A Study on the Effect of Mesh Size and Material Property of Contour Method for Residual Stress Measurement Using Finite Element Analysis

Jongmin Kim [a*], Sungwoo Kim [a] and Minjae Choi [a]
[a]*Material Safety Technology Development Division, Korea Atomic Energy Research Institute, Yuseong-gu, Daejeon, Korea*
[*]*Corresponding author: jmkim@kaeri.re.kr*

1. Introduction and Background

Contour method is used in various industries as a technology to measure the residual stress of structures. In the contour method, a member with residual stress is cut in a plane perpendicular to the direction of the stress component to be measured. Then, the residual stress can be measured by calculating the stress to return the deformation due to the cutting to the original state. It is assumed that elastic recovery stress is equivalent to the residual stress to be measured in the test. In this study, the effect of the mesh size and the difference in material properties of the weld and the base metal on the elastic recovery stress during FE (finite element) analysis was investigated.

2. Effect of Mesh Size and Material Property

2.1 Problem Definition

The model used for the analysis was 80(W) × 40(L) × 20(T), and the center of one end was curved to simulate deformation due to the residual stress, maximum deformation was 0.5 mm in center. The vertical direction was constrained and one point opposite the cut plane were fixed for boundary conditions. A commercial FE analysis code, ABAQUS was used for the FE analysis, and C3D8R element was used. In the analysis, a displacement was applied to return the curved surface to its original flat geometry by boundary conditions. In FE model, the central part was the welded zone and the other were the base metal. In parametric analysis, element size was changed, and the stress distribution was evaluated by applying different properties of the welded zone and the base metal zone.

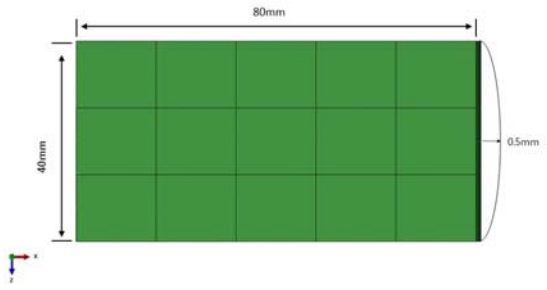

Fig. 1. FE models

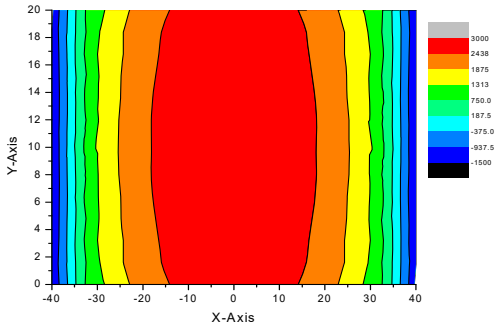

Fig. 2. Residual Stress Distribution

2.2 Effect of Mesh Size and Material Property

Figure 2 shows the stress distribution in the x-direction when the same material properties are applied to the weld and the base metal zone. It is the elastic stress (residual stress) to recover the curved surface to its original flat surface. In FE results, differences were found not only in the element size but also in the application of different properties of the weld and base metal.

3. Conclusions

In this study, the effect of the difference in element size and material properties was reviewed in the residual stress measurement technique using the contour method. Based on FE results, the difference in the predicted residual stress was shown due to the difference in element size and material properties. When using the contour method, it is expected that the application of the appropriate element size according to the size of the object and the measured point (point cloud), and the application of separate material properties of the welded zone and base metal zone will show more reasonable residual stress prediction results.

REFERENCES

[1] D. K. Kim, W. C. Woo and Y. H. Kang, Characterization of residual stress distribution of thick steel weld by contour method, Journal of Welding and Joining, 2015, Vol. 33, No. 1, pp. 23-29, http://dx.doi.org/10.5781/JWJ.2015.33.1.24.