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The Ability LNG, LPG and General Port Vessels Maneuvering in Berthing Zone of IRAN LNG Project Jetties in Persian Gulf

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ABSTRACT

For the purpose of having a safety navigation, the transportation path, deployment of carrier, physical specifications, locations and … have high level of importance. In this research, along with the above mentioned factors, we have compared the result with technical standard and commentaries for port and harbor facilities in Japan, and to analysis both advantage and disadvantages of them. The IRAN LNG project (ILC), will product the overall amount of 10/80 million tons of LNG per annum. Based on the type and capacity of LNG ship (Membrane Type,150000 m3), 13 vessels and 6 tug boat are estimated, mostly considered as high capacity LNG carriers. Since the IRAN LNG ships enter to terminal on ballast and after loading departure and also with considering number and marine traffic on South pars, one way channel with 0.5 L (L is length of ship) considered. On this base, we need Maximum width of 157.5 m and minimum 122m (for LNG Ships), and Maximum width 120m and minimum 89m (for LPG Ships). Area, circumference and diameter of basin with anchorage & buoys on general jetty that in collusive general Cargo, Sulphar & Ro-Ro berth respectively are 154610 m2, 1830m and 320m that covered Japanese's standard completely but about turning circle, we have area, circumference and diameter respectively 5896 m2, 250m and 708m which doesn't coordinate with Japan's standard except only one subject (Sulphar berth with aids tug boat).

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1. Introduction

Natural gas transmission through its gas essence and the usage of pipelines in long distance confronts many difficulties in common. Based on available technology abilities , LNG method (liquefied natural gas) as an economic and confident one, can obviate the difficulty of gas shipment to transmit gas to far distances, to a great deal.

Great southern pars gas area in Persian Gulf is the biggest in the world and contains 50% of Iran gas storage and 9% of the world gas reservation.

This area in Persian Gulf establishes 27 phases of gas refinery, 25 petrochemical, projects and 3 LNG units in southeast of Bushehr.

2- Hydroclimotology of Studies Area

1-2- BMO wind data , has been gathered and based on revising and taking vessels in special period in one area , during more than 50 years, by British Meteorological office (BMO).

In the vicinity of project site , BMO data have been provided , especially for this project , for one 59-year period (from 1949 to 2007) in an area about 26 to 28 degrees latitude and 51 to 53 degrees longitude, The area cover is shown in Figure (1) and event percent in Table (1) , result show that predominant wind direction based on BMO data, from north to west (315) and the maximum recorded speed is equivalent to 27/8 m/s (Met-ocean Measurements,2006).

Table 1: event percent of wind annum based on BMO data

Wind Speed Frequency (%)																	
Ws(m/s)\D	0	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315	337.5	Total
5.4 – 7.9	0.825	0.144	0.144	0.084	0.383	0.849	0.981	0.359	0.287	0.096	0.072	0.203	1.375	4.269	6.015	2.428	18.514
7.9 – 10.7	0.562	0.06	0.036	0.06	0.299	0.526	0.49	0.215	0.072	0.012	0.012	0.024	0.741	3.36	5.322	1.937	13.728
10.7 – 13.8	0.263	0.024	0.048	0	0.048	0.191	0.167	0.06	0.012	0.036	0.012	0.012	0.215	1.471	2.464	0.729	5.752
13.8 – 17.1	0.012	0.012	0	0	0.048	0.096	0.06	0.012	0.024	0.012	0	0	0.06	0.383	0.897	0.287	1.903
17.1 – 20.7	0.024	0	0	0	0	0.012	0.012	0	0	0	0	0	0.012	0.084	0.239	0.048	0.431
20.7 – 24.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.012	0	0.012
24.4 – 28.4	0	0	0	0	0	0.012	0	0	0	0	0	0	0	0	0	0	0.012
28.4 <	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0.686	0.24	0.228	0.144	0.778	1.686	1.71	0.646	0.395	0.156	0.096	0.239	2.403	9.567	14.949	5.429	40.352

