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Design and Analysis of Roll Cage by Composite Fibre

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***Abstract*: The Roll confine is the most basic piece of an ATV. It resembles a 3-dimensional security gave to the driver which is extremely urgent fit as a fiddle of the general vehicle. Limited component examination (FEA) is performed to acquire the variety of stress greatness at basic areas of Roll confine. Recreation inputs are taken from the particular outline. The dynamic examination is finished utilizing FEA Software called ANSYS WORKBENCH R 2016. This heap is applied to the FE model in ANSYS, and limit conditions are applied by the SAE BAJA 2018 rulebook. The investigation is accomplished for finding basic area in Roll confine. Anxiety variety alongside its disfigurement esteems are examined. The got outcomes are contrasted and the Roll confine made up of various composite materials. Results acquired from the investigation is help full to distinguish the best reasonable advantageous trade material for making the Roll confine.**

***Keywords*: Roll cage static structural analysis, Material selection, Material calculation impact force calculation.**

1. Introduction

A. Design

Various software is available for designing purpose in engineering to design roll cage of an ATV we use the software solid works, creo. Solid works is developed by basic works. We use this software because we are comfortable with this software but before implementing the line sketch on software we have sketch on the rough paper. We have gone through the SAE BAJA rulebook for designing the roll cage according to limitations. We also gone through the books which would help us to build an ATV. The ideas of our team, the design combinations we finally brought on the rough paper. We took the measurements by keeping the driver on the floor and we did the marking of the members at approximate measurements. Some design rule we should keep in mind such as.

1) Design the roll cage of an ATV by considering the ergonomic of the driver.
2) Avoid the sharp edges because it has High stress concentration on its surface and it also harmful for other for getting hurt.
3) The roll cage design would be according to the rule book.

Ones the sketching is done on the rough paper now it's time to bring the design into the software. The overall weight of vehicle should be low. Try to make the roll cage light weight but don't forget that it should bear the impacts and should have high strength. First create the line sketch on the software then give the weldment according cross section of the selected material after giving weldments the software gives the correct view of the roll cage we design. During reducing the weight don't compromise with the strength. Design the roll cage in such a way that attachment should be proper shown in assembly and considering all the attachment of the assembly. Use the triangular shape in the side member because it helps to take more load then the straight or any other shaped member. After so many iterations we came up with this final design.

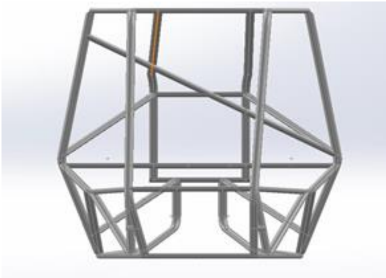

Fig. 1. Front view

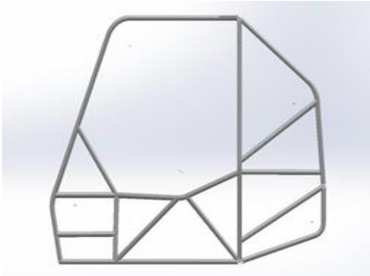

Fig. 2. Side view

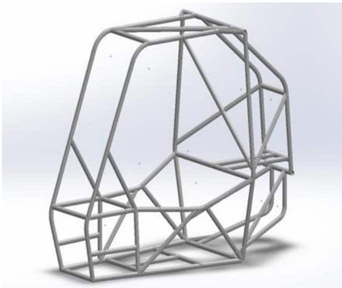

Fig. 3. Isometric view

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Basic dimensions and elements of the frame,

Attributes	Values
Length	2250mm
Width	935mm
Wheelbase	2190mm
Weight(with driver)	249.5kg
Weight(Roll cage)	40kg
Height of CG	560mm
Height	1300mm

B. Material property

Numerous materials are utilized for the move enclosure and a portion of the materials are proposed by SAE BAJA which are expressed in Baja Rule book which are AISI 1018, AISI 1040, AISI4130.

The properties of material are given underneath. The auxiliary investigation is done of the move confine. For investigation there are numerous product like Ansys, Nastran, and so on. As indicated by our accommodation we have utilized Ansys. The static conditions are utilized. The test are directed as follows:

Property	AISI 1018	AISI 1026	AISI 1040	AISI 4130
Yield Tensile Strength	370 Mpa	415 Mpa	415 Mpa	440 Mpa
Ultimate Tensile Strength	440 Mpa	490 Mpa	620 Mpa	560 Mpa
Modulus of Elasticity	205 Gpa	210 Gpa	210 Gpa	190 Gpa
Poissions Ratio	0.290	0.300	0.300	0.2

Contingent on the Yield Strength of the material we select the material. Subsequent to choosing the material the examination procedure starts.

