Load-out Operation of South Pars Gas Field-Phase 1 Production Platform in the Persian Gulf

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Abstract-**In this paper load-out operation of SPP1 production platform will be reviewed. The main items which will be discussed are mooring, push/pull and ballasting systems. Mooring system is used for aligning the skid beams of the barge and skid beams of the heavy platform area. The required tension of the wire ropes is determined, based on the information about speed of tidal current and also wind. The Push/Pull system is used to pull the heavy platform from the yard to the "SADRA FLB-124" work barge. Because of limitations on minimum breaking load of the wire ropes and also load capacity of the bollards, pulling cylinders must be located on the barge. PLC based Ballasting system is used to keep the barge horizontal and also in an appropriate level. The main effects that have been considered in the modeling of the load-out operation, are load movement and also tide. The main computer software was developed using MATLAB 5.3.1 R11, but it was translated to C^{++} language for better calculation speed and more compatibility.**

NOMENCLATURE

D	draft of the barge
H	heel
T	trim
W	water depth
g	gravitational acceleration
ϕ	angle of wind direction to ship's centerline
A_c	area of the underwater part of the barge projected on a plane perpendicular to the direction of the current
A_w	laterally projected area of ship's above water
B_w	front area of ship's above water
C_c	current force coefficient
C_w	wind force coefficient
F_c	current force
F_w	wind force
M_x	total moment about x axis
M_y	total moment about y axis
V_c	velocity of the current
V_w	velocity of the wind
W_B	total weight of the system
W_{const}	constant load (structural, equipment, oil tanks,…)
W_{ext}	external load
W_o	total buoyancy force
W_{wb}	weight of ballasting water
X_B	longitudinal position of the total weight of the system
X_{const}	longitudinal position of constant load
X_{ext}	longitudinal position of external load
X_o	longitudinal position of the total buoyancy force
X_{wb}	longitudinal position of ballasting water
Y_B	transverse position of the total weight of the system
Y_{const}	transverse position of constant load
Y_{ext}	transverse position of external load
Y_o	transverse position of the total buoyancy force
Y_{wb}	transverse position of ballasting water
γ_c	specific gravity of the water
γ_w	specific gravity of the air

INTRODUCTION

In recent years the development plans of the oil and gas fields in the Persian Gulf have required the installation of heavy offshore decks to meet the production requirements of those fields. These decks vary in size and geometry according to the type of services they are intended for. The South Pars Gas Field Development has been conceived for the exploitation of gas and condensate reservoirs located in the Iranian sector of the Persian Gulf and will be capable to produce and process 327.7 $m^3/\sec$ (1000 MMSCFD) of the reservoir fluid. The offshore complex comprises five platforms namely, SPD1 wellhead platform, SPD2 satellite wellhead platform, SPP1 production platform, SPQ1 living quarters platform and SPF1 flare platform. The production platform SPP1 forms the center of the development complex, and has a weight about 7000 metric tonnes and plan dimensions of 36m$\times$35m. The structure comprises 2 vertical trusses running N-S, and 3 trusses E-W, with plate girders forming the primary structure for the decks [1]. This paper provides details on the procedure and equipment for loading out the platform from the fabrication site to the proposed floatover and launch barge; "SADRA FLB-124".

For this purpose a "Load-out Support Frame" located on the yard skid beam, bears at 6 strong points at the bottom of the platform and for uniform stress on the yard skid beam, wooden shock absorbers are used. The main components for executing of a load-out operation are: work barge, mooring system, push/pull system and ballasting system. Load-out procedure consists of 3 activities: a) aligning the skid beams of the barge and skid beams of the heavy platform area, using mooring system, b) pulling the heavy platform from the yard to the work barge, using 1000 metric tonnes capacity push/pull jacks, c) keeping the deck of the barge horizontal and in a determined level, using ballasting system [1]. This paper covers a brief description of the mentioned systems in 5 sections. At first section we will review main specifications of the work barge, after that mooring system that plays an important rule in a successful load-out operation, will be described in the second section. Third section presents specifications of push/pull system and sliding surface. In the fourth section automatic ballasting system and the related dynamical model will be demonstrated and finally in the last section, load-out, transportation and floatover installation of heavy offshore topsides will be explained.

"SADRA FLB-124" FLOATOVER AND LAUNCH BARGE

The barge has been designed for load-out, transportation and installation of heavy deck platforms up to 10000 metric tonnes, and also load-out, transportation and launching of jackets with a maximum weight of about 6000 metric tonnes. The barge is capable to install the topsides with FLOATOVER method. The barge is non-propelled, constructed in mild steel, with rake in fore part. Principal data of the "SADRA FLB-124" floatover and launch barge are summarized in Table 1.

TABLE I
PRINCIPAL DATA OF THE "SADRA FLB-124" FLOATOVER AND LAUNCH BARGE [1].

