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BLADE LIFT HYDRAULIC SYSTEM TROUBLESHOOTING ON KOMATSU D70-LE BULLDOZER (TROUBLESHOOTING SISTEM HIDROLIK BLADE LIFT PADA BULLDOZER KOMATSU D70-LE)

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Abstract

A bulldozer is one type of heavy equipment used for cutting, pushing, and spreading material. It has a blade on the front side whose movement is controlled by a hydraulic system. The movement of the blade, combined with the weight and travel momentum of the bulldozer, creates the mechanical power used in the bulldozer's function. Problems occurring in the hydraulic system could render the bulldozer useless. In this study, a Komatsu D70-LE bulldozer unit's hydraulic system is experiencing low power and cylinder drift, where the hydraulic cylinder cannot maintain its floating position and tends to return to its full-length rod position, thus causing the blade to drop on itself. This problem is then traced through the troubleshooting method to find the cause and solution to the problem. The cause of the low power problem in the lift cylinder is that the components of the lift cylinder have been worn out and damaged, resulting in a pressure leak in the lift cylinder, which causes the blade to drop by itself (hydraulic drift). The troubling components are the wear ring seal, piston ring seal, o-ring, dust seal, and rod seal. The way to solve the low power problem in the lift cylinder is to replace the lift cylinder seal kit with a new set of wear ring seal, piston ring seal, o-ring, dust seal, and rod seal.

Keywords: Bulldozer; Hydraulic; Komatsu D70-LE; System; Troubleshooting

Introduction

Heavy equipment is a mechanical device to assist humans in carrying out heavy material moving work (Peurifoy, Schexnayder, & Shapira, 2005). Initially developed for the construction sector, heavy equipment is then widely used in the mining industry (Haycraft, 2011). It is widely used to support the mining process, from opening mines, building roads, excavations, and even transporting mining materials to the next process (Mononen & Matilla, 2022).

One type of heavy equipment that is often used in the mining industry is a

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bulldozer. It is a chain tractor that is useful for digging, digging, pushing soil or material and pulling logs or portable camps that can be operated in various fields (UT School, 2008). Bulldozer is equipped with a blade on the front side. The movement of this blade is controlled with a hydraulic system. Bulldozers, equipped with a standard blade for pushing materials, can be enhanced with additional tools on the rear side. According to UT School (2008), one such attachment is the ripper, a spur-shaped device designed to break rock and hard earth into manageable chunks that can be subsequently pushed. Another useful addition is the winch, employed for pulling materials and commonly utilized in the forestry industry, particularly for the movement of timber logs. These supplementary attachments significantly expand the versatility and functionality of bulldozers in various applications.

For the bulldozer to work optimally it is necessary for the entire system to function properly. One system that supports bulldozer performance is the blade lift hydraulic system that raises and lowers the blade. The operator controls the blade position by lengthening or shortening the rod of the blade lift hydraulic cylinders through control levers in the bulldozer cabin (Ito, 1991) (Thariq, 2022). Blade position determines the amount of material pushed by the bulldozer, also an important features when working on an uneven terrain or when spreading material over an area. Because the blade is the main component for the bulldozer in carrying out work, interference with the blade control system can cause the bulldozer to become unusable (Uzny & Kutrowski,2019)(Zhou, Lingyu & Xiaoming, 2022).

One of the Komatsu D70 LE bulldozer units operated by PT Primanuka Nunukan experienced problems with the blade lift cylinder operations. The operator has difficulty maintaining the blade in a floating position, so the operator has to adjust the blade position repeatedly during work. This problem affects the work quality of the bulldozer because it is hard for the operator to maintain a smooth and steady blade position.

The purpose of troubleshooting in machinery maintenance is to localize various possible causes of machine trouble, as well as carry out repairs and prevent the same machine troubles from happening again (Prabowo, 2008) (Doddannavar & Barnard, 2005). Therefore, to restore the optimal performance of the bulldozer and prevent the same trouble from happening again, it is necessary to troubleshoot the blade lift hydraulic system (Yang, Xiao, & Ze, 2014).

