CASE STUDY

Subsea Conductor Running in Strong Currents

AS | MOSLEY
OFFSHORE SIMULATION

BACKGROUND

Exploration wells were to be drilled in the Norwegian Sea in a water depth of approximately 1200m (4000ft). The drilling operations were to be performed from a 6th generation, ultra-deepwater dual-activity semi-submersible drilling rig. The drilling procedure required the 30" conductor to be pre-run, prior to drilling the 36" hole section. The conductor would be hung-off at the moonpool cart between the main and auxiliary rotary tables. It was suspended using heavy wall drill pipe (HWDP) which would be supported on a C-plate parking tool assembly. The auxiliary table would be used to drill and trip a pilot hole drilling assembly while the main table will be used to drill and trip a 36" drilling assembly. A schematic of the general arrangement is presented (see page 2).

AS Mosley was contracted to determine safe operating sea state limits, maximum loads on the c-plate and moonpool, as well as the minimum fatigue life of the conductor.

CHALLENGE

The HWDP and conductor could become susceptible to vortex induced vibrations (VIV) whilst suspended in the water column and exposed to strong surface currents.

Potential cross-flow VIV lock-on has the following effects:
1. Increases the effective drag diameter of both the HWDP and conductor.
2. Adds to the fatigue damage at critical locations such as the conductor connectors and along the seam weld of the conductor.

Furthermore, with an increased drag diameter comes higher drag forces which increases the bending stress in both the HWDP and conductor.

SOLUTION

AS Mosley performed three assessments to help find an effective and long-lasting solution. These were:

1. Perform a VIV assessment

This assessment was performed for a range of current profiles with speeds close to zero up to and including the 1 year extreme (1.2m/s at surface). This assessment identified the current speed at which VIV lock-on is most likely to occur, which in this case was 0.9m/s at surface.

The results also showed that the 1 year extreme current, with VIV lock-on, increased the effect drag diameter of the HWDP and conductor by a factor of 3.6 and 1.8, respectively i.e. the HWDP was much more excitable than the conductor, due mainly to its smaller hydrodynamic diameter when compared to that of the conductor.

The resulting VIV fatigue life, based on all current profiles, was 7 days at the HWDP connector closest to the c-plate. This meant that the HWDP and conductor would potentially need to be pulled back and the HWDP replaced after 7 days of continuous suspension due to VIV fatigue damage alone.

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SOLUTION

2. Perform a strength assessment

This was done by simulating all sea states likely to occur within a 1 year period. The bending stresses along the HWDP and conductor were extracted for each sea state and compared against their allowable capacities. This determined the maximum sea state limit, which was 4m (Hs) to prevent over-stressing. The increased drag amplification due to VIV was included.

The results were used to check for clashing of the HWDP with the pontoon crossbars. Additionally, the results showed that in a 4m (Hs) sea state, the c-plate and moonpool cart would not be overloaded. The vessels maximum heave range, pitch and roll amplitudes were also determined and reported.

3. Perform an irregular wave fatigue assessment

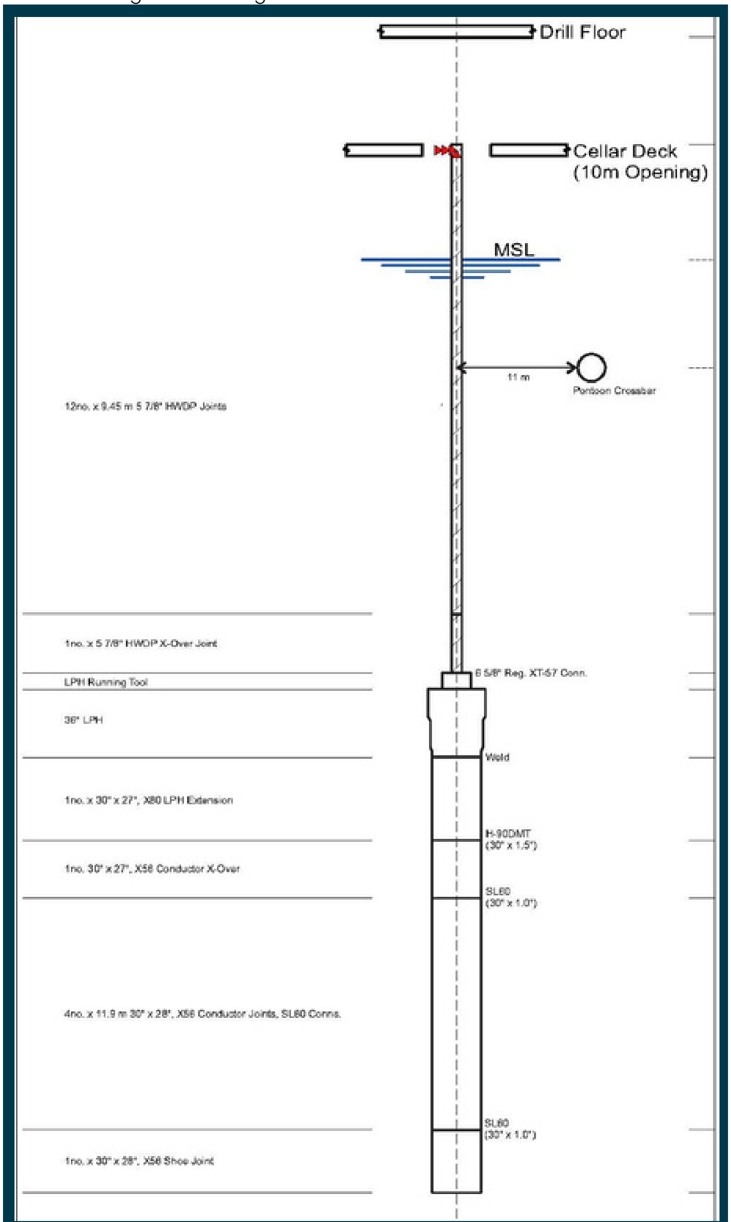
This determined the fatigue damage resulting from combined wave action and vessel motion. The minimum fatigue life was >400days at the same HWDP connector, for all sea states considered up to 4m (Hs).

RESULTS

The overall solution would be to monitor surface currents and limit the sea state to 4m (Hs). So long as the surface current remains below 0.9m/s, then the VIV fatigue damage could be mitigated. Alternatively, some form of VIV suppression would be required on the HWDP to suppress VIV excitation, such as wrapping wire ropes helically on the HWDP.

Setting the sea state limit to 4m (Hs) ensures that neither the HWDP nor conductor exceed their allowable bending stress, so that there is no clashing with the pontoon crossbars and that the c-plate and moonpool cart are not overloaded.

Schematic of general arrangement:



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CONCLUSIONS

AS Mosley's experience with VIV modelling was a key factor in the handling of this project. Clear guidance was provided to our client through limits on the surface current speed and seastates.

The client also acknowledged, that in the past, they had experienced fatigue failures in the HWDP connectors for similar operations and were re-assured to see that our analysis confirmed the same.