Length (moulded)	124 m
Breadth (moulded)	30 m
Depth (moulded)	8 m
Design Draught	6.132 m
Dead Weight	17200 tonnes
Gross Tonnage	7960 tonnes
Distance between Skid Beams	14 to 24 m
Height of Skid Beams	1.3 m
Permissible Load on Skid Beams, in the first 20 m	240 tonnes/m
Permissible Load on Skid Beams, after first 20 m	150 tonnes/m
Distributed Deck Loading	15 tonnes/m^2
Jacket Launching Capacity	6000 tonnes
Topside Floatover Capacity	10000 tonnes
Number of Ballast Tanks	23 Nos.
Ballast System Capacity	4800 m^3/hr

The main components of mooring system on the barge are as follows: 2 diesel-hydraulic double drum anchor/towing winches with 50 tonnes nominal pull and 90 tonnes brake holding force, 2 eight tonnes SSHP anchors, 3 electro-hydraulic double drum mooring winches with 25 tonnes nominal pull and 70 tonnes brake holding force and removable for various configurations during different floatover operations, wire rope sheave blocks and fairleads, and 12 bollards with 40 tonnes capacity for each [1].

4 ballast pumps with 1200 m^3/hr flow rate and 15 m head, 2 manifolds, 2 electro-hydraulic units for actuation of valves, 45 butterfly hydraulically actuated valves, 23 ballasting tanks and related PLC control system have the duty of transferring about 22422 m^3 of ballasting water [1].

The control and monitoring facilities are: PLC based control system for automatic load-out and floatover installation operation, central control console for automatic or manual ballast operation, optional fully manual ballast operation, centralized computer based monitoring system for checking all instrumentation and operations, monitoring of control valves and ballast pumps and pipelines, laptop as remote control and monitoring station, and CCTV system for monitoring of load-out and floatover operation and machinery spaces [1].

The instrumentation consists of : hydrostatic pressure transmitters for continuous level monitoring of ballast tanks and draft measurement, level switches for high and low level sensing and leak detection, ultrasonic distance transmitter for non-touch measuring of barge vertical displacement with reference to quay, inclination transmitters and inclinometers for barge trim and heel measurement, linear and angular acceleration transmitters for barge acceleration measurement in all 6 degrees of freedom, echo sounder for sea depth monitoring, wind speed and direction transmitter and monitor, portable laser targeting range finder for sounding of ballast tanks Gyrocompass and portable GPS for barge positioning [1].

MOORING OPERATION

The barge positioning and mooring arrangement has been shown in figures 1 and 2. The barge is moored/positioned by 14 lines and one tug boat. At first barge is positioned along the yard skid beam regarding to the schedule of load-out, and ballasting is done according to ballasting procedure. Two electronic teodolites control barge position continuously. Two indicators on the barge and one reference point on the land is used for this purpose. For barge displacement control due to wind and current forces in emergency cases a tug boat is used. At normal situation the connection between barge and tug boat is slack, and due to receiving any order from authority person, the tug boat starts maneuvering [1].

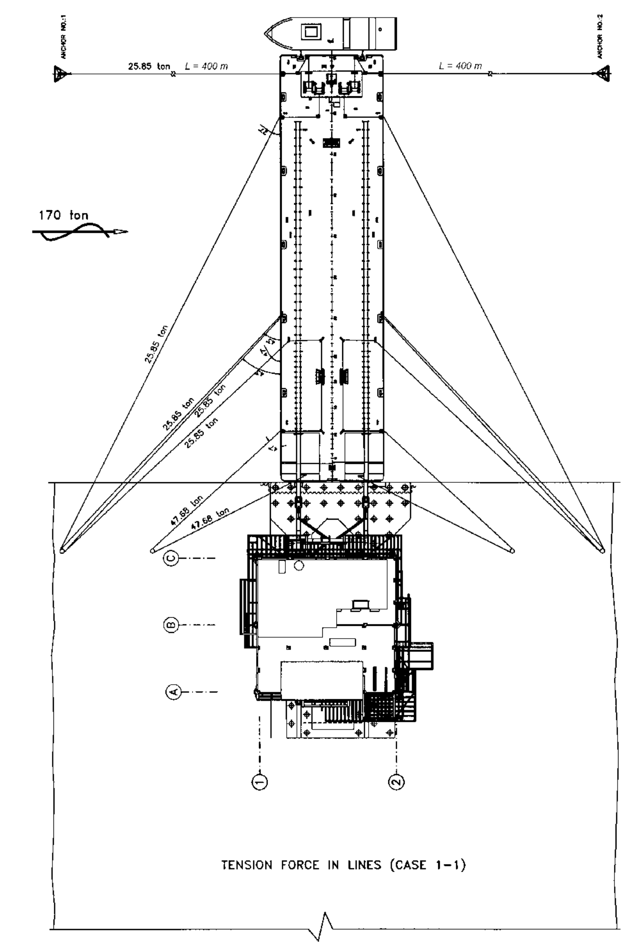

Fig. 1. Final mooring arrangement for load-out operation [1].

