한국기계가공학회지, 제18권, 제10호, pp.1～7(2019.10) ISSN 1598-6721(Print)
Journal of the Korean Society of Manufacturing Process Engineers, Vol. 18, No. 10, pp.1~7(2019.10) ISSN 2288-0771(Online)

https://doi.org/10.14775/ksmpe.2019.18.10.001

Durability Study by Strength Analysis of Bicycle Handle

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자전거 핸들의 강도 해석에 의한 내구성 연구

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(Received 15 August 2019; received in revised form 17 August 2019; accepted 28 August 2019)

ABSTRACT

Most of people are riding on their own bicycle due to the health and environmental pollution problems. The weight must be light in order to run farther and easier by bicycle. The durability will be reduced due to the light weight of tubes and handles at bicycle. To solve this problem, the three bicycle handle models 1, 2 and 3 were compared with each other for structural analysis. The structural analysis was carried out in this study. Among three models, model 2 and model 3 had the highest and lowest strengths at the structural analysis results, respectively. At this study result, model 1 is thought to be the balanced excellent model with no defect among three models.

Key Words : Bicycle(자전거), Handle(핸들), Structural Analysis(구조해석), Strength(강도), Durability(내구성)

1. Introduction

Currently, due to various problems including environmental pollution and health, people often travel a short distance or ride on their own bicycle for leisure sports. The weight of bicycle should be lighter in order to go a long distance more easily when riding a bicycle.

The material for light weight is used with the thin-thick.

At this point, there is a problem of durability reduction as the thickness becomes thin. Among the various parts of a bicycle, there is a saddle applied by the most load on which a person sits, a seat-post which is the base of a saddle, and a handle that is held and pressed by a person. This paper aims at solving the problem of durability for the light weight with respect to the part of the handle that is held and pressed by a person. Three models of the flat bar, bull-hone bar and rise bar were designed among the popular bicycle handles. These models were analyzed and compared with each other in order to investigate which handle model had the best strength. After modelling with CATIA program, the study models were analyzed with ANSYS program. This study result shows which parts of each bicycle handle are the most

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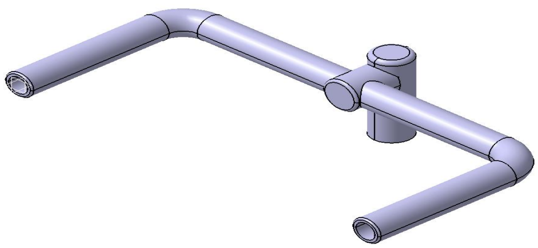
vulnerable and strongest. The purpose of the study is to develop a durable model with light weight among various bicycle handles through the analyses of different types of bicycle handle models[1-7].

2. Study Results

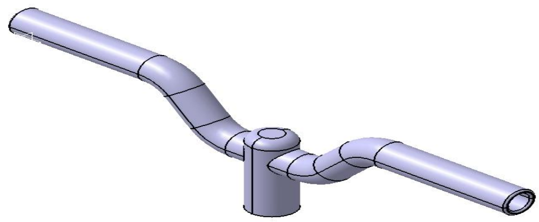
In this paper, the types of bull-hone bar, rise bar and flat bar were modeled as the bicycle handles, and three models were analyzed by applying the pressure that can be exerted by a person to the bicycle handle in order to examine the structural deformation. All models were designed to match with almost the same size of the real bicycle handle and the same thickness of tube that was actually being used on the market. Three models of bicycle handles are clearly different in shape from the naked eye. And flat bars are the most basic form of flat bars used at many bicycles. The rise bar is shaped like a cow horn, with a curved bar placed at the middle. Each handles have their own different shapes and the hand grasping parts become different accordingly. In this paper, a structural analysis was carried out by applying pressure to the handle while a person holds the handle.

2.1 Study models

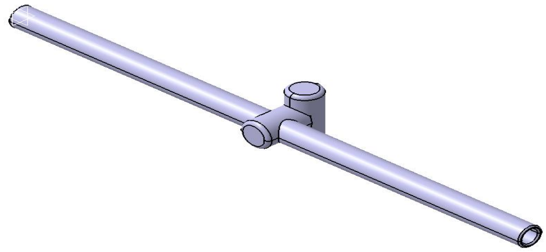
In this paper, the handle types of bull-hone, rise, and flat are designed with models 1, 2 and 3.



