DESIGN AND ANALYSIS OF SINGLE SIDED SWING ARM FOR MODIFIED BIKE

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Abstract - *The swing arm is used to mount the rear wheel of the motorcycle. It also provides the pivot point for the rear suspension of the motorcycle. Typically the swing arm supports on both sides of the wheel. Most standard swing arms also provide for the mechanical adjustment of the drive chain. Standard swing arms come in a variety of sizes up to a 360mm size tire. There are now several different types of single sided swing arms in the market most of which follow the standard manufacturing process of welding multiple pieces together to create the swing arm. The bike requirement is to support it with single side swing arm.*

Key Words: (Size 10 & Bold) Key word1, Key word2, Key word3, etc (Minimum 5 to 8 key words)…

1. INTRODUCTION

Motorcycles are one of the most affordable forms of motorised transport in many parts of the world. For most of the world's population, they are also the most common type of motor vehicle. The swingarm is the main component of the rear suspension of a modern motorcycle. It supports the rear axle while pivoting vertically to allow the suspension to absorb bumps on the road the motorcycle Swingarm is a key component of the rear suspension of a motorcycle. Motorcycle manufacturers are continually striving to improve their products and make components (e.g. the swingarm) lighter, stronger and cheaper. Automobile suspension systems and swingarms play a vital role in influencing ride comfort as well as handling dynamics. The handling qualities of motorcycles are often of great importance. They affect the pleasure to be gained from the rider–machine interactions and the safety of the rider. It connects the rear wheel of the motorcycle to the main chassis and it regulates the rear wheel-road interactions via the spring and shock absorber. Two basic designs exist, namely the single-sided and double-sided swing arms.

2. LITERATURE REVIEW

In Paper [1], CAD modeling of the swing arm was done using CATIA V5 software. A reverse engineering approach was used to model the same.

In paper [2], this paper work is on motorcycle body optimization, how to carry more number of passengers with comfort and safety. The ordinary motorcycle has only one driver seat and passenger seat: and specified as one rear wheel and twins shock absorber.

In paper [6], design of swingarms, the stiffness plays a critical role in the motorcycle response and stability, i.e. the response time during cornering and the motorcycle weave mode stability are affected. It is important therefore to determine the swingarm stiffness characteristics that would give the designer insight into how the motorcycle might respond.

3. MATERIAL SELECTION

AISI 1018 mild/low carbon steel has excellent weldability and produces a uniform and harder case and it is considered as the best steel for carburized parts. AISI 1018 mild/low carbon steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties, AISI 1018 hot rolled steel also includes improved machining characteristics and Brinell hardness.

Table -1: Mechanical Properties

Properties	Value
Hardness, Brinell	126
Hardness, Knoop	145
Hardness, Rockwell B	71
Hardness, Vickers	131
Tensile Strength, Ultimate	440 MPa
Tensile Strength, Yield	370 MPa
Modulus of Elasticity	205 GPa
Bulk Modulus	140 GPa

4. DESIGN

The weight of the motorcycle is 300 kg. Considering average weight of person as 75 kg, considering two person sitting on bike Total dead weight is 450 kg. In most two-wheelers, the distribution of weight on rear axle is 58% to 65%. For the model selected, the weight distribution is taken to be 60 % on rear axle. Thus net load on swing arm can be calculated as, Ls= [ms + 2mp] ×0.6(1) = [300+ 2*75] x 0.6 = 270 kg.

This 270 kg which will be distributed equally on the one side of beams. The load will be acting at an angle of about 50^0 at which the damper is mounted. Thus, the loads are separated into vertical and horizontal components. Vertical load Lvs=Ls Sin θs & horizontal load Lvh=Ls Cos θs.

i.e. Lvs =2650 x sin50^0= 2030 N and Lvh =2650 x cos50^0= 1703 N.