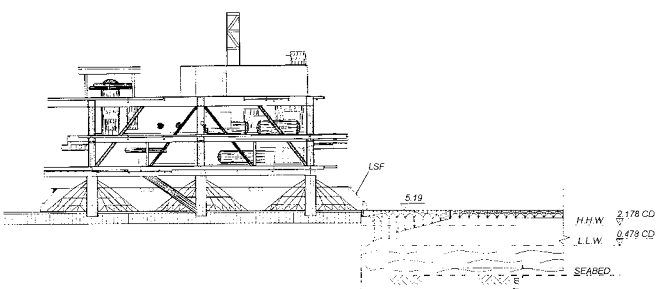

Fig. 2. Important levels at commencement of load-out operation [1].

Wind velocity 13.7 m/s (10 m above sea level) and current velocity 1.02 m/s and the load-out jetty characteristics which have been shown in Table 2. were considered for calculating tension of wire ropes during load-out operation. Wind force is calculated as follows [2]:

$$F_w = C_w \left(A_w \sin^2\phi + B_w \cos^2\phi\right)\gamma_w V_w^2 / 2g \qquad (1)$$

Wind is supposed to be cross wise to the body, hence C_w=1.3.

The important hydrodynamic effects on the bodies that are submerged in a fluid, are profile drag, shear drag, added mass, buoyancy and fluid acceleration [3,4]. In this case the most important effects are buoyancy and drag force due to current. Current force is calculated as follows [2]:

$$F_c = C_c A_c \gamma_c V_c^2 / 2g \qquad (2)$$

For calculating C_c, the following formulae is used [2]:

$$\begin{aligned} W &= D && \Rightarrow \quad C_c = 6 \\ W &= 1.5\times D && \Rightarrow \quad C_c = 3 \\ W &= 2\times D && \Rightarrow \quad C_c = 2 \end{aligned} \qquad (3)$$

TABLE II
LOAD-OUT JETTY CHARACTERISTICS [1].

Load-out jetty level	+3.2 m CD (Chart Datum)
H.H.W.	+2.178 m CD
L.L.W.	+0.478 m CD
Max. tidal zone	1.7 m
Yard skid beam level	5.2 m CD
Highest water on load-out date (29th Aug.)	1.7 m CD on 1:00 am
Lowest water on load-out date (29th Aug.)	1.00 m CD on 5:48 am

It should be noted that the current velocity was assumed the maximum value in the August, but regarding to the load-out day and load-out time schedule, the maximum current velocity was about 0.4 m/sec. Tide and current speed forecast at the area that load-out operation was occurred, on 29th August, have been shown in Fig. 3 [1].

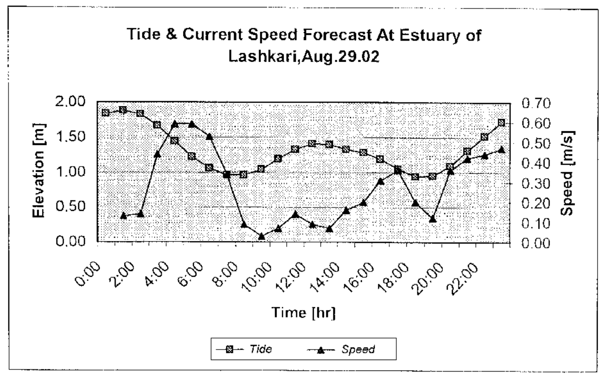

Fig. 3. Tide and current speed forecast at Estuary of Lashkari on 29th August [1].

The contact area between barge and quay wall, is a wooden block with section dimensions 900mm × 1000mm and thickness 100 mm. By considering modulus of elasticity $E = 11.2\,GPa$ for wood, normal stiffness of the contact point is derived about $k_n = AE/l = 100.8e9\,N/m$. To compute shear stiffness, because of special shape for wooden block, we neglect bending deformation effects against shear deformation effects, therefore shear stiffness by considering shear modulus of about $G = 4.48\,GPa$ for wood, is calculated about $k_s = 5/6\,AG/l = 33.6e9\,N/m$. The coefficient of friction at the lubricated contact areas is assumed to be about 0.2. The maximum transversal force of about 1703.8 kN due to wind and current was exerted on the barge, for driving the optimum arrangement of mooring lines. The load was considered as an external force with uniform distribution on the barge. Analysis of mooring was carried out by ANSYS 5.4 software, in which the barge was modeled as a plane element with rigid state, the wires were considered as link element with uniaxial tension only feature by regarding pretension ability, contact element which represents two surfaces that may maintain or break physical contact and may slide relative to each other was used for modeling the contact area and nonlinear analysis was developed. Different control cases with various wire rope tension and also mooring configuration, were assumed, and finally the mooring line arrangement that has been shown in Fig. 1, was preferred. Since the maximum displacement of the barge in current direction is under 8 mm, it is clear that this case could be recommended as a good option. It should be mentioned that, at load-out date, because of appropriate environmental conditions, anchor lines were not used. As it is shown in Fig. 1, the mooring system without anchor line is a definite system, and it can be solved without computer [1].

PUSH/PULL SYSTEM AND SLIDING SURFACE

The 300 tonnes/m capacity skid beam of the yard has been designed to be used for all of the platforms skidding, up to the capacity of the Heavy Platform Area (HPA). The main goal of designing of this skid beam is to have very small deflections on the skid beam surface in order to reach to the minimum frictions at the skidding time.

