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Research and Calculate 29/34-Seat Passenger Cars to Ensure Safety for Occupants in the Event of a Collision According to ECE R94 Standards

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Abstract

In recent years, there are so many serious crashes involving coaches, especially the frontal collision occupies 40% of the front of the vehicle, Frontal collisions account for 100% of the front of the vehicle affecting the driver and side-impact collisions that injure the person in the vehicle. Therefore, the research into improving and optimizing the structure is necessary for risk of injury for passengers in frontal accidents. In this paper, we have designed a Shock absorber that can absorb collision energy. Research using HYPERMESH software. to build the finite element model and calculate the meshing to suit the mesh size of 5mm. apply LS-DYNA software to calculate structural strength. In the study, for a vehicle to collide with a hard obstacle occupying 100% of the head of the vehicle. Then, the experimental design method, Minitab is used for find the structural parameters in the design. Improvement results showed that the acceleration of the impact on passengers and the driver is decreased by 55,17%. The mass of texture improvements is reduced by 11%, according to the requirements of European Standards ECE R94.

Keywords: *Absorb Collision Energy, Injury for Passengers, Head-On Collision, ECE R94 Standard*

1. INTRODUCTION

In recent times, there have been many traffic accidents involving passenger cars of a serious nature, especially those where passenger cars collided head-on, causing many casualties. Therefore, it is necessary to study to improve and optimize the structure to reduce human injury when a 29/34-seat passenger car has a head-on collision. Author Muhammed Talha AŞKAR has studied the vehicle's ability to absorb energy when hitting a collision [1]. Many authors have studied the stability of passenger cars when in frontal impacts [2][3][4]. Some research authors have experimented with frontal collisions with hard obstacles [5][6][7]. The authors have studied the safety of the vehicle body in the event of a collision [8][9][10]. some authors have

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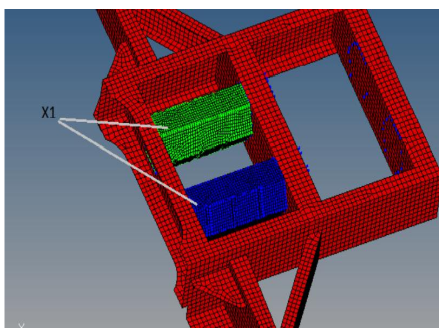
studied crash patterns and ride comfort with integrated seat cushions [11][12][13]. This study develops dampers that can absorb impact energy, then uses experimental design methods, regression methods, and optimization algorithms to find out the structural parameters in the design. The optimal results show that the collision acceleration acting on passengers and the driver is reduced by 55.17%, the weight of the improved structure is reduced by 11%, satisfying the safety conditions according to ECE R94 standards [14].

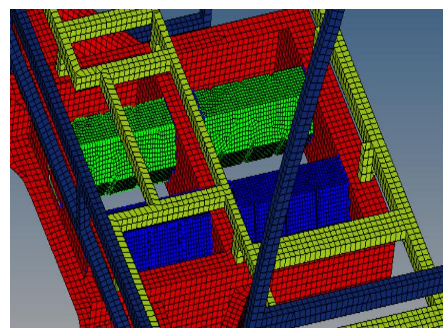
2. SIMULATION MODELS

2.1. Design Model

In the model in Figure 1, SOLIDWORKS software is used to design and improve the force absorption model, After designing the model, applying HYPER MESH software to calculate the structural strength and meshing. In figure (a) The front bumper has not been improved and figure (b) Car front bumper after improvement.



(a)



(b)

Figure 1. Car front bumper

As the materials shown in Table 1 apply to the design of the vehicle's chassis system, the chassis will use Q345B steel with allowable stress of 345MPa. Apply Q235B steel to vehicle side frame parts with allowable stress of 235 MPa. The damping system will use A5052 aluminum with allowable stress of 130MPa.

Table 1. Material parameter

Material name	Mass separately (kg/m3)	Elastic modulus E (GPA)	Poisson's coefficient (v)	Stress of fluidity (MPA)
Q235B	7850	206	0.3	235
Q345B	7850	210	0.3	345
A5052	2750	68	0.3	130

2.2. Finite Element Analysis Model

The model meshing is the basis for building a quality assurance model in HYPERMESH to provide the necessary calculation and analysis results. First we have to choose the mesh type, in this section choose the mixed mesh type (Mixed) with a size of 20 mm on the entire passenger car skeleton, after meshing the tolerance < 0.5 times that mesh size, avoid status of the grid is shoved, the link is messy.

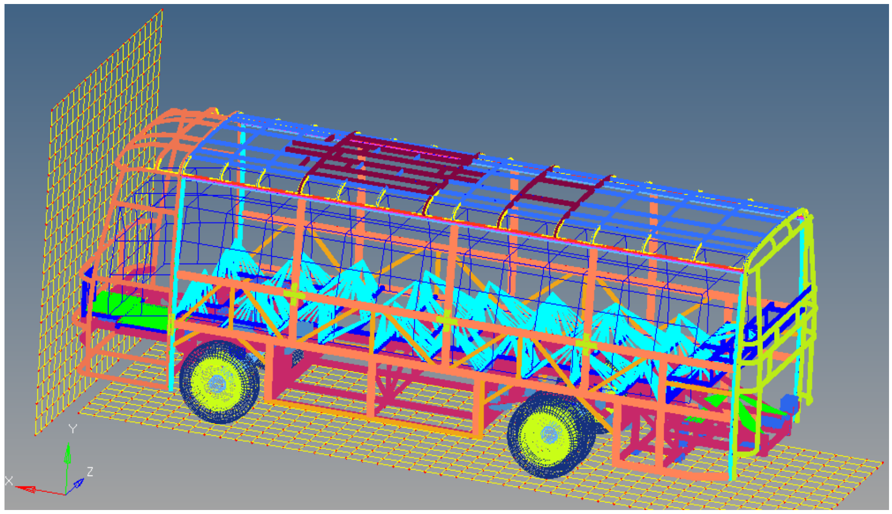


Figure 2. Full model mesh error checking.

