Development of Structural Integrity Program for Tubular Type Power Transmission Tower

Dong-Min. Lee[1,2], Hune-Tae Kim[1], Yun-Jae. Kim[1*]

[1]Department of Mechanical Engineering, Korea University, Seoul, Korea
[2]Institute of Technology/KEPCO KPS, Naju, Korea

[*]Corresponding author: kimy0308@korea.ac.kr

1. Introduction

The recent development of tubular power transmission towers is increasing due to the demand for construction of eco-friendly power towers. In Korea, about 870 tubular transmission towers are in operation and this number is expected to be increased continuously in the future. A tubular type power transmission tower failure has occurred in 2013. As a result of the investigation, defects in welds were one of the causes of failure. Also, the bolts connecting the flanges in the tower are frequently damaged. However, since there is no management procedure for such a tubular type power transmission tower, it is necessary to develop a management program for this purpose. In this study, a program to evaluate the structural integrity of a tubular type power transmission tower has been developed.

2. Structural Integrity Program

2.1. Categorization

A tubular type power transmission tower consists of cross arm, base plate, bracket, anchor bolt, column, and flange bolts.

The targets are divided into welds and column flange bolts. Welds are subdivided into longitudinal and transverse welds.

2.2. Non-destructive Examination

The bolts were verified by conventional ultrasonic inspection. Total weld length of one tubular type power transmission tower is approximately 100 m and are difficult to apply in practice since applying conventional non -destructive testing methods would entail a high cost.

In this study, metal magnetic memory method, which allows up to 50 cm of inspection per second, was applied to overcome these shortcomings. Size measurement for defect was applied with phase array ultrasonic testing.

2.3. Weld Defect Evaluation

The failure assessment diagram method was applied to evaluate defects in welds. A failure assessment line was drawn using the tensile properties according to Eq. (1) and the cut-off value was determined by Eq. (2). The stress intensity factor was calculated for defect shape by using API 579-1 code [1-3].

$$K_r = f_2(L_r) = \left[\frac{E\varepsilon_{ref}}{L_r\sigma_y} + \frac{L_r^3\sigma_y}{2E\varepsilon_{ref}} \right]^{-1/2} \quad (1)$$

$$L_r^{\max} = \frac{\bar{\sigma}}{\sigma_y} = \frac{(\sigma_y + \sigma_u)}{2\sigma_y} \quad (2)$$

The load ratio was calculated as the ratio of the applied load on the supporting structure to the limit moment of circumferential crack provided by the R6 code [2].

2.4. Inspection Period Setting

The inspection cycle was set in consideration of risk and importance. Risk is divided into three levels. Importance is divided into three stages considering the safety factor, customer status and targets to be reinforced [4]. Based on the results, a total of nine management groups were divided and non-destructive testing was established every 3 to 10 years depending on their importance.

2.5. Inspection Plan

The long-term inspection plan was developed for 10 years based on the period established in Chapter 2.4.

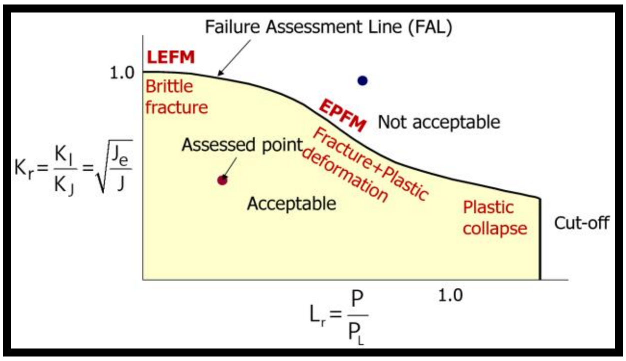

Fig. 1 Failure assessment diagram method

		Risk		
		A	B	C
Importance	I	①	②	③
	II	④	⑤	⑥
	III	⑦	⑧	⑨

Fig. 2 Management group classification criteria

3. Conclusion

The results of this study are as follows:

- An economic inspection system was established by introducing a metal magnetic memory method.

- Failure assessment diagram method is applied to assess weld defect effectively.

- Stress intensity factor was developed for evaluation of tubular type power transmission tower welds.

- The inspection cycle was set according to management group considering their risk and importance.

In this study, structural integrity program for tubular type power transmission was developed which can be used in the near future.

References

[1] ASME B&PV Code Committee, 2015 “ASME B&PV Code, Sec. XI”,

[2] R6, 2009 “Revision 4: Assessment of the integrity of Structures Containing Defect,“ British Energy Generation Ltd., Gloucester, UK

[3] ASME, API, 2007, “API 579-1 Fitness For Service”, ASME and API, Washington, USA

[4] KEPCO, 2011 “Power Transmission Tower Design Guide Line”