IMPROVING THE PERFORMANCE OF HARDWOOD JOURNAL BEARINGS

A Thesis

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Abstract:

Journal bearings made of wood have been used for centuries in traditional devices such as carts and waterwheels. They are currently used in industrial materials handling equipment and other specialized applications. Wooden bearings have potential for use in "appropriate technology" applications in developing countries such as animal-drawn carts and manual water pumps. This pilot study examines a number of factors that affect hardwood bearing performance, including wood properties, fabrication methods, and operating conditions. A testing procedure for wooden bearings was established, and a testing machine was constructed. Bearings were fabricated of different wood species, treated with various lubricants, and run on the machine under varying conditions of load and speed. Measurements were made of bearing and axle wear, static and dynamic friction, and bearing operating temperature. The results of this study show that lubricant characteristics, steel axle properties, speed and load of operation, and density, permeability, and pore distribution of wood bearing material can have considerable effect on bearing performance.

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1. Introduction

1.1 Classification of bearings

A bearing is a mechanical component that supports and positions an object while allowing that object to rotate. Bearings are an integral part of commonly used devices such as pulleys, wheels, motors, pumps, and most other machines that have rotating parts. Bearings can be classified according to the direction of the loading that they support: journal bearings support loads perpendicular to the axis of rotation, while thrust bearings support loads parallel to that axis. A journal bearing can take the form of a fixed bearing, inside of which rotates a shaft (termed the "journal"), or a fixed shaft, around which rotates the bearing (usually termed the "bushing").

Bearings can further be classified according to the nature of contact between the two surfaces: sliding bearings and rolling element bearings. In a sliding bearing there is intimate contact between the fixed and rotating surfaces. The sliding surfaces can be in direct contact (known as boundary condition) or can be separated by a thin film of oil or other lubricant (hydrodynamic condition). The bearings supporting the crankshaft of an internal combustion engine are examples of sliding bearings. In a rolling element bearing the surfaces are separated by a number of round (spherical, cylindrical, or tapered) elements, as for example the ball bearings of a bicycle wheel.

1.2 History of wooden bearings

Sliding journal bearings made of wood have been used for thousands of years, although today they are much less common than bearings made of metal or plastic. Wooden wheels and bearings were first used in the Tigris-Euphrates valley around 3500 BC, and spread throughout much of Europe and the Near East in the centuries that followed (Jenkins 1981). These solid cart wheels were crafted of planks of wood split from logs. Generally the wheels rotated on wooden poles fixed to the cart frame. In some instances a pair of wheels was fixed to a pole that rotated in notches cut in the cart frame.

Cart and wheel technology gradually became more sophisticated while continuing to employ wooden bearings. By the second millennium BC lighter spoked wheels were developed and began to replace solid wheels in some applications, particularly in "chariots" used by soldiers and rulers (Piggott 1992). Solid wheels continued to be used in other applications, principally farm wagons carrying heavy loads. Bearing lubricant also began to be used at this time, the earliest known example being animal tallow encountered on a cart axle found in an Egyptian tomb from 1400 BC (Davison 1957).

As human metalworking skills increased, bronze, and later iron, was introduced into bearing designs. Wooden bearings continued to be used in many applications such as water wheels, grain mills, construction cranes, and military machines such as catapults. Dutch windmills constructed in the 16th and 17th centuries rotated on iron shafts supported by oak bearings lubricated with pork tallow (Molen van Sloten 2001). Wooden bearings were widely used for power transmission shafts in factories during the early industrial revolution. Farm machinery such as harvesters and threshers employed wooden bearings, continuing well into the 20th century.

Wood known as lignum vitae, from *Guaiacum sp.* trees grown in tropical America, has been used for centuries in rudder- and propeller-shaft bearings on boats and ships. It performs very well, particularly when kept wet, and is the bearing of choice not only for ships but also water wheels and turbines. However, the slow-growing tree is increasingly scarce and lignum vitae is rarely used in new applications (Steuernagle 2001).

The industrial revolution sparked great advances in bearing technology during the 18th and 19th centuries, including the development of rolling-element bearings and metal alloys with low-friction properties. Of particular importance was the development of a low friction metal alloy by Charles Babbitt in 1839. Today, most bearings in industrialized countries are roller bearings made of hardened steel, or journal bearings made of metal alloys or plastics (Wilson 1986).

1.3 Current applications of wooden bearings

Wooden bearings, however, continue to be used in a number of modern applications. In the United States, wooden bearings are used in some industrial materials handling equipment (Steuernagle 2001). These bearings are generally made of hard maple wood (*Acer saccharum,* 'rock maple') and lubricated with waxes or oils. Screw conveyers used to transport bulk materials are often supported by wooden bearings, due to the bearings' ability to work well under dry, abrasive conditions with irregular lubrication. Wood is also used in roll-end bearings for roller conveyers on, for example, loading docks to unload boxes from trucks. In this application their relative low cost is an advantage over other bearing types, because of the large number of bearings used in a single conveyer. At least three companies currently manufacture wooden bearings in the United States, with total sales volume estimated at $2 million per year (Steurnagle, pers. corr. 26 April 2002).

In Russia, bearings made of laminated wood have been used successfully in large water pumps in the Moscow Canal since the end of World War II (Lazarev 1991). Compressed wood has also been used successfully as a bearing material in these pumps. In this technique, poplar and birch wood is compressed under high temperature and pressure to about half of its original volume and then machined to shape using metal-working equipment. These wood bearings reportedly performed with low friction and high resistance to abrasive particles in the water. Compressed wood bearings have also been used successfully in roller veneer dryers (Apostol and Yanin 1990). These bearings were made by boiling and soaking soft deciduous wood in machine oil before pressing them to shape under high pressure. They reportedly worked well under high-temperature operating conditions and showed little wear.

In rural areas of many developing countries, wooden bearings continue to be used in traditional devices made by local craftsmen, including wheelbarrows, animal-drawn carts, and pulleys for lifting water from wells. These devices are generally made with simple hand tools from locally available materials.

Wooden bearings have potential for "appropriate technology" applications in engineered devices designed to be used, maintained, and possibly constructed by rural populations in developing countries. The advantages of wooden bearings over other types of bearings in these applications include their low cost, local access to required materials, and relative ease of fabrication. The "Bush Pump" manual water pump originating in Zimbabwe is a successful example of this type of use (Erpf 1998). The pump employs a wooden fulcrum bearing that is inexpensive, durable, and can easily be replaced by a local carpenter when required.

Projects were implemented in several African countries during recent decades to develop improved "appropriate technology" ox-carts using wooden bearings. Greater use of animal-drawn carts could improve transport links and reduce the burden currently carried by people, principally women. However, the carts with wooden bearings suffered higher friction and wear and were not widely adopted by the population (Starkey 1989). The present study is motivated, in part, to find an ox-cart bearing that is locally accessible and has adequate performance.

1.4 Factors affecting bearing performance

Preliminary consideration of wooden bearing usage suggests that many different factors might influence bearing performance. Figure 1 illustrates this range of factors, beginning with the basic properties of the wood from which the bearing is made. Some woods may be more suitable than others for use as bearings because of their density, permeability, extractive content, or other inherent characteristics.

Once a particular wood is chosen as a bearing material, different fabrication methods may also affect the performance of the resulting bearings. For example the bearing geometry, wood grain orientation, and type of lubricant may impact bearing behavior. Thus two bearings made from the same piece of wood may perform differently if their fabrication methods are different.

Furthermore, after a bearing is fabricated and put to use, factors related to its operating conditions may influence the bearing's performance. Loading stress, rotational velocity, and shock loading can be expected to influence its performance.

Finally, a group of factors more or less beyond the control of the designer may affect the behavior of the bearing. These include humidity, temperature, rain, dust, and other ambiental conditions. While steps may be taken to protect the wooden bearing from some of these factors, it may be impractical to completely shield the bearing from all environmental forces.

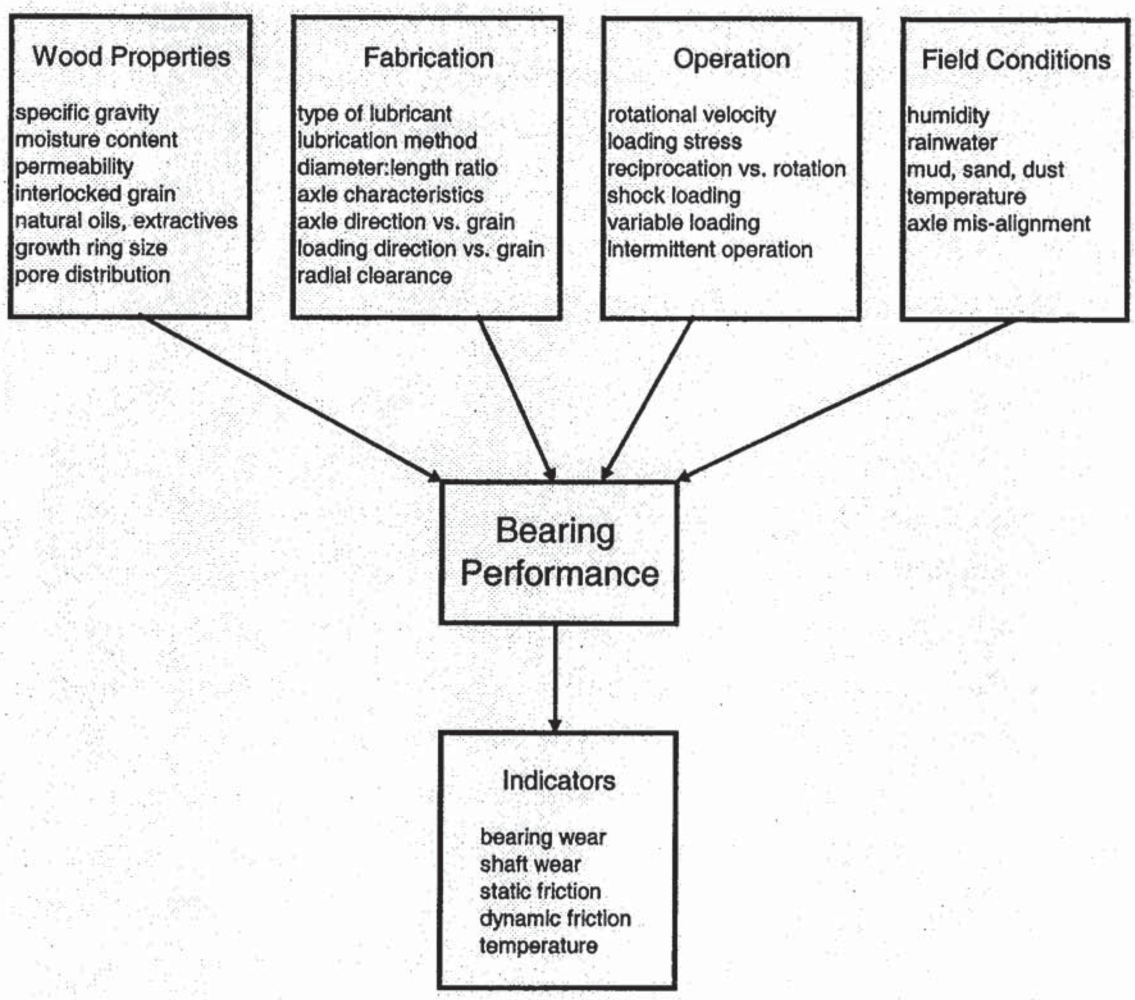


Figure 1. Factors potentially affecting hardwood bearing performance

The mechanical designer who wishes to rationally incorporate wooden bearings in an engineered device may therefore be discouraged by the range of factors that potentially affect bearing performance. This is complicated by the lack of information currently available on how those many factors actually influence bearing behavior. Despite the long and continuing use of wooden bearings, this topic has benefited from very little formal study. Sources of information on wooden bearing behavior are few and incomplete:

- Historical accounts from 16th century Holland (Molen van Sloten 2001) and 19th century United States (Martin 1892) contain local, anecdotal information on bearing manufacture that may suggest leads for further study, but is not directly applicable to current bearing design.
- Modern wooden bearing manufacturers in the United States rely on accumulated trial-and-error experience to ensure adequate bearing performance (Steurnagle, pers. corr. 19 March 2001). This application-specific experience may not be transferable to other uses or geographic regions in which the wood species, lubricant type, or other factors are different.
- Projects in Africa to develop improved animal-drawn carts produced comprehensive guidelines for overall cart and harness design (Dennis 1997), but information specific to the performance of wooden bearing is limited and sometimes contradictory. Collett (1976) described a method of wooden bearing manufacture, and Wirth (1992) made recommendations of suitable local wood types, though no comparative testing was recorded in the literature.
- Soviet researchers have studied wooden sliding bearings in considerable depth, although little of that work is currently available in English. The information available suggests that translation of additional publications (e.g. Denisenko 1962) could provide potentially useful information.

The available literature contains very few studies directly comparing the effects of basic wood properties, fabrication methods, and operating conditions on wooden bearing behavior. Very little is known about the factors that affect the performance of wooden journal bearings and how those factors might be optimized to improve bearing performance.

2 Objectives and Methods

2.1 Project objectives

The objectives of this pilot study were:

1. to develop a testing procedure for wooden bearings,
2. to identify wood properties, fabrication methods, and operating conditions that have major effects on the performance of hardwood bearings, and
3. to the extent possible, identify methods to improve the performance of wooden bearings.

2.2 Testing machine

To fulfill these objectives, a testing machine was constructed to subject wooden bearings to high loads while rotating at low to moderate speeds. The machine is shown in Figure 2. It consisted of a steel frame upon which a 19.05 mm (0.75 inch) diameter steel shaft was supported by ball-bearing pillow blocks.

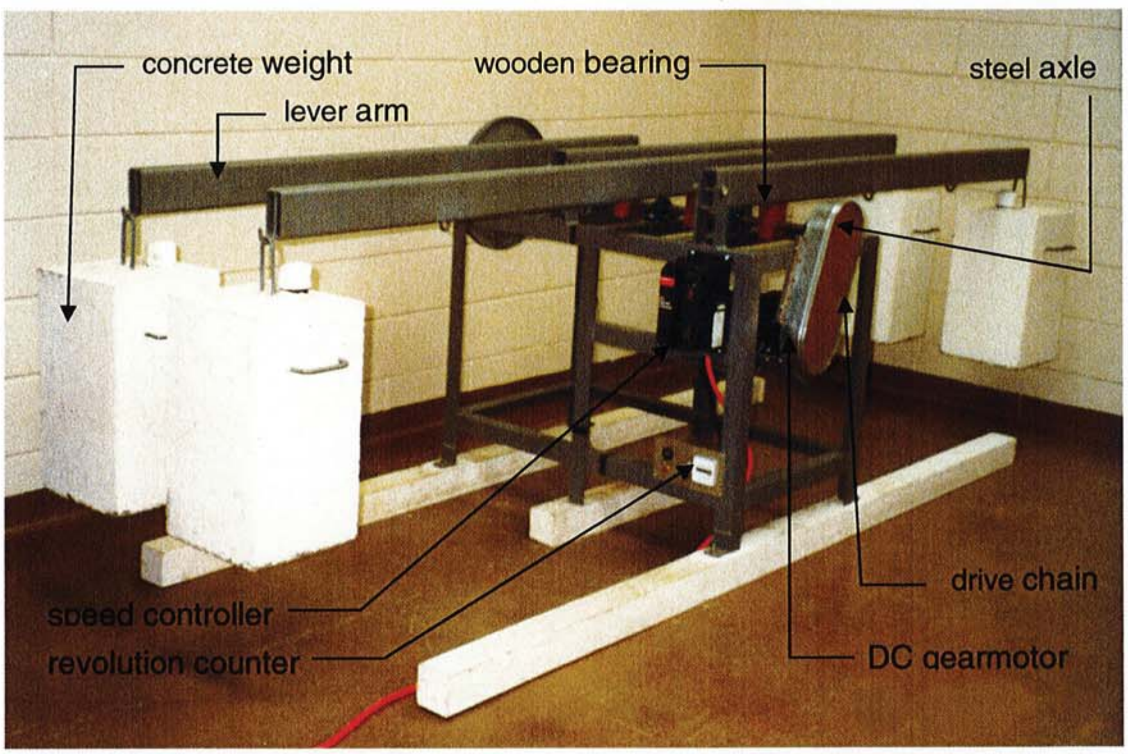


Figure 2. Wood bearing testing machine

The shaft was rotated by a DC electric motor through a drive chain mechanism. Four wooden bearings at a time were placed on the axle shaft. Downward force was applied to the bearings by weights suspended from lever arms attached to the machine frame. The rotational speed was adjusted with an electronic speed controller linked to the electric motor, and by changing the size of the drive-chain sprockets. The force on the bearings was adjusted by varying the weights suspended from the lever arms.

2.3 Fabrication of test bearings

A series of bearings was made of different wood types and treated with different lubricants, and run on the testing machine at varying conditions of speed and load. To fabricate the bearings, the wood was first cut roughly to size and allowed to air-dry to 6-9% moisture content. The bearings were then cut and planed to final size. Dimensions of the test bearings are shown in Appendix 1. The wood grain was oriented such that the axis of the axle ran in the radial grain direction and the bearing load was applied in the longitudinal grain direction. Holes for the axle shaft were bored in the bearings with a 19.05 mm (0.75 inch) Forstner bit. To determine the density and moisture content of the wood, the bearings were weighed before and after boring the holes, and the chips from the holes were weighed before and after oven-drying.

The air-dried bearings were then treated with various lubricants. The exact treatment process depended upon the properties of the lubricant. For lubricants that were liquid at room temperature (peanut oil, olive oil, motor oil, mineral oil, liquid soap), the dry bearings were submerged in the lubricant, heated in an oven at 70°C for one hour, subjected to a vacuum of 600mm Hg for 15 minutes, then maintained submerged in the lubricant for 24 hours. For bearings treated with pork tallow and beeswax, the lubricant was melted in an oven before the bearings were introduced, then returned to the oven for one hour at 70°C, subjected to the vacuum treatment described above, and then returned to the oven for one hour at which time the bearings were removed from the lubricant. Bearings treated with petrolatum wax were sent to the Woodex Bearing

Company where they were submerged in heated liquid wax for one week. Bearings treated with axle grease were liberally coated with grease and allowed to stand for six weeks, the melting point of the grease being at a temperature that would have damaged the wood. For bearings treated with graphite, a paste of powdered graphite and water was applied to the inner surface of the bearing and allowed to dry. For bearings treated with graphite and peanut oil, a paste of powdered graphite and peanut oil was applied to the inner surface of the bearing, and the bearing was then vacuum-treated in peanut oil as described above. The bearings were weighed before and after treatment to determine lubricant retention. The holes for the axle shaft were re-bored with a Forstner bit after lubricant treatment.

2.4 Experimental design

This study consisted of a series of independent experiments. In each experiment, one or two factors of interest were varied while all other factors remained constant. As shown in Figure 3, the independent variables studied were wood density, wood permeability, wood pore distribution, load stress and sliding speed, lubricant type and load stress, and steel axle type. Further information on each bearing tested is contained in Appendix 2. Complete test data for all bearings are found in Appendix 3.

Independent variable(s)	Wood type	Lubricant	Speed (m/min)	Load (kg-f/cm^2)	Axle type
wood density	maple/basswood	olive oil	5.39	43.1	mild steel
wood permeability	maple/muninga	olive oil	5.39	43.1	mild steel
wood pore distribution	maple/red oak	olive oil	5.39	43.1	mild steel
load stress, speed	maple	olive oil	1.35-5.39	43.1-86.1	mild steel
lubricant, load stress	maple	various	n.a.	21.5-86.1	mild steel
axle properties	maple	various	2.69	86.1	mild/treated

Figure 3. Summary of experimental conditions

2.5 Bearing performance

In this study, "bearing performance" was defined by measurements of the following dependent variables:

1. static rotational friction
2. dynamic rotational friction
3. wear of bearing material
4. wear of shaft material
5. operating temperature of the bearing material

These measurements are operationally defined below.

