



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: VI Month of publication: June 2017

DOI:

www.ijraset.com

Call: ☎ 08813907089

E-mail ID: ijraset@gmail.com

¹Assistant Professor, BLDEA CET Vijayapur

Keywords— *Prefill valve design, modelling, Analysis*

A valve is a mechanical device which regulates either the flow or pressure of the fluid. Its function can be stopping or starting the flow, controlling flow rate, diverting flow, preventing back flow, controlling or relieving pressure. In short, valve is nothing but a device which is necessary to control the oil energy. Pre-fill valve is Pilot-operated check valve which is designed to permit free flow in one direction and to block return flow, unless pilot pressure is applied. However, under pilot pressure, flow is permitted in both directions. It is used in hydraulic presses as pre-fill valve to permit the main ram to fill by gravity during the “fast approach” part of the stroke. Pre-fill valves are high pressure valves generally mounted on head side flange of large cylinders (300 mm to 1000 mm diameter). Fig.1 Shows the Hydraulic circuit of a one such hydraulic system where a pre-fill valve is used for pre filling the main ram during the operation

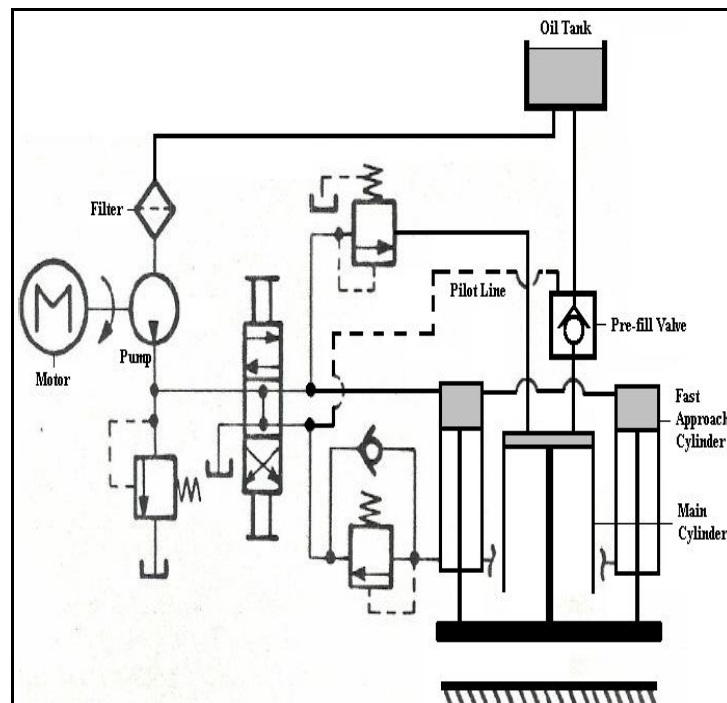


Fig.1 Hydraulic circuit of a hydraulic system

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

II. OBJECTIVE

The main objective of the study is to design the critical components of the sandwich type pre-fill valve for an operating pressure of 42 MPa and the size Equivalent to NG 200. Conventional sandwich pre-fill valves are available up to operating pressure of 31.5 MPa and size of NG 150. Stresses in intricate areas of the valve components are difficult to calculate using conventional formulae and methods. The FEA will more accurate picture in these areas. It will also help in optimizing these areas for better stresses, better machining and better flow paths.

III. MAIN PARTS OF A HIGH-PRESSURE PRE-FILL VALVE

The high pressure pre-fill valve consists of different parts which are assembled together to have the final assembly of the valve. Some parts of the valve, which are most important and for which the design is carried out are, pilot piston for applying the pilot pressure, valve poppet for flow control depending upon the system pressure, main spring for the popper to operate in the valve, pilot spring for the pilot piston, valve seat in a valve body etc. The Fig.2 shows all the necessary parts of a typical high pressure pre-fill valve.