Optimization Process:

Choosing best material from AISI 1018, AISI 1040, AISI 4130 we experienced this procedure. Right now considered the Cylinder Tube.

2. Analysis

The basic investigation is done of the move confine. For investigation there are numerous product like Ansys, Nastran, and so on. As per our accommodation we have utilized Ansys. The static conditions are utilized. The test is led as follows:

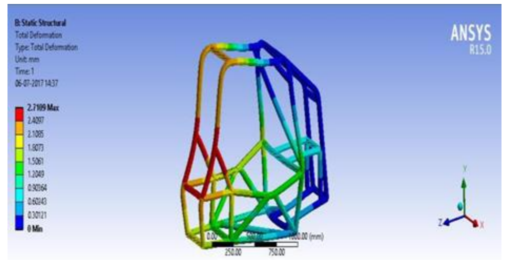
A. Front impact test

Few approximations were taken as follows Weight =300kg
v(initial)=16.67m/s v(final)=0
Impact time=0.13 sec Work done=|-0.5Mv|
=|-0.5x300x(16.67)^2|
=41683.33 Nm
Workdone=Fxd, d=t*v(initial)
=0.13x16.67
=2.1671m, F=41683.33/2.16
=20841.66 N

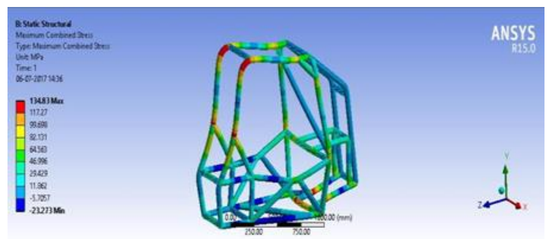
From the above outcomes the last changes are made and the structure is finished.

This is the power appropriate for front effect and examination result get from Ansys is beneath:

B. Maximum Stress Concentration



C. Total Deformation



Front impact	17000N
FOS	3.2
Total deformation	2.6mm
Maximum stress	135.690Mpa

FOS means Factor of Safety and the range of FOS should be 1.5 or above.

FOS= Yield strength of material / max stress
=435/135.69
=3.2

- *Rollover Test*

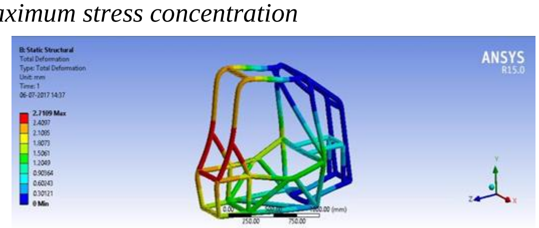
Calculations for the stress developed on a roll cage at the time of inverted fall. During the fall Potential energy is converted into Kinetic energy;

M*g*h=0.5*M*(v^2) $v=\sqrt{(g)}\times h\times 2$
10ft=3.048m v=7.733m/s

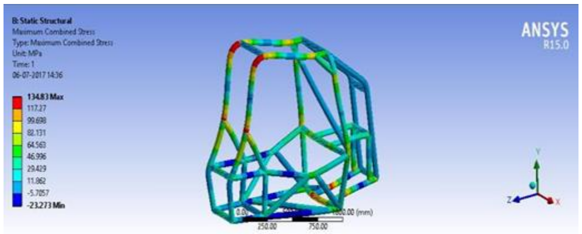
Just substitute this v in the work done equation and find outwork done.

Work done=41683.335 J
impact time(t)=0.13sec d=t*v d=1.005m
Same procedure as front impact for calculating F=force.
F=8335 N
F≅9000N

D. Maximum stress concentration



E. Total Deformation



Impact	7000N
FOS	3.2
Maximum stress	135Mpa
Total deformation	2.6 mm

The FOS of this case is also calculated by following the same steps as in case of front impact test.

- *Side impacttest*

Here we will test how much stress the roll cage can take from sideways.

