IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 3 Ver. IV (May. - June. 2018), PP 01-05
www.iosrjournals.org

Design of Automobile Concrete Pump

TurabimanaPacifique
Assistant *Lecturer in Mechanical Engineering,*
Integrated Polytechnic Region College Gishari_ IPRC Gishari
Rwanda Polytechnic _ RP, Country: Rwanda
*Corresponding Author: * TurabimanaPacifique*

Abstract : *This paper has been written with the following objective; "design an automobile concrete pump uses hydraulic power to transport the concrete with high efficiency and safely". To reduce the accidents and increasing the construction efficiency related to time this machine should be the preferable to use. The hydraulic force from a prime mover is used to push the mixed concrete in a metallic pipe. This concrete pump performs to maximum height of 85m. After studying the currently available concrete pumps, three working conditions were chosen; a maximum working pressure of 74 bars, flow rate of 150 m3/ h and a load of 145040 N. The final wall thickness was, however, reached after considering the thickness of available hydraulic cylinders working under similar conditions. The thickness of cylinder was obtained to be 5 mm; with maximum working speed of 0.78 m/s and discharge of 150m3/h; similar design procedures were followed in designing the cylinder piston rod, which is 50 mm diameter and 800 mm length of hydraulic and concrete cylinder. With this simple and quick machine the time saving and quality construction structures will be done.*

Keywords *–Machine Design, Hydraulic system, diesel engine, and mechanicalstructures analysis with ANSYS.*

Date of Submission: 02-06-2018 Date of acceptance: 18-06-2018

I. Introduction

The process of transporting concrete is an important and determining step for the success of a construction works. It is necessary to run an effective and efficient transport to ensure that the concrete reaches its final destination in the prescribed conditions, i.e. without losing properties inherent to its fresh state and later its hardened state. The transportation of concrete shall be done with equipment suitable for the type of concrete, the distance between the place of production and the jobsite without accidents and a person smelt some poisons from the concrete. Hence the concrete transportation system is designed to avoid the above circumstances which the construction companies and their workers meet. Our design is automobile concrete pump which conveys concrete constantly through pipeline by using hydraulic pressure and mainly suitable for house building.

This System is different from the existing one called simple crane machine. That is why I write this research paper on automobile concrete pump, that will use hydraulic energy and consisting of hydraulic components (oil tank, oil filter, oil pump, direction control valve, prime mover, cylinders, pistons…), grate, hopper and pipeline. Hopper stores the flesh mixed concrete through grate and allows the concrete to enter into the cylinders by suction of one piston of cylinder when there is a delivery of concrete to another piston and both pistons are hydraulically operated.

II. Modeling of Systems

ENGINEERING ANALYSIS

Engineering analysis is the technique used in order to get the solution of the problem during the design. There are different methods used to solve the engineering problems. Like: Finite element method, exact solution method. In my system has mechanical and hydraulic components, I decide to use an approximate solution or finite element method to analyze elastic deformation, stress, forces, pressure, and deflections.

Mechanical components

Some of mechanical components of this system are selected and others are designed with consideration of many different factors and the need of improving the existing system. The basic mechanical component is concrete pump frame that accommodate the other equipment. A concrete cylinder sucked the concrete from the hopper and delivery of concrete to the concrete pipeline. A concrete cylinder is the same as hydraulic cylinder, but they are differenced by the materials of construction. The hydraulic cylinder has a plunger or piston moves linearly into the cylinder to produce work hydraulically.

TABLE 1: Concrete cylinder design parameters

Nº	Parameters	Values
1	Cylinder diameter	140 mm
2	Cylinder length	800 mm
3	Piston diameter	139.9 mm
4	Piston length	60 mm
5	Rod diameter	50 mm
6	Rod length	760 mm
7	Flow rate	140 m^3/h
8	Pressure	70 bars

The concrete cylinder construction materials have the favorable properties to the concrete. The internal surface of the cylinder presents the smoothness, resistance to corrosion and high pressure from a piston stroke. The medium steel is selected to be used for constructing the concrete cylinder.

