TESTING OF AN OFF ROAD BUGGY FRAME ON SOLIDWORKS

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ABSTRACT

Nowadays Off Road buggy have become a new source of entertainment for the youths. This all terrain vehicle can navigate through the various terrains. The durability of the frame is a very important thing to consider. This paper will mainly focus on the strength testing of the frame for various materials. Solid work a CAD software is used to design and run simulations on the design. The various ground on which the frame is tested are: Impact test, Torsion test, Cost analysis.

KEYWORDS: All Terrain Vehicle, Solidworks, Impact test, Torsion test.

Originally buggy was used to describe very lightweight horse-drawn vehicles for one or two persons, the term was extended to lightweight automobiles as they became popular. As automobiles became increasingly sophisticated, the term briefly dropped out of use before being revived to describe more specialised off road vehicles

SolidWorks (stylized as SOLIDWORKS) is a solid modelling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs on Microsoft Windows. SolidWorks is published by Dassault Systèmes.

SOLIDWORKS products are easy to learn and use, and work together to help you design products better, faster, and more cost-effectively. The SOLIDWORKS focus on ease-of-use allows more engineers, designers and other technology professionals than ever before to take advantage of 3D in bringing their designs to life.

VEHICLE DESIGN ASPECTS

- Vehicle must be capable of carrying one person 75 in. tall, weighing 250 lbs.
- Vehicle must be safe for a 95th percentile male operator
- Width of the vehicle must not exceed 162 inch
- The vehicle must be capable of safe operation over rough land terrain including, but notlimited to, obstructions such as rocks, sand jumps, logs, steep inclines, mud and snow and ice.
- No components of the vehicle must come loose during a rollover
- All wiring must be sealed, protected and securely attached
- Vehicle must contain front and rear hitch point along the longitudinal centerline.
- There must be a firewall between the cockpit and the engine and fuel tank compartment. Itmust cover the area between the lower and upper lateral cross members on the Rear Roll Hoop
- The vehicle must have a hydraulic braking system that acts on all wheels and is operated by asingle foot pedal. The pedal must directly actuate the master cylinder through a rigid link
- The brake system must be capable of locking all four wheels, both in a static condition as well as from speed on paved and unpaved surfaces
- Vehicle must be capable of completing a four hour endurance test

MATERIALS SELECTION

As per the constraint given in the rulebook the roll cage material must have at least 0.18% carbon content. After an exhaustive market survey, the following materials which are commercially available and are currently being used for the roll cage of an off road buggy are shortlisted. A comparative study of these shortlisted materials is done on the basis of strength, availability and cost. The shortlisted materials are as follows.

- AISI 1020
- AISI 1035
- AISI 1045

FRAME DESIGN

The Chassis is the component in charge of supporting all other vehicle subsystems and taking care of the driver safety at all times.

The Chassis design need to be prepared for impacts created in any certain crash or roll over. It must be strong and durable, taking in account the weight distribution for better performance.

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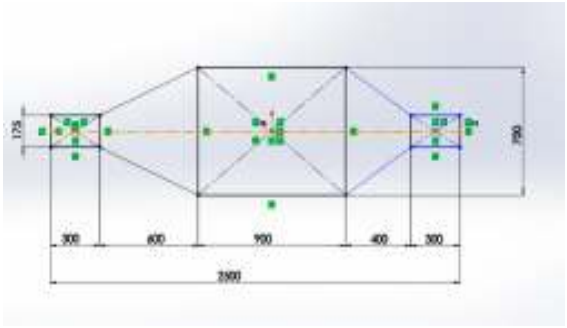
In this project our team used Steel tubes with outside diameter of 26.9 mm and thickness of 3.2 mm. We have selected steel AISI 1020, AISI 1035, AISI 1045 for the design and simulation because it has the required carbon percentage, i.e. 0.18-0.24%, and substantial amount of bending strength.

Finite Elements analysis In order to prove the safety of our chassis design we decided to use Solidworks, due to its low memory requirement and ease of use.