(a) Model 1

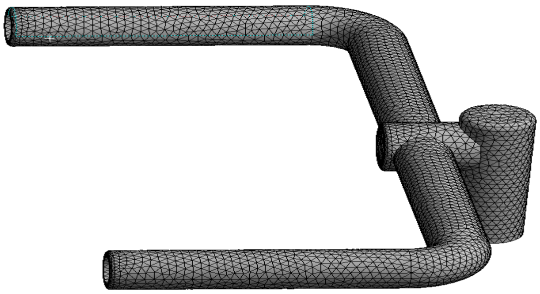


(b) Model 2

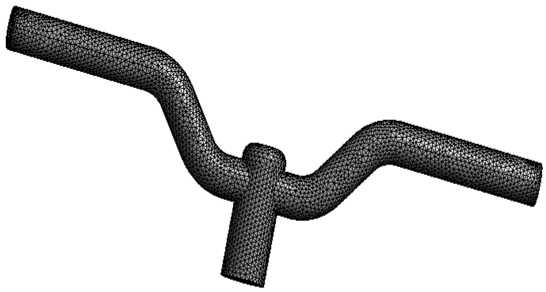


(c) Model 3

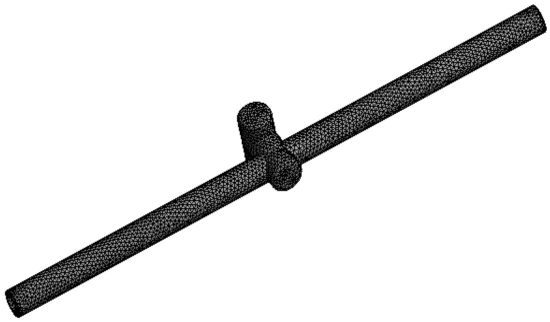
Fig. 1 Models 1, 2 and 3 with bull-horn and rise, flat types



(a) Model 1



(b) Model 2



(c) Model 3

Fig. 2 Mesh configurations of models 1, 2 and 3

Table 1 Material properties

Intents	Values
Modulus of Elasticity	68.0 GPa
Poisson's ratio	0.36
Shear Modulus	25.0 GPa
Compressive Yield Strength	460 MPa
Density	2810 kg/m^3
Tensile Strength	530 MPa

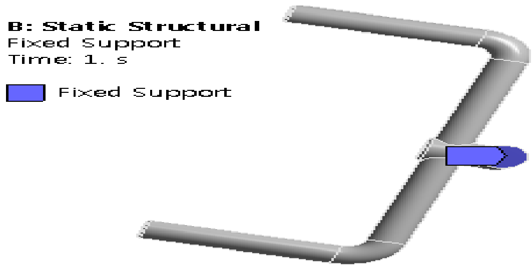
The models and mesh configurations of models 1, 2 and 3 are shown as Fig. 1 and Fig. 2 respectively. The material properties of model as aluminium are shown at Table 1. And Table 2 shows the numbers of elements and nodes for each model for the finite element analysis[8-10].

2.2 Analysis conditions

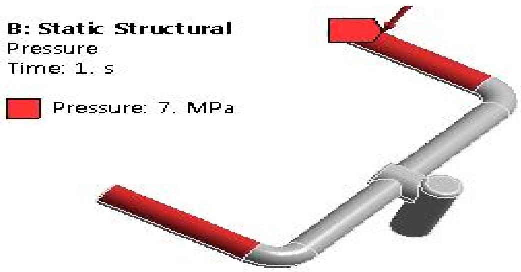
Figs. 3, 4 and 5 show the constraint conditions of all models. Figs. 3, 4 and 5 show the fixed and pressurized conditions at models 1, 2 and 3 respectively. The lower part of the stem and the fork with the wheel at model 1(Bull-horn) are fixed as shown by Fig. 3 (a). When gripping the handle as shown by Fig. 3 (b), the equivalent pressure was applied to 7 MPa at the area applied by the weight of a person assuming that a person took on board. In the case of model 2(Rise bar), the constraint conditions were applied as shown by Fig. 4. The fixed condition was shown at Fig. 4(a) and the pressure of 7 MPa as the same condition with model 1 was applied to the grips on the handle as shown by Fig. 4(b). In the case of model 3(Flat bar), the constraint conditions were applied as shown by Fig. 5. The fixed condition was shown at Fig. 5(a) and the pressure of 7 MPa as the same condition with model 1 or 2 was applied to the grip of handle as shown by Fig. 5(b).

