Impact Analysis on E-Bike Chassis Frame

P. N. V balasubramanyam, A.Sai Nadh, P.Monika, Ch.Raghava

ABSTRACT: The Electric Bike is an eco-friendly transport system which will be useful for present and broadly for future generations, so that they can use renewable energy resources to power their vehicles instead of fossil fuels and produce less pollutants or no pollutants. The frame is considered as the foundation which is even termed as the skeleton for a vehicle that supports an objective it its construction and protection for integrated parts in the vehicle. The electric bike frame which we designed is made by considering set of requirements from the data analysis and reviews, suggestions and experience which will improve the accuracy and precision of the overall bike by the acceptance of all the engineering principles. The main objective of our paper is to design the frame for the bike and to perform three types of impact analysis i.e. side impact analysis, front impact analysis and combined impact analysis for different speeds using finite analysis software.

Keywords: Electric Bike, side impact analysis, front impact analysis, combined impact analysis.

I. INTRODUCTION

India is a nation which has the second largest population and is one of the busiest road networks in the world. Because of this overwhelming population, accidents are most common resulting in major source of death in the country.There is one death every four minutes and an average of 1200 road crashes every day with a whopping 1.47 lakh deaths per annumin India. The two-wheeler accidents involved in more than 30% of road accident deaths. One of the main parts to be considered in the bike to reduce the impact of accidents on the user is the frame of the bike. The frame acts as a skeleton and supports the major components and systems by taking various loads of the bike. Different components are mounted on the frame providing them with strength to carry their specific individual loads. The frame also supports various components like seat, bodyworks, accessories, etc. Battery and motor are also mounted on the frame. The frame must be able to resist against shocks and impacts of the vehicle and provide stiffness thus protecting the user and vital parts of the vehicle. The design of the frame also depends on the transmission, steering and suspension. The impact analysis depends on various factors. Out of these factors we have chosen speed and type of impact into consideration. A user while riding a bike at different places maintains a speed of

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1. 30kmph (on busy roads and in rural areas),
2. 60kmph (on medium road and while considering the economy of the battery) and
3. 80kmph (on highways).

So, these speeds where considered to perform the analysis.

Few types of impacts considered for analysis are:

1. Frontal impact analysis- when bike hits at the front-front.
2. Side impact analysis-when bike hits at the side.
3. Combined impact analysis- when both side and frontal impacts takes places simultaneously.

An effective design must be economical and safe under extreme loading conditions also. The design must be able to withstand for all the speeds and impacts considered.Therefore, analysis gives us the information of the frame during these impacts.

DESIGN SPECIFICATIONS:

Table 1: Design Specifications

Length	1076mm
Width	120mm
Height	676mm
Head tube angle	19°

II. MATERIAL SPECIFICATIONS:

The selection of material also plays a very important role in the analysis of any structure. The material that we considered is AISI 4130. This is because it has less density and a good strength. It is also available in market at a reasonable price. We used 1-inch diameter, 2mm thickness seamless pipes for the complete frame. The composition and properties of AISI 4130 are listed below:

Table 2: Material Composition

S.NO	ELEMENT	CONTENT
1	Iron (Fe)	97.03-98.22
2	Chromium (Cr)	0.80-1.10
3	Manganese (Mn)	0.40-0.60
4	Carbon(C)	0.28-0.33
5	Silicon (Si)	0.15-0.30
6	Molybdenum (Mo)	0.15-0.25

7	Sulphur(S)	0.04
8	Phosphorous(P)	0.035

Table 3: Material Properties

PROPERTY	VALUE
Density	7850kg/m^3
Ultimate Tensile Strength	670N/mm^2
Yield Strength	435N/mm^2
Modulus of elasticity	205N/mm^2

DESIGN AND STATIC ANALYSIS:

Solid works is a design software tool utilized to design and render an object/component which includes various performance operations design modulators, conventional drawing methods by the integrity of advanced sketching mounts handled by both first and third angle projections. We used solid works 18.0 to design our bike frame. Finite Element Analysis (FEA) was done on the frame to know the performance of the bike at various situations. These analyses were done to know the strength and deformation of the bike on applying loads at different situations that it will undergo during its life time. FEA was done by using ANSYS 18.1 version. Figures show the strength and deformation of the frame. The stress under different situations were studied and the maximum von-misses stress was found to be 51.82 MPa with a maximum deformation of 0.2915 mm. From the analysis, most of the stresses are below 120 MPa.Von-mises was used to check whether the design can withstand the given load condition. If the maximum value of the von-mises exceeds the strength of the material, then the design will fail. So, the von-mises stress does not exceed the strength of the material. The maximum von-mises stress from analysis is 51.82MPa which is far less than the strength of the material (560 MPa). So, the design is safe for real life load condition.