IMPACT TESTING

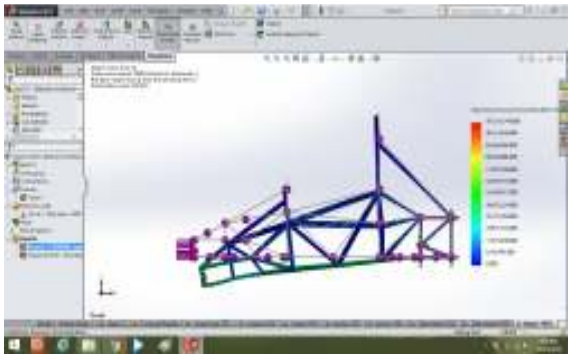
An Impact test is a form of destructive testing usually performed in order to ensure safe design standards in crashworthiness and crash compatibility for various modes of transportation or related systems and components. Crash tests are conducted under rigorous scientific and safety standards.

Each crash test is very expensive so the maximum amount of data must be extracted from each test. Usually, this requires the use of high-speed data-acquisition, at least one triaxial accelerometer and a crash test dummy, but often includes more. In all physical crash tests, dummies are used to scientifically measure the various forces on occupants and pedestrians. The data gathered from the dummies is then assessed and scores determined for each respective crash test.

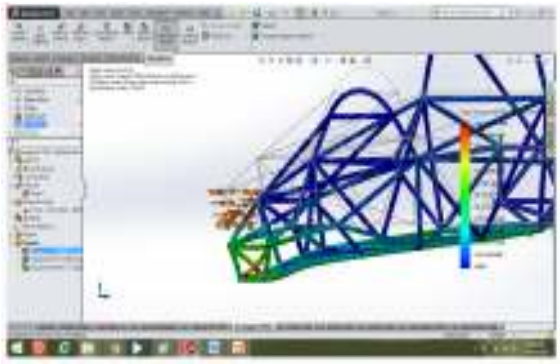
There are a number of crash test programs around the world dedicated to providing consumers with a source of comparative information in relation to the safety performance of new and used vehicles. Examples of new car crash test programs include National Highway Traffic Safety Administration's NCAP, the Insurance Institute for Highway Safety, EuroNCAP and JapNCAP. Programs such as the Used Car Safety Ratings provide consumers information on the safety performance of vehicles based on real world crash data.

TEST RESULTS OF IMPACT TEST

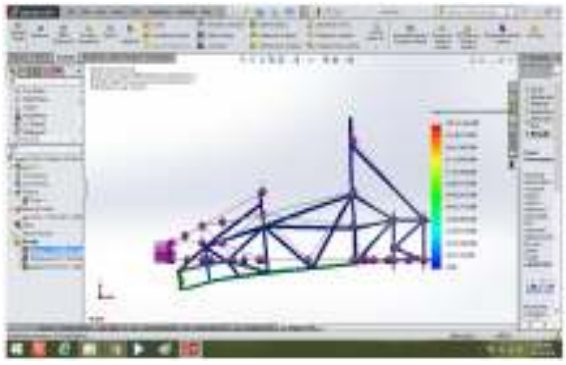
AISI 1020



AISI 1035



AISI 1045



Materials on which tests were performed:

- AISI 1020
- AISI 1035
- AISI 1045

Out of these three materials, **AISI 1045** responded the best in the Impact test.

TORSIONAL ANALYSIS

What is torsion?

Torsion is the twisting of an object due to an applied torque. Torsion is expressed in Newton per

meter square (Pa) or pound per inch square (psi) while torque is expressed in Newton-meter (Nm).

For shafts of uniform cross-section the torsion is:

General Torsion Equation (Shafts of circular cross-section)

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

1. For Solid Shaft

$$J = \frac{\pi}{2} r^4 = \frac{\pi d^4}{32}$$

2. For Hollow Shaft

$$J = \frac{\pi}{2}(r_1^4 - r_2^4)$$

$$= \frac{\pi}{32}(d_1^4 - d_2^4)$$

T = torque or twisting moment in newton metres
J = polar second moment of area of cross-section about shaft axis.
τ = shear stress at outer fibres in pascals
r = radius of shaft in metres
G = modulus of rigidity in pascals
θ = angle of twist in radians
L = length of shaft in metres
d = diameter of shaft in metres

INTRODUCTION TO TORSION TEST

Torsion tests twist a material or test component to a specified degree, with a specified force, or until the material fails in torsion. The twisting force of a torsion test is applied to the test sample by anchoring one end so that it cannot move or rotate and applying a moment to the other end so that the sample is rotated about its axis. The rotating moment may also be applied to both ends of the sample but the ends must be rotated in opposite directions. The forces and mechanics found in this test are similar to those found in a piece of string that has one end held in a hand and the other end twisted by the other.