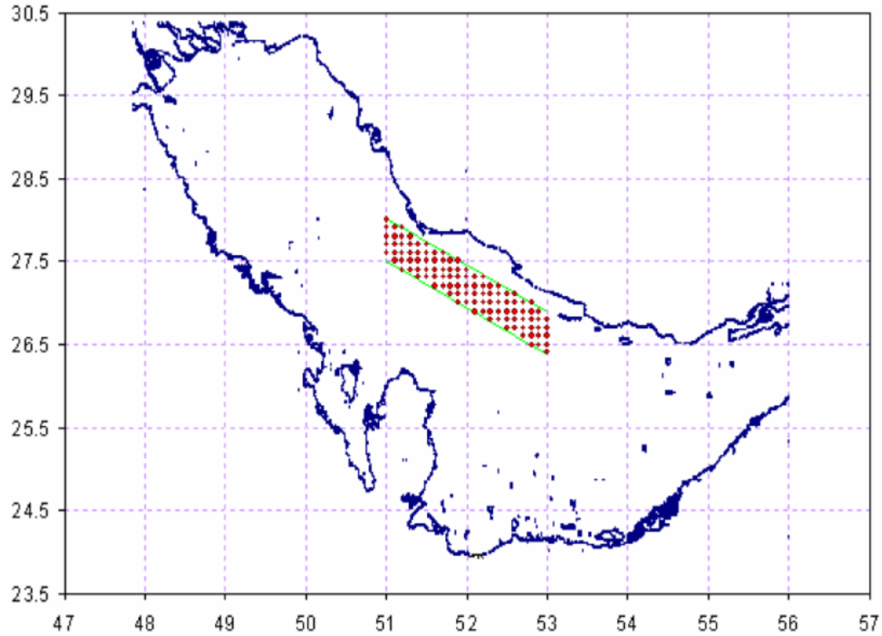

Figure 1: zone of under cover BMO near IRAN LNG site

2-2- BMO wave data

Table 2 and Figure 3; indicate the form of get wave rose of these data, statically and graphically. As it is obvious, predominant wave direction and the longest recorded wave maximum are 315° and 7/8 m /s (Met-ocean Measurements, 2006).

Table (2): height wave classification on base BMO data

Hs(m)\Dir	0	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315	337.5	Total
0.5 – 1	1.441	0.274	0.548	0.345	1.513	1.87	1.941	0.869	1.06	0.369	0.476	0.536	3.704	5.419	6.444	2.513	29.322
1 – 1.5	0.953	0.226	0.179	0.119	0.762	1.227	1.417	0.465	0.417	0.155	0.167	0.238	2.215	4.931	7.444	2.906	23.821
1.5 – 2	0.524	0.06	0.107	0.024	0.274	0.417	0.584	0.226	0.071	0.06	0.048	0.024	0.691	2.739	4.502	1.489	11.84
2 – 2.5	0.274	0.048	0.036	0.024	0.071	0.25	0.167	0.143	0.06	0.012	0.024	0.024	0.465	1.608	2.358	0.75	6.314
2.5 – 3	0.095	0	0.012	0.012	0.048	0.167	0.107	0.036	0.024	0	0.012	0.012	0.155	0.917	1.096	0.345	3.038
3 – 3.5	0.048	0.012	0.012	0	0.012	0.036	0.024	0.024	0	0.012	0	0	0.048	0.238	0.631	0.214	1.311
3.5 – 4	0.012	0	0	0	0.012	0.012	0.036	0.036	0	0.012	0	0	0.036	0.226	0.25	0.06	0.692
4 – 4.5	0	0.012	0	0	0.024	0	0	0	0	0	0	0	0.024	0.107	0.095	0.06	0.322
4.5 – 5	0	0	0	0	0.012	0	0	0	0	0	0	0	0.012	0.071	0.083	0.012	0.19
5 – 5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.071	0.048	0	0.119
5.5 – 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.036	0	0.036
6 – 6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.012	0	0	0.012
6.5 - 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.012	0	0.012
7 – 7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5 - 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.012	0	0.012
8 – 8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3.347	0.632	0.894	0.524	2.728	3.979	4.276	1.799	1.632	0.62	0.727	0.834	7.35	16.339	23.011	8.349	77.041

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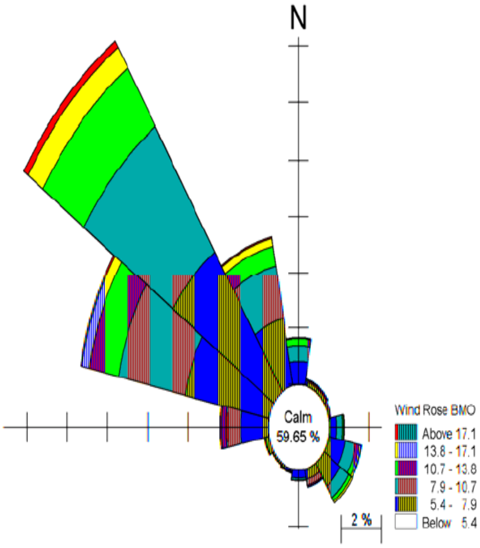