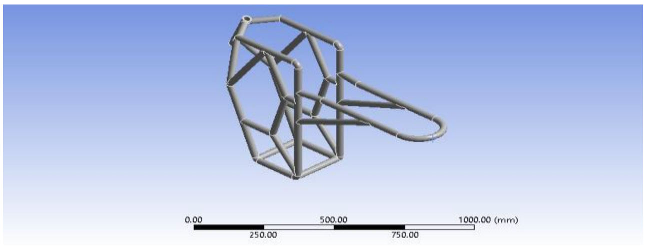


Fig 1: E-Bike Frame

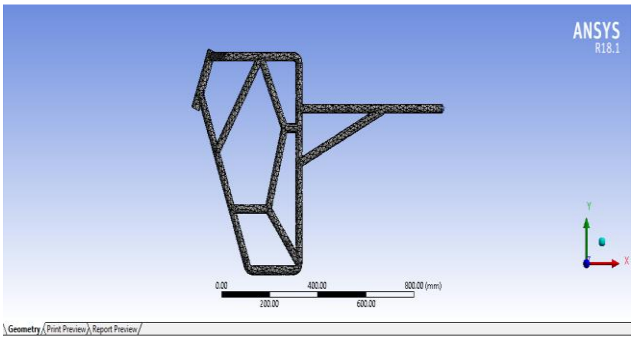


Fig 6: Total Deformation

SIDE IMPACT ANALYSIS

Fig 2: Meshing

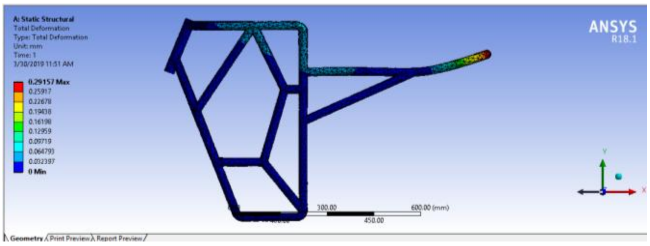


Fig 3: Total Deformation

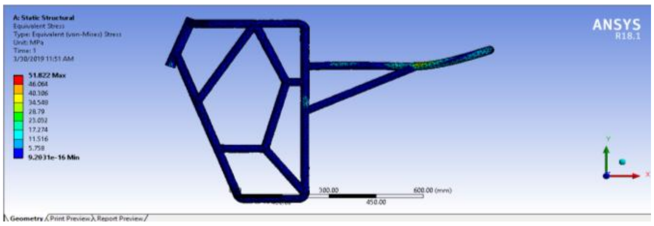


Fig 4: Von Misses Stress

III. IMPACT ANALYSIS RESULTS AND DISCUSSION:

For speed 30kmph:

FRONTAL IMPACT ANALYSIS

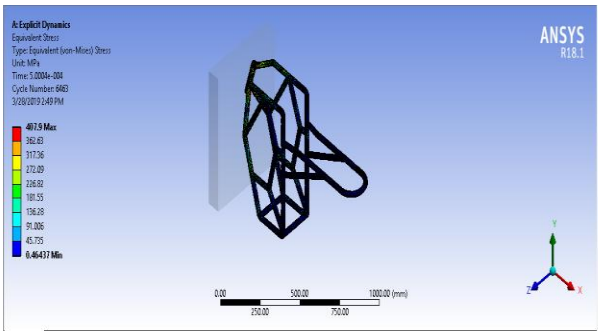
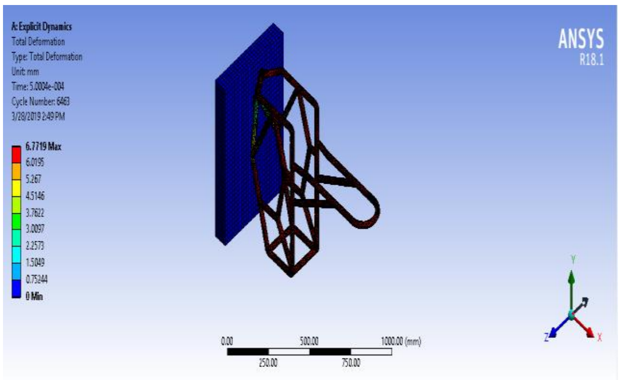


