SURE FOOTING FOR ONSHORE DRILLING SITES

When the lifespan of working platforms made of boxes that raise oil workers’ equipment over waterlogged areas did not meet expectations, engineers turned to ANSYS simulation. The time to develop new boxes has been reduced by 90 percent, and the lifespan is seven times greater than that of the previous design.

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Site preparation is a concern in many onshore drilling and production projects. For sites in marshlands and regions near riverbanks there is the added complexity of working in areas with standing water (up to a couple of centimeters) surrounding the drill site. Water makes for unpleasant working conditions, shortens equipment life and can have negative impact on the surrounding environment. One solution is to build a foundation without a large environmental impact.

To avoid this water issue, China National Petroleum Corporation (CNPC), the third largest oil company in the world, tried to shift the operating season from summer to winter, but this led to an unsustainable rise in heating costs. Another fix was to truck in tons of dirt, which added significantly to the project costs, especially after environmental legislation was introduced in 2015 that requires all dirt that is transported into a site to be removed upon drilling completion.

The current solution is to use base boxes composed of rigid steel mesh and filled with dirt. When joined together, the boxes create a platform that allows workers and machinery to traverse the worksite while remaining above the water. Base boxes substantially reduce the amount of transported dirt that is required and therefore are superior to previous alternatives.

A typical field site has platform made from approximately 200 base boxes strung together into a single set that covers all of the necessary working locations on a field. These boxes carry workers and trucks weighing 60 tons. When originally designed, these base boxes required several senior engineers to perform manual calculations, which led to experiments with numerous prototypes. The process overall required dozens of experienced workers and nearly four months to develop the boxes. The expected design life for the original base boxes was five years, but they only lasted about two years because the structural strength was degrading faster than expected.

New base boxes that had a longer lifespan were required. CNPC leveraged ANSYS Mechanical structural simulation and optimization through ANSYS Workbench to design, test, iterate and create improved base boxes. Using ANSYS DesignModeler within ANSYS Workbench, the CNPC design team starts with the dimensions of the base box for an initial design that they then modify using shape optimization to meet the constraints of the available manufacturing processes. They perform a linear buckling analysis using the static and modal analysis module with ANSYS Mechanical and determine the load limit for each box structure. The engineers optimize the design to obtain the best balance of strength, material and manufacturing costs. The thickness of the steel plate on the surface of the base box is the largest factor affecting the strength and cost of the box. For each additional millimeter of thickness in the steel plate, the cost increases by 2.5 percent and the weight increases by 125 kg per square meter. The parametric capability within ANSYS software is used to optimize the final thickness of the steel top sheet.

Using ANSYS software, CNPC engineers have replaced a time-consuming and expensive manual process with only 20 simulations that automate the design and structural parameters. Structural designs are now completed in two weeks, the development cycle is reduced by nearly 90 percent, and boxes are brought
Using ANSYS software, CNPC engineers have replaced a time-consuming and expensive manual process with only 20 simulations that automate the design and structural parameters. The newest boxes have an expected lifespan of 15 years and have saved CNPC over $2 million in earth procurement and environmental costs in one year. The weight of each base box has been decreased by 400 kg, which reduces the amount of steel by over 70 tons at each well site. This means that related transportation costs are also cut by 6.8 percent. Integrated ANSYS solutions have helped CNPC save millions of dollars by enabling it to more fully analyze and optimize base boxes for the applicable well sites. Design cycles now take one-tenth the time of the old manual process, and the environmental impact has been substantially reduced by removing the need to truck thousands of pounds of dirt in (and then out) for each well site.