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DAMAGE ANALYSIS OF FRONT FINAL DRIVE PLANETARY GEAR BACKHOE LOADER CASE 580 SN

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Abstract. Today's technology continues to develop and these developments are applied to the field of heavy equipment, therefore it is necessary to analyze one of the components of the Backhoe Loader Case 580SN heavy equipment unit, namely the Front Final Drive Planetary Gear. The Backhoe Loader is one of the heavy equipment units designed to be able to carry out one of the functions and activities of the construction process which is heavy when carried out by human labor, such as: transporting, lifting, loading, moving, digging, mixing, and so on in an easy, fast, efficient and safe way. This research method analyzes and directs spaciousness, this is because this company has a lot of heavy equipment, one of which is the Backhoe Loader which is the object of research. The results of field analysis Damage to the Front Final Drive Planetary Gear Backhoe Loader Case 580 SN is caused by a lack of Final Drive lubricant when the unit is running, this is because the O-Ring Final Drive is wearing out so that the lubricant seeps out.

Keywords : Analysis, Front Final, Loader

1. INTRODUCTION

From time to time today's technology continues to develop and these developments are applied to the field of heavy equipment, therefore it is necessary to analyze one of the components of the Backhoe Loader Case 580SN heavy equipment unit, namely the Front Final Drive Planetary Gear. Backhoe Loader is one of the units. heavy equipment designed to be able to carry out one of the functions and activities of the construction process which is heavy when carried out by human power, such as: transporting, lifting, loading, moving, digging, mixing, and so on in an easy, fast, efficient and safe way. With a variety of heavy work so that this unit requires more power than speed, this unit uses a final drive called Planetary Gear. Based on the problem of damage to the Planetary Gear Front Final Drive system, it is necessary to analyze "Front Final Drive Planetary Gear Backhoe Loader Case 580 SN Damage".

In Indonesia, the term treatment itself was modified by the Ministry of Technology (now the Ministry of Trade and Industry) in April 1970 to become Terotechnology. The word terotechnology is taken from the Greek word Terein which means to care for, maintain and protect. Therotechnology is a combination of management, finance, engineering and other activities applied to physical assets to achieve economic life cycle costs. It deals with specifications and designs for reliability and maintenance of plant, machinery, equipment, buildings and structures, and their installation, testing, maintenance, modification and replacement with feedback on design, performance and cost information [1].

Maintenance engineering comes from the word Maintenance Engineering. Maintenance can be interpreted as an activity to keep things in perfect condition. Engineering can be defined as the application of scientific principles to practice in the form of design, construction and operation of structures, equipment and systems. Thus maintenance techniques can be interpreted as the application of science that aims to maintain the condition of an equipment or machine in perfect condition. So maintenance is an activity that aims to maintain the condition of the machine so that it continues to work optimally and prevent damage as early as possible by checking equipment periodically using the senses or with sophisticated tools.

1.1 Maintenance Engineering Strategy

According to Corder, A. S; and Kusnul, Hadi [1] The maintenance engineering strategies that are currently generally applied include:

1. Breakdown Maintenance
2. Periodic maintenance (Scheduled Maintenance)
3. Predictive Maintenance

1. Breakdown Maintenance

Breakdown Maintenance can be interpreted as a maintenance strategy by means of which the machine is operated until it breaks and then it is repaired. This strategy is very imprecise, not good, can result in high maintenance costs, loss of production due to machine shutdowns, work safety is not guaranteed, machine conditions cannot be known, and time, effort and maintenance costs cannot be planned. This technique is also known as Failure Based Maintenance or maintenance based on damage. This maintenance strategy is not suitable for machines that have a high critical level and is only suitable for simple machines and tools.

2. Periodic Maintenance

Periodic maintenance is part of preventive maintenance, namely maintenance to prevent further damage. Periodic maintenance is a maintenance strategy with the aim of preventing further damage which is carried out periodically within a certain period of time. This maintenance strategy is also known as time-based maintenance.

3. Predictive Maintenance

Predictive maintenance is also part of Preventive maintenance. This predictive maintenance can be interpreted as maintenance where the maintenance is based on the condition of the machine itself. To determine the condition of the machine, inspection or monitoring is carried out. If there are signs of damage, immediate corrective action is taken to prevent further damage. If there are no signs of damage, monitoring will continue so that if symptoms occur, they can be identified as soon as possible. Predictive maintenance is also known as condition based maintenance, also known as engine condition monitoring

1.2 Definition of Power Train

Power Train is a group of components that work together to transfer power from a power source or the force is produced to the place used to do work[2]. This definition may be analogous to the process of transporting goods or "Freight Train". Freight Train is a series of components of a locomotive and a car that moves cargo from where it is produced to where it is needed. The term Power Train is actually not new, it has been used since ancient times to define a component that transmits Power from one place to another. One of the units that uses the Power Train System is as shown in Figure 1.

