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Material Selection of a Arm in Student Hybrid Formula One Car

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Abstract:- The student Hybrid Formula one car have the feature the vehicle which have low weight. The material selection of A arm of Student Hybrid Formula one car have a significant role in transmitting the road shock in to the spring damper mechanism. The paper reveals the process of selection of A arm material among the two materials AISI 1020 and AISI 4130.The material selection of the part includes drawing of the part using SOLIDWORK software and analysis using the ANSYS software.

Keywords:- *Material selection,load calculations results and discussion, conclusion; reference*.

I. INTRODUCTION

This assembly of parts which perform the function of isolation of the parts from the road shock is called suspension system; A suspension system supports an automobile and keeps its wheels always in contact with, uneven road surface. In student formula one cars the suspension is either double wishbone type suspension or pushrod/pull rod type suspension systems are used. There is significant role in the material of A arm in student formula one cars less weight, low total deformation under static load etc.

In our research we chose two materials for the A arm designing namely AISI 1020 and AISI 4130.These two materials are commonly used for the chassis material of the student formula one cars. But there is no comparison done in the material selection of these two materials. The material AISI 4130 is less weight as compared to AISI 1020, Usually used as chassis material, But AISI 1020 is cheap material as compared to AISI 4130 and have more rigidity than the AISI 4130.

II. MATARIAL SELECTION

The material selection for A arm is very important in designing process for Student Hybrid Formula one car. Strength of A arm is highly depends on the material properties such as carbon compositions, Tensile strength, Yield strength, Brinnel hardness number etc. Heavy loads are acting on the vehicle which transfer when it accelerate, decelerate and road shock conditions. All above factors only determines the strength and reliability of A arm. The key factor for selection of material for fabrication of A arms is availability of the material. Here we consider AISI 4130 and AISI 1020 as A arm material by market study material surveys. By using ANSYS WORKBENCH 16.0 stress strain analysis, Deformation of A arm with materials AISI 4130 and AISI 1020 are

III. LOAD CALCULATIONS

Designing of a arm start with calculation of maximum load on each wheels. Mainly two types of loads are acting on F1 car. They are lateral and longitudinal loads. These two load transfers acting on the suspension .the maximum of these loads transfer is used for calculation maximum load on A arm. The wheels are attached to chassis by A-arms and the loads are transfer from the road to the chassis through A arm. When vehicle accelerate, decelerate or subject to road shock A-arm will subject more load on these conditions. The probability of failure of A-arm in these conditions is greater. So calculation of the maximum load on the A arm is necessary. Applying these maximum load on the ANSYS structural analysis it can evaluate whether the designed A arm structure will able to withstand.

For the calculation following assumptions are made,

- The total weight of vehicle with driver is 320 kg
- The g forces is taken between the range 3g to 5g
- Center of gravity(CG) height is 200mm to 250mm
- Track width is 1200mm to 1300mm
- Wheelbase is 1500mm to 1550mm

Values obtained

A. Maximum longitudinal load transfer on each tire

at rest = 628 N
at 3G acceleration = 701 N

at 5G retardation = 1165N

B. Maximum lateral load transfer on each tire

at rest = 470N
at 4G cornering = 892N

Above obtained values are arrive at a Conclusion that maximum load on the vehicle under various conditions (acceleration, deceleration &road shocks) are in between the range of 1000N to 1500N.We can chose the value of 2000 N force for structural analysis which rises the factor of safety A arm.

IV. METHODOLOGY

The main stages /Processes involved in the material selection of A arm of Student Hybrid formula one car is

- Drawing By using SOLIDWORKS
- Analysis of the A arm using ANSYS
- Comparison of the results obtained from two materials of A arm
- Arriving the conclusions
- Selection the suitable material of A arm

A. Drawing of the Part

The drawing of the part including the obtaining the basic dimensions of the A arm from the Chassis design followed by the drawing in CAD software.

Figure.1 shows the drawing of A arm using the CAD software SOLIDWORKS according to the dimensions of the Chassis and Suspension system design of the car.