Figure 2: annum wind Rose based on BMO data

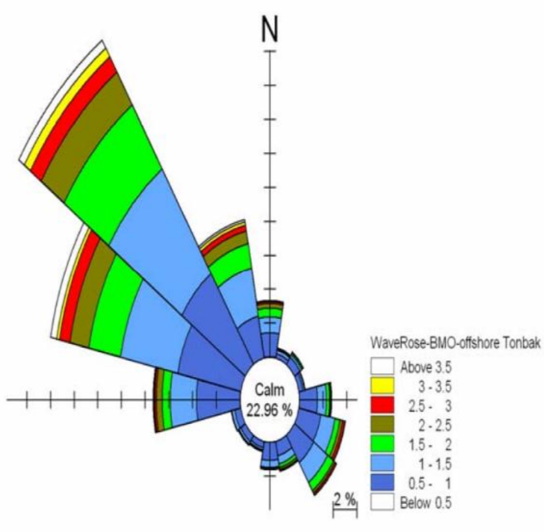

Figure 3: annum wave Rose based

3- Navigation Issues

In Consideration of physical characteristics and shipment case, vessel pith is of great importance for performing safe navigation (Navigation Aids, 2008) Therefore, we will consider navigation characteristics (length, width and depth) and turning circle (diameter) and basin (area and depth) of vessel in general and IRAN LNG (ILC) in particular, thus, we need vessels' feature listed in table 3 shortly (FEED, 2002).

Table 3: Vessels' feature in IRAN LNG Project

Properties			Overall Length (LOA)	Length between perpendiculars (LBP)	Beam (B)	Draft (D)	Capacity	Displacement tonnage (DT)
Units			m	m	m	m	Tons & m3	Tons
LNG SHIP	Max. ship		315	302	50	12.0	220,000 m^3	158,000
LNG SHIP	Min. ship		244	230	34.4	9.9	70,000 m^3	55,500
LPG SHIP	Condensate	Max. Ship	278	264	45	12	150,000 tons	182,000
LPG SHIP	Condensate	Min. ship	214	206	34	12.3	60,000 tons	73,500
LPG SHIP	LPG Vessel	Max. Ship	240	228	36	12.3	80,000 m^3	66,000
LPG SHIP	LPG Vessel	Min. ship	178	167	27	9.5	30,000 m^3	34,000
Ro-Ro SHIP			198	180	40	9.5	22000 tons	39600
General Cargo SHIP			174	158	24.8	9.5	20000 tons	28000
Sulphar SHIP			116	105	19.4	7	6000 tons	8000

It should be mentioned that for measuring the duration of LNG loading and unloading, we will act as follow: About 10 house for loading and unloading, 2.5 hours for approaching, berthing and mooring, 1.5 hours for cooling down and to hours for oceanic and atmospheric unexpected events.
Since this maneuver is done in source along with destination, loading and unloading take about 2 days. The most LNG production amount in ILC project is equivalent to 10/80 million tons which is considered as high capacity of 10/50 million, per annum.

The distance between loading location (general area , Tombak , IRAN LNG jetty) and unloading location (supposedly far east , Chinese southwest coasts) has been approximately considered 5000 sea miles , and 0/1 will be evaporated from the overall LNG , in this interval.

Required ships

$$= \frac{\dfrac{\text{factory production capacity (million tons per year)} \times \text{mean exploit percent of factory MMBTU} \times \text{termal capacity of LNG per ton}}{\text{LNG dencity}}}{\dfrac{\text{portage } (m^3) \times \text{termal capacity for per } m^3 \text{ LNG}}{\text{loading and unloading duration} + \text{berthing duration} + \dfrac{\text{interval between two port} \times 2}{\text{vessel speed} \times 24}}}$$

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So for IRAN LNG project we will have:

Number of Required Carriers

$$= \frac{\dfrac{10.8\times10^{6}\,kg}{450\,{}^{kg}\!/\!{}_{m^{3}}}}{145000m^{3}\times\dfrac{365day}{2day+\dfrac{5000mil\times2}{19\,{}^{mil}\!/\!{}_{hr}\times24\,{}^{hr}\!/\!{}_{day}}}}\approx 13\,farvand$$

1-3 width of Navigation Channel

In the determination of the width of a navigation channel, due consideration shall be given to the types and dimensions of target vessels, the traffic volume and length of the channel, and natural conditions including meteorological and marine conditions, but in such case that the use of tugboats is prescribed, a refuge area for vessel is provided, or the length of channel is very short, however, the channel width can be reduced to the extent not to hinder safe navigation of vessels.

