DESIGN, ANALYSIS AND FABRICATION OF UNIVERSAL ENGINE STAND

Matin Bagwan[1], Subham Sarwade[2], Dayanand Dhavane [3], Jalinder Shinde[4], Prof.M.D.Salunke[5]
[1,2,3,4]UG Students Department of mechanical engineering
Bhagwant Institute of Technology, Barshi, Distict: solapur, India
[5]Guide, Department of mechanical engineering
Bhagwant Institute of Technology, Barshi, Distict: solapur, India

Abstract

In the Indian market thousand of two wheeler sell delay, thousands of vehicle is goes for maintenance in workshop and garage. In on vehicle the main part or heart of vehicle is an engine. Without engine vehicle have no meaning in the workshop or garage. Engine repairing is most difficult work because of its complexity.

The repairing or maintaining for the doing repairing and handling of engine is more complicated for preventing the problem we decide to make universal engine stand on universal engine stand is a concept on which we held the sell companies vehicle engine in one stand. We try to solve above problem of mechanic with making stand in sample construction low cost.from this project we learn design concept and software skill.under the guidance of college staff.

To better handling of engine used "Universal Engine Stand" is to be designed based on the working principle of different bikes. An engine stand is a tool commonly used to repair large heavy gasoline or diesel engines, but motorcycle engine works on locally arrangement to holding engine has working to be done.

Keyword: Universal Engine Stand, Design Calculation, FEA,

I. INTRODUCTION

There is no device for holding engine probably when the repair them when the disassemble engine, it is difficult to handling engine because its complexity and the weight. Near about is 20kg average weight of any company engine. These is cause to difficult handling for repairing the worker our engine stand resolve above problem of handling engine and make safe environment for the worker.

We decided to provide this engine to garage worker with low cost. For eliminating or reducing cost we use hellow plain carbon steel material for making engine stand. We also use the design parameter and calculation for minimising the weight of engine stand. Here used latest simulations software for analysis our result.

Universal engine stand is holding all types of engine with different manufacturer, with dimensions this device is very useful for can garage worker.due to this simple construction worker easily hold engine on this stand and perform the requiring operation.
All the material, dimensions, parameters figure shows the simple constructional details of universal stand.

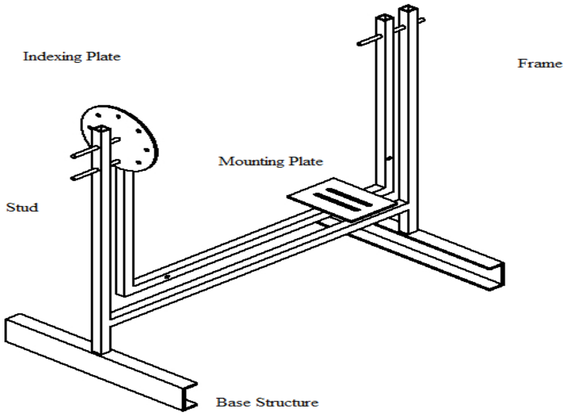


Fig.1 constructional Details

II. PROBLEM DEFINITION

Selection of this project because there is no reliable device for holding engine properly when the engine repairing. There is no device for holding vertical as well as horizontal engine on a stand.

Both the engine holding arrangement is different, so it's difficult to making universal stand. So we select this project for preventing or eliminating this problem.

When one person doing repair work it is very difficult to handling engine because of its complexity as well as weight, so select this topic. Engine had number of parts, it may be near about 100-150 parts (including nuts bolts). When repairing this part or handling chances to damage or missing these parts.all part in engine is do it's function, it was very important for this problem here provide the tray at bottom of stand for gather this parts properly.

