



CONCRETE GRAVITY PLATFORM IN SHALLOW OFFSHORE LOUISIANA WATER

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ABSTRACT

In June, 1978, the first concrete gravity platform was installed in United States Federal offshore waters.

Located off the Louisiana coast in Breton Sound Block 53, the structure rests in an approximate water depth of 12 feet on a totally submerged hull section used for oil storage. The platform contains a full range of oil and gas production facilities, auxiliary equipment, living quarters, and heliport. The remainder of the production complex consists of a well support structure and a vent structure, both of steel and connected to the platform by means of steel bridges.

The concrete platform was built in Port Bienville, Mississippi, then towed to Venice, Louisiana, where it was outfitted with all of the production and support equipment. Once equipped, the structure was towed to the site, installed on a shell mat, and secured with pin piles and rip-rap. Once the platform was in place the support structures and bridges were installed.

This paper will detail the design of the platform, tow of platform with and without equipment, site preparation, and installation of the entire production complex. The unique nature of the platform caused several problems in both design and construction.

This paper will discuss several problems of design, construction and operation of the concrete gravity structure.

Illustrations at end of paper.

INTRODUCTION

Atlantic Richfield purchased Lease No. OCS-G 3340 in the January, 1976, Department of Interior lease sale. This tract is located in Breton Sound area and is known as Block 53. The lease consists of 815 acres and the west boundary is the final decree line between federal OCS lands and the State of Louisiana. This area is on the east side of the Mississippi River Delta and is approximately 75 miles south of New Orleans. The water depth varies from 10 to 20 feet. The water depth at platform site is 12 feet. Figure 1 shows the location of the platform.

Atlantic Richfield drilled its first well using a posted style drilling barge in August, 1976. A total of eight wells were drilled with the last well being drilled in February, 1978. Six wells were completed out of the eight drilled. The wells were tested and shut in until production facilities could be constructed and installed.

A number of production schemes were reviewed and evaluated. It was decided that a single deck concrete structure with crude oil storage in the under-water base would be used. A contract was signed with Marine Concrete Structures in January, 1977, to design and construct a concrete gravity platform to meet Atlantic Richfield's specifications.

After the platform construction was completed in Marine Concrete's yard in Port Bienville, Mississippi, it was then towed to a contractor's yard in Venice, Louisiana, where the production and support equipment were installed. The platform was then

towed to the Breton Sound Block 53 installation site. This paper will describe the production facilities and discuss the design, construction, and installation of the concrete platform.

PRODUCING FACILITIES DESCRIPTION

The Breton Sound Block 53 platform is a complete production platform designed to produce 5000 BPD of oil, 2000 BPD of water and 10,000 MCFD of natural gas. The layout of the equipment is shown in Figure 2.

To meet the design criteria the platform is equipped with production and test separators to separate the oil and gas. Both separators are designed to operate from 100 psig to 1440 psig. The gas from the separators is compressed as necessary to approximately 1000 psig, then dehydrated and metered to a gas pipeline.

Water and oil from the separators are dumped to a free water knockout where oil and free water are separated. The oil is then dumped to a Chemelectric treater to break any water and oil emulsion and to dump pipeline quality oil to oil storage. The oil storage consists of three compartments in the lower hull of the platform. These underwater compartments will hold a total of 7800 barrels of oil. Each oil compartment is equipped with a shipping pump and a recirculating pump. The recirculating pumps pump oil back to the freshwater knockout and/or treater as necessary to reduce the water content of the oil to pipeline quality. The shipping pumps were designed for barge loading of the crude oil. After the platform was designed and under fabrication, an oil sales outlet by pipeline was found. All water from the free-water knockout and treater is dumped to a gas flotation style water clarifier.

Support facilities include a heliport, gas fueled generators, diesel fueled emergency generators, electric motor driven utility water pump, diesel engine driven fire water pump, and a crane. Also included are living quarters designed for four men on a limited basis, complete with a sewerage treatment unit. The platform is equipped with portable dry chemical fire extinguishers and personnel survival as required by the United States Coast Guard.

