

The Hibernia Gravity Base Structure

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ABSTRACT

Hibernia Platform was installed on its final site, offshore Newfoundland, during the Summer 1997 where it has started to produce, treat, store and export oil. This is the first platform ever designed to resist the impact of drifting icebergs. This requirement explains some of the unique features of this reinforced concrete GBS. This platform is one of the most complex structure which has ever been engineered and built.

KEY WORDS: Offshore structure ; GBS ; Reinforced prestressed concrete ; Iceberg ; Newfoundland ; Hibernia.

INTRODUCTION

To resist or to dodge ? This is the fundamental question that oil companies operating in iceberg infested areas have to answer. Hibernia is the first oil field in the world for which the operator had 1) to decide whether it was at all feasible to develop oil production under the threat of a 6 millions tonnes drifting iceberg ; and 2) to select a production support either fixed and capable of withstanding the impact, or floating and agile enough to avoid the contact.

For many reasons, the operators of the field, first MOBIL OIL CANADA, then HMDC (Hibernia Management & Development Company), selected the fixed Gravity Base Structure option (GBS).

It has been widely reported that the Hibernia Platform has been installed during Summer 1997 at its final operation site, 315 km offshore Newfoundland. The two first wells were drilled and put in production before the end of 1997. Today, the oil storage tank integrated into the GBS has been filled and emptied several times, the crude treated on the platform Topsides facilities and exported by tanker. This is the start of a new story for the Hibernia Project, planned to produce 750 millions barrels of oil, and for Newfoundland as an oil producing province.

Some aspects of this project have already been presented at previous ISOPE conferences (Loh, 1991 ; Hoff, et al, 1994 ; Bjorlo, et al, 1996). This paper will describe some of the main features of the sub-structure, which is the most innovative part of the whole platform, the part conceived to resist the direct impact of the icebergs. The recent marine operations will also be outlined.

THE GBS CONCEPT

Further to the 1979 field discovery, MOBIL OIL CANADA decided in 1985 to choose a fixed bottom founded structure, rather than a floating system, to support the drilling and production equipment.

The main challenges to be taken up by the GBS designers were the following ones :

- a) provide a fixed and safe support for the topsides drilling and production equipment, by about 80 m water depth, this support being able to resist globally and locally to the forces produced by an iceberg impact and by waves action.
- b) provide a crude oil storage capacity of about 1 300 000 bbl (approximately 207 000 m³), the storage volume being always full of liquid at all times (crude oil or sea water), to limit the variation of apparent weight.
- c) provide enough buoyancy in order to be able to transport, from a Newfoundland construction site to the Hibernia field, the platform incorporating a 39 000 tonnes head load corresponding to the deck previously installed over the sub-structure, with a floating draft of not more than 75 m.

During the impact of a drifting iceberg against a body, the kinetic energy of the iceberg has to be dissipated either by crushing the ice, or by deforming the body, or by a combination of both. Many concepts were developed to offer different possible implementations of this principle, but it is MOBIL OIL CORPORATION with its 1983 patent (see reference) which proposed the apparently straight forward concept of a cylindrical caisson featuring "nose sections" (which, eventually, became teeth !) (Fig. 1).

During the bidding process, in 1989-1990, an alternative to the base case solution was developed by DORIS, incorporating the concept of "ice-belt" (Fig. 2). While the original cylindrical toothed ice wall was kept - although optimised, with a reduced number of teeth of different shape - the internal layout was totally modified. In the design finally selected, the external ice wall and a concentric inner "tie-wall" are linked together and stiffened by V-walls and X-walls to form a lace like structural element, well fitted to spread and transmit the high local pressures corresponding to the iceberg impact. The 16 teeth, with the 1.40 m thick ice wall and the supporting lattice structure form an efficient system for the transmission of these loads, both vertically (beam effect) and horizontally (loop effect).