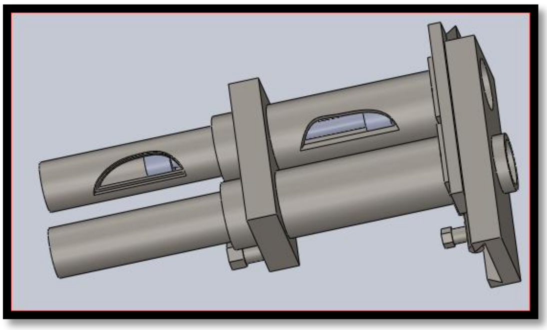

FIGURE1: Concrete Cylinder

After the concrete cylinder, there is hopper that receive the concrete before holding and sucking into the pumping cylinders, the swing tube is used to connect two cylinder with one pipeline where the concrete pass through to the delivery area.

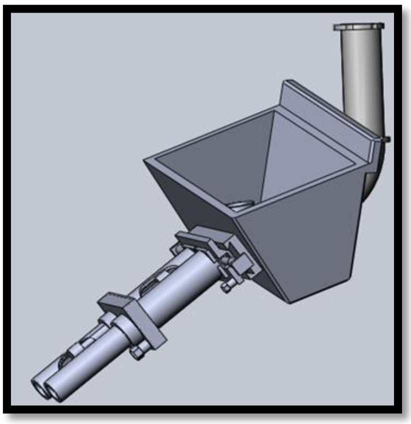

Figure 2: Assembly of mechanical parts

Hydraulic components

The hydraulic components used in this system are selected according to the function fulfilling in this concrete pump. The prime mover of the system is a diesel engine which is worked as usual in moving car and the heart of the system is a hydraulic pump. And the following table summarizes the parameters of axial pump selected.

TABLE 2: Axial piston pump parameters:

Nº	PARAMETERS	VALUES
1	Nominal displacement	8 cm^3/rev
2	Flow rate	150 m^3/h
3	Rotation speed	1420 rpm
4	Torque	11.36 Nm
5	Pressure	80 bar
6	Hydraulic Power	1.3333 Kw
8	Shaft power	1695.2 Nm
9	Overall efficiency	78.7%

HYDRAULIC PUMP, EQUATIONS

$\text{Hydraulic power} = Q \times \Delta$ *Where:* Δ *Flow rate and* *P: Pressure*

$\text{Shaft power} = \frac{2\pi NT}{60}$ *Where:* *N: Rotational speed of shaft and* *T: Torque input*

$$\text{Overall efficiency} = \frac{\text{Hydraulic power}}{ShaftPower} \times 100$$

Flow rate, Q= $n \times V \times \eta$ *Where: Q is flow in cubic meter per second* $[m^3/s]$ *, n is revolution per second [rev/s], V is swept volume in cubic meters* $[m^3]$*,and* η *is volumetric efficiency*

$$\eta_{mech} = \frac{T_{actual} \times 100}{T_{theoretical}}$$

Where: η_{mech} *is mechanical pump efficiency percent ,*$T_{theoritical}$*is theoretical torque to drive,* T_{actual} *is Actual torque to drive*

$$\eta_{hydr} = \frac{Q_{actual} \times 100}{Q_{theoretical}}$$

Where: $\eta hydr$ *: Hydraulic efficiency,* $Q_{theoretical}$ *is Theoretical flow rate outputand* Q_{actual} *is Actual flow rate output*

HYDRAULIC CYLINDER, EQUATIONS

Table 3: Hydraulic cylinder parameters

N°	*Parameters*	*Values*
1	Cylinder diameter	70 mm
1	Piston diameter	69.9 mm
2	Rod diameter	50 mm
6	Retraction speed	0.816 m/s
7	Extension speed	0.780 m/s
8	Retraction force	138602N
9	Extension force	145040N
10	Pressure	74 bar