PLATFORM DESCRIPTION

The platform consists of a single elevated deck for production equipment and a base for flotation and storage. The elevated deck is constructed of reinforced concrete and measures 80' x 80', having a 3' wide galvanized steel grated walkway around the perimeter. The deck is located at elevation +38' -9" MLW and is designed for a live load of 1,000 psf for the deck area and 500 psf for the supporting beams and columns. Where the individual equipment weights and sizes dictate, even higher loads are encountered. The deck is supported by precast and prestressed concrete columns, tied into the top deck of the base with steel reinforcing dowels. The columns are 33" hollow octagonal sections constructed of 120 pcf density (semi-light weight) concrete. All concrete used in the structure has an ultimate compressive strength of 5,000 psi minimum. The columns support precast concrete waffle deck units measuring approximately 18' by

18' by 24" deep constructed of semi-light weight concrete. The columns, deck waffles, and beams are tied into one monolithic unit by casting in place a concrete topping which forms the finished deck. All the necessary weld plates and/or anchor bolts for the equipment are embedded into the deck.

The base measures 76'-11½" wide by 112'-3½" long by 13'-1½" deep. It was designed for an internal pressure head of 8' in the oil storage compartments, and a maximum crest elevation resulting from a 100 year design storm of 46.5 feet above the mudline, or approximately 3,000 psf crushing pressure. The storage area consists of precast panels joined to give a "honey comb" effect and, hence, the base's inherent strength. The top, bottom, and strength exterior walls are of cast-in-place semi-light weight concrete measuring 12" thick. The oil storage compartment is divided into three sections, two having a capacity of 3,250 barrels each, and one having a 1,300 barrel capacity. The latter serves as an overflow compartment from the two main compartments. The ballast compartment around the perimeter is constructed of cast-in-place concrete to minimize the construction joints.

Two intermediate height platforms are located at elevation +6' MLW on opposite corners of the base connected by a concrete walkway. These serve as a landing for boat access, although the boat landing itself is a self-supported pile structure adjacent to these landings. Concrete stairs connect the main deck with these intermediate decks.

Access into the storage compartments, vents, controls, etc. is provided by concrete snorkles to the +6' elevation. Access to the ballast compartments for ballasting and deballasting is similar snorkles with additional free flooding plugs and vents added in the top deck of the base.

PLATFORM CONSTRUCTION

During construction of the concrete platform two major problems surfaced. The first problem concerned honeycombed concrete. Most of the interior walls of the lower hull were precast and the outside walls of the lower hull were formed and cast in place. The exterior walls were heavily reinforced with wire mesh and steel rebar in both the horizontal and vertical planes.

Typical dimensions of the outside walls were 12 inches thick and 80 feet long and 13 feet high. In spite of the use of mechanical vibrators some honeycomb was found in the first exterior wall poured. All of this external wall was ultrasonically tested to determine the extent of the problem, then repaired by using an epoxy grout.

The problem was traced to the use of a plasticizer in the concrete and the close spacing of the reinforcing steel. The plasticizer is an additive which improves the fluid flow characteristics of the concrete. After this problem was discovered the plasticizer was eliminated and no further honeycomb was encountered.

Near the end of the platform construction phase another problem was encountered.

This problem was a deeper draft than the draft computed during design. This excessive draft significantly reduced the freeboard and consequently the stability of the platform during tow. Motion studies and static analysis indicated the stability of the outfitted platform would be inadequate for a safe tow around the seaward side of the Mississippi Delta. The decision was made to use additional flotation for the flow from the outfitter's yard in Venice to the platform site in Breton Sound Block 53.

The added flotation consisted of six 10' x 40' x 10' high steel tanks. The tanks were tied together to form two pontoons. Each pontoon was 10' wide and 120 feet long. A pontoon was installed on each side of the platform and the reactions from the pontoons were transferred to the platform by attaching the pontoons to four 30" piles bolted to the top of the lower hull of the platform. The thirty inch piling was selected since it was available and was to be used as anchor piling for the platform installation. After the pontoons were installed the platform was towed to location and installed. Figure 4 is a photograph taken of the platform under tow to the location.

To illustrate the significant change in stability of the concrete platform, a graph of righting moments versus angle of heel is shown in Figure 3. The area beneath the righting moment curve for an outfitted platform with no pontoons is seen to be approximately one-fourth of the area beneath the righting moment curve for the same outfitted platform with pontoons.

The righting moment curve for the bare platform with no production equipment on the upper deck is also shown in Figure 3. A conventional way to measure barge stability is to compare the overturning moment curve due to a 100 knot wind to the barge righting moment curves. The overturning moment due a 100 knot wind against the outfitted barge is shown in Figure 3. This overturning moment is significantly less than all righting moment curves. No additional flotation was added for the tow from the fabrication yard in Port Bienville, Mississippi, to the outfitter's yard in Venice, Louisiana.

SITE PREPARATION AND INSTALLATION

Two soil borings were taken at the platform site. The soil borings revealed that the ocean bottom had sufficient bearing to support the platform with minimal preparation. But during drilling operations a posted drilling barge was used and scouring of the ocean bottom under the barge was a problem.