III. LITERATURE REVIEW

Near about 15 to 20 differunt companies making the two wheller in India. Sell of these companies bikes per day in showroom 2 to 3. Like Bajaj, Hero, Honda, Yamaha, TVS, Mahindra etc. And near about 1 bike for full engine maintenance in workshop. There are twotypes of engine in commonly used for making bikes are vertical and second horizontal. In local workshop or showroom service center there is no proper fixture for holding engine is present in now day. Due to the complicated construction and weight engine handling is difficult for the worker. Now a day workers repaire engine on a tyre or ground surface, on the surface problem is handling of engine. Due to the engine oil floor makes oilly causes dirty and slipary envirnment.

IV. DESIGN CALCULATION

Plain carbon steel C45*

C, Plain carbon steel

45, Average carbon content in hundredth of a percent.

*, Any of the following.

W, Fusion weldable

W_P, Pressure weldable

W_r, Resistance weldable

W_s, Spot weldable

C45

Condition	Tensile Strength N/mm²	Yield Strength N/mm²	Input Value I20d Nm
Bars and forgings,	600-750	380	41
Hardened and Tempered	520	340	
Tubes, cold drawn and anneled	700	600	

Table: 1 Property Of Materials

Material:-

Select Tubes, cold drawn and annealed

Therefore yield strength 340 N/mm²

Syt = Yield sterngth

Weight of engine P = 50 Kg

= 50 * 9.81

= 490 N

σ_c = Compression Stress

σ_c = Syt/ fos

Assume FOS = 2

$\sigma_t = \sigma_c = 340/2 = 170$ N/mm²

Design of holding pin

$$\tau = \frac{P}{2A}$$

$$\tau = P/2(\pi/4\ d^2)$$

$$\tau = 490/2(\pi/4\ d^2)$$

But $\tau = 0.5*340/2 = 85$ N/mm²

$d^2 = 490/(2* \pi/4*85)$

$d = 2$

Take d = 5mm

The body has Φ12mm hole so use Φ12mm pin but design shown it require only Φ5mm so design is safe with using Φ12 mm to provide high fitting.

Therefore d = 12mm

Bolt (pin) for plate fitting

$\tau = P/2A$

$85 = 490/2(\pi/4*do^2)$

$d_o = 2$mm

Hence standard nut of Φ6mm can be used.

Design of clamps vertical bar tensile stress

$\sigma_t = P/A$

$= 245/(25.4^2 - 19.4^2)$

$= 0.91$ N/mm²

$(\sigma_{max} = \frac{½}{Sut}$

$= ½ *340$

$= 170$ N/mm²

0.91 is less than σmax = 170 Hence design is safe.

Top pin design on shear stress

Assume from weight 6 Kg.

$\tau = P/A$

$85 = 245+6*9.81/ \pi/4\ d^2$

$d^2 = 303.86/ \pi/4 *85$

$d = 2.13$

[d = 5mm]

Finding Bending Moment

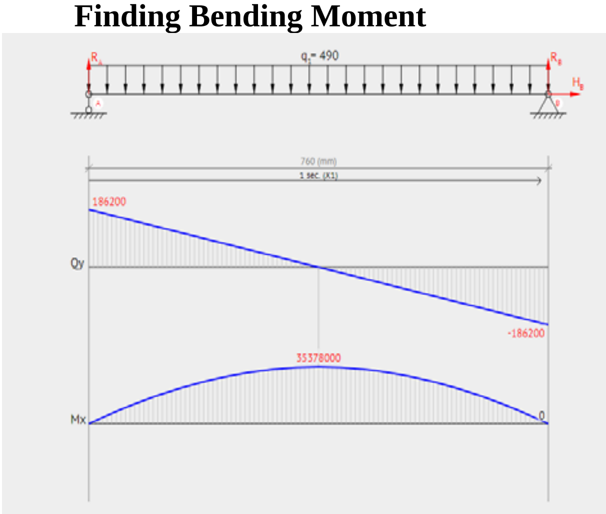


Fig: 2 Shear Strees Daigram and Bending Moment Daigram

Load 490 N = 0.49 KN

760 mm = 0.760 m

Support Reaction [upward ↑ +ve, downward ↓ -ve]