The 51 m length Load-out Support Frame (LSF) has been designed to support SPP1 topside during load-out at 6 bearing points. LSF plates include of main web plates, bearing plates, flange plates, stiffener plates and main plate girder. For uniform stress on the yard skid beam, LSF is located on the timbers which are on the yard skid beam. LSF guiding system has been designed to cancel racking force during load-out operation.

For skidding purpose Push/Pull system is used. Yard skid beam, LSF and push/pull system have been shown in Fig. 4 [1].

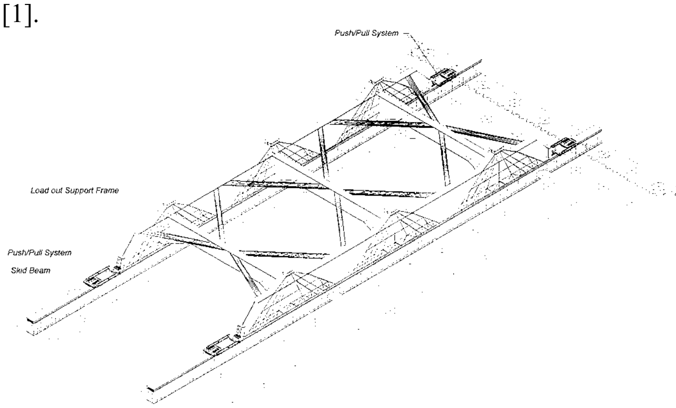

Fig. 4. Yard Skid Beam, Load-out Support Frame, and Push/Pull System [1].

Push/pull system consists of two units, one on each skid. Both skidding units are operated simultaneously by the power pack. Each system includes two cylinders which are mutually connected and operate in parallel. Each skidding unit is fitted with two gripper body halves, one at each side. The clamping force is exerted hydraulically by a number of identical gripper jacks. The total clamping stroke is 15 mm, which is normally sufficient to cover skid beam fabrication tolerances. For best performance of the skidding units the skid jack rod eyes must be connected to a swivel plate construction. The swivel plate must be equipped with an auxiliary jack, which can fixate swivel plate to the skid beam when skid jacks are operated to return stroke. At the start of moving the platform on the yard skid beams, which is called "Break Out" operation, the maximum push/pull force is required. Normally at break out operation the push jacks in the back of load-out support frame push the LSF on to the quay side. If movement needs to the extra force, the pulling jacks in the front of the load-out support frame can pull the module on the movement direction. By monitoring the pressure of the push/pull jacks, It will be seen that pressure will decrease after initial break out. The operational sequence of the system, which is shown in Fig. 5, is as follows: a) clamp grippers, b) extend (or retract) the skid jacks, moving the module over one skid jack stroke, c) release grippers, d) retract (or extend) the skid jacks to move the gripper to a new anchor point [1].

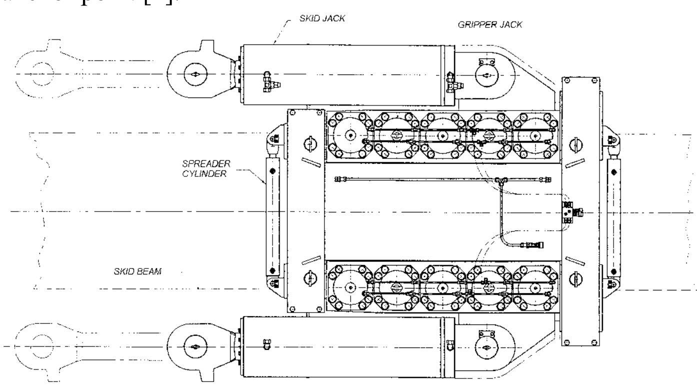

Fig. 5. Top view of skidding unit [1].

It should be noted that sliding surfaces will be shock absorber pads (Teflon pads) on steel tracks lubricated with multicoated grease with friction factor of 0.1 or less.

BALLASTING SYSTEM AND DYNAMIC MODELLING OF LOAD-OUT OPERATION

The barge is equipped with its own ballasting system to reach the effective ballasting capacity of 4800 m^3 / hr. All the tanks are equipped with remote sounding devices. A computer is used to calculate total ballast, barge displacement, loads transferred with the corresponding COGs. Ballast operation is remotely controlled from the main control console by controlling the butterfly hydraulic piston actuated control valves and ballast pumps provided for this purpose. The ballasting pumps gather the water on 2 manifolds, and only opening and closing the valves will do the ballasting and/or de ballasting of tanks. Arrangement of the ballast tanks has been shown in Fig. 6.

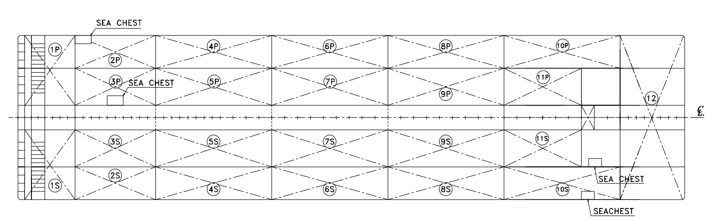

Fig. 6. Arrangement of the ballast tanks [1].