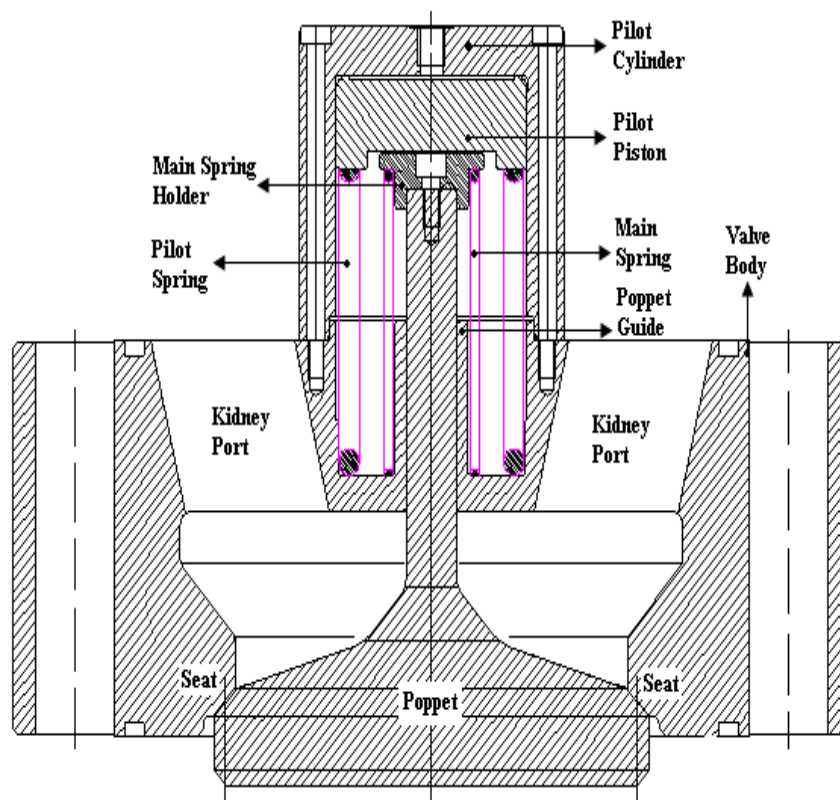


fig.2 Parts of a high-pressure pre-fill valve

Dimensions of Prefill Valve

The designing of the valve starts with the design of the body. Body design is the crucial part of the entire design, because designs of many other parts are depending on the design of the body

Diameter of Pilot Cylinder Bore $d=95\text{mm}$

Diameter of Poppet Stem $d=25\text{mm}$

Diameter of Poppet Seat Diameter $d=205\text{mm}$

Poppet Disc Thickness $t=37\text{mm}$

Seat Length $a=5\text{mm}$

Seat thickness $T=18\text{mm}$

Stroke Length for Poppet $L=42\text{mm}$

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

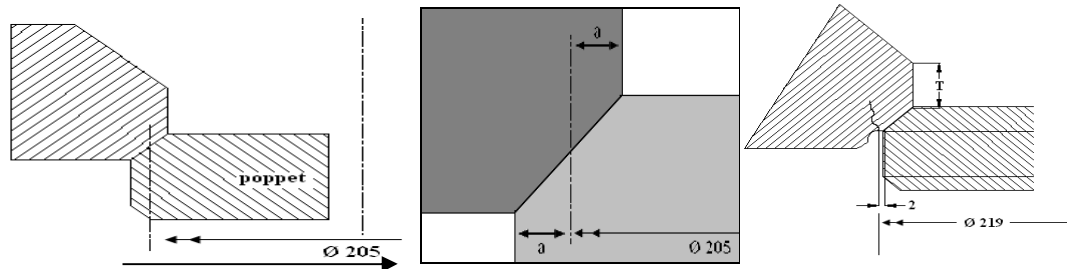


Fig.3 Cross sectional view of a valve seat

IV. FINAL DIMENSIONS OF A VALVE SEAT AND POPPET

During pre-filling the main cylinder of a heavy duty hydraulic press, due to the difference in pressure between supply tank which is at atmospheric pressure and the main cylinder, the oil will flow from supply tank into the main cylinder through pre-fill valve. Since the oil passes through pre-fill valve, apart from the calculated dimensions some profiles are also added to different of a valve components in order to have a smooth flow of oil when it passes through the pre-fill valve. Fig. 3.8 shows the dimensioned & profiled 2D sketch of a valve seat and the poppet.