$\Sigma v = 0$

Therefor RA + RB –WL = 0

RA + RB = 0.49 * 0.76

RA + RB = 0.3724

ΣMA = 0 [Clockwise +ve, Anticlockwise –ve]

WL * L/2 – RB * L = 0

0.49 * 0.76 *0.76/2 = RB * 0.76

[RB = 0.1862]

[RA = 0.1862]

 # Shear Force Calculations

SF at just left of A = SAL = 0

SF at just right of A = SAR = 0.1862

SF at just left of B = SBL = 0.1862– WL

= 0.17297 – 0.34594

= -0.1862

SF at just right of B = SBR = -0.1862+ 0.1862

= 0

 # Bending Moment Calculations

BM at A = 0

BM at B = 0

 # Maximum Bending Moment

SF at point C

x be the distance of C from A

SF at C = 0

WL – W*x

W* L/2 = Wx

W*L/2*W = x

[L/2 = x]

Bending Moment at point C

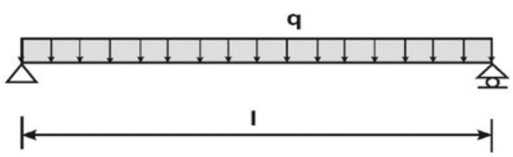
RA *x – Wx. x/2

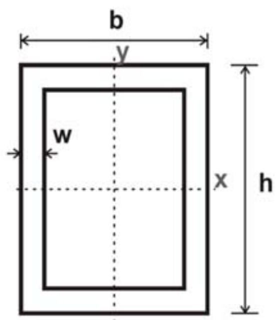
0.1862* 0.38 – 0.49 * $0.38^2/2$

0.035378 KNm

Maximum B.M 0.035378 and it occur at mid point, where SF changes its sign.

The BMD is a parabola





InputLength (l): 760 mm

Load (q): 0.49kN/m

Material: Steel

Profile: Rect. tube

Outside width b: 25.4 mm

Outside height h: 25.4 mm

Thickness w: 3 mm

Moment of Resistance Wx: 1802 mm^3

Moment of Inertia Ix: 22882 mm^3

Modulus of Elasticity E: 210000 N/mm^2

Results

Max. (Bending) moment: 0.04 kNm

Max. Stress: $19.6 N/mm^2$

Max. Deflection distance: 0.4 mm

Finding Bending Stress

M = σ_b * D^4 – d^4/6D

$35.378*10^3$ = σ_b * (25.4^4 – 19.4^4)/(25.4*6)

σ_b = $35.378*10^3/1801.7360$

[$\sigma_b = 19.63\ N/mm^2$]

Which is less than $\sigma_{max} = 170\ N/mm^2$

[Hence design is safe]

Shear failure of pin in plate

τ = P/A

85 = 303.86/ π/4 d^2

d = 2.13mm

d = 5 mm

V. Welding Calculations:-

 # welded joint subjected to bending moment

A cantilever beam of rectangular cross section is welded to support by means of two fillet welds W1 and W2 as shown in fig. According to the principle of applied mechanics the eccentric force P can be replaced by an equal and similarly directes force P acting through the plane of welds aolng with a couple. Mb = P*e as shown in fig. the force P through the plane of welds causes the primary shear stress τ1, which is given by

$\tau_1 = P/A$ …. (1)

Where A is the threat area of all welds. The moment Mb causes bending stresses are given by

σ_b = Mby/A….(2)

Where,

I = moment of inertia of all welds based on the threat area

y = distence of the point in weld based on the point in weld from the neutral-axis.

