DESIGN AND FABRICATION OF AN INDIAN ARMY VEHICLE (A CAR FOR THE CIVIL AREA WARZONE)

¹Amritpal Singh, ²Rajinder Kumar

¹Mechanical Engineer, ²Rtd. Group Instructor ITI Talwara

ABSTRACT

The function of this car is to provide convenience to the soldiers in the civil area warzone. Unlike other army vehicles, this car has broad tires which works well on the road. The car has four forward gears & four reverse gears. So after firing on the target the driver has no need to waste the time in turning the vehicle. As the differential is fixed in all other vehicles but in this project we placed a modified moving differential. Which changes its position between the forward and the reverse gear drive shafts. Hence provide convenience to the gear shifting. The car has chassis less construction. i.e., the body has directly mounted on the frame of the car with the help of fasteners. The car body is made up of fiberglass, we used the approach of clay modeling in the designing of the molds and the virtual design of the car body is designed under Catia V5. The parts of the car has been taken from the junkyard, the flushed cleaned, greased or oiled , fitted , modified if needed, tested and then painted and finally assembled in the vehicle.

KEYWORDS

Army Vehicle, car, Fiber Glass Body, moving differential, two seater, 350cc engine car.

1. INTRODUCTION

Indian defense is currently at fourth position in the whole world above are china Russia and USA. Being a patriotic engineer and responsible citizen, I accept my country as my privilege. We should aspect of the every aspect of the possibility of the warzone and should prepare yourself if needed and also act accordingly. This car is specially designed and fabricated on defense norms and on the basis of the civil warzone conditions. Indian army has many vehicle but none of them has best coordination with a civil area warzone as this car has. Now let us take an Example of a Civil Warzone in our metro cities like Pune, Bangalore, Maharashtra, Delhi, Chennai, etc. the worst condition for such environment is that the private property got destructed by the tank chains. And our responsibly as an Indian citizen is to push the war towards its possible end. It could only happen if we have such a vehicle which not only can easily handle on the debris. But also provide convenience to the gunner as well without depleting the roads. The body of the car is made Up of fiber glass hence light weight and to be less influence on the vehicle's mileage, but not less in strength than other body materials. The thickness of the layer of the fiber glass chopped strand mat is about 1.3mm and the compound thickness when solidified two layers of mat is 4mm. as the car bodied are of 3mm thickness. Still it is damp resistant and has stiffness and strength in it. The engine is 350cc Royale Enfield, Which is 12HP engine and it is good in carrying capacity due to its large bore and stroke length.so the result of it is the fuel efficiency of the vehicle. The vehicle is fully stable and the authors wants to reflect this stability and strength

from the name of the vehicle. Hence named it “Stallion”. The aim of the project is to provide a low budget Army vehicle for the civil area warzone. The main objectives of the projects are making a moving differential, making a fiberglass body from a wireframe model through clay modeling, making a low weight , low budget , fuel efficient two seater car, improved strength and stability. India was never been in war in the civil Warzone, or in other words in metro cities where destruction of property should be minimized. I aspect if this happens the problem will be the destruction of the private property. So by using such a vehicle which is using tires instead of chain, will save the roads as much as possible. Another is that the car has broad tires, hence results in maximum traction as compared to jeep which has narrow tires resulting in lower traction. To solve the problem mentioned above we have used the methodology. We have firstly draw sketches of the vehicle and then use them as blueprints in CATIA V5. Then converts the model into wireframe model, on the other hand we bought some required suspension parts, transmission parts, tires, seats etc.

Old Parts Used:- Engine, Differential , Steering column, steering wheel , transmission, steering rack , wheel hub, alloy wheels, two seats , 2 transmission shafts, rear transmission assembly, ABC Pedals, brake oil pipes, hand brake lever , shockers, leaf springs, dampers, 2 pitman arms, wind shield , dash boards , head lights , fuel tank , self-motor , alternator , exhaust.

New Parts:- Seat cover, Lock Set , Horn , Spark Plug , HT Coil , Clutch Wire , Acceleration Wire , Hand Brake Wire , Speedo Meter , Speedo meter wire , Battery Headlamps , Indicator , Drive Chain , Fuel Pump , Exhaust Pipe.

Manually Created/Modified Parts: - Engine Drive Shaft, Transmission Driven Shaft, Idler Arm, Wiring and Harness, Flywheel, Air Filter.

2. DETAILS EXPERIMENTAL

We assembled the parts according to our design requirements. As all the parts are from junkyard, so we need to re consider these parts before assembling them, another thing which was necessary is the testing of each part and its Repair, modification or the replacement of the part accordingly. We have covered various experiments during the fabrication but due to boundage of ink we are providing three major analysis which are must to be considered as they contain major design stresses during the operation. These three analysis study are:

- Fiberglass body
- Flywheel
- Alloy wheel

2.1. Materials and Procedures

The body is made up of fibreglass which has stiffness and hence passed our test on crash. The crash test consists of compressive loads along with the shock loads.both of these forces combined together to form such a cocktail which results in deformation of structure and fatigue.