In this case, is required to do complementary studies (Navigation Aids, 2008).

For ordinary navigation channels, the following values are adopted as the standard width:

a) For a double – way channel , an appropriate width that is 1.0 L or larger is adopted , except for :
   1- Cases in which the length of navigation channel is relatively long : 1.5L
   2- Cases in which the target vessels frequently pass in both ways through the channel : 1.5L
   3- Cases in which the target vessels frequently pass in both ways through the channel and the length of the channel is relatively long : 2.0L

b) For a one – way channel, an appropriate width that is 0.5 L or larger is adopted.

Since, vessels are imported in IRAN LNG project and they depart after loading and their interval time shipping is 2 days for LNG, 13 days for LPG and 20 days for sulphur ships.

Thus, sea traffic is not severe and we can consider one – way IRAN LNG, the width of navigation channel will be considered 0/5 L (Navigation Aids & Navigation study, 2008).

Based on related wharves, LNG and LPG carrier can pass one navigation channel, so based on Japan international standard we have:

Table 4: Suggested width of LPG and LNG vessels of Navigation channels in Iran LNG project.

Width of Navigation channel		Ship type
Min	Max	
244 (0.5) = 122	315(0.5)=157.5	LNG carrier
178(0.5)=89	240(0.5)=120	LPG carrier

Table 5: Suggested width of Ro-Ro , General cargo & sulphar vessels of Navigation channels in Iran LNG project

Ship type	Width of Navigation channel
Ro-Ro	198 (0.5) = 99
General Cargo	174 (0.5) = 87
Sulphar	116 (0.5) = 58

Table 6: Interval & down time shipping for IRAN LNG Project

Ship type	Interval time shipping	Down time shipping	
		Max	Min
LNG	2.2 days	0.26%	0.18%
LPG	13 days	---	---
Sulphar	20 days	27%	15%
Tug boat	---	2.51%	

Wharves of Ro-Ro, Sulphar and General Cargo vessels are located in municipal port (Ro-Ro berth Structural Design, 2008) , pass another navigation channel that is described below:

Mentioned down time for sulphur ship in above table will be per annum and if we want to consider it per season, it will be at least 40% and at most 55% (FEED, 2002).

It is required to mention that down time shipping is the duration that inappropriate atmospheric and oceanic condition, doesn't let the vessel, berth, load and unload(Mooring study for LNG & LPG condensate breath at Tombak, 2007).

3-2- Basin

In planning and design of basins , consideration shall be given to the safety in anchorage , the easiness of ship maneuvering , the cargo handling effectively, the meteorological and marine conditions , the effects of reflected waves and ship-generated waves on vessels in the harbor, and the conformity with related facilities. Therefore, the location of basin is determined appropriately in consideration of the layout of breakwaters, wharves and navigation channels, and the calmness requirement (Navigation study & Navigation Aids, 2008).

In the determination of the area of a basin used for anchorage or buoy mooring, due consideration shall be given to the purpose of the use, anchorage method, sea bottom material, wind speed, and water depth.

For buoy mooring, considerations shall be given to the type of the use and to the horizontal movement of the buoy when the tidal range is large. Swinging mooring (Fig. 4(a)) and mooring with two anchors (Fig. 4(b)) are the two most frequently used anchorage methods. The required length of anchor chain varies depending on the type of vessel, anchorage method, and meteorological and marine conditions. Therefore, it is necessary to determine the chain length in such a way that the holding powers of the mooring anchor and the chain lying on the bottom can resist the forces acting on the vessel under expected conditions. In general, the stability of the mooring system increases as the length of the anchor chain becomes longer.

The area of anchorage is defined as a circle having a radius equivalent to the sum of the vessel's length and the horizontal distance between the bow and the center of rotation.

Figure 4(c) shows a vessel moored in a single-buoy mooring, and Figure 4 (d), shows a vessel moored in a double-buoy mooring with buoys located in bow and stern the vessel. In this double-buoy mooring, it is necessary to locate the buoys in such a way that the line connecting the two buoys becomes parallel with the directions of tidal currents and winds. In the determination of the area of these types of buoy mooring areas, Table (9) may be used as a reference.