Table 2 Numbers of elements and nodes at models

Model	Nodes	Elements
Model 1	55080	30437
Model 2	76937	45743
Model 3	46050	24662

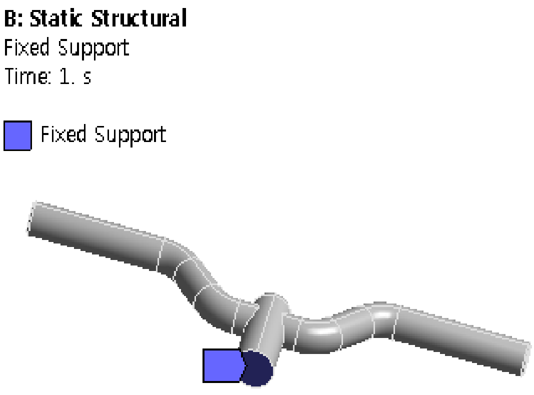


(a) Fixed condition

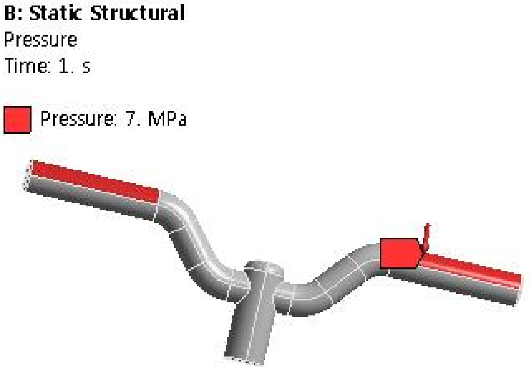


(b) Pressure condition

Fig. 3 Constraint conditions of model 1

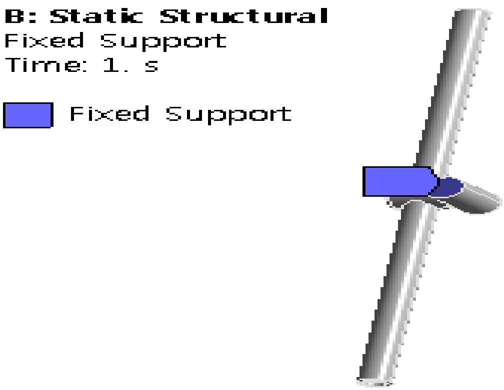


(a) Fixed condition



(b) Pressure condition

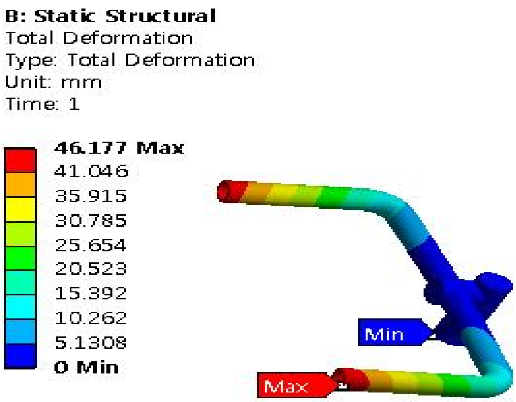
Fig. 4 Constraint conditions of model 2



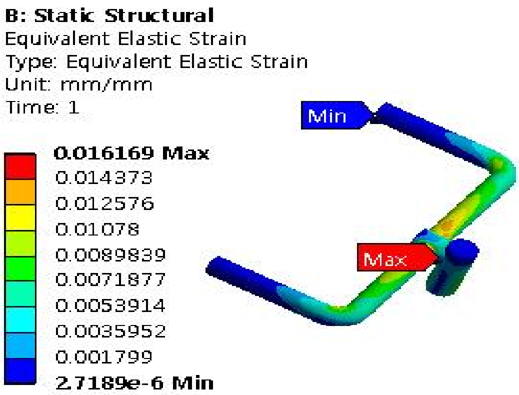
(a) Fixed condition

(b) Pressure condition

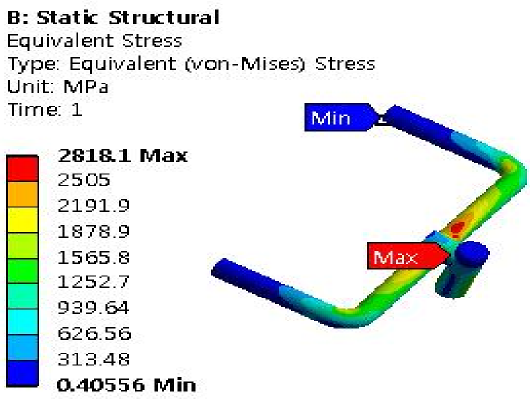
Fig. 5 Constraint conditions of model 3



(a) Contour of total deformation

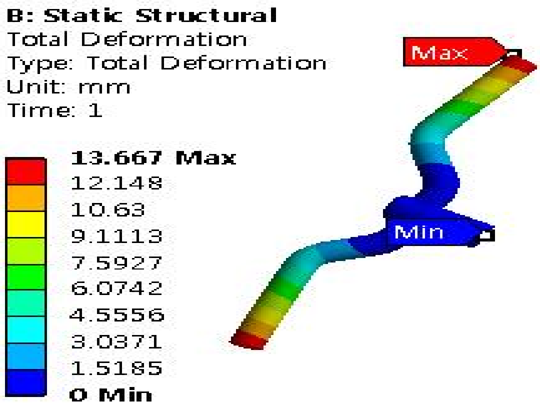


(b) Contour of equivalent elastic strain

