ISSN 2347-4289

Stuctural Analysis Of Two Wheeler Handlebar

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ABSTRACT: In day today life we frequently come across some minor incidents occurring in case of two wheeler. This includes problems like damage to various two wheeler parts because of vehicle slipping, collapsing, and minor dash or due to impact of heavy weight. In such cases the handle of vehicle deforms or undergoes buckling/bending. This dissertation aims at studding the deformation taking place due to buckling by analyzing the stresses and reducing this stresses by making modification in dimensions or by changing material properties of handlebar.

Keywords: thickness, buckling/bending, stress, deformation.

INTRODUCTION

The two-wheeler and four-wheeler industry are normally faced with challenges related to safety. The compliance of vehicle in this regard is of almost importance while the same could be approved by the concerned regulatory authorities for being used on the public roads. Besides, all other parts and components that support and/or form an integral part of the assembly of the sub-system could be required to comply with the norms. The scope of this dissertation work falls in this area where the design of the component or the sub-assembly needs to be reviewed for the sake of failure during use. In collisions and other accident, the handlebar of a motorcycle can experience more stress than any other part of the vehicle. Because of this, when any minor damage occurs to the handlebar, it is not merely repaired but completely replaced for safety's sake. For our case, the lower case of the handle bar is met with failure near the accelerator end of the handle. The deformation of the handle after collapsing on one side is up to 20 to 30 mm. A study is being initiated by the sponsoring company for identifying the source of this failure and addressing the same with modified or improved design features for reducing the incidence of failure. The material in this case is mild steel or chrome plated steel and Stainless steel. They are easy to process, can be very ductile and resistant to corrosion. Typical applications include the automotive industry, piping, containers and loading devices. Such a large number of applications require a more detailed structural analysis which, in turn, can only be reliably performed if the material behavior is well understood. There has been a substantial research effort during the last decades to understand material behavior, including its dynamic response. However, it is clear that models still require further improvements. In any event, constitutive models rely on material parameters that must be measured. Hence, any temperature, environment is important. In the case of structures undergoing large strains, dynamic loads and impact, the material model should contemplate strain rate effects on its response. Motorcycle handlebar refers to the steering mechanism for motorcycles. Handlebars often support part of the rider's weight, and provide a mounting place for controls such as brake, throttle, clutch, horn, light switch, and rear view mirrors.

INFLUENCING ELEMENTS OF BUCKLING STRESSES

a) Handlebar Material It includes the handlebar material and its physical properties (mechanical and thermal properties, microstructure, etc) which determine impact force and energy for the applied cutting conditions

b) Geometry of Handlebar It includes the geometry of handlebar like thickness, length, angle of inclination which affects on stress formation.

C) The Dynamic Characteristic of the vehicle as well as the impact force act on handlebar is to be consider.

Creating Material Properties While selecting the material properties it is assume that the material is to be isotropic in nature. The properties select for structural analysis are given in Table 1 & 2

Table 1: Properties of material

Mechanical Properties of Stainless Steel AISI302	
Yield strength(mpa)	280
Ultimate strength	515
Density (g/cm^3)	7.89
Elongation (%)	12-40
Elastic Modulus (Gpa)	180
Thermal Conductivity (W/mK)	11.2-36.7
BHN	137-595
Poisson's Ratio	0.27-0.3

ISSN 2347-4289

Table 2: Chemical Properties

Chemical Properties (Stainless Steel AISI 302)	
Alloy	302
C	0.15
Mn	2
P	0.05
S	0.03
Si	1
Cr	17.00-19.00
Ni	8.00-10.00
Mo	0.75
Cu	0.8
N	0.1
Other	-

CONSTRUCTION

Handlebars are made from hollow metal tubing, typically aluminium alloys, mild steel , chrome plated steel and Stainless steel but also of carbon fiber and titanium, shaped to the desired contour. Holes may be drilled for the internal routing of control cables such as brake, throttle, and clutch. Risers hold the handlebars above their mounting position on the upper triple tree or the top of the fork, and may be integrated into the bar itself or separate items. Bar-end weights are often added to either end of the handlebar to damp vibration by moving the bars' resonant frequency away from that generated by the engine. Electrical heating elements may be added under the handlebar grips to provide comfort to the user in cold weather.