Fig 5: Von Misses Stress



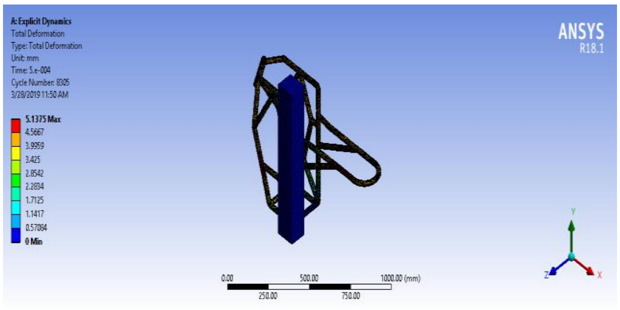


Fig 7: Total Deformation

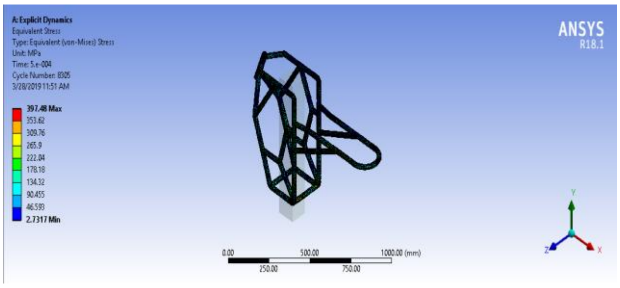


Fig 8: Von Misses Stress

Combined Impact Analysis

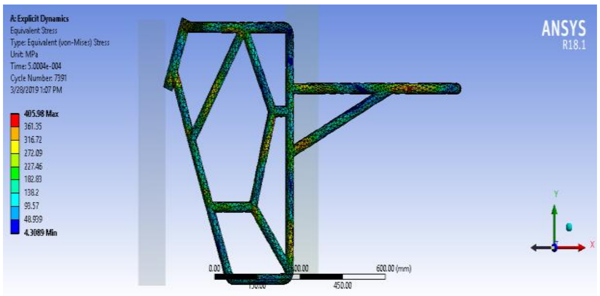


Fig 9: Von Misses Stress

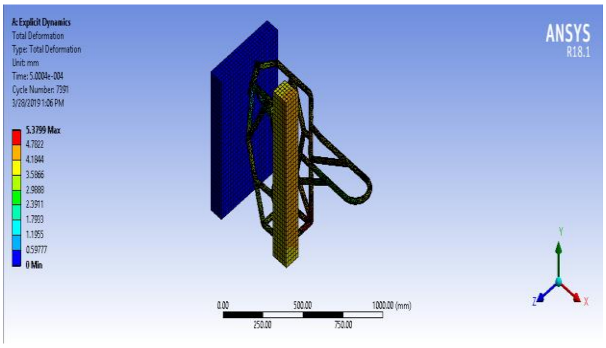


Fig 10: Total Deformation

For speed 60Kmph

FRONTAL IMPACT ANALYSIS

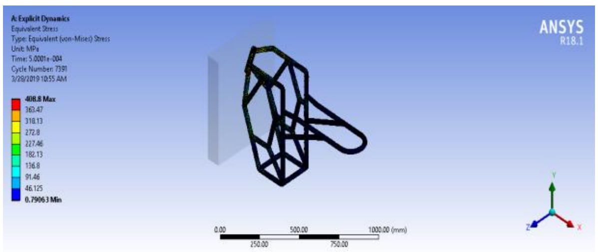


Fig 11: Von Misses Stress

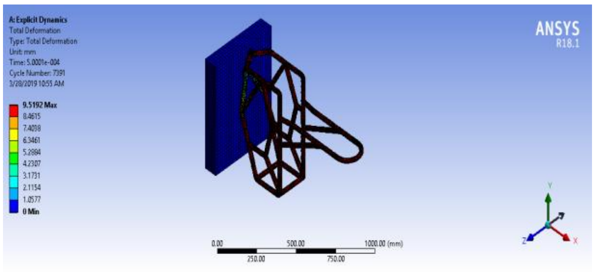


Fig 12: Total Deformation

Side Impact Analysis

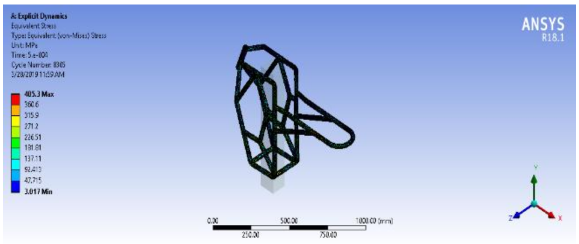


Fig 13: Von Misses Stress

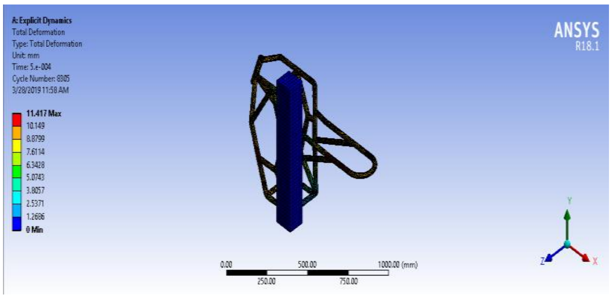


Fig 14: Total Deformation

COMBINED IMPACT ANALYSIS

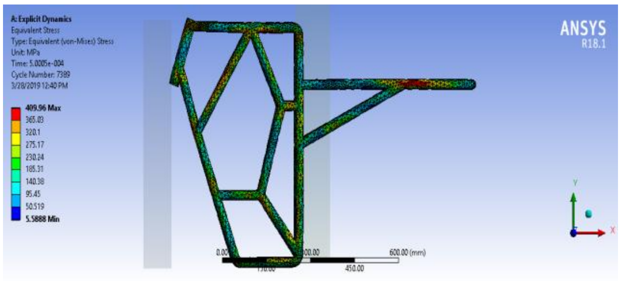


