

Application of CAE to Optimize Wiper System on Wiping and Fatigue Performance

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Abstract: Main function of wiper system is that secure a clear view to driver by removing the various obstacles, such as rain, snow and dust. To obtain optimized performances of wiper system under the consideration of many factors, the applications of CAE are needed. We developed FE analysis techniques based on ABAQUS can evaluate the wiping performance at the initial design stage. Also, It's possible to calculate durability and strength of wiper links for various loading conditions.

Keywords: Wiping, Fatigue, Blade, Hyper Elastic, Viscosity Elastic.

1. Introduction

When design the wiper system, the application of CAE is play an essential role on considering various design factors, such as blade shape, material, structure of arm and links.

First, to hold out good performance of wiping, a wiper system has uniform distribution of pressure between glass and blade. Also, the minimum cleaning has to be maintained after a certain period of time. And, a wiper system has to have the durability and strength for various loading condition occurred at field. In here, we considered the state of snowing as loading condition, then evaluate the performance with target life and stress, whether it is satisfying or not.

The purpose of this paper is to develop the unified analysis model and technique based on finite element that enable the prediction of cleaning and durability performance on wiper system.

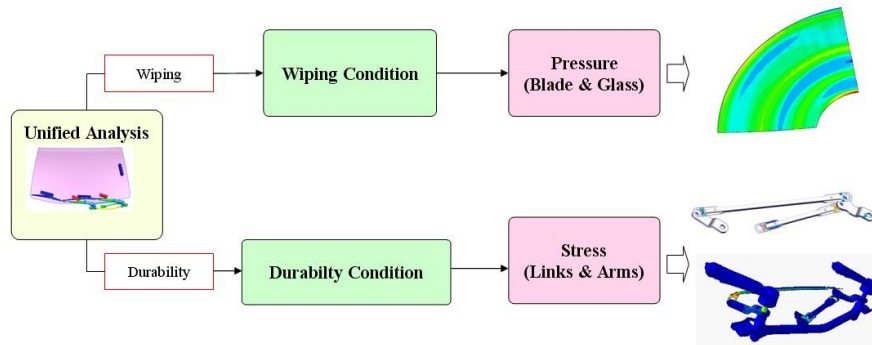


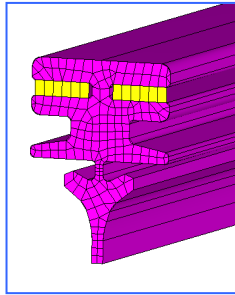
Figure 1. Concept of wiper system analysis using unified finite element model

2. Unified analysis model

So far, a finite analysis to wiper system is carried out separately about wiping and durability, because of different analysis tool and model. The developed unified analysis model for wiper system can do evaluation of various performance with only change the analysis condition about each one. Also, it can be get the results for drive and passenger at one time. In addition, it is possible to make a decision of deformation and collapse for each component with plastic-elastic analysis.

2.1 Blade model

The material of rubber blade is important for cleaning simulation, thus it is essential to get a specimen test data for hyper and viscosity elastic. In here, the test one of viscosity is used to calculate the permanent strain of blade.



$$W = C_{10}(I_1 - 3) + C_{01}(I_2 - 3) + C_{11}(I_1 - 3) \cdot (I_2 - 3)$$

$$I_1 = \lambda_1^2 + \lambda_2^2 + \lambda_3^2$$

$$I_1 = \lambda_1^2 \cdot \lambda_2^2 + \lambda_1^2 \cdot \lambda_3^2 + \lambda_2^2 \cdot \lambda_3^2$$

$$I_3 = \lambda_1^2 \cdot \lambda_2^2 \cdot \lambda_3^2 = 1$$

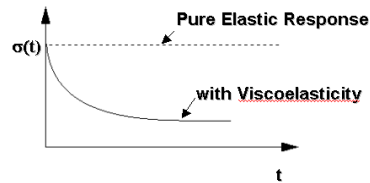


Figure 2. Finite element model of blade and material properties of rubber

2.2 Wiper links & arms

In a wiper system, there are a number of components as link and arm, and it is important to fit precisely the movement. Thus, we used a connector element to copy the behavior of joint between wiper links.