To prevent scouring under the platform, the platform base is 5 feet below the mudline with a limestone rip-rap around the perimeter of the platform. To get the platform base 5 feet below the mudline the ocean bottom was excavated to a depth of 7 feet or 19 feet below mean low water. After the excavation was completed a two foot thick shell mat was installed. The platform was then towed and positioned above the shell mat. The ballast compartments were flooded and the platform settled into place. The pontoons were removed and the limestone rip-rap was installed around the perimeter of the platform. Figure 5 is an elevation drawing of the platform in place. Prior to completion of the shell mat the well protector structure

was installed. This structure is a steel jacket set around the wells and framed into the well conductors. The well head structure was the reference point for final positioning of the platform as a prefabricated bridge 86 feet long was installed between the well-head structure and the platform after the platform was in place.

After the platform was in place a steel vent support structure was set. Then a prefabricated vent bridge complete with vent boom and piping was installed. Figure 6 is a photograph showing the entire facility.

REGULATORY REQUIREMENTS

A number of governmental agencies are involved in any offshore field development and facility installation. Normally the agencies from which permits and approvals are required are Bureau of Land Management (BLM), Corps of Engineers (CE), Environmental Protection Agency (EPA), United States Geological Survey (USGS) and United States Coast Guard (USCG). Since this was to be the first concrete gravity structure in federal waters, some of these agencies asked to be included in the design efforts earlier than usual for an offshore facility.

The oil and gas lease was acquired from the BLM which granted Atlantic Richfield the right to explore and develop. A permit was obtained from the Corps of Engineers to install structures, drilling rigs or pipelines necessary to develop and produce oil and gas. This permit required amending to allow for dredging necessary to get the concrete barge on location and dig the hole for its final installation.

A discharge permit was filed with the EPA in March, 1976, for drilling and producing operations. The USCG permit application was filed in November, 1977, which dictated the required navigational aids, personnel safety equipment and fixed the position of this facility.

The final application was submitted to the USGS for approval in March, 1978. As a part of this application, two soil borings were taken at the platform site to depth of 130 feet to determine soil conditions. These borings showed that the soils were competent and would support the structures without any problem. Analyses of these cores were included in the applications. A survey was made of all the concrete structures in use along the Gulf of Mexico. This survey showed that all of these were in inland waters and had operated without major problems for many years. These data were made a part of the application.

Since this site is in what is classified as open waters that are subjected to deep water waves and storms without any protection by barrier islands or shell reefs, a study was made to determine maximum sea states. Based on this data, the production deck was designed to be approximately 38 feet above sea level.

The production equipment and its controls were all designed and installed in accordance with OCS Orders No. 7 and 8 along with API RP 14C. These rules

establish definite guidelines which must be followed.

Obtaining approvals from the USGS prior to installation and before start-up did not delay the project in any way. This was primarily a result of preliminary contacts with this agency. These contacts allowed preparation of all the required data prior to submittal of the application.

SUMMARY AND CONCLUSIONS

The Breton Sound Block 53 production facility was the first concrete gravity platform to be installed in the United States federal offshore waters. At the time of its installation, it was also the largest such structure that had been built. Although problems in construction and installation created some delays and increased the costs they were solved.

There were no major problems in obtaining approvals from the various governmental agencies. This is

directly attributable to close contact with the agencies during design, construction, and installation phases of this project.

The facility is in operation and is performing in a satisfactory manner. It is expected that maintenance costs of the structure will be much less than for a steel structure. This project has shown that concrete gravity structures are an acceptable alternative to more conventional steel structures in open waters on a limited basis.

ACKNOWLEDGMENTS

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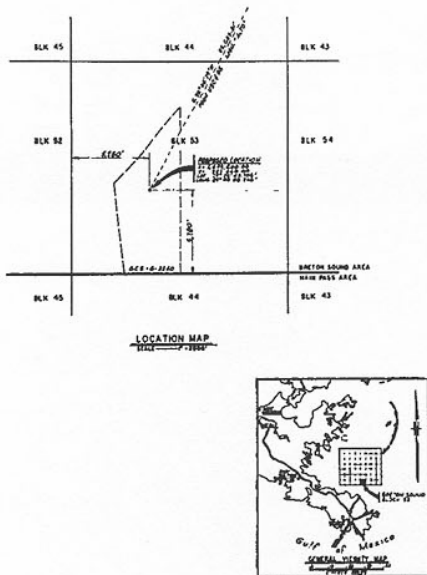


Fig. 1 - Map showing platform location.

