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Safety Evaluate of Brackets for Bare Chassis of a 30-seated Bus

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Abstract

In the manufacturing process of the bus treated as the commercial vehicle, after making the bare chassis which is the basic frame of the vehicle body, the part in which passengers ride is connected. In addition, the necessary parts such as the engine and transmission required for the operation of the bus are connected to the bare chassis. The element connecting the parts such as the boarding part of the passengers, the engine, the suspension and the transmission is the bracket. The device required for driving and operating the vehicle is mounted on the bare chassis using the bracket, which should ensure stability during bus operation. In this study, we were performed stress analysis to evaluate the stability of three types of brackets connecting the bare chassis of a new type of 30-seater bus in the development process and components required for driving and operation. The stress analysis should be preceded by the analysis of boundary conditions considering the loads applied to the brackets according to the material of the bracket to be analyzed and the driving type of the bus. The finite element model for structural analysis of brackets according to the driving type of the bus was used by Altair's Hypermesh 2017, and the solver used for structural analysis was Altair's Optistruct. The stress analysis was performed to present the safe and vulnerable parts of the three brackets.

Keywords: *Bus, Bracket, Bare Chassis, Stress Analysis, Boundary Condition*

1. Introduction

In the production process of the bus which is commercial vehicle, after the frame of the vehicle body bare chassis is manufactured, the part in which passengers ride is connected to the bare chassis. In the bare chassis of the bus, the necessary parts install to the drive and operation of vehicle. The apparatuses required for the drive and operation of vehicle are mounted on the vehicle body, the front, or the rear axis which is the bare chassis by using brackets [1-3]. The role of the brackets used at this time is to connect various devices required for driving the vehicle to the vehicle body or axis. Among the important parts mounted within the bare chassis are engines and missions. Brackets that connect the various parts required for the operation of the vehicle to the bare chassis should be able to secure stability during the operation of the vehicle [4-6]. The loads of the vehicle, including the top part on which passengers ride during the bus operation, are applied to the bare chassis [7, 8]. The vehicle is operated in various forms. According to the road and driving situation including pause, braking, acceleration and cornering etc, brackets should endure the loads applied and make the components of

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the vehicle function [9, 10].

In this study, we tried to evaluate the stability of brackets used in the bare chassis of 30-passenger bus in the development stage. Stress analysis is required to evaluate stability, and boundary conditions that analyze the loads that the vehicle receives during operation should be presented to perform stress analysis. The drive unit, the brake device, the exhaust system and steering system etc. are installed as the space in which the apparatuses required for the bare chassis is drive and operation of vehicle are installed. These devices are basically connected to a bare chassis body or axis, and the parts that connect the devices required for driving the vehicle to the bare chassis are brackets. In this study, we conducted a stability evaluation of three brackets connecting components to the bare chassis of a new type of 30-seater bus in the development process. Location and shape of the brackets for being proceed the stability evaluation are same as those of Figure 1.

