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Mathematical Analysis for Safety and Cost Effectiveness of Quad Bike for Impact on Bumper of Frame

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Abstract: ***The project is executed Mathematical Analysis For Safety And Cost Effectiveness Of Quad Bike For Impact On Bumper Of Frame. The project is executed in 2 phases to get a detailed understanding and feasibility of the idea. The design of chassis of the vehicle using PTC CREO 2.0 software and analysis is carried out using ANSYS software. Automobile bumpers formed from rolled sheet steel and each having a cross-sectional profile designed to carry impact loads without additional reinforcements, and which are selectively hardened to withstand impact of a high order of magnitude without damage. A special problem existed in the construction and styling of bumpers to provide efficient means to transmit impact energy to the energy absorbing devices attached to the vehicle body. To attain adequate beam strength in prior bumpers it has generally been necessary to provide reinforcement, often in the form of added bar structure or the section mass has been substantially increased. In order to effectively achieve this requirement, we aimed at introducing a pair of dashpot dampers which aimed at absorbing the higher impact. Below study shows the feasibility in terms of efficiency and construction cost of the system with proper implementation.***

Keywords: Quad bike frame, bumpers, fluid dashpot damper, PTC Creo, Ansys

1. Introduction

With the rapid development of automobile industry, accident rate is higher and higher; all countries begin to attach importance to the vehicle safety. Research on the safety of bumper collision has large help to improve the vehicle collision safety, so the bumper safety performance has importance significance. In the early 1930s Europe has begun studying the vehicle collision at that time, the main research method is experimental method. After the 1980s with the development of the computer, the vehicle collision research method change into the finite element method analysis.

Car accidents are happening every day. Most drivers are convinced that they can avoid such troublesome solutions. However the statistics shows that ten thousand dead and hundreds of thousands to million wounded each year. Hence, improvement in the safety of automobiles is requisite to decrease the number of accidents. Automotive bumper system is one of the key systems in passenger cars. Bumper systems are designed to prevent are reduce physical damage to the front or rear end of passenger motor vehicle in collision condition. It protects the hood, truck, grill, fuel, exhaust and cooling system as well as safety related equipments such as parking light, headlamps and taillights etc. A good design of car bumper must provide safety for passengers and should have low weight. Different countries have different performance standards for bumpers. Under the international safety regulations originally developed as European standards and now adopted by most countries outside North America, a car`s safety system still function normally after a straight-on pendulum or moving-barrier impact of 4km/h (2.5 mph) to the front and rear, and to the front and rear corners of 2.5 km/h (1.6 mph) at 45.5 cm (18 in) above the ground with the vehicle loaded or unloaded. In North America (FMSS: federal Motor Vehicle Safety Standards), it should be meet 4 kmph pendulum and barrier impacts. The function of automotive bumpers has changed considerably over the past 70 years. The last performance is achieved by a combination of careful design, material selection to obtain a particular balance of stiffness, strength and energy absorption. Stiffness and energy absorption are essential criterion. Stiffness is important because vehicle design consideration limits the packaging space for the bumper design to deform under load and energy absorption is important because bumper must limit the amount of the impact force transmitted to the surrounding rails and vehicle frame. Automotive bumper plays a very important role in absorbing impact energy (original purpose Of safety) and styling stand point/aesthetic purpose. Now days, automotive industry concentrates on optimization of weight and safety. This will increase the performance of the Bumper, improve absorbing capacity during impact load and increase the protection the protection of the front car component. By limiting physical damage to expensive components, bumper systems reduce insurance expenses for OEMs (original Equipment Manufacturer).

2. Quad Bike

Quad bike is a class of multi-wheeled vehicles; the most common types are 3- and 4-wheel machines. Quad bike (QUAD BIKE) is a vehicle that travels on low pressure tires driven using handlebar or steering wheel for steering control. Although, quad bike were first designed only for a single operator but now-a-days man companies have developed Quad bike with two or more seats. In most of the countries

around the globe, these vehicles are banned on streets. Handling quad bike is very different from other vehicles, including 2-wheel motor bikes. Operating quad bike is "rider active" where the rider must use his or her body movements to help control the machine.

The first three-wheeled quad bike was the sperry rand Tricart. It was designed in 1967 as a graduate project of John Plessinger at the Cranbrook Academy of Arts near Detroit. The Tricart was straddle-ridden with a sit-in rather than sit-on style (similar to the contemporaneous big wheel toy). In 1968 Plessinger sold the Tricart patents and design rights to Sperry-Rand new Holland who manufactured them commercially. Numerous small American manufacturers of 3-wheelers followed. These small manufacturers were unable to compete when larger motorcycle companies like Honda entered the market in the early 1970s. By the early 1980s, suspension and lower-profile tires were introduced. The 1982 Honda ATC200E Big Red was a landmark model. It featured both suspension and racks, making it the first utility three-wheeled quad bike. The ability to go anywhere on terrain that most other vehicles could not cross soon made them popular with US and Canadian hunters, and those just looking for a good trail ride.

