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Durability Study due to Shape of Clutch Pressure Plate

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클러치 압력판의 형상에 따른 내구성 연구

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ABSTRACT

The design of pressure plate for automotive clutch also has been improved. The tension of the clutch spring compresses the clutch plate onto the flywheel to deliver the power. In this study, three types of pressure plate for clutch were modelled by using CATIA program, and the structural analyses due to external forces were performed with ANSYS program. It is thought that this study result can be used to verify the stability and strength according to the shape of the pressure plate.

KeyWords : Clutch Pressure Plate(클러치 압력판), Shape(형상), Structural Analysis(구조 해석), Fatigue Analysis(피로 해석), Durability(내구성)

1. Introduction

The clutch system of vehicles in manual transmission may exhibit more defects than automatic transmission vehicles. As a result, manual transmission vehicles should pay more attention to the clutch system. Clutch is required when using a clutch to stop the vehicle or forward or reverse operation after starting the engine, and when power is temporarily cut off. The clutch does not return when the pedal is operated because the pressure plate, disc and flywheel of the clutch are not connected. It is the reason why the pressure plate is separated from the clutch disc. When the clutch pedal is released, the power is transferred back to the transmission as the flywheel of the engine, clutch disc and pressure plate are combined. If the clutch disc is worn, the pressure plate will be worn continuously. Also, if the pressure plate is worn, the rotary motion of the flywheel will not be transferred to the disk, preventing engine power from being transferred to the transmission. Therefore, many studies have been conducted on the pressure transfer and wear and durability according to the structure of the pressure plate. The shape of various clutch discs and the role of various parts are also important. As the study on the material of the pressure plate and the shape of the diaphragm spring is also an important role of pressure transfer,

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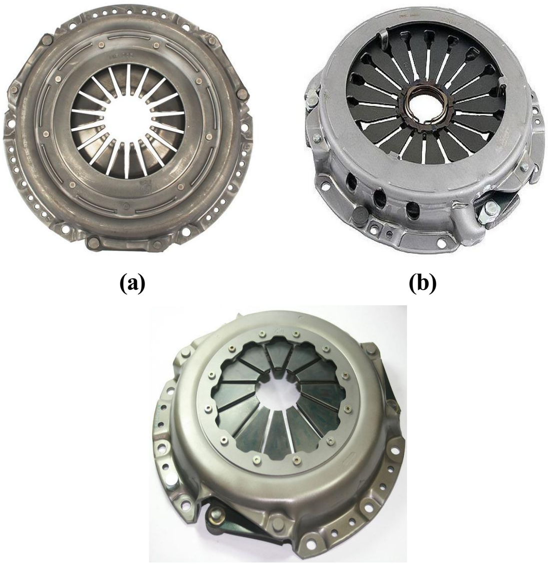


(a) (b)

(c)

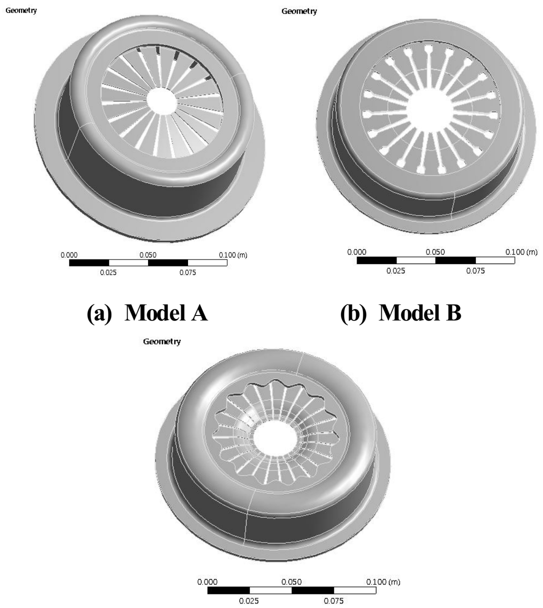
Fig. 1 Real configurations of models A, B and C as pressure plates

it becomes a necessary research task. The materials of the pressure plate used in the study were most commonly available and the castable iron as steel was used with various shapes. Also, its price is cheap, strong and elastic. However, it also has the disadvantage of being used as a rusty part, which is limited in its use as an automotive part, so it is mixed with other metals to make and use parts. In this study, various pressure plate models actually used were modelled by using CATIA program. The structural and fatigue analyses are carried out with ANSYS program by using the material as the steel among various metals. By referring to the designs of real pressure plates as shown by Fig. 1, the results of these studies will devoted to strengthen the prevention of destruction and the durability against damage caused by fatigue of pressure[1-10].