2.5.1 Static rotational friction

Static rotational friction was determined by measuring the moment required to induce rotation of the shaft. One bearing at a time was tested, with the axle shaft disconnected from the drive chain and motor. A cord was wound around a pulley on the shaft. Weights were incrementally added to a fixture on the end of the cord. When the force exerted by gravity on the weights, acting upon a moment arm equal to the radius of the pulley, produced a moment that exceeded the static friction between the bearing and the shaft, the shaft would rotate and the cord would unwind. A diagram of the test setup is shown in Figure 4. The weight required to produce this rotation was recorded. This procedure was repeated four times at quarter-rotation (90°) intervals around the axle shaft. The average weight required to produce rotation of the pulley was then calculated, and the coefficient of static friction was calculated based on this weight, the force exerted on the bearing by the lever arm, and the diameters of the shaft and pulley. The friction of the ball bearing pillow blocks supporting the axle shaft was measured separately, and a correction was made for this when calculating the friction of the wooden bearings. Bearings with lower static friction were considered to have better performance than those with higher friction.

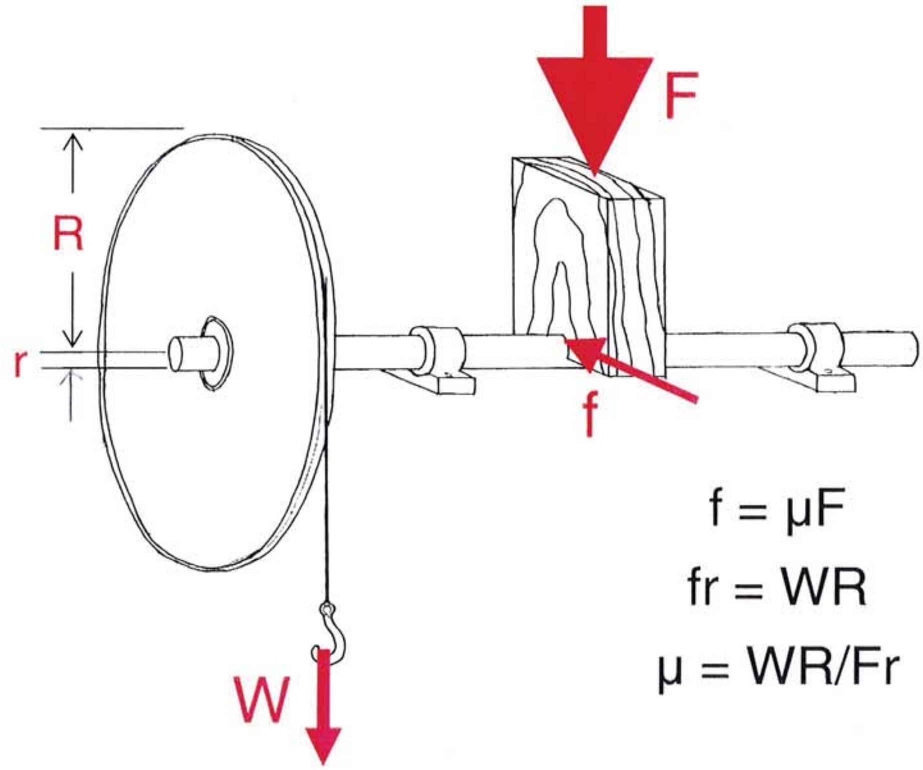


Figure 4. Diagram of friction test setup

2.5.2 Dynamic rotational friction

Dynamic rotational friction was similarly measured. However, after each increment of weight was added to the fixture, the pulley was "nudged" slightly by hand to overcome the static frictional forces. If the cord then proceeded to unwind from the pulley on its own, the moment produced by the weights would have exceeded the dynamic frictional forces between the bearing and the shaft. If not, more weight was added and the procedure repeated. The weight required to cause unwinding of the cord was recorded. This procedure was repeated two times at half-rotation (180°) intervals around the axle. The average weight required to produce unwinding of the cord from the pulley was then calculated, and the coefficient of dynamic friction was calculated as above. Bearings with lower dynamic friction were considered to have better performance than those with higher friction.

2.5.3 Bearing wear

Wear of the bearing material was measured with a digital caliper accurate to 0.01 mm (see Figure 5). A steel pin was inserted in each bearing during fabrication, and the distance between the top of the pin and the bottom of the shaft was measured to the nearest 0.01 mm. As the bearing wore, the distance measured became less and less. Measurements were made on both sides of the bearing and averaged, to account for asymmetrical wear. Bearings with lower rates of wear were considered to perform better than those with higher wear.

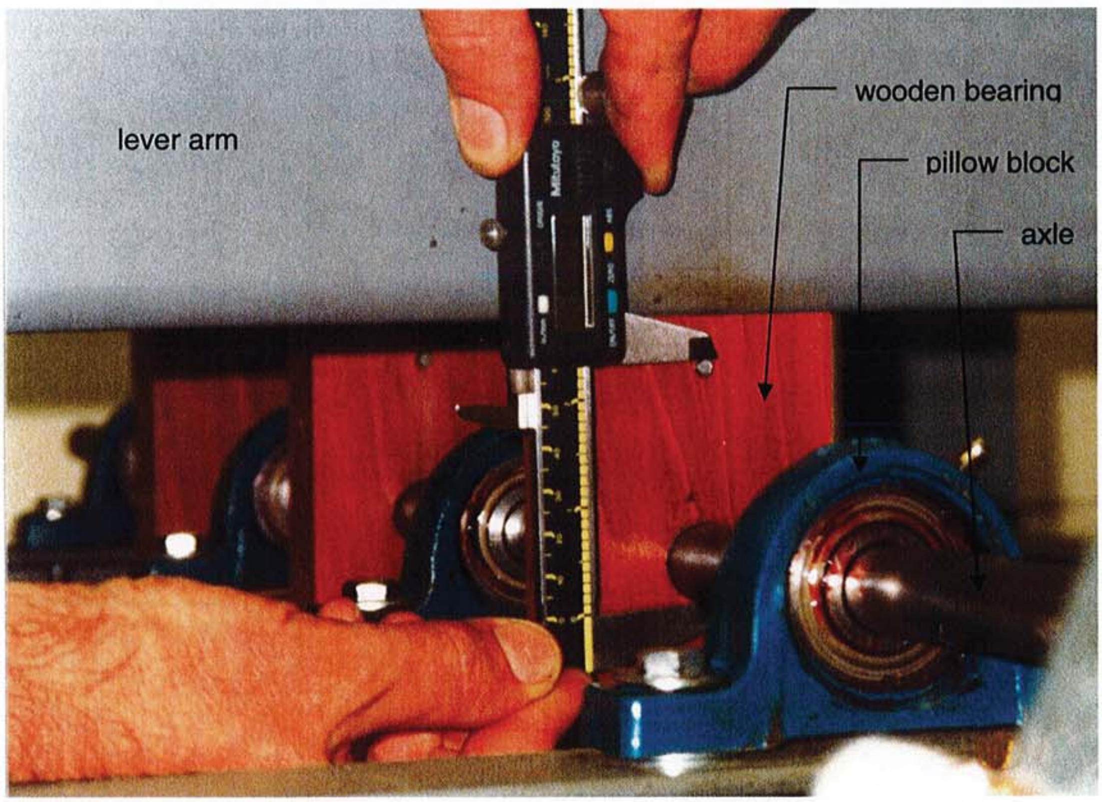


Figure 5. Measuring wear of wooden bearing

2.5.4 Shaft wear

Wear of the steel shaft was measured with a digital caliper accurate to 0.01 mm. The shaft diameter was measured to the nearest 0.01 mm at the beginning of each bearing test, and again at the end of each test. A new steel axle shaft was installed on the test machine with each new set of bearings. Wear of the axle shaft must, in general, remain very low. A bearing material that causes high shaft wear is a failure.

2.5.5 Bearing operating temperature

The operating temperature of the bearing was measured by inserting the probe of an electronic thermometer, accurate to 0.1°C, into a hole in the bearing material. Measurements were taken while the testing machine was in operation and the bearing was under load. The temperature reading was recorded to the nearest degree Celsius. The ambient air temperature was measured with the same thermometer and the difference between the bearing temperature and the ambient temperature was calculated. Lower operating temperatures were an indication of better bearing performance. Although high bearing temperature *per se* may not be disadvantageous, provided that the heat does not damage the wood or other components, the heat is a result of friction which in a well performing bearing will remain low.

3 Experimental Results

3.1 Wear model

Wear of the wooden bearings was observed to follow three distinct stages. This pattern, shown in Figure 6, is typical of sliding wear (Czichos 1992). Wear rates were high during an initial run-in period (Stage I) of up to 4 km sliding distance (sliding distance = revolutions x shaft circumference). Wear rates then declined and stabilized (Stage II). Later, some bearings failed suddenly either by splitting or burning (Stage III). These three stages were quantified by fitting a regression line to the wear measurements between the initial run-in period and failure. Coefficients of determination (r^2) for most bearings ranged from 0.88 to 0.99, indicating quite linear wear. A few bearings had more irregular wear with r^2 values as low as 0.73. The slope of the regression line is the parameter of Stage II linear wear rate (mm/km). The y value of the regression line at x=4km is the parameter of Stage I initial run-in amount (mm). The x value when failure occurs is the parameter of Stage III sliding distance to failure (km).

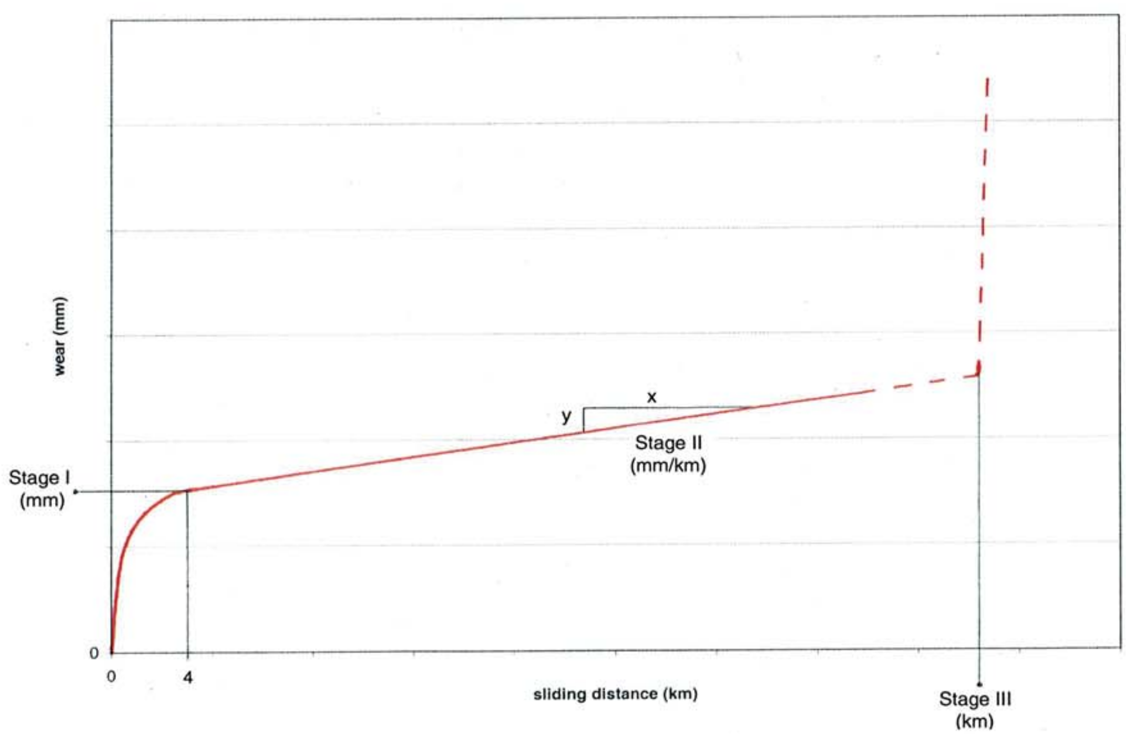
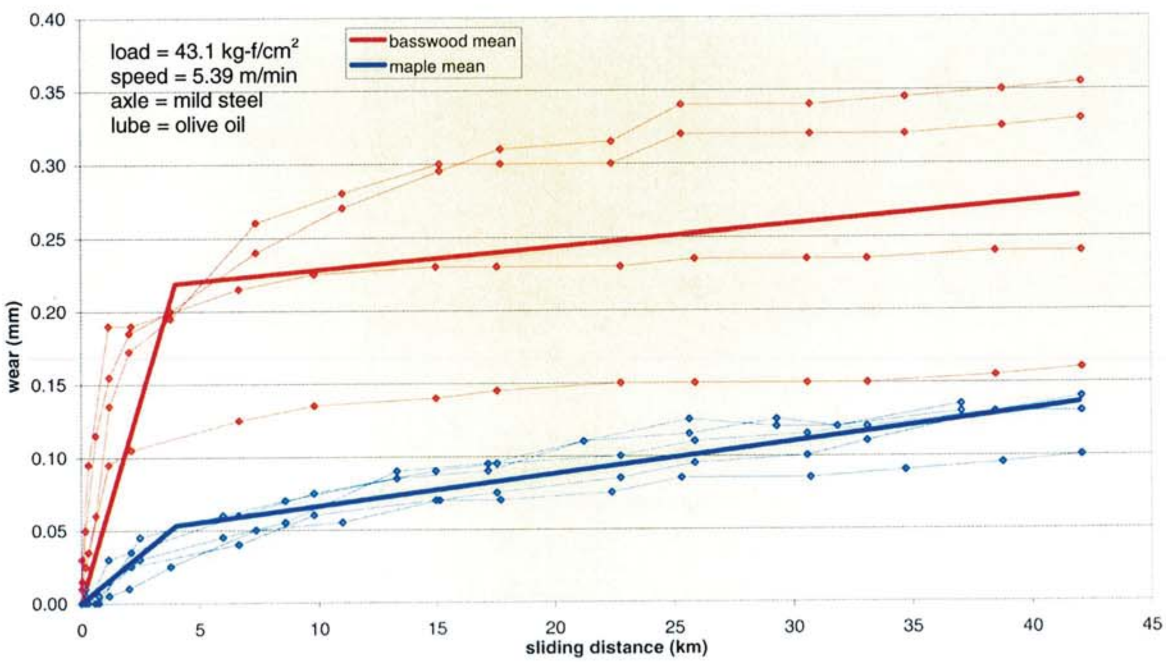


Figure 6. Bearing wear model showing parameters of three stages of wear

3.2 Wood density

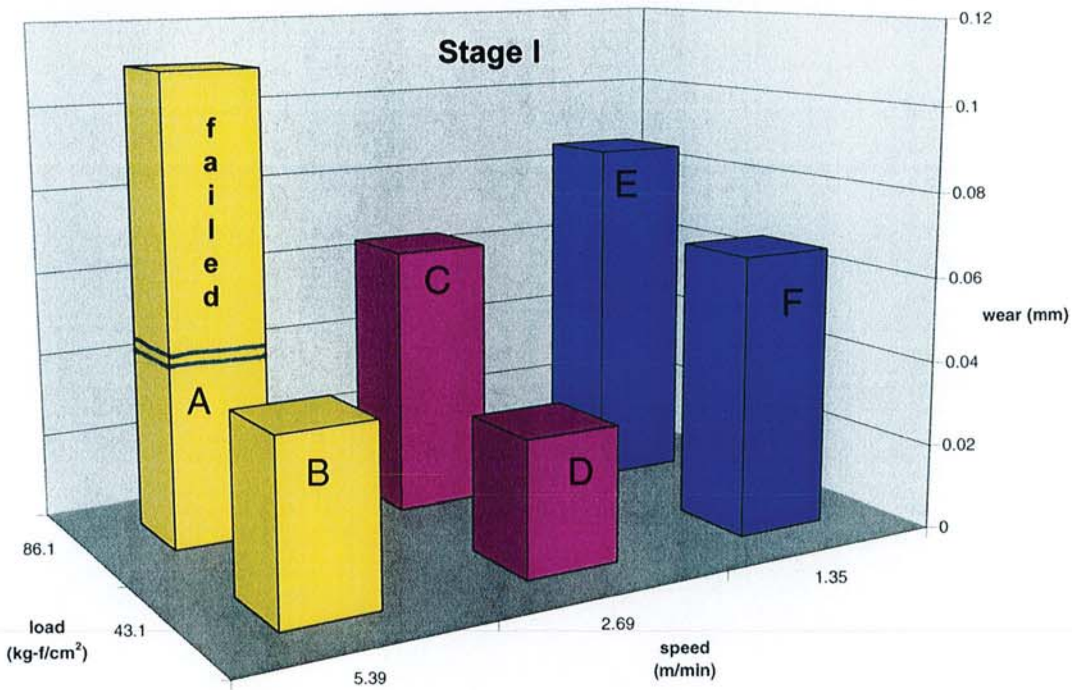
Bearings were fabricated of basswood (*Tilia sp.*) (bearings # 94,95,96,97) and maple (*Acer sp.*) (bearings # 51,54,55,63,64), two woods having similar physical characteristics including diffuse pore distribution and high permeability. The specific gravity of the basswood was 0.36 and that of the maple was 0.72. The bearings were treated with olive oil and tested to 42 km sliding distance at the same speed and load levels. As shown in Graph 1, the basswood bearings had greater wear during Stage I run-in, but after reaching Stage II the basswood bearings had a slightly lower average linear wear rate than the maple bearings. Variation in wear between individual basswood bearings was greater than the variation between maple bearings. None of the bearings reached Stage III failure.



Graph 1. Bearing wear vs. sliding distance for woods of different density

3.3 Load and speed:

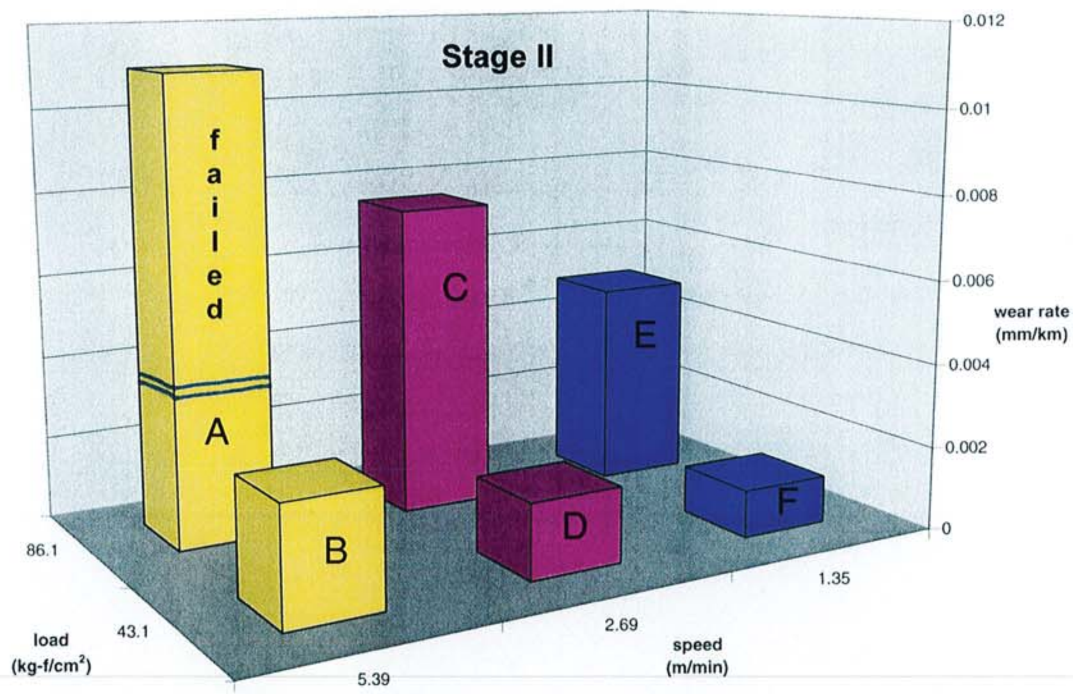
Twelve bearings were prepared of maple wood and treated with olive oil (bearings # 50,52,53,56,61,62,63,65,66,67,70,71). Two bearings were tested at each of six combinations of load and speed. Levels of sliding speed were low (1.35 m/min), medium (2.69 m/min) and high (5.39 m/min), and load stress levels were low (43.1 kg-f/cm^2) and high (86.1 kg-f/cm^2). Both bearings tested at high load and high speed failed. None of the other bearings failed during the tests, although their wear amounts and rates were not linear with changes in load and speed. Stage I run-in amount for the six groups of bearings are shown in Graph 2, while Stage II linear wear rates are shown in Graph 3. Bearing wear was more dependent on load stress than on sliding speed. This is explained in greater depth in section 4.2.