Ballasting operation is done in 2 stages: barge ballasting for leveling the barge with the jetty (before start of load-out), barge ballasting during load-out. During load-out, by transferring the load on the barge, positive buoyancy is produced in the barge. This activity will be done up to completion of the load-out operation. After executing of each step of load transfer, the control system checks the heel, trim and leveling status of the barge and if they are as the preset values, next pulling operation will be permitted. In each movement, after the load transferring on the barge, operator will enter the length of the load that has been transferred on the barge to the ballasting computer system. At next stage the control system computes the required ballast for compensate deviations of heel, trim and deck level from the appropriate value, due to load transferring. For computing the required ballasting table, the control system uses the load characteristics. The load specification is preprogrammed in control system memory. The ballasting information is collected in a table which contains the information of ballast level in all ballast tanks versus different length of load transferred. The ballasting system will measure ballast level in ballast tanks via level transmitters, and according to the ballast table, ballasting or de ballasting of the tanks will be done automatically. Above procedure will be repeated at each stage, up to heel, trim, and relative level of the barge adjusted to the zero respectively. The control system, provides appropriate volume of water for each tank, based on the dynamic model of the load-out operation, which the effects of load movement and also tide have been considered in it. Because of the important effect of the tide on the load-out operation tide is monitored to compare with predicted tide prior to proposed load-out. The effect of the tide on the barge is shown by an instrument (Reference Level Sensor) that is located between barge and quay. Ballasting system program is able to compensate this effect on the barge automatically [1].

The software which will be used in the control system during load-out operation should have the ability to adopt with the environment while minimizing disturbance and model uncertainties to achieve satisfactory results. In the other words, it is a must to consider and minimize all of modeling errors and disturbances, so the software should include an adaptive error decreasing structure. The software which is written under MATLAB, is used to automatically control load-out and floatover operations in a variety range of external load and real conditions. It should be noted that the dynamic and control analysis can be run only on geometrical and mechanical conditions of "SADRA FLB-124" work barge. To gain from this strategy for other barges, the program should be adopted with the parameters of proposed barge. Because of linearization of the equations and also some other assumptions, this software can not be used for launch procedure, which include large amount of trim (over 20 m in 120 meters length of the barge). The software simulator is prepared to simulate both geometrical variables like trim, heel and draft alignment and also mechanical strength parameters like bending moment, torsion moment and shear load distribution. Simulation results show that under the conditions during load-out or floatover the barge is easily controlled and regulated around equilibrium point or tracks the desired parameter. The dynamic relations needed for controlling the barge are derived based on Newtonian equilibrium law, assuming quasi-static conditions during load-out and floatover and a little change in state variables to simplify trigonometric relations. According to Fig. 7, and applying Newton's second law, the following equations will be derived [1]. (It should be noted that the usual Global Coordinate System, which is used in marine operation is NED (North, East, Down) coordinate system and direction of z axis of global and local coordinate system is same as gravity direction [2]).

$$
\begin{aligned}
&W_B = W_o \\
&M_x = W_o\left(Y_B - Y_o\right) \\
&M_y = W_o\left(X_B - X_o\right)
\end{aligned}
\tag{4}
$$

In which, W_B consists of the weight of the barge, ballasting water inside the tanks and external load (from the topside) [1]:

$$
\begin{aligned}
&W_B = W_{const} + W_{wb} + W_{ext} \\
&M_x = W_{const}\left(Y_B - Y_{const}\right) + W_{ext}\left(Y_B - Y_{ext}\right) \\
&\qquad + \sum W_{wb}(i) \times \left(Y_B - Y_{wb}(i)\right) \\
&M_y = W_{const}\left(X_{const} - X_B\right) + W_{ext}\left(X_{ext} - X_B\right) \\
&\qquad + \sum W_{wb}(i) \times \left(X_{wb}(i) - X_B\right)
\end{aligned}
\tag{5}
$$

In which, i represents number of ballasting tank. Also X_B and Y_B are calculated as follows [1]:

$$
\begin{aligned}
&X_B = \frac{1}{W_B}\begin{pmatrix} W_{const}\,X_{const} + W_{ext}\,X_{ext} + \\ \sum W_{wb}(i) \times X_{wb}(i) \end{pmatrix} \\
&Y_B = \frac{1}{W_B}\begin{pmatrix} W_{const}\,Y_{const} + W_{ext}\,Y_{ext} + \\ \sum W_{wb}(i) \times Y_{wb}(i) \end{pmatrix}
\end{aligned}
\tag{6}
$$

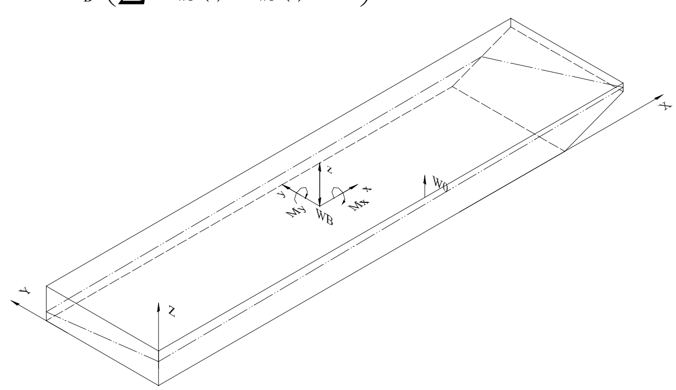

Fig. 7. Barge coordinate definition and load distribution (-.- is water surface) [1].