$A_P: = \frac{\pi D^2}{4}$ *Where:*A_P*: Piston Area and* *D: Piston Diameter*

$A_R = \frac{\pi d^2}{4}$ *Where:* A_R*: Rod Area and* *d: Rod Diameter*

$F_f = P \times A_R$ *Where:* F_f*: Forward Force and* *P: Pressure*

$F_r = P \times (A_P - A_R)$ *Where:* F_r*: Retraction force*

$V_f = Q/A_R$ *Where:* V_f*: Forward speed Q: Flow rate*

$V_r = Q/(A_P - A_R)$ *Where:* V_r*: Retraction speed*

Power = P × Q

The hydraulic circuits

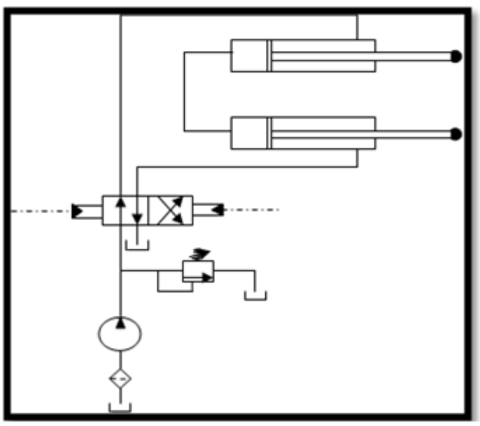

Figure 3:Hydraulic circuit commands concrete cylinders

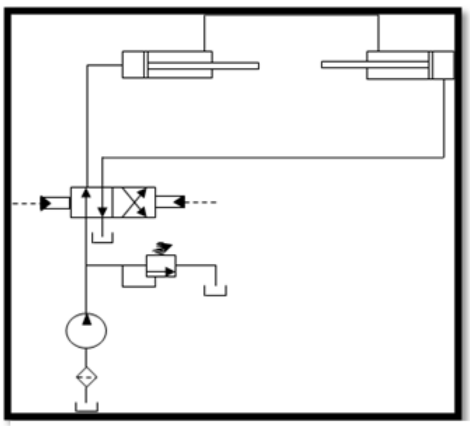

Figure 4: Hydraulic circuit commands swing tube

The bellow circuit combines together all mechanical parts and hydraulic parts. And shows how this automobile concrete pump works