STRESS MEASUREMENT

Analytical In this study behavior of handlebar is like cantilever beams under a combined compressive axial load and an imposed lateral bending deflection are analyzed. In a compression member or compression portion of a member, the load at which bending progresses without an increase in the load called as buckling Load

Buckling Stress = $\sqrt{\sigma_b{}^2 + \sigma_c{}^2}$ ....(1)

But the Gross Weight of Vehicle without Rider is

m = Dry Weight + mass of Fuel + Other ....(2)

Impact Velocity of vehicle = $\sqrt{2gh}$

By Impulse Momentum Principle

The vehicle is collapse at an angle of 45°

F × t = m [Vx- Ux]

To find out the moment of handle bar in three dimensional axis is,

The moment of a force can be expressed in following forms.

$$M_D = r \times F = \begin{bmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{bmatrix}$$

Where,

i, j ,k = Vector of axis

r = Position vector in x, y, z direction respectively

F = Force

The bending stress equation is,

$$\frac{M}{I} = \frac{\sigma}{Y}$$

& the Compressive Force;

$$\sigma = F/A$$

As per calculation we conclude that the compressive stress is very small as compared to bending stress. So here the compressive stress is very negligible, so neglected **FEA method** In the present paper, the commercial FEA software ANSYS, was used to simulate the process. A numerical model of handlebar is employed with the objective of measuring the buckling/bending stress profiles in the handlebar edge for several parameters, including: thickness and handlebar angles. The FEA observations as shown in Table

Table 3 FEA Observations of Handlebar

Thick Ness (mm)	**Buckling Stress For SS (mpa)**	**Total Defo-rmation (mm)**	**Directional Defo-rmation (mm)**	**Buckling Stress For SS (mpa)**	**Total Defo-rmation (mm)**	**Directional Defo-rmation (mm)**
1.5	459.52	11.53	10.832	767.11	19.89	18.05
2.5	257.1	5.811	5.29	429.32	9.69	8.881
2.6	246.17	5.552	5.036	410.29	9.2	8.393
2.7	235.45	5.264	4.798	392.42	8.77	7.99
2.8	225.3	5.023	4.581	375.55	8.37	7.636
2.9	215.9	4.805	4.383	359.83	8.08	7.306
3	207.2	4.605	4.202	345.34	7.67	7.003

ISSN 2347-4289

Representative results for sample obtained by ANSYS software as shown in figure 1, figure 2 respectively.

