Residual stress analysis and assessment of mechanical properties of dissimilar material welded joint between Alloy 617 and 12Cr steel.

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Abstract

The performance of thermal power plants can be improved by elevating the steam temperature. It is, therefore, necessary to develop suitable materials for such extreme environment. Inconel alloys and chromium steel alloys are used in high temperature conditions due to their incredible mechanical properties, creep strength and high corrosion resistance. As Inconel 617 and 12Cr steel have different chemical compositions and mechanical properties, we developed dissimilar material welding technology for manufacturing of hybrid structure. The specimen of dissimilar material welds, after several experiments, was manufactured under optimum welding conditions. The welded structure integrity can be evaluated after welding residual stress analysis and assessment of mechanical properties. The residual stresses of dissimilar material welded joint was evaluated both experimentally and using Finite element analysis. The hole drilling method according to ASTM-E837 was used to measure the residual stresses of the specimen. The numerical analysis of welding residual stresses was carried out by using ABAQUS Code. Element rebirth technique was used to simulate the multi-pass welding process. Fig. 1 illustrate the results of welding residual stress analysis. The results are quantitatively different but they displayed similar distribution pattern across the dissimilar material weld. Peak value was observed at 12 Cr Steel side HAZ and the value was 282 MPa by experimental method. Welding residual stress analysis shows that the high tensile residual stress was distributed in HAZ and the compressive residual stress was distributed away from HAZ. Residual stress values were high in longitudinal direction then transverse direction. For the assessment of mechanical properties, specimen were prepared according to ASTM-E8M. Fatigue test was performed using load reduction method. The fatigue limit was assessed by 306.8MPa and it is 40% of tensile strength (767MPa). Tensile test was carried out by using Instron 8801 model. Tensile test results showed that yield and tensile strength of dissimilar welded joint were higher than those of Alloy 617 base metal and less than those of 12Cr steel base metal.

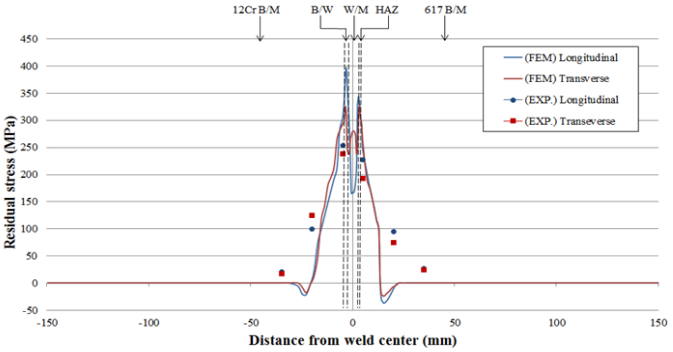


Figure 1: Results of welding residual stress analysis

Recent Publications

1. Hafiz Waqar Ahmad et al. (2016) An Assessment of the Mechanical Properties and Microstructural Analysis of Dissimilar Material Welded Joint between Alloy 617 and 12Cr Steel. *Metals* 6,242.
2. Young Soo Park et al. (2014) Fracture Mechanical Assessment of the Corrosion Fatigue Characteristics at the Low Fatigue Limit of a Multi-pass Welded Ni-based Alloy 617. Procedia Materials Science 3: 1530-1535
3. Young Soo Park et al. (2014) Assessment of the crack growth characteristics at the low fatigue limit of a multi-pass welded Ni-based alloy 617. Journal of Mechanical Science and Technology 28: 1251-1256
4. Ju Hwa Lee et al. (2016) Assessing mechanical properties of the dissimilar metal welding between P92 steels and alloy 617 at high temperature. Journal of Mechanical Science and Technology 30: 4453-4457



Biography

Dong-Ho Bae is a professor at the school of mechanical engineering, Sungkyunkwan University in Seoul, Korea. He served as a reliability division president of the Korean Society of Mechanical Engineers. He was General Secretary and Editor of Asian Pacific Conference on Fracture and Strength, 2004.Prof. Bae was Conference Chairman in 3rd International Conference on Materials and Reliability, 2015. Dr. Bae's research interests are in the area of welding design, environmental strength of materials, life prediction, and reliability assessment of the industrial facilities.

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Notes/Comments: