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STRESS ANALYSIS OF BICYCLE FRAME USING ANSYS

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Abstract: *Cycle is a principal mode of transport for lower- and middle-class people. Cycle does not create pollution, make people physically fit, provides means of transport for shorter distance, children's toys are some reasons due to which people attract towards cycle. And due to high demand companies want to make best product of cycle which can bear heavy load, stylish look, etc. Frame is an important accessory of cycle. It must be strong, stiff and light in weight. High strength and correct design of frame is necessary for safe riding. This paper deals with design of bicycle frame which is made in solid works and are analyzed in Ansys software. Stress, Strain and Total deformation of some condition are analyzed. Conditions are Static start up, Rear wheel braking, Steady state pedaling, vertical impact, horizontal impact.*

Introduction:

Bicycles were introduced in 19th century in Europe, basic appearance and arrangement in particular form of a typical upright or safety bicycle has changed little since the first chain driven model was developed around 1885, many types of bicycle have been produced then.

Manufacturers and designers keep changing the design of the bicycle keeping in mind the needs of the people as time goes by. Modification to the design of the bicycle is still underways the manufacturer and designer have very creative ideas in mind such as to decrease aerodynamic drag, increase comfort, decrement in mass of frame, increase lateral stiffness in load transfer from hand and feet to increase rider's safety.

Earlier, the trial-and-error method was used to create a cycle but the trial-and-error method did not yield the relevant result and not necessarily the result that was correct every time, it was necessary to create software that would give the relevant result. This saved the time and expenditure of producer. This problem is solved by the Finite Element Analysis (FEA). FEA is computer technique process give right result of boundary value problem by engineering method. Boundary value process is a mathematical problem which set the independent variable of one or more differential equation and follows the boundary condition.

Material Selection:

Material selection is important part of analysis since material decide the strength of frame. High compressive and tensile strength of frames assured safety of rider and also it increases the life of bicycle frame.

Materials used in bicycle frame has various mechanical properties. Steel, Aluminum, Silicon, Magnesium etc. used as common material in frame construction. Among all generally aluminium alloy (6061 Al of series 6000) with composition of Si and Mg are most usable as it has high weldability.

Modelling of Bicycle frame:

The bicycle frame is designed in Solid works 2019, After making model in Solid works, model file named XYZ.IGS is imported in Ansys software to analyze different condition at different force condition.

Properties of Material:

Component	Composition (wt.%)
Magnesium	0.8-1.2
Silicon	0.4 – 0.8
Iron	Max. 0.7
Copper	0.15-0.40
Zinc	Max. 0.25
Titanium	Max. 0.15
Manganese	Max. 0.15
Chromium	0.04-0.35
Aluminium	Rest

FEA analysis of bicycle frame using Ansys and meshing details:

Detail of Mesh:

