly for small increments in speed.

Very high loading and low speeds should be avoided since this results in a jerking movement of the journal in the bearing and subsequent shaking and vibration will result in wear of other parts.

References and further reading

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The DTU is a research unit within the School of Engineering at the University of Warwick. The aim of the DTU is to research and promote appropriate technologies for application in Developing Countries.

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