Research Method

This research was carried out at PT Primanuka site Nunukan. The method of data collection carried out is as follows:

1. Literature Study
   The literature study stage aims to collect additional information relevant to the problem. Literature study helps the researcher to achieve a better understanding of the unit and the problem itself. The source of information comes from the shop manual and part book of the studied bulldozer unit, previous research articles, and the internet.
2. Field study

In the field study stage, direct observation o the troubleshooting process for problems with the Komatsu D70 LE hydraulic system blade lift is conducted. The activities carried out in the field study were observation, interviews and documentation.

3. Observation
   The observation stage aims to directly observe the bulldozer unit that is suspected of having a problem, while having the unit operating in the field. Through this stage, the information and data about the symptoms of the disorder that occurs can be obtained. At this stage a visual inspection was also carried out on the parts suspected to be related to the problem that occurred in the bulldozer unit. Furthermore, during this stage, observation of the preliminary testing, disassembly, inspection, part repair and/or replacement, assembly, and testing are conducted (Arifin, 2018).
4. Interview
   Interviews were conducted with the operator in charge of the bulldozer unit that was suspected of having a problem. The aim of the interview is to obtain facts about the problem experienced by the bulldozer.
5. Documentation
   The data and information obtained from field study are documented to make it easier in the data processing and analysis stages as well as writing reports later.

When working in the field, all workers and researchers are required to wear personal protective equipment such as a safety helmet, safety shoes, gloves, protective goggles, and a high-visibility vest.

Tools were also needed to carry out the removal, disassembly, and inspection of components suspected of being the source of the trouble. The tools that are prepared includes spanners, socket wrenches, pipe wrenches, hammer, chisel, set of slotted screwdriver and special tools. The research flow chart is shown in Figure 1.

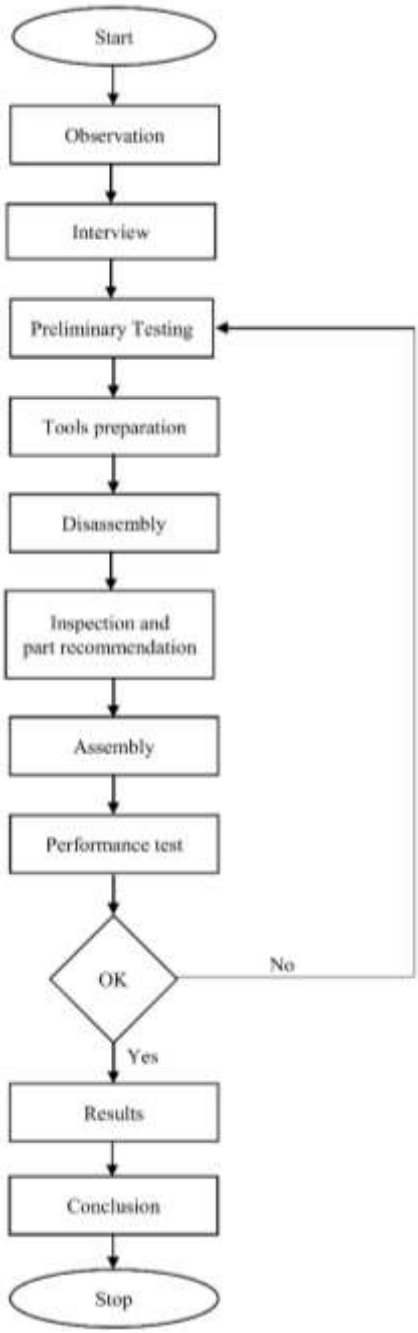

Figure 1. Flowchart

Results and Discussion

Observation

When carrying out field observations, the first thing to do is a visual inspection of the bulldozer unit and its hydraulic system components. Visual inspection is carried out on the following components:

1. Oil tank; this inspection aim to check the quality and quantity of hydraulic oil. During the inspection it is found that the unit has sufficient amount of hydraulic oil

and good quality.