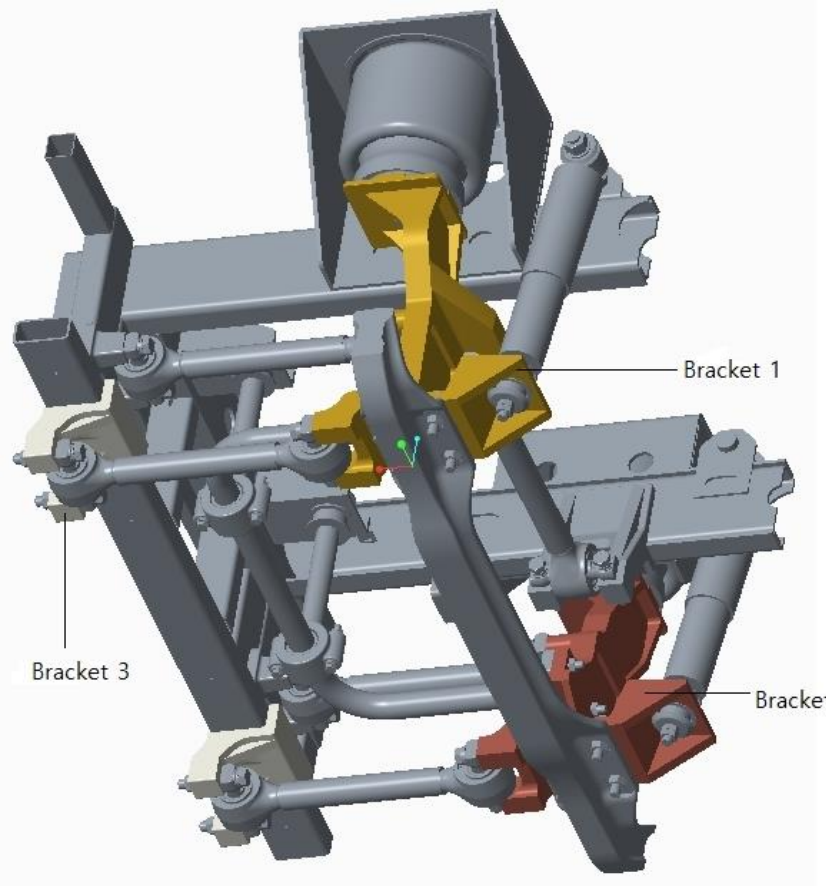


Figure 1. Brackets connected to bare chassis

In the bracket 1 and bracket 2, the load of the vehicle body actuates. And the bracket 1 is connected to the member of the side. Moreover, it is connected to the bracket 3 connected to shaft when the vehicles brakes and accelerating.

2. Modelling

The JIS specifications for the material that constitutes the bracket are Table 1, and the mechanical properties are Table 2, which are data provided by the manufacturer. According to the materials used for bracket, content can be changed.

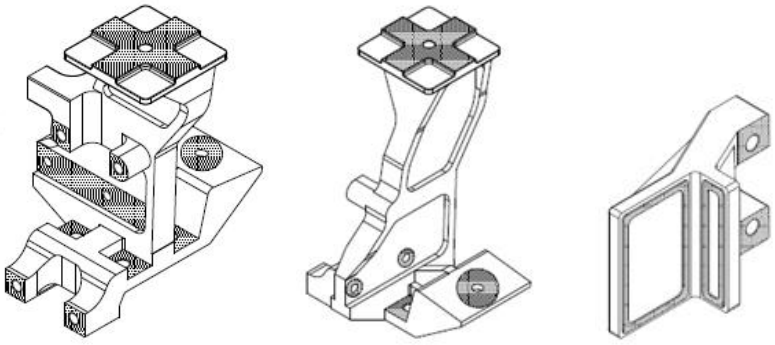
Table 1. SC450(=SC46) Standards according to JIS specifications

Sort	Regulation	Component		
SC450 (=SC46)	JIS G5101	C [%]	P [%]	S [%]
		≦ 0.35	≦ 0.04	≦ 0.04
		Intensity		
		yield intensity [MPa]	tensile intensity [MPa]	elongation [%]
		≧ 225	≧ 450	≧ 19

Table 2. Mechanical property of SC450 (=SC46)

Sort	Elasticity modulus [GPa]	Poisson's ratio	Fatigue limit [MPa]	Yield strength [MPa]	Tensile strength [MPa]	Elongation [%]
SC450 (=SC46)	200	0.29	275	350 ~ 550	650 ~ 880	8 ~ 25

In Figure 1, the shape of independent brackets connected to the bare chassis is the same as Figure 2.



Bracket 1 Bracket 2 Bracket 3

Figure 2. Bracket species

The finite element model of structural analysis used for stress analysis to evaluate the stability of brackets shown in Figure 2 was used by Altair's Hypermesh 2017, and Altair's Optistruct was used for structural analysis. The main information about the finite element model for stress analysis is the same as Table 3, and the boundary conditions required for structural analysis are considered the driving condition of the vehicle [1].

Table 3. Mechanical property of SC450 (=SC46)

Classification	Element number	Element type	Note
Bracket 1	665,187	Tetra	Second order
Bracket 2	601,303	Tetra	Second order
Bracket 3	460,296	Tetra	Second order

In order to carry out stress analysis, boundary conditions should be set; to set boundary conditions, changes in the driving situation of the vehicle were considered. According to the driving type of the vehicle, the brackets are subjected to loads, and the loads applied to the brackets are classified as boundary conditions according to the driving situation. The total weight of the 30-seater commercial vehicle was 11ton and the ratio of the front axis was 30% when the boundary condition was given. Also, the speed reduction and acceleration were 50km/hr, the radius of the road was 50m, and the speed of the vehicle was considered 50km/hr in the curved section. These data are a potentially harsh condition.

