한국기계가공학회지, 제18권, 제8호, pp.18∼23(2019.08) ISSN 1598-6721(Print)
Journal of the Korean Society of Manufacturing Process Engineers, Vol. 18, No. 8, pp.18~23(2019.08) ISSN 2288-0771(Online)

https://doi.org/10.14775/ksmpe.2019.18.8.018

A Study on Durability of Seat Height Motor Gear by Angle

Moonsik Han*, Jaeung Cho**,#
*Department of Mechanical and Automotive Engineering, Keimyung UNIV.
**Division of Mechanical and Automotive Engineering, Kongju National UNIV.

시트 하이트 모터 기어의 각도별 내구성에 관한 연구

한문식*, 조재웅**,#
*계명대학교 기계자동차공학과, **공주대학교 기계자동차공학부

(Received 25 May 2019; received in revised form 30 May 2019; accepted 7 June 2019)

ABSTRACT

In this study, structural and fatigue analyses of the motor gears that control the height of car seat were carried out at angles of 10°, 20°, and 30°. The study aims at examining which angle of the gear is superior in terms of effect on strength. In the structural and fatigue analyses, the force of 3136 N was applied to the gears, and the stress and deformation were obtained. As the analysis results, model B (30°) is suggested to have the best strength and fatigue durability among the three models.

Keywords : Height Motor(하이트 모터), Gear(기어), Strength(강도), Fatigue Life(피로수명), Durability(내구성)

1. Introduction

There is an automotive seat that brings the driver comfort when driving a car. This seat is one of the most important parts for drivers as many people drive their own car to and from work. When a driver is driving, the ride comfort must be good. The reason should be to ensure that the driver is not affected when driving on long distances. This indicates that the design of seat can play a very important role in the design of car. That's because it's connected to the ride. The recent research for development of automotive seat has been briskly conducted along with the softness of material, by ergonomically studying the design factors that add the posture correction and provide the comfort and comfort in driving. One of the seat types to provide such a comfortableness is the power seat. Power seat is also referred to as auto-regulating seat. The power seat means the seat with a device that can operate a seat by the button operation for button type. There are many kinds of parts in power seats that provide this convenience. In this case, the seat height motor(SHM) is a motor that adjusts the height of entire seat to the upper and lower positions by means of switch operation in order to enhance the convenience of vehicle passengers. According to SHM's gear angle, the structural analysis was carried out in order to determine whether the angle is good for the larger or smaller angle. Through the analysis results of this study, it

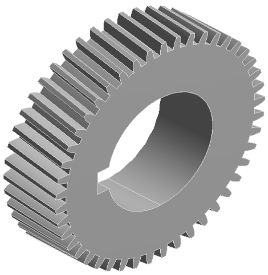
Corresponding Author : jucho@kongju.ac.kr
Tel: +82-41-521-9271, Fax:+82-41-555-9123

is thought that the design factors can be obtained in order to improve the strength of seat gear.[1~11]

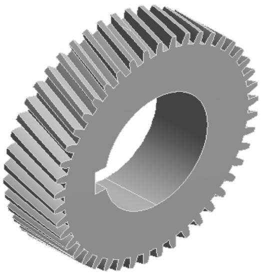
2. Study Model and Analysis Condition

2.1 Study model

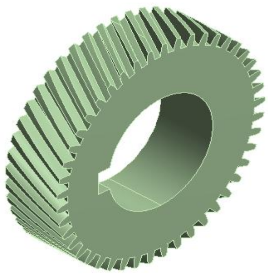
The shape of the seat height motor gear was modelled by using CATIA by referring to the shape of the actual motor. The model for the seat height motor gear is as shown in Fig. 1. The gear angles for models A, B and C are 10°, 20°and 30°, respectively.