The bending stresses are assumed to act normal to the threat area. The resultant shear stress in the welds is given by

$\tau = \sqrt{\left(\frac{\sigma b}{2}\right)^2} + (\tau 1)^2$ …..(3)

b = 25.4

d = 25.4

Permissible shear stress in weld is 80 N/mm²

The total area of the horizontal and vertical weld is given by

A = [bt + dt]
= [25.4t + 25.4t]
= 101.6t

The primary shear stress in the weld is givan by

$\tau_1 = \frac{P}{A} = \frac{151.93}{101.6t}$ N/mm² ……. (i)

Reffering to figure the moment of inertia of four welds about x-axis is given by,

$Ixx = t[\frac{bd^2}{t} + \frac{d^3}{\sigma}]$

Substituting the value

$I_{xx} = [\left(\frac{25.4*25.4^2}{2}\right) + (\frac{25.4^2}{6})]$

= 81.93532 + 2731.17

= 10924.70 t mm²

From eqution (2)

$\sigma_b = \frac{Mby}{I}$

y = 12.7

$= \frac{(151.93*800)*12.7}{10924.702t}$

$= (\frac{141.29}{t})$ N/mm²

Maximum shear stress in weld is given by

$\tau = \sqrt{\left(\frac{\sigma b}{2}\right)^2} + \sqrt{(\tau 1)^2}$

$= \sqrt{\left(\frac{141.29}{2t}\right)^2} + \sqrt{\frac{1.50^2}{t}}$

= 4990.7160 + 2.25

$= \frac{70.66}{t}$ N/mm²

Since the permissible shear stress in the weld is 80 N/mm²

$\frac{70.66}{t} = 80$

$t = \frac{70.66}{80}$

t = 0.88

t = 1 mm

And

$h = \frac{t}{0.707} = \frac{1}{0.707} = 1.41 = 21$mm

Welding calculations of C channel

A = Area
A = 2[bt + dt]
= 2[25.4t+25.4t]
= 101.6t

$I_{xx} = t[\frac{bt^2}{2} + \frac{d^3}{6}]$

$I_{xx} = 10924.70t\ mm^4$

$\tau = \frac{122.5}{101.6t}$ ----- (i)

$\sigma_b = \frac{mby}{I}$

$= \frac{(122.5*600)*12.7}{10924.702t}$

$= \frac{85.44}{t}$ N/mm² ----- (ii)

From eqution (3

Max shear stress in weld is given by

$\tau = \sqrt{\left(\frac{\sigma b}{2}\right)^2} + \sqrt{(\tau)^2}$

$= \sqrt{\left(\frac{85.44}{2t}\right)^2} + \left(\sqrt{\frac{1.20}{t}}\right)^2$

= 1824.99 + 1.44

$= \frac{42.73}{t}$ N/mm²

Permissible shear stress in the weld is 80 N/mm²

$= \frac{42.73}{t} = 80$

t = 0.5341 mm

= 1 mm

$h = \frac{1}{0.707} = 1.41$ mm

= 2 mm

VI. PROJECT OBJECTIVE

To construct unique designed engine maintenance stand.

i. To virtual design in the engine stand in MDT 6.
ii. To manufacture stand with accuracy for safety use.
iii. To analyze the design safety in Autodesk Inventors with following

a] Static structural analysis.
b] Factor of safety (FOS)
c] To test and validate the design.

VII. ANALYSIS OF ENGINE STAND

1. Total Displacement

As observing image of **Inventor** solution of displacement, we can get exact location of deformation at the loaded body.

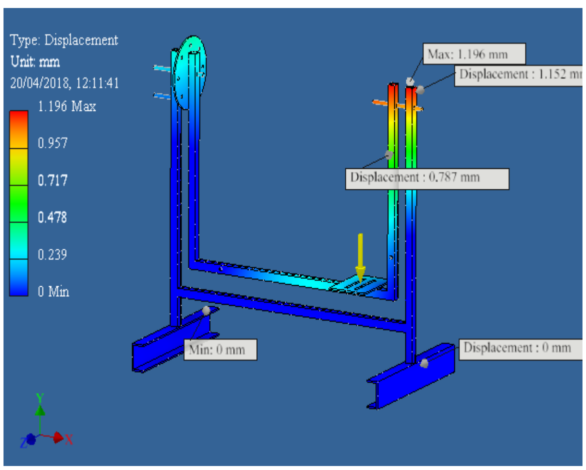


Fig.3 Displacement of the steel

2. Von Mises (Yield) Stress

Von mises stress defines the maximum yielding stress at the particular location which useful before manufacturing in actual practice.

