Study on Modeling and Simulation of Leg Hydraulic System of Trailer Concrete Pump

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ABSTRACT

According to the working principle of leg hydraulic system of a trailer concrete pump, the simulation model of leg hydraulic system is established based on AMESim, and the dynamic characteristics of leg hydraulic system is analyzed. The research result indicates that with the gravity center moves to a leg, the pressure in the corresponding cylinder will increase, and the velocity of the rod will decrease. The greater the gravity center offsets, the greater the influence of the dynamic characteristics. In order to reduce the damage to the leg cylinder, the gravity center and the geometry center should be coincident as much as possible when using a trailer concrete pump.

INTRODUCTION

Trailer concrete pump mainly consists of pumping unit, lubrication system, washing system, leg system and chassis, etc. Usually, it is towed to construction site by concrete mixing vehicle, and by linking concrete delivering pipe with the outlet of trailer concrete pump, the concrete can be pumped out. Since it has some merits including high degree of mechanization, high construction efficiency, et al., it has been widely used in lots of construction engineering such as bridges, civil building.

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hydropower station, etc[1]. The function of leg hydraulic system of trailer concrete pump is to let all tires of concrete pump leave the ground and lift the entire concrete pump to avoid the impact of pumping load so as to guarantee the trailer concrete pump has enough safety and stability during pumping process. Therefore, it is important to study the dynamic characteristics of leg hydraulic system of trail concrete pump.

In recent years, there have been some literatures contributing to leg force of trailer concrete pump. An approximate method for calculating the force of legs of trailer concrete pump was put forward, and a method for calculating the maximum possible leg counterforce was proposed in [2]. The design procedure of the bear range of front legs was introduced in [3]. The leg counterforce and lift displacement was analyzed and corresponding calculation method was given in [4]. The calculate method and general calculation formula of leg counter force was discussed in [5].

The aim of this paper is to provide some reference for improving leg hydraulic system of trailer concrete pump. The remainder of this paper is organized as follows: In section 1, the working principle of leg hydraulic system was introduced. The simulation model of leg hydraulic system of trailer concrete pump was established based on AMESim in section 2. The simulation of leg hydraulic system of trailer concrete pump was fulfilled, furthermore, the dynamic characteristics of leg hydraulic system of trailer concrete pump was analyzed in section 3. Finally, conclusions and some future work are pointed out in section 4.

**WORKING PRINCIPLE OF LEG HYDRAULIC SYSTEM**

The leg hydraulic system is mainly composed of engine, hydraulic pump, and leg cylinders, etc., as shown in Fig. 1. When engine drives hydraulic pump, pressure oil enters into the rodless chamber of four leg cylinders, then the piston rod protrudes and lifts all tires off the ground. When all piston rods of four leg cylinders extend and make all tires leave the ground entirely, all direction valves keep center position, and by using hydraulic locks to ensure corresponding leg cylinder works in a stable position. When pumping work is finished, by changing the control signal of direction valves and the pressure oil enters into the rod chamber of four leg cylinders, then piston rods retract so that all tires of trailer concrete pump touch the ground.

**AMESIM MODEL OF LEG HYDRAULIC SYSTEM**

AMESim is an efficient modeling and simulation environment involving multi-fields such as hydraulic, mechanical, and control, etc., and it has been used successfully in lots of fields such as hybrid system, clean energy, renewable energy, et al [6]. By selecting corresponding components in hydraulic library, mechanical
library and control library, the AMESim model of leg hydraulic system of trailer concrete pump was established, as shown in Fig. 2.

**Figure 1.** Leg hydraulic system of concrete pump.
1-engine 2-hydraulic pump 3- relief valve 4-direction valve
5-hydraulic lock 6-leg vertical cylinders 7-tank

**Figure 2.** AMESim model of leg hydraulic system of concrete pump.

**RESULTS AND DISCUSS**

The simulation parameters for leg hydraulic system are as follows: for a certain trailer concrete pump, weight is 6800kg, transverse span and longitudinal span of four legs are 2000mm and 4000mm respectively. The rotational speed of engine and pump is both 1450 rev/min, and the displacement of pump is 75cc/rev. The cylinder diameter, rod diameter and stroke of leg cylinders are 180mm, 125mm and 800mm respectively. The position of the center of gravity of trailer concrete pump is shown in Figure 3. Where, y is the longitudinal coordinate axis, x is the transverse axis, O is the origin, c is the longitudinal eccentricity, e is transverse eccentricity.

**Figure 3.** The position of the center of gravity of trailer concrete pump.

When the center of gravity is at O and 1-8, the force of the leg hydraulic cylinder will be in a symmetrical state, so this paper only analyzes the dynamic
It can be seen that during the extending process, pressure in each cylinder is very low before 40 seconds. After 40 seconds pressure in each cylinder can be divided into two stages. Stage 1: Pressure rises slowly. Pressure in cylinder 3 is the biggest, pressure in cylinders 1 and 4 are equal but lower than pressure in cylinder 3, while pressure in cylinder 2 is the smallest. With the center of gravity moves from 9 to 11, pressure in cylinder 3 increases accordingly. Stage 2: pressure in each cylinder rises sharply, and it will last about 0.8 second. In addition, velocity of cylinder 3 slows down at first, and then rises quickly. Velocity of cylinder 1, 2 and 4 rises slowly. Where, velocity of cylinder 2 is the fastest, velocity of cylinder 1 and 4 is lower than that of cylinder 2, and velocity of cylinder 3 is the slowest. With the center of gravity moves from point 9 to point 11, velocity of cylinder 3 is greatly affected.

**CONCLUSIONS**

According to the working principle of leg hydraulic system of trailer concrete pump, the simulation model of leg hydraulic system of trailer concrete pump is
established based on AMESim, and the dynamic characteristics of leg hydraulic system of trailer concrete pump is analyzed. With the center of gravity moves towards one leg, the pressure in the corresponding leg will rise accordingly, and the extending speed of piston rod will decrease. The greater the center of gravity offset, the greater the influence of the dynamic characteristics of the leg cylinder. When using trailer concrete pump, in order to reduce the damage to leg cylinder, the center of gravity and the center of geometry should be coincident as much as possible.

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