(a) Model A



(b) Model B



(c) Model C

Fig. 1 Study model

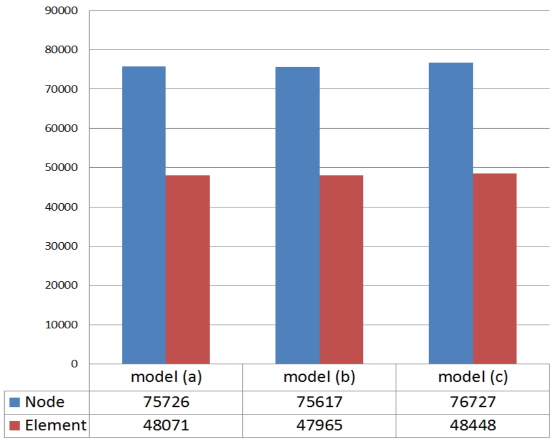


Fig. 2 Numbers of nodes and elements for each model

Table 1 Material property

Young's Modulus(Pa)	2×10^{11}
Poisson's Ratio	0.3
Density(kg/m^3)	7850
Tensile Yield Strength(Pa)	2.5×10^{8}
Compressive Yield Strength(Pa)	2.5×10^{8}
Tensile Ultimate Strength(Pa)	4.6×10^{8}
Compressive Ulitmate Strength	0

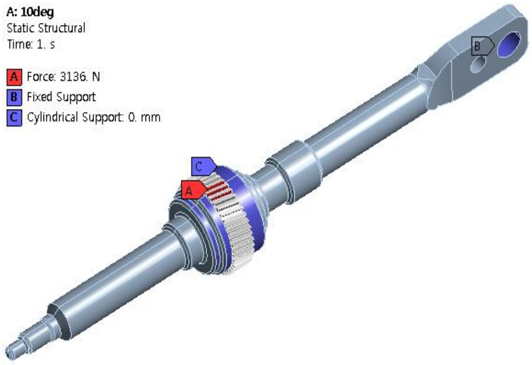
2.2 Constraint condition for analysis

Constraint conditions of models A, B, and C are shown in Fig. 3. A force of 3136 N was applied to the gear nut in the direction of Z-axis, and the screw hole at the end of the high motor link section was restrained with the fixed support. Also, the cylindrical support was applied to washers in the gear nut support.

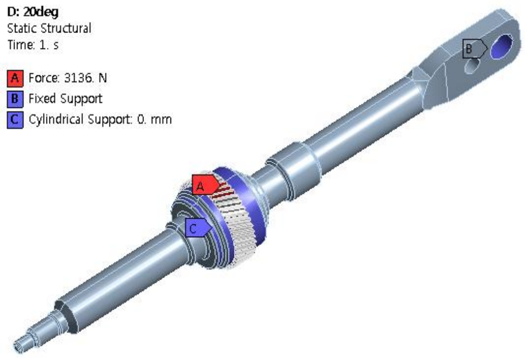
3. Analysis Results

3.1 Structural analysis result

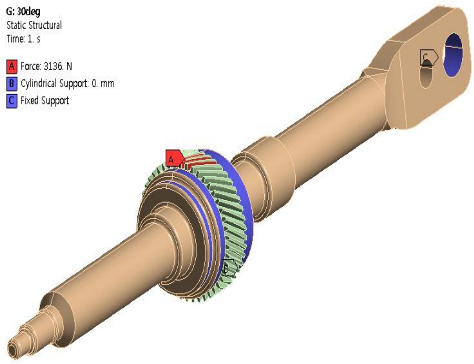
Fig. 4 shows the stress applied by the gear when the gear nut is applied with a force of 3136 N in the direction of Z-axis. For model A, the greatest stress occurred as 8.4195 MPa at the gear nut where the force was applied, while the greatest stress became 6.9011 MPa and 8.7317 MPa, respectively at the gear nut where the force was applied in cases of models B and C.[12~15]



