RESEARCHING THE FORCE ABSORPTION SYSTEM FOR THE FRONT OF THE PASSENGER CAR TO SECURE THE DRIVER

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ABTRACT

Protecting the safety of drivers in the bus is very important and necessary in front collisions. This research on the system shock absorber and absorption of force bus head in front collisions. This design will protect bus heads not violations in safe spaces and protect drivers in front collisions. The finite element model and safety analysis simulation of the system shock absorber and absorption of force by LS – DYNA and MADYMO software. The study's results show shock absorber structure ensures durability. The head part index is down 35%. The neck part index is down 28%. Drivers are protected more safely. Injury values of driver satisfy safety ECE R94 standard in bus front collision.

Keywords: *ECE R94 standard, MADYMO software, LS - DYNA software, collision, injury.*

I. INTRODUCTION

In this study, a force absorption system is designed for the front of passenger cars. This system can protect the driver in a collision. Currently, passenger cars are very popular in public transport, But the designers mainly focused on the passengers, not the driver. In recent years, there have been many traffic accidents. According to statistics, drivers are seriously injured or die in head-on collisions. Researching a force absorption system to protect the driver is completely reasonable. Author Jennifer Concepcion has studied collision injuries related to passenger cars to improve vehicle safety [1]. Author Takanobu Otaguro has researched a collision warning system that automatically sends a signal to the rescue department to protect people in the vehicle being timely first aid [2]. Author Kazuya Takaguchi has studied self-driving cars, but this research is still not reliable enough in sudden collisions [3]. Author Darsith Jayachandran studies collision detection sensors but omits the impact of the head car in collisions [4]. The author Frej has studied the comfort of people sitting in the back seat of a car. This study is comfortable when the car goes through speed bumps, But not reliable enough because has omits the safety and comfort of the driver and has not been simulated with a collision [5]. Author Lotta Jakobsson studies the balance of the 2 vehicle and the protection of adults and children in the car. This study only shows the safety when the unbalanced car horizontally flips but omits the direct collision [6]. Currently, many authors apply simulation methods to calculate the safety of passenger cars [7-9]. Some researchers have applied the optimization method to improve the head car to protect drivers [10-13]. In this study, apply HYPERMESH software to build a finite element model And calculate meshing to achieve the best structural strength. Using LS - DYNA software to analyze structural strength. Apply MADYMO and PROTOCOLRATIN software to simulate the calculation of the driver injury according to ECE R94 standards (14).

II. DESIGN

2.1 Damping system design

Applying SOLIDWORKS software to build the design of the damping system. The design is shown in Figure 1. Will be used to apply to the front chassis of passenger cars to reduce damping in head-on collisions to protect the driver. The dimensional parameters of the damping are shown in Table 1.

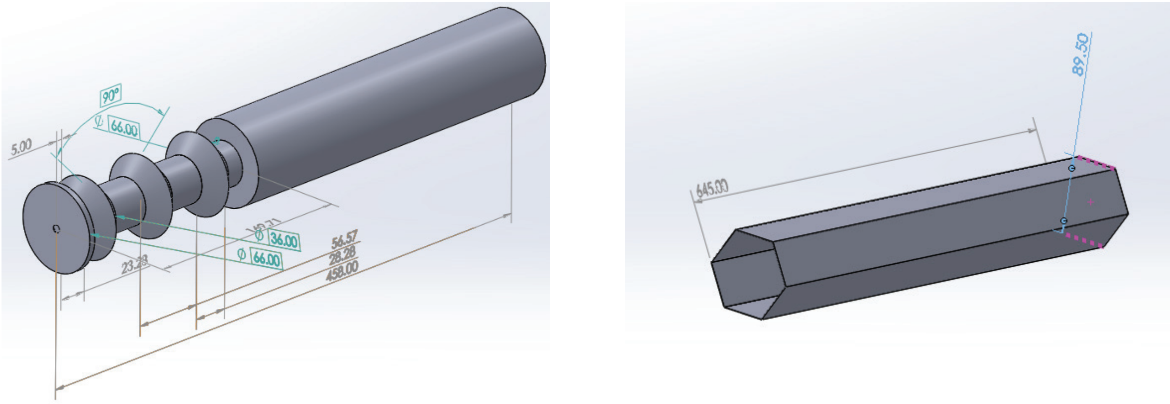

Figure 1. Damper tube.

