FABRICATION OF HYBRID ELECTRIC CHOPPER TYPE MOTORCYCLE FRONT SUSPENSION

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JUDUL: **FABRICATION OF HYBIRD ELECTRIC CHOPPER TYPE MOTORCYCLE FRONT SUSPENSION**

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MUHAMMAD AMIR AKMAL BIN AHAMAD KHALID

Report submitted in partial fulfilment of the requirements for the award of Diploma in Mechanical Engineering

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JULY 2013

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
Name of Supervisor: DR. GAN LEONG MING
Position:
Date:

STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature:
Name: MUHAMMAD AMIR AKMAL BIN AHAMAD KHALID
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Date:

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ABSTRACT

This thesis discussed the process of fabricating of hybrid electric chopper type motorcycle front suspension system. Firstly, the current chopper type motorcycle and hybrid system are studied. The studies include the design, advantages, disadvantages, material and installation. Later, the concept is selected for further studies which involving three dimensional modeling by using software SolidWorks. The fabrication of this hybrid electric chopper type motorcycle front suspension system is later do because the chassis first. The found out of problems also included. The problems covered from the start till project ends. Lastly, the conclusion of the project is documented and given some recommendation for further studies on the project.

ABSTRAK

Tesis ini membincangkan proses reka hibrid elektrik helikopter jenis motosikal sistem suspensi hadapan. Pertama, semasa helikopter jenis motosikal dan sistem hibrid dikaji. Kajian termasuk reka bentuk, kelebihan, kekurangan, bahan dan pemasangan. Kemudian, konsep yang dipilih untuk melanjutkan pelajaran yang melibatkan tiga model dimensi dengan menggunakan perisian SolidWorks. Fabrikasi hibrid elektrik helikopter jenis motosikal sistem suspensi hadapan ini kemudian dilakukan kerana casis pertama. Mendapati daripada masalah juga dimasukkan. Masalah-masalah yang dibincangkan dari awal hingga akhir projek. Akhir sekali, kesimpulan projek didokumenkan dan diberikan beberapa cadangan untuk kajian lanjut mengenai projek itu.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The suspension system allows relative motion in the vehicle and provides comfort and smoothness for the rider. The suspension also helps to support the vehicle weight, keeping the vehicle tires in contact with the road and maintaining the correct vehicle ride height. Suspension system consists of springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two.

For instant, front suspension in a motorcycle consists of spring, absorber and linkage helped in handling the vehicle, supporting the loads and provide user comfort. There are various types of front suspension available in the market, these include telescopic, trailing tube, leading link, springer, earles, girder, telelever, duolever, coaxial steering front suspension, non-fork and triple tree. The numerous types of front suspensions provide different characters to suit the motorcycle design. The front suspension is selected by refer to the objective of the build of motorcycle (Wilson and Hugo, 1995).

Figure 1.0: Chopper motorcycle

Source: http://www.otoriders.com/2010-honda-fury-chopper (3 June 2013)

Figure 1.1: Springer front suspension

Source: Reza N. Jazar (2008)

Figure 1.2: Telescopic front suspension

Source: http://www.hawghalters.com (5 June 2013)

On this project, telescopic front suspension is used. The triple tree of telescopic is selected. The reasons triple tree is selected are the triple tree provide enough clamps lateral offset that the forks clear the sides of the front tire. The triple tree also increase stabilize motorcycle and the Trail is a measurement, on the ground, from a point projected through steering axis to the center of the tire's contact patch directly below the axle, and determines the self-centering stability of the steering (Wilson and Hugo 1993).

1.2 OBJECTIVES

The project objectives are:

a. To reverse engineering of long and highly slanted front suspension unit.

b. To fabricate the working prototype of front suspension unit for two wheels motorcycle.

1.3 SCOPES OF WORK

The scopes that will be figure out in this project are :

a. Reverse engineering.
b. Design in 3D modeling.
c. Machining required part (Absorber part).
d. Fabrication prototype based on the refined design.
e. Servicing fork.
f. System intergration and operation verification.
g. Final report prepared

1.4 PROBLEM STATEMENT

Fabrication of a long and highly slanted front suspension unit for a hybrid electric Chopper type motorcycle can be done by refer to the current chopper rake angle through reverse engineering. However, it is impossible to get the prototype exactly same long and highly slanted as design. Therefore it is necessary to solve the problems in fabrication to ensure the fabricated prototype is functional and provide comfort to the riders.