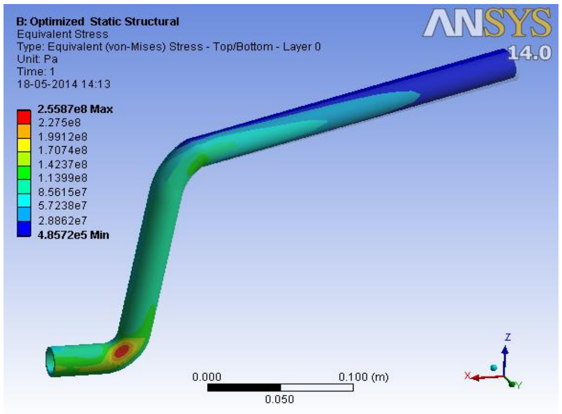

Fig 1 Buckling/Bending Stress Distribution for 2.8 mm Thickness

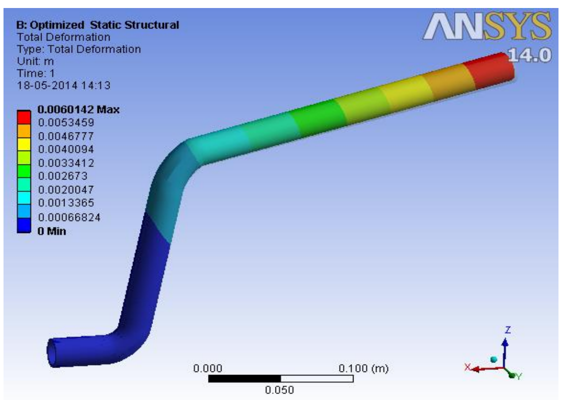

Fig 2 Total Deformation for 2.8 Thicknesses

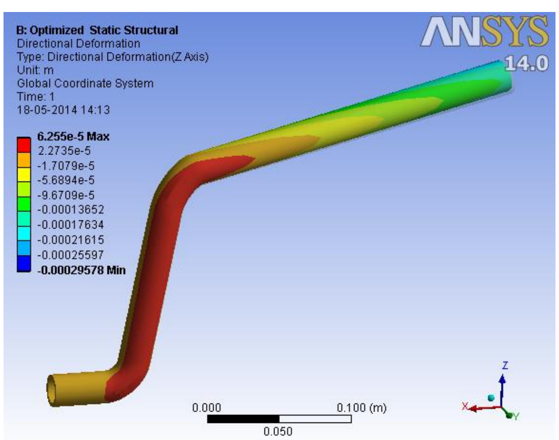

Fig 3 Directional Deformation for 2.8 mm Thickness

Effect of Thickness (t) on Buckling/Bending Stress, Total Deformation And Directional Deformation:

Fig 3 shows the stress distribution handlebar edge after being impact at 2.8 mm thickness. It is observe that the Buckling/Bending Stress shows maximum value at minimum thickness and minimum at optimizing 2.8 mm thickness (i.e.14.4 mm ID). It can be seen from fig.6.9 that, as the thickness of inner diameter of handlebar is increases the buckling stress shows minimum stress value. It can be seen from fig 4 the total deformation of handlebar is also decreases with increasing thickness but for optimizing thickness is 2.8 mm. It is also observe that the directional deformation is also decreases with decreasing stress of hollow handlebar but in z- direction shown in fig 6.

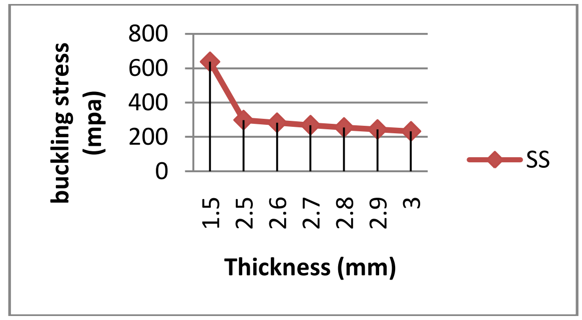

Fig 4 Stress Distribution Vs Thickness for SS (AISI302) Material

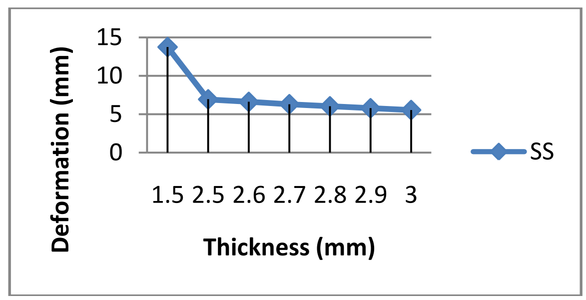

Fig 5 Total Deformation Vs Thickness (SS AISI302)

