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Design of a Versatile Jig and Fixture for Welding of Suspension Arms

Anuj Shrivastava [1], N. Jayanth Shyam [2]

[1] *Student, Department of Mechanical Engineering (SMEC), Vellore Institute of Technology, Chennai, India*
[2] *Student, Department of Mechanical Engineering (SMEC), Vellore Institute of Technology, Chennai, India*

Abstract - *In manufacturing industry, fixtures have a direct impact upon product manufacturing quality, productivity and cost. Welding fixtures are designed for the components which are difficult to weld in normal way or without any holding unit. The fixture is to be designed for the welding of suspension arms for any passenger vehicle. The investigation involves study of basics of fixtures, need of fixture, location principle. In this work, welding fixtures are designed considering all the welding factors like access to its welding area, cycle time, and availability of space for fixture. Welding is the important factor in assembly of automobile component so whenever there is need of welding its performance matters. If proper welding is not done it will directly affect the strength of the component. Manufacturer rely on product development to deliver products that add value to their portfolios. Efficient designs reduce material and manufacturing labor costs. In this we aim to design an adjustable fixture and jig for welding suspension arms, which can be adjusted according to the required dimensions of the a-arm lengths. The purpose of this welding fixture is to conduct proper welding of sub - component. This includes basic study of fixtures. Design of welding fixture as per component. Analysis of welding fixture and validation of results of analysis with respect to analytical calculation.*

Keywords: suspension setup welding, suspension jig and fixture, passenger vehicle suspension welding fixture, double wishbone welding setup, MacPherson strut welding setup.

1. INTRODUCTION

An a-arm is an essential part of the suspension system of a vehicle. It is the link between the wheel (from the hub) to the chassis of the vehicle. An a-arm can have different configurations depending upon the suspension points located on the chassis and also the configurations vary in cars from different manufacturers. Implementing the use of jigs to weld various components to design an a-arm ensures accuracy and solid build quality. There are different configurations of a suspension setup one passenger car itself. So, manufacturers have to use different fixtures and jigs for assembly of different configurations which time consuming, less productive and quite a hassle.

The aim of the project is to design a versatile fixture and jig suitable to weld the components of an a-arm to complete its assembly. The versatility of the fixture corresponds to the design feature of the fixture that certain components of the fixture can be adjusted in a way such that the fixture adapts to the dimensions of the suspension arms being welded. Hence all the different configurations of a-arms for front wheels and rear wheels can be assembled through the use of one fixture and jig design improving productivity and all the hassle.

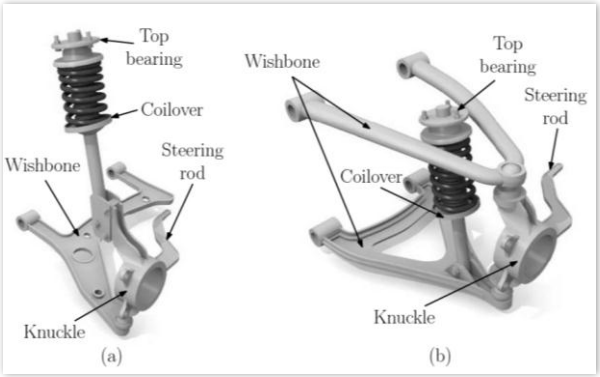

Fig-1 Suspension Systems (a) MacPherson Strut ; (b) Double Wishbone

2. DESIGN FEATURES

2.1 Versatility

It is adaptive to different dimensions for the required assembly of the a-arm (angles, lengths). Design has enough degree of freedom to complete the weld operation.

2.2 Productivity

It is able to process, load, unload and clamp as quickly as possible. Interference with the welding process is as less as possible. The clamping is suitable to reduce distortion.

2.3 Cost Efficiency

One of the main aspects of design is to keep the cost as low as possible while ensuring necessary operation requirement is fulfilled. Material cost has been considered to keep the cost as low as possible.