Longitudinal force acting on Swingarm,

The maximum acceleration of the motorcycle is found to be a = 5.5 m/s^2. Also total mass mt = 450 kg. Hence longitudinal force acting on the swing arm can be found as

FL = mT × a=450 x 5.5=2475 N

The dimension of plate is 100 x 60 x 10 mm. Also, the cross sectional area on which acceleration force is acting is found to be 350 mm2. Design of plate at eye,

1) Design for tensile Strength,
   Effective area = 60 x 10=600 mm^2
   =600- (25 x 10)
   =350 mm^2

$$\sigma_t = \frac{p}{a} = \frac{2475}{350} = 7.07mpa$$

2) Design for shear,
   Effective area = 2 x 30 x 10=600 mm^2

$$\varphi = \frac{F}{a} = \frac{2475}{600} = 4.125\text{mpa}$$

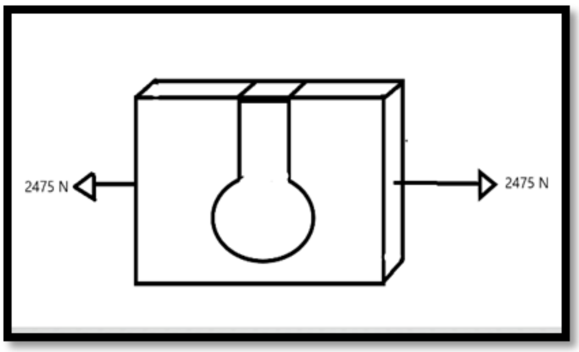

Fig.- 2: Forces during Cornering condition

Braking Condition

This condition is similar to the one mentioned above the difference being that the pressure due to braking will be in opposite direction. The minimum braking time was evaluated experimentally and maximum deceleration was found. For rear braking, the maximum deceleration was found when braking from 50 kmph to 0 in 2 seconds.

From this value, the maximum deceleration is -7 m/s^2.

Considering the inertia of the bike and this acceleration, the longitudinal force on swing arm is

FL = mt × ab

=450 × (-7) = -3150 N

(negative sign indicates force acting in backward direction).

Design for tensile Strength,

Effective area = 60 x 10=600 mm^2

=600- (25 x 10)

=350 mm^2

$$\sigma_t = \frac{p}{a} = \frac{3150}{350} = 9mpa$$

Design for shear,

Effective area = 2 x 30 x 10=600 mm^2

$$\tau = \frac{F}{a} = \frac{3150}{600} = 5.25 \text{ mpa}$$

Design of Hub,

Design for tensile Strength,

$$\sigma_t = \frac{p}{a} = \frac{3150}{160x2x2} = 4.92mpa$$

Design for shear,

$$\tau = \frac{p}{a} = \frac{3150}{160x2x2} = 4.92mpa$$

Cornering Condition

Cornering is one of the important criteria in design on motorcycle components. During cornering, different components are subjected to variation in loads in magnitude as well as direction. In case of swing arm, high lateral forces act in unbalanced state. The magnitude of variation depends upon the angle of inclination and the vehicle speed.

Loads and boundary conditions- It is assumed that 20% more load are transferred to the inner side during cornering. Thus, the inner side beam will have 70% of the total weight and remaining 30% on the outer side beam. If we consider a maximum cornering angle of 40^o, and divide the forces into vertical and horizontal components.

There will be torsional and lateral imbalance on the middle part.

So, 70% of weight ,

Fmax= 0.7× m × g

=0.7× 450 × 9.81

= 3090 N

And remaining 30%,

Fmin = 0.3× m × g

=0.3 × 450 × 9.81

= 1324.35 N.

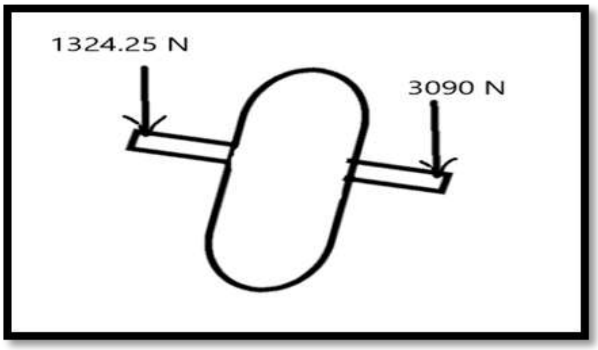

Fig.- 2: Forces during Cornering condition

Thus there are imbalanced forces acting during cornering. For analysis. The maximum values i.e. the inner side swing arm and the middle part is analyzed. The inner side Swingarm will experience more force than outer one. The imbalance will be acting on the middle part.