Figure 1. Backhoe Loader (General Machine) [3]

1.3 Power Train Function

Power Train on a machine is a system and a series of components that transmit power from the Engine, from the Torque Converter to the Final Drive, to the wheels or Tracks.

The Power Train functions are:

1. Connect and disconnect power from Engine
2. Change the moving speed and torque
3. Change the direction of motion of the Machine
4. Equalize the power distributed to the drive wheels

1.4 Main Components of Power Train

Basically, the main components in the Power Train series of a heavy equipment consist of:

1. Engine

Serves as a source of prime mover to be forwarded to other movers.

2. Coupling/Clutch

According to Siwonto [3] Coupling/Clutch serves to connect power from the engine to the transmission. This component can also cut off the flow of power from the Engine. This allows the engine to run while the engine is idle. There are two types of couplings found in heavy equipment, namely Flywheel Clutch and Torque Converter. Flywheel Clutch is a component that connects the Engine with Transmission mechanically, this connection can be connected or disconnected according to the needs of the operator. While the Torque Converter is a component that connects the Engine with the Transmission both mechanically and hydraulically. However, there is no direct mechanical relationship between the Engine and Transmission.

3.Transmission

Function to change the power or rotation so that you get back and forth motion and change the speed according to the desired gear. The Transmission functions as:

a. Motion direction changer (forward and backward)
b. Motion speed changer (fast and slow)
c. Torque converter (big and small)

4. Gear Transfer

Transfer Gear is used to transmit power to the Differential and also to lower the rotational axis from the Torque Converter to the Transmission. Some heavy equipment, such as the Backhoe Loader, have two Differentials, namely the front and rear Differentials. The use of Transfer Gear in this case to divide the power to the front and rear Differentials. Depending on the placement position, there are two types of Transfer Gear, namely:

a. Input Transfer Gear, located between Torque Converter and Transmission
b. Transfer Gear Output, located between Transmission and Differential

5. Differential

This component serves to transmit power from Transmission to Final Drive and allows the wheels to rotate at different speeds when turning. Differential is used on the Wheel Type Machine (Machine that uses wheels) while on the Track Type Machine (Machine that uses Track) Bevel Gear is used.

6. Final Drive

The components of the Power Train System as the final mover are towards the wheels or Track. Its function is to multiply Torque/Reduce the final rotation which aims to get more power. The sequence from Power Train to Final Drive is as shown in Figure 2.

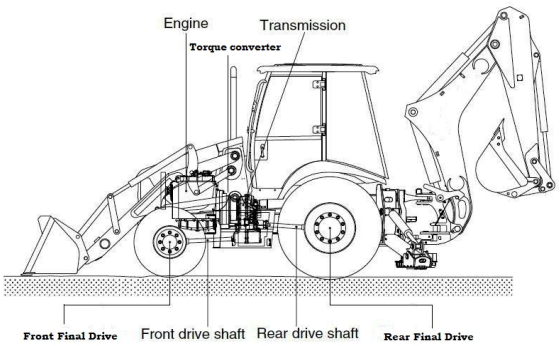

Figure 2. Power Train Backhoe Loader Components [4]

Backhoe Loader is a machine that uses a Drive Train Wheel Type Machine as shown above. Power Train components on this type of heavy equipment are:

a. Impeller Clutch Torque Converter
b. Gear Transfer Input
c. Transmission
d. Gear Transfer Output
e. Rear differential (not shown)
f. Rear Drive Shaft
g. Rear Final Drive
h. Front differential (not visible)
i. Front Drive Shaft
j. Front Final Drive

1.5 Planetary Gear System Transmission

The Planetary Gear system consists of three elements, namely: Sun Gear, Planet and Ring Gear. Sun Gear is located in the center of the Planetary Gear arrangement as a rotating shaft, then this Sun Gear is linked to the Planetary Gear, Planetary Gear can be three, four, and five pieces arranged on a frame called a Carrier. The Planet Gear rotates around the Sun Gear's central axis and is encircled by the Ring Gear. The Gear Ring acts like a fastener that holds the entire Gear Set in place. Most of the use of Planetary Gear is in the Transmission System which is used to change the direction of rotation so that it allows the unit to move forward or backward. There are two kinds of Planetary Gear, namely Planetary Single Pinion and Planetary Double Pinion.

