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Design of Hydraulic Fixture for Engine Side Cover

Nishikant A. Gunjarge[1], Shrikant M. Fulmali[2]
[1]PG Scholar, [2]Professor, Department of Mechanical Engineering,
Bapurao Deshmukh College of Engineering & Technology Sevagram, Wardha, Maharashtra, India

Abstract— A fixture is a work-holding device used in the manufacturing industry. Fixture's primary purpose is to create a secure mounting point for a work piece, allowing for support during operation and increased accuracy, precision, reliability, and interchange ability in the finished parts. This paper present design of hydraulic fixture for engine side cover. This component is a part of three wheeler auto. The operation to be performed is boring & spot facing on vertical milling machine (VMC). The evaluated fixture uses hydraulic pusher, hydraulic cylinders, and hydraulic work support for holding the work piece driven by hydraulic power pack. Thus the new fixture achieves automatic and simultaneous clamping of parts.
Keywords— Hydraulic Fixture, accuracy, clamping, productivity, VMC.

I. INTRODUCTION

A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. It is a production tool that locates, holds, and supports the work securely so the required machining operations can be performed. Fixtures have a much-wider scope of application than jigs. These work holders are designed for applications where the cutting tools cannot be guided as easily as a drill. With fixtures, an edge finder, centre finder, or gage blocks position the cutter. Examples of the more-common fixtures include milling fixtures, lathe fixtures, sawing fixtures, and grinding fixtures. Moreover, a fixture can be used in almost any operation that requires a precise relationship in the position of a tool to a work piece.

Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing operation. There are many standard work holding devices such as jaw chucks, machine vises, drill chucks, collets, etc. which are widely used in workshops and are usually kept in stock for general applications. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually. These work holding devices are collectively known as jigs and fixture. A fixture should be securely fastened to the table of the machine upon which the work is done. Though largely used on milling machines, fixtures are also designed to hold work for various operations on most of the standard machine tools. Fixtures vary in design from relatively simple tools to expensive, complicated devices. Fixtures also help to simplify metalworking operations performed on special equipment.

II. LITERATURE REVIEW

Komal Barge[1], Smita Bhise[2] (2015) This paper represented hydraulic fixtures for VMC, Implementation of this project eliminates the need of human operator for clamping of manifolds. It reduces the cycle time. It gives an economically feasible design of rest pad guide rod front pusher vee block rear resting block. Also ensures accurate & efficient clamping of parts. The suggested system helps in achieving sophisticated, precise, reliable, safe as well as accurate production methods. The clamping systems are designed such that they withstand the huge retention forces applied from the machining operations onto the work piece. The propose hydraulic fixture will fulfilled researcher production target and enhanced the efficiency, reduces operation time and increases productivity.

1 Mr. A. H. Nalbandh, 2 Prof. C. C. Rajyaguru (2002) Fixtures are used to locate, hold and support work pieces in manufacturing operations such as machining, inspection, and assembly. Researching the possibilities for fixture design optimization has been in the sphere of interest of a number of authors worldwide for a longer period. Genetic Algorithm method has been selected as optimization of fixture design. This paper presents a brief review of Fixture Design optimization and Genetic Algorithm integration in terms of fixture layout, clamping position and part deformation.

Sridharakeshava K. B. (2013) has discussed about the General Requirements of a Fixture which includes constraints of Deterministic location, contained deflection, geometric constraint in order to maintain the work piece stability during a machining process. They also discussed three broad stages of fixture design, Stage one deals with information gathering and analysis, Stage two involves product analysis, and Stage three involves design of fixture elements. Shailesh S.Pachbhai1, Laukik P.Raut2 (2014)

This paper represented hydraulic fixtures for VMC, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. The various methodology used for clamping operation used in different application by various authors are reviewed in this paper. Hydraulic fixture is required in various industries according to their application. This can be achieved by selecting the optimal location of fixturing elements such as locators and clamps. Fixtures reduce operation time and increases productivity and high quality of operation is possible. The efficiency and reliability of the fixture design has enhanced by the system and the result of the hydraulic fixture design has made more reasonable. The propose hydraulic fixture will fulfilled researcher production target and enhanced the efficiency, reduces operation time and increases productivity, high quality of operation, reduce accidents.

Kharmizan Binti Japar (2007) This research paper is focused on the designed of the jigs and fixture. This title had been suggested because of the problems that encounter during using the surface grinder which are the vibration of the long parts, the instability of the work piece and problems to grind the non magnetic material so that this kind material can be grinding the surface grinder machine. The some concept generations had been generated and do the sketching. The analysis using Finite element analysis is a computer simulation technique used in engineering analysis. It uses a numerical technique called the finite element method (FEM). Three phases in any computer-aided engineering task: pre processing(definition the finite element model and environmental factors to be applied to it),Analysis solver (solution of finite element model) and post processing of results (using visualization tools) will be used to analysis whether the drawing can be used or not.
S.D.V.V.S.B.Reddy (2013) Auther discussed about data required to design fixture, hydraulic fixture elements for transmission case, cutting force calculation and analysis of fixture body to check whether the fixture is withstanding the maximum cutting force during machining

Faiezul Bin Zainal (2007) The purpose of this project is to do the case study about jig and fixture for vertical milling machine in perspective of cylindrical work piece, a new design and development a new product fixture is needed. On the other hands, this design can improve the ability and characteristic of the vertical milling machine. There are four designs of the jig and fixture for this project and all design are creating by Autodesk Inventor 9 software. By the four of the design, the analysis about the specification, safety factor, characteristic and other factor is needed then select one for the best design. The determination bout the suitable material is in order to produce this jig and fixture also important. The designed fixture for this project can totally solve the problem for vertical milling machine in perspective of cylindrical parts.

