

Design of Test Rig for Cushioning Endurance Testing of Medium and Large Excavator Hydraulic Cylinders

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Abstract—Hydraulic cylinders are quite satisfactory, when used to drive small loads at low speeds, but when it is used to drive heavy loads at a high velocity, there is a danger of piston hitting the cylinder head at the end of the stroke with a large force thereby inducing high stress in the cylinder body and destroying the cylinder. In some extreme cases the kinetic energy may be large enough to pull the piston off the cylinder. Hence, hydraulic cylinders when used to drive heavy loads at high velocities need to be decelerated. Hence cushioning is required, for this purpose we are designing a test rig.

Keywords—*Hydraulic cylinder; Cushioning; Design; Test rig*

I. INTRODUCTION

The cylinders, before they are used in the actual application, should be tested thoroughly. A testing rig is an apparatus used for assessing the performance of a piece of mechanical or electrical equipment. The basic purpose of designing this rig is for endurance test of cushioning durability, because when hydraulic cylinder is operated there are chances of piston hitting the cylinder at high velocity both at head end and cap end i.e. at the end of the stroke. In such cases when piston hits at high velocity at the end of the stroke, it induces stress in other components as well, resulting in wear and tear. Thus, reducing life of the parts and it also causes ergonomic related problems to the person who is operating the excavator machine. To avoid these problems and to increase cushioning durability, the test rig is designed.

The test rig replicates the actual working conditions in which the cylinder is supposed to work. The test rig may be used for fatigue analysis or to check the performance of the cylinder under high temperature or to check the performance of the cylinder under specific kinds of loads. The test rig taken up in this study will be used to test the cushioning performance of a cylinder which will be used in the medium and large excavators.

“Modelling and Analysis of an Auto adjustable stroke End Cushioning Device for Hydraulic Cylinders” by C. Schwartz, V.J. De Negri and J.V. Climaco - This paper describes the theoretical experimental study of an auto- adjustable stroke end cushioning device utilized in hydraulic cylinders, focussing the characterization of the bush geometry effect on the cushioning achieved. A non linear model is presented which includes the physical phenomena that exert a significant influence on the performance of this hydraulic component such as: friction, fluid compressibility and pressure energy loss in the cushioning section. The model is validated through the comparison between theoretical and experimental results, under different conditions of load, supply pressure and piston speed. From this point it is possible to obtain a model applicable for the design of stroke end cushioning devices in hydraulic cylinders, consequent contributions related to proportional directional valves modeling are also presented”

“Fixture and Setup Planning and Fixture Configuration System” by Rétfalvi Attila, Michael Stampfer, Szegh Imre - 2212-8271 © 2013 Science direct - In this paper a fixture planning and design system is presented, which makes the work of the process engineer easier and quicker.

“Design and manufacturing of 8 cylinder hydraulic fixture for boring yoke on VMC – 1050” by Chetankumar M. Patel, Dr.G.D.Acharya - 2212-0173 © 2014 ScienceDirect - This Paper gives utility of hydraulics in fixture design in three different ways: (i) reduces cycle time, (ii) reduces operator fatigue and increases productivity and (iii) reduces wear and tear of fixture components.

III. METHODOLOGY

It involves three Parts namely design of design of test rig, hydraulic system and instrumentation and control part which are explained in further sections.

A. DESIGN OF TEST RIG

An apparatus used for assessing the performance of a piece of mechanical or electrical equipment is known as test rig. It consists of a mechanical fixture to accommodate and withstand high impact generated by the cylinders during endurance test. A Fixture is a work holding device used in the manufacturing industries. Fixtures are used to securely locate the position or location and to support the work, ensured that all parts produced using the fixture will maintain conformity and interchange ability. Using this fixture improves the economy of production by allowing smooth operation and quick transition from part to part production.