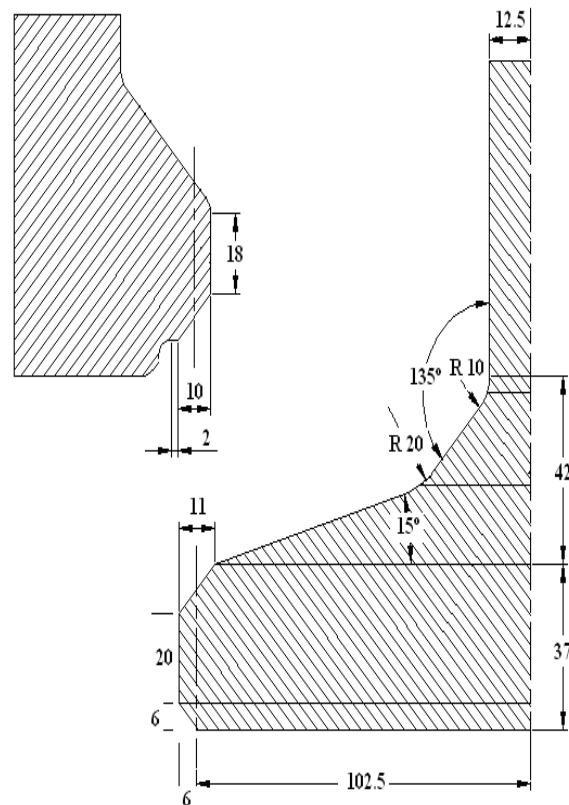


fig.4 Final dimensions of valve seat and the poppet

V. ANALYSIS OF VALVE POPPET

From the CAD drawing, a quarter part of the poppet model is created in CATIA software and then the model is saved in a cat.part file format so that, it can be directly imported into the Ansys software and carry out the required analysis. Fig.5 shows the meshed solid model of poppet in Ansys. Since, quarter part of the model is created and used to analyze, it has to be given a symmetrical boundary conditions in order to make it as a complete solid part. And then, in order to carry out the analysis, the boundary conditions and loads are applied to the Finite Element model and the problem is made to solve by the software.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

