International Journal of Research Publication and Reviews, Vol 3, no 3, pp 1583-1585, March 2022

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Finite Element Analysis of bus structure as per ECER29

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A B S T R A C T

India is a developing country with longest and busiest route in the world after USA so the road accidents are always a huge issue on highways and every year accident gross rate increases up to 1.5 %. In India road accidents are a leading cause of death with rank one across 199 other countries. As per National Highway Traffic Safety Administration accident statics 11,000 people have lost their life in bus accident every year. There are some common type of bus accident happed like frontal impact, side impact, rear impact and rollover and in between frontal accident rate is higher than any other fatality because there is no crumple zone provided by thy bus manufacture. In case of frontal collision the energy absorption of the frontal structure is very low and remaining impact energy directly transferred to the occupant So in this research work we performed the frontal impact analysis of bus structure as per ECER29 using finite element analysis to evaluate injury and suggest some modification.

Keywords:ECER29, FEM, Crashworthiness, Dummy injuries, Fatality

1. Introduction

The finite element analysis is a most popular method in advanced automotive industry to solve complex engineering problems including structural, fluid flow, thermal and electromagnetic etc. FEM is type of numerical method for solving partial differential equations, to solve any problem Fem subdivide the system in to small elements by discretization method FEA generally helped as to reduce the number of iteration during development process, the explicit LS-Dyna code was used for this purpose.

As per ECER29 standards all automotive structure should be design in such a way that at the time of accident the minimum survival space is guaranteed. This standard generally adopted by truck cabin structures only, standard should not applicable for agriculture and construction vehicle. The legal requirements of driver cabin safety are fixed in ECER29 regulation. The rigid surface with the area of 2500X800 mm2 and the mass of 1500kg must be positioned below 50mm to the R point of the driver seat. The impact energy has to be in the rage of 45KJ as per vehicle maximum permissible weight.

2. Methodology

To start this study with research on various scenario of accidents happen with buses and evaluate risk of injury accordingly. Our work starts with CAD modeling then we Export this cad data in STEP format and perform meshing using finite element method after that applied boundary condition as per ECER29 standard and check the survival space between the dummy and steering system.

Fig. 1 –Frontal Crash

CAD model prepared using creo software all dimensions are in mm.

Dimensions – Maximum length – 8000MM

Maximum width – 2600 MM

Maximum Height – 3800MM

Seating Type - 2X2

Seating capacity – 32 seats

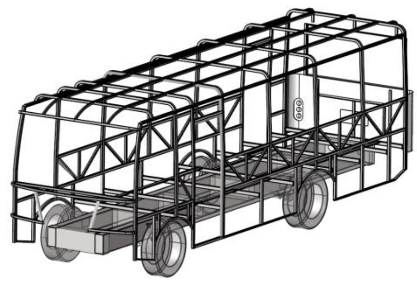
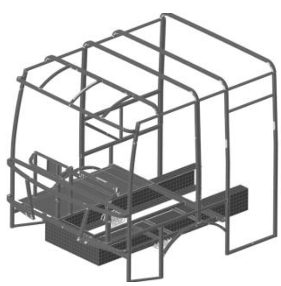


Fig. 2–Cad Modeling

A finite element analysis is most common method for structural analysis using numerical technique called finite element method. This technique used to reduce number of prototype and improve product quality in design phase.



Element quality criteria-

1-d							
2-d (selected)	warpage	>	15.000	length	<	3.000
3-d	aspect	>	10.000	length	>	10.000
time	skew	>	60.000	jacobian	<	0.650
user	chord dev	>	0.100	equia skew	>	0.600
group	cell squish	>	0.500	area skew	>	0.600
				taper	>	0.500

Fig. 3–Meshed Model

3. Boundary Condition

The rigid pendulum of 2500mmX800mm shape with 1500kgs in weight, suspended by two rigid beam of 1000mm apart and 3500mm long from the axis of suspension from the axis of impact. The CG of pendulum should be 50mm below to the R point of the driver seat as shown in figure.

The impact angular velocity w and pendulum rotation can be calculated by given formulas

$$mg\Delta h = \frac{1}{2} I_{xx} w^2$$

m – Mass of the vehicle in Tones

g – Acceleration due to gravity

Δh - Height between Max. CoG & Final CoG

I_{xx} - Mass moment of inertia about rotational axis

w - Angular Velocity

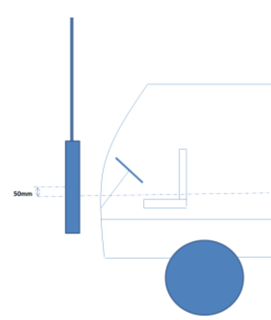


Fig. 4–Boundary Condition

4. Results

As per the AIS standard we evaluate the deformed shape of the structure found some deformation in frontal area and we can clearly observe the minimum space between the steering system and rigid dummy model.

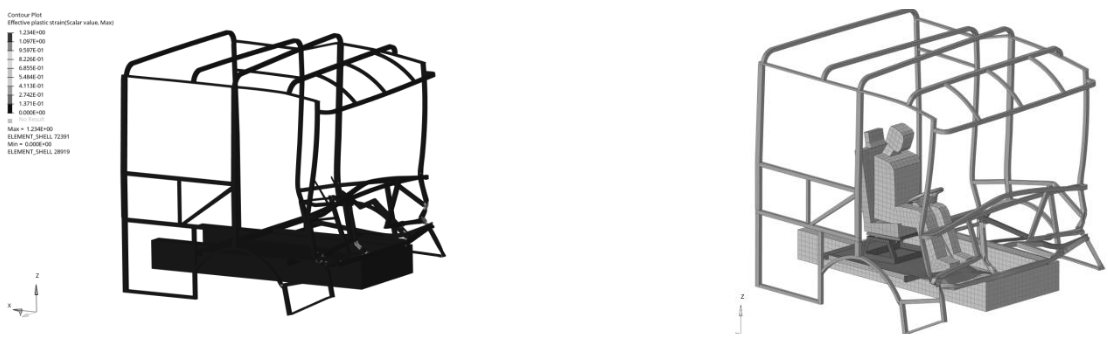


Fig. 5–Results

In the way of crash worthiness improvement we develop two different zones in front structure one is called crumple zone and second one is called driver compartment zone as similar to the passenger cars. The crumple zone is made in such a way that can absorb maximum deformation energy and driver compartment zone designed to resist deformation**.** After modification we got sufficient survival space between dummy and steering column as shown in figure below.

Fig. 6–Modified Results

5. Conclusion

The purpose of this study to perform frontal crash analysis on bus structure as per ECER29 and try to improve the crashworthiness and reduce risk of fatality. It was observed that the baseline design doesn't meet the ECER29, there is no space between dummy and steering system. To avoid failure and improve crashworthiness we develop two different zones in front structure one is called crumple zone and second one is called driver compartment zone as similar to the passenger. The crumple zone designed in such a way that it can observe maximum percentage of energy by deformation in own shape and remaining energy will transferred driver compartment area which has high strength as compared to the crumple zone so it will not deformed so badly and try to avoid deformation by changing the load path. In this standard we insure the safety of the passenger by measuring the gap between rigid dummy and steering system so after modification we found the sufficient survival space which insure the safety of the occupant.

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