Graph 2. Stage I run-in amounts for bearings tested at different loads and speeds

3.4 Wood permeability

Bearings were prepared of maple (bearings # 51,54,55,63,64) and muninga (*Pterocarpus angolensis*) (bearings # 108,109) two woods of similar density (SG=0.62-0.72) and diffuse pore distribution. The bearings were treated with olive oil using the vacuum method described above. The maple bearings retained an average of 48.4% of their air-dry weight in lubricant while the muninga bearings retained only 4.2% lubricant. On the testing machine, the maple bearings uniformly ran to 40+ km sliding distance with less than 0.15 mm wear. None of the maple bearings failed. At the same operating speed and load,



Graph 3. Stage II linear wear rates for bearings tested at different loads and speeds

the muninga bearings experienced Stage I run-in amounts averaging 3.1 times greater than the maple bearings, and Stage II linear wear rates averaging 2.6 times greater than the maple bearings. One of the muninga bearings failed within 32 km sliding distance. The operating temperature of the muninga bearings averaged 12.5°C greater than the maple bearings.

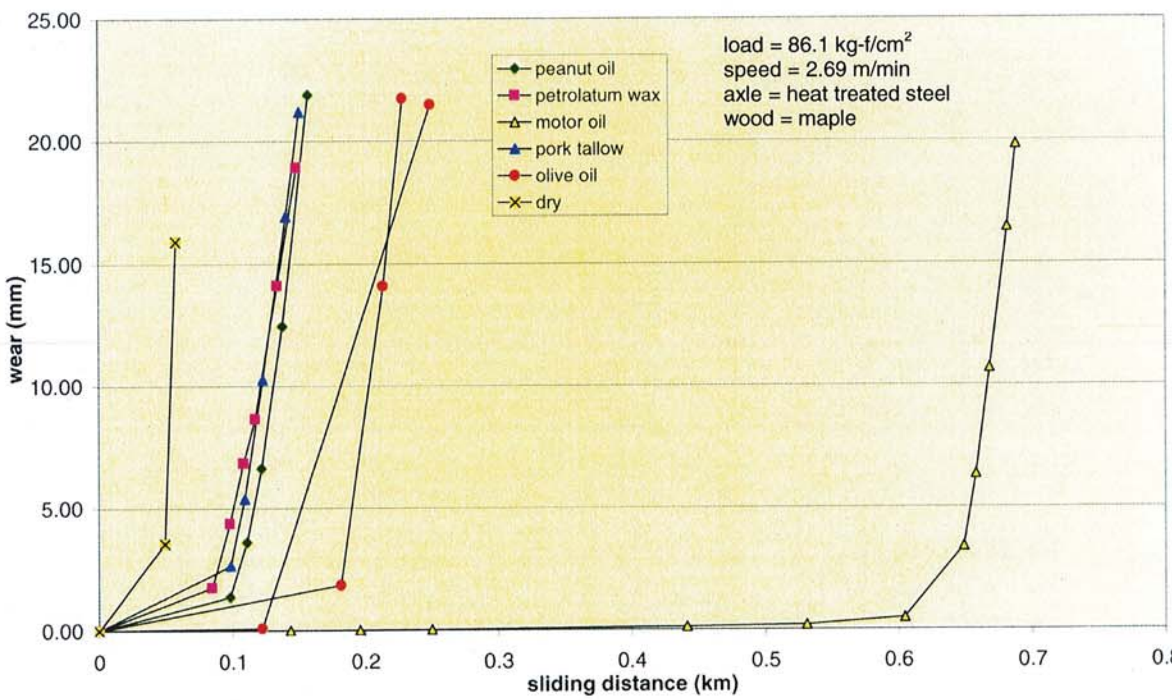
3.5 Wood pore size and distribution

Bearings were prepared of maple (bearings # 51,54,55,63,64) and red oak (*Quercus sp.*) (bearings # 104,105) two woods of fairly similar density (SG=0.59-0.72) and high permeability. The maple wood was diffuse porous, with small conduction vessels uniformly distributed throughout its cross-section. The oak wood was ring porous, with larger vessels concentrated in growth rings about the tree's cross-section. The bearings were treated with olive oil and retained from 47.5 to 48.4% of their air-dry weight in lubricant. The bearings were tested at the same load and speed for 40+ km sliding distance. The oak bearings experienced Stage I run-in amounts averaging 2.7 times greater than the maple bearings.

After running-in for 4 km sliding distance, the two wood types experienced similar Stage II linear wear rates. None of the bearings failed.

3.6 Axle properties

Tests were conducted with axle shafts made of cold-drawn 1018 mild steel and ground-and-polished 4140 heat-treated steel. Bearings made of maple wood were treated with a variety of lubricants and tested on the two types of steel shafts. Bearing life was remarkably shorter when run on the ground and polished heat-treated shafts, as shown in Graph 4. Of six lubricated maple bearings tested on heat treated shafts (bearings # 25,26,27,28,29,31), most failed within 0.15 km sliding distance and the longest lasting failed after 0.65 km. Conversely, of 20



Graph 4. Wear vs. sliding distance for bearings run on heat-treated steel axles

lubricated maple bearings tested on mild steel axles under identical load and speed conditions (bearings # 6,9,11,12,13,14,15,16,17,18,19,20,21,24,32,33, 34,35,66,70, bearings lubricated with dry graphite and liquid soap not included), many bearings continued operating past 30 km, and the shortest-lived bearing stopped after 4.2 km because of axle breakage. Coefficients of dynamic friction for the heat-treated shafts were 17% to 42% higher than those for the same lubricant with a mild steel shaft. Operating temperatures were much higher with the heat-treated shafts, and all of the bearings failed by burning. No measurable axle wear was noted in any test.

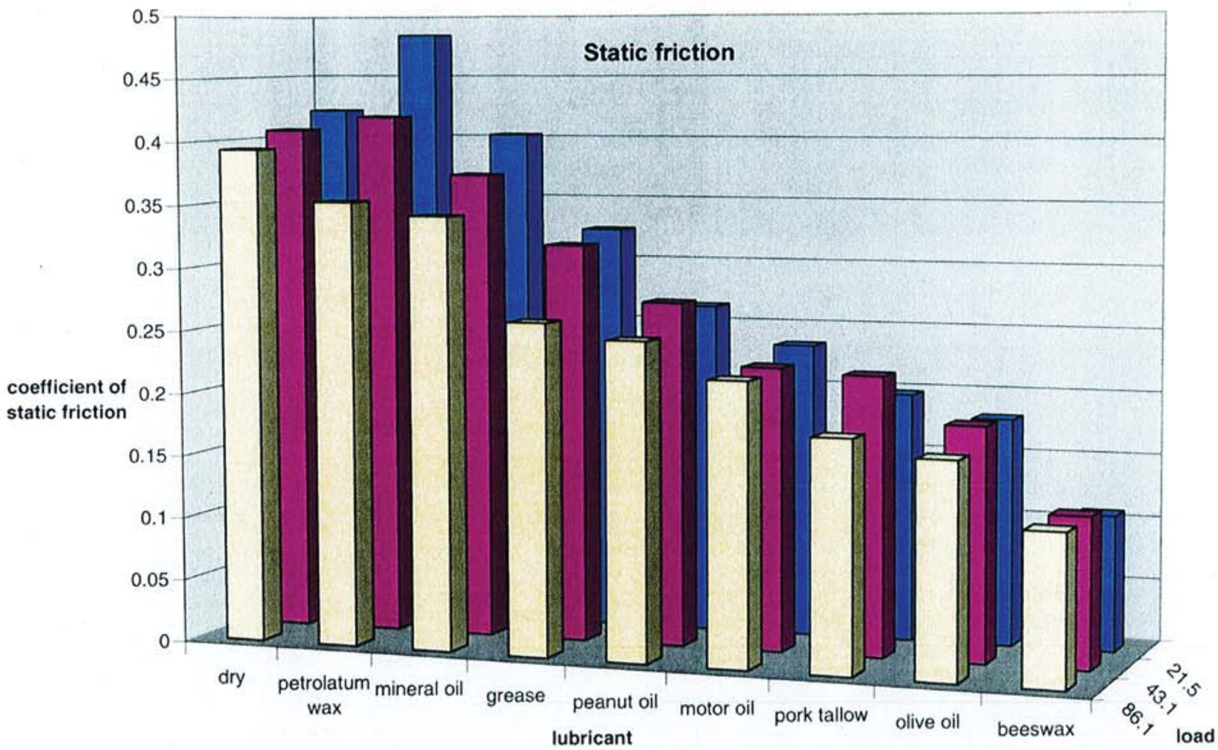
3.7 Static friction

Tests were conducted to determine the coefficient of static friction at three load stress levels for maple bearings treated with eight types of lubricant. Dry bearings without lubrication were also tested. Two bearings treated with each of the following lubricants were tested, as well as three unlubricated bearings:

peanut oil (bearings # 82,83)
olive oil (bearings # 78,79)
30W motor oil (bearings # 90,91)
mineral oil USP (bearings # 88,89)
petrolatum wax (bearings # 22, 23)
beeswax (bearings # 74,75)
axle grease (bearings # 76,77)
pork tallow (bearings # 86,87)
dry (unlubricated) (bearings # 80,84,85)

As shown in Graph 5, coefficients of static friction ranged from 0.11 to 0.48. There was little difference in static friction between dry bearings and some of the worst performing lubricants. Coefficients of friction were often, but not always, slightly lower at higher load stress levels. Bearings lubricated with beeswax had the lowest friction.

There was no apparent difference in friction between liquid lubricants as a group (peanut oil, olive oil, motor oil, mineral oil) and solid lubricants (pork tallow, beeswax, petrolatum wax, axle grease). There was also no apparent difference between petroleum-based lubricants as a group (motor oil, mineral oil, petrolatum wax, and axle grease) and animal- and vegetable-based lubricants (olive oil, peanut oil, pork tallow, beeswax).

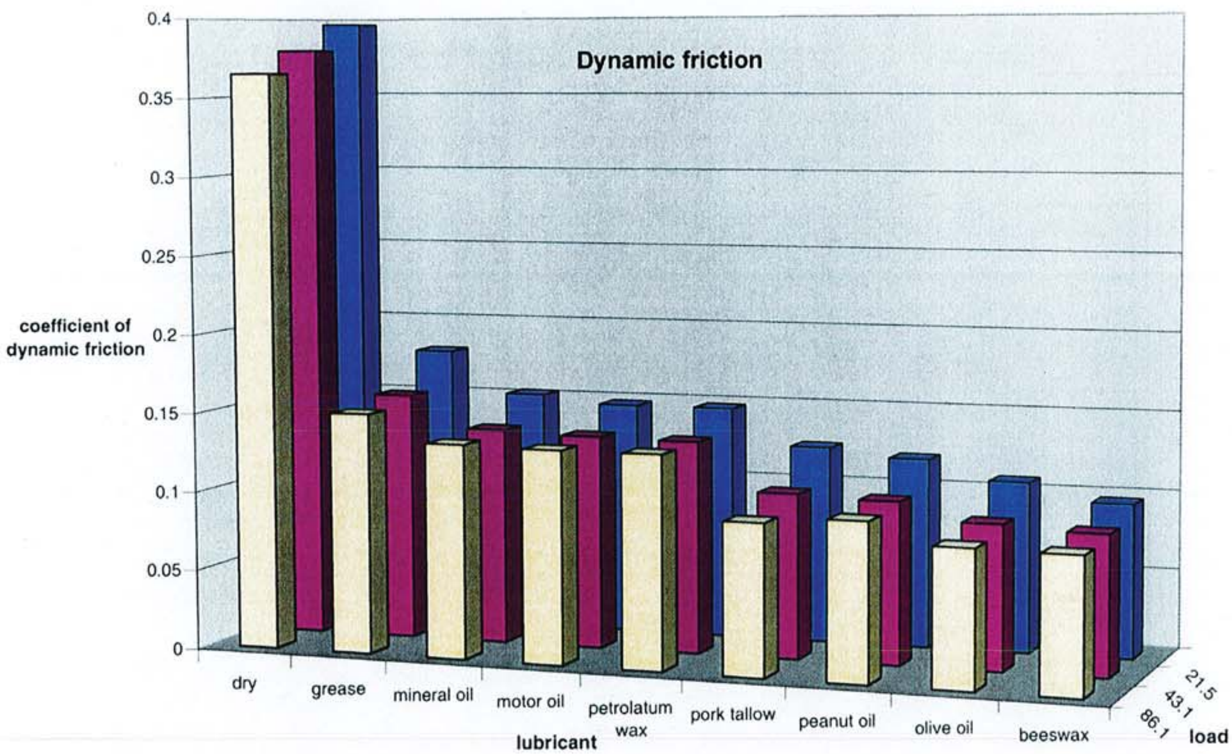


Graph 5. Static friction of eight lubricants at three load stress levels

3.8 Dynamic friction

Tests were conducted to determine the coefficient of dynamic friction of eight different lubricants at three load stress levels. The same bearings and lubricants as tested above for static friction were also tested for dynamic friction. As shown in Graph 6, there was a large difference in dynamic friction between dry and lubricated bearings. Petroleum-based lubricants, as a group, had higher friction than animal- and vegetable-based lubricants. There was no apparent difference between solid and liquid lubricants. All lubricants tested showed a slight down-ward trend in coefficient of dynamic friction as the load level increased. Bearings lubricated with beeswax had the lowest friction levels of all lubricants tested.

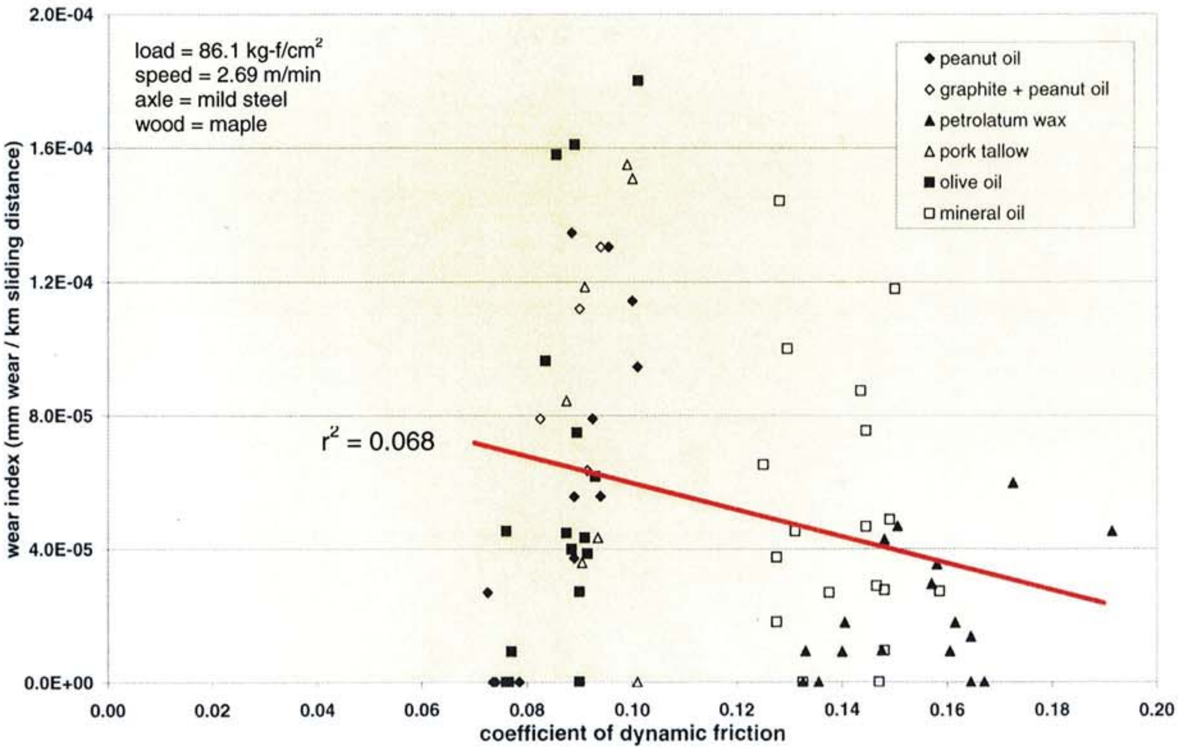
Limited tests were conducted using powdered graphite, and graphite mixed with peanut oil, as lubricant. The presence of graphite produced no apparent reduction in friction or wear. One maple bearing (#10) lubricated only with powdered graphite exhibited high friction and very short lifespan, similar to an unlubricated maple bearing (#7) tested under the same load and speed conditions. Two maple bearings (#19,33) lubricated with powdered graphite mixed with peanut oil showed fairly low friction and wear rates, similar to two maple bearings (#6,11) lubricated with peanut oil alone.



Graph 6. Dynamic friction of eight lubricants at three load stress levels

3.9 Wear vs. friction

To establish a relationship between bearing wear and friction, a series of maple bearings (# 6,11,12,13,14,15,17,19,20,21,24,32,33,34,35) treated with various lubricants were tested for up to 45 km sliding distance, with periodic measurements made of both wear and dynamic friction. For each consecutive pair of measurement points, the wear rate and mean friction were calculated and plotted in Graph 7. There was no apparent correlation between bearing friction and wear. Data points were somewhat clustered according to lubricant type. Bearings lubricated with petrolatum wax registered the highest friction levels but low wear rates. A distinction was evident between the petroleum-based lubricants



Graph 7. Bearing wear rates vs. dynamic friction for various lubricants

(mineral oil, petrolatum wax), which had coefficients of friction in the range of 0.13 to 0.17, and the animal- and vegetable-based lubricants (peanut oil, olive oil, pork tallow) with coefficients of friction of 0.08 to 0.10. Within each of these two groups, however, wear rates ranged from zero to high.

4 Discussion

4.1 Lubricants

The choice of lubricant can greatly affect bearing performance. All unlubricated bearings tested showed very high friction and wear rates. The presence of any lubricant (except dry graphite) reduced dynamic friction levels to less than half that of dry bearings. Dynamic friction of the petroleum-based lubricants was in all cases greater than that of the animal- and vegetable-based lubricants. No difference in dynamic friction was noted between solid and liquid lubricants. This suggests that the bearings operate in the boundary lubrication regime, in which physical contact is made between the bearing and shaft, rather than the hydrodynamic regime in which the two surfaces are separated by a layer of oil. Friction levels in the boundary regime are determined by the chemical makeup of the lubricant, while in the hydrodynamic regime the friction depends on the viscosity of the lubricant (Moore 1975). Animal- and vegetable-based lubricants are composed of polar fatty acid molecules that attach strongly to the sliding surfaces, forming layers that slide against each other with lower friction. Non-polar petroleum-based lubricant molecules cannot attach strongly to the surfaces and do not form a low-friction layer.

Graphite should also be a good boundary lubricant because it has a crystal lattice structure composed of layers, the bonds between atoms in the same layer being strong while the bonds between adjacent layers are weak. As the graphite is compressed between two sliding surfaces, it shears relatively easily between layers resulting in low sliding friction (Ellis 1970). Experimental results, however, show that graphite was not an effective lubricant for wooden bearings. A possible explanation is that the compressive strength of the wood is roughly the same as that of the graphite crystal, so that the graphite may become embedded in the wood rather than shear between the wood bearing and steel axle. The compressive strength of graphite is about 3,000 to 6,000 kPa (Ellis 1970), while the compressive strength parallel to grain of maple wood is about 4,000 kPa (Forest Products Laboratory 1999).

Another consideration when choosing a lubricant is the tendency of liquid lubricants to drip out of the bearing during storage and use. The dripping of lubricant from the bearing, and the dust that may be attracted to the liquid, creates a cleanliness problem that may be more disadvantageous in some applications than others. Beyond the cleanliness issue, however, oil that drips from the bearing is no longer available to lubricate the bearing, resulting in possible long-term longevity problems. For this reason, lubricants that are solid at room temperature may be preferred to liquid lubricants.