2.4 Material Properties

	Mild Steel	Tool Steel	Aluminum 6061	Stainless Steel	Copper / Copper Alloys
Material Cost	Low	Medium	Medium	High	High
Wear Resistance	Medium	High	Low	Medium	Low/ High
Electrical Conductivity	Low	Low	Medium	Low	High
Thermal Conductivity	Low	Low	High	Low	High
Thermal Expansion	Low	Low	High	Medium	Medium

Tab- 1 Material Properties

Material	Aluminum	Stainless steel	Copper	Bronze
Density (x1000 kg/m³)	2.71	8.03	8.94	7.8 – 8.8
Melting point (°C)	660.3	1371 - 1399	1085	1050
Boiling point (°C)	2519		2562	-
Thermal expansion coefficient ($x10^{-6}$/°C)	23.0	17.2	16.6 – 17.6	18.0 – 21.0

Tab- 2 Physical Properties

MILD STEEL PROPERTIES	
DENSITY	7850 kg/m^3
MELTING POINT	1350-1530°C
THERMAL EXPANSION COEFFICIENT	5.9 x 10^-6 /°C

Tab- 3 Mild Steel Physical Properties

From the data given in the above tables and figure it's clear that mild steel stands out as the most suitable material because of its low cost, low wear resistance, low thermal and electrical conductivity, thermal properties. Square tubes of mild steel are used

Hence cost is reduced and efficiency is increased by the use of MILD STEEL.

2.5 Size of the Setup

The size of the a-arms and the angles made by them with the central axis determine the size of the fixture.

Since our model's aim is to have an adjustable setup so as to weld different configurations of suspension a-arms to required dimensions, the values from various research papers were collected so as to have a standard value which can accommodate sizes of passenger car vehicle suspension a-arms. [1], [4], [6], [7]

a=350mm

b=175mm

c=391.2mm

AB is the maximum length of the suspension a-arm.

BC and AC are the adjustable lengths of the fixture.

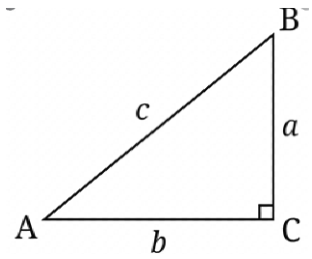

Fig-2 Dimension triangle

The size of the v block depends upon the variation of diameters of the tubes used in suspension a-arms. In passenger vehicles the size (outer diameter) of the tubes used in suspension varies from 20mm to 50mm.

Hence the v-block of an angle 90 degrees is used to support the tubes.

Since the v-block is a separate component which can be placed on the fixture so as to support the tubes has its bottom surface lined with a silicone layer of 0.5mm thickness for stability.

Figure 3 V-block

2.6 Hole Sizes & Locating Pin Sizes

The hole sizes in the fixture and the size of the locating pins in the fixture have been selected as a standard size of the bearings which are used in passenger vehicles.

The size of the outer diameter of the spherical ball bearing determines the size of the pins and holes.

The standard sizes (outer diameter) of the bearings in a vehicle suspension system vary from 8mm to 30mm. [3], [5]

3. COMPONENTS

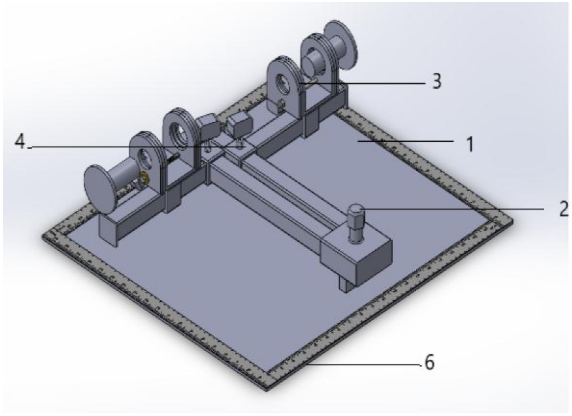

Fig-4 Jig and Fixture for Welding of Suspension Arms

3.1 Base Plate

The base plate has a thickness of 5mm. and has a millimetre scale attached to it along the boundaries.

3.2 Diamond Pin Locator

The diamond pin locator is used to support the main bearing hole of the suspension a-arm. It restricts the motion in x-axis and y-axis. It also restricts any rotational motion of the assembly.

3.3 Adjustable Bearing Hole Mount with Screw Clamp

The bearing hole mount is adjustable and can be adjusted to the required dimension of the suspension a-arm configuration. So as to achieve movement restriction in x and y axes it is aided with a screw clamp. While the rotational and movement in z-axis is restricted by the pin that goes through the bearing hole mount.