1. Planetary Gear Single Pinion
   How it works when the Ring Gear is held down, the Planet Gear will rotate in the opposite direction to the Sun Gear and the Planet Gear will rotate around the Ring Gear. This is one of the applications on Planetary Gear Transmission to get a forward motion position by holding the Ring Gear, if as input the Sun Gear rotates to the right and as the output Planet Gear, the Planet Gear will rotate to the left around the Ring Gear. The Planetary Gear Single Pinion Type can be seen in Figure 3.

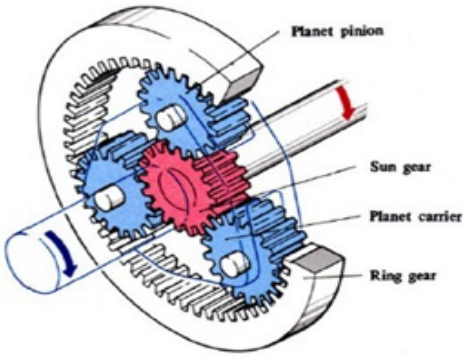

Figure 3. Planetary Gear Single Pinion Type [5]

2. Planetary Gear Dual Pinion Type
   In this system, if the Ring Gear is detained, the Carrier will fight with Sun Gea (Taufik, 2022). Applications of the Planetary Gear System as used for reverse motion (Reverse). That is Sun Gear as input rotation rotates to the right, Carrier as output will rotate to the left if the Ring Gear is held down. The Planetary Gear Dual Pinion Type can be seen in Figure 4.

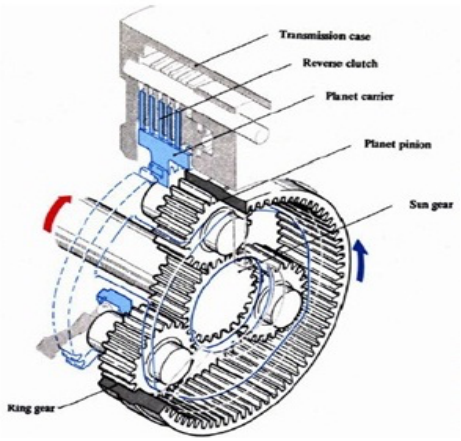

Figure 4. Planetary Gear Dual Pinion Type [5]

1.6 Planetary Gear System Final Drive

In the form of a set of straight gears and or a set of Planetary Gears as the final drive gear that serves to reduce rotation and increase torque on heavy equipment, such as Backhoe Loaders, Bulldozers, Dump Trucks, Wheel Loaders, and others. other. Final Drive has 2 parts, namely Front Final Drive and Rear Final Drive. The working

principle of Planetary Gear Final Drive is the same as the working principle of Planetary Gear on the transmission, where there is a reduction in rotational speed and an increase in torque by utilizing the difference in the number of teeth on the gear. The Planetary Gear Final Drive consists of three main components, namely Sun Gear, Planetary Gear and Ring Gear, of the three main components it is used to reduce rotation so that the final torque rotation becomes greater.

2. METHODS

This research method analyzes and directs spaciousness and interviews with mechanics, this is because this company has a lot of heavy equipment, one of which is the Backhoe Loader which is the object of research. The tools and materials used are as follows:

2.1 Tools

The tools used when conducting this research are as follows:

a. Shock Lock
b. Crocodile jack
c. Tire support
d. L key
e. Hammer
f. Snap pliers

2.2 Material

The materials used in this activity are as follows:

a. Planet Gear (3pcs)
b. Gasket Glue
c. O – Ring
d. SAE 140 (1 Liter) Oil
e. 1 unit Backhoe Loader

The materials used in the repair of the Planetary Gear Front Final Drive in this final project are as shown in Figure 5.

Planet Gear (3pcs)

Gasket Glue

O – Ring

Backhoe Loader

Figure 5. Materials used

2.3. Final Drive Planetary Gear Backhoe Loader Case 580 SN

The Backhoe Loader Case 580 SN unit uses Final Drive Planetary Gear both the front and rear wheels. Planetary Gear on the Backhoe Backhoe Loader Case 580 SN uses the Single Pinion type. The way it works is that the rotation that goes to the Final Drive is reduced (minimized) by the main Gear in it such as: Sun Gear, Planetary Gear, Ring Gear. So that the end result of the output rotation becomes smaller and the torque becomes

larger. On Final Drive 580 SN Sun Gear functions as input, then Planet Gear as an intermediary which is then forwarded to Ring Gear as output. The components of the Planetary Gear Single Pinion Final Drive consist of three main components as shown in Fig. 6 and Fig.7.

