A Study on Software Design Methods for Roll Cage of An All-Terrain Vehicle

Alekh S. Kadam
Mechanical Engineering
B.E, Mumbai University

Manjushree D. Sutar
M.E Design Engineering
Solapur University

Abstract:-**The present paper deals with the study of software design methods and analysis of roll cage of an All-Terrain Vehicle. The work proceeds with stepwise design Methodology of roll cage showing its model development using three software's (CATIA, PRO E, SOLIDWORKS). Then the analysis is done. the paper explains the ease and simplicity of using software according to application.**

Keywords:- Roll Cage, ATV, Design Methods, Software.

I. INTRODUCTION

In the early 19th century, direct product design methods was been used. An idea of modeling was directly implanted into the final product. This method led to some bad results to certain extent, causing waste of materials, less comfort and safety of the product. As years passed, development of small sized product of the same idea came into existence. Practically, it too had certain limitations. This was called as model prototype method. Simultaneously, during this period industrial revolution boosted and developing a model on the paper brought an ease in designing of a particular product. Invention of computer, made developers to take the model designed on paper to computer screen. Hence, various designing software were developed, models on screen with free hand use, 2D model developing software, 3D model developing software and product developing software. Use of 3D designing software brought a drastic change in the mass production of certain products; consumers' needs could be easily satisfied by this method. Analyzing of these CAD models became easier and efficient. In this paper, we are going to see few methods of designing, using model of a Roll-cage of an All-Terrain Vehicle using SOLIDWORKS, CATIA, PRO-E and analyzing it in ANSYS.

However, designing of a model in these software individually exist, but a parallel comparison might give an idea to use certain software for various operations. For example, CATIA and SOLIDWORKS are the software developed by Dassault systems; SOLIDWORKS is generally used in solid modelling and CATIA for surface modelling. Thus, in this paper, modelling of roll cage with various ways using different software with their own advantages and disadvantages.[1]

A roll-cage is a designed framework of a vehicle. It is a part of chassis. The major function of the roll cage is driver safety and comfort. A roll cage is a specially engineered and constructed frame built in (or sometimes around, in which case it is known as an exo cage) the passenger compartment of a vehicle to protect its occupants from being injured in an accident, particularly in the event of a rollover. The design of roll cage depends upon the use or requirement of the vehicle. Roll-Cage can be designed based on following requirements. For example, we need a vehicle for spending reasons so is the chassis and roll-cage is designed in an airfoil manner and light weighted whereas if the vehicle is to be used on marshy, hard and tough roads then the design changes as well as the size is also taken into consideration.[3][4]

II. DESIGN METHODOLOGY

The basic need for design of a model in software is to analyze the model with every possible aspect, and the tasks going to be performed by the model. All the physical properties are to be brought under static and safer conditions without changing its basic structure. Steps involved in design methodology are as follows;
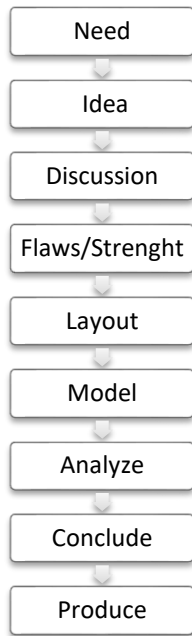

Fig 1. Roll Cage

Fig 2. Design Methodology

A. Design Methodology for the Design of A Roll-Cage:

- The basic need of the roll-cage is to provide driver safety in case of crash or rollover.
- Developing a cabin where the driver sits in a hard cage form.
- Number of members to be used, shape of the cage, cross section, material to be used, weight and other dimensions.
- Excessive joints at single point can cause damage easily; forces of impact must split effectively with least impact on the driver. Cross members, triangle joints could more efficient for strength.
- Get a brief layout of the discussed ideas.
- Generate a model using this layout in a software.
- Analyze the generated model in all aspects; conditions to be faced by the model.
- Finalize the model based on the analysis or certain changes to be done.
- Start producing the model.