C.RadhaMadhavi, B.Ramu, K.Srinivasulu (2014) This Project presents the Design of Machining Fixture for Gas Turbine Rotor Blade for Machining on VMC (Vertical Machining Centre). Fixture Design consists of High product rate, low manufacturing operation cost. The fixture should be designed in such-a-way that part/product change overtime is very less. The report consists of study of input data from customers like Part drawing and Assembly drawing. The actual design begins with study details of project proposal summary from customer. After that machining fixture concept is done. Locating and clamping points are decided. This also includes accessibility, loading and unloading sequence of parts, required material for this fixture is selected, and Fixture is designed using Industrial application standards. Locating accuracy and machined part quality tested and found that the fixture is as good as any dedicated fixture in production.

Fazlina Bintimansor (2010) The project study is about a designing and evaluating of jig for holding cylindrical parts for mass production of drilling operation. Three design were draw and compared in terms of material and also the strength of the jigs to select the best design. This report begins with an introduction of jigs which is definition and important component in jigs and advantages of the jigs.The author gives the information of mechanical and chemical property of the material used for jigs and fixture.

Goutham.N, Ramesh Babu.K (2005) Jigs and fixtures are the special production tools which make the standard machine tool, more versatile to work as specialized machine tools. They are normally used in large scale production by semi-skilled operators; however they are also used in small scale production by when interchangeability is important. This paper integrates all these aspects and the evolutionary functional approach of designed fixture is proved from the fact that a real industrial component is considered for fixture designing.

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III.COMPONENT DETAIL

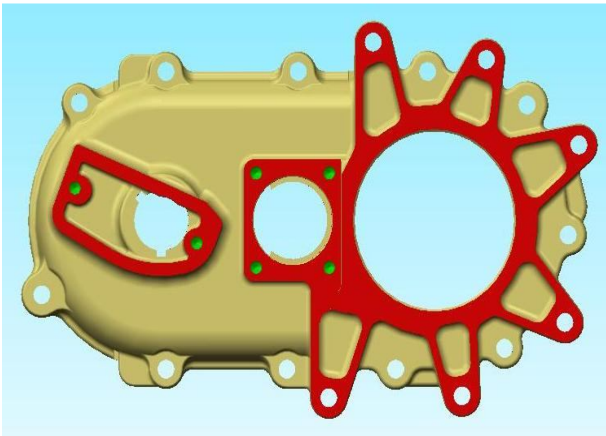


Fig- Front side view

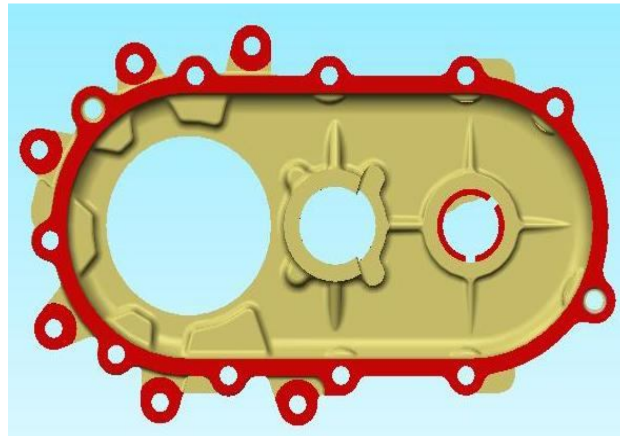
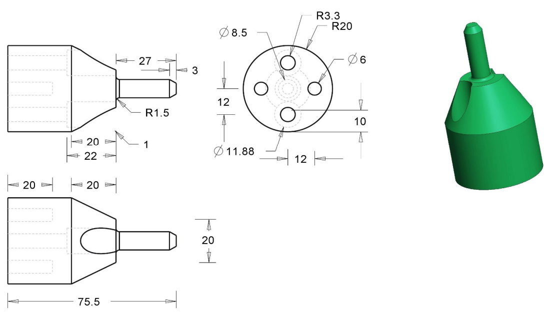
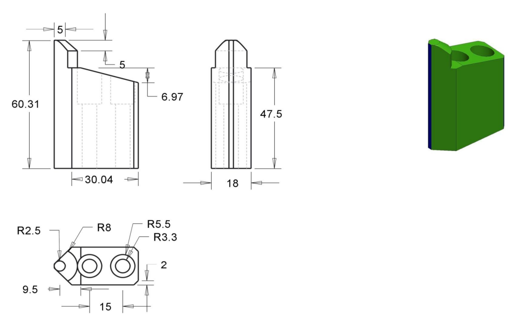