3.4 Adjustable Extension to the Bearing Hole Mount with Screw Clamp

It adjusts the length of the a-arm to the required dimension of the suspension a-arm configuration. It is aided with a screw clamp.

3.5 V-Block Jig

It is used to support the cylindrical tubes(a-arm) for stability and movement restriction in x and y axes. It can be placed on the base plate after the mounts have been adjusted according to the configuration of the suspension a-arm.

3.6 Millimeter Scale

The scale helps to align the mounts according to the required dimensions for the a-arm lengths.

4. DESIGN AND ANALYSIS

Since the fixture is used for welding components, various load involving operations like drilling, cutting, grinding or other machining processes are not used and hence the only force is that of welding.

4.1 Welding Force

Formula for welding force…

$$F = \frac{\mu_0 I^2}{8\pi}\left(1 + 2\ln\frac{R_2}{R_1}\right)$$

F= welding force, μ= permeability of free space, I= current in amps

R1 is the radius of the arc where it contacts the welding electrode, and Rz is the radius of the arc where it contacts the base plate.

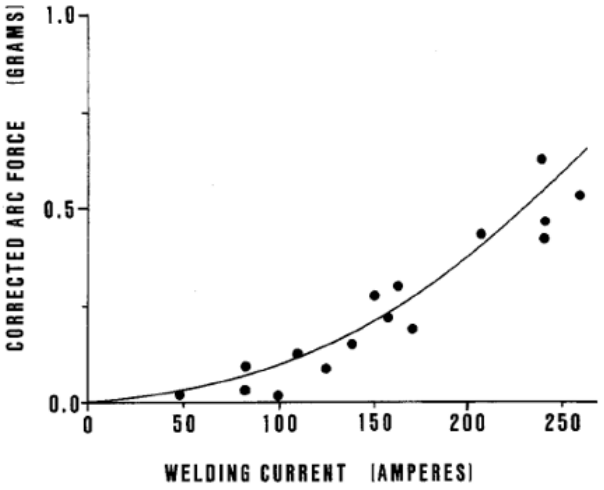

Fig-5 Linear relationship between Arc Force and Welding Current [2]

A linear relationship between arc force and welding current with a value of approximately 0.05 Newtons for an arc of 200 amps from the graph plotted using the formula given above (standard value of R1/R4=4). [2]

4.2 Moment

Moment = Force x Distance or M = (F)(d)

We have the Force as 0.5N and the max length of the a-arm or tube as 391.2mm

Therefore,

Maximum moment = 0.5 x 391.2mm = 195.6 N-mm

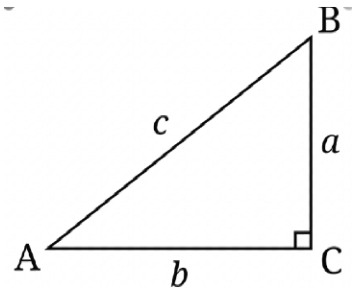

Fig-6 Dimension Triangle

a=350mm, b=175mm, c=391.2mm

AB is the maximum length of the suspension a-arm.

BC and AC are the adjustable lengths of the fixture.

4.3 Clamping force

To calculate the clamping force resulting from torqueing a nut and bolt to a particular level.

$$T = K \times D \times P$$

T= Torque (in-lb), K = Constant to account for friction (0.15 - 0.2 for these units), D = Bolt diameter (inches), P = Clamping Force (lb)

Take T as 0.2 N-m or 1.76 in-lb (small force exerted by the hand)

D=10mm or 0.393 in

Therefore, Clamping Force, P = (1.76) / [(0.2) x (0.393)] = 22.39 lbs or P = 10.156 Kg for each clamp.

5. FUNCTION

The general idea behind the design is to adjust to the required configuration of the required a-arm design parameters.

The main locating points are the mount for the ball bearings at the points A & B, and the diamond pin at the point O.

Once the mounts are adjusted according to the required dimensions i.e. with the help of the millimetre scale attached with the base plate. The mounts have locating points to easily locate the dimension on the scale.

The mounts are clamped with the screw clamp.

Now, tubes are to be welded to the points OA and OB respectively. To keep the tubes in place a V-Block is used and is placed over the base plate so that the tubes' movement is restricted.

Once the tubes are welded from the top, the welded components (i.e. the a-arm assembly) can be unclamped and flipped to weld the remaining area on the same jig by interchanging the dimension adjustment of the mounts.