Based on all these considerations, a recommendation can be made to use animal- or vegetable-based lubricants that are solid at room temperature. Two such lubricants tested in this experiment were pork tallow and beeswax. Pork tallow showed low static and dynamic friction and low wear rates. Beeswax showed even lower friction levels but was not tested for wear. A potential disadvantage of these two lubricants, however, is the possibility that insects or rodents may be attracted to the treated bearings.

4.2 Load and speed

A "P-V index" is commonly used to rate journal bearing materials for their suitability for use under different working conditions. The product of loading stress (P) and sliding velocity (V) should not exceed a designated value that varies with material. Limiting individual values for maximum P and for maximum V are also specified. This implies that, as long as the product of load and speed does not exceed PV_{max} and the individual limits of P_{max} and V_{max} are not exceeded, a bearing should perform equally well if the speed is doubled and the load is halved. For wooden bearings, values of the PV_{max} found in the literature range from 260 to 320 (kg-f/cm^2)(m/min), with P_{max} of 140 (kg-f/cm^2) and V_{max} of 600 (m/min) (Wilcock and Booser 1957; Product Engineering 1977; Steuernagle 2001). This range of values is plotted on logarithmic axes in Figure 7.

Lancaster (1978) explained that the maximum load that a journal bearing can support is generally limited by the compressive strength of the material, while

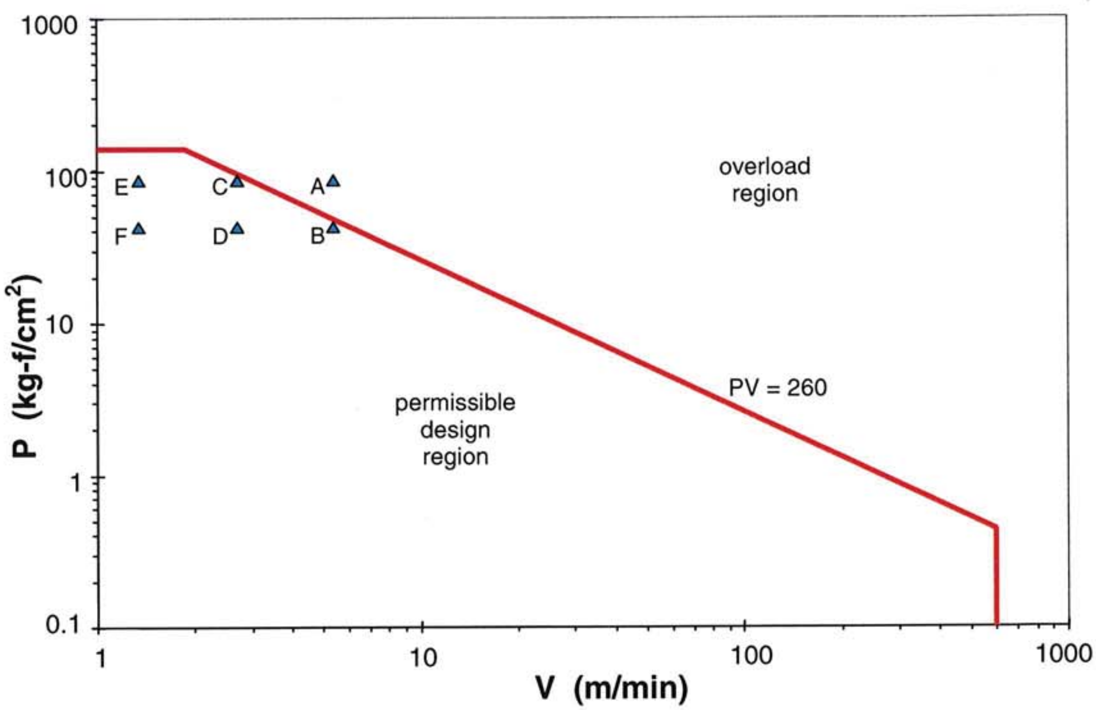


Figure 7. P-V diagram showing load and speed of bearings tested

the limiting speed is determined by the ability of the bearing assembly to dissipate heat generated by friction. The P-V relationship is linear only in the middle ranges of load and speed, and becomes non-linear as load or speed approaches maximum value asymptotically.

The tests conducted in this experiment focused on the high-load, low-speed end of the P-V continuum, the operating regime of animal-drawn carts. The operating conditions of the bearings tested are shown on Figure 7 as points A, B, C, D, E, and F. Note that point A is outside the permissible design region because the product of speed (86.1 kg-f/cm^2) and load (5.39 m/min) exceeds the PV_{max} of 260. The failure of both bearings tested under these conditions of speed and load supports the literature's suggested PV_{max} range of 260 to 320.

Data from the other bearings tested suggest that load has a greater effect on bearing wear than does speed. Sets of bearings were tested at differing loads and speeds, but with the product of load and speed resulting in constant P-V values. Bearings at points B and C all had total P-V values of 232, although bearings B operated at twice the speed and half the load of bearings at point C.

Similarly, bearings at points D and E all had total P-V values of 116, while bearings D operated at twice the speed and half the load of bearings at point E. In all cases, wear was greater in bearings operated at higher load and lower speed. Bearings at points B and D, corresponding to conditions of higher load and lower speed, averaged 2.1 times greater Stage I run-in amounts (shown in Graph 2) and 2.8 times greater Stage II linear wear rates (shown in Graph 3) than bearings tested at points C and D under lower load and higher speed.

This study explored only a part of the possible range of loads and speeds under which wooden bearings can operate. Further studies are required to elaborate the true nature of the P-V curve at higher speeds and lower loads, as well as with different types of wood and lubricant.

4.3 Wood properties

The wood matrix has at least two functions in a wooden bearing. First, it must provide physical support for the load imposed on it. Second, it must act as a vehicle for the bearing lubricant. To satisfy the first function the wood structure must be sufficiently robust to withstand the compressive forces and retain its form under load. This requires a certain density of wood matter to provide the needed mechanical strength, as woods of higher density generally have higher compressive strength. However, to satisfy the second function the wood must have sufficient porosity to contain and conduct the lubricant. Thus, these two functions are contradictory. A very dense wood will provide high mechanical strength but have low lubricant capacity, and a wood of low density may contain a large quantity of lubricant but have inadequate physical strength.

This trade-off is understood by manufacturers of porous metal bearings. This type of bearing is made by fusing ("sintering") metal particles together under heat and pressure. The density and porosity of the bearings can be varied by changing the particle size, heat, and pressure. It has been found that the best porosity for most porous metal bearing applications ranges from 25 to 35 per cent (Morgan and Cameron 1957). Applied to oven-dry wood, this range of porosity corresponds to wood with specific gravity ranging from 0.97 to 1.12.

However, a distinction should be made between the porosity and the permeability of a wood. Wood may be highly porous, but because of pit aspiration, tyloses, or other impediments to flow, have low permeability and not allow the movement of lubricant through its structure. Such a wood would provide neither high mechanical strength nor high lubricant capacity.

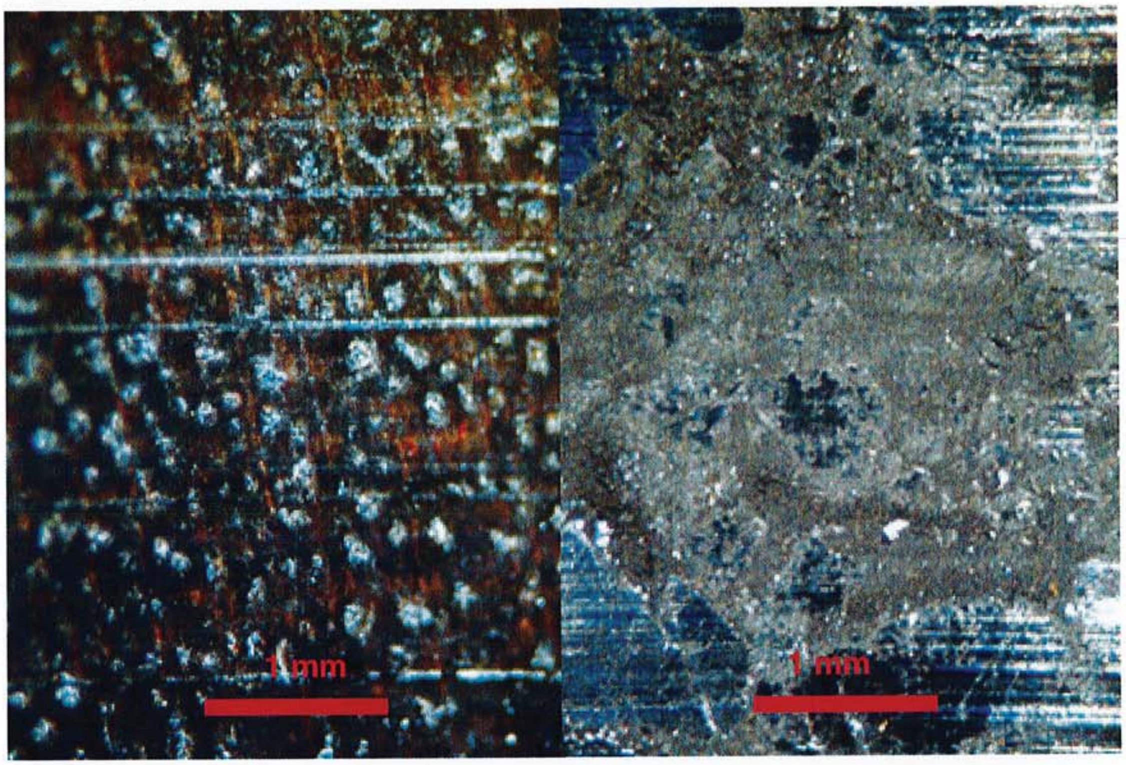


Figure 8. Magnified images (24x) of surfaces of maple bearing (left) and muninga bearing (right)

Limited wear tests were conducted on wood species of different density and permeability. Basswood, with high permeability and low density, had a greater Stage I run-in amount than did maple, a wood of high permeability and comparatively high density. However, the Stage II linear wear rates of the two woods were comparable. Muninga wood, fairly dense and yet with low permeability, had both high run-in amounts and high linear wear rates. This suggests that permeability is more important to bearing longevity than is density. Magnified images of the bearing surfaces (Figure 8) show that the maple bearing remained oil-soaked after 42 km sliding distance, while the surface of the muninga bearing was dry and charred.

The limited tests conducted in this study of woods of different pore distribution suggest that diffuse porous woods perform better than ring porous woods. Further studies of the effect of pore distribution and pore size on bearing performance should be undertaken. With porous metal bearings, it has been shown that the size distribution of pores is an important feature (Morgan 1957). The capillary forces holding the lubricant varies with pore size, allowing oil to first be removed from the larger size pores and later from progressively smaller pores, thus extending bearing life. If the same relationship holds for wooden bearings, a semi-ring porous wood with a large range of pore sizes may make a good bearing material.

4.4 Axle properties

The difference in wear rates between bearings run on cold-drawn 1018 mild steel axles and bearings run on ground and polished 4140 heat-treated steel axle shafts is striking. Wood/lubricant combinations that performed very well on the mild steel shafts burned up within minutes or hours when run on the heat-treated shafts. It seems likely that the surface properties of the steel shafts account for the difference in wear, rather than the metallurgical properties of the different metals. Magnified images of the surfaces of the axles (Figure 9) show parallel ridges on the heat-treated steel caused by the grinding and polishing process. The ridges on the heat-treated shaft ran in the direction of rotation, so that as the shaft rotated the ridges tended to dig into the wood surface and prevented any accumulation of lubricant or wood debris. In contrast, the surface of the cold-drawn mild steel axle had a more mottled appearance. It may be that the irregular topography of the cold-drawn steel surface allowed lubricant or debris to build-up between the sliding surfaces, thereby reducing wear. Further tests should be conducted with heat-treated shafts that are ground and polished along the axis of the shaft rather than around the circumference.

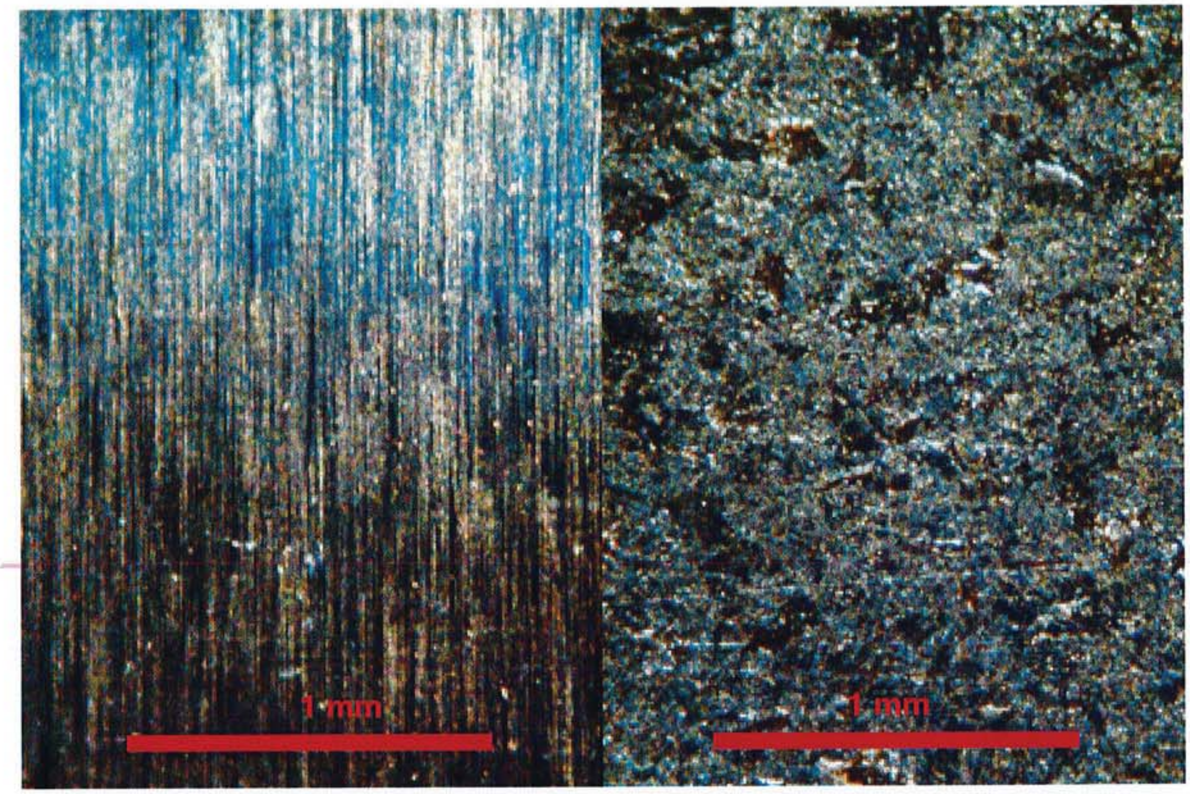


Figure 9. Magnified images (48x) of surfaces of heat treated steel axle (left) and mild steel axle (right)

5 Conclusion

Wooden bearings have a long history of use, and they continue to be used in a number of applications. Many factors affect bearing behavior, none of which are well understood. Successful applications of wooden bearings have relied on trial-and-error experience to establish reliable performance. The present pilot study has examined several wood properties, fabrication methods, and operating conditions in an attempt to provide an understanding of some of the more important factors that influence bearing performance. The results indicate that under certain conditions hardwood bearings can operate with reasonably low levels of friction and wear. The study has also shown that under unsuitable conditions wooden bearings can exhibit high friction and extreme wear.

Specifically, the study results indicate that:

- higher wood density gave lower wear,
- higher wood permeability gave lower wear,
- permeability may be more important than density to bearing longevity,
- diffuse porous wood gave lower wear than ring porous wood,
- within the range of loads and speeds tested, load stress level had a greater effect on wear than did speed level,
- the maximum PV index from the literature was confirmed,
- extremely high wear rates occurred with ground-and-polished heat-treated steel axles,
- some lubricants gave static friction levels comparable to unlubricated bearings,
- petroleum-based lubricants gave higher friction than animal- and vegetable-based lubricants,
- lubricant viscosity had no apparent effect on friction,
- wood bearings appear to operate in the boundary lubrication regime,
- beeswax lubricant gave the lowest static and dynamic friction levels,
- the coefficients of friction decreased slightly at higher load stress levels, and
- no correlation was apparent between friction and wear.

This study begins to illuminate some of the factors that control bearing behavior, which is a critical step to using wooden bearings in a rational manner. Additional work is needed, however, not only to confirm and expand on these findings but also to address the many additional factors not covered by this study.

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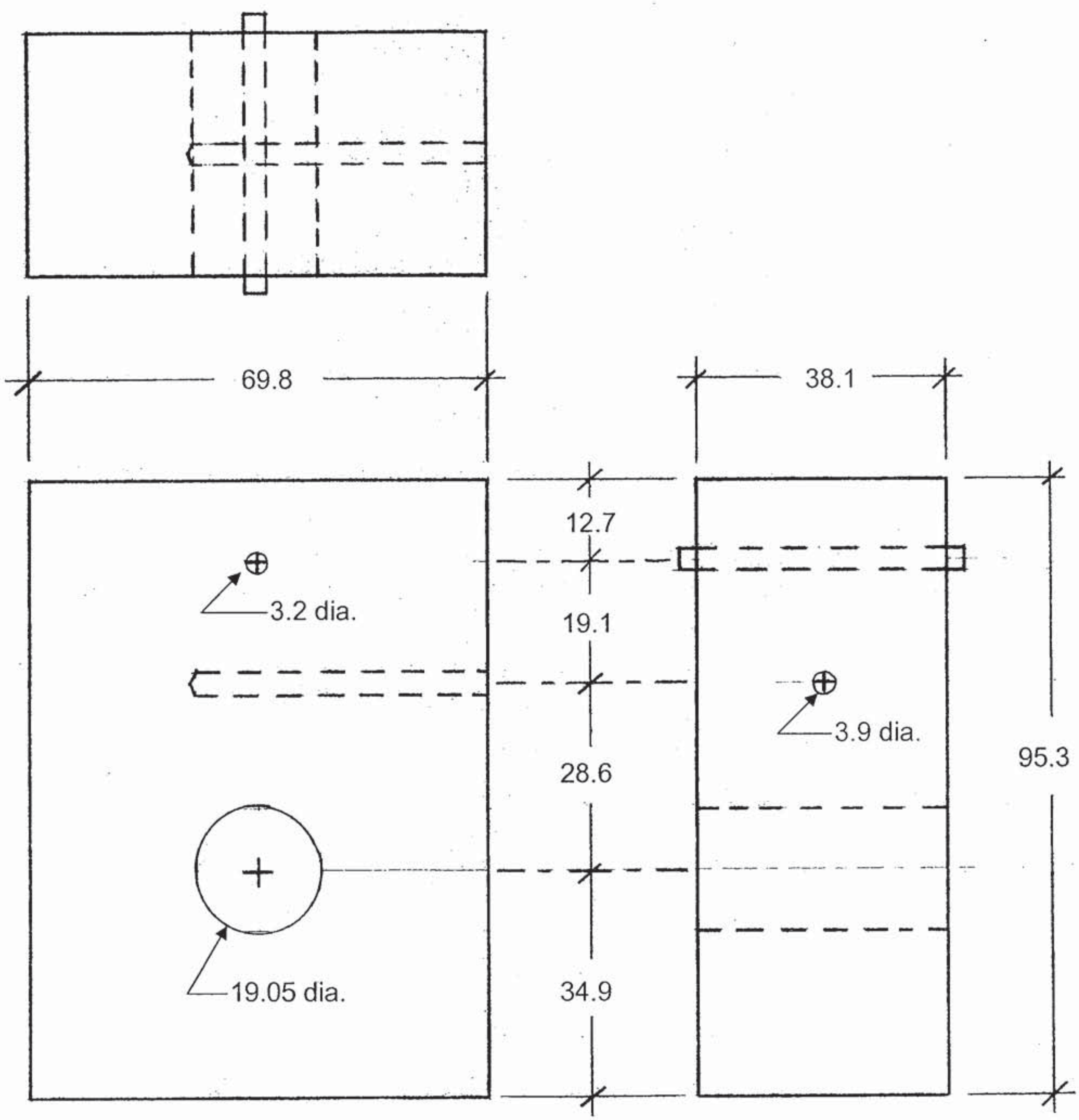
Appendix 1: Dimensions of test bearings