(a) Model A

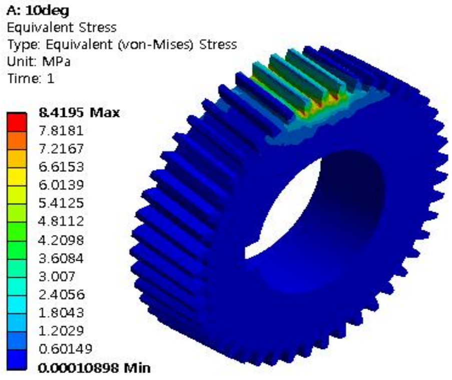


(b) Model B

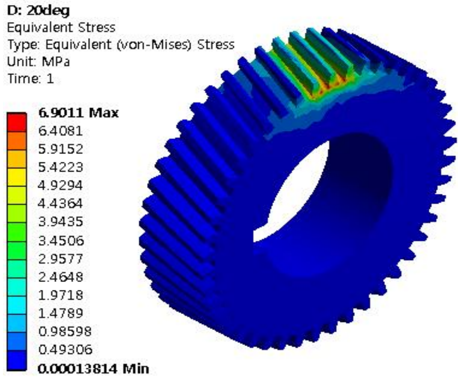


(c) Model C

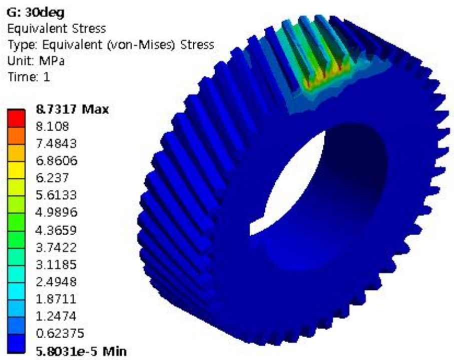
Fig. 3 Constraint condition for analysis



(a) Model A



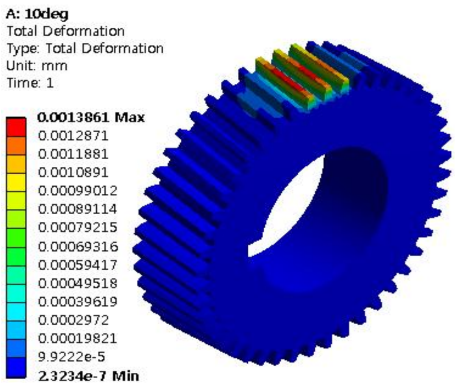
(b) Model B



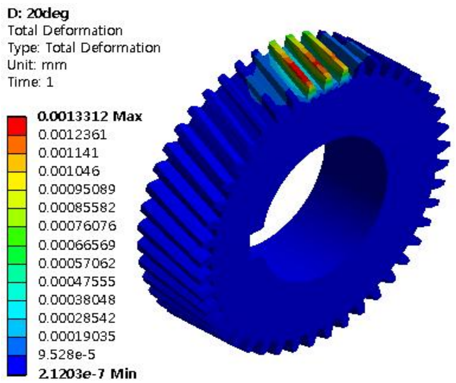
(c) Model C

Fig. 4 Equivalent stresses of models

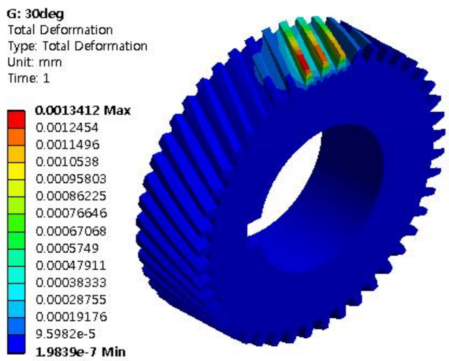
In cases of models A, B and C, Fig. 5 shows the total deformations of gears when the gear nut is



(a) Model A



(b) Model B



(c) Model C

Fig. 5 Total deformations of models

applied with a force of 3136 N in Z-axis direction. For model A, the maximum deformation became 0.0013861 mm, while the maximum deformations became 0.0013312 mm and 0.0013412 mm, respectively in cases of models B and C. The stress on the lower part of the gear nut became the greatest. In case of model B, the greatest stress of 6.9011 MPa was shown, resulting in the smallest stress among all models A, B and C. Since the maximum total deformation is also the smallest at 0.0013312mm in model B, it is considered that designing the angle of the gear at 20°becomes a good idea.

