Research on slippage shipment technology of the large platform in paralic zones

Xiaochun Zhang [1*], Song Jin [2], Qingguo Yin [1], Ling Yang [2], Xiaobo Jiang [1], Yuezhou Dong [3], Yunhao Zhang [3], Yan Zhu [2], Hongtao Xing [3], Dongmiao Li [4]

[1] Petroleum Engineering Research Institute of PetroChina Dagang Oilfield Company, Tianjin, 300280, China

[2] Foreign Cooperation Project Department of Dagang Oilfield Company, Tianjin, China

[3] The Fourth Oil Production Plant of PetroChina Dagang Oilfield Company, Tianjin, China

[4] The First Oil Production Plant of PetroChina Dagang Oilfield Company, Tianjin, China

*Corresponding author: zhangxchun@petrochina.com.cn

Abstract. With the continuous growth of the demand for oil and gas resources, the exploration and development has been increasing, the number and scale of fixed platforms in paralic zones are also increasing, and the offshore construction capacity and technology is improving. As one of the key technologies for offshore installation of large-scale platforms, slippage shipment technology is widely used. Based on the wharf environment, the platform structure and weight, this paper comprehensively analyses the allowable tidal window, the longitudinal strength of the ship, the load adjustment capacity, then gives the check results to ensure the safety of the shipment process.

Keywords: Paralic zones, slippage shipment technology, large platform.

1. Introduction

In recent years, with the continuous growth of the demand for oil and gas resources, the development of oil and gas resources in paralic zones is also increasing. The paralic zones of Bohai Bay is very rich in oil and gas resources, and has a large scale of exploration and development. At present, the oil and gas resources in paralic zones are developed relying on fixed platforms, and the platform is also developing towards large-scale and comprehensive [1-2]. At present, slippage shipment technology is mainly used for large platforms, that is, using large winch system and barge-loading technology to smoothly pull the large platform from the wharf to the barge [3]. In the process of slippage shipment, the water volume of the ballast water tank is adjusted by the load regulating system, and the barge is dynamically adjusted to overcome the influence of the shift of platform barycenter and the change in tide on the floating state and stability of the barge, to ensure the smooth transfer of the large platform to the barge.

2. Platform loading plan

The topside of the large fixed platform mainly includes modular drilling rig, injection system, living building, oil and gas system, public system, etc., with a total weight of about 10,000 tons. The platform is located in paralic zones with shallow water, making it difficult for large cranes to enter. Therefore, the upper block of the platform will be built as a whole and installed on float-over scheme, which can reduce the installation workload and the commissioning time at sea, and save the project cost. After the upper block of the platform is built as a whole on land, there are three main ways to load it onto the barge: lifting, rolling and slipping. For large platforms, the slippage shipment scheme is usually adopted . Four DSU support legs are set on the intersection of the slideway and the A\B axis of the upper block. In order to disperse the overall reaction force of the topside, there is a row of artificial legs on the outside of the four DSU support legs (4 in total), as shown in Figure 2-1.

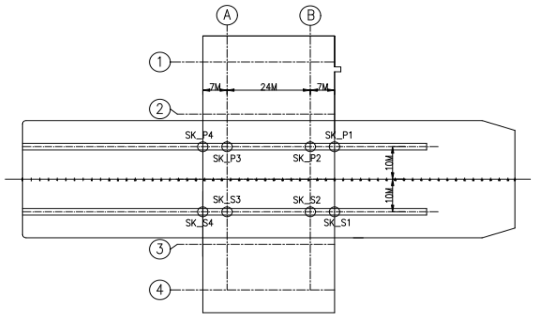

Figure 2-1 Schematic diagram of platform fulcrum position

According to the supporting structure form of topside, wharf strength, pulling speed of tension jack and barge load adjustment capacity, the shipment process is divided into 6 steps, as shown in Table 2-1, so as to avoid sudden falling and warping of the stern during the dragging process. During the shipment process, special attention should be paid to the typical load transfer steps such as the start of the topside of the platform and the complete transfer of the load on board.

Table 2- 1 Description of topside loading steps

Step	Block weight onboard	Topside location
0	0%	All topside at the dock
1	25 %	The weight of DSF's 1st row leg slipper is fully onboard
2	50 %	The weight of DSF's 2nd row leg slipper is fully onboard
3	75 %	The weight of DSF's 3rd row leg slipper is fully onboard
4	100 %	The weight of DSF's 4th row leg slipper is fully onboard
5	100 %	The topside is in the final dragging position

Note: DSF is the topside support structure.