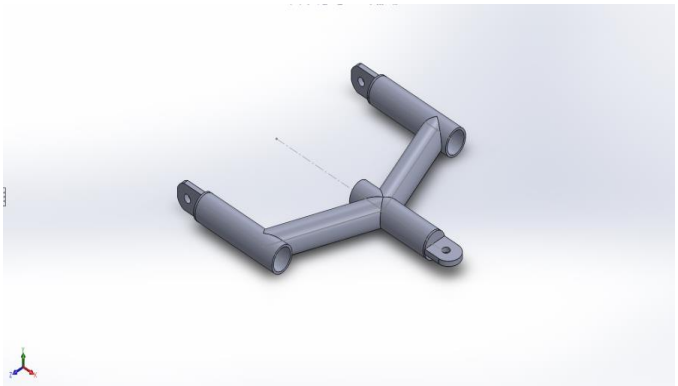

Fig 1:- Drawin of A arm in SOLIDWORKS

B. Analysis of the Part

Analysis of the part is done using the software ANSYS, includes

- Importing the part drawing in to the ANSYS from the SOLIDWORKS
- Material selection of the part
- Meshing of the part drawn in SOLIDWORKS
- Fixing the points of the part to apply the load
- Selection of the type of load applied on the part
- Selection of direction of force acting
- Applying the load
- Generation of the results

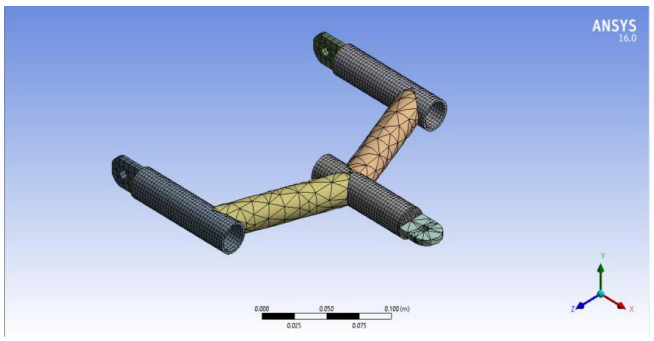

Fig 2:- Meshing of A arm in ANSYS WORKBENCH 16.0

Meshing is the process of dividing the part to be tested in to small number of parts the load is acted on the each parts of the A arm.Figure.2 shows the meshing of the A arm in ANSYS software the part drawing is imported from the SOLIDWORKS to ANSYS work bench

C. Analysis of the A arm

Analysis of A arm is done two steps one for the material AISI 1020 and one is for the material AISI 4130.The analysis is done on the two type of material at under loading gives Equivalent elastic strain, Equivalent stress and total deformation under the load of 2000N.

The results obtained from the analysis of A arm with two materials are given below. Figure.3, Figure.4, Figure.5 are the results of the material AISI 1020.Figure.6, Fiure.7, Figure.8 are the results the material AISI 4130.

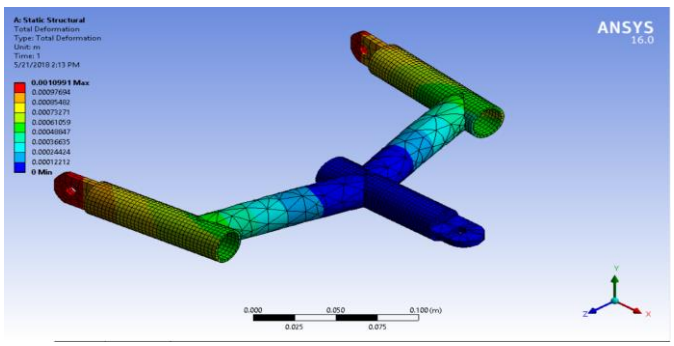

Fig 3:- Total deformation of A arm in ANSYS Workbench (Material AISI 1020)

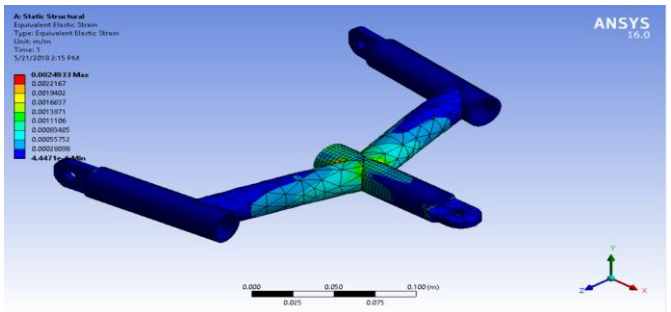

Fig 4:- Equivalent Elastic strain of A arm in ANSYS Workbench 16.0(Material AISI 1020)