3.2 Fatigue analysis result

The lives for all parts of the gear under fatigue can be predicted and the effects of fatigue life due to load changes are analyzed. The boundary conditions of the model for fatigue analysis are shown like that of structural analysis in Fig. 3. The variation of fatigue load applied to the fatigue analysis is shown in Fig. 6. The details of magnification factors for the average load which are described as the SAE bracket history are shown on the longitudinal axis. And the application range becomes the values of 582 to 990.

Fig. 7 shows the contours of fatigue lives for each model. Based on the analysis results, the less fatigue life was shown at the lower part of the gear nut and up to one third point of the front part in

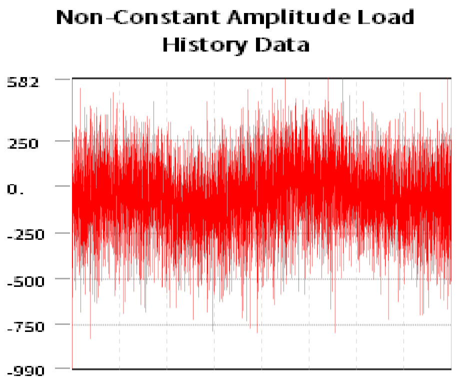
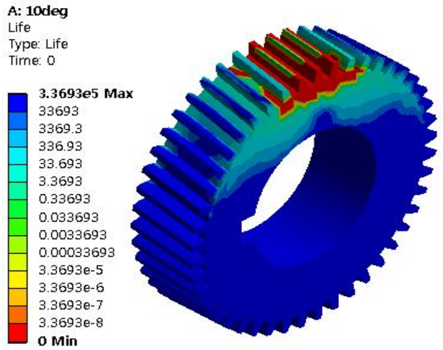
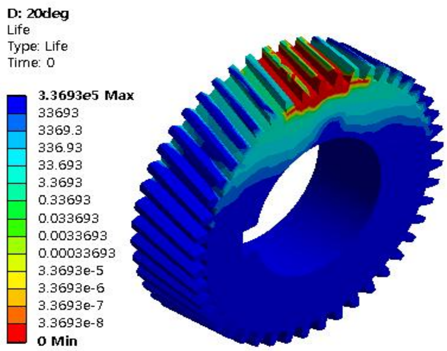


Fig. 6 SAE bracket history

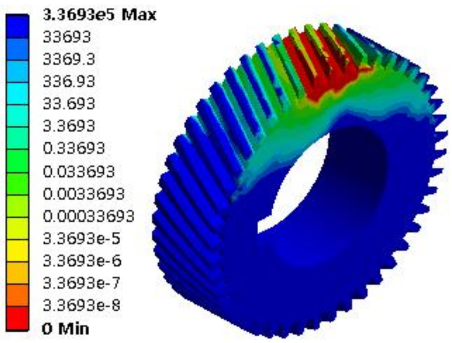
case of model A. The less fatigue life was shown up to the lower part of the gear nut and up to one quarter point of the front part of the gear nut in case of model B. The less fatigue life was shown up to the lower part of the gear nut and up to one half point of the front part of the gear nut in case of model C. Therefore, model B is shown to have the longest fatigue life among three models.



(a) Model A



(b) Model B



(c) Model C

Fig. 7 Fatigue lives for each model

4. Conclusion

In this study, the structural and fatigue analyses were performed by applying the force according to the gear angle in the seat height motor. The analysis results are as follows;

1. Structural analysis showed that model B produced the smallest stress and had the least deformation when a force was applied in the direction of the gear as Z-axis.
2. As the analysis results, model B with an gear angle of 30° is suggested to have the best strength and fatigue durability among three models.
3. In this study, the analysis results were combined to study the strength and durability of gear according to the angle of the seat height motor gear. It is thought that the result values are devoted to make a good design factor for the seat height motor gear.