dimensions in millimeters



Appendix 2: Summary of bearings tested

Bearing number	Wood type	Lubricant type	Axle type	Load (kg-f/cm2)	Speed (m/min)	Failure mode
1	muninga	dry	mild steel	86.1	2.69	split
3	muninga	peanut oil	mild steel	86.1	2.69	split
4	maple	peanut oil	mild steel	43.1	2.69	none
5	maple	peanut oil	mild steel	64.6	2.69	none
6	maple	peanut oil	mild steel	86.1	2.69	none
7	maple	dry	mild steel	86.1	2.69	split
8	maple	liquid soap	mild steel	86.1	2.69	split
9	maple	motor oil	mild steel	86.1	2.69	wear
10	maple	graphite	mild steel	86.1	2.69	wear
11	maple	peanut oil	mild steel	86.1	2.69	axle
12	maple	olive oil	mild steel	86.1	2.69	axle
13	maple	pork tallow	mild steel	86.1	2.69	axle
14	maple	petrolatum wax	mild steel	86.1	2.69	axle
15	maple	petrolatum wax	mild steel	86.1	2.69	none
16	maple	motor oil	mild steel	86.1	2.69	split
17	maple	pork tallow	mild steel	86.1	2.69	axle
18	maple	mineral oil	mild steel	86.1	2.69	split
19	maple	graphite/peanut	mild steel	86.1	2.69	axle
20	maple	olive oil	mild steel	86.1	2.69	axle
21	maple	pork tallow	mild steel	86.1	2.69	axle
22	maple	petrolatum wax	mild steel	friction test		none
23	maple	petrolatum wax	mild steel	friction test		none
24	maple	petrolatum wax	mild steel	86.1	2.69	wear
25	maple	petrolatum wax	heat treated	86.1	2.69	wear
26	maple	olive oil	heat treated	86.1	2.69	wear
27	maple	pork tallow	heat treated	86.1	2.69	wear
28	maple	peanut oil	heat treated	86.1	2.69	wear
29	maple	olive oil	heat treated	86.1	2.69	wear
30	maple	dry	heat treated	86.1	2.69	wear
31	maple	motor oil	heat treated	86.1	2.69	wear
32	maple	olive oil	mild steel	86.1	2.69	axle
33	maple	graphite/peanut	mild steel	86.1	2.69	axle
34	maple	mineral oil	mild steel	86.1	2.69	axle
35	maple	mineral oil	mild steel	86.1	2.69	split
40	combretum	olive oil	heat treated	86.1	2.69	wear
41	combretum	dry	heat treated	86.1	2.69	wear
42	adina	olive oil	heat treated	86.1	2.69	split
43	adina	dry	heat treated	86.1	2.69	split
45	lignum vitae	dry	heat treated	86.1	2.69	wear/split
46	gmelia	dry	heat treated	86.1	2.69	wear
47	gmelia	olive oil	heat treated	86.1	2.69	wear
48	gmelia	dry	heat treated	86.1	2.69	wear
49	gmelia	olive oil	heat treated	86.1	2.69	wear/split

Bearing number	Wood type	Lubricant type	Axle type	Load (kg-f/cm2)	Speed (m/min)	Failure mode
50	maple	olive oil	mild steel	86.1	1.35	none
51	maple	olive oil	mild steel	43.1	5.39	none
52	maple	olive oil	mild steel	86.1	5.39	split
53	maple	olive oil	mild steel	43.1	1.35	none
54	maple	olive oil	mild steel	43.1	5.39	none
55	maple	olive oil	mild steel	43.1	5.39	none
61	maple	olive oil	mild steel	43.1	2.69	none
62	maple	olive oil	mild steel	43.1	2.69	none
63	maple	olive oil	mild steel	43.1	5.39	none
64	maple	olive oil	mild steel	43.1	5.39	none
65	maple	olive oil	mild steel	43.1	1.35	none
66	maple	olive oil	mild steel	86.1	2.69	none
67	maple	olive oil	mild steel	86.1	5.39	wear
70	maple	olive oil	mild steel	86.1	2.69	none
71	maple	olive oil	mild steel	86.1	1.35	none
74	maple	beeswax	mild steel	friction test		none
75	maple	beeswax	mild steel	friction test		none
76	maple	grease	mild steel	friction test		none
77	maple	grease	mild steel	friction test		none
78	maple	olive oil	mild steel	friction test		none
79	maple	olive oil	mild steel	friction test		none
80	maple	dry	mild steel	friction test		none
82	maple	peanut oil	mild steel	friction test		none
83	maple	peanut oil	mild steel	friction test		none
84	maple	dry	mild steel	friction test		none
85	maple	dry	mild steel	friction test		none
86	maple	pork tallow	mild steel	friction test		none
87	maple	pork tallow	mild steel	friction test		none
88	maple	mineral oil	mild steel	friction test		none
89	maple	mineral oil	mild steel	friction test		none
90	maple	motor oil	mild steel	friction test		none
91	maple	motor oil	mild steel	friction test		none
94	basswood	olive oil	mild steel	43.1	5.39	none
95	basswood	olive oil	mild steel	43.1	5.39	none
96	basswood	olive oil	mild steel	43.1	5.39	none
97	basswood	olive oil	mild steel	43.1	5.39	none
104	red oak	olive oil	mild steel	43.1	5.39	none
105	red oak	olive oil	mild steel	43.1	5.39	none
108	muninga	olive oil	mild steel	43.1	5.39	wear
109	muninga	olive oil	mild steel	43.1	5.39	none

Appendix 3: Test data

BEARING NO:	1	LUBRICANT:	DRY
WOOD TYPE:	MUNINGA	LUBE RETENTION (g):	0
MOISTURE CONTENT (%):	8.7	LUBE RETENTION (%):	0.0
SPECIFIC GRAVITY:	0.57	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #1	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				58.28	57.54	57.91	0.00	4.48	4.32	4.40	0.271
43200	2.59				53.74	53.53	53.64	4.27				

bearing failed by splitting

BEARING NO:	3	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MUNINGA	LUBE RETENTION (g):	4.21
MOISTURE CONTENT (%):	9.7	LUBE RETENTION (%):	2.7
SPECIFIC GRAVITY:	0.57	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #1	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00		0		57.55	57.74	57.65	0.00	3.29	3.37	3.33	0.205
68557	4.10		42		57.28	57.61	57.45	0.20	3.70	3.69	3.70	0.228
133153	7.97		44		57.12	57.56	57.34	0.30	4.01	4.01	4.01	0.247
196946	11.79		48		57.12	57.41	57.27	0.38	4.21	4.15	4.18	0.258
259855	15.55		51		57.07	57.41	57.24	0.41	4.29	4.31	4.30	0.265
323892	19.38		53		56.98	57.35	57.17	0.48	4.44	4.48	4.46	0.275
387113	23.17		49		56.93	57.32	57.13	0.52	4.57	4.70	4.64	0.286

bearing failed by splitting

BEARING NO:	4	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	101.4
MOISTURE CONTENT (%):	7.6	LUBE RETENTION (%):	59.6
SPECIFIC GRAVITY:	0.66	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #2	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				57.48	58.17	57.83	0.00	1.66	1.67	1.67	0.103
71058	4.25	12	36	24	57.63	58.00	57.82	0.02	1.72	1.93	1.83	0.112
135485	8.11	12	38	26	57.66	57.93	57.80	0.03	1.82	2.00	1.91	0.118
199920	11.97	13	37	24	57.62	57.87	57.75	0.09	1.93	2.08	2.01	0.124
262891	15.73	12	39	27	57.62	57.83	57.73	0.11	1.96	2.18	2.07	0.128
326326	19.53	12	37	25	57.65	57.85	57.75	0.08	1.99	2.20	2.10	0.129
390932	23.40	12	33	21	57.60	57.83	57.72	0.11	2.12	2.29	2.21	0.136
449404	26.90	12	32	20	57.61	57.82	57.72	0.11	2.11	2.21	2.16	0.133
569635	34.09	12	30	18	57.63	57.78	57.71	0.13	1.99	2.22	2.11	0.130
636514	38.10	9	28	19	57.61	57.75	57.68	0.15	2.04	2.30	2.17	0.134
696782	41.70	8	26	18	57.60	57.77	57.69	0.14	2.05	2.28	2.17	0.133

bearing OK

BEARING NO:	5	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	98.2
MOISTURE CONTENT (%):	7.1	LUBE RETENTION (%):	57.0
SPECIFIC GRAVITY:	0.66	LOAD (kg-f/cm^2):	64.6
AXLE:	MILD STEEL #2	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				57.78	57.74	57.76	0.00	2.20	2.15	2.18	0.089
71058	4.25	12	39	27	57.74	57.60	57.67	0.09	2.03	2.12	2.08	0.085
135485	8.11	12	39	27	57.74	57.54	57.64	0.12	2.10	2.17	2.14	0.088
199920	11.97	13	39	26	57.69	57.53	57.61	0.15	2.10	2.11	2.11	0.086
262891	15.73	12	41	29	57.64	57.51	57.58	0.18	2.15	2.11	2.13	0.088
326326	19.53	12	37	25	57.66	57.51	57.59	0.18	2.13	2.08	2.11	0.086
390932	23.40	12	33	21	57.66	57.51	57.59	0.18	2.06	2.14	2.10	0.086
449404	26.90	12	33	21	57.63	57.50	57.57	0.20	2.05	2.07	2.06	0.085
569635	34.09	12	30	18	57.64	57.49	57.57	0.20	2.12	2.21	2.17	0.089
636514	38.10	9	26	17	57.60	57.46	57.53	0.23	2.14	2.23	2.19	0.090
696782	41.70	8	26	18	57.61	57.50	57.56	0.20	2.21	2.28	2.25	0.092

bearing OK

BEARING NO: 6
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.9
SPECIFIC GRAVITY: 0.70
AXLE: MILD STEEL #2

LUBRICANT: PEANUT OIL
LUBE RETENTION (g): 94.4
LUBE RETENTION (%): 55.3
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				57.13	58.17	57.65	0.00	3.06	2.94	3.00	0.092
71058	4.25	12	48	36	57.01	57.96	57.49	0.16	2.72	2.78	2.75	0.085
135485	8.11	12	47	35	56.98	57.93	57.46	0.20	2.95	3.08	3.02	0.093
199920	11.97	13	48	35	56.91	57.87	57.39	0.26	2.98	3.16	3.07	0.095
262891	15.73	12	71	59	56.80	57.75	57.28	0.38	3.36	3.45	3.41	0.105
326326	19.53	12	79	67	56.70	57.64	57.17	0.48	3.17	3.12	3.15	0.097
390932	23.40	12	39	27	56.62	57.60	57.11	0.54	2.62	2.65	2.64	0.081
449404	26.90	12	38	26	56.64	57.58	57.11	0.54	2.44	2.47	2.46	0.076
569635	34.09	12	39	27	56.64	57.57	57.11	0.54	2.28	2.40	2.34	0.072
636514	38.10	9	37	28	56.62	57.55	57.09	0.57	2.29	2.44	2.37	0.073
696782	41.70	8	37	29	56.60	57.57	57.09	0.56	2.28	2.51	2.40	0.074

bearing OK

BEARING NO: 7
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 7.5
SPECIFIC GRAVITY: 0.63
AXLE: MILD STEEL #3

LUBRICANT: DRY
LUBE RETENTION (g): 0
LUBE RETENTION (%): 0.0
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				57.58	57.97	57.78	0.00	6.00	>6	>6	>0.185
2086	0.12											

bearing failed by splitting at 2086 revs

BEARING NO: 8
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 7.7
SPECIFIC GRAVITY: 0.63
AXLE: MILD STEEL #3

LUBRICANT: DISHWASHING LIQUID
LUBE RETENTION (g): 136.6
LUBE RETENTION (%): 78.3
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				54.95	55.81	55.38	0.00	4.82	4.74	4.78	0.147
1306	0.08											

bearing became swolen and plasticized by lubricant treatment
bearing failed by splitting at 1306 revs

BEARING NO:	9	LUBRICANT:	30W MOTOR OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	62.1
MOISTURE CONTENT (%):	7.6	LUBE RETENTION (%):	35.3
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #3	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				58.60	59.26	58.93	0.00	4.74	4.76	4.75	0.146
58920	3.53	12	82	70	58.06	58.80	58.43	0.50	5.27	5.26	5.27	0.162
107366	6.43				47.68	48.31	48.00	10.94				
120645	7.22	13	104	91	47.50	48.18	47.84	11.09	5.49	5.44	5.47	0.168
<160000	<9.58				34.15	34.67	34.41	24.52				

bearing failed by excessive wear

BEARING NO:	10	LUBRICANT:	POWDERED GRAPHITE
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	0.06
MOISTURE CONTENT (%):	7.5	LUBE RETENTION (%):	<0.01
SPECIFIC GRAVITY:	0.63	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #3	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				57.70	58.35	58.03	0.00	>6	>6	>6	>0.185
986	0.06				44.95	45.61	45.28	12.75				

bearing failed by excessive wear

BEARING NO:	11	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	100.7
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	59.9
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #5	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			58.96	58.50	58.73	0.00	3.32	3.06	3.19	0.098
59566	3.57	6	42	36	58.89	58.30	58.60	0.13	3.01	3.04	3.03	0.093
74728	4.47	7	45	38	58.88	58.27	58.58	0.15	3.00	2.97	2.99	0.092
118852	7.11	7	43	36	58.82	58.32	58.57	0.16				

axle shaft broke

BEARING NO:	12	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	98.1
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	57.3
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #5	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			59.91	59.53	59.72	0.00	3.12	3.00	3.06	0.094
59566	3.57	6	43	37	59.69	59.43	59.56	0.16	2.68	2.76	2.72	0.084
74728	4.47	7	47	40	59.65	59.40	59.53	0.20	2.85	2.82	2.84	0.087
118852	7.11	7	48	41	59.61	59.37	59.49	0.23				
119899	7.18	8			59.57	59.37	59.47	0.25				
158743	9.50				59.53	59.39	59.46	0.26				

axle shaft broke

BEARING NO:	13	LUBRICANT:	PORK TALLOW
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	83.6
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	49.0
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #5	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			58.51	57.98	58.25	0.00	3.33	3.53	3.43	0.106
59566	3.57	6	53	47	58.29	57.91	58.10	0.15	3.13	3.00	3.07	0.094
74728	4.47	7	54	47	58.26	57.88	58.07	0.18	2.90	2.82	2.86	0.088
118852	7.11	7	56	49	58.21	57.84	58.03	0.22				
131417	7.87	8	45	37	58.13	57.85	57.99	0.26	2.90	2.77	2.84	0.087
176970	10.59	5	44	39	58.12	57.84	57.98	0.27				

axle shaft broke

BEARING NO:	14	LUBRICANT:	PETROLATUM WAX
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	90.0
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	53.2
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #6	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			58.31	57.67	57.99	0.00	4.94	5.47	5.21	0.160
15522	0.93	16	51	35	58.33	57.69	58.01	0.00	5.42	5.53	5.48	0.169
56945	3.41	17	57	40	58.31	57.67	57.99	0.00	5.27	5.43	5.35	0.165
123758	7.41	9	57	48	58.30	57.64	57.97	0.02	5.08	5.19	5.14	0.158
183793	11.00	12	54	42	58.24	57.58	57.91	0.08	6.06	6.06	6.06	0.187
250034	14.96	9	50	41	58.18	57.55	57.87	0.13	6.19	6.56	6.38	0.196

axle shaft broke

BEARING NO: 15
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 0.64
AXLE: MILD STEEL #7
LUBRICANT: PETROLATUM WAX
LUBE RETENTION (g): 87.6
LUBE RETENTION (%): 50.6
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	1			58.37	58.25	58.31	0.00	5.10	4.69	4.90	0.151
50850	3.04	11	44	33	58.35	58.22	58.29	0.03	5.29	5.41	5.35	0.165
114748	6.87	11	49	38	58.30	58.24	58.27	0.04	4.93	5.17	5.05	0.156
178717	10.70	11	48	37	58.28	58.17	58.23	0.09	4.60	4.84	4.72	0.145
245693	14.70	12	53	41	58.23	58.17	58.20	0.11	4.31	4.49	4.40	0.136
309294	18.51	14	49	35	58.23	58.17	58.20	0.11	4.31	4.43	4.37	0.135
373428	22.35	15	52	37	58.23	58.16	58.20	0.12	4.24	4.29	4.27	0.131
436356	26.12	15	56	41	58.22	58.16	58.19	0.12	4.30	4.41	4.36	0.134
501640	30.02	17	50	33	58.19	58.18	58.19	0.13	4.57	4.88	4.73	0.146
564601	33.79	15	48	33	58.18	58.16	58.17	0.14	4.71	4.97	4.84	0.149
625394	37.43	17	48	31	58.14	58.14	58.14	0.17	5.08	5.63	5.36	0.165
756175	45.26	17	51	34	58.10	58.11	58.11	0.20	5.20	5.43	5.32	0.164

bearing OK

BEARING NO: 16
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 0.64
AXLE: MILD STEEL #4
LUBRICANT: 30W MOTOR OIL
LUBE RETENTION (g): 54.07
LUBE RETENTION (%): 30.6
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.06	57.56	57.81	0.00	4.49	4.60	4.55	0.140
24477	1.46	6			57.92	57.30	57.61	0.20				
69587	4.16	6	90	84	57.72	57.07	57.40	0.26	4.71	4.62	4.67	0.144
96767	5.79				55.31	54.56	54.94	2.72				

bearing failed by splitting

BEARING NO: 17
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 0.64
AXLE: MILD STEEL #4
LUBRICANT: PORK TALLOW
LUBE RETENTION (g): 80.64
LUBE RETENTION (%): 45.4
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.62	57.89	58.26	0.00	3.35	3.43	3.39	0.104
24477	1.46	6			58.46	57.79	58.13	0.13				
69587	4.16	6	55	49	58.32	57.84	58.08	0.18	3.12	2.98	3.05	0.094
133135	7.97	9	41	32	58.23	57.71	57.97	0.29				

axle shaft broke

BEARING NO:	18	LUBRICANT:	MINERAL OIL USP
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	93.5
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	53.0
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.23	58.25	58.24	0.00	5.45	5.57	5.51	0.170
24477	1.46	6			57.94	58.09	58.02	0.23				
69587	4.16	6	99	93	55.10	55.26	55.18	3.06	>6	>6	>6	>0.185
84158	5.04				54.79	55.02	54.91	3.34				
96767	5.79				53.76	53.97	53.87	4.38				

bearing failed by splitting

BEARING NO:	19	LUBRICANT:	GRAPHITE/PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	99.6
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	57.8
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.19	57.40	57.80	0.00	3.18	3.26	3.22	0.099
24477	1.46	6			58.11	57.30	57.71	0.09				
69587	4.16	6	36	30	58.04	57.29	57.67	0.13	2.69	2.56	2.63	0.081

axle shaft broke

BEARING NO:	20	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	100.6
MOISTURE CONTENT (%):	6.7	LUBE RETENTION (%):	59.4
SPECIFIC GRAVITY:	0.64	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #6	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			58.04	57.53	57.79	0.00	2.85	2.95	2.90	0.089
15522	0.93	16	43	27	58.03	57.53	57.78	0.01	3.13	2.97	3.05	0.094
56945	3.41	17	47	30	58.01	57.50	57.76	0.04	2.89	2.81	2.85	0.088
123758	7.41	9	45	36	57.95	57.46	57.71	0.09	2.83	2.81	2.82	0.087
183793	11.00	12	43	31	57.91	57.40	57.66	0.13	2.88	2.95	2.92	0.090
250034	14.96	9	44	35	57.90	57.37	57.64	0.16	2.98	2.86	2.92	0.090
262464	15.71	3			57.90	57.32	57.61	0.18	2.52	2.51	2.52	0.077
328545	19.66	2	33	31	57.93	57.20	57.57	0.23	2.46	2.43	2.45	0.075
389877	23.33	4	34	30	57.91	57.20	57.56	0.23	2.50	2.47	2.49	0.077
455626	27.27	3	34	31	57.92	57.19	57.56	0.23	2.50	2.46	2.48	0.076
520541	31.15	4	34	30	57.93	57.17	57.55	0.24	2.51	2.53	2.52	0.078

axle shaft broke

BEARING NO: 21
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 0.64
AXLE: MILD STEEL #6