In 1985 Suzuki introduced to the industry the first high-performance four-wheel quad bike, the Suzuki L.T250quad racer. This machine was in production for the 1985–1992 models

Figure 1.2: 3D Model of bumper with frame of Quad Bike.

1. Mathematical modelling

Material 1st– E 250A Mild Steel.

- Density = 7.87 g/cc
- Poisson Ratio = 0.29
- E = 190 GPa
- Sut = 420 MPa
- Syt = 330 MPa

Material 2nd – AISI 4130 Alloy Steel.

- Density = 7.85 g/cc
- Poisson Ratio = 0.3
- E = 210 GPa
- Sut = 560 MPa
- Syt = 460 MPa

Analysis parameters Frame design specification:

- Overall length = 55"
- Overall width = 50"
- Overall Height = 19.2"
- Frame weight = 62 kg
- Shocks weight = 1.2kg*2

Front impact analysis (phase - I) Assumptions

- Bike velocity (V) = 80 km/h = 22.22 m/s
- Bike mass (M1) = 220 kg
- Rider mass (M2) = 80 kg
- Total mass (M) = (M1+M2) = 300 kg
- Moment P = M*V

= 300*22.22
= 6.666 kgm/s

- Frontal Impact force

F = P / Δt (Δ = impact time)
= 6.666/1
= 6.666 N

- Quad bike will have max. Of 1.68g force under accident limit.
- Impact force F = 1.68*m*a

= 1.68*300*9.81
= 4944 N

- Values of the forces are practically comparable.
- According to a research body has to pass 6.8g force for extreme worst case collision.
- Static frontal analysis force is calculated as

  F = 6.8*m*a
  = 6.8*300*9.81
- F = 20.021 N approx 20 kN

Unit Installed (Phase - II)

MTS test results

- Max. Damping force Vavg. = 9.4 m/s
- Fmax. = 940 kg/damper
- Overall damping force = 940*2

= 1880 kgf

- Impact absorbed by unit = 940*9.81

= 9221N

- Force transmitted to chassis = 20.021-9221

=10.008N
Fn = 10 kN (50%)

Cost analysis

- We need 58 links for bumper manufacturing, then
- Area of cross section = 1.2056*10^6 mm^2
- Length = 15070 mm + 30% extra = 20 meter
- Price of E 250A is 170 Rs. Per meter, then
- 170*20M = 3400/- Rs.
- Price of AISI 4130 is 500 Rs. Per meter, then
- 500*20 = 10000/- Rs.

Modified bumper unit price

2 Shock absorber Hero CD Deluxe New=1100 each

- 1200 Rs. For our unit because we used old one.

Bumper frame and installation

- Pipe = E 250A
- Length = 2 meter (Max.)
- Fabrication cost = 550 Rs.
- Total cost = 1750 Rs.

Cost saving = (10000-3400-1750)
= 4850/- Rs.

Weight analysis

- Frame weight with ought unit = 62 kg.
- Frame with Unit

Suspension = 1200gm*2 = 2400 Frame = 1500gm
= 3900gm (added)

3. Analysis

We are utilizing analysis programming for examination on the bumper that we had structured and programming variant is ANSYS 19.2 Ansys Inc. Is an American on roll organization situated in Canonsburg, Rolln Sylvania. It creates and markets building recreation programming. Ansys programming is utilized to plan items and semiconductors, just as to make attachments that test an items sturdiness, temperature appropriation, smooth motion and electromagnetic properties.

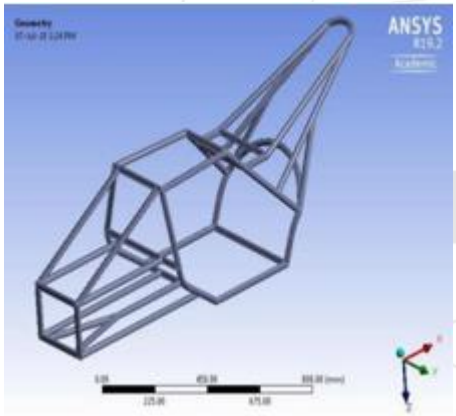

Figure 6.1: Geometry of Quad Bike

4. Conclusions

From the study of above analysis we must think about safety of human being because safety criteria is major concern now a days, but if safety deals with cost reduction initiative than its a great combination and by the help of this analysis below mentioned concluded results generated:

- This analysis shows the benefits of chipper material (E 250A) over AISI 4130.
- Safety increases around 50% within cost range of project.
- It also reduces sudden impact and shocks.
- Stress concentration distributed over quad bike.
- Additional damping increase vehicle stability.

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