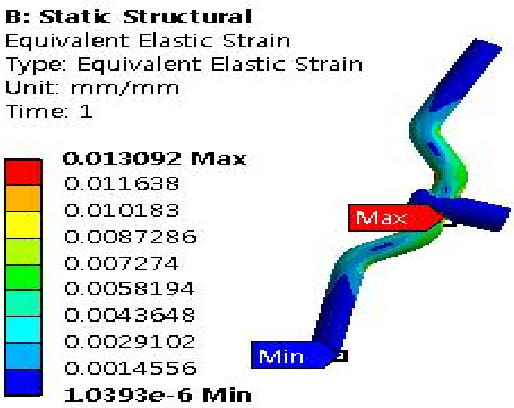


(c) Contour of equivalent stress

Fig. 6 Contours of structural analysis results at model 1



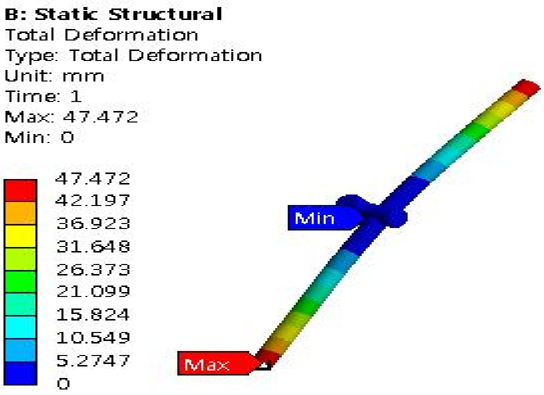
(a) Contour of total deformation



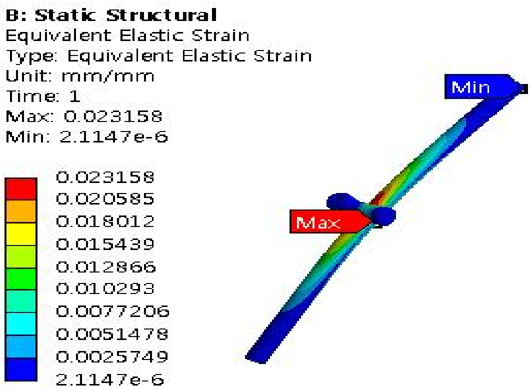
(b) Contour of equivalent elastic strain

(c) Contour of equivalent stress

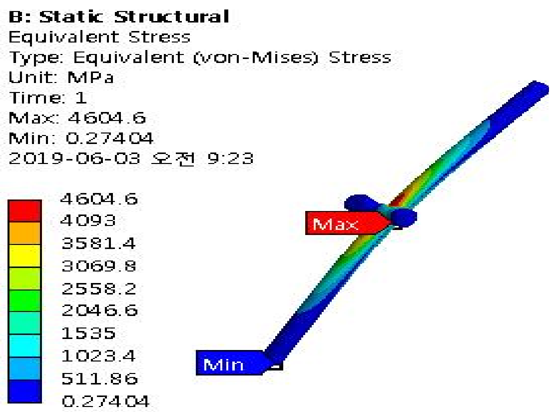
Fig. 7 Contours of structural analysis results at model 2



(a) Contour of total deformation



(b) Contour of equivalent elastic strain



(c) Contour of equivalent stress

Fig. 8 Contours of structural analysis results at model 3

2.3 Analysis results

As shown by Figs. 6, 7 and 8, the total deformation, equivalent elastic strain and equivalent stress are shown respectively at models 1, 2 and 3[11-13].

