Research On Maintenance Strategies For Cracking Steam Turbine Blades In Thermal Power Plants

(Energy Research Laboratory： Wu, Hsien-Cheng; Chen, Ruey-Chyi; Chung, Chen-Chou; Liao, Chia-Chi; Huang, Tai-Yuan; Lo, Chi-Hao; Lin, Jyuan-Han; Liu, Da-Ming; Duan, Shiang-Ren)

I. Research Background

During the major overhaul of the thermal power plant, cracks were found near the lacing wire of the suction side of the low-pressure steam turbine blades. Figure 1 shows the crack locations of the turbine blades. Due to the lack of spare blades for the low-pressure turbine from the power plant and OEM, it would be time-consuming and costly to repair the blade cracks by stopping the units. Therefore, the power plant entrusts Taiwan Power Research Institute(TPRI) to support the maintenance and repair strategies for steam turbine blade cracks. The main content of the strategies is to study the method and manufacturing process of welding-repaired cracked blades on the low-pressure turbine rotor without disassembling the cracked blades.

Fig. 1 Photo of the suction side of the low-pressure turbine blades (left) and the location of its crack(right).

II. Research results：

This research has been investigated to repair cracked steam turbine blades without removing the blades from the rotor. It can shorten the time of removing, repairing, and installing the blades from the rotor, reducing the power generation shortage because of maintenance time. The processes for blade

welding repair are as follows: nondestructive testing of blades to confirm whether there are cracks and the length of the cracks, confirmation of blades composition, dimensional measurement and modeling of blades, analysis of structural mechanics, verify the welding test specimen and formulate the welding procedure specifications (WPS), grinding, grooving, welding repair of the cracked area of blades, nondestructive-testing after welding repair, stress relief heat treatment after welding repair, dimensional measurement to confirm post-welding deformation.

The blade geometry is obtained by dimensional measurement and is analyzed by the finite element method (FEM) software for structural mechanics analysis. The analysis results showed that the location where blade crack initiation is where stress is concentrated, and the centrifugal stress location is quite close to the modal stress location. To improve the stress concentration, TPRI increases the thickness of the stress concentration point and verifies it through structural mechanics simulation. The analysis results show that this modification can reduce concentrated stress. Figure 2 shows the stress distribution diagram of blades before improvement (left) and after improvement (right).

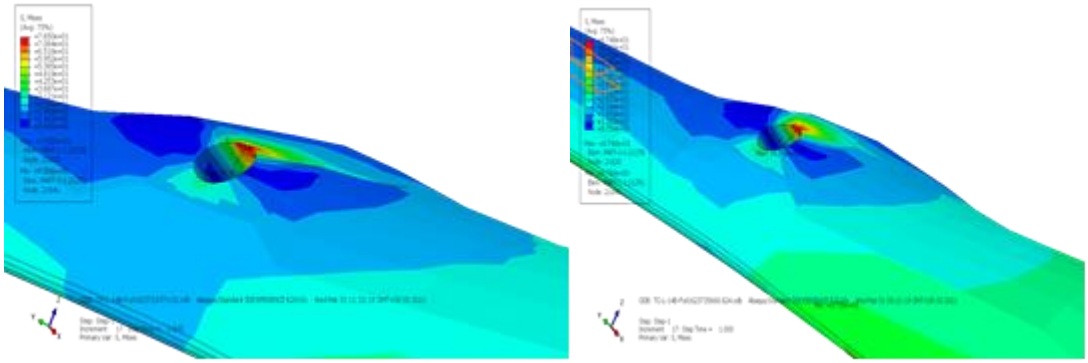

Fig. 2 Blade stress distribution diagram before improvement(left) and after improvement(right).

Before repair welding, test specimens were made to verify appropriate repair space and welding parameters. Verification projects include penetration testing, radiographic testing, hardness testing, tensile testing, impact testing, metallographic testing, heat treatment, etc. Verification is completed when the experimental results and

mechanical properties are confirmed to be similar to or better than those of the blade material. After verification, the cracked blades on the steam turbine rotor will be ground, grooved, welded, non-destructive tested, and stress-relieved heat treated. Finally, confirm the dimension of the repaired blade and compare it with the original dimension. Fig. 3 shows a photo of the welded test specimen (left) and the blades to be repaired on the steam turbine rotor (right). Fig. 4 indicates reverse scanning and modeling of the blade after heat treatment.

This research can be widely used in different types of steam turbine blades in various thermal power plants in the future. Establishing the technology of welding and repairing steam turbine blades on the rotor without removing the blades helps to reduce maintenance time and ensure a stable power supply.

Fig. 3 Photo of the welded test specimen (left) and the blades to be repaired on the steam turbine rotor (right).

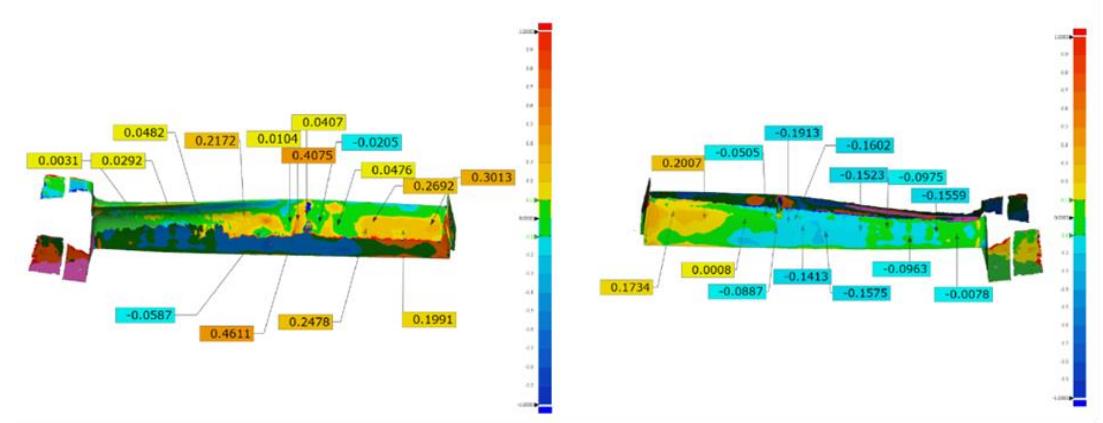

Fig. 4 Reverse scanning and modeling of the blade after heat treatment.