Design of a Leg Guard at Different Loading Conditions

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Abstract- Increasing popularity of high performance engine technology into two-wheeler market segment has pushed the average speed of the motorcycle to a higher limit which has already increased the possibility of motorcycle impacts causing major knee and lower tibia injuries. Vehicle manufacturers are going through a rigorous process of design, experimentation, and validation based on best of strength requirement, weight reduction, improved fuel efficiency etc. but having least scope in vehicular safety requisite during an vehicular impact. Here we are going to design a leg pad which used in Hero Passion bike which is frequently used in India. We will analyse it by using two different materials and going to improve its material strength & are going to redce its diameter for same strength likewise cost also.

Keywords – Leg guard, Deformation, Strength.

I. INTRODUCTION

Research on the feasibility of rider crash protection devices which might be fitted to motorcycles has occurred during the last 30 years in almost every country. Accidents costs, life injuries and compensations resulting from accidents in India are very high in comparison to other countries of the world. By considering the causes of accidents we observe that the motorcycle riders are the most vulnerable class and that the motorcycle riders have remarkably more probability of losing their life in an accident. Also considering the cheap price of motorcycles, number of the motor vehicle is more in India especially in the capital city (about one million motorcycles equal to 25% of total motor vehicles of the whole country). Therefore, wide studies should be taken to decrease the damage incurred to motorcycle riders at the time of accident.

By considering the accidents of motorcycles it is evident that the most vulnerable limb of the body in motorcycle accident is legs in such a manner that about 60% of motor cycle accident resulted into leg injury of motorcycle rider. One of the effective means of decreasing the injury of this body limb is motor cycle leg protector (Guard) especially front leg protector. At the time of collision of motorcycle with other motor vehicle or ground, the front guards cause into probable decrease in serious injury. One of the effective means of decreasing the injury of this body limb is motor cycle leg protector (Guard) especially front leg protector. At the time of collision of motorcycle with other motor vehicle or ground, the front guards cause into probable decrease in serious injury. The most important part of body in motorcycle accidents is the leg; as in about 60 percent of motorcycle accident that cause injuries, leg injuries are perceivable. Hence to reduce such damage proper analysis should be done on leg guard to reduce harm so here we are going to use two different materials on which after applying different load condition which one can predict which material is better one.

II. LEG GUARD THEORY - ROAD ACCIDENT & LEG INJURY:

Leg protectors and airbags are always mentioned in many researchs and articles, to be the two main secondary safety devices. Leg injuries account for approximately 60% of serious injuries to motorcyclists, and frequently lead to permanent disability. Leg protectors have been suggested as a way of reducing such injuries. Researchs has resulted in contradictory claims for the efficacy of leg protectors, with some studies suggesting that they would reduce leg injuries, but others suggesting that they might even increase the risk of other kinds of injury.

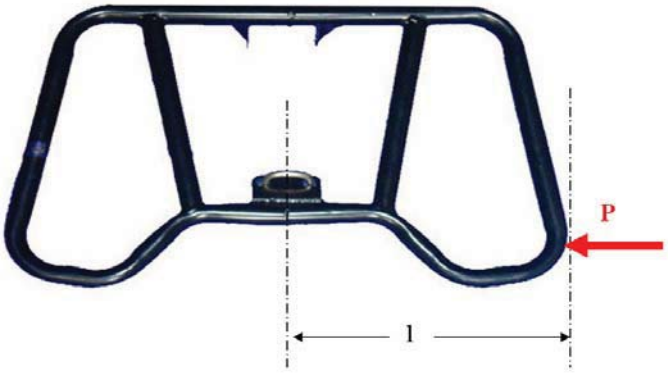

Fig.1 Leg guard

III. PROBLEM DEFINITION

Day by day as the technology is changing we are optimizing the material so as to get maximum capacity by giving less efforts, here the leg pad which is the important part of bike is designed in such a way that its weight & cost should be reduced, & its strength must be increased.

For design of a leg guard we will consider Different loading conditions as 3000N, 5000N, 7000N etc. Then the compressive as well as bending forces have to calculate. To obtain such result here we are going to design the existing material & then new material, and then we will compare their result to obtain the best material for leg guard.

