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Design and Fabrication of All-Terrain Quad Bike

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Abstract— Designing purpose of this Quad bike is to manufacture an off road vehicle that could help in transportation in hilly areas, farming field and as a reliable experience for a weekend enthusiast. In order to accomplish this task, different design aspects of a Quad Bike vehicles were analyzed, and certain elements of the bike were chosen for specific focus. There are many facets to an off-road vehicle, such as the chassis, suspension, steering, drive-train and braking, all of which require thorough design concentration. The most time and effort went into designing and implementing these components of the vehicle because it was felt that they most dramatically affect the off-road driving experience.

Index Terms— All-Terrain vehicle, Design, Hub, Prototype and Greadability etc.

I. INTRODUCTION (HEADING 1)

Main purpose of this paper is to understand the design and fabrication of Quad Bike. ATV means an All-Terrain vehicle, classified as quad, quad bike, 3 wheelers, 4 wheelers, or quad-tricycle is defined by the American National Standards Institute (ANSI) as a vehicle that travels on low pressure tires, with a seat that is straddled by the operator, along with the handle bar for a steering control. As the name implies, it is a design to handle a wider variety of terrain than most other vehicles. The ATV is specially designed for an off road 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.

The designing work is initiated to achieve the best standardized as well as optimized design possible. CATIA was the CAD software used for designing and ANSYS was used to analyze the impact test and all specification available was the 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 various sub-systems that will keep the driver safe. Its secondary objectives are to provide reliable mounting locations for components, appealing, low in cost, and low in weight. The main objective was to create an ATV i.e. Quad Bike prototype to ride easily in rough terrains such as deserts and overcome muddy ditches. Quad bikes are primarily designed to ride in deserts and off road terrain areas like as conventional bikes and vehicles can't be used in this terrain.

II. PROBLEM FORMULATION

We are going to design and fabricate such a vehicle that will eliminate most of the problems such as to ride easily in rough terrains like deserts and muddy ditches. Productivity increased by the vehicle specially designed to ride in deserts and off road terrain areas where conventional bikes and vehicles can't be used.

Concept and Objective of the machine is explained below

a. Concept

By introducing a low cost vehicle was to overcome various limitations with the current manual traditional method. The concept of the work is,

(1) Observe the manual procedure and method and to identify the limitations.
(2) Identifying and obtaining various process variables and keeping them in mind.
(3) Investigate and verify all areas of automating the technology.
(4) Produce a specification for a cheaper than other automatic all-terrain vehicle.

b. Objective

The main objective of this project is to overcome the traditional method

(1) To provide a 3-dimensional protected space around the various sub-systems.
(2) To keep the Driver safe.
(3) To provide reliable mounting locations for components.
(4) To produce a low cost light weight ATV.

III. DESIGN OF THE VEHICLE

(1) Chasis specifications

(1) Material used = AISI 4130
(2) Density (g/cm^3) = 7.85
(3) Yield tensile strength(MPa) = 435

(4) Ultimate tensile strength(MPa) = 655
(5) Outer Diameter = 31.75 mm
(6) Wall thickness = 1.651 mm

(2) Engine specifications

(1) Engine type = Single Cylinder,Air-cooled
(2) Capacity = 250cc
(3) Bore = 67 mm, Stroke = 65 mm.
(4) Compression ratio = 9.0:1
(5) Max. Net Power & Rotating Speed = 11.5kw/7000 RPM
(6) Max. Torque & Rotating Speed = 16.0N.m/6000 RPM
(7) Ideal RPM = 1420 RPM
(8) Starter = Electric/Kick Starter

(3) Steering System Parameters

(1) Wheel base = 1070 mm
(2) Track Width= 1000 mm
(3) Tie rod angle with plates= 1.327^o
(4) Tie rod length = 415.3 mm
(5) Inner angle = 32.12^o
(6) Outer angle = 22.46^o
(7) Turning radius(inner) = 2062.1 mm
(8) Turning radius(outer) = 2870.1 mm
(9) Steering Arm length = 90 mm
(10) Steering arm angle with wheel = 16^o

(4) Design of Shaft

(1) Material used = EN24
(2) Ultimate tensile strength, Sut = 840 N/mm^2
(3) Yield tensile strength, Syt = 680 N/mm^2
(4) Assuming load suddenly applied (minor shock), K_b =1.2, K_t = 1.5