And once cooled, the assembly can be removed and is ready for further machining. Hence the desired configuration of suspension a-arm is achieved.

The bearing sizes can vary hence the diamond pin can be replaced by another diamond pin of the required dimension. The same goes for the bearing sizes at the end of the a-arm (points A and B).

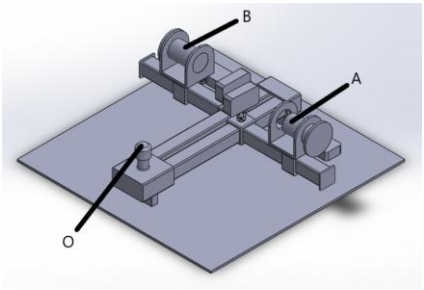

Fig-7 General Setup

6. CAD MODEL

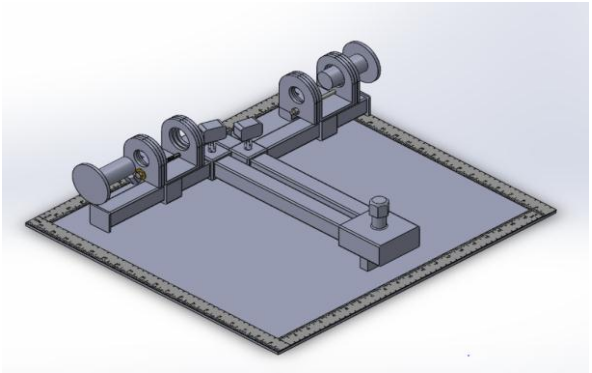

Fig-8 Complete Design (isometric view)

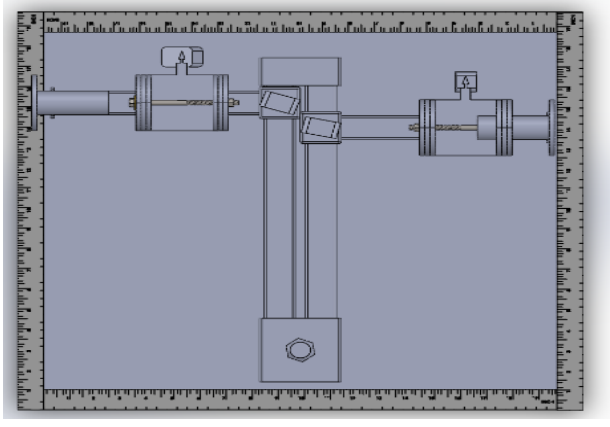

Fig-9 Complete Design (top view)