2. Hydraulic pump; the visual inspection on the hydraulic pump shows the pump working properly and there are no oil leakage occurred.
3. Control valve; here are no leaks found on the control valve body and the control lever are functioning properly.
4. Hydraulic hoses and fitting; the inspection on the hydraulic hoses along the path for the blade lift cylinder shows no leakage, wheter from the hoses or the fittings.
5. Hydraulic cylinder; the inspection shows no leaks found around the cylinder. The cylinder rod is straight and smooth on the surface. The fittings and hoses for the hydraulic cylinders are also in good condition.

Interviews

Interviews were conducted with the operator who was working with the bulldozer when trouble occurred. The operator is also the one who reported the problem with the unit when it happened the first time. The results of interview is shown in Table 1.

Table 1
Results of interviews conducted with operators

No	Question	Answer
1	How many hours does this unit operate in one day?	8 hours per day
2	How is the condition of the unit when it is operated?	When the blade lift cylinder lever is pulled, the blade will automatically go up but slowly the blade will go down by itself even when the lever is in floating position
3	What steps do you take when the unit has trouble?	Stop the unit in a safe place and immediately report to the mechanic

Preliminary Testing

The preliminary testing was carried out to more precisely determine where the troubles in the Komatsu D70-LE bulldozer occured. Based on the report from the operator on duty, where there was a problem for him maintaining the bulldozer blade in floating position during the operation. The mechanic then checks and tests by operating the blade drive hydraulic system. The hydraulic control system functions properly, the actuator follows the input from the control levers. The problem appears when the control lever is left in the floating position, the blade will drop due to its own weight. This symptom shows that the lift cylinder cannot hold the blade position according to the command of the control lever. From the test result, it turned out that the problem was in the blade lift cylinder component. where the lift cylinder cannot maintain it's pressure, which resulted in the blade going down by itself (hydraulic drift). From the preliminary testing and the results of visual inspection it is concluded that the source of the trouble is in the blade lift cylinder. To correct this problem it is necessary to dismantle the blade lift hydraulic cylinder (Anhar & Faisal, 2021) (Simanjuntak & Novan, 2019)(Yang, Xiao, & Ze, 2014).

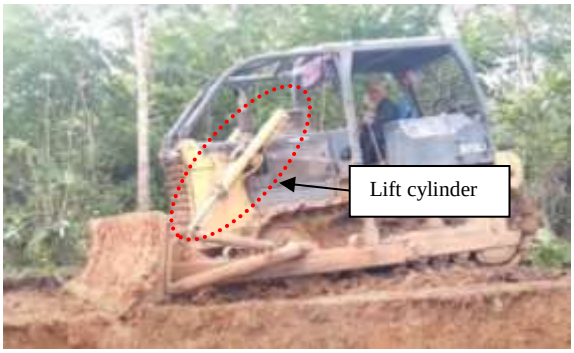

Figure 2. Blade lift hydraulic cylinder

Tools Preparation

Tools that are prepared for the disassembly work are spanners, socket wrenches, pipe wrenches, hammer, chisel, set of slotted screwdriver and special tools.

Disassembly

Disassembly aims to separate the components into smaller parts so as to facilitate the inspection stage. Disassembly must be done carefully so as not to cause new damage. Some components of the hydraulic cylinder are reusable and some are not which have to be replaced disregarding the condition of the hydraulic cylinder. Before removing the hydraulic cylinder, the system pressure must be relieved. The blade is rested on a solid base, the hydraulic fittings are released and the cylinder pins are removed. The hydraulic cylinder then removed from the blade and disassembled to reach the inner components of the hydraulic cylinder.