1.5 FLOW CHART

Figure 1.3 illustrate the project flow chart

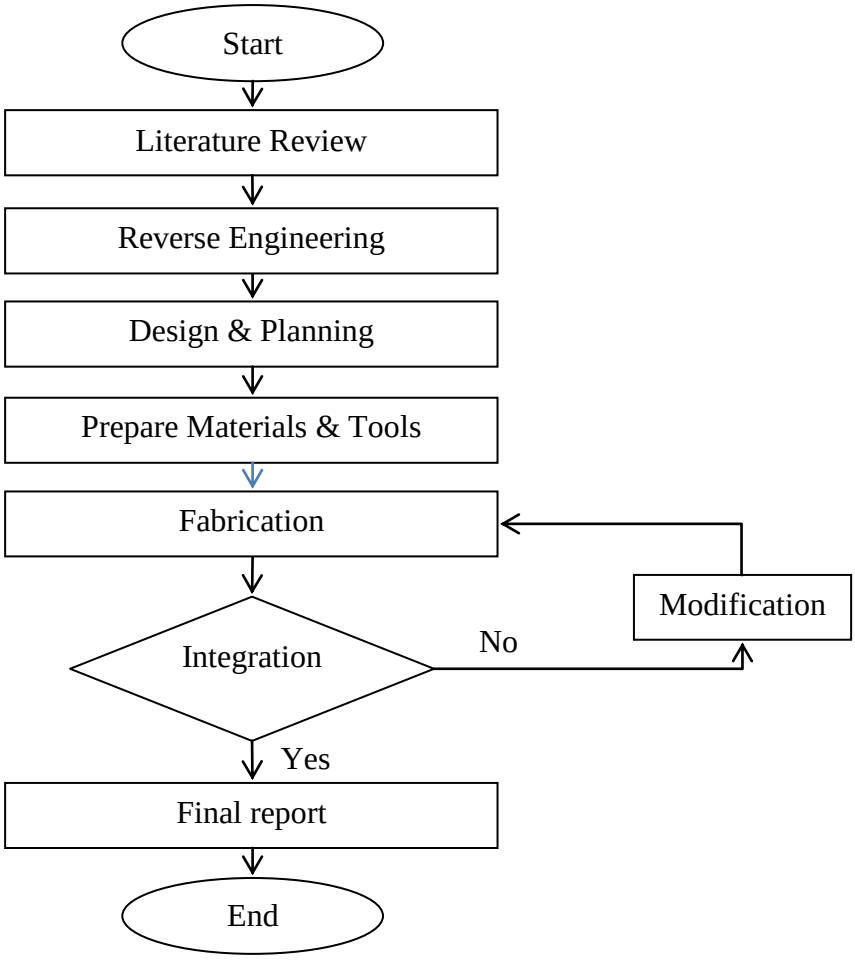

Figure 1.3: Flow Chart

1.6 GANTT CHART

Refer in Appendix

CHAPTER 2

LITERATURE REVIEW

2.1 SUSPENSION SYSTEM

Suspension is the term given to the system of spring, shock absorber and linkages that connect a vehicle to its wheels and allows relative motion between two whether move forward or backwards (Wilson and Hugo, 1995). Suspension system is important to insulate the weight of rider and motorcycle also the shock from the road. The suspension system also important to keep the wheels contact with the ground for maximum control, steering and holding. Suspension has two types which is Front suspension and Rear suspension. Front suspension is the suspension that located in front of the system while rear suspension is vice versa to the front suspension. The typical motorcycle has a pair of fork tubes for the front suspension, and a swing arm with one or two shock absorbers for the rear suspension.

2.2 FRONT SUSPENSION

The main structure of front suspensions is made up of components joined each other by shaft-hub coupling.

Figure 2.1: CAD model of front motorbike suspension

Source: http://www.puppascott.hubpages.com(3 June 2013)

There are many type of front suspension the world. The most common front suspension used for the modern motorcycle is the telescopic fork. The telescopic fork is used because it can be simply large hydraulic shock absorbers with internal coil spring and most stable than other front fork. The telescopic fork allowed the front wheel to working imperfection to the road when isolating the rest of the motorcycle from that motion.

The upper part of the forks are connected to the body of motorcycle by using triple tree clamp, that allow to forks to be turned in order to steer the motorcycle. The lower part of forks will connect to the front axle which in the front wheel spins by using a shaft. Fork consists of many parts. Table 2.1 will show the different type and advantages of the type of front suspension.