Nodes: 64792

Elements: 33050

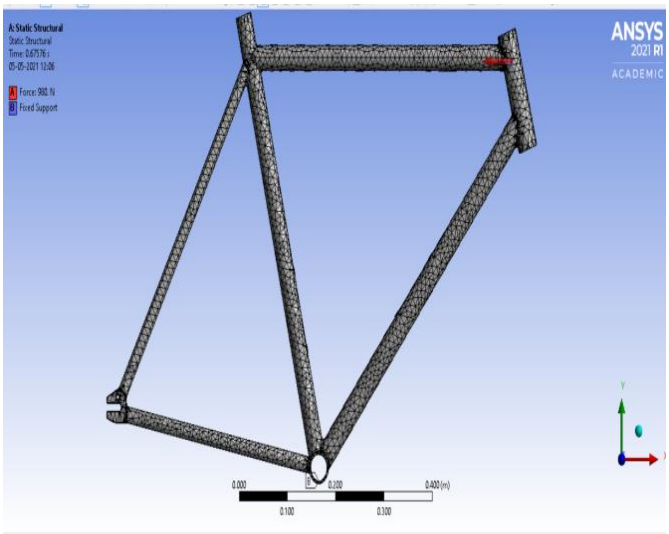
Mesh Size (single unit): 10mm

Type of Analysis: Static Structural

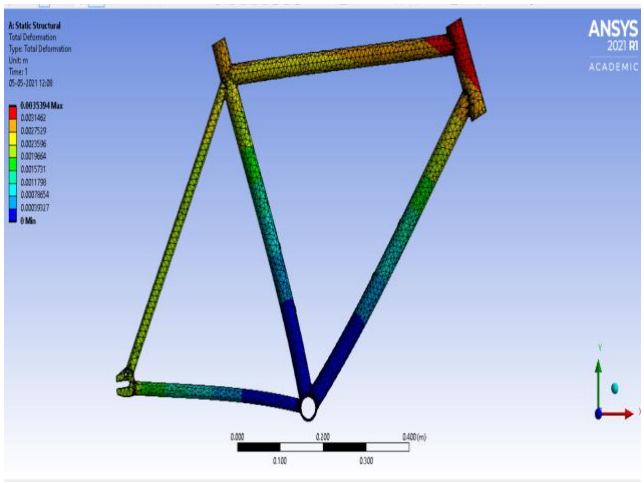
1) Horizontal Impact:

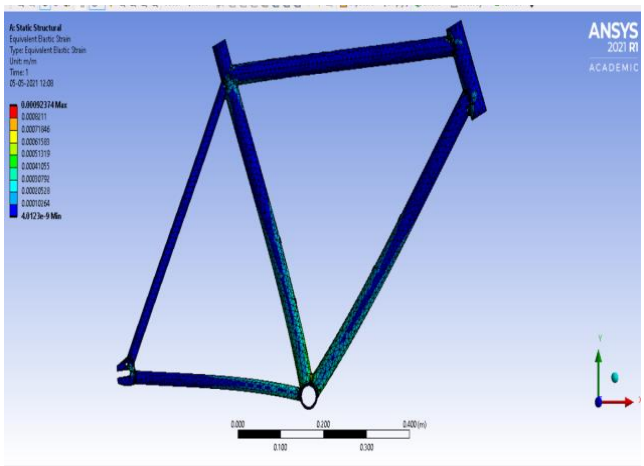
Let, horizontally 980N force applied on the handle of bicycle, this condition is like there is a collision of bicycle from wall owe with any other material and to pass this test there should no deformation or fracture in frame after collision.

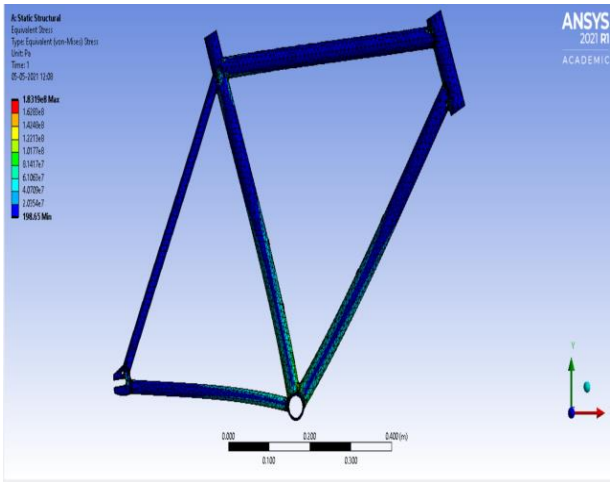
- Force and fixed support on frame:



- Result after analysis on Ansys:



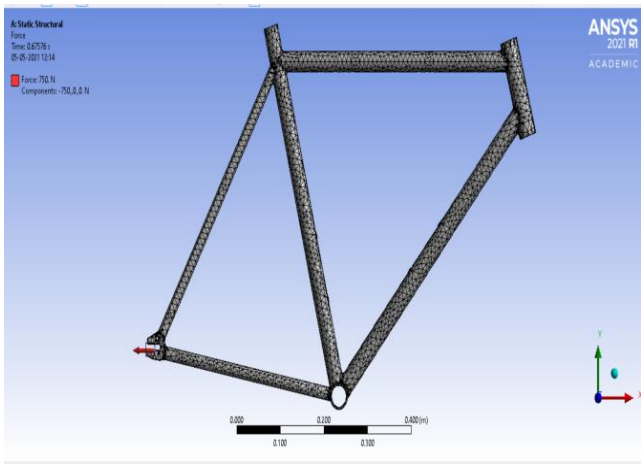




2) Rear Wheel braking:

Due to heavy braking, whole weight of body concentrates over rear wheel that they lock which cause skidding.

