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Subsea Pipeline Free Span Mitigation: Case Study and Lesson Learnt of Optimised Design Approach

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Abstract

Objectives/Scope: Pipeline free span analysis has been widely practiced assessing the unsupported sections of subsea pipelines, in which the span develops due to scouring effect, uneven seabed or pipeline sitting on support structures. The pipeline is subjected to fatigue damage from Vortex Induced Vibration and wave action. However, in a conservative approach, this can result in a high probability results of total excessive span numbers. Challenges to rectify the pipeline free span before pipeline hydrotest must also be considered. “X” project is a green gas field development that flows its full well stream from a wellhead platform 37km away via 10-inch, 14.27mm wall thickness carbon steel pipeline to “Y” CPP, designed without concrete coating and located in a very dynamic seabed condition region. This paper shares the strategies and key lessons learnt in solving the high number of excessive pipeline free span as well as reducing the requirement for free span corrections post installation stage.

Methods, Procedures, Process: In this project, the free span analysis was originally assessed based on DNV-RP-F105 screening assessment during the detail engineering stage. Based on this, the pipeline has a very short maximum allowable span which results in a high number of predicted free span locations based on-bottom-roughness analysis. These spans require rectification after installation, before hydrotest and after operation. Due to the complexity of the installation schedule and duration limitation between installation and pre-commissioning, rectification must be performed prior to the hydrotest. Free span mitigation optimization assessment was then performed by applying the Finite Element Analysis method followed by fatigue life calculation using in-house developed analysis system. This system adopts a digitalization approach in pipeline engineering from non-quantitative analysis into analytics and quantitative analysis. It is an integrated and automated system which carries the function of streamline engineering tools, electronic document management, faster engineering analysis and instant reporting. The assessment was done on a risk-based approach, considering respective span configuration such as length, gap, exact residual bottom lay tension and seabed stiffness at each respective span. Further optimization was also performed by obtaining directional Hs TP scatter of current and wave data. This detailed analysis was conducted to ensure the unsupported pipeline meets fatigue life criteria to ensure its integrity throughout the design life.

Results, Observations, Conclusions: The optimized maximum allowable static span length for ULS with 0% corrosion allowance, hydrotest case was able to be extended to minimize free span rectification. Since the free span rectification to be performed before pipeline hydrotest, this case is selected as governing case as the optimized free span length for operational case was found much longer than hydrotest case and fatigue life was also found exceed the required design life.

Novel/Additive Information: This case study and lesson learnt approach can be replicated to optimized pipeline free span mitigation for offshore pipeline.