Table 2.1: The comparison of front suspension

Tube Forks	Springer Forks	Girder Forks
	The Ups	
Internal suspension components	Classic chopper styling	Resembles springer-style
Traditional and inverted style	Lightest of the three types	Typically employs a shock and spring
Most popular style front end	Better at longer length	Allowances for mounting hardware
Available in several width	Least amount of routine maintenance	Better at longer lengths
	The Downs	
Heaviest of the tree type	May have to make allowance for mounting hardware	Subject to harmonics and vibration if not dampened
Not suited for higher rakes	Subject to harmonics and vibration if not dampened	Do not allow for trail adjustment may require mods, for proper trail
	Do not allow for trail adjustment may require mods for proper trail	

Source: http://www.puppascott.hubpages.com(3 June 2013)

2.3 CHOPPER TYPE MOTORCYCLE

A chopper motorcycle originally means modified from the original factory frame. Basically, the unnecessary part will “chopped up” and some original part are replaced with custom parts (Wasef, Basem and Leno, 2007). The engine and transmission are removed

and the factory frame it cut and welded back together to make it lower and lighter. Some modification was made to the certain part like chroming the fork, and custom paint designs. The overall look and performance make chopper different from factory motorcycle. The chopper motorcycle is suitable for hybrid because chopper motorcycle has a big space for insert the engine, drive train and electric engine. Chopper motorcycle also can carry a weight because it is consider a torque of the chopper motorcycle is high (Frank and Wong, 2001).

Figure 2.2: Chopper Motorcycle

Source: http://www.clarkdever.com(4 June 2013)

2.4 HYBRID ELECTRIC MOTORCYCLE

A hybrid electric motorcycle thrusts with two or more energy sources and at least one of them deliver electrical energy. The electric system in hybrid electric motorcycle operates at high efficiency, allow diversification of energy resources, zero local emission and work silently (Chau and Wong, 2002). The hybrid electric motorcycle had many advantages than fuel motorcycle. In price factor the hybrid electric motorcycle more costly

because the cost production of hybrid electric motorcycle still small and the target market of the rider to hybrid electric motorcycle still small.

Figure 2.3: Electric Chopper motorcycle

Source: http://www.clarkdever.com(5 June 2013)

Figure 2.4: Electric engine

Source: http://www.clarkdever.com(5 June 2013)

2.5 BEARING

A bearing is machine part, which support a moving element and confines its motion. The supporting member usually designated as bearing and the supporting member be journal. Since there is a relative motion between the bearing and the moving element, a certain amount of power must be absorbed in overcoming friction, and if the surface actually touches, there will be a rapid ware (Guran, Ardéshir and Rand,1997).

The term "bearing" is derived from the verb "to bear" a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most

demanding applications are very precise devices; their manufacture requires some of the highest standards of current technology (Merriam-Webster, Inc. 1964).

The main function of a rotating shaft is to transmit power form one end of the line to the other. The bearing also ensure stability and frictionless rotation (Purtell and John, 1999/2001).

For instants, there is many type of bearing in the market. The common bearing is tapered roller bearing and deep groove ball bearing. The needed of bearing depend on the purpose. There are various types of bearing available in the market, these include journal bearing, solid bearing, bushed bearing, pedestal bearing, thrust bearing, footstep bearing, collar bearing, rolling contact bearing, spherical roller bearing, cylindrical roller bearing and tapered roller bearing. Figure 2.5 will show the tapered roller bearing and Figure 2.6 will show needle roller bearing.

Figure 2.5: Tapered roller bearing

Source: http://www.kml-bearing.com(5 June 2013)

Figure 2.6: Needle roller bearing

Source: http://www.kml-bearing.com(5 June 2013)

CHAPTER 3

METHODOLOGY

3.1 REVERSE ENGINEERING

A front suspension or fork in motorcycle Modenas Jaguh, Figure 3.1 will show the Modenas Jaguh front suspension is dismantled for reverse engineering purpose. In order to reduce the time frame and cost, the fork will be modified and reuse in the hybrid electric Chopper, however the existing fork is not long enough to produce a long and high slanted front suspension unit, therefore the upper part of the fork is replace by a new machining part. Figure 3.2 show the new part after machining.

The new part used stainless steel 304 to provide the require strength and corrode resistance. On the other hand, the ball bearing is replace by tapered roller bearing. The tapered roller bearing is easier to handle and service. Figure 3.3 shows the ball bearing.