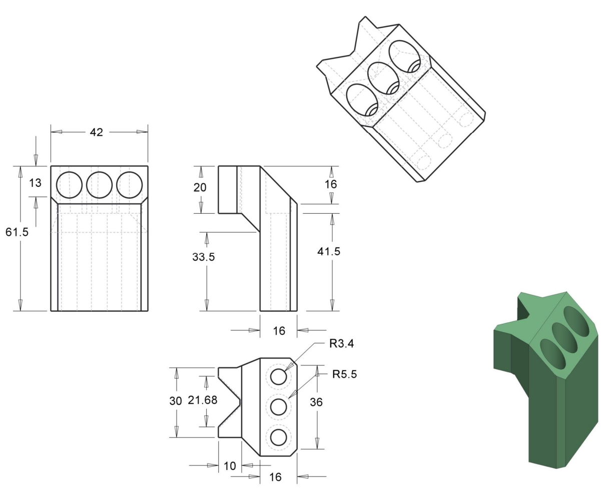
Fig-Rear side view

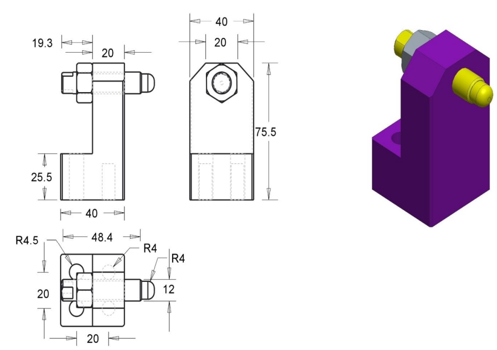
The component is engine side cover made up of ALSI-132 is one of the components of engine. It is mounted on cylinder head of I.C engine. The component is made by sand casting process. Operations to be performed on are boaring & spot facing on vertical milling machine (VMC)

IV.DESIGN OF HYDRAULIC FIXTURE COMPONENT









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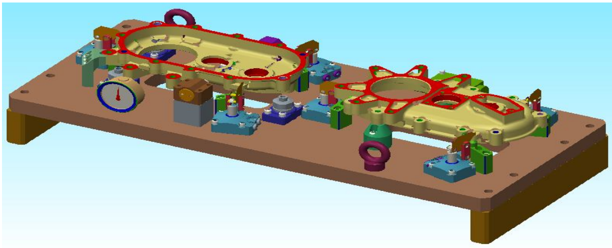
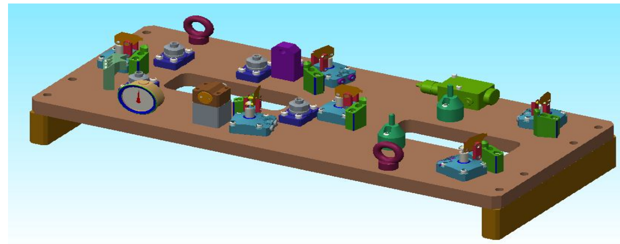
V. HYDRAULIC FIXTURE ASSEMBLY

VI. CALCULATION

A. Clamping Force Calculations

1) Hydraulic Fixture

Diameter of cylinder bore = 40mm = 4.0 cm

Area of cylinder = 0.785 d2 = 0.785 x (Piston dia.)^2 = 0.785 x 4^2 = 12.56 cm2

Clamping Force (F) = (22.38 x P)/ (L-20.5)

Hydraulic supply pressure (P) = 4 bar

Distance between the piston centre and the clamping point (L) = 44.5mm

F = (22.38 x 4) / (44.5-20.5)

F = 3.39 KN (for 1 Hydraulic fixture**)**

In one setup 3 Hydraulic fixture are used

F = 3.39 KN x 3

Total Clamping Force F =10.17KN (for G4058)

MODEL NO	G4058
Cylinder bore diameter	40
Locking cylinder area (cm^2)	12.56
Clamping force calculation formula (KN)	F = (22.38* P) / (L-20.5)
Full stroke (MM)	28.5
Lock stroke (MM)	25.3
Stroke allowance (MM)	3.2
Cylinder capacity at locked	35.79
Cylinder capacity at released	32.59
Maximum operating pressure (MPA)	7
Minimum operating pressure (MPA)	1
Maximum rated pressure (MPA)	10…5
Use pressure (˚C)	70
Weight (KG)	4.1

B. Machining Operation Calculations

1) Spot facing 2) Boring

Spot facing calculations

For 1st setup-

Given data-

Dc = 24mm ; Insert - AJ type ; Material – ALSI132 ; Si ≥13%

(Assumed 3mm casting allowances are given)

Vc = 200m/min ; F=0.1mm/t ; Kc = 660 N/mm^2

Number of revolution-

N = (1000 x Vc) ÷ (∏×Dc); N = (1000×200) ÷ (∏×24) ; N = 2654 per min

Table feed-

Vf =Fz x Z x N ; Vf = (0.1×3×2654) ; Vf =796 mm/min

Cutting time-

T = (L ÷ Vf) ; = (758 ÷ 796) ; T = 0.95min (for 1mm depth of cut)

Total cutting time

= 0.95 × 3 (total 3mm depth of cut) ; = 2.85 min

Power-

P = (Kc x Ap x Ae x Vf) ÷ (60 x 1000 x 1000) ; P = (660 × 3 × 17.75 × 796)÷(60 × 1000 × 1000)

P = 0.4662 KW

Cutting force-

Fc = P ÷ Vc ; = 0.4662 × 103 ÷ 200 ; Fc= 2.33KN

For 2nd setup-

Given data-

Dc = 24mm ; Insert - AJ type ; Material – ALSI132 ; Si ≥13%

Vc = 200m/min ; F=0.1mm/t ; Kc = 660 N/mm^2

Number of revolution-

N = (1000 x Vc) ÷ (∏×Dc) ; N = (1000×200) ÷ (∏×24) ; N = 2654 per min

Table feed-

Vf = Fz x Z x N; Vf = (0.1×3×2654) ; Vf = 796 mm/min

Cutting time-

T = (L ÷ Vf) ; = (1091 ÷ 796) ; T = 1.37min (for 1mm depth of cut)