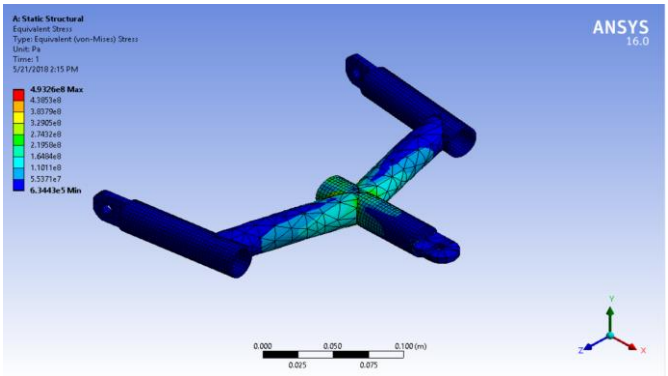

Fig 5:- Equivalent stress of A arm in ANSYS WORKBENCH 16.0 (Material AISI 1020)

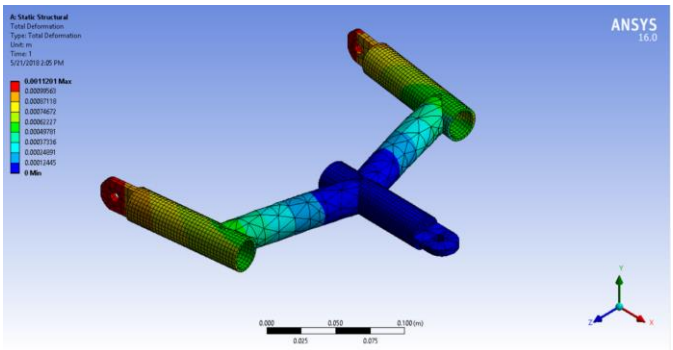

Fig 6:- Total deformation of A arm in ANSYS WORKBENCH 16.0(Material AISI 4130)

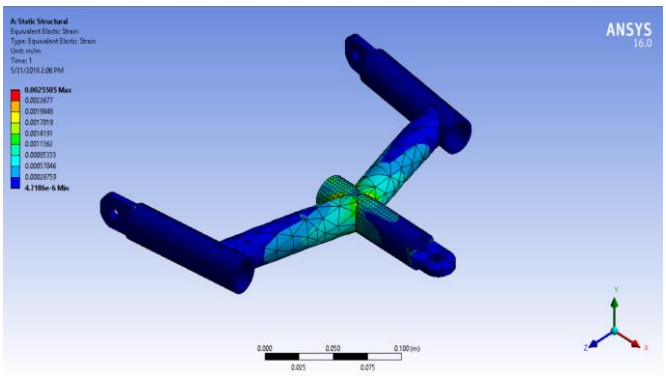

Fig 7:- Equivalent Elastic strain in ANSYS Workbench 16.0(Material AISI 4130)

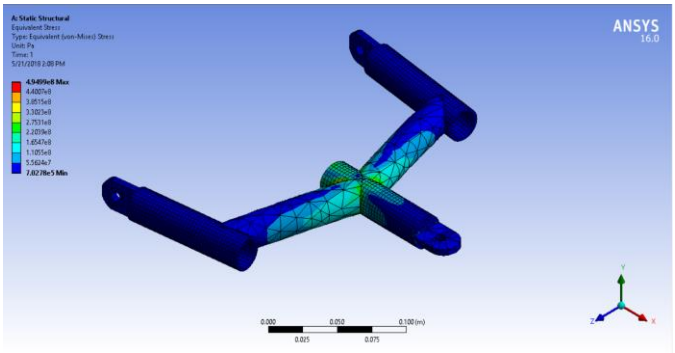

Fig 8:- Equivalent stress of AISI 4130 A arm in ANSYS Workbench 16.0(Material AISI 4130)

The comparison of the results obtained from the materials AISI 1020 and AISI 4130 are showed in the table below. The material AISI 4130 less weight than that of AISI 1020.The material AISI 1020 has less total deformation under same loads. The Equivalent Elastic strain is low in the material AISI 1020 than that of AISI 4130.

Properties	AISI 4130	AISI 1020
Volume	8.4112e-005 m^3	8.4112e-005 m^3
Mass	0.66028 kg	0.66196 kg
Total deformation	1.1201e-003 m	0.66196 kg
Equivalent elastic strain	2.5505e-003 m/m	2.4933e-003 m/m
Equivalent stress	4.9499e+008 Pa	4.9326e+008 Pa

Table 1. Comparison of AISI 1020 and AISI 4130

V. CONCLUSIONS

The static analysis of A arm successfully completed using the ANSYS software. By the comparison of the two material used for A arm namely AISI 4130 and AISI 1020,AISI 1020 gives less deformation, Equivalent elastic strain and Equivalent stress under testing. While the material AISI 4130 have less weight as compared to the material AISI 1020.

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