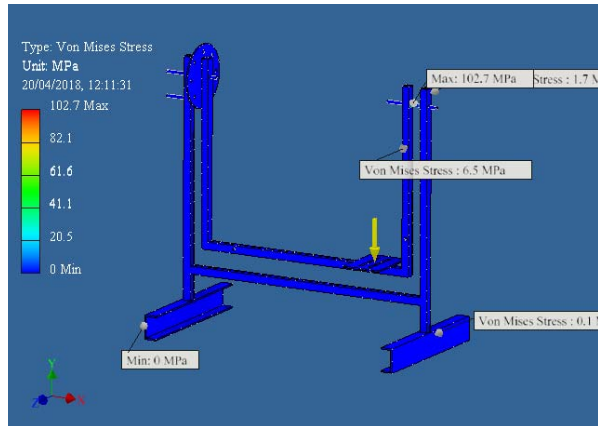


Fig.4 Von Mises stresses on steel

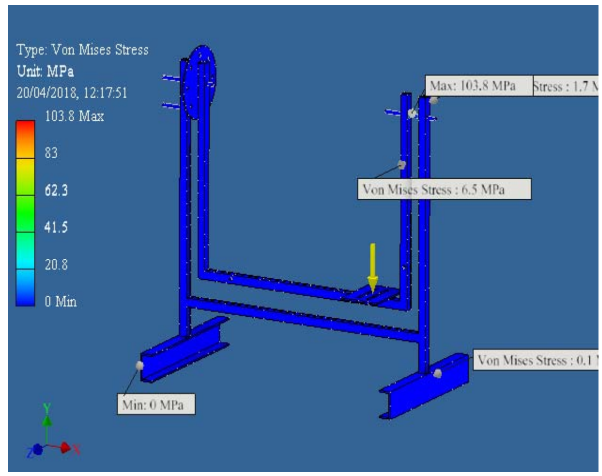


Fig.5 Von Mises stresses on Aluminum

3. Safety Factor

The project mainly focuses on study safety factor plays an important role as deciding factor for thickness of material.

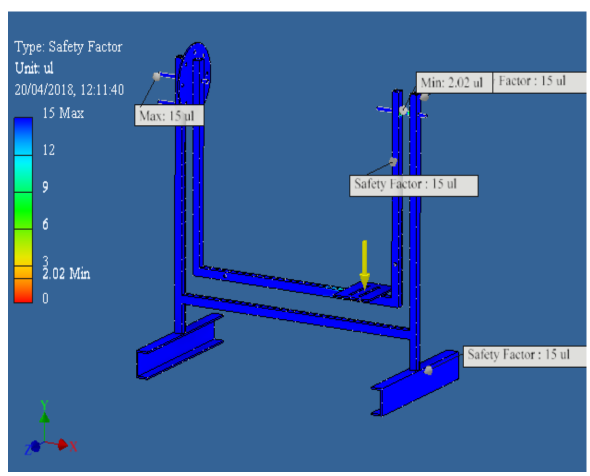


Fig.6 Safety Factor for the Steel

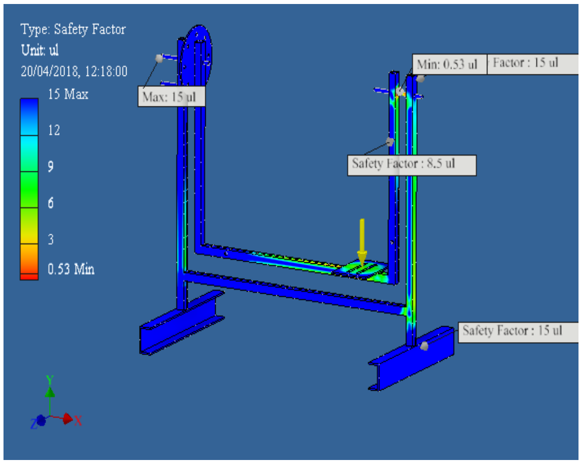


Fig.7 Safety Factor for the Aluminum

Fig 8 Final fabricated engine stand

VIII. RESULTS AND DISCUSSIONS

Parameters	Steel		Aluminum	
	min	**max**	**min**	**max**
Von mises stress	**0**	**102.7**	**0**	**103.8**
displacement	**0**	**1.196**	**0**	**3.81**
Safety Factor	**2.02**	**15**	**0.53**	**15**