(5) Design of Brakes and Caliper

(1) FRONT DISC: Outer diameter (D_{of}) = 200 mm, Inner diameter (D_{if}) =174 mm, $R_{eff,f}$ = 0.0925 m
(2) REAR DISC: Outer diameter (D_{or}) = 270 mm, Inner diameter (D_{ir}) = 230 mm, $R_{eff,r}$ = 0.124375 m
(3) FRONT CALIPER: Caliper piston diameter (D_f) = 24 mm, Area of piston = 452.39 mm^2
(4) REAR CALIPER: Caliper piston diameter (D_r) = 27 mm Area of piston = 572.555 mm^2
(5) FRONT BRAKES: Leverage ratio (L_1/L_2) =5.5, Driver force (F_d) =6 Kg, Coefficient of friction of brake pad (μ_b) = 0.3
(6) REAR BRAKES: Leverage ratio = (L_1/L_2) =2, Driver force (F_d) =18 Kg, Coefficient of friction of brake pad (μ_b)= 0.3

(6) Suspension system

(1) Point of attachment of strut =152.16 mm from chassis end
(2) Reaction force acting from the ground on the wheel = 383.179 N
(3) Horizontal distance of reaction force from hinge point = 380.404 mm
(4) Horizontal distance of strut attachment point from hinge point = 228.244 mm
(5) Spring Forces = 638.627 N
The other parameters are as per the spring type which is as following

a. Front spring

(1) Angle of inclination of the Spring Damper = 60^o
(2) Dynamic force acting on Front spring = 1596.57 N
(3) Required Spring Stiffness = 15.714 N/mm

b. Rear spring

(1) Angle of inclination of the Spring Damper = 60^o
(2) Dynamic Forces on Rear spring = 2645.757 N
(3) Required Spring Stiffness = 66.143 N/mm

(7) Electrical system

(1) Switches used = 2 Kill switches, Ignition switch, Fuse box and Relays for protection purpose
(2) Mechanism used = push to off
(3) Mechanisms used for break overdrive switch = push to off
(4) Battery rating = 12V
(5) Alternator used = for charging of battery
All circuits are grounded.