By comparing with the maximum total deformations of all models, model 2 had the greatest strength with the lowest total deformation among three models. The maximum values of total deformations were shown to be 46.177 mm, 13.667 mm, and 47.472 mm respectively at models 1, 2 and 3. The values of model 1 and model 3 were different each other by about 1.3 mm, but model 3 became the model with the greatest deformation. By comparing with the maximum equivalent elastic strains of all models, model 2 was also the best model with the lowest equivalent elastic strain among three models but model 3 became the worst model with the highest value. The maximum values of equivalent elastic strains were shown to be 0.016169 mm/mm, 0.013092 mm/mm, and 0.023158 mm/mm respectively at models 1, 2 and 3. By comparing with the maximum equivalent stresses of all models, model 2 had also the greatest durability with the smallest equivalent stress among three models and the maximum value of model 3 was far larger than those of other models, indicating that model 3 became the worst model. The maximum values of equivalent stresses were shown to be 2818.1 MPa, 2582.2 MPa, and 4604.6 MPa respectively at models 1, 2 and 3.

3. Conclusion

Through the structural analyses on three bicycle handle models 1, 2 and 3 with bull-hone, rise, and flat types, the study results were concluded as follows;

1. For total deformations, model 2 was the best one as the maximum value of 13.667 mm and model 3 was the worst one as the value of 47.472 mm.
2. For equivalent elastic strains, model 2 was the best model with the maximum value of 0.013092 mm/mm, and model 3 was the worst model with that of 0.023158 mm/mm.
3. For equivalent stress, model 2 had the highest strength as the maximum value of 2582.2 MPa and model 3 had the lowest strength as the value of 4604.6 MPa. Consequently, it is thought that model 2 has the highest durability and model 3 has the lowest durability among three models. Through the analyses of different types of bicycle handle models, this study result can be applied at developing a durable model with light weight among various bicycle handles.

REFERENCES

1. Kweon, B. S., Lee, C. W. and Shin, Y. I., “A Study on the Vibration Analysis of Impeller and Shaft in Cryogenic Submerged Pump,” Journal of the Korean Society of Manufacturing Process Engineers, Vol. 16, No. 2, pp. 56-62, 2017.
2. Yang, Y. S. and Bae, K. Y., “Stress Analysis of Pipe Connection Process Using Clamping Ring,” Journal of the Korean Society of Manufacturing

Process Engineers, Vol. 16, No. 2, pp. 81-87, 2017.
3. Choi, G. G. and Cho, J. U., "A Convergence Study through Durability Analysis due to the Configuration of Automotive Frame Butted," Journal of the Korea Convergence Society, Vol. 9, No. 11, pp. 271-276, 2018.
4. Lee, J. H. and Cho, J. U., "Study on Convergence Technique due to the Shape of Cruiser Board through Structural Analysis," Journal of the Korea Convergence Society, Vol. 6, No. 4, pp. 99-105, 2015.
5. Wang, Z. H. and Kwon, Y. C., "Structural Analysis according to Load of Height-adjustable Table," Journal of Korean Society of Mechanical Technology, Vol. 20, No. 3, pp. 273-278, 2018.
6. 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 Korean Society of Mechanical Technology, Vol. 20, No. 2, pp. 154-159, 2018.
7. Oh, Y. T., "Study on the Structural Analysis of SCARA Industrial Robot," Journal of Korean Society of Mechanical Technology, Vol. 19, No. 6, pp. 866-871, 2017.
8. Jung, Y. S., Gao, J. C., Kim, J. Y. and You, G. J., "A Study on the Structural Analysis of Fiber Guide accept to 4C MM Optical Fiber," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 16, No. 6, pp. 75-80, 2017.
9. Han, M. S. and Cho, J. U., "Structural and Fatigue Analysis on Shock Absorber Mount of Automobile," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 11, No. 1, pp. 125-133, 2012.
10. Han, M. S. and Jo, J. W., "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.
11. Ko, J. H. and Kang, D. M., "CAE Analysis on Strength and Fatigue of Rear Door of Passenger Car," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 13, No. 3, pp. 63-69, 2014.
12. Cho, J. U. and Han, M. S., "Structural Analysis on Tension Bearing of Automotive Engine," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 11, No. 5, pp. 21-28, 2012.
13. Ha, S. H., Kim, S. J. and Song, J. I., "Structure Analysis and Torque Reduction Design of Industrial Ball Valve," Journal of the Korean Society of Manufacturing Process Engineers, Vol. 13, No. 6, pp. 37-45, 2014.