REFERENCES

1. Yoo, B. S., Koo, S. W. and Joh, J. S., “A Study on Suppression of Vibration Caused by Quick-stop Operation of Hydraulic Excavator Boom,” Journal of the Korean Society for Precision Engineering, Vol. 27, No. 12, pp. 33-40, 2010.
2. Lee, J. I., “The Convergence Design for Stiffness and Structure Advancement of Automotive Body,” Journal of the Korea Convergence Society, Vol. 8, No. 4, pp. 189-197, 2017.
3. Cho, J. U. and Han, M. S., "A Study on Durability of Under Bar at Car through Structural and Fatigue Analysis,” Journal of the Korean Society of Manufacturing Process Engineers, Vol.

14, No. 2, pp. 44-50, 2015.
4. Lee, Y. S., Ok, J. K., Kim, H. J. and Yoo, W. S., "Analytical Investigation on the Track Separation Mechanism for Tracked Excavator," Transactions of the Korean Society of Automotive Engineers, Vol. 14, No. 6, pp. 66-72, 2006.
5. Kang, H. J., Kim, B. H., Kim, H. J. and Seo, J. H., "Structural Weld Strength Analysis on Door Hinge of Field Artillery Ammunition Support Vehicle," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 15, No. 3, pp. 58-65, 2016.
6. Cho, J. U., Min, B. S. and Han, M. S., "Basic Study on Impact Analysis of Automobile," J ournal of the Korean Society of Manufacturing Process Engineers, Vol. 8, No. 1, pp. 64-70, 2009.
7. Lee, J. I., "A Study on the Design of Blimp Type Rotor Craft Blade according to Pitch Angle," Journal of the Korean Society of Mechanical Technology, Vol. 20, No. 5, pp. 606-611, 2018.
8. Wang, Z. H., Byun, S. J. and Kwon, Y. C., "Fatigue and Vibration Analysis of Table according to Applied Loads," Journal of the Korean Society of Mechanical Technology, Vol. 20, No. 5, pp. 568-573, 2018.
9. Wang, Z. H. and Kwon, Y. C., "Structural Analysis of Center Pillar according to Applied Load," Journal of the Korean Society of Mechanical Technology, Vol. 20, No. 4, pp. 401-406, 2018.
10. Lee, B. H., Lee, C. R., Jeong, Y. J. and Kim, B. H., "A Study on the Structural Analysis of Electric Vehicle Rotor Shaft for Light-Weight," Journal of the Korean Society of Mechanical Technology, Vol. 20, No. 2, pp. 154-159, 2018.
11. Lee, J. I., "The Suggestion of Finite Element Modeling Method for Structural Design of Automotive Body," Journal of the Korean Society of Mechanical Technology, Vol. 21, No. 2, pp. 311-320, 2019.
12. Moon, S. G., Park, Y. J. and Lee, G. H., "Determination of Equivalent Moment of Inertia of Flywheel for Inertial Endurance Test of Excavator Slewing System," Journal of the Korean Society for Precision Engineering, Vol. 34, No. 6, pp. 383-390, 2017.
13. Cho, J. U. and Han, M. S., "Structural Safety Analysis of Car Body," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 7, No. 3, pp. 12-16, 2008.
14. Cho, J. U. and Han, M. S., "Durability Study on Structural Strength due to the Shape of Excavator Wheel," Transactions of the Korean Society of Automotive Engineers, Vol. 21, No. 6, pp. 166-174, 2013.
15. Ryu, J. M., Park, K. C. and Kang, T. W., "A Study on the Structural Design for Safety Improvement of the Winch Mount of an Armored Recovery Vehicle," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 16, No. 1, pp. 58-62, 2017.