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Subsea connectors aid swift placement of Perdido spar

Brian Green
First Subsea

Ballgrab mooring connectors recently were deployed to moor Shell's Perdido direct vertical access spar platform in around 8,000 ft (2,438 m) of water in Alaminos Canyon in the Gulf of Mexico.

"A particular challenge Shell faced at Perdido was delivery and installation of the spar and 'storm safe' mooring system prior to the peak of the hurricane season last August," says Curtis Lohr, Shell's project manager for the spar and mooring system. "The use of subsea mooring connectors helped to quickly and safely connect each mooring line to the associated anchor pile."

The Ballgrab subsea connection system, developed by First Subsea, comprises a male connector and a female connector. It works on the simple principle of a ball engaged in a taper. The male connector is inserted within the female connector. As the balls roll up the male connector's tapers, the tightness of the grip to the female connector increases in direct proportion to the load applied. In the field, the tool is aligned into position and inserted; once engaged it cannot be released until the load is removed.

The Perdido Regional Host truss spar has a nine-leg, taut chain-polyester/rope-chain mooring system averaging 13,833 ft (4,216 m) in length with suction anchors. The nine mooring lines are configured in a 3 x 3 pattern with polyester rope main sections and chains at the end of each line.

Off-vessel mooring equipment in each leg includes the following: Suction anchor, pile shackle, pile chain, D-shackle, subsea mooring connector, D-Shackle, ground chain, rope shackle, polyester rope segments with H-link connecting segments, polyester insert, H-link, adapter, D-shackle, platform chain, pear link, and tail chain system.

The nine male connectors, each 2.8 m (9.18 ft) long and with 11 rows of balls, were designed with a maximum break load of 17,259 kN. In typical use, the Perdido spar connectors would experience around 30% of this load.

Heerema Marine Contractors was responsible for installing the mooring system using its deepwater crane vessel *Balder*. "We've had a lot of experience with Ballgrab connectors in deepwater and find them straightforward to install," says Yigal Oosterink, project engineer, Heerema Marine Contractors. "On the Perdido project, this experience allowed us to concentrate on other, more challenging, areas of the mooring system such as handling the long lengths of polyester rope."



Perdido First Subsea male SMC with mooring chain attached.



Perdido First Subsea female SMC with ground chain attached to pile.

Suction pile docking porch

Each suction pile was pre-fitted with a female connector, held in a docking porch at the top of the pile, and connected to 22.8 m (74.8 ft) of 5.28-in. (13.4-cm) ground chain. Once the pile was in position, an ROV was deployed to fit a receptacle cap containing anti-corrosion chemicals to the top of the female connector.

To provide a secure fit within the docking porch, each female connector features a trunnion – cylindrical projections welded to each side of the connector. Finite element analysis is applied to the design of the trunnion, which can take the weight of the ground chain, in this case 11.2 metric tons (12.34 tons), but tested to withstand 40 metric tons (44.1 tons) without the trunnion bending.

The male Ballgrab connector is prepared by testing the ball-locking mechanism and adding corrosion inhibitors within the body of the connector. This means that the male connector can be connected to the female

connector at any time within the following 24 hours.

On Perdido, the male connector was attached to 1,170 ft (357 m) of 5.28-in. (13.4-cm) chain and lengths of polyester mooring rope, and then lowered, using the *Balder's* purpose-built, mooring line deployment winch, to within 50 m (164 ft) above the female connector. An ROV then removed the female receptacle plug and the male connector was guided into position directly above the female connector, using the vessel's dynamic positioning capability, and stabbed into the female connector.

Once the male connector is fully inserted into the female connector, the latter is lifted out of the docking porch. The ROV removes the male connector's T-bar to engage a secondary locking mechanism and thereby complete the mooring connection.

Key benefit

"One of the key benefits for HMC of this system is that you need to insert the male connector vertically to get a connection, without a lot of ROV intervention," says Oosterink.

Perdido's mooring connections were completed sequentially, working counter-clockwise per cluster with a male connector attached to each of the three clusters. With the first three mooring lines connected to each of the clusters, the spar was considered "storm-safe." The mooring connector installation sequence was then repeated for the remaining connectors. All the Ballgrabs were installed in 18 days. ●



Perdido pile and First Subsea SMC schematic.

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