Load During accident,

Assume accident condition occurring at 100 kmph. Hence, Retardation occurs is a=138.88 m/s^2

Fa=m x a=450 x 138.44 = 62500 N

1) Failure at plate,

$$\sigma = \frac{F}{a} = \frac{62500}{350} = 178.58\ mpa$$

2) Failure at Hub,

$$\sigma = \frac{62500}{160x2x2} = 97.65 mpa$$

Torsional Strength,

$$= \frac{TR}{J},$$

T=F_{max} x L , Where,

F_{max}=3090 N

L=60+25=85mm

T=3090 x 85= 262650 N-mm

$$J = \frac{\pi}{32}(D^4 - d^4) = \frac{\pi}{32}(50^4 - 46^4)$$

$= 174019\ mm4$

$$\tau = \frac{262650x\ 25}{174019} = 37.73\ mpa$$

Factor of Safety

The factor of safety Become,

S_{yt}/σ = 370/178.58 =2.07

5.0 ANASYS VALIDATION

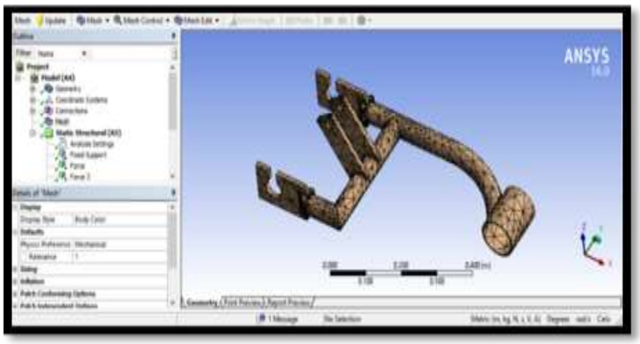

Fig.- 3: Mesh Generation

Result

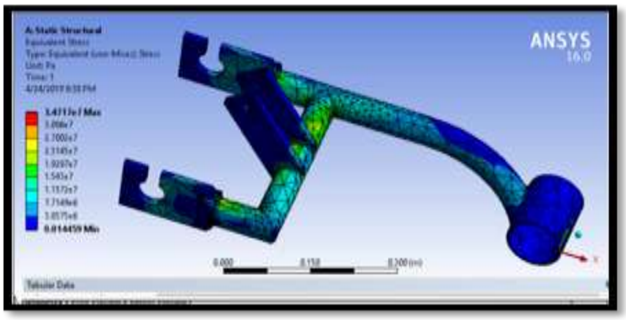

Fig.- 4: Equivalent Stress

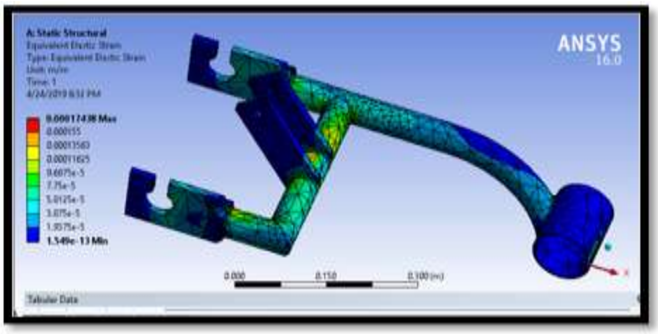

Fig.- 5: Strain value

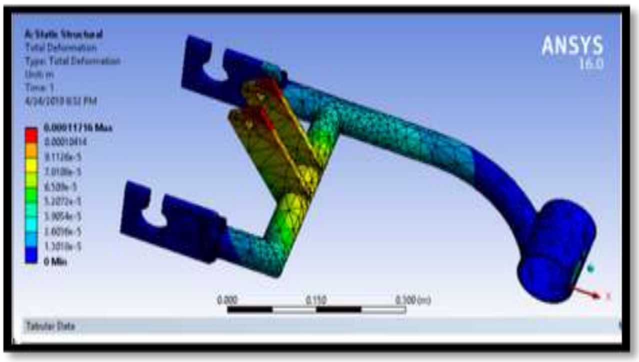

Fig.- 6: Total Deformation

The mass of swingarm model is 9.26 kg .The maximum value of stress induced is 34.71 mpa. As it is much lower than yield strength thus the swingarm is safe in operation.

6. CONCLUSION

It looks likely that double sided swing arm will remain dominant in future, but there will also always be a place for the single sided swing arm. Both systems have their pros and cons and selection depends on application. With the help of above design procedure there is significant reduction of weight is observed. As in ansys validation stress value is also low so, it's clear that design swingarm can give good performance in actual working condition.

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