IV. COMPONENTS AND ASSEMBLY

a. Components

Fig. 1 CATIA model of Chassis

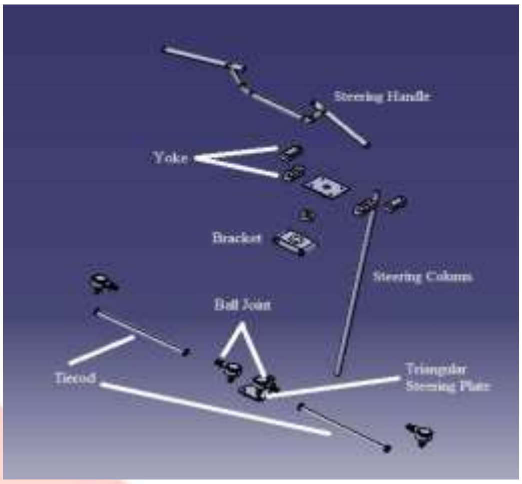

Fig. 2 Exploded View of Steering

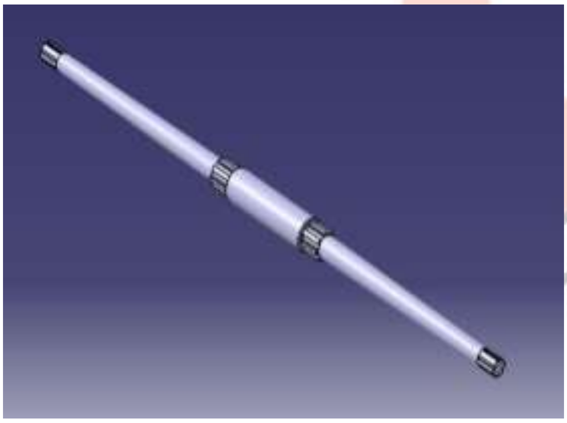

Fig. 3 CATIA model of Shaft

Fig. 4 CATIA model of Front Brake Disc

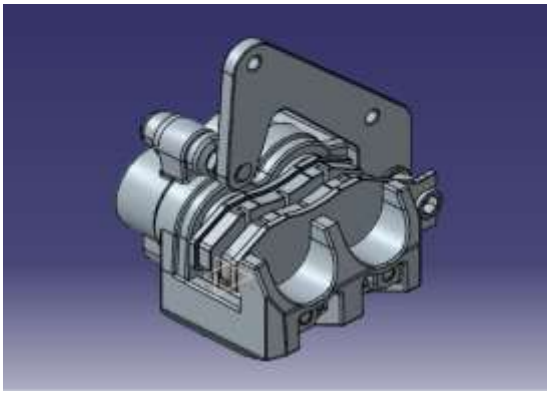

Fig. 5 CATIA model of Rear Caliper

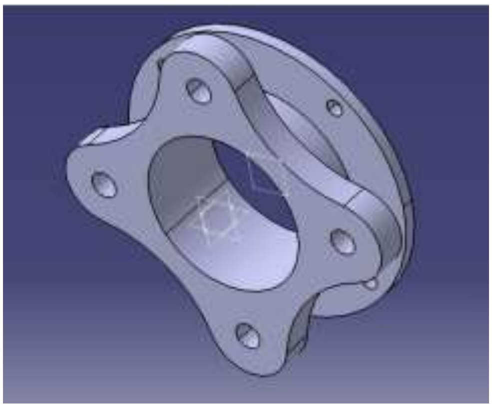

Fig. 6 CATIA model of FRONT HUB

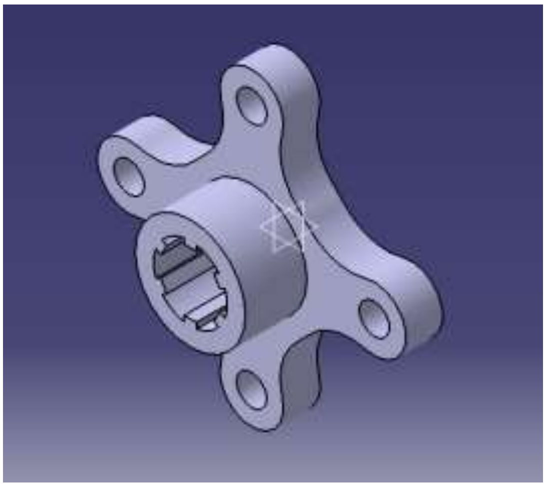

Fig. 7 CATIA model of REAR Hub

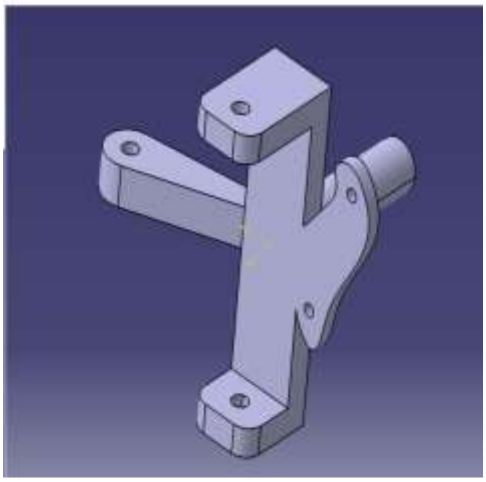

Fig. 8 CATIA model of KNUCKLE

b. Final assembly

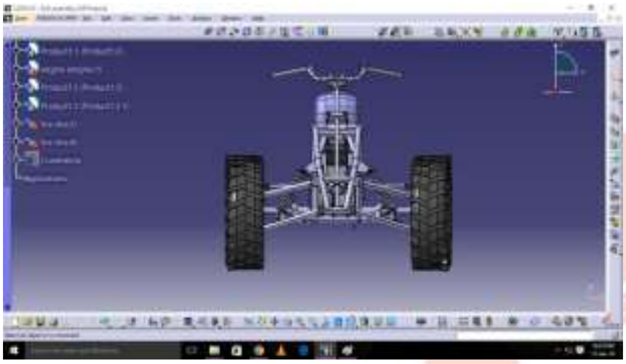

Fig. 9 Back View of Vehicle

Fig. 10 Isometric View of Vehicle

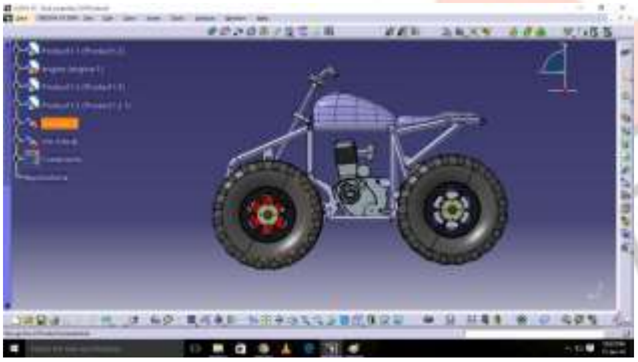

Fig. 11 Side View of Vehicle

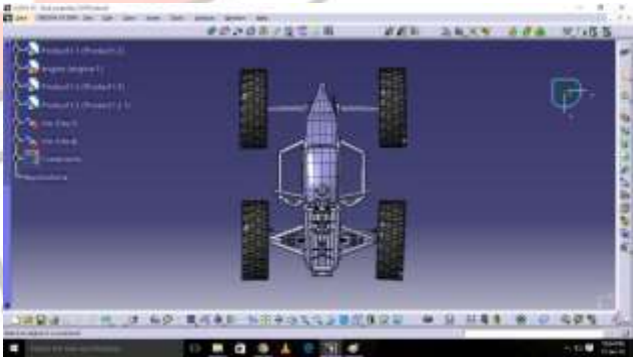

Fig. 12 Top View of Vehicle

Fig. 13 Image of prototype

V. TESTING AND ANALYSIS

Each component of all-terrain vehicle is tested in ANSYS and all the tests were conducted. After taking readings, we have found out results of All-terrain Quad Bike. All the results are in favor and hence design is safe.