Force and fixed support on frame:



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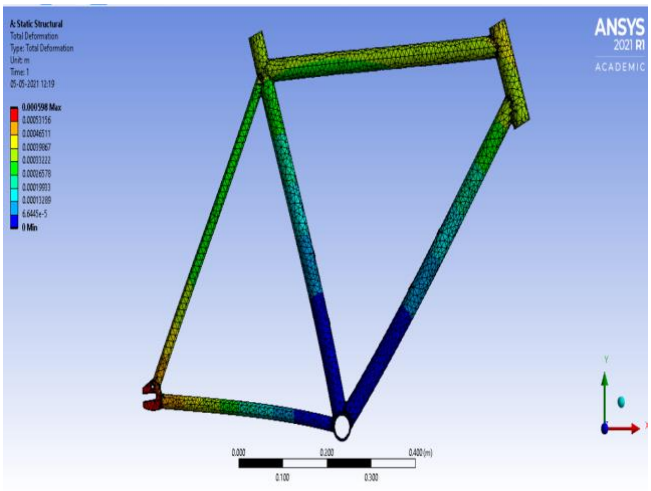
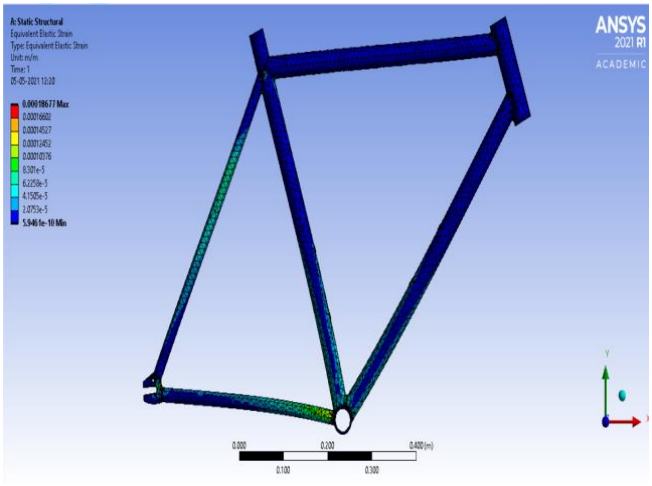
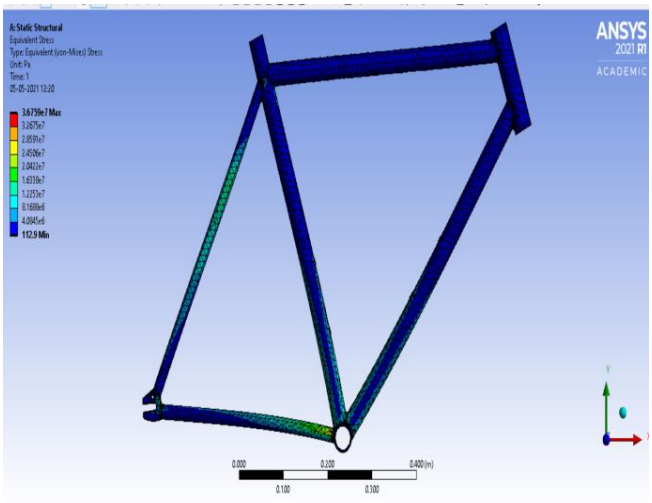


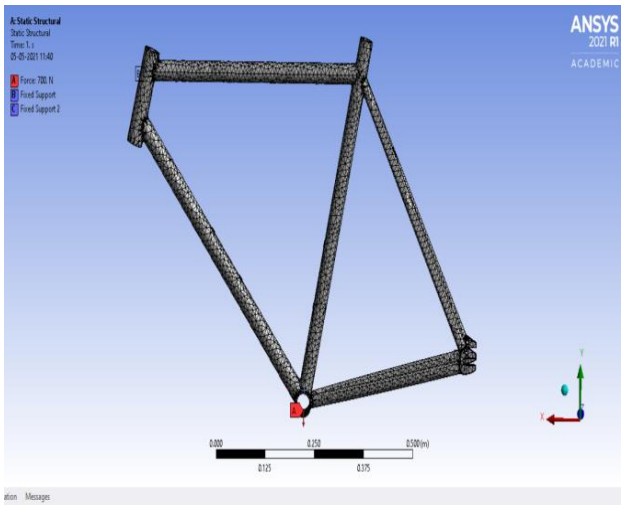




3) Static Start up:

700N force applied by rider in paddle in vertically equilibrium state with rear wheel point straight.