III. MODELLING

The common model of a Roll-Cage is been used to demonstrate the various methods used in development of this model and analyzing it. These ideas may also represent the respective applications of certain software and efficiency of those in various ways[5]. 2D layout of the model is given below:
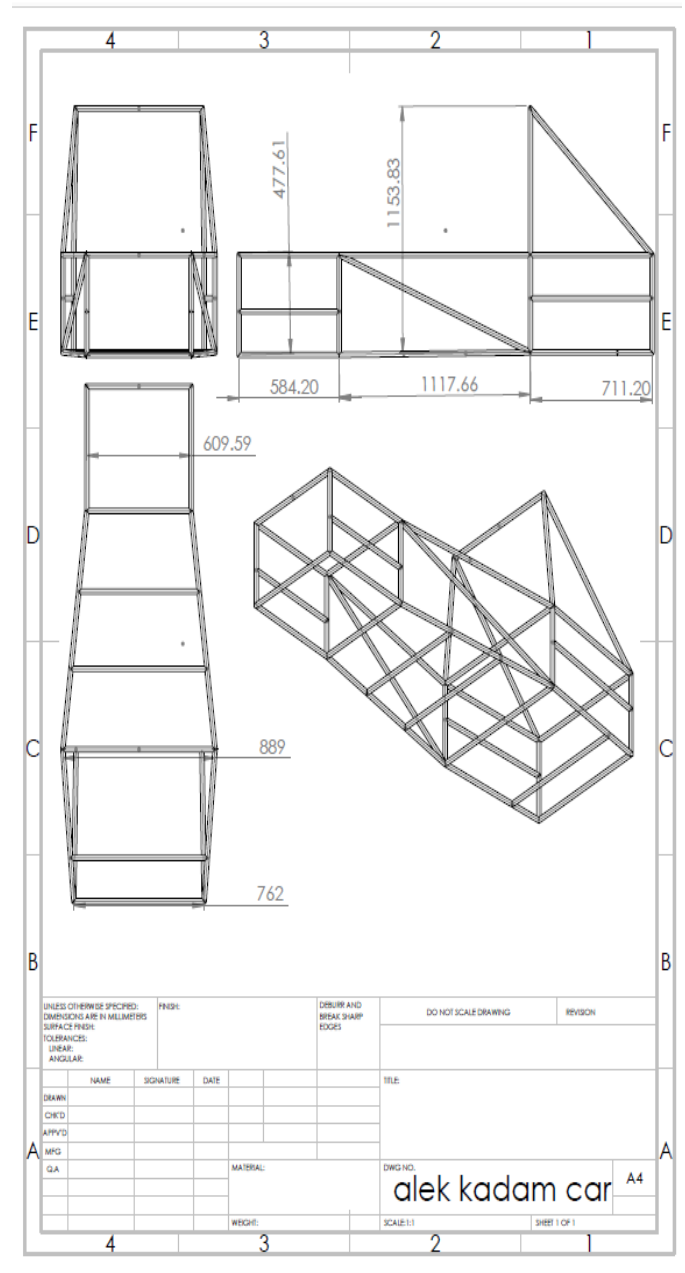

Fig 3. 2D Model

Software used for model generation:

- SOLIDWORKS
- PRO-E
- CATIA

Software used for analysis of model:

- ANSYS
- SOLIDWORKS

IV. MODEL GENERATION

A. Solidworks

[8][9]In SOLIDWORKS,this model can be generated using three methods:

a). Creating Various Planes (Mostly Used)

Creating an initial basic 2D sketch with major mounting points like suspensions, engine, steering, etc. generating planes accordingly and further linking design members with reference to this plane. Moreover, completing the 3D model with the help of planes. Further completing the model by adding weldments to profile.

b). 3D Sketching

Direct 3D sketching is an easier alternative to plane creation method. A proper layout and immense concentration of the operator is essential. Continuous member forming on every point possible or start point continuous sketching until the end. In this type of modelling profile of each member can also done once by choosing start point and end and defining the curve. As the entire model completes in one go, it turns out to be a single curve.

c). Layer by Layer

Generating geometric shapes of every possible members and assembling it from one layer to another. Common example of this method is construction of a Building; it takes place layer by layer. Here you will need to add weldments as per the given layout.

B. PRO-E

Almost similar to SOLIDWORKS PRO-E also known as CREO follows the same 3D modelling techniques as done in SOLIDWORKS. The only difference in this software is adding body members. Here, we do not have weldments but we use Sweep- Protrusion command to add members.

Thus, in this software we face constraints when there are sharp internal edges. And have to work extra comparatively.

C. CATIA

a). Wireframe Design

Just as 3D sketching in SOLIDWORKS we have wireframe modelling in CATIA, here we use different axis and dimensions to develop a complete model. Later we add profile to the model created. The workspace of CATIA is complicated as compared to SOLIDWORKS with respect to this model design.

b). Surface Design

As we used planar methods in SOLIDWORKS as well as PRO-E, similarly it can be used here also by generating planes at various meshing points and adding a linking member between two of the planes.

