

# Fatigue testing strategies for the X65 steel catenary riser with small-scale specimens considering the effect of welding residual stress

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## Abstract

Wave-induced fatigue damage is inevitable for the deepwater steel catenary riser (SCR). To accurately evaluate the fatigue performance of the full-scale SCR using small-size specimens, five kinds of fatigue testing strategies were explored, considering the effect of welding residual stress. Further, the corresponding fatigue tests were conducted regarding the welded joint specimens with the same weld profile, and the relevant differences in fatigue testing results were comprehensively analyzed. Through comparison with the full-scale resonant bending fatigue testing results, the most equivalent strategy using small-scale specimens was confirmed. The relevant results indicated that compared with the fatigue lives of full-scale pipeline joint specimens, the fatigue testing lives under the constant applied maximum stress of the yield strength for base material or the constant applied mean stress of the peak value of transverse welding residual stress strategy are relatively lower. The fatigue life values obtained from the high-stress ratio testing strategy are higher, especially in the low-stress range region. Comparatively, the fatigue lives obtained under the 80 mm wide specimen without the cutting process strategy were higher in the high-stress range region. The variable applied mean stress strategy using the 25 mm wide welded joint specimen was most suitable for equivalence with full-scale fatigue testing results, and the difference in the fatigue life testing results was only 9.7%. The difference between the applied mean stress and the actual transverse welding residual stress under various fatigue testing strategies is the key to affecting the equivalence of fatigue testing results.

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