The flywheel we used is of maruti 800 and is made up of cast iron. As maruti 800 is 3 cylinder engine and our engine has single cylinder. So we turned the flywheel on lathe to our desired mass. So that it becomes sufficiently heavy to obtain turning moment for the engine crank shaft.

The alloywheel is made up of aluminium alloy, we tested the material on lab and put the concluded values in ANSYS software for the analysis.

2.2. Analysis

2.2.1 Fiberglass body crash test

We tested the body hood under crash analysis with the vehicle speed as 900m/s , and crash it on a concrete wall at a distance 3m apart , the deformation found is 12.3mm and the factor of safety is 2.31. The ambient condition is 25°C.

2.2.2 Flywheel stress analysis

The specimen is tested in lab. The values found on RPM is 10000 RPM. And for the virtual simulation the modeling is done in Catia V5 using reverse engineering. We prepared a sketch and then by applying shaft command made a rim. After this we made some extrusions, holes in the rim. We meshed the model in tetrahedron mesh in 12 nodes and the elements have 286524 no. of nodes. We fixed the flywheel from its 6 holes and then apply cylindrical supports on it. The circumference of the rim has 20N force applied on it. The maximum stress produced on the wheel is 0.14838 MPa.

And the maximum deformation is 5×10^{-5} mm.

2.2.3 Alloy wheel static structural analysis

The modeling is done under Catia V5 using reverse engineering. We prepared a sketch and then applying shaft command made a rim. After this we did some cutting, extrusion and then finally shape the wheel. We meshed the model in tetrahedron mesh with 10 nodes and the elements were 208273 and the no. of nodes are 347677. We fixed the wheel from its bolt holes and then apply cylindrical support to it.

The 200KPa of pressure is applied on the inner circumference area of the rim. The max. Equivalent stress is 11.283 MPa and has max. Deformation of 0.033487mm with FOS as 2.

3. RESULTS AND DISCUSSION

3.1. Fiberglass Crash Test

The body survived the test and has maximum deformation as 12.3mm in the elastic range. So due to the stiffness of the material the body will suddenly retrace its original position on the removal of external load. The body does not have any kind of permanent deformation in it after on during the application of the load.

3.2. Flywheel Stress Analysis

The results found in the lab testing on 10000 RPM are more than satisfactory. The test specimen did not only survived on the amount of rotation but also it performed normal even after the removal of extra mass from it and still gives the max stress of 0.14838 MPa with max. Deformation of 5×10^{-5} mm.

3.3. Alloy wheel static structural analysis

Rectangular specimen was shaped from the test alloy for the testing in the lab. The wheel specimen was cut with band saw and then tested under metallurgical lab along with the testing on UTM (Tensile Test).

The values found are the inputs of ANSYS for static structural Analysis and hence gives the FOS of 2.

COMPARISON WITH OTHER ARMY VEHICLES

Comparison with Jeep:

The advantage of this vehicle over Jeep is that it has large wheel base , large wheel track, broad tires and most importantly it has four reverse and forward gears.

Pressure and Contact

There are two ways to get traction (a function of friction) on any surface: increase the contact area or increase the pressure per square inch. Skinny tires must carry the same amount of weight as fat tires, but must do so with far less contact with the road. This increases the force in pounds per square inch on the tire tread, theoretically allowing the thinner tire to "cut" into the road surface. You could compare the pressure effects of fat tires to skinny to (respectively) a baseball bat and a samurai sword.

Dry Traction

In completely dry conditions, wider and fatter is always better for traction. A dry road and dry tires allow every inch of rubber to grab the road with no interference, so traction increase/decrease is almost linear with tire size. The only downside to larger tires on dry roads is that they can increase steering effort in low-speed conditions. Traction is traction, whether it's rolling forward or swiveling on an axis.

Wet Conditions

Generally speaking, wider tires will perform better in wet conditions than skinny tires, but it depends on the tread pattern. Wide tires can easily trap water underneath while rolling, making efficient water removal channels (called "sipes") a priority for design. Narrow tires can get away with having fewer sipes because they're not as inclined to trap water underneath and because their higher contact pressure tends to "squish" water out of the way.

Snow Safety

The long-held belief that narrow tires are better in snow and ice is generally true. One side effect of high contact pressure is heat, which can, in many cases, squeeze any snow beneath back into its liquid state. When combined with a sipes designed to carry that melted ice and snow away, the end result is a tire that performs far better in winter conditions than wide summer rubber. Wide tires tend to float over the top of ice and snow rather than digging in.