- Force and fixed support on frame:



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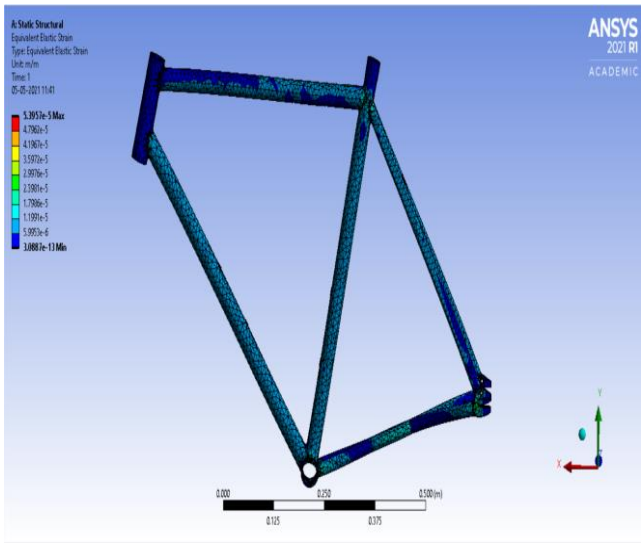
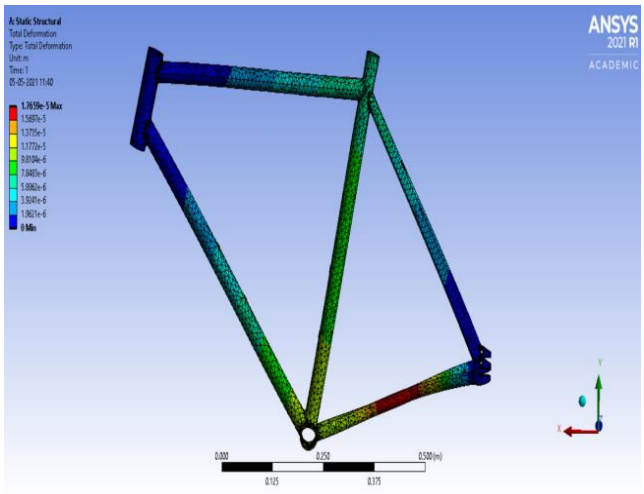
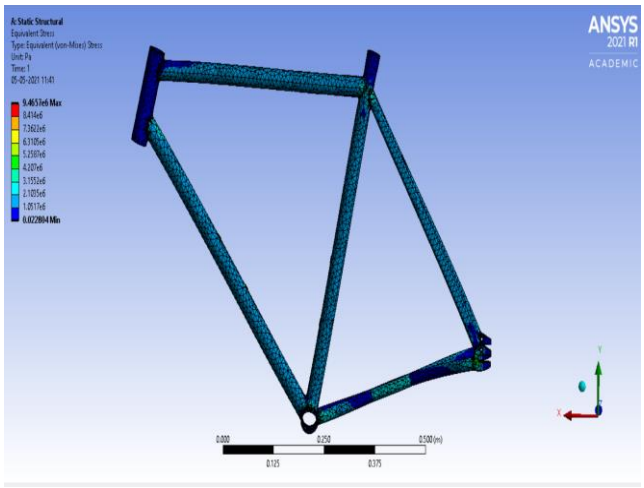


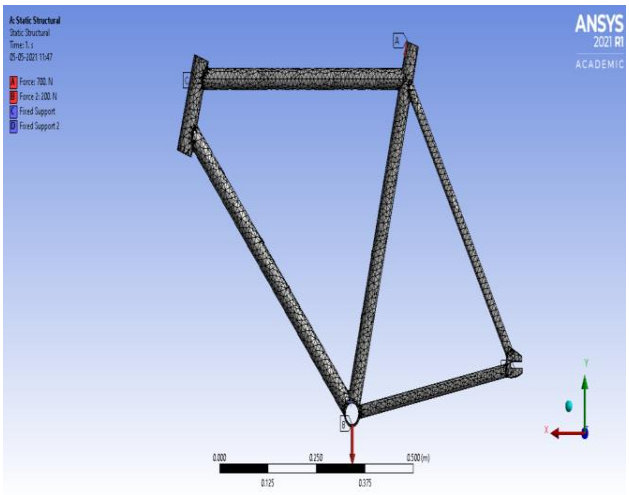




4) Steady state:

Rider with his 700 N weight seated on bicycle applied force of 200 N on pedal from his leg.