3. Stress analysis

The precondition for evaluating the stability of the bracket considering the loads acting on each bracket should calculate the size of the load acting on the brackets. Also, the load change which acts according to the driving situation of the vehicle should be considered. The result of stress analysis considering the load applied to the three brackets according to the driving situation change of the vehicle is as follows.

3.1 Bracket 1

In the bracket 1 is the top 1 place, the load of the vehicle body is received. The reaction force which generates while the vehicles passes by concavo-convex actuates on the lower part 4 place. Loads acting on the bracket 1 the vehicle body load, the repulsive power which generates while passing by concavo-convex, the inertial force by the acceleration or deceleration, and the centrifugal force by cornering. Each loads are divided into the general condition and harsh condition. The content indicating the direction of the load is Figure 3.

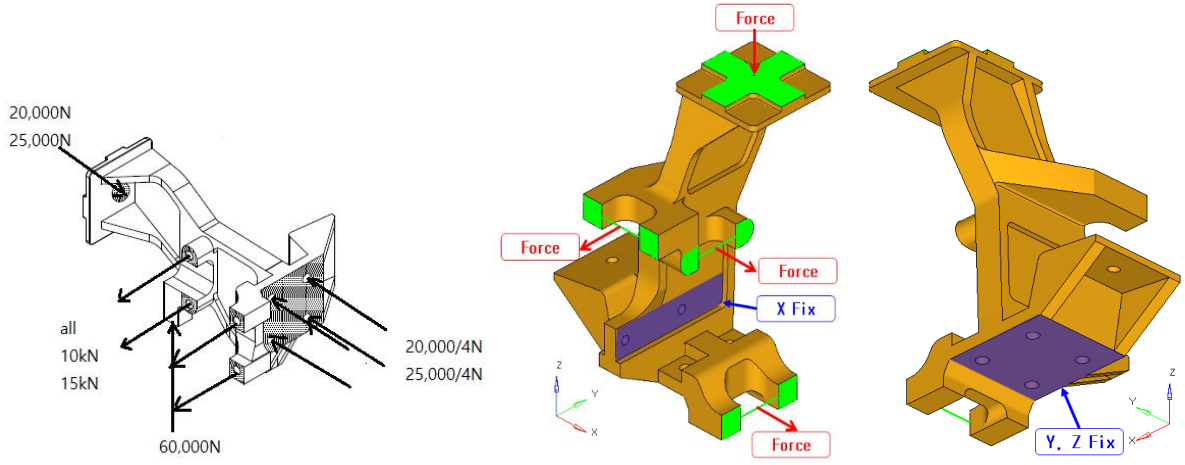


Figure 3. Loads and modeling on bracket 1

The stress analysis results are the same as Figure 4 by selecting the harsh conditions among the load conditions of Figure 3.