Figure 6. Sun Gear and Ring Gear

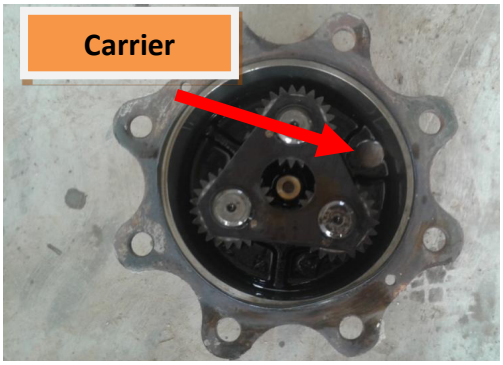

Figure 7. Planet Gear and Carrier

4. RESULTS AND DISCUSSION

4.1 How Front Final Drive Planetary Gears Work

In the Front Final Drive Planetary Gear Backhoe Loader Case 580 SN using the Single Pinion Planetary Gear type, the way it works is that the rotation that goes into the Final Drive is reduced (minimized) by the main gear inside, such as: Sun Gear, Planetary Gear, Ring Gear. So that the end result of the output rotation becomes smaller and the torque becomes larger. In Final Drive Backhoe Loader 580 SN Sun Gear functions as input, then Planet Gear as an intermediary which is then forwarded to Ring Gear as output. The components on the Planetary Gear Single Pinion Final Drive consist of three main components as shown in Figure 8.

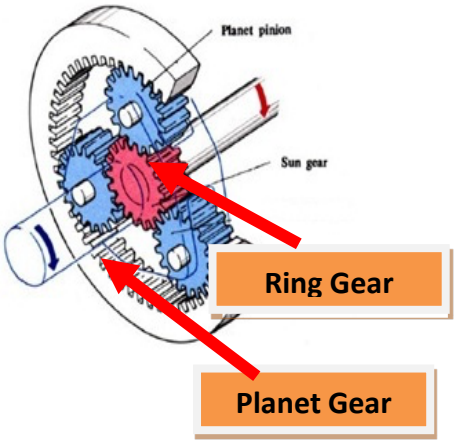

Figure 8. Planetary Gear Final Drive Components [5]

4.2 Identification of Damage

The damage that often occurs to the Planetary GearBackhoe Loader Case 580 SN component is that the teeth are damaged or fall out, this damage occurs due to a lack of maintenance carried out by the operator, namely not checking and maintaining the lubrication conditions in the Planetary Gear system such as checking for possible shortages in the amount of lubricant. [6][7]. Or the O-Ring on the Final Drive is damaged so that the lubricating oil becomes drastically reduced which results in the Planetary Gear components experiencing direct friction without getting lubrication. If not addressed immediately, this will cause more fatal damage, namely the teeth on the Front Final Drive Planetary Gear components will fall out and can even break so that it will greatly disturb the unit while operating, such as a loud noise when the unit is running or even the wheels on the damaged part. does not move at all if any of the Planetary Gear components are broken,[8] especially on Planetary Gear which often happens. To prevent damage to the Final Drive Planetary Gear, especially the Backhoe Loader Case 580 SN, the operator must carry out daily checks on the components of the unit being operated, one of which is the Final Drive Planetary Gear for possible damage to the O-Ring on the Final Drive which causes oil to seep out. so that the amount of oil in the Final Drive Planetary Gear is drastically reduced, in addition to doing regular maintenance by changing the Final Drive oil every 1000 working hours.[9].

4.3 Damage Analysis

After making repairs, the next step is to analyze the irregularities or damage that occurred in the Front Final Drive Planetary Gear Backhoe Loader 580 SN.

1. O-Ring Damaged

   Before making repairs, the first thing to do is to check for visual disturbances such as using sight or hearing. When the unit is running, there is a loud noise on the right front wheel which means there has been a disturbance in the Final Drive Planetary Gear, then an immediate inspection is carried out to see oil seeping out through the Final Drive Casing. after that, when the lubricant has been drained, the next step is to disassemble the Final Drive Planetary Gear components. At the time of disassembly it was seen that the O-Ring was damaged which resulted in Final Drive oil seeping out, the O-Ring damage was caused by dirt stuck to the Final Drive Casing while the unit was operating [10]. The damaged O-Ring can be seen in Figure 9. .