With reference to the above equations and based on the specifications of the work barge, the state space equation of the system will be as follows [1]:

$$
A\,X = B \tag{7}
$$

In which A and B are functions of geometrical and mechanical specifications of the system including dimension of the barge, dimension and position of the tanks, structural weight, ballasting water weight, magnitude and position of external load and also tide conditions. X is a 3×1 matrix and contains the draft, trim and heel of the work barge [1]:

$$X=\begin{pmatrix}D & T & H\end{pmatrix}^T \qquad (8)$$

Therefore the steady state situation of barge can be achieved if ballasting loads $W_{wb}(i)$ are determined as control inputs. Equation (7) shows that the mentioned analysis is performed in steady state condition. This assumption remains valid while the whole ballasting operation was perform in quasi-static situation. By the way, it should be considered that (7) is not a linear equation, because the coefficients A and B are dependant to control values in a complex nonlinear manner. So, an absolute algebraic solution can not be achieved to control this dynamic. One can show that by addition of numerical iterative methods, it is possible to yield an algebraic solution for controlling procedure by decreasing the number of independent control inputs. By knowing the magnitude and position of the loads (external load and ballasting water), it is possible to calculate bending, torsion and shear stress on the structure of the barge. In figures 8, 9, 10, 11 and 12, load distribution on the barge, and related shear load, bending moment and buoyancy force have been shown for different steps of load transfer.

The critical cases gathered in 3 groups. First, the barge without any load is focused and analyzed in the boundary tidal condition. In the time period for SPP1 load out, the tidal boundaries are +0.7mCD and +2.2mCD. Results related for these cases have been presented in figures 8 and 9. Then, the barge with SPP1 topside on it is considered. In this case, the external load is placed at the aft end of the barge. In the other words, this case is yielded when the load is moved aboard barge and there is not any contact between load and jetty, but the load has not been moved (positioned) to its final situation. In this case, results in both drafts 4.8m and 6.3m are focused and presented in figures 10 and 11. The last group occurs when the barge is ready for transportation with desired draft and trim and fixed topside with proper seafastening. Related analysis for longitudinal strength has been shown in Fig. 12. The load distribution of the SPP1 topside on the skid beam of the barge at its final position has been shown in Fig. 13.

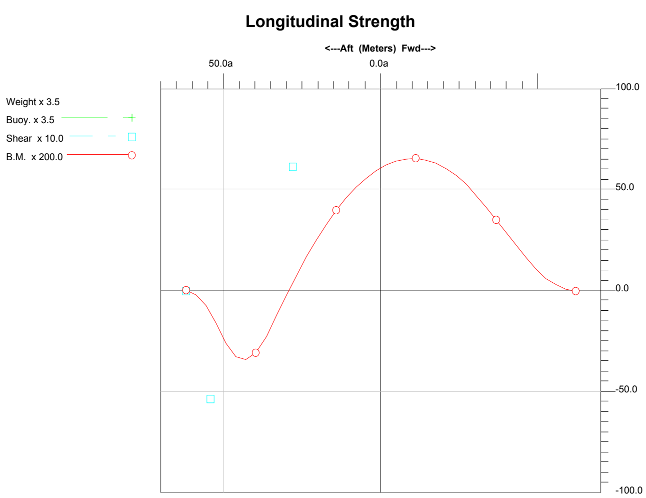

Fig. 8. Load distribution, buoyancy force, shear force and bending moment on the barge, at 4.8m draft without external force.

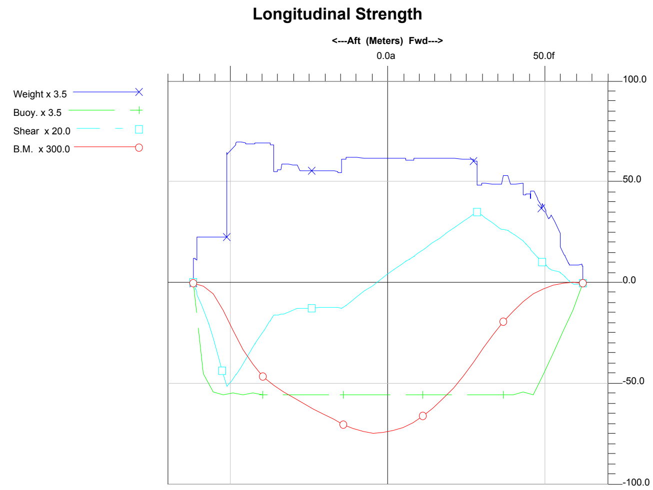

Fig. 9. Load distribution, buoyancy force, shear force and bending moment on the barge, at 6.3m draft without external force.