2. Research Models and Study Results

2.1 Research models

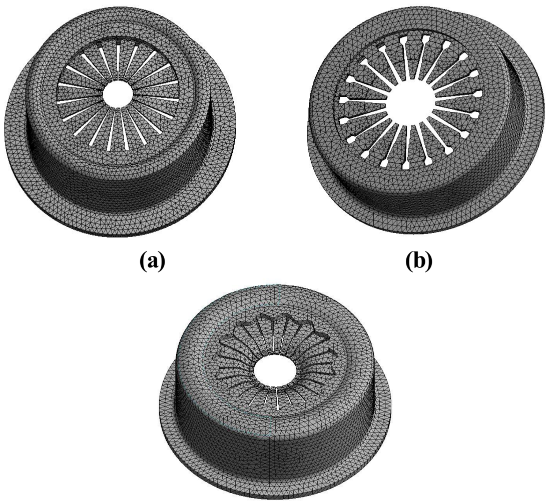
Analytical models A, B and C were designed as the configurations of pressure plates as shown by Fig. 2 and Fig. 3 shows the meshes of models A, B and C in order to perform the analyses.



(a) Model A (b) Model B

(c) Model C

Fig. 2 Analytical models



(a) (b)

(c)

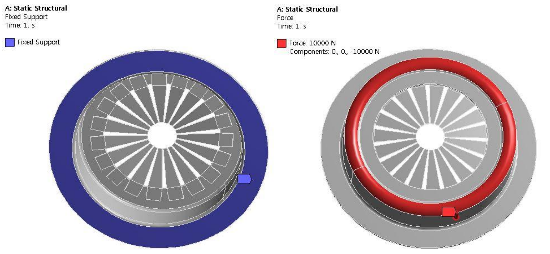
Fig. 3 Meshes of models

Table 1 Numbers of meshes and nodes for each model

Item / Model	Elements	Nodes
Model A	32940	62269
Model B	31776	59749
Model C	31991	59909

Table 2 Material property of structural steel

Young's Modulus	2×10^5 MPa
Poisson's Ratio	0.3
Density	7850 Kg/㎥
Tensile Yield Strength	250 MPa
Compressive Yield Strength	250 MPa
Tensile Ultimate Strength	460 MPa



(a) Fixed support **(b) Applied force**

Fig. 4 Analysis conditions of models A, B and C

Table 1 shows the number of meshes and nodes for each model. Table 2 shows the material property of structural steel used for analysis.

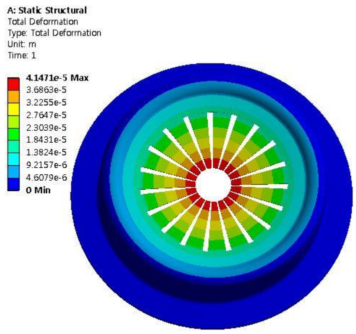
2.2 Analysis conditions

Fig. 4 shows the conditions of the fixed support and applied force at each model for analysis. As shown in this figure, the pressure plate is fixed and the direction of the force is applied to the fixed support part. Therefore, the force of 10000 N was applied in the -Z direction rather than in the Z direction. The area under pressure is applied to the entire face of the topmost part of the pressure plate.

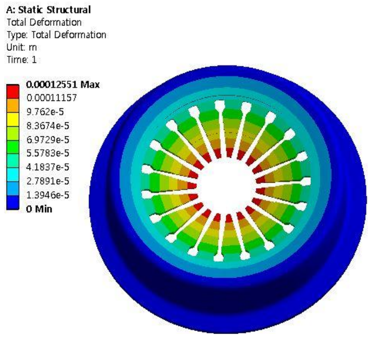
2.3 Analysis results

2.3.1 Structural analysis result

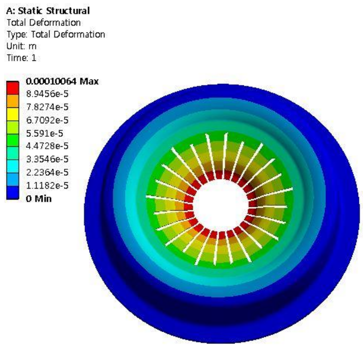
For the contours of total deformations of the pressure plate models A, B and C as shown by Fig. 5, the maximum result values were 0.041471mm for model A, 0.2551mm for model B and 0.10064mm for model C[11,12]. All three models had the largest deformation at the top.