c). Curve Drawing

In CATIA, it is preferable to use this method to generate a model. You have to draw curves (lines in this model) from starting point to the end until you do not complete the loop of the roll cage. If you intend to use blend command to add the profile of the members, you will need to make sure your model is continuous loop without any defect.
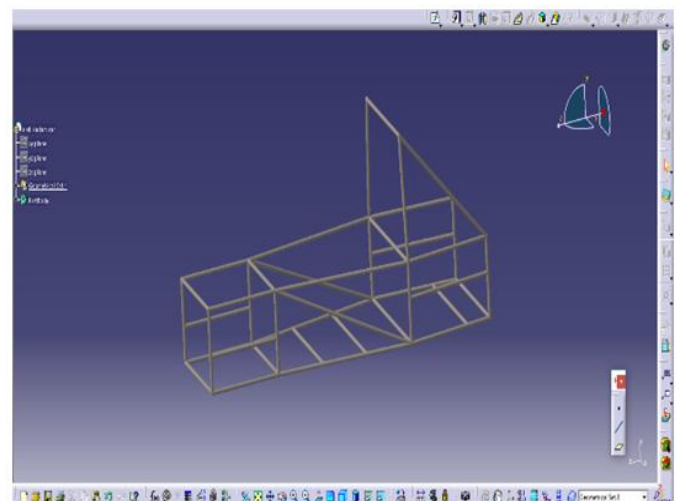

Fig 4. Solidworks Model

Fig 5. Catia Model

V. ANALYZING MODEL

A. ANSYS

Most common used software for analyzing models in various sectors electrical, fluid mechanics, civil, architecture, etc. It includes importing model from various software or designing in itself. Adding material, editing material properties, selecting meshing points, member or an entire frame is a great advantage in ANSYS. Working in ANSYS provides flexibility largely with respect to results also.[3][7][8]
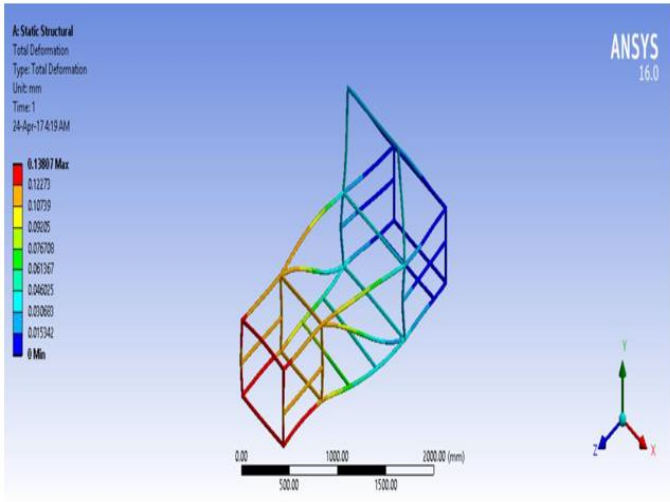
B. SOLIDWORKS

If you want everything in a single software then SOLIDWORKS becomes an easy option unless you are not professional in each single software respectively. It provides you every possibility needed to analyze in a respective field. The drawback generally faced during working with SOLIDWORKS is adding different material, less meshing properties and not that effective flexibility as what we get in ANSYS. But if we consider this type of model SOLIDWORKS analyzing would give sufficient amount results.
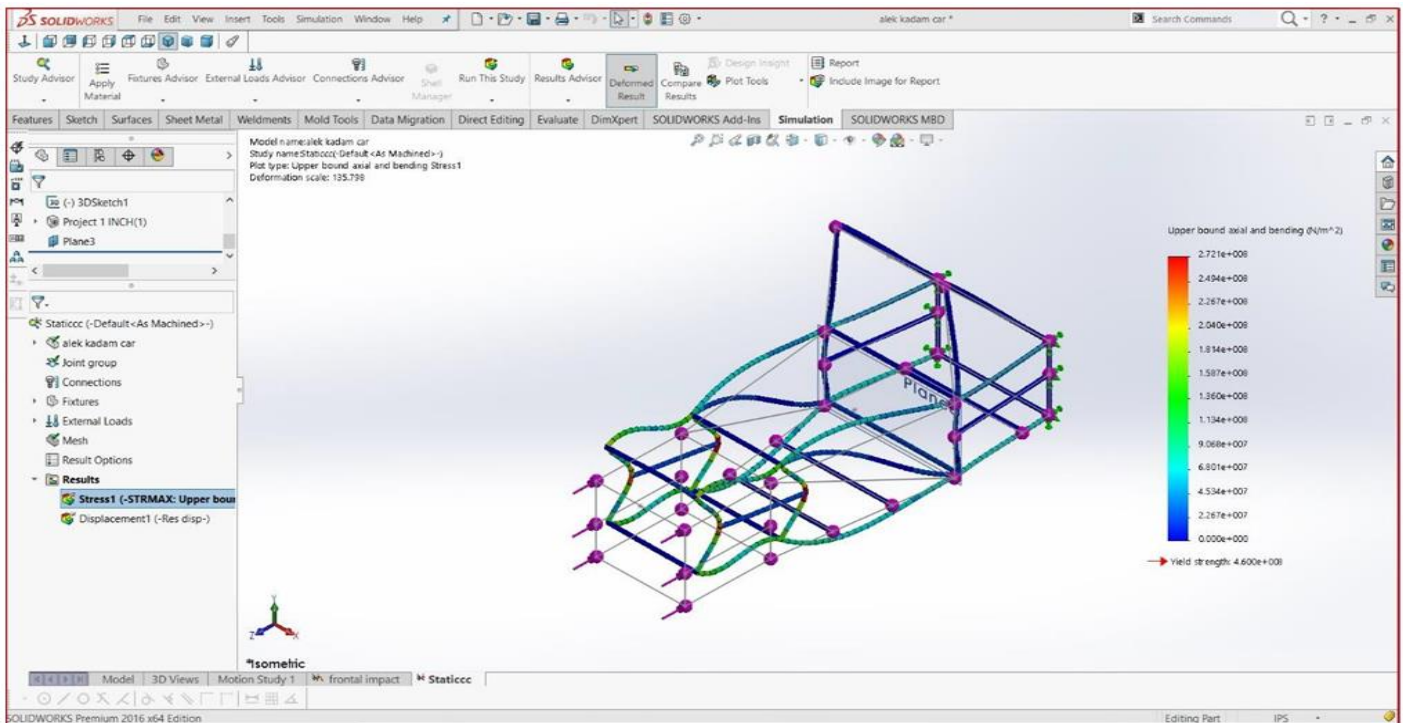