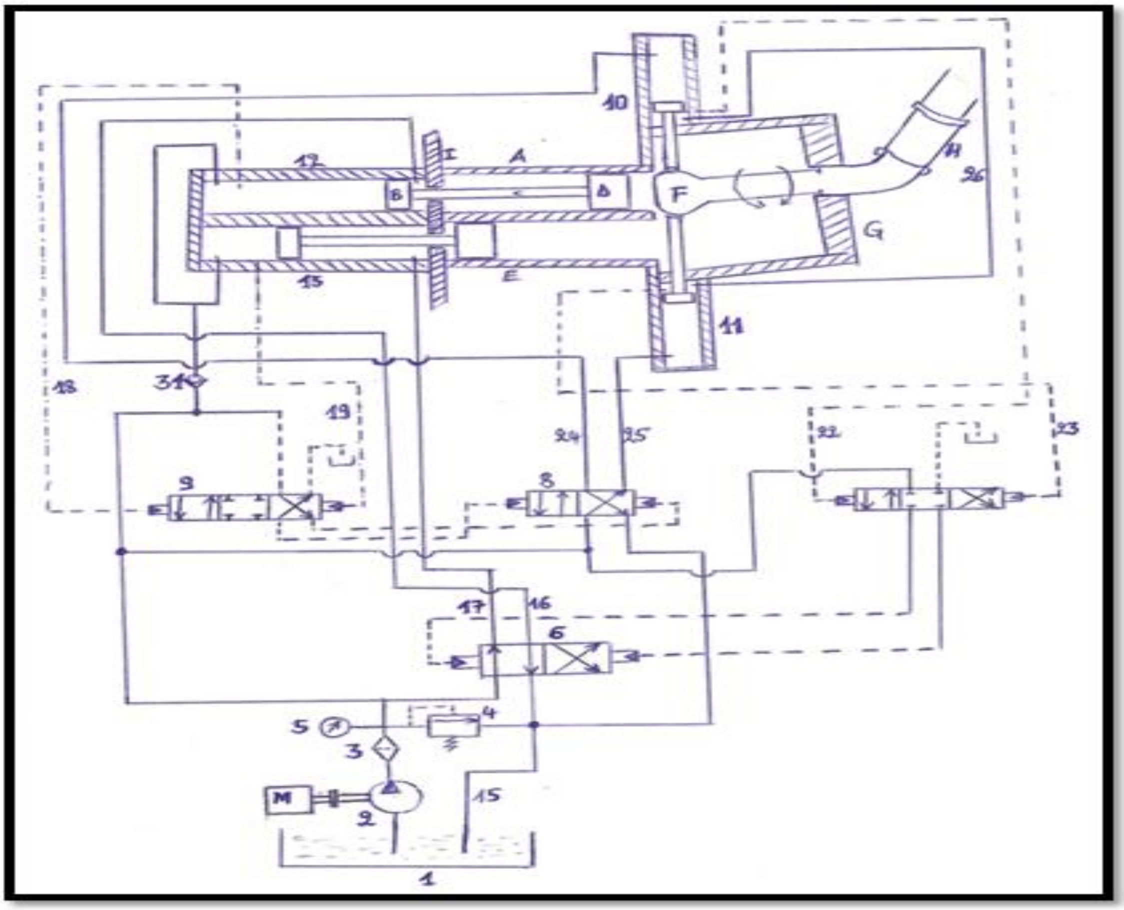

Figure 5: Combined circuit for both systems (Mechanical and Hydraulic)

WORKING PRINCIPLE OF THE SYSTEM

The pumping operation starts with the suction of concrete by concrete cylinder (E) and discharge of concrete by concrete cylinder (A), usually from a ready mix truck, into a hopper (G) large enough to hold a small supply of fresh concrete. In the hopper (G) an agitator keeps the fresh concrete flowing smoothly into the concrete pumping cylinders. Concrete piston pump (D) operate on the same principle as a twin cylinder reciprocating engine, in which one concrete cylinder (E) draws concrete from the hopper (G) on the return stroke and another concrete cylinder (A) pushes it on the forward stroke into the concrete pipeline (H) through swing tube (F). Pistons in both cylinders operate in opposite directions so there is constant pressure on the concrete in the concrete pipeline (H) and uninterrupted flow. The piston of concrete cylinder (A) is driven by piston of hydraulic cylinder (12) and piston of concrete cylinder (E) is driven by piston of hydraulic cylinder (13) which are powered by a hydraulic pump as clearly explained in operating principle of hydraulic circuit. Swing tube is sliding into a hopper and it has a function of connecting pipeline to a concrete cylinder when concrete is pushed out (concrete delivery from concrete cylinder). A swing tube is also hydraulically operated by using two small double acting cylinders (10, 11); its operation is shown in working principle of hydraulic circuit number four.

III. Conclusion

This design based on Automobile concrete pump, it provides an entry level low cost technology intended to initiate and accelerate the economic benefits of construction industries with the safety and best quality of their works. It is also improve performance of the concrete pump with respect to design goals compared to the existing systems. Its efficiency is also higher compared to the need inputs.

References

[1]. Allen, EA. (2009). Fundamentals of building construction materials and methods. Hoboken, NJ: John Wiley & Sons.
[2]. Applied hydraulic and pneumatic by V jayakumar
[3]. Bruus, H. (2007). Theoretical Microfluidics.
[4]. Concrete pumping and spry by Dr. Carlton Akeley. 1895. ISBN:0-7176-1068-3
[5]. http://hydraulicspneumatics.com/other-technologies/chapter-6-hydraulic-reservoirs
[6]. Kennedy, Rankin (1905). The Book of Modern Engines and Power Generators.
[7]. Modern Automotive technology by Verlag Europa-Lehrmittel, Nourney, Vollmer GmbH & Co. KG, 42781 Haan-Gruiten, Germany, 2006.
[8]. Oak, João, (2008). A little on the history of the concrete. DEC/UEM, Center of Technology Department of Civil Engineering, University of Maringa.
[9]. Parr, Andrew (2011). "Hydraulics and Pneumatics a technician's and engineer's guide", p. 38. Elsevier.
[10]. Robert Mark, Paul Hutchinson: "On the Structure of the Roman Pantheon", Art Bulletin, Vol. 68, No. 1 (1986), p. 26.
[11]. Robles, PE, Daniel. "Potable Water Pipe Condition Assessment for a High Rise Condominium in the Pacific Northwest". Community Engineering Services. Retrieved December 3, 2012.
[12]. S.C. Jain & C.R. Rai, (1999). Farm Tractor Maintenance and Repair, Second edition, ISBN: 81-86308-60-1. NaiSarak, Delhi.

Mr.TurabimanaPacifique."Design of Automobile Concrete Pump" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 15, no. 3, 2018, pp. 01-05