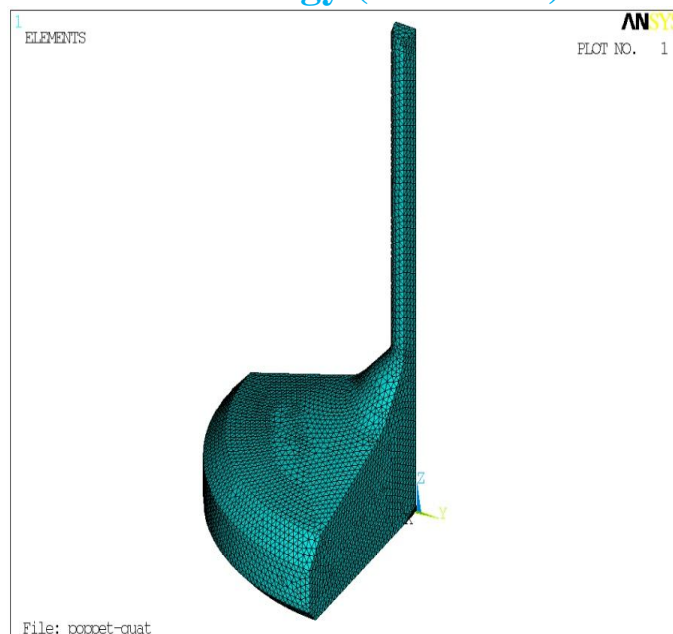


Figure.5 Finite Element model of a poppet

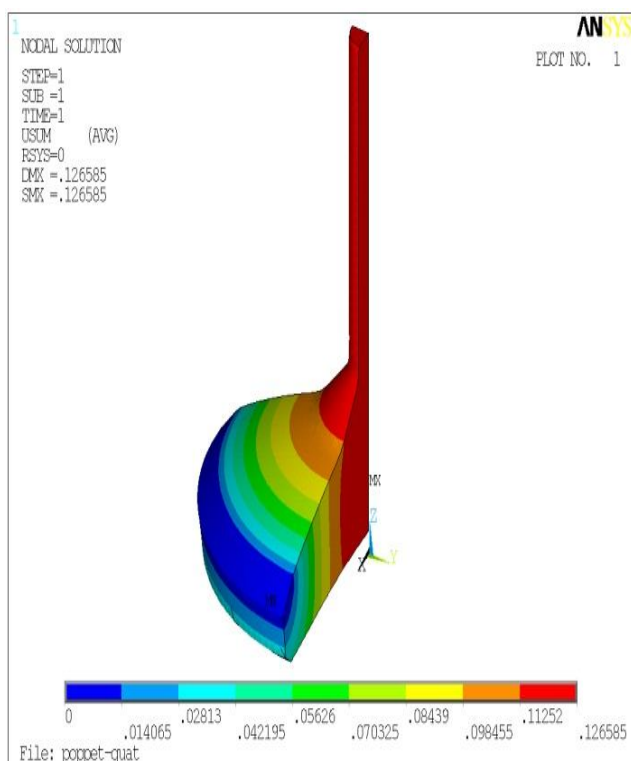


Fig.6 deformation result of poppet

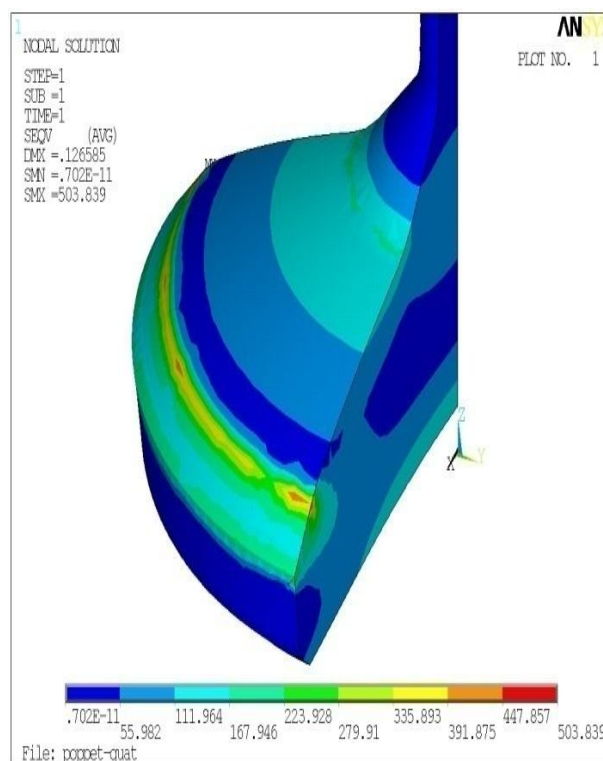


Fig.7 Vonmises stress distribution in poppet

The above obtained analysis results for different meshing are noted down and a graph is plotted. Fig.7 shows the graph of Number of Nodes Versus Maximum bending stress for the poppet.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

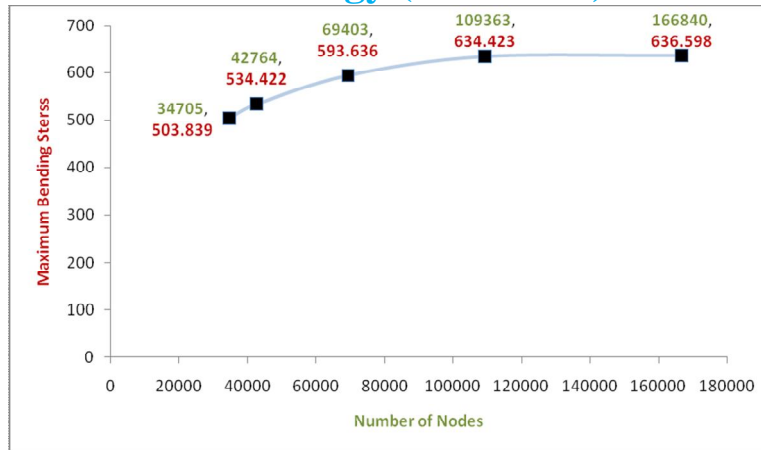


Figure.8 Graph of Number of Nodes Vs. Maximum bending stress

From above analysis results it is observed that the maximum bending stress induced due to a pressure of 42 MPa is 636.598 MPa, which is greater than the yield strength (578 MPa) of valve material selected. This is because of fixing the all degree of freedom on area which rests on the seat when the poppet is closed. But in actual condition which is not true. Therefore, the stresses of nodes near to the boundary which is showing maximum bending stresses are seen randomly and there average is taken. Fig.9 shows the bending stresses of randomly chosen nodes near to the boundary showing maximum stresses.