Figure 9. O-Ring Broken

2. Bram Mixed Lubricants

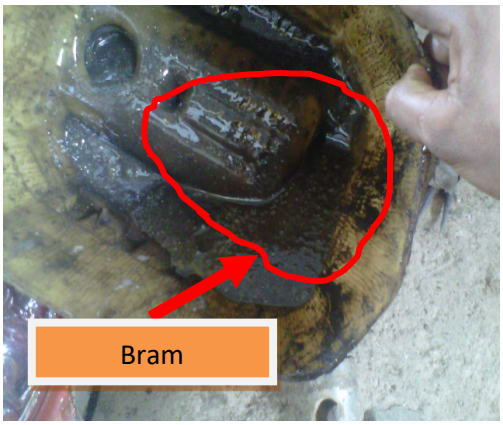

Figure 10. Oil already mixed with Brama

After draining the Planetary Gear Final Drive oil, there are a lot of brakes that have been mixed with oil, the brakes that have mixed with the Planetary Gear oil are due to direct friction on the Planetary Gear components when operating but experiencing a lack of lubricant caused by the O-Ring Final The drive is

damaged so the lubricant is seen seeping out during the previous inspection. The negligence of the operator who does not carry out routine daily checks on the operated unit, causes damage to the components of the Front Final Drive Planetary Gear which continue to operate when the unit is running [11][12][13]. The oil that has been mixed with bram can be seen in Figure 10.

3. The teeth on the planet gear are damaged

After disassembling the Planetary Gear and when doing an inspection, it turned out that the Planetary Gear was damaged where part of the teeth fell out. The damaged Planet Gear on the Backhoe Loader Case 580 SN causes a loud noise on the Front Final Drive when the unit is running, if in the long term no repairs are made it will cause the Planet Gear to break so the wheels cannot move when the unit is running [14]. This can also cause damage to other parts, especially the Sun Gear and Ring Gear which continue to experience friction with Planet Gear while operating. Damage that occurs to the Planetary Gear is caused by a lack of lubricant when the Planetary Gear components operate and excessive loads when the unit transports or pushes materials [15]. The Planet Gear that has experienced loss can be seen in Figure 4.7 below.

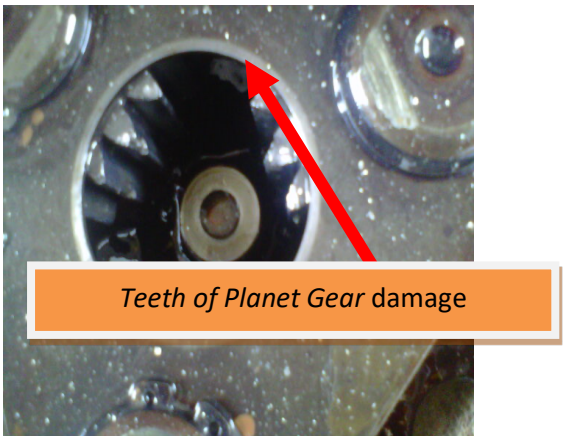

Figure 11. Planet Gear Broken

Based on the results of these inspections, where the Planetary Gear's teeth were damaged/lost severe enough so that the rotation of the Sun Gear could not be continued perfectly to move the Ring Gear which resulted in a noisy sound on the Planetary Gear's Front [15][16].Final Drive when the unit was running. Therefore, to overcome the damage that occurs, the Planetary Gear must be replaced with a new one when carrying out the process of reinstalling the Planetary Gear Front Final Drive components, unless the damage / loss that occurs is not too severe then if you just want to eliminate the noise on the Final Drive, simply replace the lubricant. use Grease / grease [17][18][19]. Replacement components are carried out so that the Planetary Gear can function optimally when continuing to rotate from the axle to drive the wheels, in addition to the damaged O-Ring Final Drive must also be replaced or given gasket glue to prevent similar damage where Planetary Gear lubricating oil seeps out of the Final. drives.[20].

5. CONCLUSION

From the research results obtained, for that there are several things that can be concluded, namely as follows:

1. To prevent premature damage, a daily inspection program (P2H) and periodic maintenance on the Front Final Drive Planetary Gear must be carried out, namely checking the condition of the Final Drive Planetary Gear components and changing the lubricating oil every 1000 working hours and carrying out daily inspections on the units operated in particular. on the Front Final Drive to prevent unforeseen damage.
2. If the Front Final Drive Planetary Gear component is damaged, it must be immediately replaced with a new one, if left unchecked this will cause noise and the wheels cannot move if any of the Planetary Gear components are broken so that it interferes with the operator while working.
3. Damage to the Front Final Drive Planetary Gear Backhoe Loader Case 580 SN is caused by a lack of Final Drive lubricant when the unit is running, this is because the O-Ring Final Drive is worn so that the lubricant seeps out. As a result, the Planetary Gear components experience high wear and friction so that the Planetary Gear is damaged/falls out which causes noise on the Front Final Drive when the unit is run.

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