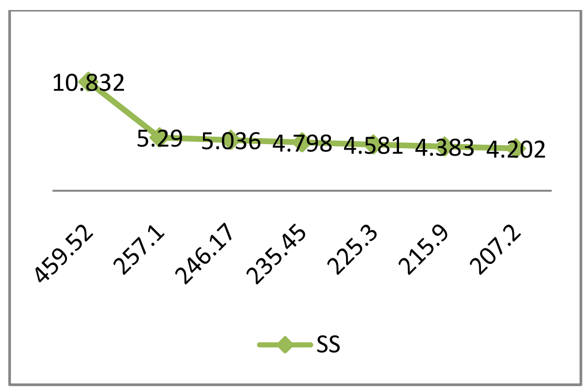

Fig 6 Directional Deformation Vs Stress Distribution

Figure 7 shows stress distribution of mild steel and stainless steel (SS AISI302) . It is observe that the stress distribution in mild steel(423.80Mpa) is maximum than stainless steel(255.87Mpa) at 2.8 mm thickness for same impact force and, directed in y- direction. The figure shows difference of buckling stress is up to 168Mpa. And resulting into the deformation of handlebar is decreases with decreasing stress up to 3 to 4 mm shown in figure 8

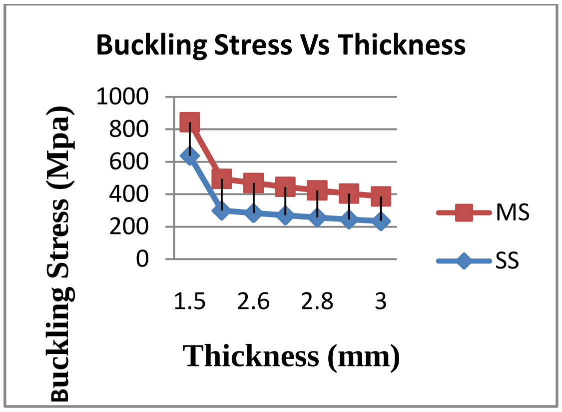

Fig 7 Comparing Stress Distribution between Mild Steel and Stainless Steel (SS302)

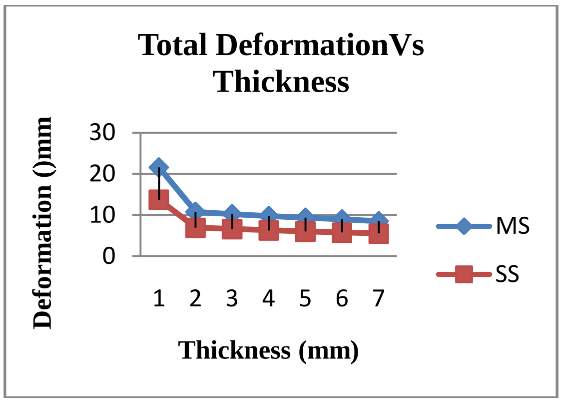

Fig 8 Comparing Total Distribution between Mild Steel and Stainless Steel (SS302)

As per the FEA solution the stress developed by impact force in Y direction is more than that of Z directional impact shown in figure 9 In Mild steel the buckling stress value is decreases up to 423.89Mpa and 255.87 in Stainless steel (AISI302) for 2.8 mm thickness of handlebar. So as per design consideration, the handlebar is safety in second material. Shown fig.10

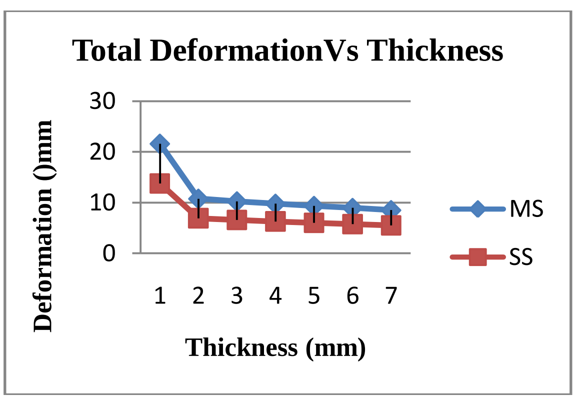

Fig 9 Comparing Total Distribution between Mild Steel and Stainless Steel (SS302)