LUBRICANT: PORK TALLOW
LUBE RETENTION (g): 79.4
LUBE RETENTION (%): 46.3
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			58.62	58.19	58.41	0.00	3.41	3.40	3.41	0.105
15522	0.93	16	39	23	58.61	58.22	58.42	0.00	3.14	3.15	3.15	0.097
56945	3.41	17	42	25	58.55	58.20	58.38	0.03	2.98	2.86	2.92	0.090
123758	7.41	9	44	35	58.49	58.18	58.34	0.07	2.86	3.06	2.96	0.091

axle shaft broke

BEARING NO: 22
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 7.4
SPECIFIC GRAVITY: 0.71

LUBRICANT: PETROLATUM WAX
LUBE RETENTION (%): 39.4
AXLE: MILD STEEL #15

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORRECTED	COEFF
25% LOAD (21.5 kg-f/cm2)	3.9	3.5	3.5	3.9	3.7	3.7	0.45
50% LOAD (43.1 kg-f/cm2)	7.0	6.3	6.7	7.3	6.8	6.7	0.42
100% LOAD (86.1 kg-f/cm2)	10.1	11.1	11.9	11.6	11.2	11.0	0.34

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORRECTED	COEFF
25% LOAD (21.5 kg-f/cm2)	1.2	1.2	1.2	1.2	0.14
50% LOAD (43.1 kg-f/cm2)	2.2	2.2	2.2	2.1	0.13
100% LOAD (86.1 kg-f/cm2)	4.4	4.4	4.4	4.3	0.13

BEARING NO: 23
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 7.4
SPECIFIC GRAVITY: 0.71

LUBRICANT: PETROLATUM WAX
LUBE RETENTION (%): 38.8
AXLE: MILD STEEL #15

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORRECTED	COEFF
25% LOAD (21.5 kg-f/cm2)	4.4	4.4	3.9	4.2	4.2	4.2	0.52
50% LOAD (43.1 kg-f/cm2)	7.3	6.3	6.7	7.3	6.9	6.8	0.42
100% LOAD (86.1 kg-f/cm2)	11.3	12.7	12.2	12.2	12.1	11.9	0.37

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORRECTED	COEFF
25% LOAD (21.5 kg-f/cm2)	1.2	1.3	1.3	1.2	0.15
50% LOAD (43.1 kg-f/cm2)	2.2	2.3	2.3	2.2	0.14
100% LOAD (86.1 kg-f/cm2)	4.5	4.5	4.5	4.4	0.13

BEARING NO:	24	LUBRICANT:	PETROLATUM WAX
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	79.9
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	39.6
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #8	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	10			58.34	58.44	58.39	0.00	5.00	4.77	4.89	0.151
7290	0.44		52		58.34	58.42	58.38	0.01				
17130	1.03		53		58.31	58.43	58.37	0.02				
69822	4.18	21	65	44	58.27	58.40	58.34	0.05	4.74	4.70	4.72	0.145
118173	7.07	21	107	86	57.49	57.72	57.61	0.78	6.07	6.24	6.16	0.190
132030	7.90	19	127	108	53.14	53.24	53.19	5.20				
132280	7.92		+		48.09	48.14	48.12	10.28				
132430	7.93		+		45.10	45.18	45.14	13.25				
132630	7.94		+		40.75	40.98	40.87	17.53				
132740	7.94		+		38.10	38.50	38.30	20.09				

bearing failed by excessive wear

BEARING NO:	25	LUBRICANT:	PETROLATUM WAX
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	74.7
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	39.1
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0	2			58.58	58.31	58.45	0.00	6.54	6.80	6.67	0.206
1410	0.084				56.72	56.67	56.70	1.76				
1640	0.098	2	77	75	54.06	54.08	54.07	4.38				
1810	0.108	2	99	97	51.60	51.60	51.60	6.85				
1960	0.117	2	110	108	49.86	49.73	49.80	8.66				
2240	0.134		+		44.15	44.50	44.33	14.13				
2480	0.148		+		39.57	39.50	39.54	18.92				

bearing failed by excessive wear

BEARING NO:	26	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	87.0
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	45.3
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #2	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	13			58.34	58.33	58.34	0.00	3.54	3.64	3.59	0.111
1485	0.09	13	62	49								
1890	0.11	13	72	59								
2047	0.12	13	74	61	58.24	58.27	58.26	0.09				
3240	0.19	13	89	76								
4173	0.25		+		36.68	37.05	36.87	21.48				

bearing failed by excessive wear

BEARING NO:	27	LUBRICANT:	PORK TALLOW
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	81.1
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	43.7
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0	8			59.64	60.02	59.83	0.00	4.87	4.82	4.85	0.149
1646	0.099	8	98	90	57.05	57.31	57.18	2.65				
1826	0.109	8	109	101	54.28	54.63	54.46	5.38				
2056	0.123		+		49.62	49.51	49.57	10.27				
2346	0.14		+		42.85	42.94	42.90	16.94				
2516	0.151		+		38.50	38.78	38.64	21.19				

bearing failed by excessive wear

BEARING NO:	28	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	87.6
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	46.9
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	2			58.59	58.36	58.48	0.00	4.05	3.96	4.01	0.123
1640	0.10	2	88	86	57.28	56.95	57.12	1.36				
1850	0.11				54.90	54.86	54.88	3.60				
2040	0.12	2	117	115	51.80	51.92	51.86	6.62				
2300	0.14		+		45.90	46.17	46.04	12.45				
2631	0.16		+		36.54	36.65	36.60	21.89				

bearing failed by excessive wear

BEARING NO:	29	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	85.2
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	44.6
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #3	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.43	58.41	58.42	0.00	3.39	3.36	3.38	0.104
1450	0.09	3	50	47								
2320	0.14	3	77	74								
2810	0.17	3	89	86								
3030	0.18	3	103	100	56.51	56.64	56.58	1.85				
3570	0.21		+		44.36	44.31	44.34	14.09				
3820	0.23		+		36.63	36.75	36.69	21.73				

bearing failed by excessive wear

BEARING NO:	30	LUBRICANT:	DRY
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	0.0
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	0.0
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #3	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			58.32	58.72	58.52	0.00	7.39	7.92	7.66	0.236
820	0.05	3	88	85	54.05	54.17	54.11	4.41				
960	0.06	3	117	114	51.76	52.15	51.96	6.57				
1190	0.07		+		47.51	47.30	47.41	11.12				

bearing failed by excessive wear

BEARING NO:	31	LUBRICANT:	30W MOTOR OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	32.9
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	17.7
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #4	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	8			58.93	58.95	58.94	0.00	5.81	5.90	5.86	0.180
2394	0.14	8	65	57	58.92	59.00	58.96	0.00				
3274	0.20	8	72	64	58.89	58.97	58.93	0.01				
4184	0.25	8	77	69	58.88	58.94	58.91	0.03				
7374	0.44	8	88	80	58.80	58.85	58.83	0.11				
8873	0.53	8	92	84	58.71	58.79	58.75	0.19				
10106	0.60	8	98	90	58.44	58.49	58.47	0.47				
10842	0.65	8	113	105	55.64	55.47	55.56	3.39				
10994	0.66		+		52.62	52.56	52.59	6.35				
11164	0.67		+		48.29	48.20	48.25	10.70				
11384	0.68		+		42.41	42.50	42.46	16.49				
11494	0.69		+		38.90	39.32	39.11	19.83				

bearing failed by excessive wear

BEARING NO:	32	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	87.24
MOISTURE CONTENT (%):	7.4	LUBE RETENTION (%):	46.8
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #8	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	10			58.72	58.83	58.78	0.00	3.39	3.75	3.57	0.110
7180	0.43		58		58.41	58.93	58.67	0.11				
16990	1.02		53		58.42	58.95	58.69	0.09				
69822	4.18	21	55	34	58.29	58.85	58.57	0.21	3.01	2.96	2.99	0.092
118173	7.07	21	57	36	58.25	58.80	58.53	0.26	3.01	3.07	3.04	0.094
132030	7.90	19	56	37	58.18	58.78	58.48	0.30				
182181	10.90	15	43	28	58.15	58.74	58.45	0.34	2.75	2.78	2.77	0.085
246935	14.78	17	44	27	58.16	58.76	58.46	0.32	3.10	3.04	3.07	0.095

axle shaft broke

BEARING NO: 33
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 0.64
AXLE: MILD STEEL #5

LUBRICANT: GRAPHITE/PEANUT OIL
LUBE RETENTION (g): 96.18
LUBE RETENTION (%): 53.4
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			57.65	56.98	57.32	0.00	3.53	3.44	3.49	0.107
59566	3.57	6	44	38	57.47	56.90	57.19	0.13	2.58	2.70	2.64	0.081
74728	4.47	7	48	41	57.45	56.89	57.17	0.15	2.70	2.72	2.71	0.084
118852	7.11	7	51	44	57.43	56.85	57.14	0.18				
131417	7.87	8	46	38	57.38	56.84	57.11	0.21	3.23	3.22	3.23	0.099
176970	10.59	5	49	44	57.38	56.84	57.11	0.21				

axle shaft broke

BEARING NO: 34
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 7.6
SPECIFIC GRAVITY: 0.67
AXLE: MILD STEEL #6

LUBRICANT: MINERAL OIL USP
LUBE RETENTION (g): 91.6
LUBE RETENTION (%): 51.3
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	7			57.00	57.72	57.36	0.00	4.90	4.60	4.75	0.146
15522	0.93	16	47	31	57.00	57.73	57.37	0.00	4.82	4.77	4.80	0.148
56945	3.41	17	53	36	57.00	57.67	57.34	0.02	4.73	4.67	4.70	0.145
123758	7.41	9	57	48	56.95	57.66	57.31	0.05	4.24	4.23	4.24	0.130
183793	11.00	12	44	32	56.82	57.60	57.21	0.15	4.23	4.15	4.19	0.129
250034	14.96	9	56	47	56.82	57.56	57.19	0.17	4.16	4.01	4.09	0.126
262464	15.71	3			56.79	57.54	57.17	0.20	4.39	4.02	4.21	0.130
328545	19.66	2	50	48	56.83	57.38	57.11	0.25	4.34	4.22	4.28	0.132
389877	23.33	4	67	63	56.81	57.31	57.06	0.30	5.85	4.95	5.40	0.166
455626	27.27	3	62	59	56.82	57.24	57.03	0.33	4.78	5.04	4.91	0.151
520541	31.15	4	61	57	56.79	57.21	57.00	0.36	4.67	4.76	4.72	0.145
554856	33.21	3			56.77	57.13	56.95	0.41	4.56	4.64	4.60	0.142

axle shaft broke

BEARING NO:	35	LUBRICANT:	MINERAL OIL USP
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	87.4
MOISTURE CONTENT (%):	7.1	LUBE RETENTION (%):	50.0
SPECIFIC GRAVITY:	0.66	LOAD (kg-f/cm^2):	86.1
AXLE:	MILD STEEL #7	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	1			57.60	58.37	57.99	0.00	5.74	5.44	5.59	0.172
50850	3.04	11	48	37	57.56	58.22	57.89	0.10	4.09	4.20	4.15	0.128
114748	6.87	11	56	45	57.52	58.18	57.85	0.14	4.12	4.11	4.12	0.127
178717	10.70	11	56	45	57.45	58.12	57.79	0.21	4.00	3.97	3.99	0.123
245693	14.70	12	67	55	57.44	58.12	57.78	0.21	4.65	4.54	4.60	0.142
309294	18.51	14	64	50	57.37	58.04	57.71	0.29	4.81	4.72	4.77	0.147
373428	22.35	15	62	47	57.32	57.99	57.66	0.34	4.65	4.59	4.62	0.142
436356	26.12	15	71	56	57.29	57.99	57.64	0.35	5.00	5.02	5.01	0.154

bearing failed by splitting

BEARING NO:	40	LUBRICANT:	OLIVE OIL
WOOD TYPE:	COMBRETUM IMBERBE	LUBE RETENTION (g):	4.0
MOISTURE CONTENT (%):	10.2	LUBE RETENTION (%):	1.4
SPECIFIC GRAVITY:	1.06	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #1	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				59.30	58.76	59.03	0.00	4.16	4.04	4.10	0.126
1639	0.10	3			58.98	58.40	58.69	0.34	3.86	3.71	3.79	0.117
3173	0.19	3	93	90								
3737	0.22				41.02	41.20	41.11	17.92				

bearing failed by excessive wear

BEARING NO:	41	LUBRICANT:	DRY
WOOD TYPE:	COMBRETUM IMBER	LUBE RETENTION (g):	0.0
MOISTURE CONTENT (%):	11.2	LUBE RETENTION (%):	0.0
SPECIFIC GRAVITY:	1.11	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #1	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				58.37	58.05	58.21	0.00	>11	>11	>11	>0.34
766	0.05				45.99	45.68	45.84	12.38				

bearing failed by excessive wear

BEARING NO: 42
WOOD TYPE: ADINA MICROCEPHALA
MOISTURE CONTENT (%): 13.3
SPECIFIC GRAVITY: 0.85
AXLE: HEAT TREATED #1
LUBRICANT: OLIVE OIL
LUBE RETENTION (g): 11.7
LUBE RETENTION (%): 4.9
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				59.46	58.92	59.19	0.00	3.19	3.22	3.21	0.099
47615	2.85	3	51	48	55.85	55.39	55.62	3.57	3.42	3.45	3.44	0.106
64601	3.87	8	56	48	55.80	55.34	55.57	3.62	3.51	3.59	3.55	0.109
112697	6.74	7	52	45	55.75	55.27	55.51	3.68	4.87	4.87	4.87	0.150
122465	7.33	9	84	75	55.00	54.54	54.77	4.42				

bearing failed by splitting

BEARING NO: 43
WOOD TYPE: ADINA MICROCEPHALA
MOISTURE CONTENT (%): 13.3
SPECIFIC GRAVITY: 0.85
AXLE: HEAT TREATED #1
LUBRICANT: DRY
LUBE RETENTION (g): 0.0
LUBE RETENTION (%): 0.0
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00				59.29	58.87	59.08	0.00	6.74	6.75	6.75	0.208

bearing failed by splitting at approx. 26000 revs = 1.56 km

BEARING NO: 45
WOOD TYPE: LIGNUM VITAE
MOISTURE CONTENT (%): 6.7
SPECIFIC GRAVITY: 1.24
AXLE: HEAT TREATED #2
LUBRICANT: DRY
LUBE RETENTION (g): 0.0
LUBE RETENTION (%): 0.0
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	13			58.87	58.60	58.74	0.00	>15	>15	>15	>0.46
1485	0.09	13	42	29								
1890	0.11	13	44	31								
2047	0.12				58.36	58.18	58.27	0.47				
3285	0.20	13	66	53								
4455	0.27	13	72	59								
5235	0.31	13	74	61	56.75	56.55	56.65	2.09	>15	>15	>15	>0.46
19580	1.17	11	+		54.62	54.41	54.52	4.23	>15	>15	>15	>0.46
62247	3.73	12	+		50.17	49.93	50.05	8.69	>15	>15	>15	>0.46
78909	4.72		+		46.14	46.08	46.11	12.63	>15	>15	>15	>0.46

bearing failed by splitting and excessive wear
coefficient of friction was ~0.2 when hot, >0.46 when cold

BEARING NO: 46
WOOD TYPE: GMELIA ARBOREA
MOISTURE CONTENT (%): 5.9
SPECIFIC GRAVITY: 0.47
AXLE: HEAT TREATED #2
LUBRICANT: DRY
LUBE RETENTION (g): 0.0
LUBE RETENTION (%): 0.0
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	13			57.72	57.93	57.83	0.00	6.29	6.31	6.30	0.194
1080	0.06	13	46	33								
1485	0.09	13	58	45								
1890	0.11	13	72	59								
2047	0.12	13	93	80	35.39	35.57	35.48	22.35				

bearing failed by excessive wear

BEARING NO: 47
WOOD TYPE: GMELIA ARBOREA
MOISTURE CONTENT (%): 5.9
SPECIFIC GRAVITY: 0.47
AXLE: HEAT TREATED #2
LUBRICANT: OLIVE OIL
LUBE RETENTION (g): 3.4
LUBE RETENTION (%): 2.6
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	13			58.47	58.40	58.44	0.00	3.90	3.90	3.90	0.120
675	0.04	13	93	80								
800	0.05				38.24	38.28	38.26	20.18				

bearing failed by excessive wear

BEARING NO: 48
WOOD TYPE: GMELIA ARBOREA
MOISTURE CONTENT (%): 5.9
SPECIFIC GRAVITY: 0.47
AXLE: HEAT TREATED #3
LUBRICANT: DRY
LUBE RETENTION (g): 0.0
LUBE RETENTION (%): 0.0
LOAD (kg-f/cm^2): 86.1
SPEED (m/min): 2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			59.24	59.40	59.32	0.00	5.96	5.99	5.98	0.184
920	0.06	3	42	39	59.23	59.35	59.29	0.03				
3090	0.18	3	57	54	59.18	59.27	59.23	0.09				
3980	0.24	3	72	69	58.59	58.73	58.66	0.66				
4240	0.25	3	89	86	53.52	52.98	53.25	6.07				
4430	0.27		+		39.52	39.70	39.61	19.71				

bearing failed by excessive wear

BEARING NO:	49	LUBRICANT:	OLIVE OIL
WOOD TYPE:	GMELIA ARBOREA	LUBE RETENTION (g):	3.0
MOISTURE CONTENT (%):	5.9	LUBE RETENTION (%):	2.3
SPECIFIC GRAVITY:	0.47	LOAD (kg-f/cm^2):	86.1
AXLE:	HEAT TREATED #3	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)				DYNAMIC FRICTION			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR	A (KG)	B (KG)	AVG	COEFF
0	0.00	3			57.85	58.52	58.19	0.00	4.00	3.91	3.96	0.122
870	0.05				54.56	54.73	54.65	3.55				
1020	0.06				43.28	41.28	42.28	15.91				
1065	0.06							SPLIT				

bearing failed by excessive wear and splitting

BEARING NO:	50	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	86.7
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	45.6
SPECIFIC GRAVITY:	0.72	SPEED (m/min):	1.35
AXLE:	MILD STEEL #10	LOAD (kg-f/cm^2):	86.1