Total cutting time =

= 1.37 × 3 (total 3mm depth of cut) ; = 4.11 min

Power-

P = (Kc x Ap x Ae x Vf) ÷ (60 x 1000 x 1000); P = (660 × 3 × 24 × 796)÷(60 × 1000 × 1000) ; P = 0.630 kw

Cutting force-

Fc = P ÷ Vc ; = 0.630 × 10^3 ÷ 200 ; Fc= 3.15KN

2. Boring calculations

For 1st setup-

Given data-

Dc = 34mm ; Insert - AJ type ; Material – ALSI132 ; Si ≥13%

(Assumed 3mm casting allowances are given)

Vc = 200m/min; F=0.1mm/t

Number of revolution-

N = (1000 x Vc) ÷ (∏×Dc) ; N = (1000×200) ÷ (∏×34.92) ; N = 1874 per min

Cutting depth-

Ap = (D-d) ÷ 2 ; Ap = (34.92-31.91) ; Ap = 1.5mm

Cutting cross section-

A = (Ap x F x Z) ; = 1.5 x 0.1 x 3 ; A = 0.45mm^2

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Cutting time-

T = L ÷(f x N) = 13 ÷(0.1 x 1874) ; T = 0.069min (for 1mm depth of cut)

Total cutting time =

= 0.069 × 3 (total 3mm depth of cut) ; = 0.207 min

Power-

P = (Kc x Ap x Vc x f) ÷ (60 x 1000) ; P = (1130 × 1.5 × 200 × 0.1)÷(60 × 1000) ; P = 0.565 kw

Cutting force-

F = P ÷ Vc ; = 0.565 × 10^3 ÷ 200 ; F= 2.825KN

For 2nd setup-

Given data-

Dc = 34mm ; Insert - AJ type ; Material – ALSI132 ; Si ≥13%

(Assumed 3mm casting allowances are given)

Vc = 200m/min ; F=0.1mm/t

Number of revolution-

N = (1000 x Vc) ÷ (∏×Dc) ; N = (1000×200) ÷ (∏×34.92) ; N = 1874 per min

Cutting depth-

Ap = (D-d) ÷ 2 ; = (42-39)÷ 2 ; Ap = 1.5mm

Cutting cross section-

A = (Ap x F x Z) ; = 1.5 x 0.1 x 3 ; A = 0.45mm^2

Cutting time-

T = L ÷ (f x N) ; = 12.3 ÷(0.1 x 1874) ; T = 0.081min (for 1mm depth of cut)

Total cutting time = 0.081 × 3 (total 3mm depth of cut) ; = 0.243 min

Power-

P = (Kc x Ap x Vc x f) ÷ (60 x 1000) ; P = (1130 × 1.5 × 200 × 0.1)÷(60 × 1000) ; P = 0.565 kw