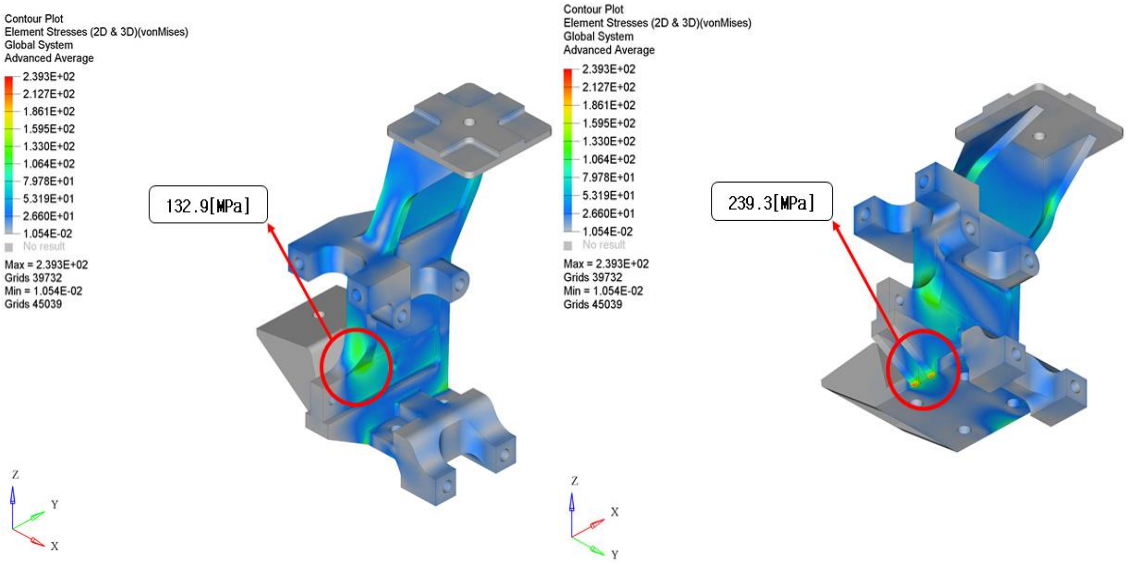


Figure 4. Stress analysis results for bracket 1

The maximum stress in Figure 4 is 239.3MPa. It is judged that the fatigue limit of SC450 comprising bracket 1 is 275MPa, so it is stable. However, in order to maintain a safer form, reinforcement of the lower support is needed.

3.2 Bracket 2

The bracket 2 the part in which loads operate when being the load of the vehicle body, the reaction force by the concavo-convex passage, and the acceleration or the braking situation. Based on the above-mentioned contents, the size of the load acting and the direction of the load for modeling are the same as Figure 5.

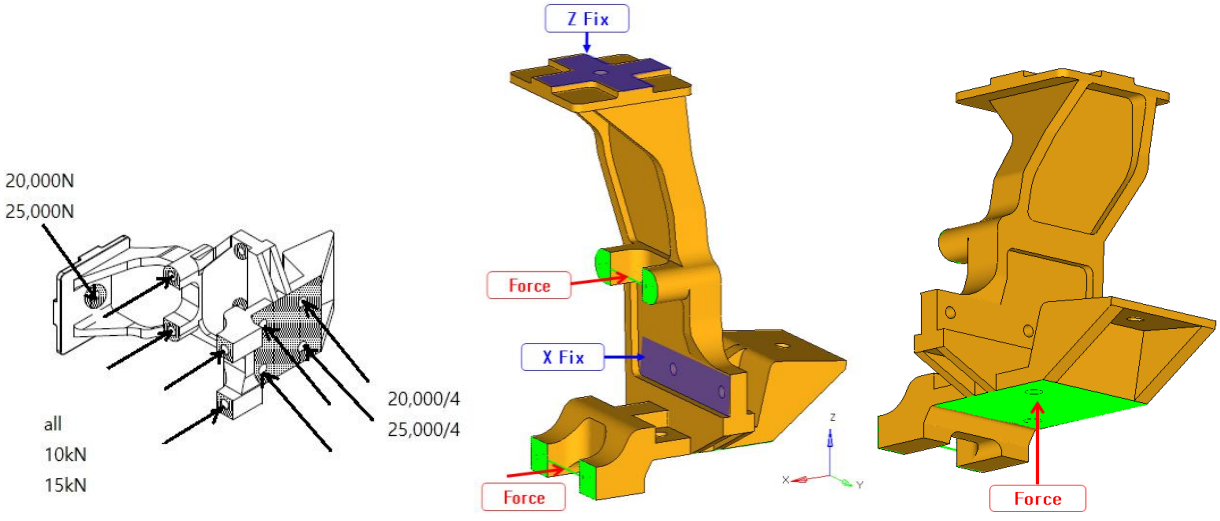


Figure 5. Loads and modeling on bracket 2

The stress analysis is performed by selecting the harsh conditions among the applied loads. The stress analysis result is the same as Figure 6.