3. Slippage shipment technology

3.1 Site

In this project, the influence of factors such as land construction, barge mooring, land slideway strength, wharf strength and height, water depth, tide and other factors on the selection of the construction site was comprehensively considered, and an offshore engineering base in Qingdao was selected as the construction site. The track width is 11m+12m+11m, 500t/linear meter. After proper dredging, the water depth at the front end of the land slideway is 10m below the chart datum, the wharf elevation is 5.8m above the chart datum, the wharf slideway is 1.2m high and the slideway onboard is 1.8m high, so that the barge with ballast, the onboard slideway is flush with the dock slideway, and the gap between the barge and the mud surface is greater than 0.5m. The strength of the site and wharf meets the requirements.

3.2 Vessels

Taking into account the weight of the topside, the notch width, the deck elevation and the water depth, the selected barge is NO. 221. Main parameters of the barge: total length 153.55 m, profile length 142 m, profile width 36 m, profile depth 9.75 m, and ballast 38103 m^3. The ballast tanks of the barge include the left tanks, the left middle tanks, the right tanks, and the right middle tanks, with a total of 27 ballast tanks. The barge's own ballasting capacity is $3\times1500m^3/h+2\times1800m^3/h$.

3.3 Wharf mooring design

In designing the mooring system, according to the forces of wind, waves, currents, tide and other environmental factors on the barge and the topside of the platform, the bow cables and several sterns are symmetrically arranged on both sides of the ship's side, so as to meet the requirements of mooring force in case of cable breakage on one side. Mooring lines are available to replace mooring lines in case of breaking due to sudden weather deterioration. Ensure safe construction of loading operation.

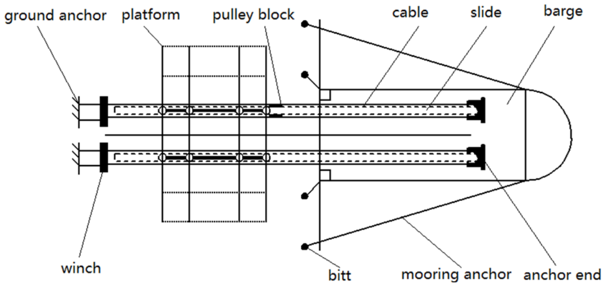

Figure 3-1 Layout plan of sliding shipment of platform

3.4 Climate window

The tidal range required for loading can be obtained by calculating the minimum draft for each step of slippage shipment. When calculating the draft of the barge, it is assumed that 5% of the bilge water remains in the empty tank, and the maximum capacity of the full tank can reach 95%.

1) According to the main parameters of the barge and the wharf, the draft of the barge at 0 tide level can be calculated [4]:

Wharf height+ wharf slide height - barge depth - barge slide height = 4.55 (m).

2) Calculate the draft of the barge according to each step of slippage shipment, and finally determine the draft range: 7.0m ~ 8.75m;

3) According to the corresponding relationship between barge draft and tide level, calculate the variation range of tide level. In order to keep the same elevation of the wharf slideway and the ship slideway during the process of slippage shipment, it is necessary to limit the tidal range during the process until the topside load is completely transferred to the barge. The allowable range of draft and tidal for each step are listed in table 3-2.

Table 3-2 The allowable range of draft and tide for each step of loading

Step	Draft range (m)		Tide range (m)	
	Minimum draft	Maximum draft	Lowest tide	Highest tide
0	3.40	8.75	-1.15	4.2
1	3.40	8.75	-1.15	4.2
2	5.30	8.75	0.75	4.2
3	6.80	8.75	2.25	4.2
4	7.00	8.75	2.45	4.2
5	7.00	8.75	-	-

The tidal curve is the main factor controlling the loading time. Therefore, when checking the loading time, analyze whether the tide level meets the requirements of loading time according to the situation of the barge. The total time from the 1st row legs to the last row legs is the factor to determine whether loading is feasible, and this time should generally be less than 6h. The two horizontal lines in Figure 3-2 are the lowest and highest tide levels, and the allowable tidal range for loading is 245cm to 420cm. According to the tide table of Qingdao wharf, the climate window days for loading are 19 days.