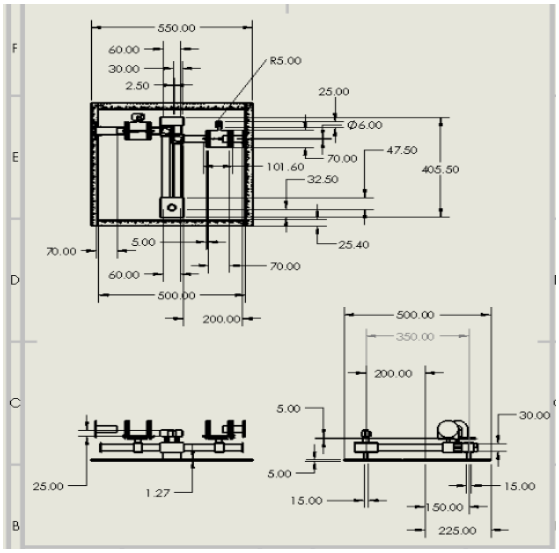

Fig-10 2D-drawing with dimensions

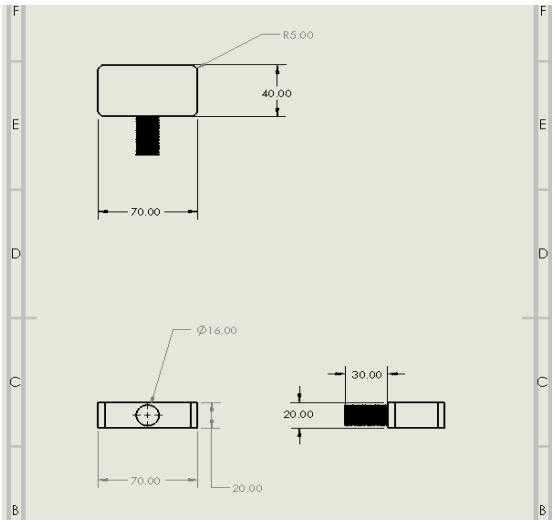

Fig-11 Screw Clamp 2D drawing

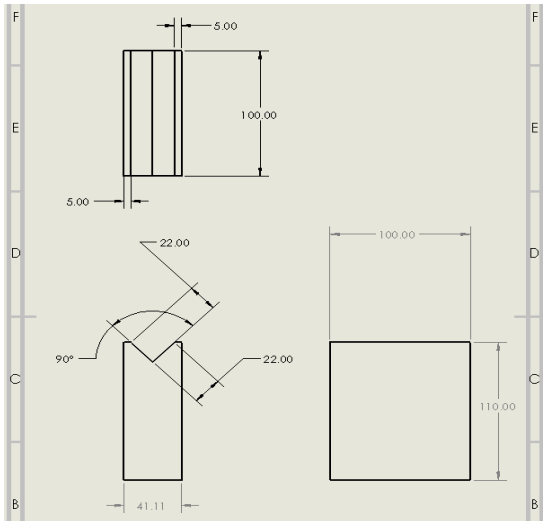

Fig-12 V-Block 2D drawing

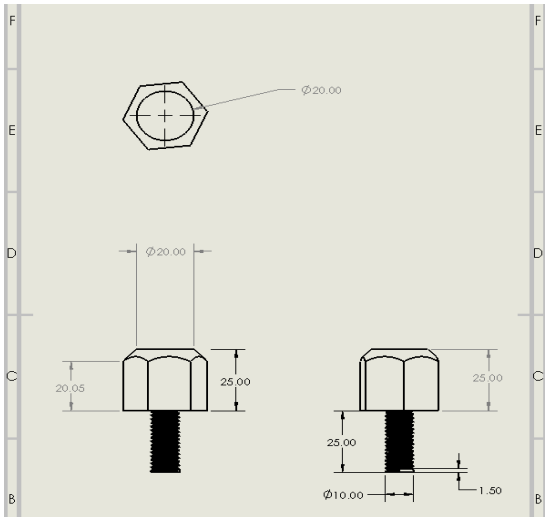

Fig-13 Diamond Pin Locater 2D drawing

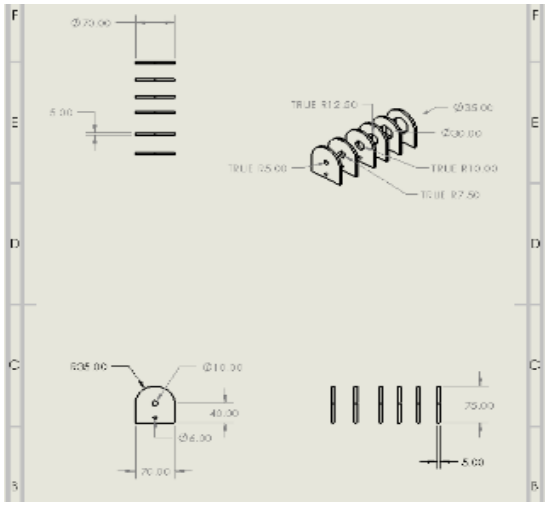

Fig-14 Removable mount plates 2D drawing

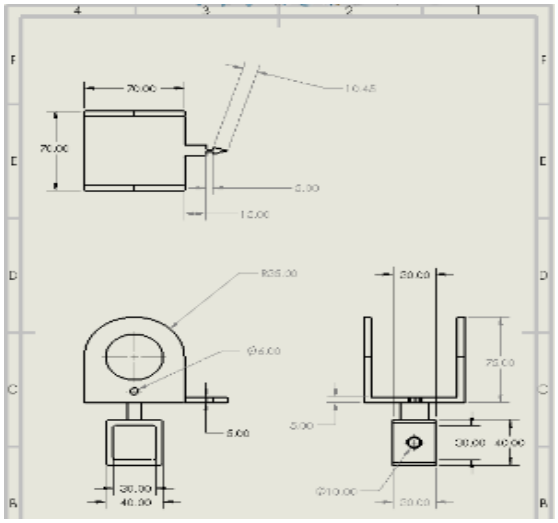

Fig-15 Bearing hole mount with pointer to adjust along the scale 2D drawing

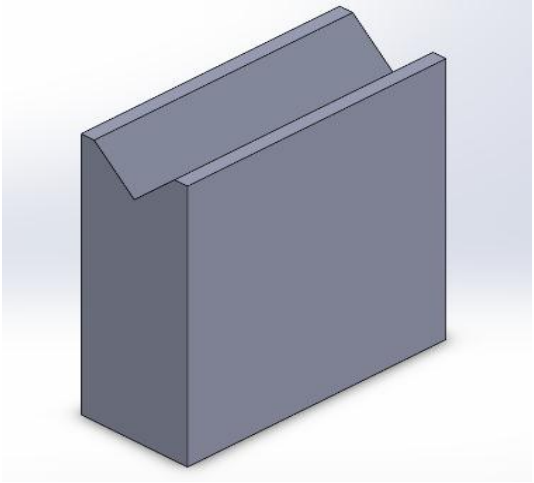

Fig-16 V-Block

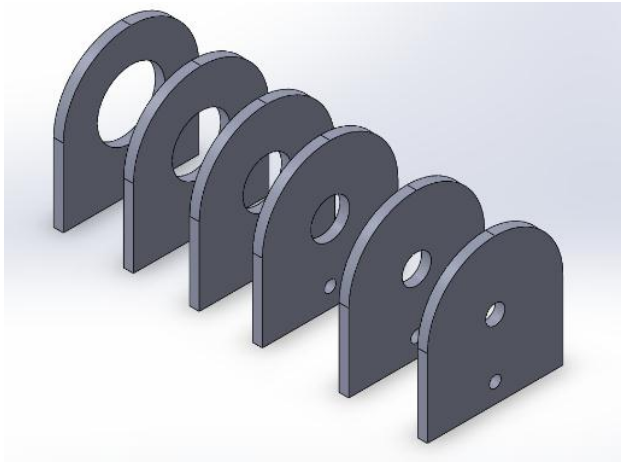

Fig-17 Removable mount plates

7. CONCLUSIONS

The complete fixture for welding of a Versatile Jig and Fixture for Welding of Suspension Arms has been designed analytically. The design can be used for any passenger vehicle suspension a-arm welding, is cost efficient, is productive and is safe. The fixture satisfies the functionality of the welding.

The uniqueness of the project is accredited by the versatility or the ability of the fixture to weld suspension a-arms of any passenger vehicle in the automobile industry.

The complete fixture for welding of a Versatile Jig and Fixture for Welding of Suspension Arms has been designed analytically. The design can be used for any passenger vehicle suspension a-arm welding, is cost efficient, is productive and is safe. The fixture satisfies the functionality of the welding.