Cutting force-

F = P ÷ Vc ; = 0.565 × 10^3 ÷ 200 ; F= 2.825KN

C. Equivalent Stress Calculations

For 1st setup-

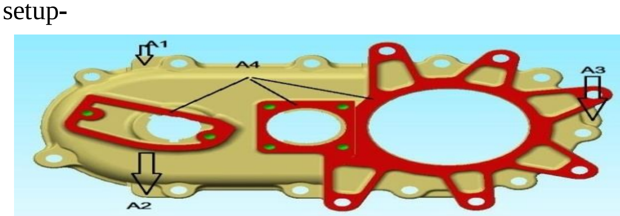

Fig- Front side view

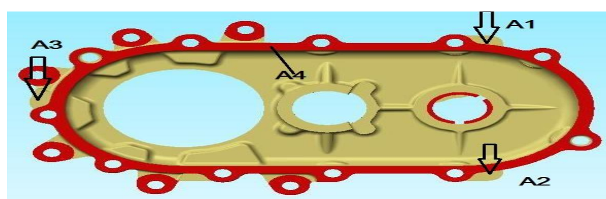

Fig-Rear side view

Cutting force= F4=Fc= 2.33KN or 2330 N

Cutting Area= A4= 6786 mm^2

Clamping Force/compressive force = F1=F2=F3=3.39KN or 3390 N

Clamping area –

A1=157.7 mm^2 ; A2=157.7 mm^2 ; A3=180.4 mm^2

Stress1= (F1/A1) ; = (3390/157.7) ; = 21.49N/mm^2

Stress2= (F2/A2) ; = 21.49N/mm^2

Stress3= (F3/A3) ; =(3390/180.4) ; = 18.79N/ mm^2

Stress4= (F4/A4) ; =(2330/6786) ; = 0.34N/ mm^2

Equivalent stress=

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=35.73N/ mm^2

2^{st} setup-

Cutting force= F4=Fc= 3.15KN or 3150 N

Cutting Area= A4= (6081+1668+1551) =9300 mm^2

Clamping Force/compressive force = F1=F2=F3=3.39KN or 3390 N

Clamping area –

A1=146.7 mm^2 ; A2=146.7 mm^2 ; A3=83.32 mm^2

Stress1= (F1/A1); =(3390/146.7) ; = 23.11N/ mm^2

Stress2= (F2/A2) ; = 23.11N/ mm^2

Stress3= (F3/A3) ; =(3390/83.32) ; = 40.68N/ mm^2

Stress4= (F4/A4) ; =(3150/9300) ; = 0.34N/ mm^2

Equivalent stress=

=52.18N/mm^2

D. Stresses on Locating Pin

Stress= (F/A) ; = (796/156) ; = 5.10N/ mm^2

E. Stresses on Rest PAD

Stress= (F/A) ; = (796/19) ; = 41.89N/ mm^2

F. Stresses on V Block

Stress= (F/A) ; = (796/53.7) ; =14.82N/mm^2

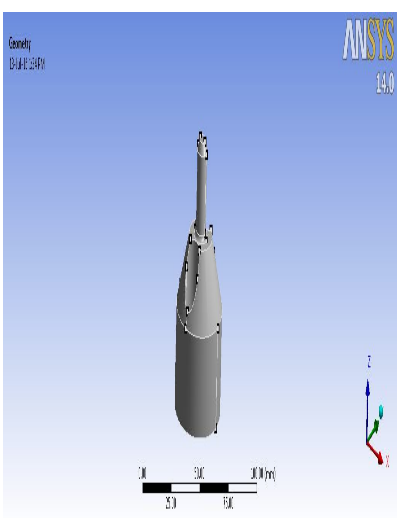
G. *Stresses on Side Butting Block*

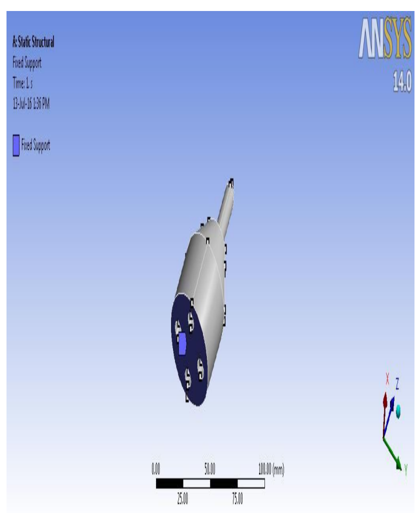
Stress= (F/A) ; = (796/4.9) ; =162.45N/mm^2