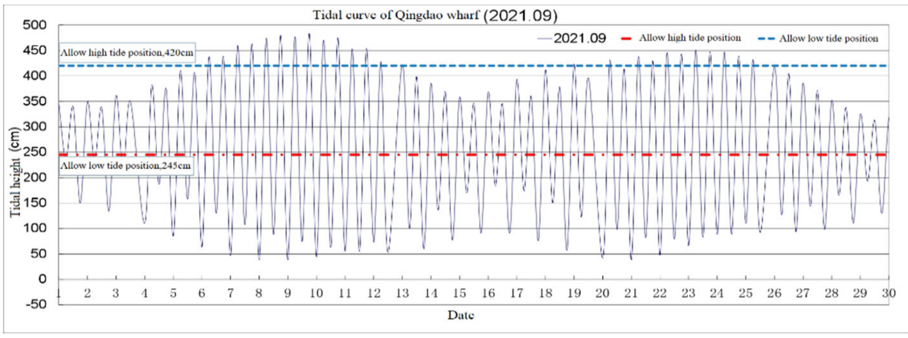

Figure 3-2 Tidal Curve of Qingdao Wharf

3.5 Loading scheme

It can be seen from table 3-2 that the minimum variation range of barge draft is 7.0m～8.75m. In order to reduce the workload of load adjustment, it is recommended that the variation range of barge draft is controlled to a small extent during the entire loading process, that is, to meet the draft range of the fourth row legs on board. From the ballast system of barge, the barge has 8100 m^3/h capacity, which can meet the requirements of ballast water regulation.

3.6 Stability and longitudinal strength

During the loading process, considering the wind speed of 10m/s, the stability of barge is calculated as shown in Table 3-3. The DNVGL specification is adopted for checking the stability of the loading conditions, the damage stability is not considered, and the minimum freeboard requirement is 1m. The minimum GM value in the loading steps is 6.28, which meets the specification requirements.

Table 3-3 Statistical table of loading stability calculation results

Draft (m)		Freeboard (m)	GMT(m)	area ratio
Step 0	3.40	6.35	29.00	80.00
	8.75	1.00	11.68	148.58
step 1	3.40	6.35	29.00	80.00
	8.75	1.00	11.22	36.88
Step 2	5.30	4.45	14.56	22.79
	8.75	1.00	8.98	6.88
Step 3	6.80	2.95	8.96	5.91
	8.75	1.00	6.94	1.88
Step 4	7.00	2.75	7.66	3.86
	8.75	1.00	6.28	1.44
Step 5	7.00	2.75	8.22	4.25
	8.75	1.00	6.77	1.58
Require	\	>=1.0	>0.0	\

During the loading process, since the barge is moored at the wharf, only the still water bending moment and sheer force of the hull are considered in the calculation of longitudinal strength [5]. Whether the total longitudinal strength of each step of the ship meets the requirements is calculated according to the specifications. The bending moment and shear force results are shown in Figure 3-3 and Figure 3-4. Through the calculation and analysis of each step, it is concluded that the longitudinal strength of the barge is the most unfavorable when the weight of the second row legs is fully loaded onboard. Under this condition, the maximum bending moment and shear force UC are 0.69 and 0.54, which meet the requirements of the specification.

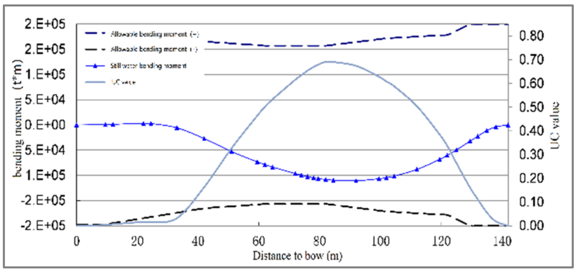

Fig. 3-3 Contrast curve of still water bending moment of loading

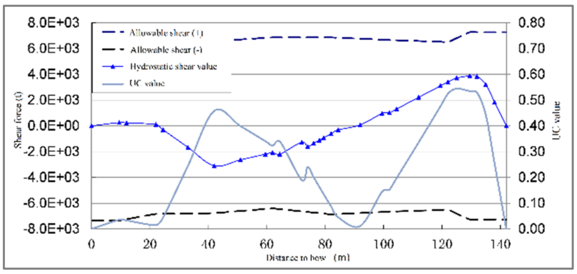

Figure 3-4 Contrast curve of still water shear force for loading

4. Conclusion

Combined with a fixed platform in paralic zones, this paper discusses and analyses the slippage shipment technology in detail. Due to the uneven distribution of platform structure and weight, the slippage shipment technology needs to comprehensively consider the factors such as loading site, slideway, barge load regulation capacity and possible working conditions, and reasonably design the block support structure, mooring system and loading steps, and optimize the appropriate climate window. The stability and total longitudinal strength of the barge, and the structural strength of the platform were calibrated according to the specifications and guiding documents. Through the analysis in the early stage of the project, it provides a theoretical basis for the construction of large fixed platform slippage shipment, and strengthens the structure in time to ensure the safety of the loading process.

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