Figure 3.1 : Modenas Jaguh front suspension

Figure 3.2 : New part after machining

Figure 3.3 : Ball bearing

3.2 DESIGN AND PLANNING

The front suspension components 3D models are build in CAD software SolidWork. Then, the models are integrated into the hybrid electric chopper chassis. Figure 3.4 presents the 3D model for the new upper part of the fork which require machining.

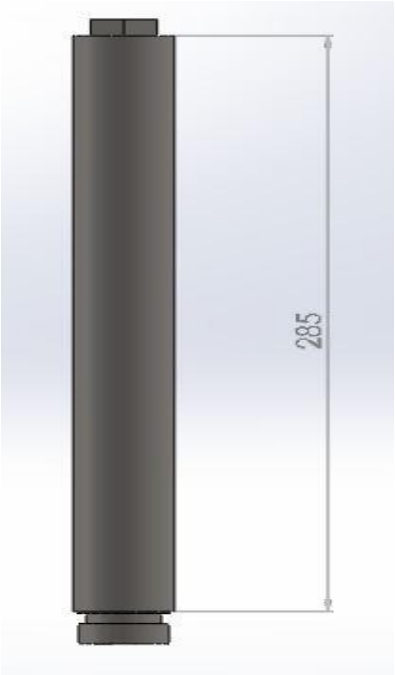

Figure 3.4: New upper part of the fork

The new fork when use 50 degree also design at the SolidWorks. Figure 3.5 present the side view of the front suspension in 3D and Figure 3.6 present the front view.

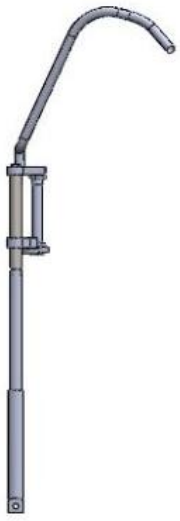

Figure 3.5 : Side view of front suspension in 3D

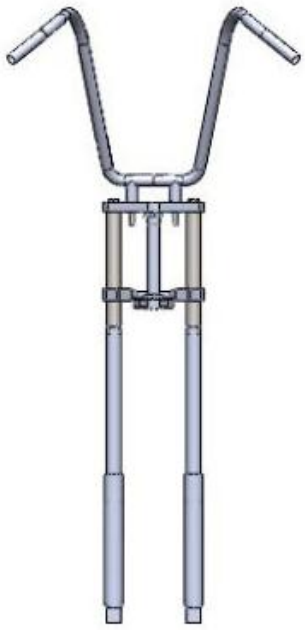

Figure 3.6 : Front view of front suspension in 3D

After the all part are design in SolidWork, the parts are assemble to show the integrating of front suspension into the hybrid electric Chopper chasis. Figure 3.7 show the integrating the front suspension into the hybrid electric Chopper chassis.

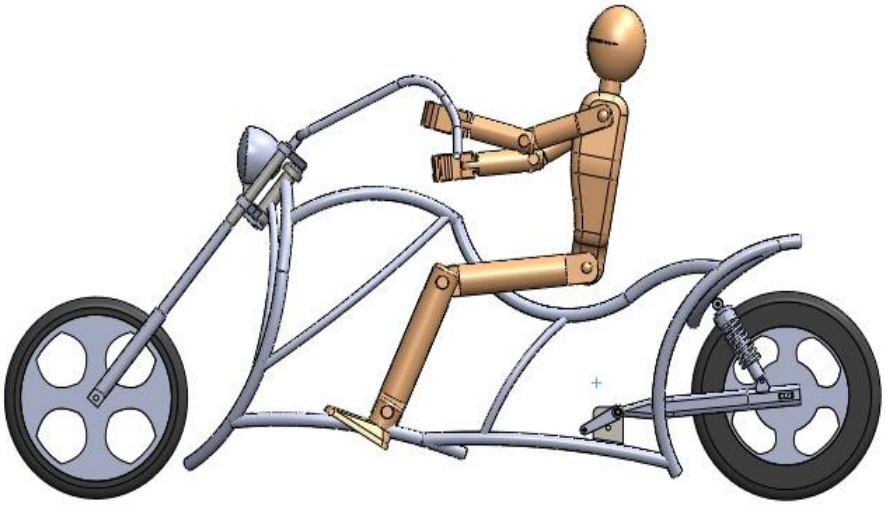

Figure 3.7 : Integrating the front suspension into the hybrid electric Chopper chassis

3.3 MATERIAL AND TOOLS PREPARATION

The equipment and material that are needed in the project are prepared. The materials include a front suspension unit from motorcycle Modenas Jaguh, two tapered roller bearing, new machining part for the upper fork tube in assembly fork and triple tree housing , the machining parts are outsource to workshop to ensure the accuracy in order to hold the front suspension at 50 degree, a jig is build using angle iron, square 1.5 inches iron and MIG welding.