Table 7: anchorage area in mooring with anchor

Purpose of the use of the basin	**Anchorage method**	**Sea bottom material or wind speed**	**Radius**
Offshore waiting or cargo handling	Swinging mooring	Good anchoring	L + 6D
		Poor anchoring	L + 6 D + 3m
	Moring with two anchors	Good anchoring	L +4.5 D
		Poor anchoring	L +4.5D +25m

Thus, by basing the above table for IRAN LNG, we will have:

Table 8: area of basin in mooring with anchor in IRAN LNG Project

Kind of vessel				**LNG ship**		**LPG ship**	
Purpose of the use of the basin	Anchorage method	Sea bottom material or wind speed	Radius	Max(m)	min(m)	Max(m)	min(m)
Offshore waiting	Swinging mooring	Good anchoring	L+6D	315+6(15) =405	244+6(15) = 334	240+6(15)= 330	178+6(15) = 268
		Poor anchoring	L+6D+30 m	315+6(15)+30= 435	244+6(15)+30= 364	240+6(15)+30 = 360	178+6(15)+30= 298
	Mooring with two anchors	Good anchoring	L+4.5D	315+4.5(15)= 382.5	244+4.5(15)= 311.5	240+4.5(15) = 307.5	178+4.5(15)= 245.5
		Poor anchoring	L+4.5D+ 25m	315+4.5(15)+25 = 407.5	244+4.5(15)+25= 336.5	240+4.5(15)+ 25 = 332.5	178+4.5(15)+25= 270.5

Kind of vessel				**General cargo ship**		**Ro-Ro ship**	
Purpose of the use of the basin	Anchorage method	Sea bottom material or wind speed	Radius	Max(m)	min(m)	Max(m)	min(m)
Offshore waiting	Swinging mooring	Good anchoring	L+6D	174+6(11) =240	158+6(11) =207.5	198+6(11)= 264	180+6(11) =246
		Poor anchoring	L+6D+30m	174+6(11)+30= 270	158+6(11)+30= 154	198+6(11)+30 = 294	180+6(11)+ 30 = 276
	Mooring with two anchors	Good anchoring	L+4.5D	174+4.5(11)= 223.5	158+4.8(11)= 207.5	198+4.5(11) = 247.5	180+4.5(11) = 229.5
		Poor anchoring	L+4.5D+25m	174+4.5(11)+25 = 248.5	158+4.5(11)+25 = 232.5	198+4.5(11)+2 5 = 272.5	180+4.5(11)+ 25 = 254.5

Kind of vessel				**Sulphar ship**	
Purpose of the use of the basin	Anchorage method	Sea bottom material or wind speed	Radius	Max(m)	min(m)
Offshore waiting	Swinging mooring	Good anchoring	L+6D	116+6(11) =182	105+6(11) = 171
		Poor anchoring	L+6D+30m	116+6(11)+30 = 212	105+6(11)+30 = 201
	Mooring with two anchors	Good anchoring	L+4.5D	116+4.2(11) = 165.5	105+4.5(11) = 154.5
		Poor anchoring	L+4.5D+25m	116+4.5(11)+25 = 190.5	105+4.5(11)+25= 179.5

Since the largest circle that can be embedded in general cargo, Ro-Ro basin , and Sulphar berth is approximately 320 meters long, it doesn't cover international standards and commentaries for port and harbor facilities in Japan , and the only corresponding

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case in Sulphar Ship is mooring with two anchors (Figures 5 and 6).

It is required to mention that L is the overall vessel and D, the water depth in below equations.

Table 9: area of basin used for buoy mooring

Anchorage method	Area
Singe-buoy mooring	Circle having a radius of (L+25m)
Double-buoy mooring	(L+50m) × L/2 rectangle

In IRAN LNG project, the area of basin in single – buoy mooring method is equivalent to:

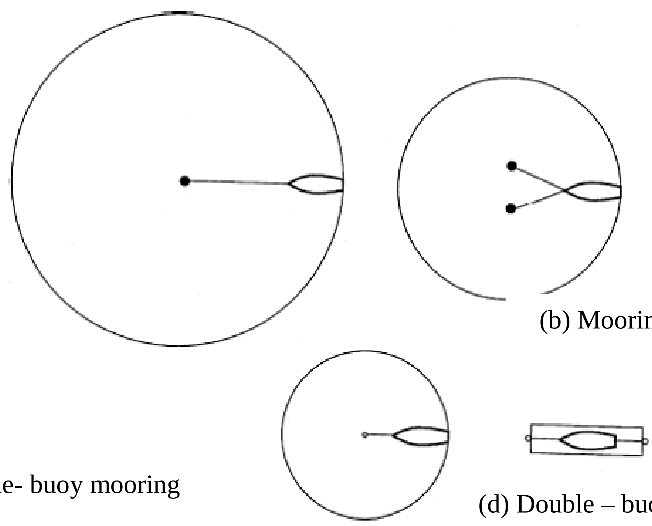
Table 10: The area of basin single – buoy mooring in ILC project