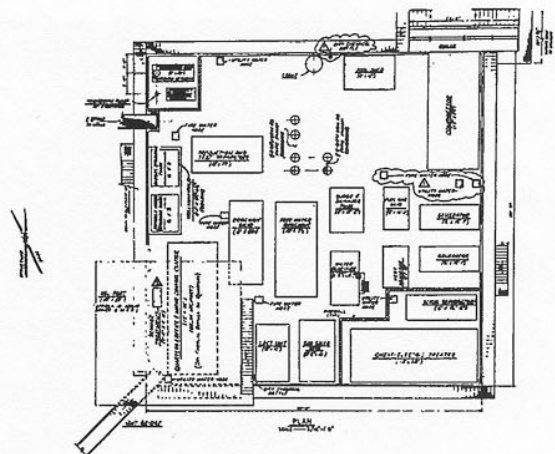


Fig. 2 - Plan view of equipment layout.

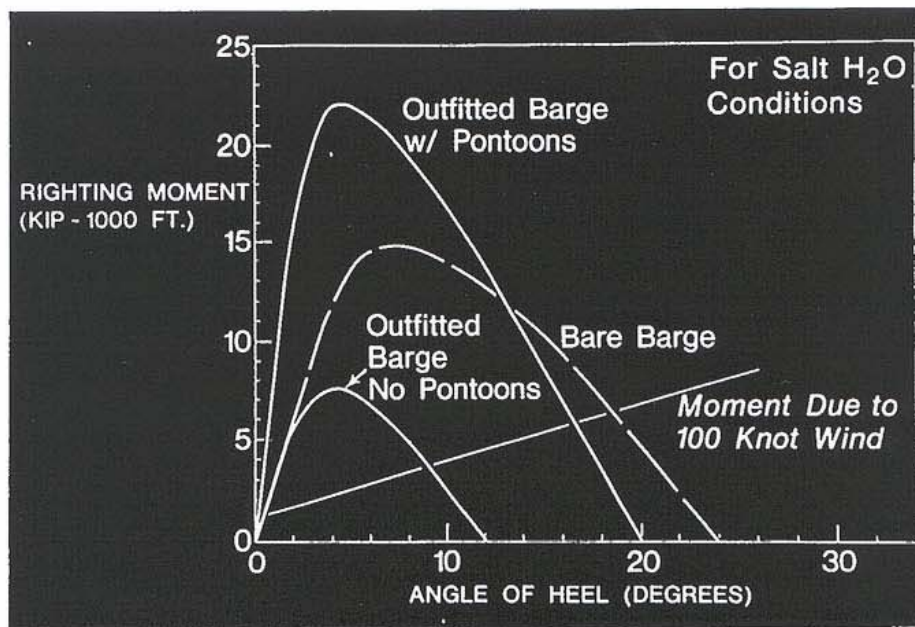


Fig. 3 - Righting moment versus angle of heel.

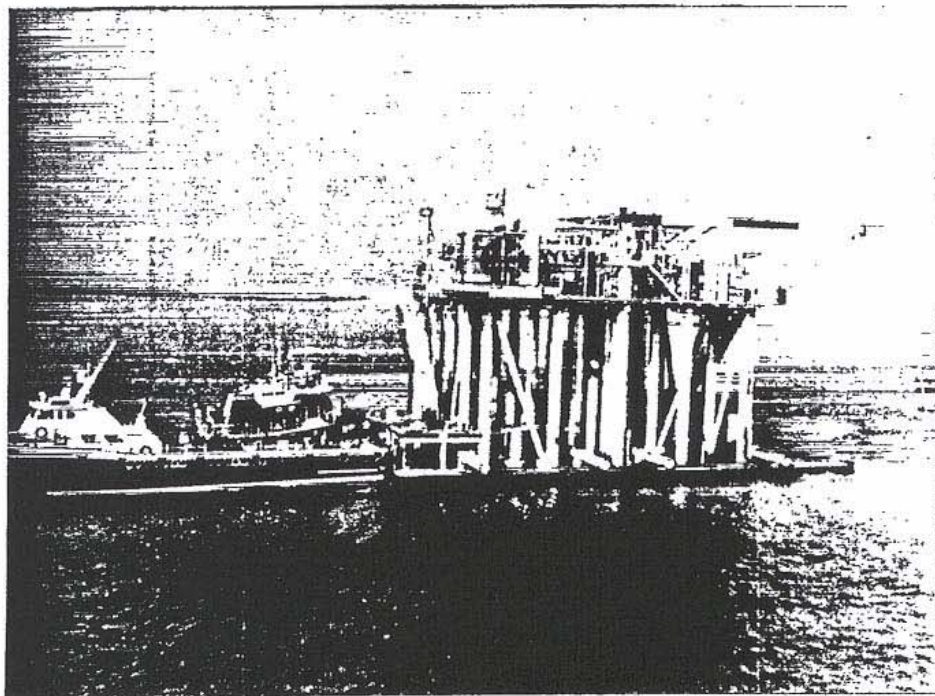


Fig. 4 - Platform under tow to location.

