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Dynamic Analysis of Full-scale Composite Risers using Time-domain Based Semi-Empirical Coupled Fluid-Structure Technique

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The responses of both composite and steel risers subjected to the Gulf of Mexico current are investigated, followed by parametric studies on the effect of current drag and riser ends boundary conditions. A homogenization technique is used to obtain the equivalent transverse-isotropic material properties of the twenty-ply carbon fiber reinforced composite riser. The global analyses are conducted using Aqua, to simulate riser dynamics with appropriate consideration of fluid inertia and drag effects. Static and eigenvalue analyses are first performed followed by a time-domain based vortex-induced vibration (VIV) step where oscillatory forces are applied. The riser deflection, excited modes, maximum displacements and RMS strains and stresses are compared to provide insights to the riser's performance. Local analyses are next conducted by plotting maximum moment and tension values onto failure envelopes derived through damage modeling with Hashin's failure criteria for the consideration of first ply failure. Conclusions are then made on the strength and reliability of the risers and the possible locations and ply-layers where damage will occur.

Keywords: Composite, Riser, Time-domain, RMS, Vortex induced vibration (VIV), Global-local analysis