Figure 3.8 : Front suspension unit hold at rake 50 degree angle

Figure 3.9 : MIG welding machine

3.4 JIG FABRICATION PROCESS

In order to hold the front suspension slanted at 50 degree, a jig is build using angle iron, square 1.5 inches iron and MIG welding.

Figure 3.10 : Tire holder

After the holder of front tyre holder is finished. The basement of the jig is build by measure the length and height of the motorcycle. Refer figure 3.11.

Figure 3.11 : Measure the height for motorcycle

The purpose of the man sit is for get the accurate high to build the chasis. After the basement of the jig has finished, the new permanent front tyre holder at the jig is build. Refer Figure 3.12.

Figure 3.12 : Build the permenant front tire holder at the jig

The jig must build at the flatten surface because to get the accurate height and the center of the motorcycle. To make sure the surface is flatten and the height of pair of holder is same, leveling is used and weld it after get a accurate high by using MIG weld. Figure 3.13 show leveling is used for get the same height and test the flatness of the surface and Figure 3.14 show measure the height of tire holder.

Figure 3.13 : Leveling is used

Figure 3.14 : Measure the height of tire holder

Fabrication of jig is continue to hold the front suspension in 50 degree that long and high slanted from the ground. Figure 3.15 show a jig that used for front suspension holder 50 degree and Figure 3.16 show the 50 degree of slanted front suspension unit.

Figure 3.15 : A jig for front suspension 50 degree slanted

Figure 3.16 : 50 degree of slanted front suspension unit

3.5 SERVICING / OVERHAULING FRONT SUSPENSION

The front suspension is send to Modenas outlet for servicing and overhauling. Exhausted parts are replaced such as the gasket, this is to prevent oil leak in front suspension which might cause the front suspension to less effective, others include replace the oil to maintain the damping of the spring when pushed through the small hole and rebound back. The processes of servicing/ overhauling front suspension in Modenas outlet are observed and recorded.

The servicing starts with removing the fork from the triple tree. Loose and removed the front suspension part. Using the impact wrench, with a 6mm, Allen wrench attached to it. Figure 3.17 shows the Modenas worker loose and remove the part the the front suspension.

Figure 3.17 : Loosed and remove the part

The following step is to remove the fork cap and dump out the fork oil. The spring spacer, spring / spacer washer, and fork spring will tend to slide out from the tube. Figure 3.18 shows the fork oil and spring after removed from the fork tube.

Figure 3.18: Remove the fork oil and spring

Next step is use the Allen wrench to the bottom of fork and remove the damper rod bolt. Figure 3.19 present the Allen wrench is used to remove the damper rod bolt.

Figure 3.19: Use Allen Wrench to remove damper rod bolt

Figure 3.20 shows the internal part of fork tubes. Consist of damper, the fork spring, the spacer washer, the spacer and the fork cap.

Figure 3.20 : Internal part of fork tubes

Next step is peel up the O-ring off the fork tube and remove the stopper ring at the fork cylinder. Then, separate the fork tube from fork cylinder. Figure 3.21 present the O-ring is removed.

Figure 3.21 : Peel the O-ring from fork tube

The O-ring, fork oil and stopper ring had been changes to new once. Assemble the fork as the original and made some tested to the fork. A assemble is reverse of disassemble. Push the fork triple or more and see how the fork works. The oil helps the spring when dumping.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 RESULTS

Original upper fork tube is 94mm while the new machine upper fork tube is 285mm. The additional length gives long and highly slanted rake angle on the front suspension unit. The material used for the new machine parts are stainless steel 304 which are corrode resistance and better in strength.