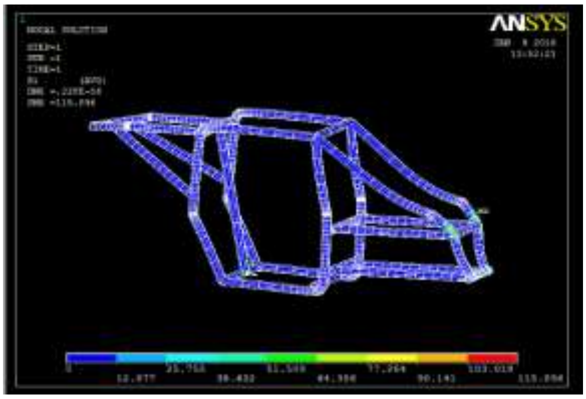

Fig. 14 ANSYS model of Chassis

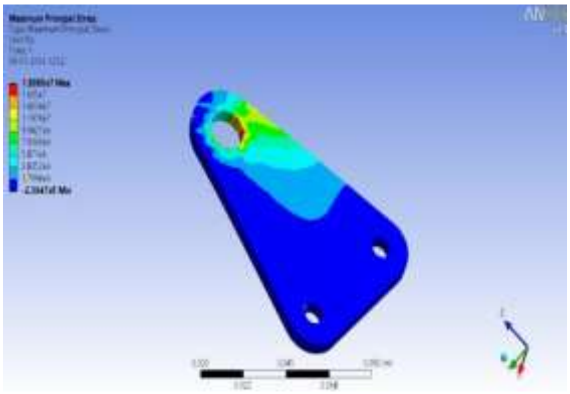

Fig. 15 ANSYS model for Steering Plate

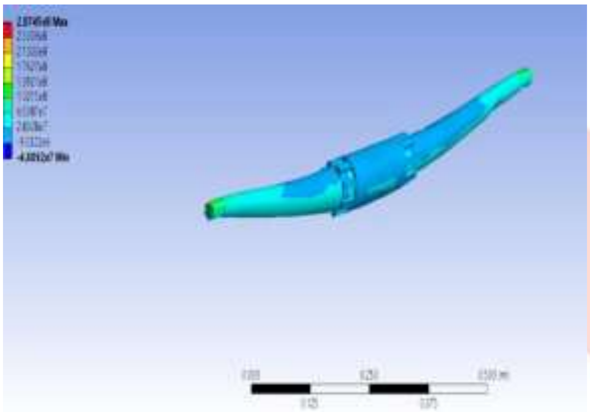

Fig. 16 ANSYS model of Shaft

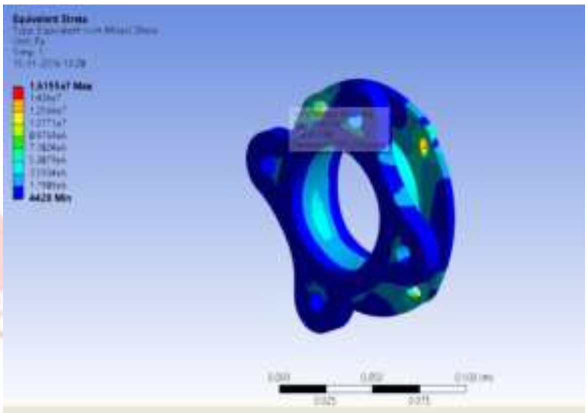

Fig. 17 ANSYS model of Front Hub

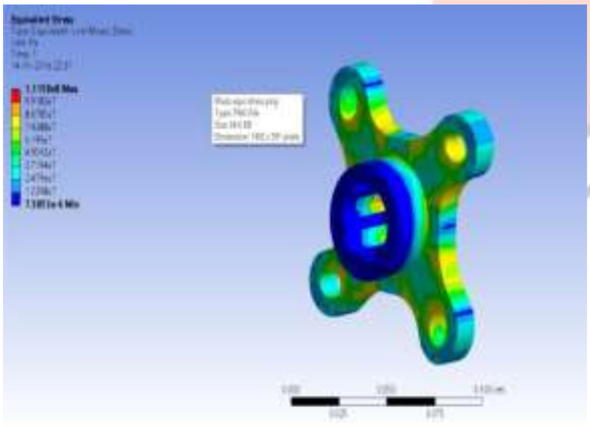

Fig. 18 ANSYS model of Rear Hub

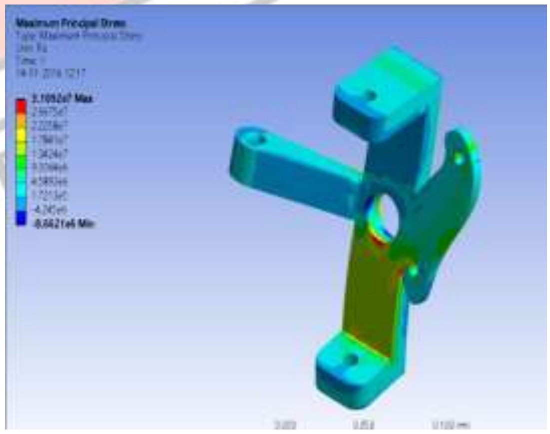

Fig. 19 ANSYS model of Knuckle

VI. RESULTS

Table 1 Gradeability Calculations

Gear	Max Speed (km/hr)	Torque on wheel (Nm)	Tractive Effort (N)	Acceleration (m/sec^2)	Total Time (sec)	Total Distance (m)	Gradeability (%)
1	17.13	502.1	1581	5.6	3.04	26	88.8
2	27.39	341.2	1074.75	3.7	2.72	87	64.4
3	37.34	262.9	828.3	2.8	2.84	181	44.4

Results in terms of Graphs :

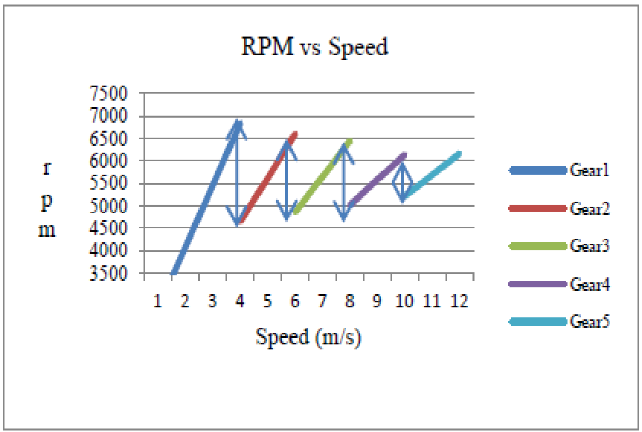

