storage island

When in operation, the nine compartments of the storage tank will always be filled with either water or low sulphur crude oil with a specific gravity of 0.83 or a combination of both. The storage compartments are kept pressurized by a water tower located on the top of the tank. During the tank filling operation, the oil enters from the production separators and pushes out the seawater contained in the tank. Any residual oil in this water is removed and retained before the water is flushed into the water tower. Water level in the tower is maintained to automatically replace the oil pumped out of the tank. An internal plumbing system removes sludge from the bottom of the tank by agitating and flushing it with high pressure water jets. Oil is pumped into the tank through a 30-inch line which also serves as the discharge line for pumping oil into the holds of tankers.

The oil-water levels are continuously monitored by a system of instruments and controls in the tank. Other auxiliary equipment includes automatic venting, a fire-fighting system and required navigational aids.

Prior to construction of the storage tank, water level and wave force measurement tests were conducted in a wave flume on a prototype model at the River and Harbor Laboratory of the Technical University of Norway, Trondheim. Pressure distribution measurements were also taken to determine the forces of wave action on the bottom and sides of the tank and the forces due to the differential water level in the outer chamber. The parameters involved under towing and various sea conditions were investigated at the "Bassin des Carenes" of the French Navy and scour tests were made at the Laboratoire central d'Hydraulique de France (Maisons-Alfort) to observe the influence of wave action at the toe of the structure.

The concrete and prestressing engineering was performed by Europe Etudes, Paris, and Société Technique de l'Utilisation de la Précontrainte, Paris, both companies acting as sub-contractors. A three-dimensional finite elements analysis was carried out at the University of Calgary, Calgary, Alberta, with the help of Professors A. Chaili, W. H. Dilger and Y. K. Cheung. This analysis showed that the stress-strain relationships derived from calculation and adopted from the design were adequate.

The determination of the stresses on the storage tank and perforated wall allowed for the design of the structure in accordance with acceptable structural codes and standards. For the concrete structures the design standards followed were those of the American Society for Testing Materials, the American Concrete Institute and the Norwegian Concrete Code. The recommendations of the "Comité Européen du Béton — Fédération Internationale de la Précontrainte" were applied to the post-tensioning system.

The structure was built in two different stages — in dry dock and while afloat. The raft foundation was first built in dry dock at Stavanger. At the end of this phase the double-floor raft was 20 feet high, surrounded by a 29-foot high perforated breakwater wall. The perforations were temporarily blocked off to permit floatation of the breakwater raft.

The floating structure was then towed from the drydock and moored in a sheltered area. The perforated breakwater wall was constructed of pre-cast concrete elements and these were carefully lowered into place by cranes mounted on barges. The inner tank was built using the slip-forming technique which allowed a fast wall erection. The post-tensioning operations were then performed so as to allow the entire unit to be in a compression state. As the storage tank and outer walls rose the whole structure was allowed to sink lower into the sea, keeping enough freeboard to allow setting of the concrete.

Stability of the floating structure was provided by ballasting the storage tanks. After wall and roof completion, piping and pumps for the oil and water systems were installed and the entire unit is being made ready for installation at the Ekofisk field. Once the storage tank is positioned in its proper location in the drilling complex, it will be slowly lowered into place by ballasting the storage tanks with sea water. A careful survey was made of the towing routes to avoid running aground or encountering other navigational dangers.

All present indications are that the storage tank will be used safely and successfully. If the perforated storage tank proves to be an efficient and safe means of storing crude oil at an offshore drilling site and providing stable and strong deck areas, the sea platform may be used to provide marine bases for oceanographic studies and other industrial applications such as offshore nuclear power plants and offshore oil and gas drilling and production platforms. ☐ Donald Crockford

Below—Another view of the floating raft before it was towed and moored in deep water. • *Ci-dessous: l'île artificielle avant d'être remorquée jusqu à son emplacement définitif.*

Opposite page—Aerial view of the floating raft under construction. The nine oil storage tanks are located inside the perforated breakwater. • *Page de droite: vue de l'île artificielle en cours de construction. Les neuf réservoirs de pétrole sont entourés de la digue perforée.*