Impact time (t) =0.30sec Velocity(v)=16.67m/s

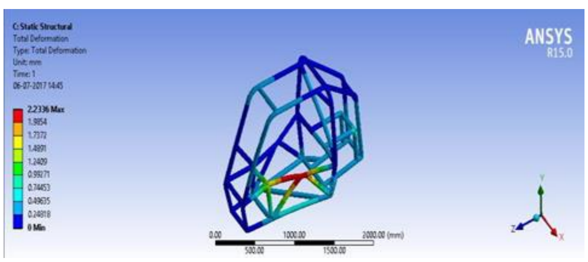
Again by same method we have calculated the work done.

Work done=41683.335J d=v*t d=5.001m F=work done/d

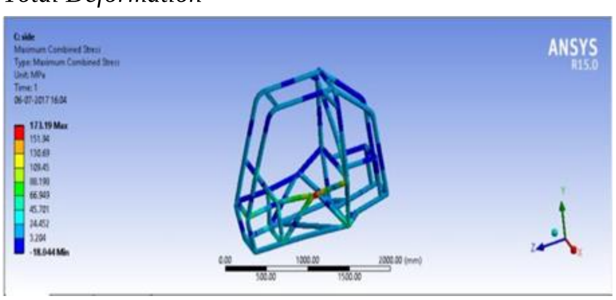
F=8335 N

F≅9000 N

F. Maximum Stress Concentration



G. Total Deformation



Side impact	7000N
FOS	2.5
Maximum stress	173Mpa
Total deformation	2.23mm

Steps for calculating FOS is same in every condition.

- *Rear impact test*

Considering the impact coming to the roll cage from the rear part.

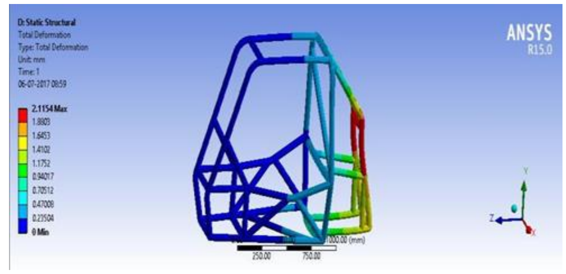
Impact time(t)=0.30sec v=16.67m/s

work done is again calculated by same method and is 41683.33N, d=t*v d=5.001m F=workdone/d

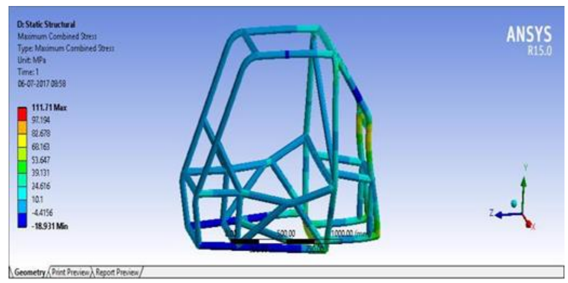
F=8335N,

F≅9000N

H. Maximum stress concentration



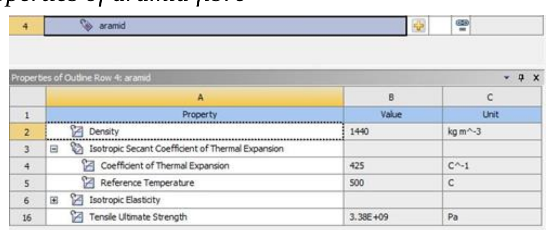
I. Total Deformation



Rear impact	7000N
FOS	3.4
Maximum stress	112Mpa
Total deformation	2.11mm

Steps for calculating FOS is same in every condition.

J. Properties of aramid fibre



Properties of Outline Row 4: aramid

	A	B	C
1	Property	Value	Unit
2	Density	1440	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
4	Coefficient of Thermal Expansion	425	C^-1
5	Reference Temperature	500	C
6	Isotropic Elasticity		
16	Tensile Ultimate Strength	3.38E+09	Pa

3. Conclusion

This paper investigates the methods for structuring the move enclosure of an off-road vehicle and furthermore sheds on conceivable key focuses kept as a main priority for structuring. You can likewise discover examination brings about this paper alongside their separate outcomes and formulae utilized. During the static investigation of the move confine the structure of the move confine was changed a few times so as to get a higher FOS. A higher estimation of factor of wellbeing guarantees the strength of the move confine in the most outrageous conditions and thus makes the move confine safe in terms of creation.

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