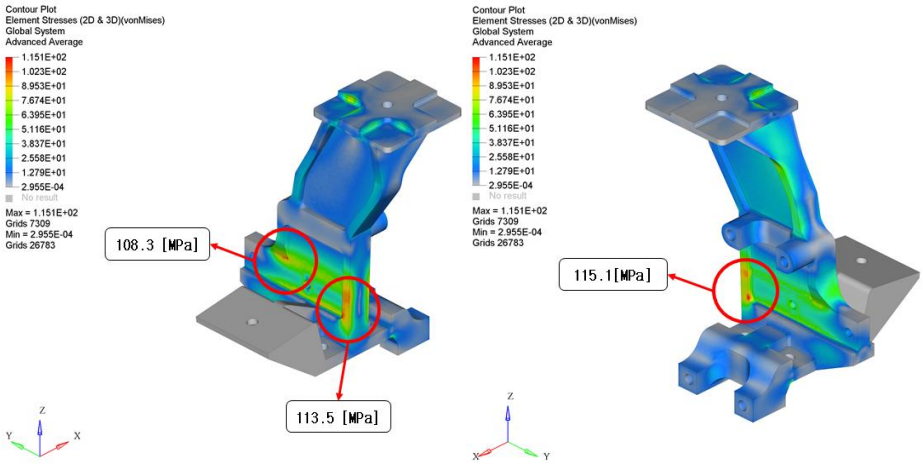


Figure 6. Stress analysis results for bracket 2

Figure 6 is the result of stress analysis for bracket 2, and the maximum stress is 115.1MPa, which is safe because it is sufficiently lower than the fatigue limit of bracket 2 material.

3.3 Bracket 3

The bracket 3 is actuated by the load when accelerating or braking; the size and direction of the load acting on the bracket 3 are as follows when the vehicle accelerates or brakes.

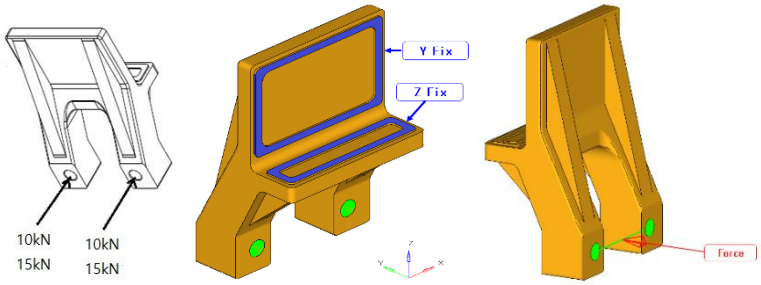


Figure 7. Loads and modeling on bracket 3

The stress analysis results of the large loads of the load conditions of Figure 7 are as follows.

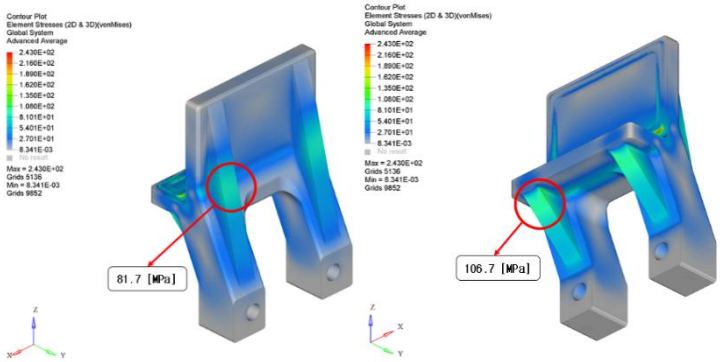


Figure 8. Stress analysis results for bracket 3

The maximum stress of the Bracket 3 is 106.7MPa, which is lower than the fatigue limit of the Bracket 3 material and is safe enough.

4. Conclusion

In this study, stress analysis was performed to verify the safety of brackets applied to bare chassis in the structural design of the development stage of 30-passenger bus, which is a commercial vehicle. The boundary conditions of the three types of brackets connected to the front axis of the bare chassis of the 30-seater bus and the vehicle body were classified and analyzed. The material of the bracket was considered SC450, and the boundary conditions according to the driving condition of the vehicle were classified and stress analysis was performed to obtain the following conclusions.

1) In order to analyze the load changes acting on the brackets, boundary conditions should be classified according to the driving situation of the vehicle.

2) The driving condition classification of the vehicles should consider the vehicle body load, reaction force by concavo-convex, deceleration, acceleration and corner driving.

3) The maximum stress of bracket 1 is 87% of the fatigue limit, so it is necessary to reinforce it.

4) The bracket 1 and 2 showed the greatest stress in the curved part of the upper part and the support part in the lower part.

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