Table 1. Steel specifications and materials

Steel name	Specific weight Kg/m^3	Elastic module GPA	Coefficient Poisson	yield strength, σ_c/MPA	Tensile Strength, σ_c/MPA
Q345B	7850	210	0.3	345	470-630

2.2 Finite Element Analysis

In collision simulation, the meshing ratio is very important. Whether the result is close to reality is due to the accuracy of the meshing. In this study, HYPERWORKS software is used for meshing. The mesh size of 5mm is applied to the damping part. Calculating and analyzing the structural durability of vehicles using LS-DYNA software.

To simulate closer to reality. In this paper, the passenger car will run at a speed of 50 Km/h. Collision with 100% of the head car area. During a collision, the head of the vehicle must be fully protected. Impossible to violate the safe space of the passenger car. Therefore, the damping system is welded at the front position of the head of the passenger car at the location shown in Figure 2.

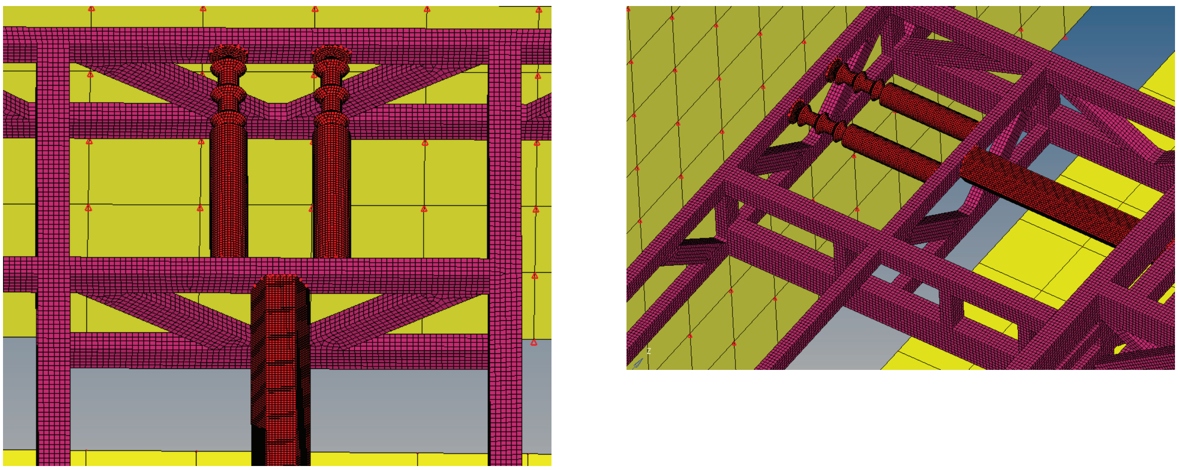

Figure 2. Meshing.

2.3 The head injury index is given by Equation (1)

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

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

III. ANALYZE SIMULATION RESULTS

3.1 Simulation results of passenger cars

Applying LS-DYNA software to calculate the simulation with the allowed speed of 50km/h. The results show that the head of the car will bear the maximum impact force. So the head will have the maximum stress shown in Figure 3. With the allowable stress of Q345B steel shown in Table 1 is 345 MPA. The head overcomes the allowable stress due to the reason to absorb the force of the whole passenger car. But must have to make sure the safe space isn't violated.