Staggering Tire Size

Another aspect to the fat vs. skinny debate involves using different sized tires on the front and rear axles, also known as "staggering." Generally speaking, whichever axle gets the power (the rear tires on rear-wheel-drive or front tires on front-wheel-drive) gets wider tires to help plant it. Pro drag cars often use very skinny tires on the front wheels, but that's mainly to reduce both weight and the tendency of the car to "oversteer" at high speed. In the real world, this "fats and skinnies" approach will often lead to dangerously bad handling with very little increase in straight line performance.

Comparison with Tank:

Good thing is that tanks has also the capability to move forward , reverse , sideways with its full power. But the power of the tank is so large as compare to this vehicle that it leads to large fuel consumption, more maintenance and initial cost as well as it left chain marks on the roads. But this vehicle has tires instead of chain, light weight body and 12HP engine. Which need less maintenance and provides more fuel efficiency.

CONCLUSIONS

The behavior of all above major studies was analyses under ANSYS and the major conclusions are as Follows:

- In all the cases, the design and the test specimens survived and results with safe design for the requirement.
- The failure occurs in all the virtual simulations, when the velocity, RPM and the pressure is Four times simultaneously in the studies. (The ambient condition in all the testing is considered to be 25°C.)

ACKNOWLEDGMENTS

As a result of Safe design simulation he body , flywheel and the alloy wheel was assembled on the project to test them in real life , real conditions under real loadings, and they worked well with the project.

REFERENCES

- [1] P. Meghashyam, S. Girivardhan Naidu and N. Sayed Baba (2013), “Design and Analysis of wheel Rim using CATIA and ANSYS”, “ International journal of Application or Innovation Engineering and Management (IIAIEM), Volume 2, Issue 8, ISSN 2319-4847.
- [2] <https://www.youtube.com/watch?v=UuiNvwsEgMs>
- [3] N. Satyanarayana & Ch.Sambaiah (2012), “Fatigue Analysis of Aluminum Alloy Wheel under Radial Load”, International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 – 6477, Vol-2, Issue-1.
- [4] P. Ramamurthy Raju , B. Satyanarayana , K. Ramji , K. Suresh Babu(2007), “Evaluation of fatigue life of aluminum alloy wheels under radial loads”, Science Direct, Engineering Failure Analysis 14 (2007) 791–800.

- [5] M.V. Prabha and Pendyala Veera Raju(2012), “Design and development of aluminum alloys”, International Journal of Advanced Science, Engineering and Technology,ISSN 2319-5924,Vol 1, Issue 2, 2012, pp 5560.
- [6] S Vikranth Deepak, C Naresh and Syed, Altaf Hussain (2012), “Modelling and analysis of alloy wheel for four wheeler vehicle”, ISSN 2278 – 0149, Vol. 1, No. 3.
- [7] https://www.youtube.com/watch?v=MRu5Ntl_d5I
- [8] <https://www.youtube.com/watch?v=-yWIn0dAdM8>
- [9] <https://www.youtube.com/watch?v=3ZWtNHfFu0>
- [10] <https://www.youtube.com/watch?v=nlAHBLDwJE>
- [11] <https://www.youtube.com/watch?v=kGUUPo2liQQ>
- [12] <https://www.youtube.com/watch?v=ayO4KO3Fv3s>
- [13] <https://www.youtube.com/watch?v=-FbJUV2yu1Y>
- [14] <https://www.youtube.com/watch?v=9czAWTxW0-c>
- [15] <https://www.youtube.com/watch?v=qFuSX8UVp4M>
- [16] <https://www.youtube.com/watch?v=9EuHrYWoeIw>
- [17] D.W. Zhou and L.A. Louca “Numerical simulation of sandwich T-joints under dynamic loading” Department of Civil and Environmental Engineering, Composites Part B 39 (2008) 973–98520 January 2008.
- [18] G. DiBella “Experimental and numerical study of composite T-joints for marine application” University of Messina, Messina, Salita Sperone 98166, Italy 7 March 2010.
- [19] Jeom Kee Paika “The strength characteristics of aluminum honeycomb sandwich panels” Pusan 609-735, San Francisco, CA 94105, USA 1999
- [20] Elena Bozhevolnayaa and Ole T.Thomsen “Local effects across core junctions in sandwich panels” Composites: Part B 34 (2003) 509–517, DK-9220 Aalborg East, Denmark 22 March 2003
- [21] Ferry Dharmawan and Rodney S “Geometry and damage effects in a composite marine T-joint” Australia Composite Structures 66 (2004) 181–187, 10 June 2004
- [22] A.P.Mouritz “Review of advanced composite structure for naval ships and submarines” Composite structure 53 (2001) 21-41Department of Aerospace Engineering RMIT University December 2001

Authors

Er. Amritpal Singh, Mechanical Engineer, SolidWorks Mechanical Design Associate.

Rajinder Kumar, Rtd. Group Instructor, Best Instructor 2006 in Pujab ITI Talwara.