ESCSI

FEATURED PROJECT 06-2003 STALITE

Hibernia Offshore Platform • Newfoundland, Canada

PROJECT
Hibernia Offshore Platform

CONSTRUCTION LOCATION
St. John's, Newfoundland, Canada

OPERATIONAL LOCATION
Jeanne d'Arc Basin, Hibernia Oil Field, Canada

OWNER
Hibernia Management and Development Company, Ltd.

CONCRETE ENGINEER
Mobile Oil Company, George Hoff

LIGHTWEIGHT CERAMIC AGGREGATE PRODUCER
Carolina *STALITE* Company Salisbury, NC

LIGHTWEIGHT AGGREGATE
Expanded Slate: *STALITE*

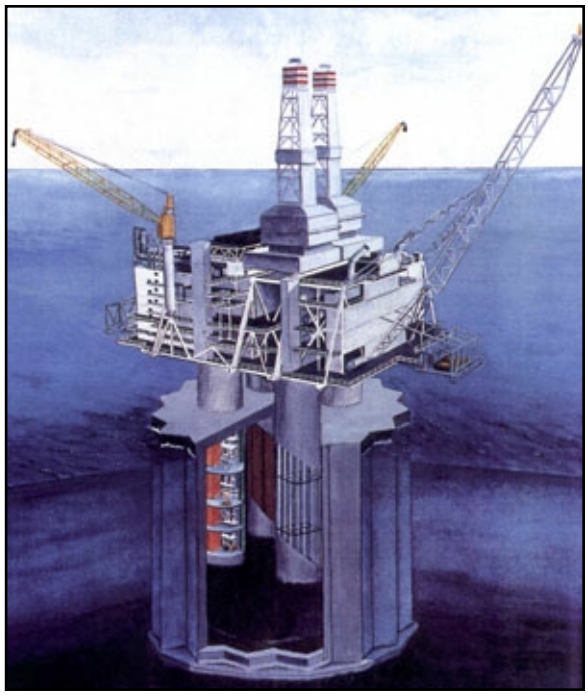
JOINT INDUSTRY RESEARCH
See the listing of companies involved in research and testing on page 4.

Wind Loads, Freezing and Thawing, Iceberg Impact, Ice Abrasion, Wave Action . . .

STALITE Reduces Weight, Yet Maintains the Strength and Durability to Meet the Rigorous Engineering Challenges of the North Atlantic

STALITE Lightweight Aggregate Addresses Durability, Performance, and Density Issues for Hibernia Project

The Hibernia Oil Field lies approximately 200 miles (315 Km) east-south-east of St. John's, Newfoundland, Canada. When an offshore platform was deemed necessary to tap this rich petroleum resource, serious challenges were faced by engineers and developers. The project had to meet a tight construction schedule while overcoming the problems of working in extremely cold weather conditions. The structure had to withstand the most severe environmental stress of freezing and thawing, ice abrasion, wind and wave action, and chemical attack. In addition, the giant structure was required to float, be towed to the site, and after placement, withstand the



Artist's cut-away view of completed platform in position in the Hibernia Oil Field

Remote construction site, Bull Arm, Newfoundland

impact of a 5.5 million ton iceberg. To satisfy the tough requirements, a reinforced Gravity Base Structure (GBS) was designed. Weighing more than 1.2 million tons, the Hibernia Offshore Platform is the largest floating structure ever built in North America.

PROJECT REQUIREMENTS

To satisfy the requirements of constructability, concrete production and placement, and durability, a 10,000 psi (69 MPa) normal density concrete was originally specified for this project. Among other characteristics, this concrete was to consistently have the following:

- **High strength**
- **High modulus of elasticity**
- **High tensile strength**
- **High resistance to freezing and thawing**
- **High workability and slump with no segregation**
- **Low permeability**
- **High pumpability**

To improve buoyancy of the GBS, it was later determined that a reduction of about 10% in the concrete density would be advantageous. The weight reduction had to be achieved without affecting the strength, durability and constructability spelled out in the original design. To achieve these objectives, approximately 50% (by volume) of the normal density coarse aggregate needed to be replaced with high-quality lightweight aggregate.

