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FABRICATION OF ALL TERRAIN VEHICLE BY USING CONTINUOUSLY VARIABLE TRANSMISSION SYSTEM

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Abstract- The objectives of this design and analysis of an ATV fun to drive, versatile, safe, durable, and high performance off road vehicle. We have to ensure that the vehicle spastics the limits of set rules. This vehicle must be capable of negotiating the most extreme terrain with confidence and ease. We met these objectives by dividing the vehicle into its major component subsystems. The ATV design on the basis to apply the principles of engineering science to expose their proficiency in the automotive world. The design focuses towards explaining the procedure and methodology used for designing the off road vehicle. We have tried to design an all terrain vehicle that meets international standards and is also cost effective at the same time. We have focused on every single system to improve the performance of each component. Our vehicle can navigate through almost all terrain, which ultimately is the objective behind the making of any all terrain vehicles. We began the task of designing by conducting extensive research of each main component of the vehicle. We did not want to design certain areas such as the frame, and then make the rest to fit. We considered each component to be significant, and thereby designed the vehicle as a whole trying to optimize each component while constantly considering how other components would be affected. This forced us to think outside the box, research more thoroughly, and redesign components along the way in order to have a successful design.

I. INTRODUCTION

ATV means a all terrain vehicle which is specially designed for a off roads driving. ATV is designed for very rough terrain, jumps, maneuverability and endurance. The design process of this single-person vehicle is iterative and based on several engineering and reverse engineering processes. Following are the major points which were considered for designing the off road vehicle:

Endurance

- Safety and Ergonomics.
- Market availability.
- Cost of the components.
- Standardization and Serviceability.
- Maneuverability.
- Safe engineering practices.

The designing work is initiated to achieve the best standardized as well as optimized design possible. Creo Parametric 1.0 (Pro Engineer) was the CAD software used for designing and ANSYS 13.0 was used to analyze the Impact test and all.

Specifications laid down by the standard specification available **foremost concern while designing and selection of the parts**. Besides performance, consumer needs of serviceability and affordability were also kept in concern which we got to know through the internet research and reviews for all terrain vehicles. The primary objective of the frame is to provide a 3-dimensional protected space around the driver that will keep the driver safe. Its secondary objectives are to provide reliable mounting locations for components, be appealing, low in cost, and low in weight. These objectives were met by choosing a frame material that has good strength and also weighs less giving us an advantage in weight reduction. A low cost frame was provided through material selection and incorporating more continuous members with bends rather than a collection of members welded together to reduce manufacturing costs. PRO-ENGINEERING were used to model a frame that is aesthetically appealing and meets all requirements. The design criterion followed here is design for the worst and optimize the design while avoiding over designing which would help in reducing cost. We proceeded by setting up the budget for the user throughout the design process we distributed the budget in such a way that if we assign more money to one system, we reduce that amount from some other system.

II. DESIGN METHODOLOGY

We have designed the roll cage keeping in view the safety and aesthetics. These are the two factors which matters us the most, therefore they are given utmost consideration.

III. ROLL CAGE DESIGN

Roll Cage can be called as skeleton of a vehicle, besides its purpose being seating the driver, providing safety and incorporating other sub-systems of the vehicle, the main purpose is to form a frame or so called Chassis.

IV. MATERIAL OF THE ROLL CAGE

Material selection of the chassis plays crucial part in providing the desired strength, endurance, safety and reliability to the vehicle. To choose the optimal material we did an extensive study on the properties of different carbon steel. The procurement team was directed to get the quote of those steel pipes. Wefirst considered AISI 1018 steel. The strategy behind selecting the material for roll cage was to achieve maximum welding area, good bending stiffness, minimum weight and maximum strength for the pipes. So, after market analysis on cost, availability and properties of these two alloys, we finalized AISI 1018 of the following dimensions:

Outer Diameter: 26.7 mm Wall Thickness: 3 mm, Then analyses of the roll cage considering AISI 1018 pipes of shown dimensions was done and we got the safe factor more than 2, which justified the selection .

V. VEHICLE DIMENSIONS

A wider track width at the front than at the rear will provide more stability in turning the car into corners decreasing the tendency of the car to trip over itself on corner entry and more resistance to diagonal load transfer. Wheel Base is 1600mm and Track Width is 1550mm. This has been chosen to ensure better balance and straight-line stability. This has also created ample space for the driver and other systems.