Kind of vessel		LNG ship		LPG ship	
Size		Max (m)	min (m)	Max(m)	min(m)
Single-buoy mooring	Circle having a diameter of (L+25m)	315+25=340m	244+25=269	240+25=265	178+25=203
Double-buoy mooring	Rectangular (L+50m) L/2	(315+50)315/2= 57487.5	(244+50)244/2= 35868	(240+50)240/2= 34800	(178+50)178/2= 20292

Kind of vessel		General cargo ship		Ro-Ro ship	
Size		Max (m)	min (m)	Max(m)	min(m)
Single-buoy mooring	Circle having a diameter of (L+25m)	174+25=199	158+25=183	198+25=223	180+25=205
Double-buoy mooring	Rectangular (L+50m) L/2	(174+50)50/2= 5600	(158+50)50/2= 5200	(198+50)198/2= 24552	(180+50)180/2= 20700

Kind of vessel		Sulphar ship	
Size		**Max (m)**	**min (m)**
Single-buoy mooring	Circle having a diameter of (L+25m)	116+25=141	105+25=130
Double-buoy mooring	Rectangular (L+50m) L/2	(116+50)50/2= 4150	(105+50)50/2= 3875

Since area , circumference and diameter of basin in ILC project for General cargo, sulphur, and Ro-RO vessels are 154610 m^2 , 1630m and 320m (Navigation Aids , 2008 , [14] , the only corresponding case with international standard in Japane , is the area of basin in sing – buoy mooring method for sulphur ship (Figures 5 to 7).



(a) Swinging mooring

(b) Mooring with two anchors

(c) single- buoy mooring

(d) Double – buoy mooring

Figure 4: Basin concept of area of basin (per vessel)

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The area of basin for LPG and LNG wharves doesn't have any limitations in this case and doesn't correspond to international standards either.

3-3- Turning circle

Turning basins are used for vessels' maneuvering.

In the determination of the area of a basin used for bow turning, due considerations shall be given to the method of bow turning, the vessels' bow turning performance, the layout of mooring facilities and navigation channels, and the meteorological and marine conditions, and turning basins should be located appropriately in front of mooring facilities in consideration of the layout of other navigation channels and basin (Navigation Aids & Navigation study, 2008). The standard area of turning basin is as follows:

(a) Bow turning without assistance of tugboats: circle having a diameter of 3L.

(b) Bow turning using tugboat: circle having a diameter of 2 L.

Thrusters with a sufficient power may be considered as equivalent to a tugboat (Maneuvering Simulations with three types of ships for the industrial part of Tombak, 2008). As for small ships, when the above standard area cannot be provided due to topographic conditions, the area of turning basin may be reduced to the following level by using mooring anchors, winds, or tidal currents (Navigation study, 2008):

a) Bow turning without assistance of tugboat: circle having a diameter of 2L.

b) Bow turning using tugboat: circle having a diameter of 1.5L.

The area of turning basin for different vessels of IRAN LNG project is measured based on international standards and port facilities in Japan, listed in Table 11.

Table 11: The Area of Required Turning Circle for Vessel Maneuvering.

Kind of vessel		*LNG ship*		*LPG ship*	
size		*Max*	*min*	*Max*	*min*
Without tog boat	*Circle having a diameter of 3L*	*3(315)=945*	*3(244)=732*	*3(240)=720*	*3(178)=534*
With using tog boat	*Circle having a diameter of 2L*	*2(315)=630*	*2(244)=488*	*2(240)=480*	*2(178)=356*

Kind of vessel		*General cargo ship*		*Ro-Ro ship*	
size		*Max*	*min*	*Max*	*min*
Without tog boat	*Circle having a diameter of 3L*	*3(174)=522*	*3(158)=474*	*3(198)=594*	*3(180)=540*
With using tog boat	*Circle having a diameter of 2L*	*2(174)=348*	*2(158)=316*	*2(198)=396*	*2(180)=360*