- Force and fixed support on frame:



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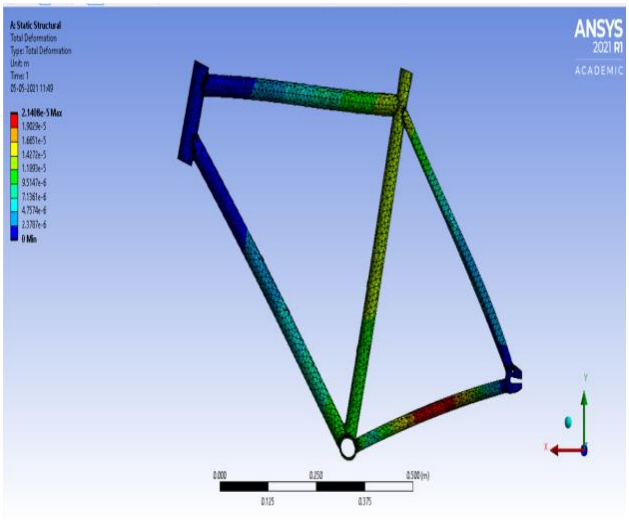
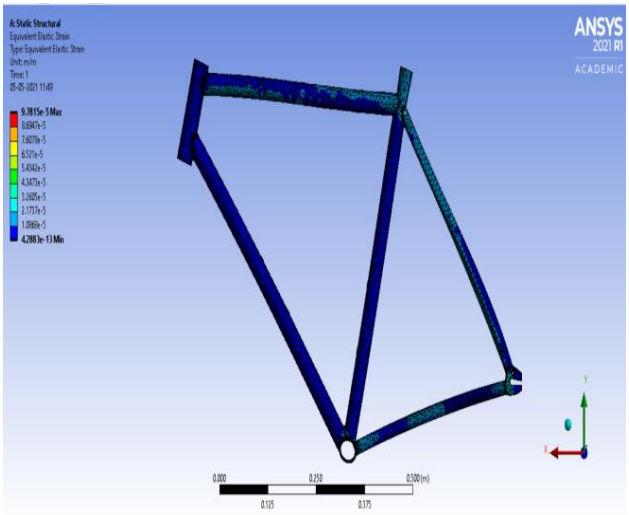
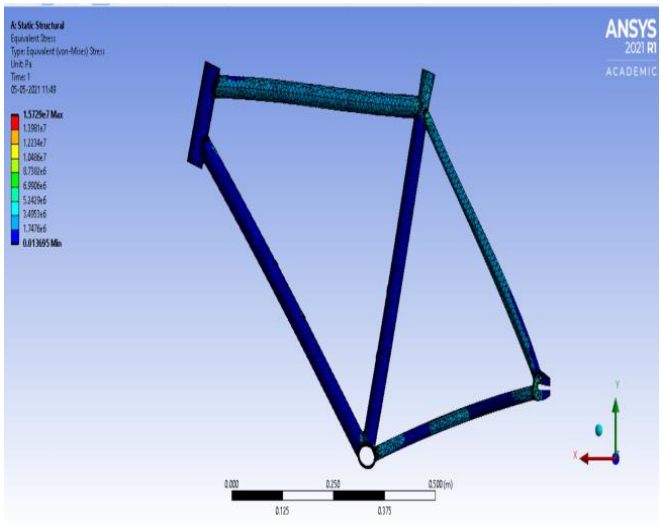