To evaluate whether the head of the vehicle has achieved structural strength, stress, displacement on impact. The simulation of a head-on collision with 100% of the head of the vehicle is shown in Figure 3. The largest displacements and stresses are concentrated on the front part of the vehicle

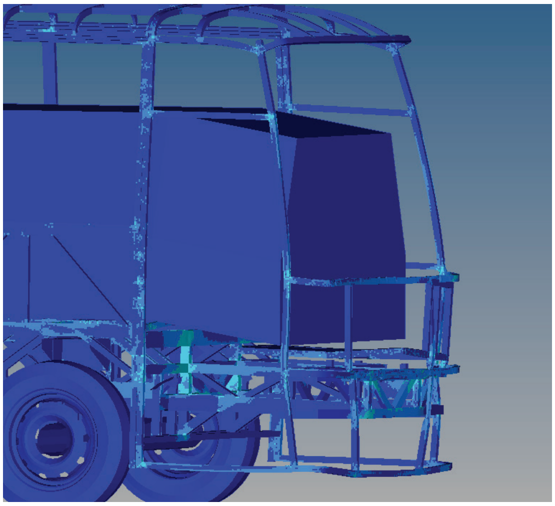

Figure 3. Maximum stress at process collision.

3.2 Analysis results

Case 1: Without damping systems.

The results in Figure 4 shows that there is no damping system. When the car collides with an obstacle, it will experience a huge acceleration, causing the driver to be affected. Reviews ECE R94 standards, when people in the vehicle are injured more than the allowable index according to the standard, then cannot be used.

With results exported by PROTOCOL RATING-7.5 software. Shows that the driver's

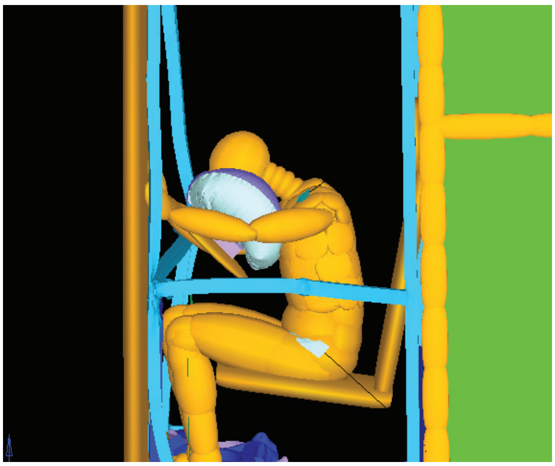

Figure 4. Unprotected drivers.

head is injured, with a damage value of 75%. The neck tension is 114%, with the resulting parameters shown in Table 2. The driver can kill in a collision

Table 2. Damage data

HEAD Value Rating		
Hic 36ms	748	75
Resultant Acc. 3ms exceedence (g)	85.14	106
Head Assessment 106		
NECK Value Rating		
Pos shear level exceeded (KN)	0.06	2
Neg shear level exceeded (KN)	0.53	17
Tension level exceeded (KN)	3.75	114
Extension (Nm)	43.03	75
Neck Assessment 114		

Case 2: With damping systems.

When there is a damping system, the driver's sudden influence on collision acceleration reduces. The driver will displace from positions less. The force applied from the seat belt to the body is also less shown in Figure 6. So the driver is protected.

The results in Table 3 show that after

Figure 6. Protected drivers.

welding the damping system to the head of the passenger car. Shows that the driver is not affected too much in collisions. Applying PROTOCOLRATING-7.5 software to analyze the injury results of the driver in Table 3. the driver's head is injured, with a damage value of 40%. The neck tension is 86%. Meets the safety index of the head and neck when head-on collision according to ECE R94 standards. Infers that the safety damping system can be applied to use in passenger cars.

Table 3. Injury data after improvement

HEAD Value Rating		
Hic 36ms	401	40
Resultant Acc. 3ms exceedence (g)	64.11	80
Head Assessment 80		
NECK Value Rating		
Pos shear level exceeded (KN)	0.06	2

HEAD Value Rating		
Neg shear level exceeded (KN)	0.42	14
Tension level exceeded (KN)	2.83	86
Extension (Nm)	28.95	51
Neck Assessment 86		

IV. CONCLUSION

This article shows the head vehicle damping system in Figure 1. The head passenger car's safety space is better protected. The driver's injury index is improved according to ECE R94 standards shown in Table 4. The head part index is 40%, The index has not improved is 75%, down 35%. The neck part index is 86%, Compared to the old index of 114%, down 28%. Infers the safety of the driver is better protected with this system.

Table 4. Compare results

No improvement	Improvement	reduction
The head part index is 75 %	The head part index is 40%	35 %
The neck part index is 114 %	The neck part index is 86%	28 %

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