2.3. Human Injury Analysis Model.

The head injury index is given by Equation (1)

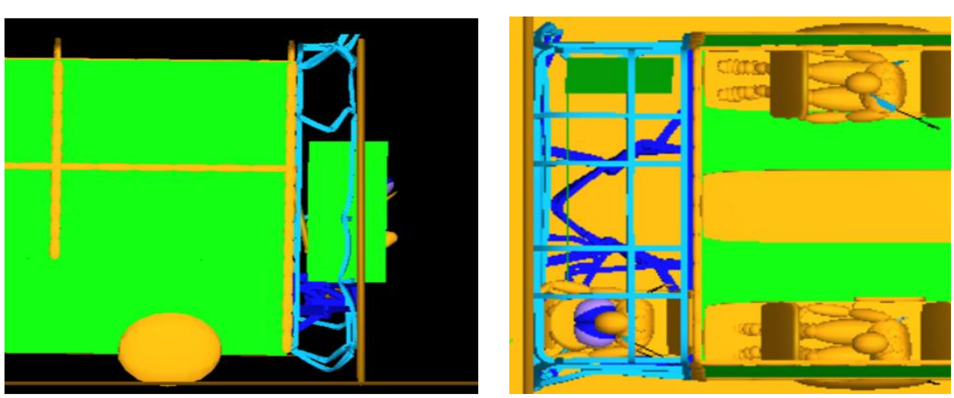
$$HIC = max\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} a(t)\,dt\right]^{2,5}(t_2 - t_1) \tag{1}$$

In Equation (1), with t_1, t_2: time to change the maximum acceleration value, $t_2 - t_1$: maximum range 36m/s a: acceleration with time at the center of the dummy head.

3. ANALYZE SIMULATION RESULTS

3.1. Results of Structural Strength Analysis of Integrated Seats

Based on the initial simulation results using MADYMO software, Figure (a) and (b) show that the front bumper of the passenger car is very deformed, and the safe space is violated in Figure 3. necessary when it comes to human injury. But this distortion violates the ECE R66 safe space.



(a) (b)

Figure 3. Infringed part of safe space

Through simulation, we see that with a chassis thickness of 8mm and headframe parts of 2mm, the front frame is severely deformed, and entering a large safe space can cause serious injury to the vehicle driver. Figure 4 shows the biggest impact, the headframe is deformed and collides with the driver when it has not been improved.

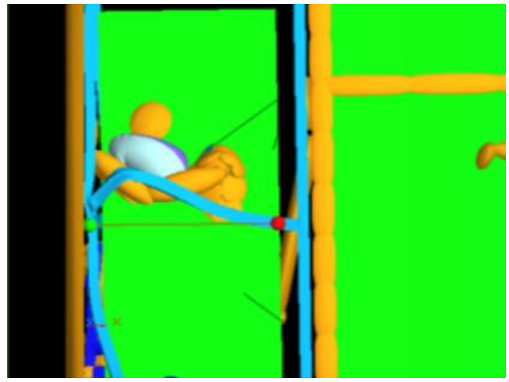
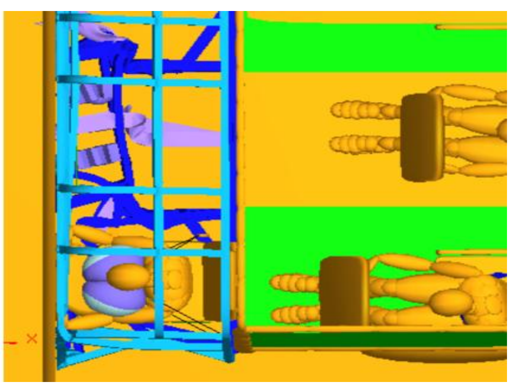
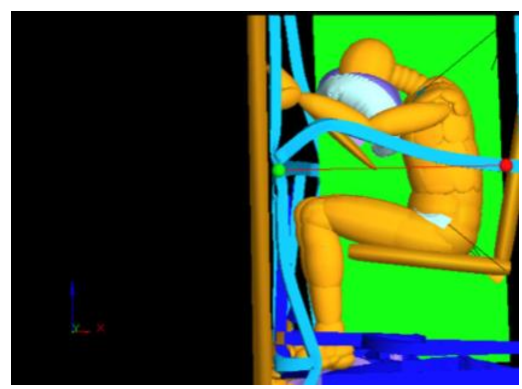


Figure 4. Safe space after collision in case the vehicle is not optimal

Figure 5 shows the chassis with an improved damping system. The front part of the passenger car in the event of a collision is protected. Figure (a) shows the improved head undercarriage. Figure (b) the front frame is better and doesn't violate the safe space. The overview of the front of the car in Figure 5 shows that after improving the front of the car with a damping system. The driver is protected safely.



(a)



(b)

Figure 5. Safe space after a collision in case the vehicle has a damping system

4. CONCLUSION

In this paper, we designed a damping system for the underbody of the passenger car's head. The results of injury analysis showed that after installing the energy absorber on the front of the vehicle and optimizing it, the head injury indexes were significantly improved and were within a safe level to reduce the possibility of death of the driver. and passengers. At the same time, after optimization, the weight of the front end of the vehicle is reduced by about 11% compared to the original vehicle's weight without the energy absorption system and not being optimized; The post-collision safe space of the optimal case increased by 16.98% compared to the post-collision safe space of the pre-optimal case. The results are consistent, minimizing the risk of death in the event of a collision.

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