Pumping trials for long distance, high pressure, high workability concrete

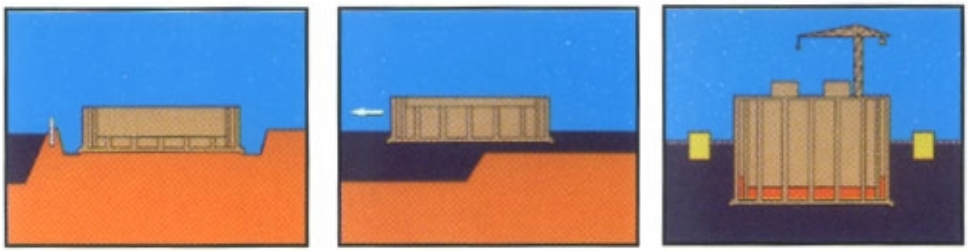
View of the massive, heavily reinforced “ice walls”

Tight schedule maintained by intensive round-the-clock construction of the GBS in “dry dock”

The GBS was floated and towed into a deep water harbor for construction completion.

FLOATING THE GBS

The base “raft” portion of the GBS was built in an earthen “dry dock.” By flooding the dock, the base raft was floated, towed to a deep water harbor area, anchored, and construction continued. Once completed, this floating giant was towed to the oil field site and set in place on the ocean floor in about 240 ft (80 m) of water. The GBS was designed to be maintenance free for its 30-year life.



1. Base in Dry Dock
2. Flood and Float
3. Deep Water Construction

Hibernia Offshore Platform 4

JOINT-INDUSTRY RESEARCH AND TESTING

The original research for the use of High Strength Lightweight Aggregate Concrete in Offshore Arctic applications was done as a joint-industry study funded by Mobil Research and Development Corp., Standard Oil of California, Exxon Production Research Company, Shell Oil Company, SOHIO Petroleum Company, Kajima Corp., Taisei Corp., Shimizu Construction Company, Takenaka-Kotem Company, Ltd., Hazama-Gumi, Ltd., and PC Bridge Company, Ltd.

Completed platform being towed to Hibernia Oil Field site in the North Atlantic

The actual testing work and project report preparation was done by ABAM Engineers, Inc., Construction Technology Laboratories, Inc., Wiss, Janney, Elstner, and Associates, Inc., Ben C. Gerwick, Inc., Mitsui Engineering and Shipbuilding/Kajima Corp., and Mr. Sal Calabrese of Rensselaer Polytechnic Institute under the guidance of ABAM Engineers, Inc, who managed the study. The study was done in three phases over a three and one-half year time period. (Published ACI SP-136, 1992, American Concrete Institute, PO Box 9094, Farmington Hills, Michigan 48333)

REDUCED DENSITY CONCRETE — Physical Properties

Fresh Properties*

Unit Weight	135.4 lb/ft^3	2,170 kg/m^3
Air Content	2.1%	2.1%
Slump	8.25”	210 mm
Water/Cement Ratio	0.33	0.33

Hardened Properties (28 Days)*

Compressive Strength	11,588 psi	79.9 MPa
Splitting Tensile Strength	851 psi	5.87 MPa
Modulus of Elasticity	4.4 x 10^6 psi	30.5 GPa
Poisson’s Ratio	0.22	0.22

* Reference: *The Use of Structural Lightweight Aggregate In Offshore Concrete Platforms*,. G.C. Hoff, R. Walum, J.K. Weng, R.A. Nunez, 1995

Reduced Density Alternatives (Tested) shown on Page 5)

REDUCED DENSITY ALTERNATIVES (Tested)

Mix ID	LWA, As A Replacement of Coarse Normalweight Aggregate	Unit Weight		Compressive Strength	
	(%)	(lb/ft^3)	(kg/m^3)	(psi)	(MPa)
LWC-2	100	126	2,020	10,281	70.9
LWC-7	75	134	2,140	10,861	74.9
LWC-8	50	139	2,230	11,484	79.2
LWC-9	25	145	2,320	12,731	87.8
LWC-6	-	150	2,410	13,021	89.8

Mix ID	Splitting Tensile Strength		Air Content	Elastic Modulus	
	(psi)	(MPa)	(%)	(psi x 10^6)	(GPa)
LWC-2	667	4.6	2.3	4.1	28
LWC-7	783	5.4	1.6	4.4	30
LWC-8	798	5.5	1.8	4.8	33
LWC-9	885	6.1	1.8	5.1	35
LWC-6	783	5.4	1.6	5.4	37

For Additional Information About Structural Lightweight Concrete or Other ESCS Applications

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