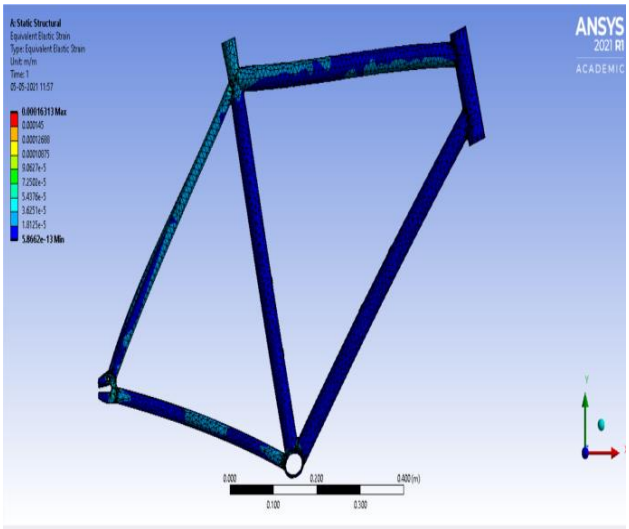


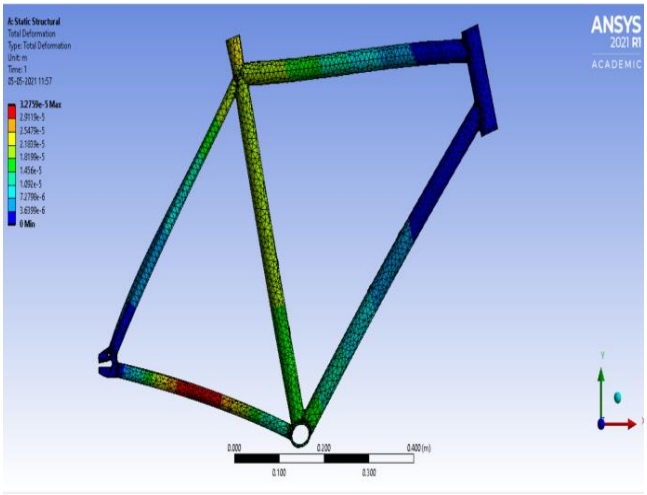
5) Vertical impact;

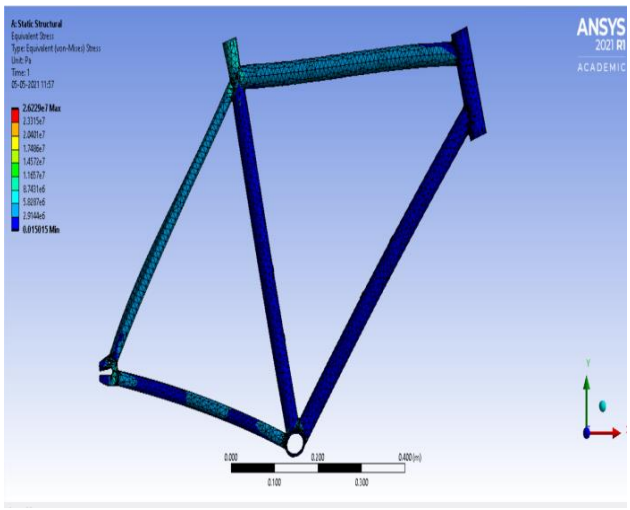
Rider with cycle dropped vertically on rigid surface from some specific height exert force.

- Force and fixed support on frame:

Result after analysis on Ansys:



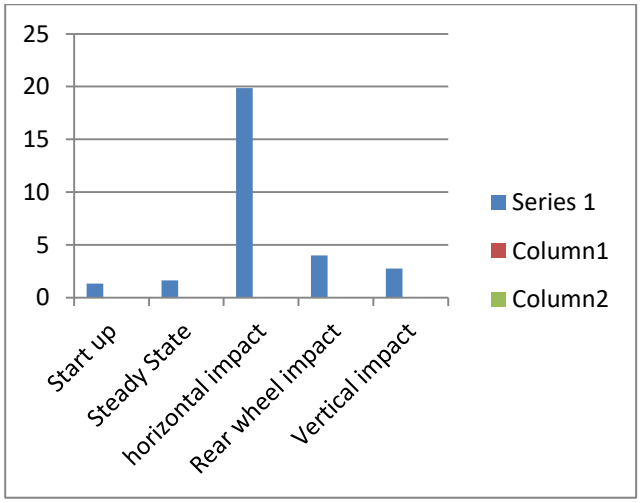




Results in table form

Conditions	Max. Total deformation (in mm)	Avg. Elastic Strain (in mm/mm)	Avg Stress (in Mpa)
Static Start Up	0.03	1.19	1.32
Steady state	0.021	1.55	1.63
Vertical impact	0.032	2.43	2.76
Horizontal impact	3.53	0.0002	19.86
Front wheel impact	0.598	4.15	3.98

Avg. Stresses (Von Mises):



Conclusion:

From the results of Finite element analysis, it is clear that the stress induced in bicycle frame is minimal and factor of safety is greater than the limit. Ultimate strength for the material is also greater than equivalent stress (Von Mises). Thus, the bicycle frame design is strong. By using Ansys software calculation become fast and several repetitions of process arrive to best possible results.

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