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEAR	DIFF	A	B	AVG	WEAR
0	0.00	14			59.21	59.32	59.265	0.000
3340	0.20	17	40	23	59.18	59.30	59.240	0.025
7779	0.47	17	39	22	59.17	59.28	59.225	0.040
14699	0.88	13	34	21	59.10	59.26	59.180	0.085
28994	1.74	13	32	19	59.09	59.24	59.165	0.100
40046	2.40	22	40	18	59.08	59.23	59.155	0.110
61215	3.66	16	32	16	59.07	59.23	59.150	0.115
72226	4.32	24	41	17	59.06	59.23	59.145	0.120
93476	5.59	19	36	17	59.05	59.22	59.135	0.130
104729	6.27	23	39	16	59.04	59.22	59.130	0.135
134062	8.02	18	34	16	59.02	59.22	59.120	0.145
164556	9.85	16	32	16	59.01	59.21	59.110	0.155
189857	11.36	13	29	16	58.99	59.20	59.095	0.170
222835	13.34	17	33	16	58.98	59.19	59.085	0.180
254535	15.23	14	32	18	58.97	59.19	59.080	0.185
287176	17.19	15	32	17	58.94	59.18	59.060	0.205
319401	19.12	16	34	18	58.93	59.18	59.055	0.210

bearing OK

BEARING NO:	51	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	89.8
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	47.4
SPECIFIC GRAVITY:	0.72	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #13	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	22			58.47	58.80	58.635	0.000
4726	0.28	20			58.50	58.83	58.665	0.000
19282	1.15	32	64	32	58.44	58.80	58.620	0.015
35292	2.11	29	63	34	58.42	58.80	58.610	0.025
110904	6.64	20	56	36	58.40	58.79	58.595	0.040
163611	9.79	26	62	36	58.38	58.77	58.575	0.060
250065	14.97	21	57	36	58.36	58.77	58.565	0.070
293194	17.55	27	62	35	58.35	58.77	58.560	0.075
380087	22.75	23	62	39	58.34	58.76	58.550	0.085
432135	25.86	28	65	37	58.33	58.75	58.540	0.095
510815	30.57	22	58	36	58.32	58.75	58.535	0.100
553041	33.10	26	60	34	58.31	58.74	58.525	0.110
642778	38.47	22	61	39	58.29	58.72	58.505	0.130
703330	42.09	26	62	36	58.28	58.71	58.495	0.140

bearing OK

BEARING NO:	52	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	86.6
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	45.6
SPECIFIC GRAVITY:	0.72	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #9	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	13			58.87	58.80	58.835	0.000
2803	0.17	13	71	58	58.71	58.74	58.725	0.110
5329	0.32	13	81	68	58.67	58.71	58.690	0.145
12273	0.73	13	87	74	58.63	58.66	58.645	0.190
41463	2.48	13	88	75	58.19	58.16	58.175	0.660
99891	5.98	11	72	61	58.06	58.07	58.065	0.770
143458	8.59	14	72	58	58.05	58.03	58.040	0.795
222501	13.32	10	68	58	57.97	57.97	57.970	0.865
243244	14.56	13	72	59	57.97	57.97	57.970	0.865
287045	17.18	14	77	63	57.95	57.96	57.955	0.880
354628	21.22	11	78	67	57.93	57.92	57.925	0.910
428339	25.64	15	81	66	57.89	57.88	57.885	0.950
489437	29.29	13	81	68	57.83	57.84	57.835	1.000

bearing failed by splitting

BEARING NO:	53	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	85.0
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	44.9
SPECIFIC GRAVITY:	0.72	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #10	SPEED (m/min):	1.35

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	14			59.22	59.07	59.145	0.000
3340	0.20	17	31	14	59.21	59.06	59.135	0.015
7779	0.47	17	29	12	59.20	59.06	59.130	0.020
14699	0.88	13	26	13	59.17	59.04	59.105	0.045
28994	1.74	13	23	10	59.16	59.03	59.095	0.055
40046	2.40	22	31	9	59.15	59.02	59.085	0.065
61215	3.66	16	22	6	59.15	59.02	59.085	0.065
72226	4.32	24	31	7	59.15	59.02	59.085	0.065
93476	5.59	19	26	7	59.14	59.02	59.080	0.070
104729	6.27	23	28	5	59.14	59.02	59.080	0.070
134062	8.02	18	23	5	59.14	59.02	59.080	0.070
164556	9.85	16	21	5	59.14	59.01	59.075	0.075
189857	11.36	13	18	5	59.13	59.01	59.070	0.080
222835	13.34	17	21	4	59.13	59.01	59.070	0.080
254535	15.23	14	19	5	59.13	59.01	59.070	0.080
287176	17.19	15	19	4	59.13	59.01	59.070	0.080
319401	19.12	16	21	5	59.13	59.01	59.070	0.080

bearing OK

BEARING NO:	54	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	88.5
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	46.8
SPECIFIC GRAVITY:	0.72	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #13	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	22			59.24	58.94	59.090	0.000
4726	0.28	20			59.24	58.99	59.115	0.000
19282	1.15	32	58	26	59.17	58.95	59.060	0.030
35292	2.11	29	57	28	59.16	58.95	59.055	0.035
110904	6.64	20	48	28	59.12	58.94	59.030	0.060
163611	9.79	26	54	28	59.11	58.92	59.015	0.075
250065	14.97	21	48	27	59.09	58.91	59.000	0.090
293194	17.55	27	54	27	59.09	58.90	58.995	0.095
380087	22.75	23	51	28	59.08	58.90	58.990	0.100
432135	25.86	28	57	29	59.07	58.89	58.980	0.110
510815	30.57	22	54	32	59.06	58.89	58.975	0.115
553041	33.10	26	57	31	59.06	58.88	58.970	0.120
642778	38.47	22	54	32	59.05	58.87	58.960	0.130
703330	42.09	26	58	32	59.05	58.87	58.960	0.130

bearing OK

BEARING NO:	55	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	89.0
MOISTURE CONTENT (%):	5.6	LUBE RETENTION (%):	47.4
SPECIFIC GRAVITY:	0.72	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #9	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	13			59.96	59.48	59.72	0
2803	0.17	13	37	24	59.94	59.48	59.71	0.01
12273	0.73	13	46	33	59.92	59.51	59.72	0.00
41463	2.48	13	43	30	59.85	59.53	59.69	0.03
99891	5.98	11	42	31	59.82	59.53	59.68	0.05
143458	8.59	14	46	32	59.82	59.51	59.67	0.05
222501	13.32	10	44	34	59.77	59.49	59.63	0.09
287045	17.18	14	49	35	59.76	59.49	59.63	0.09
354628	21.22	11	46	35	59.74	59.48	59.61	0.11
428339	25.64	15	48	33	59.72	59.47	59.60	0.13
489437	29.29	13	47	34	59.73	59.47	59.60	0.12
532030	31.84	18	52	34	59.73	59.47	59.60	0.12
619014	37.05	12	43	31	59.71	59.47	59.59	0.13

bearing OK

BEARING NO:	61	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	84.2
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	46.3
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #11	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	8			58.87	58.88	58.875	0.000
5918	0.35	18	32	14	58.87	58.87	58.870	0.005
17005	1.02	19	33	14	58.86	58.87	58.865	0.010
33656	2.01	19	34	15	58.85	58.87	58.860	0.015
63506	3.80	17	31	14	58.84	58.86	58.850	0.025
85578	5.12	23	37	14	58.84	58.86	58.850	0.025
128415	7.69	18	31	13	58.82	58.86	58.840	0.035
148304	8.88	25	42	17	58.82	58.86	58.840	0.035
194149	11.62	20	36	16	58.81	58.86	58.835	0.040
227568	13.62	23	42	19	58.81	58.86	58.835	0.040
262203	15.69	22	41	19	58.80	58.85	58.825	0.050
292948	17.53	23	43	20	58.80	58.84	58.820	0.055
323437	19.36	21	41	20	58.80	58.84	58.820	0.055
345054	20.65	26	46	20	58.79	58.84	58.815	0.060
388359	23.24	18	38	20	58.79	58.84	58.815	0.060
414630	24.82	21	40	19	58.79	58.84	58.815	0.060
452461	27.08	14	34	20	58.78	58.84	58.810	0.065
474191	28.38	24	43	19	58.78	58.84	58.810	0.065
517675	30.98	19	38	19	58.78	58.83	58.805	0.070
539696	32.30	25	42	17	58.77	58.83	58.800	0.075
582304	34.85	21	37	16	58.76	58.82	58.790	0.085

bearing OK

BEARING NO:	62	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	86.4
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	47.7
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #11	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	8			58.59	58.53	58.560	0.000
5918	0.35	18	33	15	58.58	58.52	58.550	0.010
17005	1.02	19	34	15	58.57	58.51	58.540	0.020
33656	2.01	19	33	14	58.56	58.50	58.530	0.030
63506	3.80	17	31	14	58.54	58.49	58.515	0.045
85578	5.12	23	37	14	58.54	58.49	58.515	0.045
128415	7.69	18	31	13	58.52	58.48	58.500	0.060
148304	8.88	25	41	16	58.52	58.48	58.500	0.060
194149	11.62	20	37	17	58.51	58.47	58.490	0.070
227568	13.62	23	41	18	58.51	58.47	58.490	0.070
262203	15.69	22	40	18	58.50	58.47	58.485	0.075
292948	17.53	23	43	20	58.50	58.46	58.480	0.080
323437	19.36	21	40	19	58.50	58.46	58.480	0.080
345054	20.65	26	45	19	58.49	58.46	58.475	0.085
388359	23.24	18	37	19	58.49	58.46	58.475	0.085
414630	24.82	21	39	18	58.49	58.46	58.475	0.085
452461	27.08	14	33	19	58.48	58.46	58.470	0.090
474191	28.38	24	42	18	58.48	58.45	58.465	0.095
517675	30.98	19	37	18	58.47	58.45	58.460	0.100
539696	32.30	25	42	17	58.47	58.45	58.460	0.100
582304	34.85	21	37	16	58.47	58.44	58.455	0.105

bearing OK

BEARING NO:	63	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	88.7
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	49.0
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #9	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	13			59.17	59.15	59.16	0
2803	0.17	13	42	29	59.18	59.13	59.16	0.00
12273	0.73	13	54	41	59.16	59.16	59.16	0.00
41463	2.48	13	51	38	59.13	59.10	59.12	0.04
99891	5.98	11	49	38	59.13	59.07	59.10	0.06
143458	8.59	14	54	40	59.11	59.07	59.09	0.07
222501	13.32	10	50	40	59.09	59.06	59.08	0.08
287045	17.18	14	54	40	59.08	59.06	59.07	0.09
354628	21.22	11	50	39	59.06	59.04	59.05	0.11
428339	25.64	15	53	38	59.06	59.03	59.05	0.11
489437	29.29	13	51	38	59.06	59.01	59.04	0.13
532030	31.84	18	57	39	59.09	58.99	59.04	0.12
619014	37.05	12	48	36	59.07	58.98	59.03	0.13

bearing OK

BEARING NO:	64	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	94.0
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	51.6
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #12	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			58.39	58.70	58.545	0.000
2530	0.15	16			58.39	58.70	58.545	0.000
9988	0.60	23	49	26	58.40	58.70	58.550	-0.005
19781	1.18	26	55	29	58.39	58.69	58.540	0.005
33863	2.03	26	58	32	58.38	58.69	58.535	0.010
63148	3.78	24	59	35	58.36	58.68	58.520	0.025
122856	7.35	23	59	36	58.33	58.66	58.495	0.050
183834	11.00	26	63	37	58.33	58.65	58.490	0.055
252736	15.13	22	59	37	58.31	58.64	58.475	0.070
295773	17.70	27	62	35	58.31	58.64	58.475	0.070
373935	22.38	18	56	38	58.31	58.63	58.470	0.075
422827	25.31	23	57	34	58.30	58.62	58.460	0.085
513167	30.71	17	49	32	58.30	58.62	58.460	0.085
580056	34.72	19	54	35	58.30	58.61	58.455	0.090
647929	38.78	15	48	33	58.29	58.61	58.450	0.095
703480	42.10	16	46	30	58.28	58.61	58.445	0.100

bearing OK

BEARING NO:	65	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	84.5
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	45.9
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #10	SPEED (m/min):	1.35

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	14			59.13	58.94	59.035	0.000
3340	0.20	17	29	12	59.11	58.93	59.020	0.015
7779	0.47	17	29	12	59.11	58.93	59.020	0.015
14699	0.88	13	26	13	59.06	58.88	58.970	0.065
28994	1.74	13	23	10	59.06	58.88	58.970	0.065
40046	2.40	22	30	8	59.06	58.87	58.965	0.070
61215	3.66	16	22	6	59.05	58.87	58.960	0.075
72226	4.32	24	31	7	59.05	58.87	58.960	0.075
93476	5.59	19	26	7	59.05	58.87	58.960	0.075
104729	6.27	23	29	6	59.05	58.87	58.960	0.075
134062	8.02	18	24	6	59.04	58.87	58.955	0.080
164556	9.85	16	22	6	59.04	58.87	58.955	0.080
189857	11.36	13	19	6	59.04	58.86	58.950	0.085
222835	13.34	17	22	5	59.04	58.86	58.950	0.085
254535	15.23	14	20	6	59.04	58.86	58.950	0.085
287176	17.19	15	20	5	59.03	58.86	58.945	0.090
319401	19.12	16	21	5	59.03	58.86	58.945	0.090

bearing OK

BEARING NO:	66	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	86.2
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	46.5
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #11	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	8			59.30	59.18	59.240	0.000
5918	0.35	18	48	30	59.27	59.17	59.220	0.020
17005	1.02	19	48	29	59.24	59.15	59.195	0.045
33656	2.01	19	49	30	59.23	59.11	59.170	0.070
63506	3.80	17	47	30	59.21	59.08	59.145	0.095
85578	5.12	23	59	36	59.20	59.07	59.135	0.105
128415	7.69	18	56	38	59.17	59.05	59.110	0.130
148304	8.88	25	62	37	59.14	59.05	59.095	0.145
194149	11.62	20	58	38	59.13	59.03	59.080	0.160
227568	13.62	23	61	38	59.12	59.02	59.070	0.170
262203	15.69	22	61	39	59.11	59.02	59.065	0.175
292948	17.53	23	71	48	59.11	59.02	59.065	0.175
323437	19.36	21	57	36	59.03	58.89	58.960	0.280
345054	20.65	26	62	36	59.02	58.88	58.950	0.290
388359	23.24	18	52	34	59.01	58.87	58.940	0.300
414630	24.82	21	53	32	59.00	58.87	58.935	0.305
452461	27.08	14	47	33	58.99	58.86	58.925	0.315
474191	28.38	24	56	32	58.99	58.84	58.915	0.325
517675	30.98	19	49	30	58.98	58.83	58.905	0.335
539696	32.30	25	56	31	58.97	58.84	58.905	0.335
582304	34.85	21	53	32	58.97	58.83	58.900	0.340

bearing OK

BEARING NO:	67	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	89.8
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	48.7
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #9	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	13			59.29	58.90	59.10	0
2803	0.17	13	64	51	59.25	58.89	59.07	0.02
5329	0.32	13	77	64	59.24	58.89	59.07	0.03
12273	0.73	13	91	78	59.25	58.88	59.07	0.03
25000	1.50	13			45.25	44.90	45.08	14.02

bearing failed by excessive wear

BEARING NO:	70	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	83.9
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	44.3
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #11	SPEED (m/min):	2.69

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	8			58.72	58.91	58.815	0.000
5918	0.35	18	49	31	58.70	58.90	58.800	0.015
17005	1.02	19	49	30	58.67	58.88	58.775	0.040
33656	2.01	19	49	30	58.64	58.87	58.755	0.060
63506	3.80	17	49	32	58.61	58.86	58.735	0.080
85578	5.12	23	59	36	58.60	58.85	58.725	0.090
128415	7.69	18	52	34	58.57	58.83	58.700	0.115
148304	8.88	25	60	35	58.55	58.82	58.685	0.130
194149	11.62	20	55	35	58.53	58.81	58.670	0.145
227568	13.62	23	59	36	58.52	58.81	58.665	0.150
262203	15.69	22	58	36	58.51	58.80	58.655	0.160
292948	17.53	23	62	39	58.50	58.79	58.645	0.170
323437	19.36	21	57	36	58.49	58.78	58.635	0.180
345054	20.65	26	61	35	58.49	58.77	58.630	0.185
388359	23.24	18	51	33	58.48	58.77	58.625	0.190
414630	24.82	21	53	32	58.47	58.77	58.620	0.195
452461	27.08	14	46	32	58.44	58.72	58.580	0.235
474191	28.38	24	52	28	58.43	58.70	58.565	0.250
517675	30.98	19	44	25	58.42	58.69	58.555	0.260
539696	32.30	25	49	24	58.41	58.69	58.550	0.265
582304	34.85	21	45	24	58.41	58.69	58.550	0.265

bearing OK

BEARING NO:	71	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (g):	84.6
MOISTURE CONTENT (%):	5.7	LUBE RETENTION (%):	45.0
SPECIFIC GRAVITY:	0.71	LOAD (kg-f/cm2):	86.1
AXLE:	MILD STEEL #10	SPEED (m/min):	1.35

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	14			59.09	58.72	58.905	0.000
3340	0.20	17	38	21	59.07	58.70	58.885	0.020
7779	0.47	17	37	20	59.07	58.70	58.885	0.020
14699	0.88	13	33	20	59.02	58.67	58.845	0.060
28994	1.74	13	31	18	59.01	58.65	58.830	0.075
40046	2.40	22	38	16	59.01	58.65	58.830	0.075
61215	3.66	16	32	16	59.00	58.63	58.815	0.090
72226	4.32	24	42	18	59.00	58.63	58.815	0.090
93476	5.59	19	36	17	59.00	58.62	58.810	0.095
104729	6.27	23	41	18	59.00	58.61	58.805	0.100
134062	8.02	18	37	19	58.98	58.61	58.795	0.110
164556	9.85	16	35	19	58.98	58.60	58.790	0.115
189857	11.36	13	32	19	58.97	58.60	58.785	0.120
222835	13.34	17	36	19	58.96	58.59	58.775	0.130
254535	15.23	14	33	19	58.96	58.59	58.775	0.130
287176	17.19	15	34	19	58.95	58.59	58.770	0.135
319401	19.12	16	34	18	58.94	58.59	58.765	0.140

bearing OK

BEARING NO:	74	LUBRICANT:	BEESWAX
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	48.8
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
(21.5 kg-f/cm2)	0.9	1.1	0.9	1.1	1.0	1.0	0.12
(43.1 kg-f/cm2)	2.2	2.2	2.3	2.2	2.2	2.1	0.13
(86.1 kg-f/cm2)	4.5	4.2	4.6	4.4	4.4	4.2	0.13

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.8	0.8	0.8	0.8	0.10
50% LOAD (43.1 kg-f/cm2)	1.5	1.6	1.6	1.5	0.09
100% LOAD (86.1 kg-f/cm2)	3.0	3.0	3.0	2.9	0.09

BEARING NO:	75	LUBRICANT:	BEESWAX
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	48.8
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.8	0.8	0.8	0.7	0.8	0.8	0.09
50% LOAD (43.1 kg-f/cm2)	1.8	1.8	1.8	1.8	1.8	1.7	0.11
100% LOAD (86.1 kg-f/cm2)	3.6	3.6	3.6	3.6	3.6	3.4	0.11

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.8	0.7	0.8	0.7	0.09
50% LOAD (43.1 kg-f/cm2)	1.4	1.4	1.4	1.3	0.08
100% LOAD (86.1 kg-f/cm2)	2.7	2.8	2.8	2.6	0.08

BEARING NO:	76	LUBRICANT:	AXLE GREASE
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	2.3
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.0	2.7	2.6	3.2	2.9	2.8	0.35
50% LOAD (43.1 kg-f/cm2)	5.8	5.6	5.1	5.5	5.5	5.5	0.34
100% LOAD (86.1 kg-f/cm2)	8.6	9.3	9.0	9.2	9.0	8.9	0.27

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.4	1.4	1.4	1.4	0.18
50% LOAD (43.1 kg-f/cm2)	2.5	2.5	2.5	2.5	0.15
100% LOAD (86.1 kg-f/cm2)	4.9	5.0	5.0	4.8	0.15

BEARING NO:	77	LUBRICANT:	AXLE GREASE
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	2.3
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.5	2.5	2.4	2.5	2.5	2.5	0.30
50% LOAD (43.1 kg-f/cm2)	4.8	5.1	4.7	5.0	4.9	4.9	0.30
100% LOAD (86.1 kg-f/cm2)	9.1	8.1	8.3	7.8	8.3	8.2	0.25

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.5	1.5	1.5	1.5	0.18
50% LOAD (43.1 kg-f/cm2)	2.6	2.7	2.7	2.6	0.16
100% LOAD (86.1 kg-f/cm2)	5.2	5.0	5.1	5.0	0.15

BEARING NO:	78	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	54.9
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.6	1.4	1.4	1.3	1.4	1.4	0.17
50% LOAD (43.1 kg-f/cm2)	2.9	3.0	2.7	2.8	2.9	2.8	0.17
100% LOAD (86.1 kg-f/cm2)	6.0	5.8	6.2	6.1	6.0	5.9	0.18

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.8	0.8	0.8	0.8	0.10
50% LOAD (43.1 kg-f/cm2)	1.4	1.4	1.4	1.4	0.08
100% LOAD (86.1 kg-f/cm2)	2.7	2.7	2.7	2.6	0.08