VI. ROLL CAGE COMPONENTS

The components used to design the Roll Cage, their functions and designing procedure is mentioned below:

a) Rear Roll Hoop (RRH):

The RRH was the first section of the chassis to be designed. It is angled back at 100° angle to provide the driver with the most natural sitting position possible. It consists of four sections of tubing welded on the ends. The Rear Roll Hoop Lateral Diagonal Bracing (LDB) keeps the RRH from deforming and increases overall stiffness of the chassis. Two lateral members have been used for support and mounting points for seat belts and engine.

b) Roll Hoop Overhead (RHO):

The RHO is welded to the RRH. The RHO provides the appropriate head room for a 6 feet 3 inch driver with additional 6 inch clearance.

c) Lower Frame Side Members (LFS):

The LFS is welded at the bottom of the RRH as shown in Fig. 1.
The width of LFS keeps on decreasing along the length.
This provides maximum driver space and at the same time it reduces the size of the vehicle.
The Lateral Cross (LC) Member joins the LFS in the front. The width of the LC member is selected so as to accommodate the three pedals comfortably.

d) Side Impact Members (SIM):

The SIM increases chassis stiffness and is a major member that provides protection to the driver in a side-on collision. It is a single piece of tubing with two bends as shown in Fig. 1. The SIM extends straight up to the driver's elbows and then converges in the front.

The LC connecting the SIM in the front is a very important member because it is the first member of chassis to be hit in case of frontal impact. It not only protects the driver from frontal impacts but also increases the stiffness of the Roll Cage.

e) Rear Bracing:

The Rear Bracing encloses the engine, transmission, and rear drive assembly. The rear bracing also incorporates an independent rear suspension. The main properties of the rear chassis are all constrained by the driveline. Before the base of the rear was designed, the length of the drive axle was considered. Also the height of the lower rear roll cage is defined by the rear suspension mounting points. From this point the rest of the rear roll cage is designed. To check the accommodation of driver in the roll cage design made, the team took two more days to make a dummy cockpit using Poly Vinyl Chloride pipes. The driver was seated to check out the comfortably and front visibility from the vehicle. After this test two major changes were done in the design:

i) Two front members were removed and its replacement was done by adding supports.
ii) The dimensions of the car were changed by a small ratio.

VII. MECHANICAL PROPERTIES

- Density (×1000 kg/m3) -7.7-8.03
- Poisson's Ratio -0.27-0.30
- Elastic Modulus (GPa) -190-210
- Tensile Strength (Mpa) -440
- Yield Strength (Mpa) - 370
- Elongation (%) -28.2
- Reduction in Area (%) -55.6
- Hardness (HB) -156
- Impact Strength (J)IZOD -61.7

VIII. DRIVER ERGONOMICS

For the purpose of driver comfort/ergonomics an assembly was imported to AUTO CAD software. This assembly included the roll cage of the car, seat, steering system and the driver. The driver was placed in order to mimic the actual situation during the race. Using AUTO CAD:

- Proper pedal positioning is ensured for easy operation of pedals by driver
- International Journal of Mechanical And Production Engineering, Design and analysis of an All Terrain Vehicle Posture of driver is examined so that any of his body parts does not interface with the proposed design of Chassis
- Finally a simulation was done in AUTO CAD Ergonomics Analysis to ensure that driver could get out of the car within 5 seconds in case of emergency.

IX. FINITE ELEMENT ANALYSIS OF ROLL CAGE

After completing the design of the Roll Cage, Finite Element Analysis (FEA) was performed on the Roll Cage using ANSYS 13.0 to ensure expected loadings do not exceed material specifications. Beam 188 element was selected with the cross section as the dimensions of pipe. The meshing was done globally with a size of 3mm and smooth transition in mesh. Ex= 3.65 x 108 N/m^2 and PRXY= 0.3 was used as per AISI 1018 properties. Standard loads as per Europe National Car Assessment Programme (EUNCAP) were applied on the key points and the results were obtained for Frontal Impact, Side Impact and Roll over. Results obtained were not so safe for the Impact so we added two more members to the roll cage. Finally, the maximum stress was found due to Frontal Impact on the truss members. It is around 1.74 x 108 N/m^2 which is within the limits. For other situations also results provided by the ANSYS are within limits. From the results of analysis we conclude that Von Mises stresses are within the limits and FoS is always greater than 2. Hence design is safe.

X. SUSPENSION

An ATV is supposed to have the best of the suspension systems than the other categories of vehicles. The unpredictable nature of off-road racing creates the need for a reliable and efficient suspension system. So the selection of suspension system was a tenacious task for the team, even the roll cage was designed keeping in concern the position of suspension mounting points. Selection of suspensions was based on the criteria of their degree of freedom, roll-center adjustability, ease in wheel alignment parameters etc. The suspension system will be tuned according to the actual needs, keeping in mind the manufacturing aspects and the nature of loading it will have to suffer.

The design goals of the suspension system were:
1. Improve vehicle handling
2. Increase the ride height and total wheel travel
3. Improve durability of components International Journal of Mechanical And Production Engineering, Because of inconsistencies in the track each of the four wheels need to act independently of each other. For this reason, an independent suspension was chosen over a dependent one. Among the independent suspensions MacPherson Strut, Double Wishbone and Semi-Trailing Arm were among our chief Considerations.

XI. BRAKING SYSTEM

An excellent braking system is the most important safety feature of any land vehicle. Competition regulations require at least two separate hydraulic braking systems, so that in the event of a failure of one, the other will continue to provide adequate braking power to the wheels. The main requirement of the vehicle's braking system is that it must be capable of locking all four wheels on a dry surface. Ease of manufacturability, performance and simplicity are a few important criteria considered for the selection of the braking system.