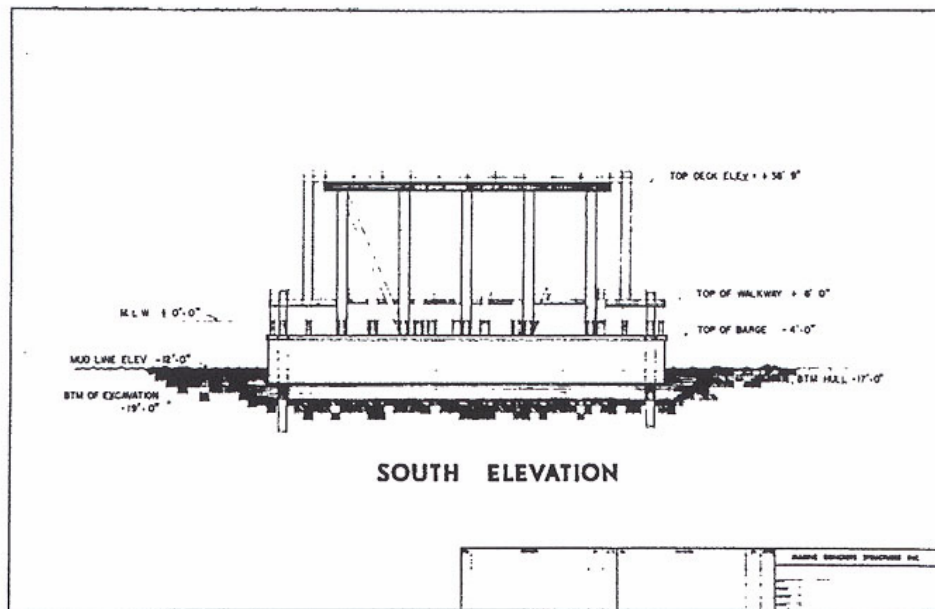


Fig. 5 - Elevation drawing of the platform in place.

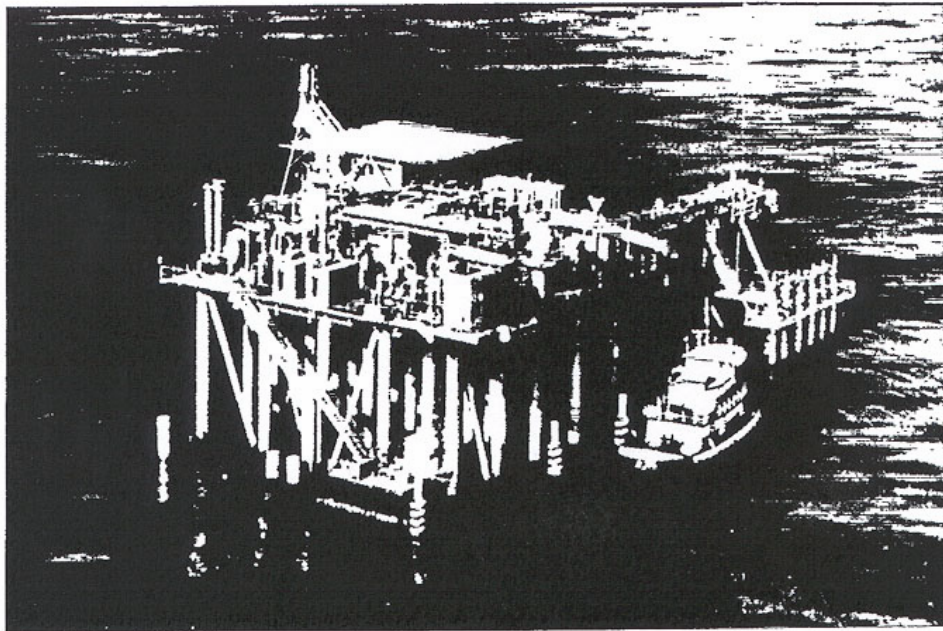


Fig. 6 - Photograph of the complete facility.