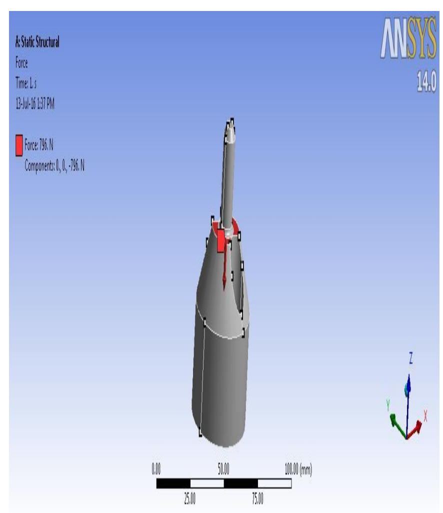
VII. FINITE ELEMENT ANALYSIS

A. Location PIN

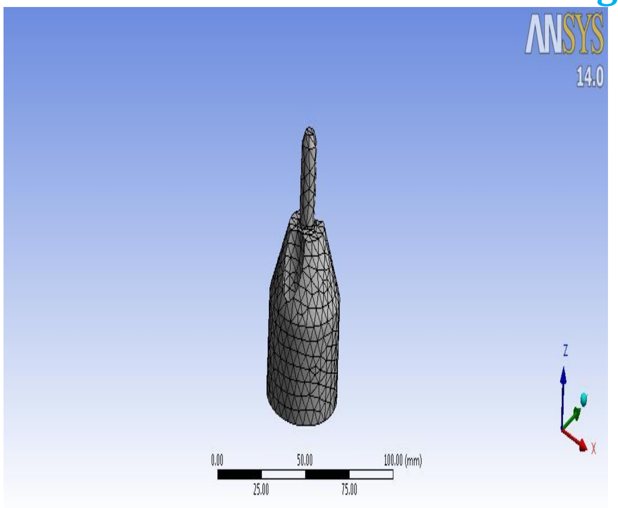
1) Geometry Boundary Force

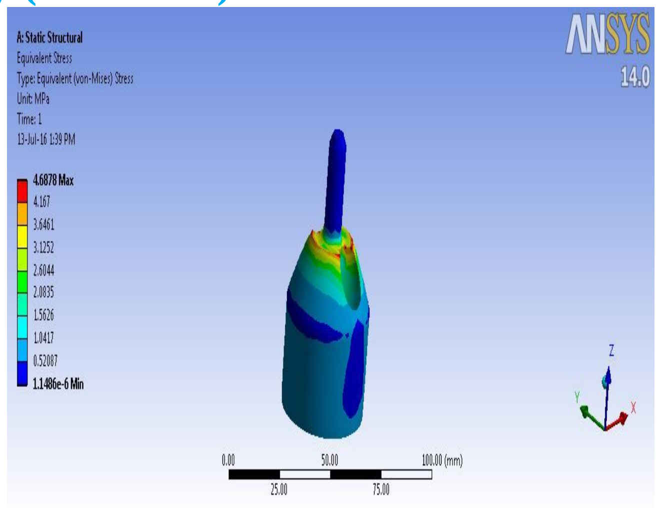






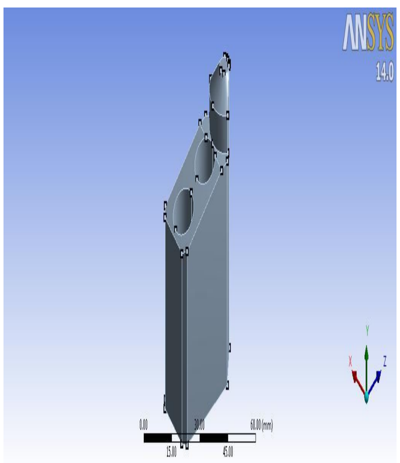
Meshing Equivalent stress



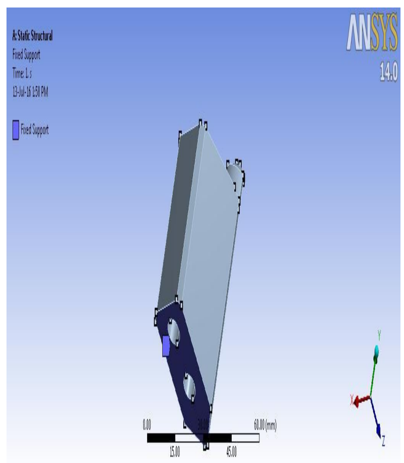


B. Rest PAD

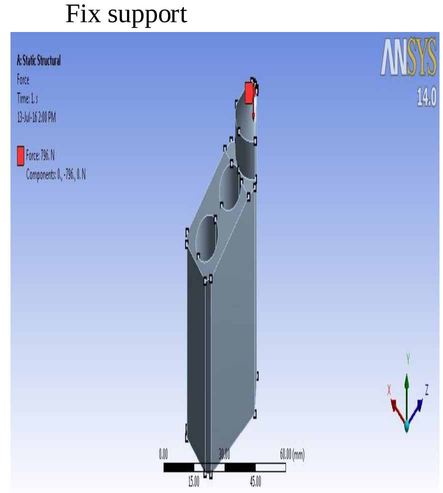
Geometry



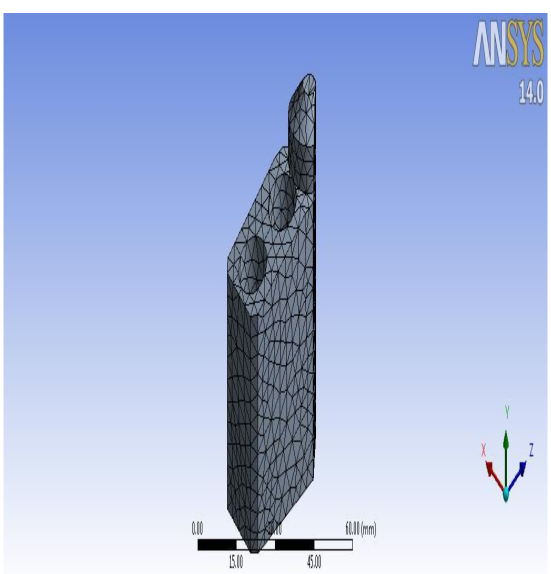
Force



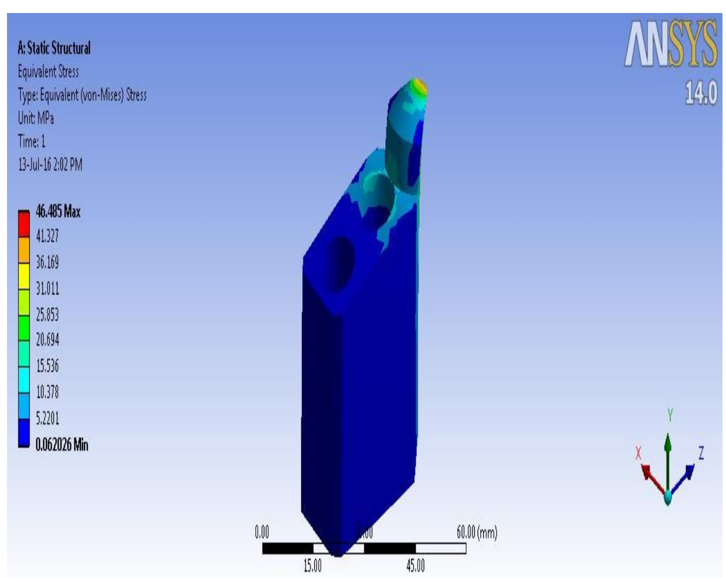
Fix support



Meshing



Equivalent stress



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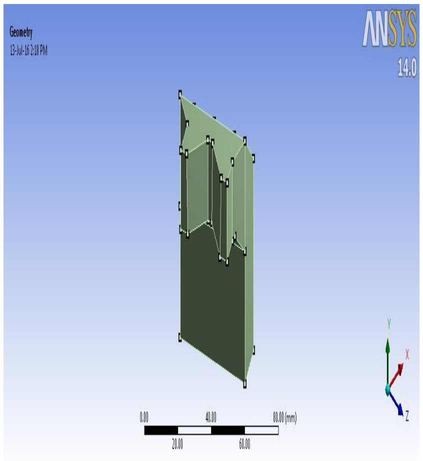
C. V Block