(a) Model A



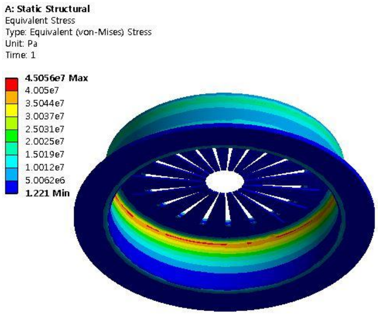
(b) Model B



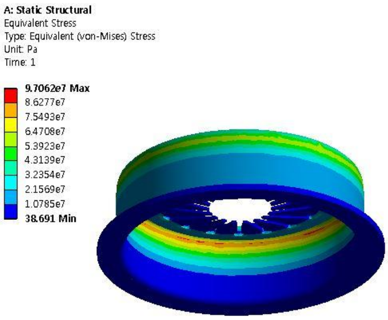
(c) Model C

Fig. 5 Total deformations of models

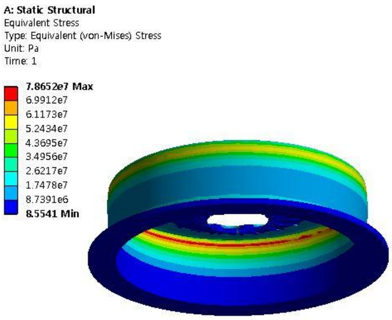
Fig. 6 shows the contours of equivalent stresses on models A, B and C. The maximum equivalent stresses for each model were 45.056 MPa for model A, 97.062MPa for model B and 78.652MPa for model C. As the analysis result values of total deformations and equivalent stresses, the model A showed the lowest total deformation and equivalent stress, indicating that model A has the best strength as compared with three models.



(a) Model A



(b) Model B



(c) Model C

Fig. 6 Equivalent stresses of models

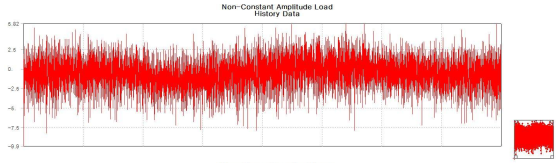
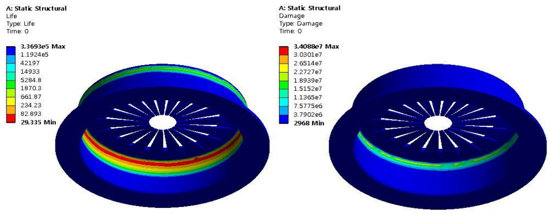
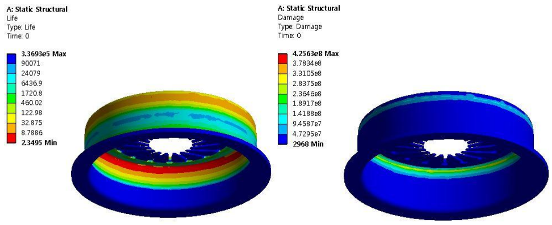


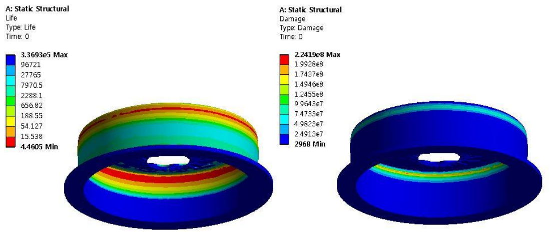
Fig. 7 Plot of magnification coefficient about the amplitude load to fatigue average stress at SAE bracket history



(a) Model A



(b) Model B



(c) Model C

Fig. 8 Contours of fatigue lives and damages for models A, B, and C

2.3.2 Fatigue analysis result

The constraint condition at fatigue analysis is the same to the structural analysis condition of Fig. 4. The mean stress remains constant and Fig. 7 shows the magnification coefficients about the amplitude load to fatigue average stress at the applied fatigue load of SAE bracket history[13-15]. Life and damage of each pressure plate model were analyzed during the fatigue analysis with SAE bracket data during the history data.

Fig. 8 shows the contours of fatigue lives and damages for models A, B, and C by the fatigue load application of SAE bracket history and model A shows the result for longer fatigue lives at many areas. In addition, as the result of fatigue damages, the maximum damage values of model A are 3.488×10^{7}, 4.2563×10^{8} and 2.2419×10^{8} for models A, B and C, respectively. Also, The fatigue analysis shows that the top parts of all three models under force are very weak in life and damage and model A has the least damage area among models A, B and C.

3. Conclusion

In this study, three kinds of models were designed by being based on the pressure plate actually used. The structural and fatigue analyses were carried out with each model. The results of this study are as follows;

1. All three models had the largest deformation at the top, with model B having the largest total deformation and equivalent stresses than models A and C.
2. The fatigue analysis shows that the top parts of all three models under force are very weak in life and damage. At the same result as structural analysis, model A showed stable results in all parts of the fatigue analysis.
3. The structural analysis and fatigue analysis of the three models A, B, and C showed that the Though all three models were applied with same material as the pressure plate and the same force condition was applied to the models, all these models were shown be different from the state that was structurally stable individually.
4. If the result of this study is used to design various pressure plates, it is thought to help prevent the breakage and improve the durability.

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