Fig 15: Von Misses Stress

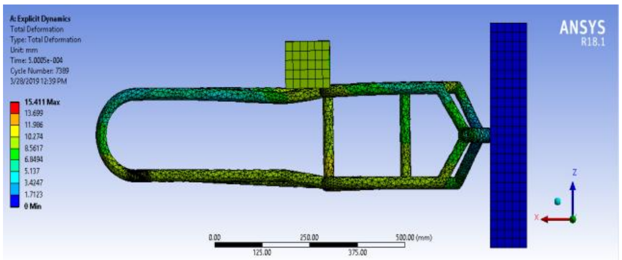


Fig 16: Total Deformation
For speed 80Kmph

FRONTAL IMPACT ANALYSIS

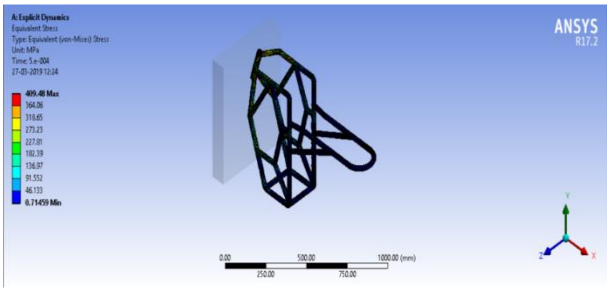


Fig 17: Von Misses Stress

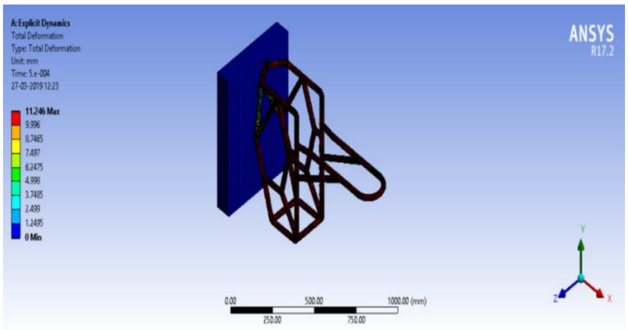


Fig 18: Total Deformation

SIDE IMPACT ANALYSIS

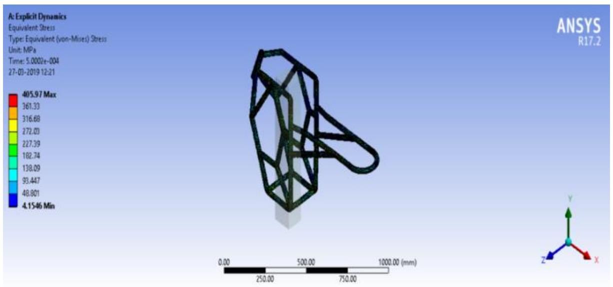


Fig 19: Von Misses Stress

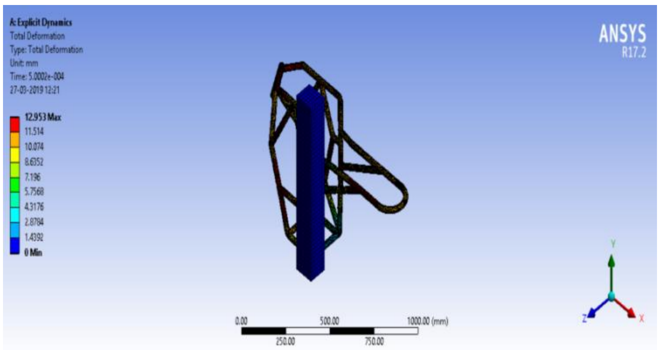


Fig 20: Total Deformation

IV. COMBINED IMPACT ANALYSIS:

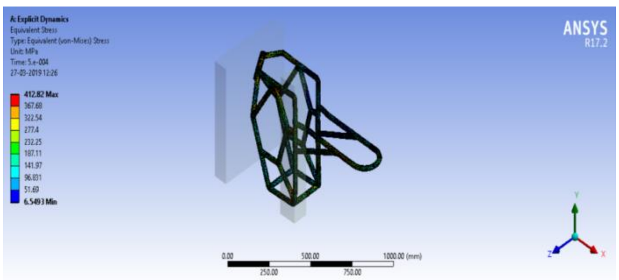


Fig 21: Von Misses Stress

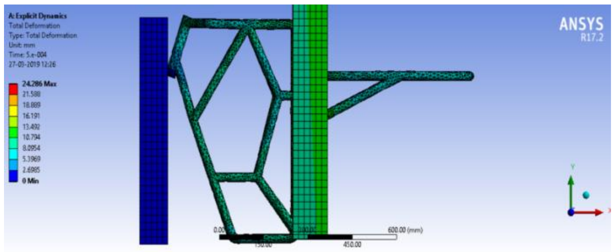


Fig 22: Total Deformation

Von Misses Stress for different speeds:

Table 4: Von Misses Stress Results

Type of impact	30Kmph	60Kmph	80Kmph
Frontal	407.90 MPa	408.80 MPa	409.48MPa
Side	397.48 MPa	405.30 MPa	405.97MPa
Combined	405.98 MPa	409.96 MPa	412.82MPa

Total Deformation for different speeds:

Table 5: Total Deformation Results

Type of impact	30Kmph	60Kmph	80Kmph
Frontal	6.77mm	9.51mm	11.246mm
Side	5.13mm	11.41mm	12.95mm
Combined	5.37mm	15.41mm	24.286mm

V. CONCLUSION:

The design and functional requirements of an electric bike were considered while designing the frame. The frame design not only provides better strength but also better components mounting. A FEA model was created and an analysis of the frame was carried out for different speeds and different types of impacts which showed that the design is safe for even the maximum speed (80 Kmph).

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