IV. METHODOLOGY

Here we are going to analyse c440 Stainless steel which is existing material & then c 650 Stainless steel as a new material. Now initially for c440 Stainless steel following conditions are considered.

a) Conditions considered- For c440 stainless steel

Length l = 320 mm
Outer diameter d_0 = 40 mm
Inner Diameter di = 32 mm
Youngs modulus = E = 350 Gpa = 350 x 10^3 N/mm2

b) Conditions considered- For c650 stainless steel

Length l = 320 mm
Outer diameter d0 = 40 mm
Inner Diameter di = 33 mm
Youngs modulus = E = 460 GPa = 460 x 10^3 N/mm2

c) Force considered

a) P1 = 300 Kg = 3000N
b) P2 = 500 Kg = 5000N
c) P3 = 700 Kg = 7000N

5. Deflection on leg guard

Initially we calculate the cross sectional area
Area A = p (d_0^2 - d_i^2) / 4

a) Deflection

= dl = Pl/AE = Load x length / Area x young's modulus

b) Bending force

Initially we calculate the moment of inertia for the section

I = p (d_0^4 - d_i^4)/64 Deflection dl = Wl3/3EI
= Load x length3 / 3 x Young's modulus x Moment of inertia

c) Stresses Consideration
Initially we calculate the cross sectional area
Area A = p (d_0^2 - d_i^2) / 4
Stress s = P/A = Force / Area

d) Bending force
W = p (d_0^4 - d_i^4)/32 d_0
Moment = Mb = P x l = Force x Length
Stress s = Mb / W = Moment / Axial sectional module

VI. Result and discussion

Sr. no.	Content	Old material	New material
Deflection - in Compression			
1	d1 - 300 KG	0.006 mm	0.005 mm
2	d2 - 500 KG	0.010 mm	0.008 mm
3	d3 - 700 KG	0.014 mm	0.012 mm
Deflection - in Bending			
4	d1 - 300 KG	1.262 mm	1.056 mm
5	d2 - 500 KG	2.104 mm	1.761 mm
6	d3 - 700 KG	2.941 mm	2.464 mm
Stresses - in Compression			
7	s_1 - 300 KG	6.63 N/mm^2	7.48 N/mm^2
8	s_2 - 500 KG	11.06 N/mm^2	12.46 N/mm^2
9	s_3 - 700 KG	15.48 N/mm^2	17.44 N/mm^2
Maximum Stress bearing capacity		**440 N/mm^2**	**670 N/mm^2**
Stresses - in Bending			
10	s_1 - 300 KG	258.52 N/mm^2	284.04 N/mm^2
11	s_2 - 500 KG	431.60 N/mm^2	473.40 N/mm^2
12	s_3 - 700 KG	604.24 N/mm^2	652.76 N/mm^2
Maximum Stress bearing capacity		**440 N/mm^2**	**670 N/mm^2**
Maximum load bearing capacity		**500 Kg**	**700 Kg**

VII. Comparison of Dimension & cost

Dimension			
Sr. no.	Content	Old material	New material
1	Outer diameter	40 mm	40 mm
2	Inner Diameter	32 mm	33 mm
3	Thickness	4 mm	3.5 mm
4	Cross sectional area	452 mm^2	401.13 mm^2
5	Volume	623760 mm^3	553559.4 mm^3
6	Weight	4.86 Kg	4.31Kg

Cost			
1	Per Kg Rate	Rs 164/- per Kg	Rs 180/- per Kg
2	Product Cost	Rs 801.90/-	Rs 775.80/-
Cost Saving Rs 26.1/-			

VIII.CONCLUSION

1) The deflection under compression are negligible, This ensures there is no problem even at a force of 700 KG.
2) The deflection under bending is also very less, compared with the space between the leg guard and actual leg.
3) Stresses under compressive load are also very less, ensure no failure under this condition.
4) Stress under bending load are a concern, they are with the yield strength till a load of 500 Kg, which is very much more compared to the actual weight of the vehicle that is only 100 Kg.
5) If we use c650 material then the load carrying capacity of material will increase upto 700kg

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