OBJECTIVES

The goals for the braking system were:

1. Reduce weight in the overall system.
   - Increased reliability
   - Improved performance. [2]

XII. CONTROL ARMS

Design for optimal geometry of the control arms is done to both support the race-weight of the vehicle as well as to provide optimal performance. Design of the control arms also includes maximum adjustability in order to tune the suspension for a given task at hand. Also kinematic analysis on the control arms was done as shown in the figure below to determine the dimensions of cross-section of control arms Parameters affected by the lower mounting point are the speed and the steering ability of the vehicle. Both of them are equally important for us therefore lower mounting points of the shocks will be more or less in the middle of the A-arm. In the rear the shockers are mounted on the upper arms as it can't be mounted on the lower arm as the axle runs between the upper and the lower arms. Therefore the shocks will be mounted in the center of the upper A-arms Main features of our suspension design are

- We have positioned our roll centers at 81.66 mm and 114.82 mm above the ground in the front and rear respectively. These values allow us to minimize jacking forces while maintaining acceptable values for roll.
- The ratio of Rear to Front Roll center is 1.44, close to 1.5 which is considered ideal.
- We have provided Nose dive type roll axis to minimize vehicle roll.[5]

XIII. STEERING

The essentials still remaining the same, the importance of the steering mechanism cannot be compromised with. The BAJA track consisting of sharp turns and bumpy roads, the stability of the system and the response time (Feedback) are vital factors in deciding the vehicles' run. The Worm and Sector mechanism, Rack and pinion and the circulating ball mechanism were among our options to go with. Buton consideration of mounting ease, simplicity in design and considering that our vehicle is of the compact category; rack and pinion was chosen over the others. The rack and pinion being a simple system; can be easily maneuvered and the defect, if any, can be spotted and taken care of Moreover the steering wheel and other relevant apparatus are so placed in the design, for easy entering and exit of the driver.

1. Steering Geometry:

The Ackermann geometry is the easiest to implement and has been tested for BAJA vehicles all over the globe and hence it was a unanimous choice for the steering geometry. With Ackermann Steering all four wheels of the vehicle pivot around the same point making sharp turns relatively easy to accomplish. This ensures that the vehicle tires do not slip during turns that are sudden. The major parameters in steering design are,

1. The Caster angle has been adjusted to 50 as it increases directional stability and handling of the vehicle in bumpy sections.
2. The Camber is kept negative to ensure maximum contact of tire with ground during cornering and to reduce chances of flipping over.
3. Ackermann type of steering geometry ensures consistent and smoother ride and prevents the slipping of tires during cornering.
4. We have a scrub radius of 44 mm approximately. This is acceptable as it is neither a negative value nor too large of a positive value. Such a small value will leave the car slightly harder to steer at very low speeds. It is important for this value to be equal on both tires to avoid the car "pulling" to one side.

2. TECHNICAL SPECIFICATION CONCLUSION:

When undertaking design of any vehicle there are several factors to be considered that are common to all engineering vehicles. A vehicle must have a proper scope with clearly defined goal.. With such an approach, engineers can come up with the best possible product for the society.

We are also planning to conduct a customer needs survey to improve the vehicle further more. Anything being done for the first time, few difficulties are sure to come. Further improvements and a detail design of all other systems of the vehicle will lead to competitive vehicle. We hope to come with the best possible final product.

CONCLUSION

The objective of designing a single-passenger off-road race vehicle with high safety and low production costs seems to be accomplished. The design is first conceptualized based on personal experiences and intuition. Engineering principles and design processes are then used to verify and create a vehicle with optimal performance, safety, manufacturability, and ergonomics. The design process included using Solid Works, CATIA and ANSYS software packages to model, simulate, and assist in the analysis of the completed vehicle. After initial testing it will be seen that our design should improve the design and durability of all the systems on the car and make any necessary changes up until the leaves for the competition. The power-train used in the design offers easy operation and maintenance. Multiple unique design features provide easy adjustability that give the owner more control over the vehicle. Further, software analysis shows us that the vehicle can take frontal impacts of up to 159.46 Mpa and side impacts of up to 189.66 Mpa. This clearly reaffirms the vehicle's ability to withstand extreme conditions.

REFERENCES

[1] Eisler, "Automobile Engineering"
[2] ack Erjavec "Automotive Technology"
[3] ohn Fenton "Handbook of vehicle design analysis"
[4] 2013 Baja SAE Rules, SAE India.
[5] www.wikipedia.com
[6] www.howstuffworks.com
[7] Julian Happian-Smith, "An Introduction to Modern Vehicle Design: Edited",
[8] "SAE BAJA 2013 Preliminary Design Report" by Richard Doley

FINAL DESIGN VIEW OF AN ALL TERRAIN VEHICLE