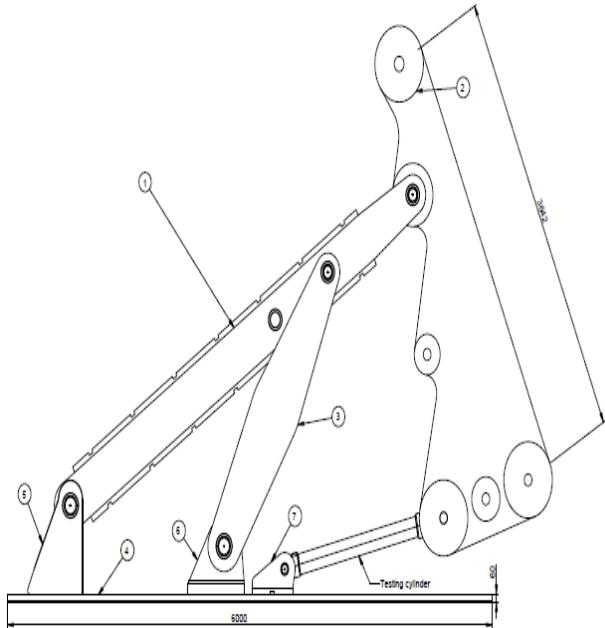


Fig 1: Design model of test rig

This test rig consists of a base which is placed on a concrete foundation and is locked with bolts and nuts. It consists of fixture for cylinder mounting on which testing cylinder is laid, swinging structure, arms to support the fixture for cylinder mounting, rear base, front rear base and fabricated base structure, the solid model is created using PRO E software as per dimensions.

Sl no	Components
1	Fixture for cylinder mounting
2	Swinging structure
3	Arms
4	Base
5	Rear base
6	Front rear base
7	Fabricated base structure

Table 1: Name of individual parts

The design model is created as per dimensions through modeling software.

B. HYDRAULIC SYSTEM

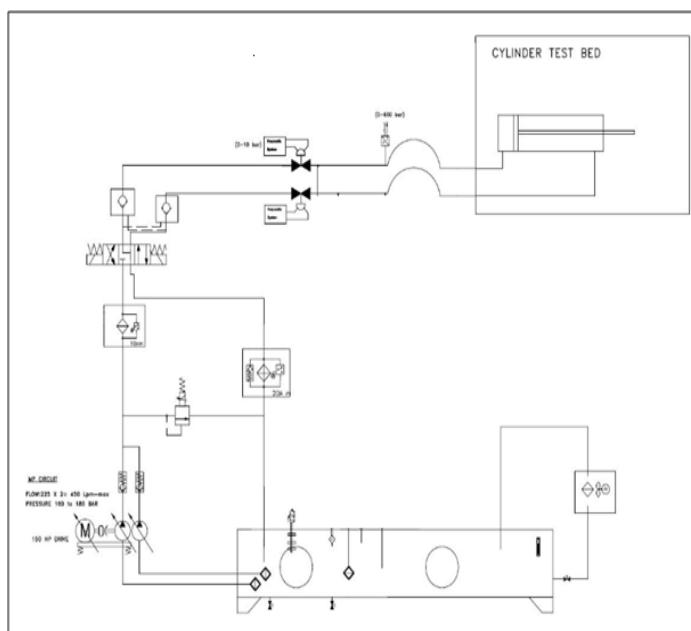


Fig 2: Hydraulic Circuit

Hydraulic circuit used for present test rig is shown in the fig 2. It consists of a reservoir to store and to circulate hydraulic fluid. Reservoir is connected to chiller for the purpose of cooling the circulated oil, from reservoir oil is supplied to cylinder by means of pump. The pump used here is double tandem type pump and pressure relief valves are provided to regulate the pressure and directional control valves which serve the purpose of control the direction of flow of oil in the cylinder bed.

It involves selection of accessories, pumps, valves and filters needed in the system. The pump used here for cushioning endurance testing is K3V112DT which is double tandem of pump so as to achieve the required testing conditions; directional control valve selected is 4WEH G32 which is electro hydraulic type of directional control valves (Rexroth). Reservoir used here has a capacity of 800 ltrs and motor capacity is 150 HP

All these components are connected by means of a manifold; a hydraulic manifold is a manifold which regulates the fluid flow between pumps and actuators and other components in hydraulic system

C. INSTRUMENTATION AND CONTROL

Instrumentation and control in this part includes the pressure sensor, displacement sensor for the purpose of recording the flow rate, oil temperature, and pressure required. It controlled through National Instrumentation (NI) laboratories so as to make the process automated

WIKA pressure transducer is used here for head end cushioning and cap end cushioning, temperature sensor to record the oil temperature

D. FOUNDATION

Mechanical fixture is laid on the concrete base. A layout design for concrete foundation is made as per the fixture dimensions and concrete base is laid on the floor. Safe rigid guard must be provided around the test rig.

REFERENCES

- [1] C. Schwartz, V.J. De Negri and J.V. Climaco "Modelling and Analysis of an Auto adjustable stroke End Cushioning Device for Hydraulic Cylinders"
- [2] Fixture and Setup Planning and Fixture Configuration System" by Rétfalvi Attila, Michael Stampfer, Szegh Imre - 2212-8271 © 2013 Science direct
- [3] Design and manufacturing of 8 cylinder hydraulic fixture for boring yoke on VMC – 1050" by Chetankumar M. Patel, Dr.G.D.Acharya - 2212-0173 © 2014 ScienceDirect
- [4] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.