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Application of Advanced Buckling Model Leads to Lighter Well Architecture for Deepwater Development, Saving Cost and CO2 Emissions

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Abstract

The use of basic torque and drag modeling as well as the application of industry-standard buckling formulae can limit the options for well design. Advanced buckling modeling, and a fundamental understanding of the effects of buckling, can be used to generate lighter well architectures, resulting in significant savings in cost and CO2e emissions, without compromising well integrity and zonal isolation.

The fundamental load regime, and associated assumptions, were analyzed to define the worst-case axial load that could be applied to the surface casing of the proposed lighter well architecture. Two different configurations of the surface casing string were modeled in engineering software using a stiff-string model with unique post-buckling capabilities. The identified load cases were simulated, and different sensitivities were performed, to refine the configuration of the surface casing. The detailed results (including von Mises stress, casing deformation, and axial displacement) were interpreted and combined with operational constraints to produce a final surface casing configuration that met all requirements.

The final configuration of the surface casing for the lighter well architecture was estimated to save the operator 5.1 days of operational time per well, generating savings in the region of $4M USD and 1367klbm of CO2e per well. The operator decided to deploy the new architecture on six wells of their ongoing drilling campaign, two of which have already been successfully realized. With this success, the operator is looking to optimize the architecture further by refining some of the conservative load inputs, with measured data, to justify a reduction in the maximum expected load. The advanced buckling model revealed that the distance between centralizers and the radial clearance (created by the geometry of the centralizers) influences the bending stresses in the casing in a nonlinear way and that there is a sweet spot to be found, depending on the axial load. This discovery would have otherwise been missed if industry standard buckling equations were used. Understanding this allowed an informed decision to be made regarding the final configuration of the surface casing.

Understanding the limitations of industry-standard buckling formulae and their use with basic torque and drag modeling will make the practicing engineer aware of other methodologies and processes that can be applied to reimagine their well design.

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