Geometry



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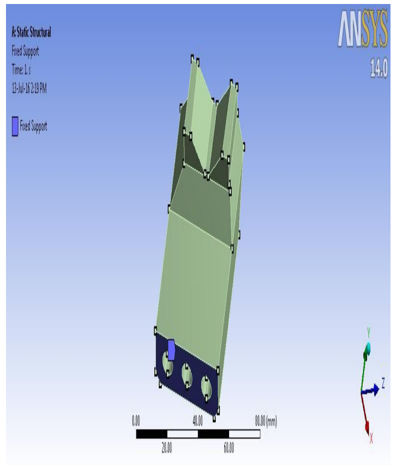
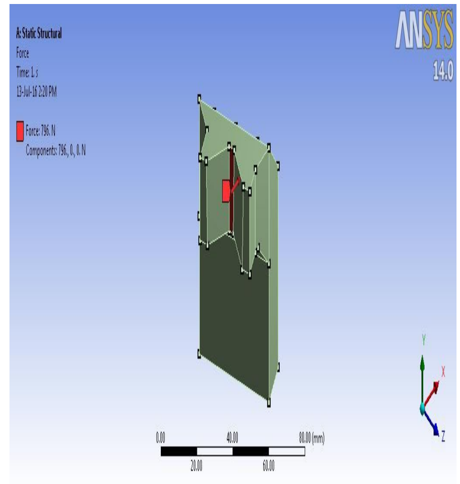
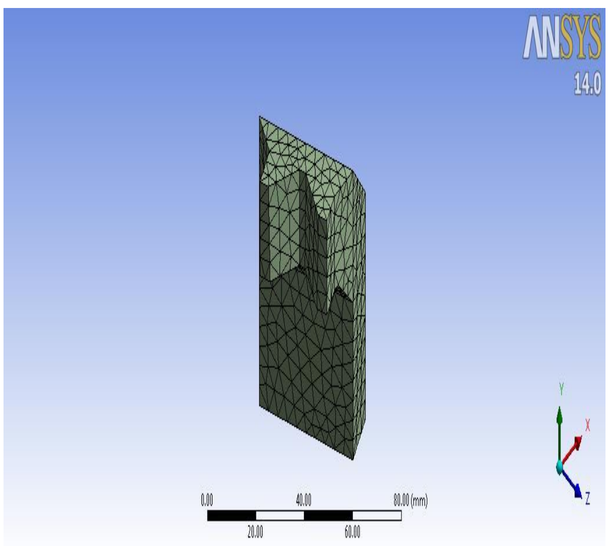


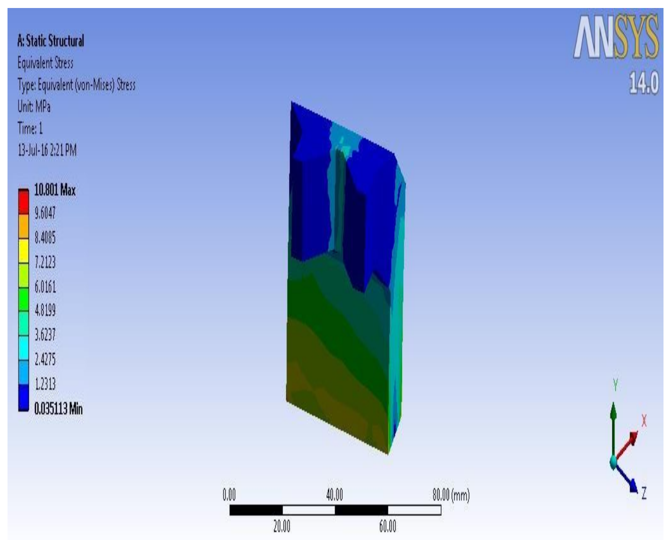
Force



Meshing

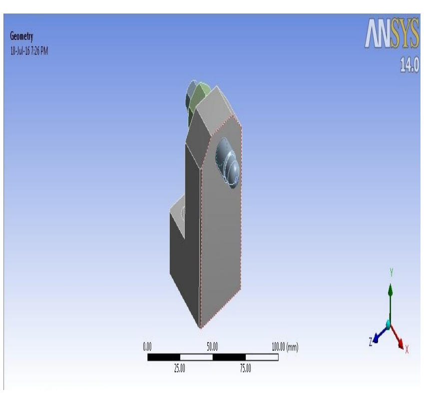


Equivalent stress

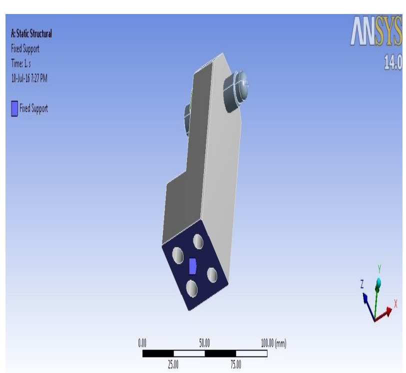


D. Side Butting

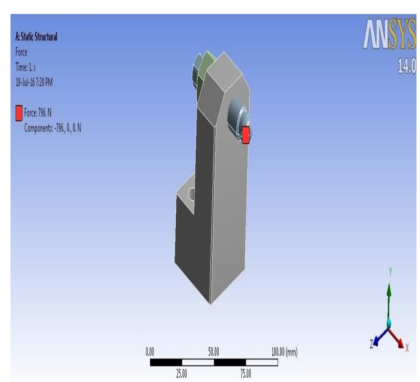
Geometry



Fix support



Force



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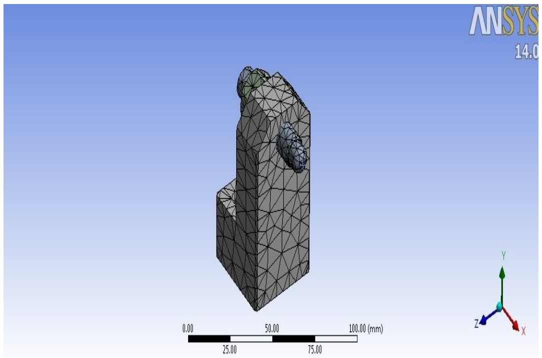
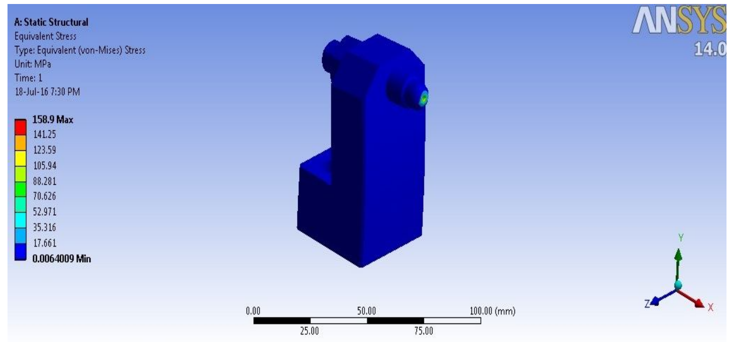
Meshing Equivalent stress