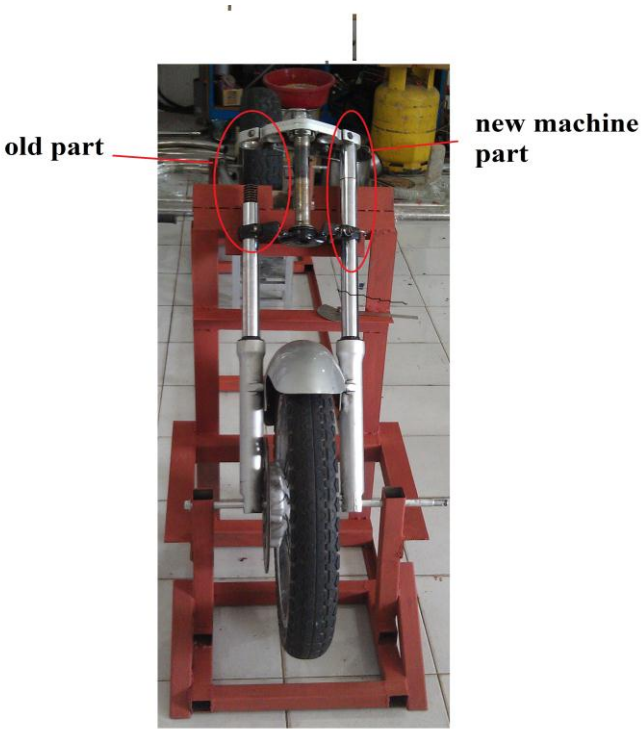

Figure 4.1: The different of length of upper part

Figure 4.2: Tapered roller bearing

Another machine part is the triple tree housing to fits in tapered roller bearing. Tapered roller bearings are stronger, dimensional stability, long life, durable steel cage and easier to service.

Figure 4.4: Front suspension after servicing

The front suspension unit is sent to Modenas outlet to service. The O-ring, fork end stopper ring are replaced to prevent oil leak which might causes the front suspension unit less effective when dumping.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.2 CONCLUSION

The project is completed in the time frame and achieve objectives which are to reverse engineering of long and highly slanted front suspension unit and to fabricate the working prototype of front suspension unit for two wheels motorcycle. The front suspension unit alike the design in Solidwork, this is because of good control during fabrication process. In the mean time, the front suspension is able to perform damping on a bumpy road.

5.3 RECOMMENDATIONS

The jig fabrication need to be precise to ensure the fabricate prototype is alike a design. If the jig not properly build it might cause the prototype differ from design.

REFERENCES

Chopper motorcycle, Topten Review , http://www.chopperparts.com (Accessed 5 June 2013).

D.Croccolo, M.De Agostinis and N.Vincenzi, 2010. Recent improvement and design formulae applied to front motorbike suspension. Engineering Failure Analysis ,17: 1173-1187.

D.Croccolo, R.Cuppini, N.Vincenzi, 2009. Design improvement of clamped joints in front motorbike based on FEM analysis. Finite Elements in Analysis and Design, 45: 406-414.

E.R. Teoh, M. Campbell / Journal of Safety Research 41 (2010) 507–512, Science Direct.

Eric R.Teoh, M.Campbell, 2010. Role of motorcycle type in fatal motorcycle crash.Journal of Safety Research,41 : 507-512.

Hsien-Chung Lai, Jing-Sin Liu and Li-Sheng Wang, 2003. Design parameters study on the stability and perception of riding comfort of electrical motorcycle under rider leaning. Mechatronics, 13:49-76.

Motorcycle Mechanics Institute,The Complete Guide to Motorcycle Mechanics, 1984, Prentice-Hall, Inc., ISBN 0-13-160549-6, p. 291.

P.E. Uys and M. Thoresson, 2007. Suspension settings for optimal ride comfort of off-road vehicles travelling on roads with different roughness and speeds. Journal of Terramechanics, 44: 163-175.

Reza N. Jazar (2008). Vehicle Dynamics: Theory and Applications. Spring. Retrieved 2012-06-24, p. 455.

Wasef, Basem; Leno, Jay (2007), Legendary Motorcycles: The Stories and Bikes Made Famous by Elvis, Peter Fonda, Kenny Roberts and Other Motorcycling Greats.

Wilson, Hugo (1995). "The A-Z of Motorcycles". The Encyclopedia of the Motorcycle (in UK English). London: Dorling Kindersley. p. 100. ISBN 0-7513-0206-6.

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APPENDIX A

PROJECT ACTIIVITIES		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14
LITERATURE REVIEW	PLANNING														
	ACTUAL														
REVERSE ENGINEERING	PLANNING														
	ACTUAL														
DESIGN & PLANNING	PLANNING														
	ACTUAL														
PREPARE MATERIAL & TOOL	PLANNING														
	ACTUAL														
FABRICATION	PLANNING														
	ACTUAL														
SYSTEM INTEGRATION	PLANNING														
	ACTUAL														
MODIFICATION	PLANNING														
	ACTUAL														
FINAL REPORT	PLANNING														
	ACTUAL														