Kind of vessel		***Sulphar ship***	
size		***Max***	***min***
Without tugboat	*Circle having a diameter of 3L*	*3(116)=348*	*3(105)=315*
With using tugboat	*Circle having a diameter of 2L*	*2(116)=232*	*2(105)210*

Since the area, circumference and diameter of turning circle in Ro-Ro general cargo and Sulphar jetties confines, are equivalent to 5896 m^2 , 708 and 250m respectively (Navigation study,2008) depending on the computations of the above table, it is determined that this diameter doesn't correspond international in Japan except for one case.(Sulphar ship with tugboat)

4-3 Depth of basin

The depth of basin below the datum level shall be determined by adding an appropriate keel clearance to the maximum draft expected (such as full draft). Where the seasonal variation in the mean sea level is larger than the tide level variation due to astronomical tide and the mean sea level frequently becomes lower than the datum level or waves or swell of appreciable heights enter the basin, it is necessary to consider the effects of these phenomena.

In IRAN LNG project, water depth in Ro-Ro, General cargo and Sulphure basin limit is varied from -5 to -11 meters reaching 11 meters after dredging the depth of the whole areas. Water depth in LNG and LPG jetties limit, is also equal to -15 meter (FEED, 2002). It is also required to mention that 10 degrees of berthing angle, 0, 02 m/s berthing design speed and loading vessel have under keel clearance, equals 1.5 meter and along with 20 fenders installed in 20 m intervals (Mooring study for LNG & LPG condensate breath at Tombak, 2007).

5-3 Calmness of basin

For basins that are located in front of mooring facilities and used for accommodating or mooring vessels, the calmness of a specified level shall be achieved for 97.5% or more of the days of the year, except for these cases where the use of the mooring facilities or the area in front of the mooring facilities is categorized as a special use.
The threshold wave heights for cargo handling for basins in front of mooring facilities should be determined appropriately in consideration of the type, size and cargo handling characteristics of the vessels. For this purpose, the values listed in Table (12) may be adopted (Mooring study for LNG & LPG condensate breath at Tombak, 2007).
Calmness of basin is usually evaluated by the wave height in the basin, but it is desirable to consider as necessary the effects of wave direction and period which affect the motions of moored vessels as well.

Table 12: Threshold wave height for Cargo Handling.

Ship Size	Threshold wave height for cargo handling (H 1/3)
Small- sized ships	0.3 m
Medium- and – large- sized vessels	0.5 m
Very large vessels	0.07 – 1.5 m

Displacement Tonnage (DT) is equivalent to 555000 and 34000 respectively, for the smallest LNG and LPG vessels, and the largest ones are 158000 and 66000.
Thus, depending on this category, LNG vessels are classified as very large & LPG ones, as large to very large vessels. Since the computation base of hydrodynamic IRAN LNG (ILC) project is BMO data, we will have Table 12: ($_{Hs}$) mean = 0.88 m, (Hs) max = 7.8 m.

Table 13 , gives as references the allowable amplitudes of vessel motions for different type of cargo handling, that have been suggested by Ueda, and Shiraishi and PIANC, we can find allowable amplitudes of LNG and LPG vessel motions, that are a special kinds of tugboat, in a following table:

Table 13: Allowable Amplitudes of Vessel Motions for Different Type of Vessels

Vessel type	Surging	Swaying	Heaving	Rolling	Pitching	Yawing
General Cargo ships	±1	±0/75	±0/5	±2/5	±1	±1/5
Grain carriers	±1	±0/5	±0/5	±1	±1	±1
Ore carriers	±1	±1	±0/5	±3	±1	±1
Oil tankers(foreign route)	±1/5	±0/75	±0/5	±4	±2	±2
Oil tankers (coastal route)	±1	0/75	±0/5	±3	±1/5	±1/5
Container ships (Lo/Lo)	±0/5	±0/3	±0/3	±1/5	±0/5	±0/5
Ferries, container ships (Ro-Ro) and pure car carriers	±0/3	±0/6	±0/3	±1	±0/5	±0/5

4-References:

Report

Sahel consultant engineering, 2008, ″ Ro-Ro berth Structural Design ″
Sahel consultant engineering, 2008, ″ LPG Trestle Structural Design ″
JGC group, 2002, ″ Front End Engineering Design Package (FEED) ″, P III
Water & environment technology co., 2006, ″ Met-ocean Measurements ″
Sahel consultant engineering, 2007, ″ Hydrodynamics studies report ″
Sahel consultant engineering, 2008, ″ Hydrologic and climatic studies ″
JGC group, 2002, ″ Specification for LNG jetty″ for Tombak, Iran
Sahel consultant engineering, 2008, ″ Navigation Aids ″
Sahel consultant engineering, 2008, ″ Navigation study ″
Alkyow hydraulic consultancy & research, 2007, ″ Mooring study for LNG & LPG condensate breathe at Tombak″
Alkyow hydraulic consultancy & research, 2008, ″ Maneuvering Simulations with three types of ships for the industrial part of Tombak″
Sahel consultant engineering, 2008, ″ Berthing approach system spec.″
Sahel consultant engineering, 2008, ″ Geotechnical Design Parameters (Part 1) ″
Sahel consultant engineering, 2008, ″Morphodynamic studies″
Sahel consultant engineering, 2008, ″Geotechnical Design Parameters (Part 2)″
Sahel Consultant engineering, 2008, ″ Suspended Deck Structures design Criteria″
Sahel consultant engineering, 2008, ″ Ro-Ro berth structural analysis ″
Books:
2002, ″ Technical standards and commentaries for port and harbour facilities in Japan″, handbook of harbour facilities
2006 ,″ port and Marine Structures Design Manual in IRAN ″, NO.300-6

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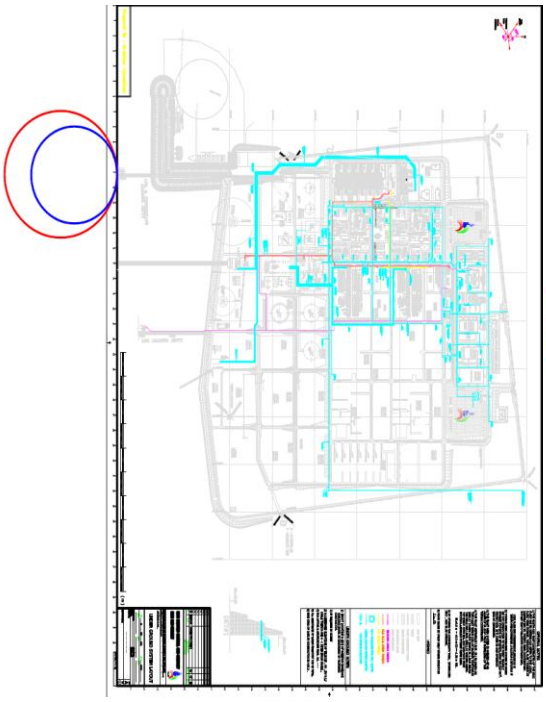
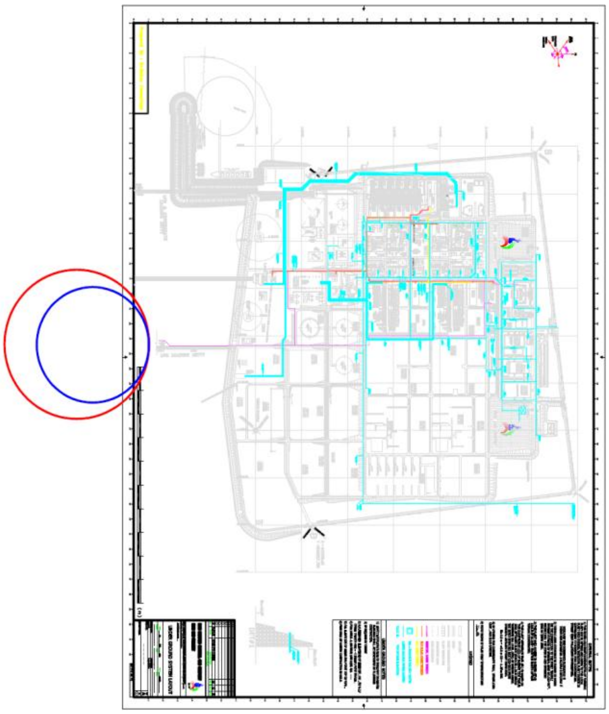
General port: Area basin used for buoy mooring, single buoy Max. Radius: 141m, min. Radius: 130m

General port: anchoring area, offshore waiting, swinging mooring, good anchoring, Max. Radius: 247.5m Min. radius: 229.5m



Area basin used for buoy mooring, single buoy, For LPG jetty, Max. Radius: 265m, min. Radius: 203m



Area of turning circle for LNG jetty, with using tug boat Max. Radius: 315m, min. radius: 244m

Figure 5: Basin and Turning circle Area in IRAN LNG project jetties

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