VIII. RESULT AND DISCUSSION

Maximum cutting force for setup (1) = 2.33KN
Maximum cutting force for setup (2) = 3.15KN
Clamping force = 3.39 KN

SPECIFICATIONS	MANUAL RESULT	SOFTWARE RESULT
Clamping force	3390N	3390N
Equivalent Stresses on location Pin	5.10N/mm^2	4.69N/mm^2
Equivalent Stresses on rest pad	41.89N/mm^2	46.48N/mm^2
Equivalent Stresses on V block	14.83N/mm^2	10.80N/mm^2
Equivalent Stresses on side butting	162.4N/mm^2	158.9N/mm^2

IX. CONCLUSION

From the above result and discussion the design parameters of hydraulic fixture for engine side cover have been investigated. The hydraulic fixture design has been analyzed using Static Analysis (ANSYS). The design parameters such as maximum compressive stress and maximum holding force were presented. It is found that the clamping and holding the work piece securely during machining process. The proposed design safe for manufacturing of hydraulic fixture.

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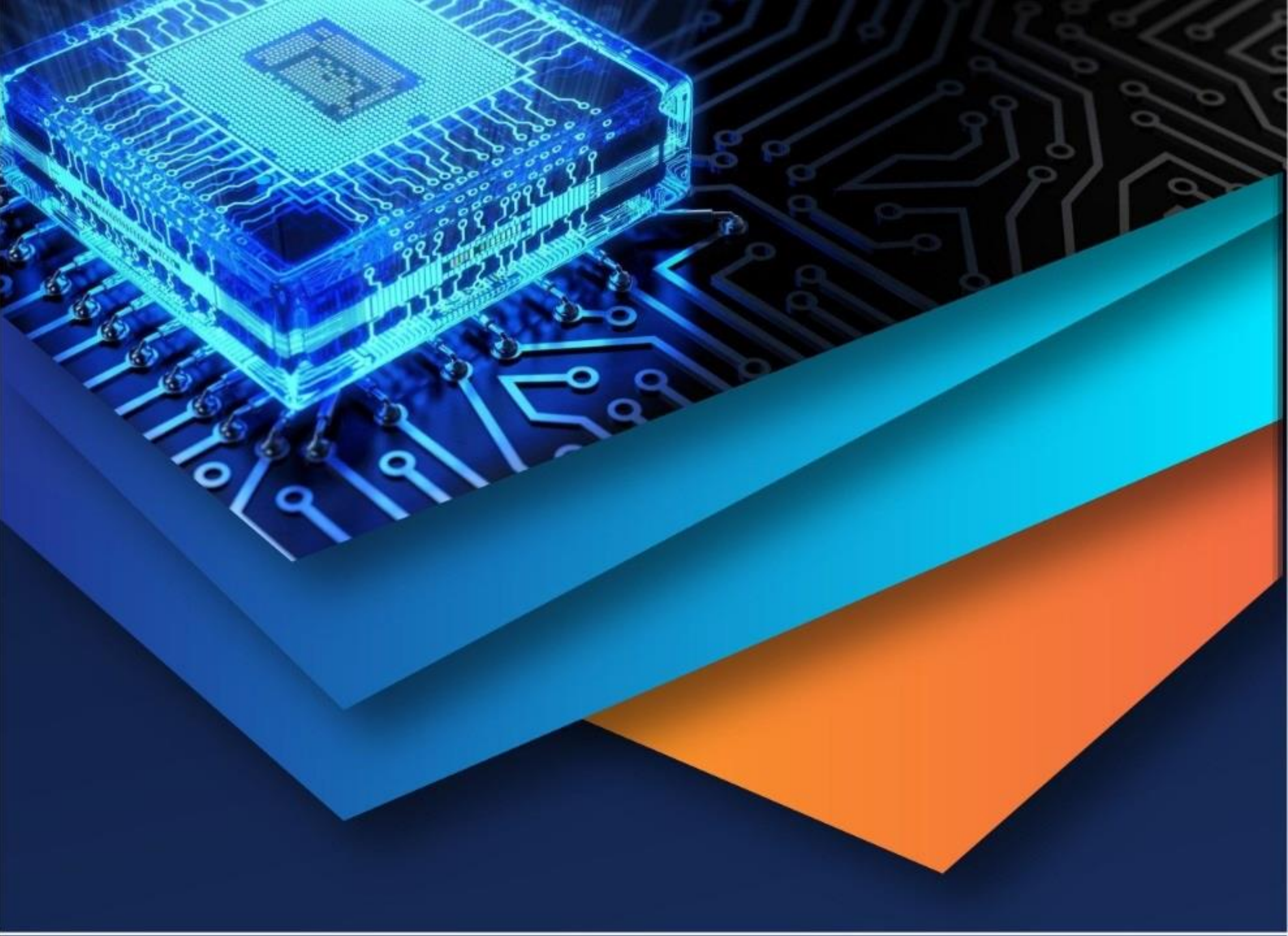

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