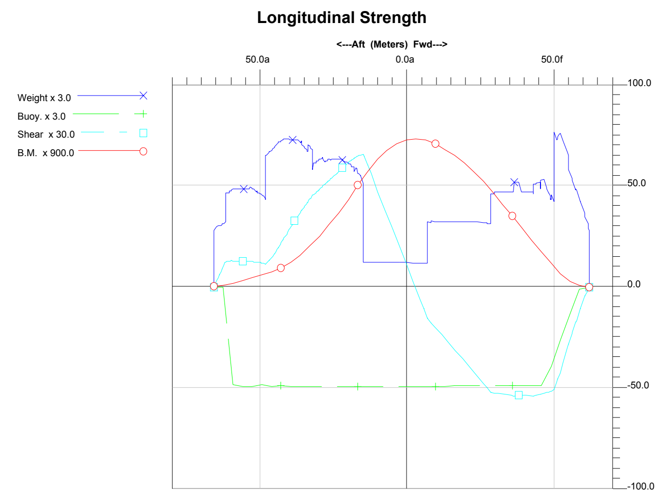

Fig. 10. Load distribution, buoyancy force, shear force and bending moment on the barge, at 4.8m draft considering the load of the SPP1 topside on barge aft.

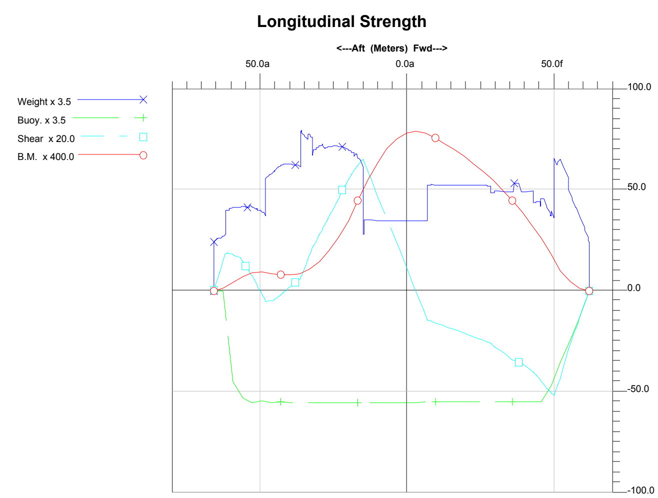

Fig. 11. Load distribution, buoyancy force, shear force and bending moment on the barge, at 6.3m draft considering the load of the SPP1 topside on barge aft.

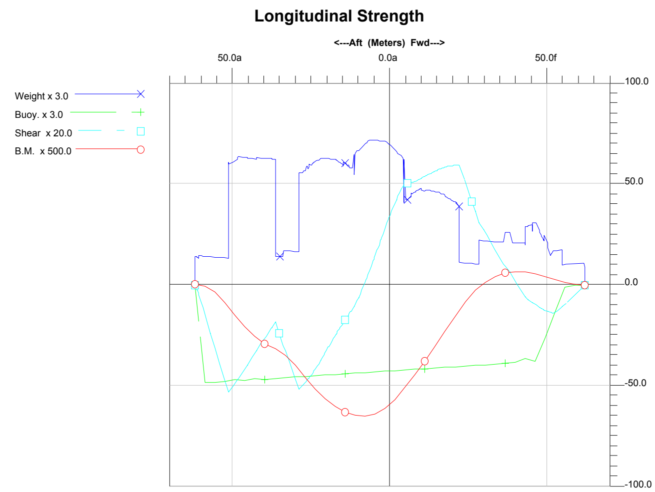

Fig. 12. Load distribution, buoyancy force, shear force and bending moment on the barge, for SPP1 topside at final position and ready for transportation.

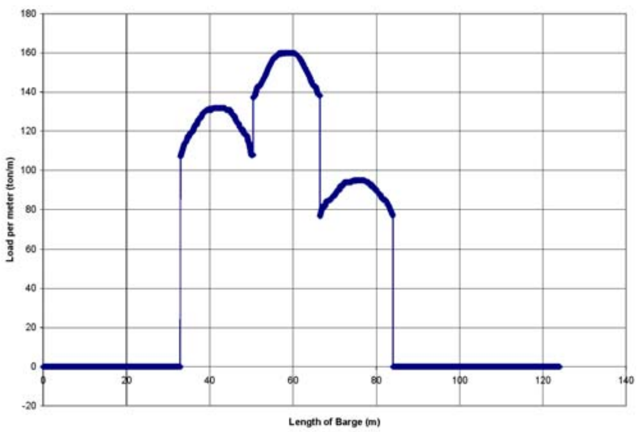

Fig. 13. Load distribution of SPP1 topside at final position.

Since the maximum allowable bending moment on the barge is 105000 MTon.m, the transportation allowable bending moment will be 45000 MTon.m (the dynamic effects of transportation is considered and will decrease the maximum allowable bending moment amount in still water condition). Also the maximum allowable shear load is 3450 Mton and for transportation allowable shear load is 2480 Mton. Results show that the maximum bending moment and shear load in still water are 63% and 57% of their maximum allowable amount respectively. Besides for transportation, the maximum bending moment and shear load are 72% and 48% of their maximum allowable amount respectively. These amounts show that the barge withstands the load out and transportation in the viewpoint of mechanical strength and with the given tidal amounts and known ballasting. It should be noted that aft trim of about 0.57˚ was considered to reduce the drag force and also to increase the maneuverability.