Fig 6. Ansys Analysis

Fig 7. Solid works Analysis

VI. NOTABLE FINDINGS AND CONCLUSION

From the above content, it is clear that various software can be used to perform different kinds of modeling tasks. Every single software has its own specialty of performing unique applications. Depending on the application or the physical properties, one can choose particular software to design it. This selection may equally depend on the designer who feels comfortable with one single respective software.

Hence, performing a model in various software and observing the ease in every possible way, this model of roll-cage of an ATV can be designed and analyzed in SOLIDWORKS more easily and comfortably.

REFERENCES

[1]. Documented lectures of CATIA V5 by Dr. Ahmed Kovacevic

[2]. http://www.catia.com.pl/tutorial/part_design.pdf

[3]. Ammar Qamar Ul Hasan, "SIMULATION OF ATV ROLL CAGE TESTING", IOSR-JMCE, e-ISSN: 2278-1684, P-ISSN: 2320-334, Volume 12, Issue 3 Ver. Ii, Pp 45-49, May. - Jun. 2015.

[4]. Upendra S. Gupta,Shubham ,Jain,Harsh Jain,Sameer Singh Rathi 'Static & Dynamic Analysis of F-SAE Roll cage Vehicle" International Journal of Engineering Trends and Technology (IJETT) – Volume 27 Number 5 - September 2015.

[5]. Design and Analysis of FSAE Rollcage Pruthviraj Vitthal Wable UG Student, Department of Mechanical Engineering, Trinity college of Engineering and Research, Pune, Maharashtra India.

[6]. Impact Analyses and Optimization of Roll Cage of a Car 1 Jayesh S More, 2Aniket C Mehare, 3 Samiksha O Podutwar, 4Yogesh M Jadhav 1,2,3,4Mechanical Engineering Department, College of Engineering Pune, Pune, Maharashtra, India-411005.

[7]. Structural Analysis of an ATV Frame Alok Dangarh(1) , Vedang Kulkarni(2) , Rajnish Katarne(3) and Manoj Sharma(4); 1,2 Student, Swami Vivekanand College of Engineering, Indore 3,4Assistant Professor, Swami Vivekanand College of Engineering, Indore.

[8]. Structural and modal analysis of different roll cage models in on-road transport vehicle. N.M.Kedarnath1, D.J.Johnson2 1Pursuing M.Tech (CAD/CAM), Mechanical Engineering, Pragati Engineering College, Andhrapradesh, INDIA 2Asst. Professor, Mechanical Engineering, Pragati Engineering College, Andhrapradesh, INDIA.

[9]. Design and Dynamic Analysis of Roll Cage for The Off-Road Vehicle Y. Mahajan1 , N. Pagare2 , R. Awate3 , N. Phalke4 , Prof. V. Shinde5 1, 2, 3, 4, 5 Department of Mechanical Engineering 1, 2, 3, 4, 5 DY Patil COE, Ambi, Talegaon-Dabhade, Pune-410506.

[10]. Design And Finite Element Analysis Of Roll Cage Of All Terrain Vehicle Shubham Yembarwar , Bhushan Kamble , Prashant Pande , Aman Wankhade; Students, Mechanical Engineering, JDIET, Yavatmal, India.