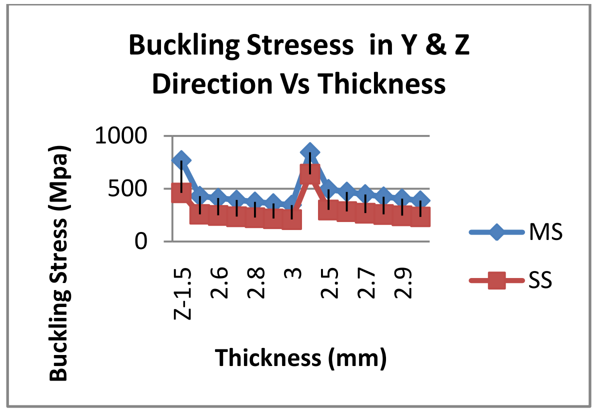

Fig 10 Comparing Z & Y Directional Stress Distribution between Mild Steel and Stainless Steel (SS302)

Similarly comparing the effect of impact force in Y and Z direction on handlebar. By observing the graph it shows the total deformation in Z direction is less than that of Y directional deformation. It also shows that the total deformation for mild steel is also greater than of SS (AISI302) material in both direction of force. The Figure 6.15 is shows the comparison of total deformation viruses directional deformation in Z and Y directional impact force cases in both mild steel and SS(AISI302) material.

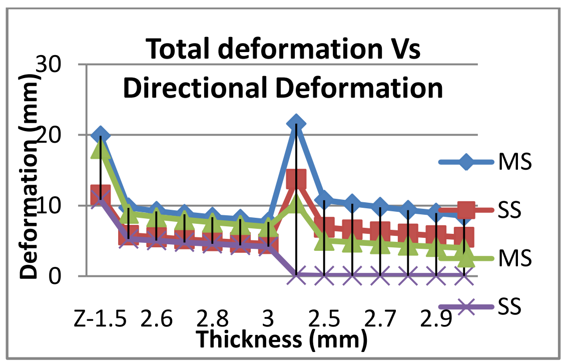

Fig 6.14 Comparing Z & Y Direction Total Deformation Vs Directional Deformation for Mild Steel and Stainless Steel (AISI302) material

RESULT AND DISCUSSION

EXPERIMENTATION

Impact Test

The test is conducting on UTM (Universal Testing Machine). The testing apparatus consisted of a 300 N drop hammer being released at a height and velocity of 1087 mm and 4.6 m/s respectively above the end span of the specimen. The support conditions were kept similar to the static testing; however, to prevent the specimens bouncing when struck by the hammer, roller bars were placed above the specimen at the supports or other end of specimen is clamped by nut and bolt. Post yield strain gauges were used in the testing, with a specified accuracy of up to 20,000με. The strain gauge was located on the underside of the columns longitudinally placed in the direct centre. Laser deflection systems were used at the quarter point of the specimens, with the end span deflections measured using a wire potentiometer. They provided a comparison for the accuracy of the results and also gave an indication of the curvature of the column. The results from both the laser deflections and the wire potentiometers were similar and proportionate for all tests.

Load Vs Deflection

The initial peak and the area termed mean residual load are illustrated in Figure 7.1. The area underneath the load deflection graphs can be calculated to give an indication of the energy absorption, which is approximately equal to the impact energy. Impact energy can be calculated through a simple potential energy calculation using equation.

$$P.E. = mgh$$

In this set of experiments the mass of the drop hammer was 300N, with a drop height of 1087mm, giving PE equal to 326.1 J. All sections approximately absorbed the same amount of potential energy. The difference in shape of the load vs. deflection graph, most notably the ultimate deflection, provides an indication of the relative energy absorption ability and ductility. The load vs. deflection graphs for the relative sections are shown in Figure 7.1 and 7.2

