Gravity Base Structure off the coast of Canada

Major oil deposits have been discovered off the east coast of Canada. Their continental shelf is expected to contain similar volumes as those discovered on the Norwegian shelf. Hebron was one of the first fields to be discovered, back in the early 1980s. This field contains oil equivalent to one of the big Norwegian fields in the North Sea, around 1 billion barrels. The field has been developed with a single concrete structure fixed to the sea bed, which supports an integrated topsides structure. The platform will be capable of drilling and production, and contains living quarters for 220 people, while the concrete substructure acts as a storage facility for the oil being produced. Daily production could be as much as 150,000 barrels.
The Hebron field is about 350 kilometres east of Newfoundland and located in the path of the big icebergs which travel down from Greenland every spring and summer. Many years of records have shown that on average 30 icebergs a season enter the area where the Hebron platform has been installed. Some of these icebergs can be extremely large and cannot be redirected. This means that the structure must be designed to be strong enough to withstand the impact load of one of these icebergs. This amounts to a horizontal load as high as 150 tonnes/m2 across a significant part of the structure. The total impact load could amount to as much as 60,000 tonnes, which represents an iceberg of 3.1 million tonnes, moving at a speed of 0.7 m/s.

It was a requirement of the authorities of the province that a significant proportion of the engineering services and construction work had to be performed locally. The entire engineering design team operated out of St John's (capital of the province of Newfoundland and Labrador). Aas-Jakobsen, along with several other Norwegian engineering companies, contributed key personnel to form an experienced and highly-qualified team. Around half of the engineers were local staff with no experience from this type of structure. This meant that a great deal of training was required. Several challenges relating to leak-tightness, major ice loads and earthquakes had to be handled during the course of the project.

The GBS has only one large shaft (central cell) which will accommodate 52 big

Project name:
Hebron GBS

Project period:
2011-2015

Owner:
Exxon Mobile

Client:
Kværner

In brief:
Engineering design of concrete structure (GBS) fixed to the sea bed, strong enough to withstand large icebergs

Project size:
Water depth 93m, 130 000 m3 concrete, 45 000 tons reinforcement (350 kg/m3), 3 500 tons tension cables

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drill strings, in addition to a vast array of other outfitting and numerous steel pipes. A great deal of 3D modelling work was involved to handle the logistics needs and space requirements for all the disciplines. A further challenge was that walls and slabs contained many penetrations for all the different types of pipes, as well as embedded plates, and these often had to be located in many of the most congested areas. The GBS has seven storage cells for oil, which are positioned in a ring around the shaft. This resulted in a challenging geometry since it created several unconventional node points at which the various structural components connected to each other. These node points required local analyses and detailed calculations, and the geometry also created major challenges in order to find a simple, practical and effective reinforcement arrangement, particularly in view of the fact that in places, the reinforcement density could amount to as much as 1,000 kg/m3, often in addition to crossing tensioned cables.

The authorities imposed extremely stringent safety and environmental requirements on the structure, not least regarding leak-tightness. For example, they required the oil storage compartments to have double enclosing walls, so that if the outer wall were to crack, the oil in the storage cells would not leak into the ocean and harming the rich fishing banks in the area. The leak-tightness of the concrete walls was a recurrent theme in many project meetings and resulted in many advanced and non-linear analyses in order to find the right solutions and document a sufficient level of safety.

Despite the fact that many unforeseen challenges arose, these were effectively resolved through openness and communication, with the client being an active participant. This openness, respect and willingness to listen to the preferences and needs of everyone involved, from the client to the contractors, was considered to be an extremely important factor, and also enabled the client to become closely involved with the engineering design. During the entire engineering design period, the client expressed great satisfaction with this openness and with the work that was performed by the design team.