Customer Benefits

- A single integrated flexible riser global analysis with detailed multi-layer models and direct stress recoveries
- More realistic simulations leading to more accurate stress and fatigue life predictions
- Direct stress recovery from the global analysis itself where the responses/stresses are most accurate
- Eliminate secondary local stress analyses with detailed segment models that did not participate in the global analysis itself
- All of the above equate to significant Risk/Cost/Schedule reductions

Introduction

- Flexible risers exhibit nonlinear dynamic behavior due to stick/slip interaction between the pipe wall layers
- Capturing this interaction in a compliant system that can undergo large 3D translations/rotations is a highly nonlinear, computationally intensive problem
- Current industry practice is to perform global analysis with simplified line models. This type modeling does not reflect the actual riser behavior impacting analysis accuracy and fatigue life predictions
- Industry goal is incorporate detailed flexible riser modeling into the global analysis itself
- Recent attempts at nonlinear dynamic simulation with detailed multi-layer flexible pipe models have resulted computational resource requirements that are impractical for real analyses
- Perdrizet et al (2011) reports Abaqus nonlinear static simulation of half-bending cycle of a 7m 5-layer flexible pipe taking 48 hours on 32 CPU cores processing in parallel
- Clearly, more advanced computational methods, with very high degrees of computational efficiency, are required to solve this problem
Our technology enables efficient flexible riser global analyses with detailed multi-layered models and direct stress recoveries from the global analysis itself. This type simulation is superior in accuracy to global analyses with simplified line elements and eliminates the need for local models/analyses.

Advanced Approach

- Our technical approach expands the well established, computationally efficient frame work of dynamic substructuring to fully nonlinear
- Large displacements, large rotations, bending (friction) hysteresis, ...
- This expanded frame work, which we shall call “Nonlinear Dynamic Substructuring” (NDS), allows for a very high degree of computational efficiency for highly nonlinear dynamic problems

- Enables a significant reduction in the order of the nonlinear simulation while maintaining accuracy
- With this, we can incorporate detailed multi-layer flexible riser models into a global nonlinear dynamic analysis and efficiently simulate
- Also, we can directly recover stresses from the global analysis itself
- NDS has been benchmarked against the industry standard software benchmarking problem for flexible risers

Publications

OTC 2013 - 24196: A Nonlinear Dynamic Substructuring Approach for Efficient Detailed Global Analysis of Flexible Risers
A. Majed, S. Bhat, M. Dib, P. Cooper

ISOPE 2013: Efficient Global Nonlinear Dynamic Analysis of Flexible Risers with Detailed Models and Direct Stress Recovery
A. Majed, S. Bhat, M. Dib, P. Cooper

ISOPE 2013: High Fidelity Sink Trajectory Nonlinear Simulations for Dropped Subsea Objects
A. Majed, P. Cooper

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