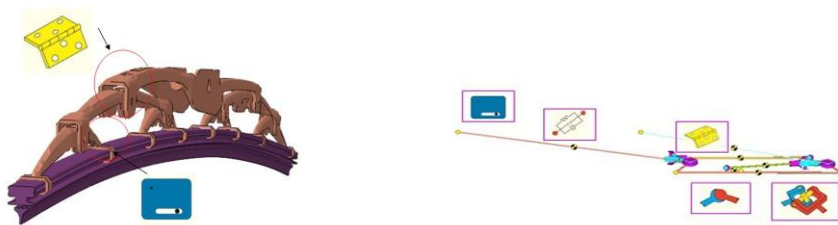


Figure 3. Connector elements of wiper arm and link

2.3 Analysis Template for wiper system

To facility the finite element modeling of wiper system, the analysis templates about various type are constructed by MOTION VIEW, which is general visualization tool for mechanical system. We can make easily a base model of wiper system for specific vehicle by change the geometry information. Base model by template is rigid links, thus it has to be replace with flexible finite element to calculate stress. Also this job can be done in MOTION VIEW

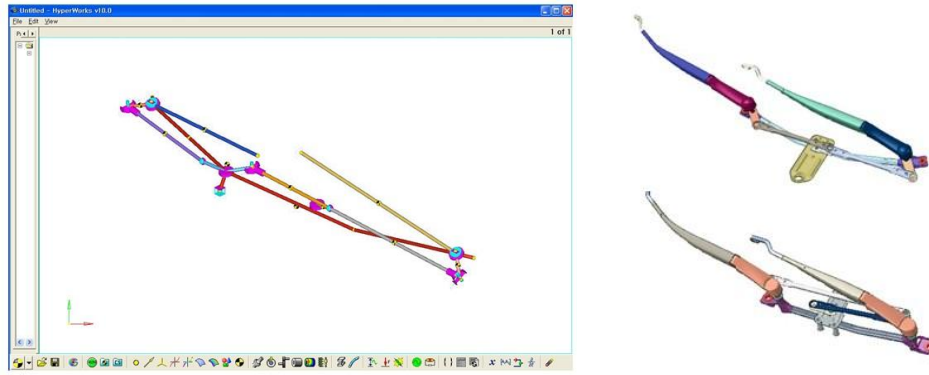


Figure 4. Analysis template using by MOTION VIEW

3. Analysis results

3.1 Wiping

Analysis procedure of wiping is as Figure 5. The first step is that blade reach in good condition on glass. This is very important, because deformation shape of blade section on glass affects the results on total wiping area.

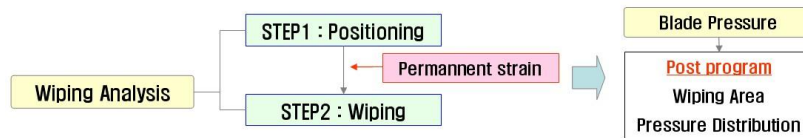


Figure 5. Procedure of wiping analysis



Figure 6. Analysis of STEP1 for positioning

At next step, a rotational moment equivalent to motor torque is loaded. After analysis, we get the pressure between blade and glass at every increment in total range of wiping. Additionally, we can calculate the permanent strain of rubber blade and the pressure at that state after appointed time and temperature. Then, final outputs are reported using in house post program. The calculated results are compared with criterion of design specification and make a decision whether it is satisfying or not.

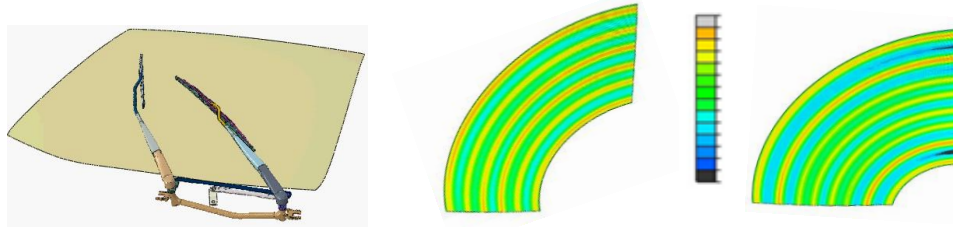


Figure 7. The results of wiping analysis (Pressure distribution)

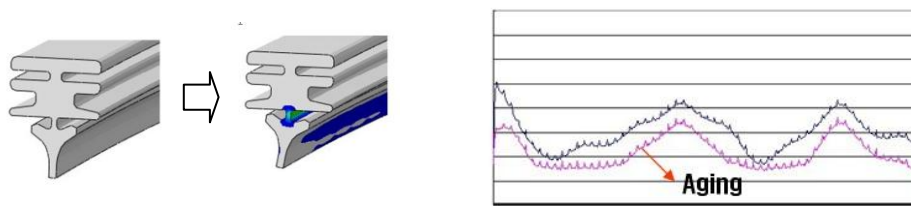


Figure 8. Comparison of results the front and the rear aging

3.2 Durability and strength

Analysis procedure of durability and strength is as Figure 9. There is no difference between wiping and durability on analysis model. Durability analysis is carried out with only change the boundary and loading conditions. In detail, blocks as snow are mounted at normal position on glass to analyze the durability and strength. The same of wiping analysis, the rotational moment is entered as loading condition. When the blade arm contact with snow block on wiping, an inner force is occurred at links of wiper system. Using the stress from inner force, we can get the results for fatigue life and plastic deformation.