REFERENCES

1. Akshay G. Bharadwaj, Sujay M., Lohith E., Karthik S., "Design, Analysis, Simulation and Validation of Suspension System for an Electric All-Terrain Vehicle (ATV)" International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), ISSN (Online)2319-8753, Vol. 5, Issue 12, December 2016
2. Burleigh, T., Eagar, Thomas, "Measurement of the Force Exerted by a Welding Arc" Metallurgical Transactions. 14. 1223-1224. 10.1007/BF02659870
3. Metric Spherical Bearings (http://www.mcgillmotorsport.com/bearings-plain-spherical-metric-spherical-bearings/)
4. Nikita G., Deepak Y., Shweta C., Apoorva L., Shreyash D., "Design, Modelling & Analysis of Double Wishbone Suspension System" International Journal on Mechanical Engineering and Robotics (IJMER), ISSN (Print) : 2321-5747, Volume-4, Issue-1,2016
5. RBC Bearings in Spherical Plain Bearings (http://www.rbcbearings.com/sphericalplainbearings/index.htm)
6. Shijil P, Albin Vargheese, Aswin Devasia, Christin Joseph, Josin Jacob, "Design And Analysis of Suspension System for An All Terrain Vehicle" International Journal of Scientific & Engineering Research (IJSER), ISSN 2229-5518, Volume 7, Issue 3, March-2016
7. Suresh, Ganzi, "Design Optimization of a Wishbone Suspension of a Passenger Car" Jawaharlal Nehru Technological University Ananthapuram, 2011-13