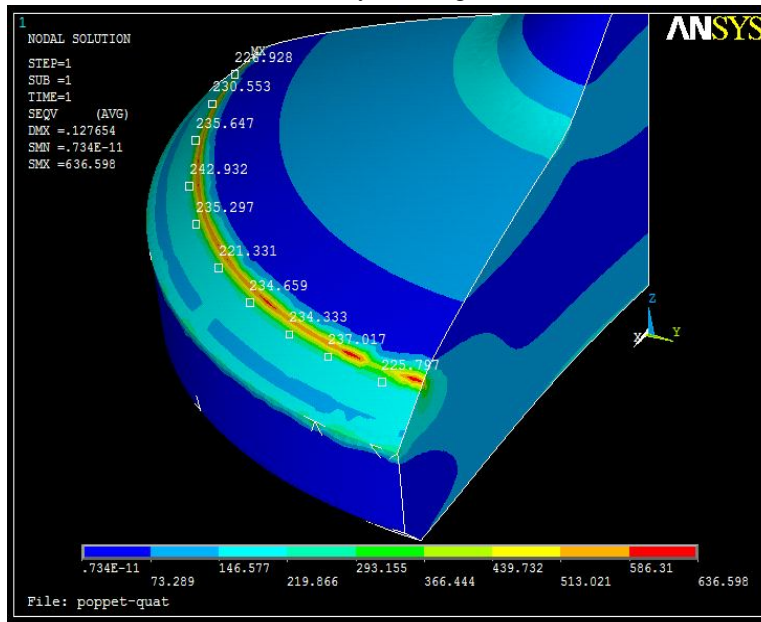


Figure.9 Bending stresses at randomly chosen nodes

The values of stress on randomly chosen nodes are 225.797, 237.017, 234.333, 234.659, 221.331, 235.297, 242.932, 235.647, 230.553 and 226.928 MPa.

Therefore, average bending stress is

$$\frac{225.797 + 237.017 + 234.333 + 234.659 + 221.331 + 235.297 + 242.932 + 235.647 + 230.553 + 226.928}{10}$$

$$= 232.449 \text{ MPa} \approx \sigma_{allow} \text{ (Safe)}$$

The average bending stress is almost equal to the allowable stress i.e. 231.2 MPa, the poppet is safe under bending.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

VI. ANALYSIS OF VALVE SEAT

Fig.10 show the meshed solid model of a valve body with a applied force of F/8 on the seat area and analysis results of a valve body respectively.