Fig. 20 Plot of RPM vs. Speed

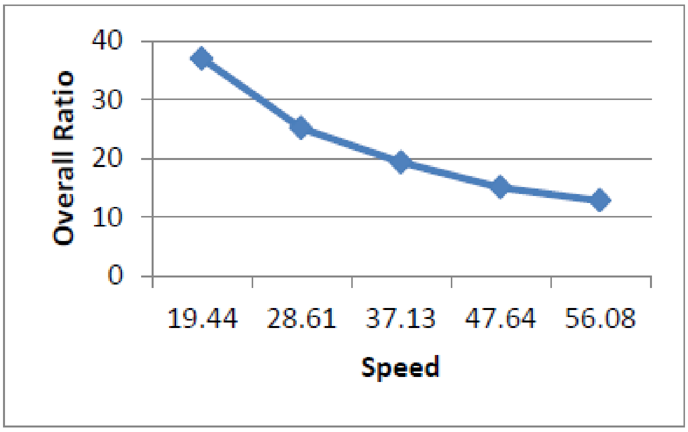

Fig. 22 Plot of Overall Gear Ratio Vs Speed

VII. CONCLUSION

This work presents the design of an all-terrain vehicle. The body was fabricated using materials that were sourced locally. The advantage to be derived from the use of this machine far out weights its shortcomings.

The design and construction of all-terrain vehicle has been a challenging task. A detailed study of various automotive systems is taken as our approach. Thus this paper provides a clear insight in design and analysis of our vehicle. This project has helped students in extensive learning and gaining practical knowledge on the theoretical concepts imparted in classrooms.

VIII. ACKNOWLEDGMENT

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