THE EFFECTS OF A MICRO HOLE IN THE BELLOWS CONVOLUTION WITH POSITIVE ROTATION MOVEMENT ON THE STRESS BEHAVIOR

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1. Abstract

The effects of a micro defect on the stress behavior for the bellows are studied in this paper. Distribution of micro defect in the bellows is various, but the analysis is performed on the case that a defect is on the 1st convolution which is expected to occur the maximum stress. The von_Mises stress distribution for the bellows and around the hole is obtained. In addition, the relation between upward lateral deflection and positive rotation angle on the von_Mises stress for the bellows with micro hole is also obtained.

2. Introduction

The stress analysis in the presence of defects and cracks is the vital part of failure assessment in the course of service life of structures or parts weakened by defects. Most studies focus on the stress analysis of a plane containing defects [1], [2]. Although, researches for stress analysis of the defect in the plane are very many, research on the stress caused by the defect in the curved surface is insufficient. To analyze the stress caused by defects on the curved surface, a defect in the bellows is used.

Bellows are frequently used in the pressure vessels or piping system, aerospace, micro electro mechanical and industrial system, etc. it has the function to absorb regular or irregular expansion and contraction in the system. Since the bellows require high strength as well as good flexibility. The design, manufacturing and analysis of bellows are more complicated than other general tubes. Numerous papers have dealt with various aspects of bellows failure, design, forming process and analysis: K. Guan analyzed and found the most probable reason for the failure of SS 304 bellows [3]. C. Becht IV reported fatigue of bellows a new design approach [4] and lots of papers focused on design for manufacturing and design. In the above results, it can be seen that researches on the defective bellows are very few.

In this study, stress behavior caused by a defect on the bellows is analyzed. As bellows is loaded with combined tensile and compressive loadings during its service life, lateral deflection and positive angular rotation are used as boundary conditions. The effects of upward lateral deflection or downward lateral deflection with a positive rotation angle with respect to micro hole on the stress is analyzed in the study.

3. Analysis Model

Bellows is modeled with the finite element code. It is meshed with 8 node shell elements and elastic - plastic non-linear analysis is performed.

Tangent Modulus [GPa]	Young's Modulus [GPa]	Inner Diameter of Tube[mm]	Thickness [mm]	Diameter of Micro Hole(mm)	Quantities of Flexible tube [ea]	Type of Element
1.880	188	64.32	0.315	0.05	23	8-node Shell

Table 1. Material properties and geometric dimensions

4. Results and Discussions

Fig. 1 represents the elastic-plastic boundary with upward lateral deflection (U.D.) and rotation angle (R.A.). The internal line segment is an elastic zone and outside the area of the line is plastic zone. σ_{V_Max} around the hole caused by the upward deformation is greater than σ_{V_Max} of defect free bellows in less than an arbitrary L.D. and R.A.. This value is as shown in Fig. 2. If L.D. and R.A. is lower than the line, σ_{V_Max} around the hole caused by the upward deformation is greater than σ_{V_Max} of defect free bellows. In addition, σ_{V_Max} around the hole caused by the upward deformation is equal to σ_{V_Max} of defect free bellows in an upper part than the line.

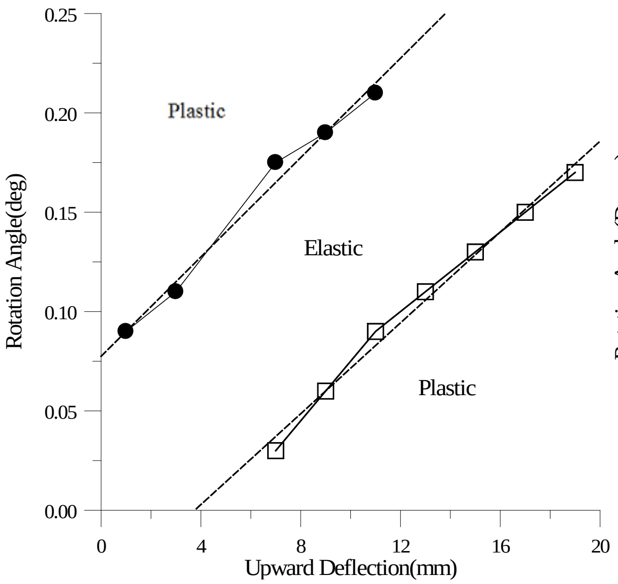

Fig. 1 Elastic-plastic boundary with U.D. and R.A.

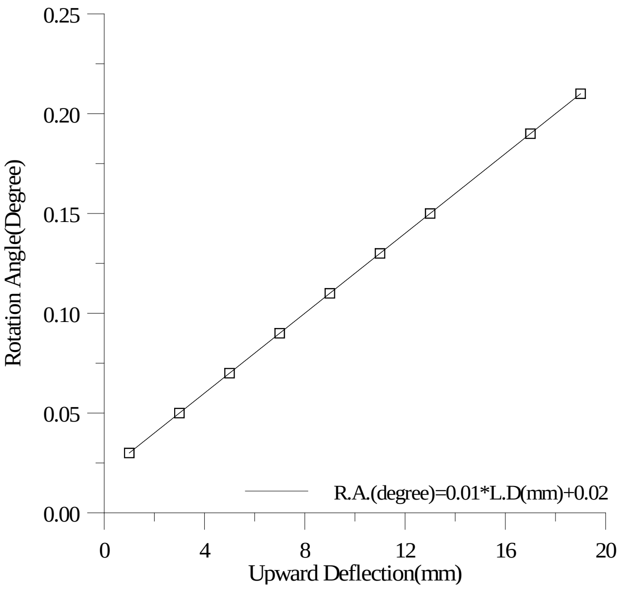

Fig. 2 U.D. and R.A. relation which σ_V_max of non-defective bellows equals σ_V_max of around hole

5. Conclusions

Obtained results of the study are as follows;

(1) Elastic-plastic boundary with upward lateral deflection (U.D.) and positive rotation angle (R.A.) for the model used in the study is obtained.

(2) U.D. and positive R.A. relation which σ_{V_Max} of non-defective bellows equals σ_{V-Max} of around the hole is R.A.(degree) = 0.01 x L.D.(mm) + 0.02 for the model used in the study.

6. References

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