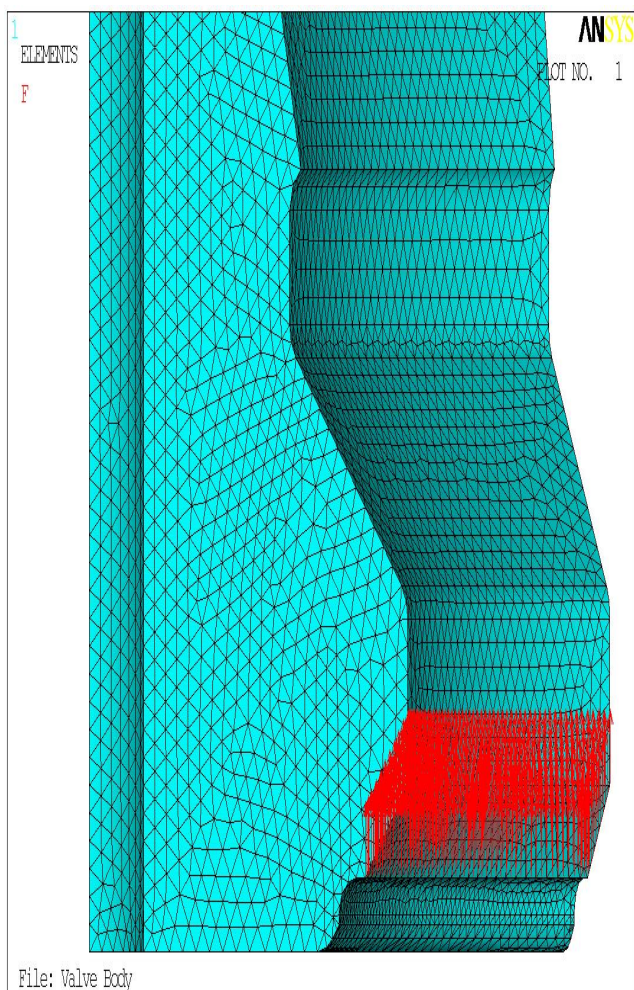


Fig .10 FE model of a valve body with force applied on valve seat
valve seat

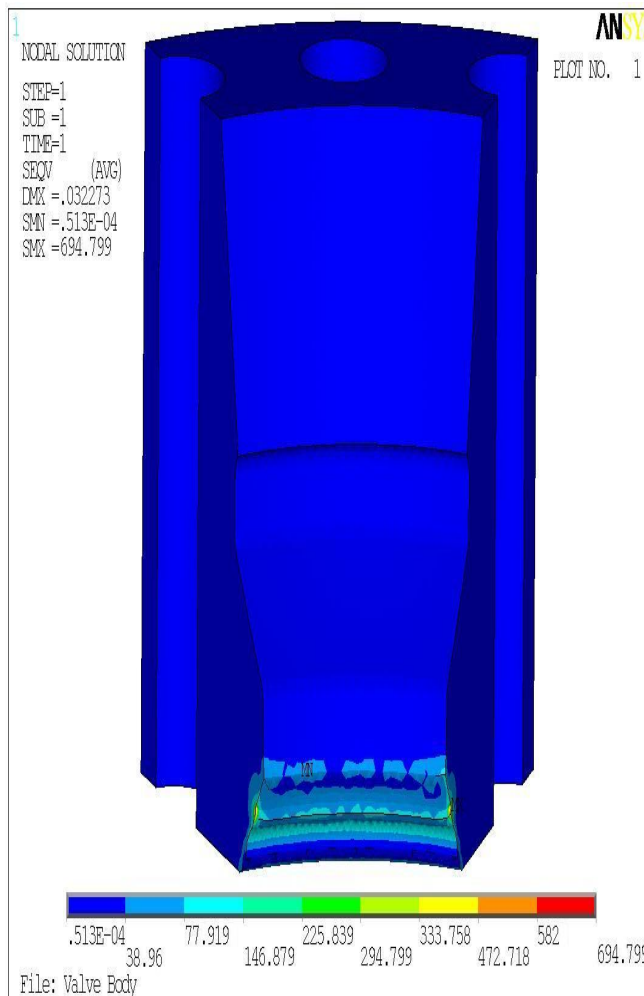


fig.11 Von-Mises stress distribution in

From fig.11 analysis results it is observed that the maximum bending stress induced due to applied force is 694.799 MPa, which is greater than the yield strength (578 MPa) of valve material selected, this stress is seen only at the ends of the model. But from figure it can be clearly observed that the bending stress in valve body is not exceeding the allowable stress i.e. 231.2 MPa except those two end corners. Hence the valve body and the seat are safe under bending.

VII. CONCLUSION

The present study involves the design of high pressure pre-fill valve as per the customer requirements for industrial applications. That is, the design is carried out for a valve operating pressure of 42 MPa and pilot cylinder operating pressure of 15 MPa. The analysis is carried out in ANSYS for some critical parts of the valve, comparisons are made between allowable stress of a valve material and ANSYS results and the following conclusions can be derived. The seat designed for the valve body is capable of taking the desired working pressure. That is, the maximum bending stress induced in a valve body for a specified operating pressure (42 MPa) is well within the allowable stress of a valve material.

REFERENCES

- [1] Industrial Hydraulics, John Pippenger, Tyler Hicks, Third Edition, Reprint 1980.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

- [2] Industrial Hydraulic Systems and Circuits, By Bhagwati Prasad Gupta, pp 8,132.
- [3] Oil Hydraulics Systems, Principles and Maintenance, S. R. Majumdar, Thirteenth Reprint 2006, pp 1-4, 13.
- [4] Module – 6, Actuators, Lesson - 24, Directional Control Valves, Switches and Gauges, Version 2 EE IIT , Kharagpur, pp 3 – 6.
- [5] HAWE Hydraulik catalogue, Check Valves and Pre-fill Valves, D 6960.
- [6] Steel Hand Book, Carbon, Stainless, Tool and Alloy Steel, German Standard Specifications, Edition 2002 – 2004.
- [7] Design Data Hand Book, for Mechanical Engineers, K. Mahadevan, K. Balaveera Reddy, Third Edition, Reprint 2005.
- [8] Machine Design, R. S. Khurmi, J. K. Gupta, Reprint 2005, pp. 537 – 540.
- [9] Indian Standard “Steel Wire for Mechanical Springs Specifications”, Part-2, Oil Hardened and Tempered Steel Wire, Second Edition, IS: 4454 (Part 2) : 2001.
- [10] Indian Standard “Helical Compression Springs”, Part-1, Design and Calculations for Springs Made From Circular Section Wire and Bar, IS: 7906 (Part 1) – 1976.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)