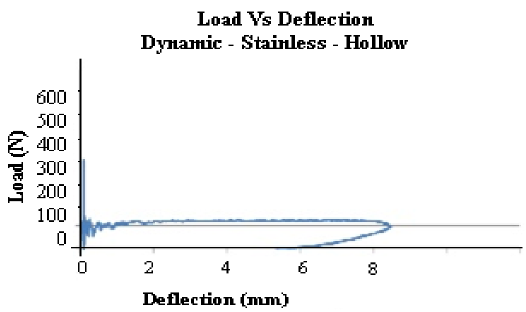

Fig. 7.1 Impact Load Vs Deflection Graphs for Stainless Steel (Hollow)

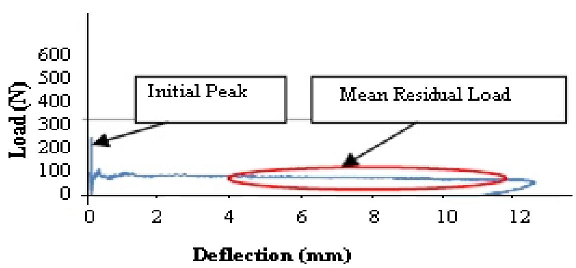

Fig. 7.2 Impact Load Vs Deflection Graphs for Mild Steel (Hollow)

VALIDATION BETWEEN EXPERIMENTAL AND FEA RESULT

As evidence of the ability of the simulation procedure to model the buckling stresses in the handlebar, a validation is made between finite element predictions and the experimental results obtained by technique. The Table 7.1 represents the percentage of error between physical results and finite element analysis results. Uncertainty is the amount of doubt in the result of a measurement. It is usually described by a parameter that defines the range within which the true value of the quantity being measured is estimated to fall (within a given confidence – usually 94%). At all stages in the measurement and subsequent analysis of data there exist potential sources of error. Error is the measurement result minus the true value of the quantity being measured. Whenever possible, a correction equal and opposite of the error should be applied to the result. To evaluate measurement uncertainty, all sources of. It is observed from the table 4 that the predicted results were nearly same magnitude as those obtained by experimentally and therefore the FEA model can be applied to study the influence of impact parameters on buckling stresses.

Table 4 Validation between Experimental Results with FEA Results

Description	**Material**	**SS (AISI 302)**	**MS (ASTM A36)**
Buckling Stress	Experimental Results	264.48	448.55
	FEA results	255.87	423.89
	Percentage Error	3.25	5.49
Total Deformation	Experimental Results	6.29	10.235
	FEA results	6.014	9.345
	Percentage Error	4.38	8.69
Directional Deformation	Experimental Results	0.06	4.5
	FEA results	0.0571	4.017
	Percentage Error	4.83	9.55

It is observed from the result obtained by physical and software testing, if thickness of handlebar increases the buckling stresses decreases, resulted into deformation is also decreases. The experimental result is obtained for different material as shown in table 7.1. Comparing experimental and FEA result with different handlebar material, the stainless steel (AISI302) having deformation for same impact load and for same thickness is less than that of mild steel as well as CRCA (Cold Rolled Close Annealed) According to Thomas W. McDowell [3] the material for handlebar which is to minimizes the buckling stresses and deformation, which leads to increasing tool life. So for satisfying above properties, we conclude that stainless steel is better material at 2.8 mm thickness for two wheeler handlebar.

CONCLUSION

- 3D modelling of the tube drawing process helped in visualization and conceptualization. The modelling saves the research time and minimizes the risk of design failure.

ISSN 2347-4289

- Simulation of the process helps to check the design of dies and plug as well helps to visualize the deformation of handlebar.
- The experimental investigation was conducted to turn mild steel as per ASTM A36 using AISI 302 stainless steel handlebar and by employing UTM (Universal Testing Machine) and Finite Element Analysis. The effect of dimensions of specimen on the buckling/bending stresses of the handlebar was studied under dry condition and the following conclusions are drawn:
  1. Increasing the thickness of handlebar the decrease of the buckling/bending stresses.
  2. Increasing the thickness of handlebar the decrease of the total deformation as well as directional deformation also.
  3. Resistance to corrosion which increases the life of handlebar.

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