Table: 2 Results

1. Maximum Displacement due tensile force 490 N is 1.19mm for steel and Maximum Dislacement due to force 490 N is 3.81mm
2. Maximum Von mises stresses found in steel is 102.676 MPa which is observed on the stud. Maximum Von mises stresses found in Aluminum is 103.786 MPa which is observed on the stud. Maximum von mises stress indicates that stud will first start yielding in both materials. so with increasing stud dimension reduce the stress.
3. Minimum Safety Factor for the steel is 2.01604 and for Aluminum 0.529 on stud.

IX.CONCLUSION

From the above theoretical and analytical study conclude that

1.Due to the maximum safety factor of Steel compairing with Aluminum, steel is useful for making stand

2.Maximum stresses are produced on the stud and chance of failure first stud. But the design load at 490N with factor of safety 2 the stud does not fail so stand design is safe.

3.From all the calculation parameter steel is better with compaire to aluminum so for making stand select steel material.

4. On actual fabricated Engine Stand vetical as well as horizontal engine are holded and tested .no dout it's called the Universal Engine Stand as vetical and horizontal engine engines can hold and worked comfort.

X.ACKNOWLEDGEMENTS

It gives us a great pleasure to thank all those people who helped us in successful completion of project. First of all we would like to express our deep sense of gratitude and sincere thanks to our respected principal **Dr. A.K. Deshmane** for his constant inspiration and motivation towards of the project. We express our thanks to **Prof. V.L. Mundhe,** Head of Department of mechanical engineering for his motivation and permission for avail the workshop facilities.

We are very much thankful to our guide **Prof. M.D. Salunke,** for his timely advice, highest level of co-operation and valuable suggestions helped us to put our efforts in satisfactory manner and for the completion of the report. Last but not least we thank all those who have helped directly or indirectly for the completion of our project.

XI.REFERENCES

1. |"motorcycle, n.", Oxford English Dictionary Online, Oxford University Press, March 2009, 1. A two-wheeled motor-driven road vehicle, resembling a bicycle but powered by an internal-combustion engine; (now) spec. one with an engine capacity, top speed, or weight greater than that of a moped.
2. Setright, L.J.K. (1979), The Guinness book of motorcycling facts and feats, Guinness Superlatives, pp. 8–18, ISBN 9780851122007
3. Long, Tony (30 August 2007), "August 30, 1885: Daimler Gives World First 'True' Motorcycle", Wired, ISSN 1059-1028
4. Falco, Charles M.; Guggenheim Museum Staff (1998), "Issues in the Evolution of the Motorcycle", in Krens, Thomas; Drutt, Matthew, The Art of the Motorcycle, Harry N. Abrams, pp. 24–31, ISBN 0-89207-207-5
5. "Honda Worldwide | Technology Close-up". World.honda.com. Archived from the original on 2011-06-04. Retrieved 2010-12-04.
6. www.ijies.net/finial-docs/finial pdf/ 1803 172017252.pdf
7. https://www.iagresearch.com.au/images/stories/.../2009_03_rcar_mc_design_guide.pd..

- **BOOKS:-**
- **‘**Design of machine Elements’ ‘V.B. Bhandari’, ‘McGraw Hill Education Private Limited’
- Strength of Materials[Mechanics of solids] R.K.RAJPUT S.CHAND
- Automobile Engineering vol. 1and vol. 2 by kripal singh -Standard publisher