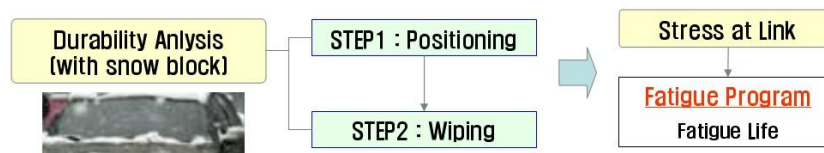


Figure 9. Procedure of durability analysis

4. Optimization of wiping and durability

The superiority of unified analysis model is that enable to optimize with considering various design factors related to the performance of wiping and durability.

Figure 10. is shown the example of good cleaning at local area by the optimized section shape of rubber blade.

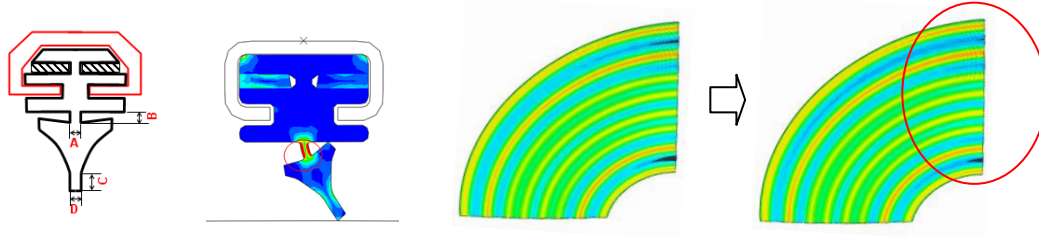


Figure 10. Comparison of results for optimized blade section

Also, with optimized blade arm and link, we can achieve the light weight of wiper system without a lowering of basic performance.

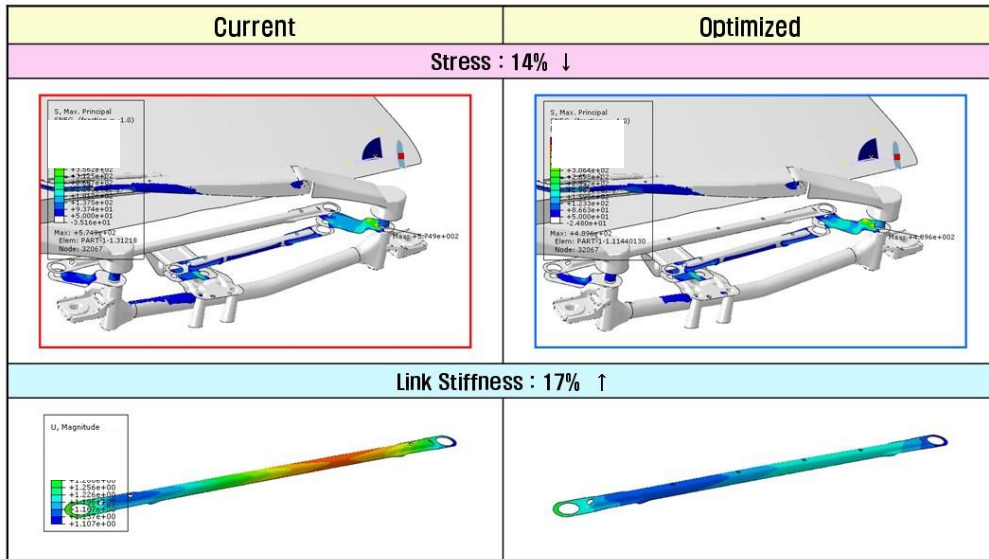


Figure 11. Comparison of results for optimized arm and link

5. Conclusions

We have found a modeling and analysis techniques of finite element based on template of various wiper types. Also, we verified the validity of analysis results by compare with test one of mass produce vehicle. Ultimately, by these developed unified analysis model and technique, we can predict effectively the performance of wiping and durability on wiper system at initial design stage.

6. References

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