We have applied "4G" force, according to the BAJA rule book for torsion test keeping the rear end fixed and applying the mentioned force in the front end in the form of a couple which produces torsion.

PURPOSE OF TORSION TEST

The purpose of a torsion test is to determine the behavior a material when twisted or under torsional forces as a result of applied moments that cause shear stress about the axis.Measurable values include:

- the modulus of elasticity in shear
- yield shear strength
- torsional fatigue life
- ductility
- ultimate shear strength
- modulus of rupture in shear.

These values are similar but not the same as those measured by a tensile test and are important in manufacturing as they may be used to simulate the service conditions, check the product's quality and design, and ensure that it was manufactured correctly.

Reasons for torsional deflection in a vehicle:

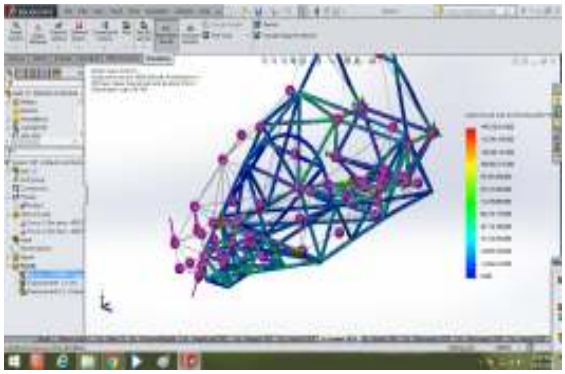
- When vehicle traverse on an uneven road.
- When one of the wheels goes through the breaker and the rest of the wheel remains in ground.

Performing Torsional analysis using SolidWorks software:

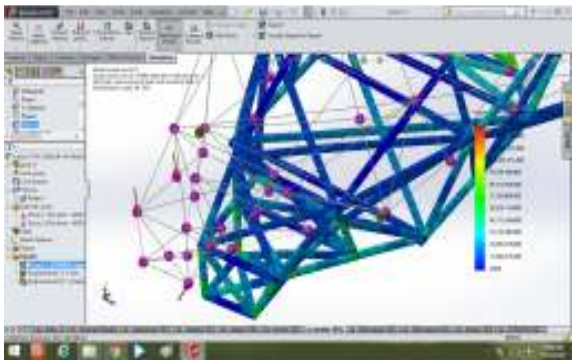
TEST RESULT OF TORSION TEST

AISI 1020

AISI 1035



AISI 1045



Materials on which tests were performed:

- AISI 1020
- AISI 1035

- AISI 1045

Out of these three materials, **AISI 1035** responded the best in the torsion test.

COST ANALYSIS

Cost per ton of metal is

- AISI 1020 = Rs 24500
- AISI 1035 = Rs 35000 - Rs 38500
- AISI 1045 = Rs 49000

Thus cost of building the frame is about

- AISI 1020 = Rs 2500
- AISI 1035 = Rs 3500 - Rs 3860
- AISI 1045 = Rs 4900

Out of these three materials, **AISI 1035** is the best according to cost analysis as the cost is intermediate.

CONCLUSION

The project is now concluded according to the following results

- Material AISI 1020 is the weakest against impact test, whereas AISI 1045 shows best results, AISI 1035 shows intermediate result
- Material AISI 1045 is the weakest against torsional test, whereas AISI 1035 shows best results, AISI 1020 shows intermediate result
- Material AISI 1020 has the lowest cost, whereas AISI 1045 has the highest cost, AISI 1035 has intermediate cost

Thus we conclude that material **AISI 1035** is the best for the manufacturing of the design of the OFF ROAD BUGGY.

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