LOAD-OUT, TRANSPORTATION AND FLOATOVER INSTALLATION

Load-out operation includes 2 phases: movement of SPP1 module to quayside, load-out of SPP1 module onto the barge via quay wall [1]. At first phase the skid beams which are made up of fabricated beam sections are lined up. The skid beam top surface is cleaned and ground smooth for any projection. When all preparations and checks are completed, the push/pull system provides movement of the topside to the quay side. For breakout operation the maximum push/pull force is required [1]. Continuous checks on the load-out support frame-skid beam interface should carried out to ensure that the guides of LSF are not pressing hard against the skid beam, and the LSF is skidding in a straight path and in unison at each end of the stroke. Skidding will continue until the end of LSF reaches the quay side. In the second phase, the following jobs should be done: during load-out day, prior to load-out , the barge will be ballasted and maintained such that top of skid beam on quay side (5.2 m CD) is 1 cm higher than barge skid beam (5.19 m CD). The jacks then push the topside until the outboard ends of the LSF overhang by approximately 1 m. The barge is then de ballasted until the deck makes contact with the LSF and therefore begins to take load. After checking the skid beams, barge and jacking system, skidding will be carried out in strokes of 1000 mm and will be timed against the tidal rise ballast rate. The maximum skidding rate, as determined from the double acting jacking system is 17 m/hr, but the speed of skidding relative to the ballasting operation will be adjusted as necessary to maintain ±10 mm relative level. Load-out operation will continue until module's load-out support frame is completely on the barge and in the final position. Some steps of load-out operation have been shown in figures 14 and 15. The final positioning of the module on the barge will be performed as per barge stability report during transportation and sea fastening calculations. After the final module positioning, the barge will be berthed along the quay wall. For barge berthing following activities will be performed: release mooring line for barge forward movement, using two tugboats for barge controlling, barge movement to the quay by tugboats and mooring lines, barge berthing along the quay wall, and replace the mooring points on the quay. After doing the required sea fastening barge is ready for transportation [1]. Sea fastening should be designed to accept hog, sag and twisting of the barge in the seaway [5].

Fig. 14. Side view of Load out operation of SPP1 topside on SADRA FLB 124 barge.

Fig. 15. Load out operation of SPP1 topside on SADRA FLB-124 barge.

The method in which the platform will be installed on the 6 legged jacket is floatover method. Decks installation using floatover method in lieu of the traditional derrick lifting is a well known method all over the world and specially in the Persian Gulf. This method provides an attractively cost effective method for the decks installation specially when the deck weight exceeds 2000 tonnes. Floatover installation method has been successfully used in numerous deck installations in the Persian Gulf. The floatover method can be done in two ways. The first way is by entering the installation barge inside the jacket, mooring it inside and then lowering the installation barge to transfer the deck load to the piles using ballast water only. This method is called floatover installation by barge ballasting. The second way is typically the same as the first except that hydraulic jacks are used to lift the deck prior to entrance in the jacket and then used again to rapidly transfer the deck load to the piles. This method is called floatover installation by jacking system. This second case is mainly used when the deck is required to be transported with a low center of gravity above installation barge deck and is then required to be raised prior to entrance in the jacket to maintain sufficient clearance for the entrance [6]. A typical floatover operation by barge ballasting consists the following major steps [6]:

a) Rigging up and preparing the cargo/installation barge with the necessary equipment. b) After reaching the field the installation barge should be aligned with the jacket in the direction of entrance, mooring lines connected and gravity anchors set. This stage is “aligning” stage. c) Prior to entrance of the installation barge inside the jacket the barge should be de ballasted to the required level in order to achieve the required clearance with the piles. The installation barge is then moved by winches and assisted with tug boats inside the jacket until the deck legs coincide with the piles. This stage is called “entrance” stage. d) The barge is then lowered by ballasting it to engage the deck legs in the piles and start the load transfer to those piles. This stage is called “load transfer” stage. e) The installation barge is further ballasted to achieve a clearance between the deck and the supporting substructure on the barge. f) After a sufficient clearance between the deck and the substructure is achieved the installation barge is pulled from underneath the deck by tug boats until it is retrieved outside the jacket. This stage is called “barge retrieval” stage [6].

A fendering/shock absorbing system need to be used for the operation to prevent steel to steel contact at any stage of installation. One other important factor for the floatover method is that it requires calm weather conditions to perform the operation safely. The limited weather criteria can be met in the Persian Gulf even when the required wave height should not exceed 0.3 m [6]. Also tide magnitude and cycle plays a very important role during the entrance, load transfer and retrieval stages. It is always the case that the barge entrance shall be with the rising tide to help get more clearance between deck legs and the piles. On the other hand, the load transfer and barge retrieval stages are better done with the falling tide. This will help in reducing the amount of ballast water pumped into the installation barge during those stages [6].

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