Figure 3. Dust seal removal

Inspection and Part Recomendation

The disassembled hydraulic cylinder parts were then inspected, and it was found that the cylinder seal kit components were damaged. The problem started with the delay in performing hydraulic oil changes. The service life of hydraulic oil that exceeds the standard service life will result in a decrease in the quality of quality, especially with regard to lubrication capabilities (Anhar & Faisal, 2021) (Simanjuntak & Novan, 2019). Hydraulic oil also serves to reduce friction and wear and tear, dissipate heat, and drain debris (cleaner) on the parts that mutual motion sliding (ASM International, 1992). This

matter corresponds to the results of visual observations internal elevator cylinder that is experiencing wear. Friction between internal components of the lift cylinder becomes excessive due to not maximizing lubrication. Periodic Service (PS) plays an important role in maintaining the performance of the unit, especially the hydraulic system and oil. More than 50% of hydraulic system problems hydraulic system are related to hydraulic oil (Doddannavar & Barnard, 2005) (Wen & Chuan, 2014).

The seal kit consists of a wear ring seal, piston ring seal, o-ring, dust seal, and rod seal. The damage to these components causes internal leakage in the lift cylinder, thus causing the lift cylinder to be unable to maintain the hydraulic pressure required to maintain the piston position. The mechanic made a part recommendation list to replace the damaged components. The recommended part should fulfill the manufacturer standard. The part number reference is shown in Figure 4 (D70 LE Lift Cylinder Part Number, n.d.).

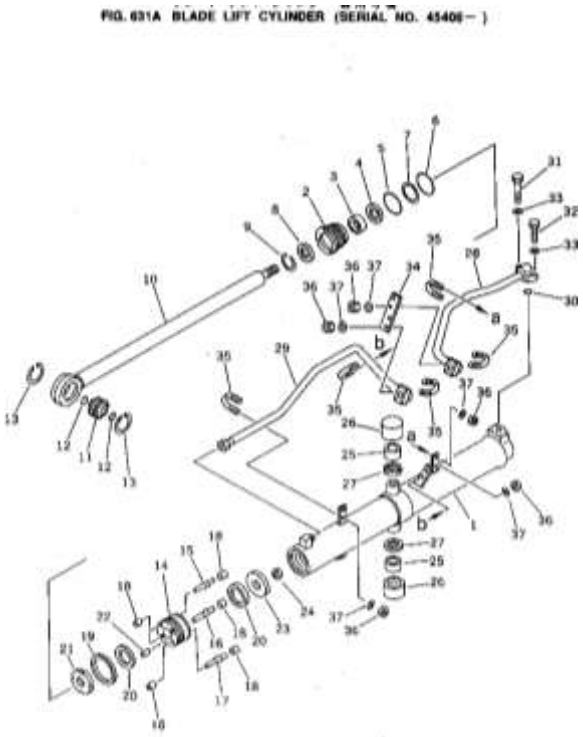

Figure 4. Part number reference

Assembly

Assembly is the process of assembling components into a ready-to-use form, returning to its initial form. After the hydraulic cylinder is assembled, it is then reinstalled on the bulldozer body and blade. The hydraulic hoses and fittings also reconnected. This process is done by following the manufacturer shop manual (Prabowo, 2008).

Figure 5. New wear seal on cylinder piston

Performance Test

After the installation is complete, a performance test is carried out on the repaired components. The bulldozer engine is started and allowed to reach its working temperature. Then, with the bulldozer stationary, the operator raises the blade until it hangs above the ground. This blade position is observed for approximately five minutes to see if the blade still descends on its own, this test indicates whether the internal leakage in the blade lift hydraulic cylinder is still occurring or not. After the results of this first test are considered satisfactory, the second test is conducted. The bulldozer is run forward and backward while maintaining the blade in a floating position. During the bulldozer's travel movement, the position of the blades is observed. If the blade remains in its designated position, then it is known that the internal leakage has been repaired. The result of the second test are also considered satisfactory, so the troubleshooting process is considered complete.

Conclusion

The research findings indicate that the low power in the lift cylinder is attributed to worn and damaged components within the lift cylinder seal kit, leading to an internal leak and hydraulic drift. The failing components include the wear ring seal, piston ring seal, o-ring, dust seal, and rod seal, primarily affected by wear, tear, and age. To address the low power issue, the recommended solution is the replacement of the lift cylinder seal kit with a new set. The author expresses gratitude to the Director of Politeknik Negeri Nunukan for their support in the paper's development and acknowledges family and colleagues for their assistance in completing the research.

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