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Evaluation of Stress Relief using Ultrasonic Peening in GTAW Welding and Stress Corrosion Cracking (SCC) in Stainless Steel, and Comparison with the Thermal Method

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Abstract : In the construction industry, the lifespan of a metal structure is directly related to the quality of welding. In most metal structures, the welded area is considered critical and is one of the most important factors in design. To date, many fracture incidents caused by these types of cracks have occurred. Various methods exist to increase the lifespan of welds to prevent failure in the welded area. Among these methods, the application of ultrasonic peening, in addition to the stress relief process, can manually and more precisely adjust the geometry of the weld toe and prevent stress concentration in this part. This research examined Gas Tungsten Arc Welding (GTAW) on common structural steels and 316 stainless steel, which require precise welding, to predict the optimal condition. The GTAW method was used to create residual stress; two samples underwent ultrasonic stress relief, and for comparison, two samples underwent thermal stress relief. Also, no treatment was considered for two samples. The residual stress of all six pieces was measured by X-Ray Diffraction (XRD) method. Then, the two ultrasonically stress-relieved samples and two untreated samples were exposed to a corrosive environment to initiate cracking and determine the effectiveness of the ultrasonic stress relief method. Thus, the residual stress caused by GTAW in the samples decreased by 3.42% with thermal treatment and by 7.69% with ultrasonic peening. Furthermore, the results show that the untreated sample developed cracks after 740 hours, while the ultrasonically stress-relieved piece showed no cracks. Given the high costs of welding and post-welding zone modification processes, finding an economical, effective, and comprehensive method that has the least limitations alongside a broad spectrum of usage is of great importance. Therefore, the impact of various ultrasonic peening stress relief parameters and the selection of the best stress relief parameter to achieve the longest lifespan for the weld area is highly significant.

Keywords : GTAW welding, stress corrosion cracking(SCC), thermal method, ultrasonic peening.
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