BEARING NO:	79	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	54.9
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.6	1.5	1.4	1.6	1.5	1.5	0.19
50% LOAD (43.1 kg-f/cm2)	3.5	3.3	3.3	2.9	3.3	3.2	0.20
100% LOAD (86.1 kg-f/cm2)	5.4	5.3	5.2	4.9	5.2	5.0	0.16

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.9	0.9	0.9	0.9	0.11
50% LOAD (43.1 kg-f/cm2)	1.6	1.6	1.6	1.6	0.10
100% LOAD (86.1 kg-f/cm2)	3.1	3.1	3.1	3.0	0.09

BEARING NO:	80	LUBRICANT:	DRY
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	0.0
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.7	3.8	3.4	3.6	3.6	3.6	0.45
50% LOAD (43.1 kg-f/cm2)	7.2	7.3	7.4	6.8	7.2	7.1	0.44
100% LOAD (86.1 kg-f/cm2)	14.0	14.4	13.9	13.5	14.0	13.8	0.43

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.3	3.2	3.3	3.3	0.40
50% LOAD (43.1 kg-f/cm2)	6.6	6.5	6.6	6.5	0.40
100% LOAD (86.1 kg-f/cm2)	13.7	13.4	13.6	13.4	0.41

BEARING NO:	82	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	56.0
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.4	2.3	2.4	2.2	2.3	2.3	0.29
50% LOAD (43.1 kg-f/cm2)	4.6	5.1	4.5	4.9	4.8	4.7	0.29
100% LOAD (86.1 kg-f/cm2)	8.7	9.4	8.3	8.2	8.7	8.5	0.26

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	0.9	0.9	0.9	0.9	0.11
50% LOAD (43.1 kg-f/cm2)	1.7	1.7	1.7	1.6	0.10
100% LOAD (86.1 kg-f/cm2)	3.2	3.3	3.3	3.1	0.10

BEARING NO:	83	LUBRICANT:	PEANUT OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	56.0
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.1	2.2	2.1	1.7	2.0	2.0	0.24
50% LOAD (43.1 kg-f/cm2)	4.2	4.2	4.3	4.3	4.3	4.2	0.26
100% LOAD (86.1 kg-f/cm2)	7.9	7.4	7.9	8.4	7.9	7.8	0.24

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.0	1.0	1.0	1.0	0.12
50% LOAD (43.1 kg-f/cm2)	1.8	1.8	1.8	1.7	0.10
100% LOAD (86.1 kg-f/cm2)	3.3	3.4	3.4	3.2	0.10

BEARING NO:	84	LUBRICANT:	DRY
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	0.0
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.2	3.2	3.0	3.3	3.2	3.2	0.39
50% LOAD (43.1 kg-f/cm2)	6.0	6.0	5.8	5.9	5.9	5.8	0.36
100% LOAD (86.1 kg-f/cm2)	10.8	10.8	9.8	10.3	10.4	10.3	0.32

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.6	2.8	2.7	2.7	0.33
50% LOAD (43.1 kg-f/cm2)	5.1	5.0	5.1	5.0	0.31
100% LOAD (86.1 kg-f/cm2)	8.6	8.4	8.5	8.3	0.26

BEARING NO:	85	LUBRICANT:	DRY
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	0.0
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.6	3.4	3.4	3.5	3.5	3.5	0.43
50% LOAD (43.1 kg-f/cm2)	6.7	6.9	7.0	6.9	6.9	6.8	0.42
100% LOAD (86.1 kg-f/cm2)	14.8	14.7	14.2	14.1	14.5	14.3	0.44

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.4	3.4	3.4	3.4	0.42
50% LOAD (43.1 kg-f/cm2)	6.9	7.0	7.0	6.9	0.43
100% LOAD (86.1 kg-f/cm2)	14.0	13.8	13.9	13.8	0.42

BEARING NO:	86	LUBRICANT:	PORK TALLOW
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	53.6
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.1	2.0	2.1	1.9	2.0	2.0	0.25
50% LOAD (43.1 kg-f/cm2)	4.6	4.7	4.2	4.3	4.5	4.4	0.27
100% LOAD (86.1 kg-f/cm2)	5.5	6.8	6.9	6.7	6.5	6.3	0.19

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.1	1.1	1.1	1.1	0.13
50% LOAD (43.1 kg-f/cm2)	1.8	1.7	1.8	1.7	0.10
100% LOAD (86.1 kg-f/cm2)	3.2	3.2	3.2	3.1	0.09

BEARING NO:	87	LUBRICANT:	PORK TALLOW
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	53.6
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.4	1.2	1.1	1.2	1.2	1.2	0.15
50% LOAD (43.1 kg-f/cm2)	3.1	3.0	2.6	2.6	2.8	2.8	0.17
100% LOAD (86.1 kg-f/cm2)	5.8	5.9	5.8	4.9	5.6	5.4	0.17

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.0	1.0	1.0	1.0	0.12
50% LOAD (43.1 kg-f/cm2)	1.7	1.7	1.7	1.7	0.10
100% LOAD (86.1 kg-f/cm2)	3.2	3.3	3.3	3.1	0.09

BEARING NO: 88
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 8.2
SPECIFIC GRAVITY: 0.64
LUBRICANT: MINERAL OIL USP
LUBE RETENTION (%): 53.8
AXLE: MILD STEEL #15

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.7	3.4	3.2	2.9	3.1	3.0	0.38
50% LOAD (43.1 kg-f/cm2)	5.2	4.7	6.0	5.5	5.4	5.3	0.33
100% LOAD (86.1 kg-f/cm2)	11.1	11.0	10.5	8.5	10.3	10.1	0.31

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.1	1.1	1.1	1.1	0.14
50% LOAD (43.1 kg-f/cm2)	2.1	2.1	2.1	2.0	0.13
100% LOAD (86.1 kg-f/cm2)	4.3	4.1	4.2	4.0	0.12

BEARING NO: 89
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 8.2
SPECIFIC GRAVITY: 0.64
LUBRICANT: MINERAL OIL USP
LUBE RETENTION (%): 53.8
AXLE: MILD STEEL #15

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	3.7	3.8	3.4	3.2	3.5	3.5	0.43
50% LOAD (43.1 kg-f/cm2)	6.3	7.3	7.1	6.6	6.8	6.8	0.42
100% LOAD (86.1 kg-f/cm2)	11.9	12.8	12.1	12.7	12.4	12.2	0.38

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.3	1.3	1.3	1.3	0.17
50% LOAD (43.1 kg-f/cm2)	2.4	2.5	2.5	2.4	0.15
100% LOAD (86.1 kg-f/cm2)	4.9	4.7	4.8	4.7	0.14

BEARING NO: 90
WOOD TYPE: MAPLE
MOISTURE CONTENT (%): 8.2
SPECIFIC GRAVITY: 0.64
LUBRICANT: 30W MOTOR OIL
LUBE RETENTION (%): 39.7
AXLE: MILD STEEL #15

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	2.4	2.5	2.5	2.5	2.5	2.4	0.30
50% LOAD (43.1 kg-f/cm2)	4.4	4.5	4.3	4.5	4.4	4.3	0.27
100% LOAD (86.1 kg-f/cm2)	8.1	7.4	7.6	7.7	7.7	7.5	0.23

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.1	1.1	1.1	1.1	0.13
50% LOAD (43.1 kg-f/cm2)	2.0	2.1	2.1	2.0	0.12
100% LOAD (86.1 kg-f/cm2)	4.1	4.2	4.2	4.0	0.12

BEARING NO:	91	LUBRICANT:	30W MOTOR OIL
WOOD TYPE:	MAPLE	LUBE RETENTION (%):	39.7
MOISTURE CONTENT (%):	8.2	AXLE:	MILD STEEL #15
SPECIFIC GRAVITY:	0.64		

STATIC FRICTION	1 (kg)	2 (kg)	3 (kg)	4(kg)	AVG	CORR	COEFF
(21.5 kg-f/cm2)	1.5	1.4	1.4	1.4	1.4	1.4	0.17
(43.1 kg-f/cm2)	2.9	3.0	3.1	3.1	3.0	3.0	0.18
(86.1 kg-f/cm2)	6.8	6.8	7.3	7.3	7.1	6.9	0.21

DYNAMIC FRICTION	1 (kg)	2 (kg)	AVG	CORR	COEFF
25% LOAD (21.5 kg-f/cm2)	1.3	1.3	1.3	1.3	0.16
50% LOAD (43.1 kg-f/cm2)	2.4	2.4	2.4	2.4	0.15
100% LOAD (86.1 kg-f/cm2)	4.8	4.8	4.8	4.6	0.14

BEARING NO:	94	LUBRICANT:	OLIVE OIL
WOOD TYPE:	BASSWOOD	LUBE RETENTION (g):	154.5
MOISTURE CONTENT (%):	8.9	LUBE RETENTION (%):	158.0
SPECIFIC GRAVITY:	0.36	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #12	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			59.27	59.41	59.340	0.000
450	0.03	16			59.27	59.39	59.330	0.010
2980	0.18	16			59.25	59.38	59.315	0.025
10438	0.62	23	57	34	59.19	59.37	59.280	0.060
20231	1.21	26	63	37	59.12	59.29	59.205	0.135
34313	2.05	26	65	39	59.08	59.26	59.168	0.172
63598	3.81	24	63	39	59.05	59.24	59.145	0.195
123306	7.38	23	64	41	58.99	59.17	59.080	0.260
184284	11.03	26	62	36	58.97	59.15	59.060	0.280
253186	15.15	22	53	31	58.95	59.13	59.040	0.300
296223	17.73	27	56	29	58.95	59.13	59.040	0.300
374385	22.41	18	49	31	58.95	59.13	59.040	0.300
423277	25.33	23	51	28	58.93	59.11	59.020	0.320
513617	30.74	17	47	30	58.93	59.11	59.020	0.320
580506	34.74	19	48	29	58.93	59.11	59.020	0.320
648379	38.81	15	45	30	58.92	59.11	59.015	0.325
703930	42.13	16	41	25	58.92	59.10	59.010	0.330

BEARING NO:	95	LUBRICANT:	OLIVE OIL
WOOD TYPE:	BASSWOOD	LUBE RETENTION (g):	153.8
MOISTURE CONTENT (%):	8.9	LUBE RETENTION (%):	158.3
SPECIFIC GRAVITY:	0.36	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #12	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			59.46	59.45	59.455	0.000
450	0.03	16			59.45	59.43	59.440	0.015
2980	0.18	16			59.42	59.39	59.405	0.050
10438	0.62	23	55	32	59.42	59.26	59.340	0.115
20231	1.21	26	59	33	59.38	59.22	59.300	0.155
34313	2.05	26	59	33	59.35	59.19	59.270	0.185
63598	3.81	24	57	33	59.33	59.18	59.255	0.200
123306	7.38	23	57	34	59.30	59.13	59.215	0.240
184284	11.03	26	58	32	59.27	59.10	59.185	0.270
253186	15.15	22	51	29	59.25	59.07	59.160	0.295
296223	17.73	27	57	30	59.24	59.05	59.145	0.310
374385	22.41	18	46	28	59.23	59.05	59.140	0.315
423277	25.33	23	51	28	59.21	59.02	59.115	0.340
513617	30.74	17	44	27	59.21	59.02	59.115	0.340
580506	34.74	19	46	27	59.21	59.01	59.110	0.345
648379	38.81	15	44	29	59.20	59.01	59.105	0.350
703930	42.13	16	42	26	59.20	59.00	59.100	0.355

bearing OK

BEARING NO:	96	LUBRICANT:	OLIVE OIL
WOOD TYPE:	BASSWOOD	LUBE RETENTION (g):	147.8
MOISTURE CONTENT (%):	8.9	LUBE RETENTION (%):	152.1
SPECIFIC GRAVITY:	0.36	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #13	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	22			59.42	59.17	59.295	0.000
450	0.03	22			59.39	59.14	59.265	0.030
5176	0.31	20			59.40	59.12	59.260	0.035
19723	1.18	32	61	29	59.34	59.06	59.200	0.095
35742	2.14	29	60	31	59.33	59.05	59.190	0.105
111354	6.66	20	47	27	59.30	59.04	59.170	0.125
164061	9.82	26	52	26	59.29	59.03	59.160	0.135
250515	14.99	21	46	25	59.28	59.03	59.155	0.140
293644	17.57	27	50	23	59.28	59.02	59.150	0.145
380537	22.78	23	46	23	59.27	59.02	59.145	0.150
432585	25.89	28	51	23	59.27	59.02	59.145	0.150
511265	30.60	22	47	25	59.27	59.02	59.145	0.150
553491	33.13	26	48	22	59.27	59.02	59.145	0.150
643228	38.50	22	43	21	59.26	59.02	59.140	0.155
703780	42.12	26	46	20	59.26	59.01	59.135	0.160

bearing OK

BEARING NO:	97	LUBRICANT:	OLIVE OIL
WOOD TYPE:	BASSWOOD	LUBE RETENTION (g):	147.0
MOISTURE CONTENT (%):	8.9	LUBE RETENTION (%):	150.5
SPECIFIC GRAVITY:	0.36	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #13	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	22			59.75	59.74	59.745	0.000
450	0.03	22			59.73	59.70	59.715	0.030
5176	0.31	20			59.69	59.61	59.650	0.095
19723	1.18	32	68	36	59.58	59.53	59.555	0.190
35742	2.14	29	66	37	59.60	59.51	59.555	0.190
111354	6.66	20	56	36	59.58	59.48	59.530	0.215
164061	9.82	26	56	30	59.58	59.46	59.520	0.225
250515	14.99	21	50	29	59.58	59.45	59.515	0.230
293644	17.57	27	55	28	59.58	59.45	59.515	0.230
380537	22.78	23	49	26	59.58	59.45	59.515	0.230
432585	25.89	28	53	25	59.58	59.44	59.510	0.235
511265	30.60	22	48	26	59.58	59.44	59.510	0.235
553491	33.13	26	51	25	59.58	59.44	59.510	0.235
643228	38.50	22	47	25	59.57	59.44	59.505	0.240
703780	42.12	26	52	26	59.57	59.44	59.505	0.240

bearing OK

BEARING NO:	104	LUBRICANT:	OLIVE OIL
WOOD TYPE:	RED OAK	LUBE RETENTION (g):	73.4
MOISTURE CONTENT (%):	7.1	LUBE RETENTION (%):	47.3
SPECIFIC GRAVITY:	0.59	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #14	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			59.00	58.77	58.885	0.000
450	0.03	16			58.98	58.78	58.880	0.005
4672	0.28	16			58.67	58.92	58.795	0.090
14257	0.85	15	63	48	58.57	58.92	58.745	0.140
30829	1.85	23	59	36	58.53	58.92	58.725	0.160
53214	3.18	21	56	35	58.48	58.90	58.690	0.195
117899	7.06	18	49	31	58.45	58.88	58.665	0.220
159111	9.52	21	53	32	58.44	58.88	58.660	0.225
247535	14.81	19	49	30	58.44	58.88	58.660	0.225
376677	22.54	18	46	28	58.41	58.86	58.635	0.250
418390	25.04	23	49	26	58.40	58.85	58.625	0.260
505780	30.27	19	46	27	58.39	58.85	58.620	0.265
562812	33.68	26	63	37	58.37	58.82	58.595	0.290
638995	38.24	24	50	26	58.36	58.81	58.585	0.300
702440	42.04	24	48	24	58.35	58.81	58.580	0.305

bearing OK

BEARING NO:	105	LUBRICANT:	OLIVE OIL
WOOD TYPE:	RED OAK	LUBE RETENTION (g):	73.2
MOISTURE CONTENT (%):	7.1	LUBE RETENTION (%):	47.7
SPECIFIC GRAVITY:	0.59	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #14	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			58.96	58.99	58.975	0.000
450	0.03	16			58.92	59.01	58.965	0.010
4672	0.28	16			58.83	59.00	58.915	0.060
14611	0.87	15	54	39	58.81	58.98	58.895	0.080
79777	4.77	26	64	38	58.80	58.97	58.885	0.090
136372	8.16	27	70	43	58.78	58.96	58.870	0.105
211377	12.65	26	74	48	58.76	58.97	58.865	0.110
273604	16.38	26	77	51	58.69	58.98	58.835	0.140
336972	20.17	23	77	54	58.69	58.98	58.835	0.140
467225	27.96	25	81	56	58.67	58.98	58.825	0.150
517352	30.96	27	84	57	58.66	58.98	58.820	0.155
595994	35.67	22	75	53	58.62	58.96	58.790	0.185
639491	38.27	28	88	60	58.62	58.96	58.790	0.185
724687	43.37	22	79	57	58.57	58.90	58.735	0.240
758905	45.42	27	80	53	58.56	58.89	58.725	0.250
787277	47.12	26	78	52	58.55	58.89	58.720	0.255
859069	51.42	22	72	50	58.55	58.87	58.710	0.265
917375	54.90	22	73	51	58.54	58.86	58.700	0.275
1005012	60.15	23	76	53	58.53	58.86	58.695	0.280

bearing OK

BEARING NO:	108	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MUNINGA	LUBE RETENTION (g):	6.8
MOISTURE CONTENT (%):	8.4	LUBE RETENTION (%):	4.3
SPECIFIC GRAVITY:	0.62	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #14	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			58.91	58.65	58.780	0.000
450	0.03	16			58.91	58.62	58.765	0.015
4672	0.28	16			58.90	58.56	58.730	0.050
14257	0.85	15	58	43	58.88	58.54	58.710	0.070
31032	1.86	23	59	36	58.86	58.50	58.680	0.100
92005	5.51	26	61	35	58.84	58.43	58.635	0.145
155373	9.30	23	60	37	58.83	58.41	58.620	0.160
285621	17.09	25	81	56	58.77	58.34	58.555	0.225
335753	20.09	27	85	58	58.75	58.32	58.535	0.245
414395	24.80	22	77	55	58.74	58.30	58.520	0.260
457892	27.40	28	83	55	58.71	58.26	58.485	0.295
543088	32.50	22	83	61	58.50	58.03	58.265	0.515
577306	34.55	27	78	51	55.36	54.93	55.145	3.635
605678	36.25	26	74	48	54.20	53.73	53.965	4.815
677470	40.55	22	97	75	53.17	52.75	52.960	5.820
735776	44.04	22	76	54	53.15	52.71	52.930	5.850
823413	49.28	23	78	55	53.08	52.58	52.830	5.950

bearing failed by excessive wear

BEARING NO:	109	LUBRICANT:	OLIVE OIL
WOOD TYPE:	MUNINGA	LUBE RETENTION (g):	6.7
MOISTURE CONTENT (%):	8.4	LUBE RETENTION (%):	4.1
SPECIFIC GRAVITY:	0.62	LOAD (kg-f/cm2):	43.1
AXLE:	MILD STEEL #14	SPEED (m/min):	5.39

		TEMP (°C)			SIZE (mm)			
REVS	KM	AIR	BEARING	DIFF	A	B	AVG	WEAR
0	0.00	16			58.54	58.39	58.465	0.000
450	0.03	16			58.52	58.37	58.445	0.020
4672	0.28	16			58.47	58.29	58.380	0.085
14257	0.85	15	72	57	58.48	58.28	58.380	0.085
30829	1.85	23	59	36	58.45	58.24	58.345	0.120
53214	3.18	21	58	37	58.42	58.19	58.305	0.160
117899	7.06	18	48	30	58.39	58.12	58.255	0.210
159111	9.52	21	50	29	58.38	58.10	58.240	0.225
247535	14.81	19	49	30	58.34	58.07	58.205	0.260
376677	22.54	18	50	32	58.32	58.02	58.170	0.295
418390	25.04	23	57	34	58.31	58.02	58.165	0.300
505780	30.27	19	52	33	58.29	58.01	58.150	0.315
562812	33.68	26	71	45	58.29	58.00	58.145	0.320
638995	38.24	24	70	46	58.26	57.96	58.110	0.355
702440	42.04	24	73	49	58.22	57.93	58.075	0.390
768773	46.01	26	86	60	58.17	57.96	58.065	0.400
825368	49.40	27	77	50	58.15	57.94	58.045	0.420
900373	53.89	26	72	46	58.13	57.93	58.030	0.435

bearing OK