Technical Notes on Intact and Damage Stability Properties and Decks Distribution of Floating Hotels

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This technical note article presents the static stability considerations in determining the number of decks and the general arrangement of a floating hotel barge according to standard rules. An increased number of decks elevates the vertical center of gravity, potentially compromising stability and increasing the risk of capsizing. Additionally, in emergency situations, the simultaneous movement of a large number of passengers to one side of the hotel barge can lead to accidents and disasters. Therefore, stability considerations in hotel barges differ significantly from those of commercial ships. To address this, the stability characteristics of a hotel barge have been simulated as a case study. The general arrangement of the hotel has been evaluated to determine the centre of gravity, ensuring that heavier decks and tanks are placed in the lower sections, while lighter components are positioned on the upper levels. The simulation results indicate that the floating hotel model can safely accommodate up to nine decks, while maintaining a minimum reserve of buoyancy of 30% and adequate metacentric height. Finally, the article provides key design recommendations for improving the stability and general arrangement of floating hotel barges.

KEY WORDS
~ Stability
~ Floating structures
~ Hotel barge
~ General arrangement
~ Metacentre
~ Floating hotel stability

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doi: 10.7225/toms.v15.n01.009

Received: 31 Mar 2024 / Revised: 20 Oct 2025 / Accepted: 11 Mar 2026 / Published: 20 Apr 2026

1. INTRODUCTION

Ship stability is a fundamental aspect of naval architecture and ship design, determining how a vessel behaves under various sea conditions in both intact and damaged states (Tamunodukobipi, Jaja, & Tamunodukobipi, 2022). Insufficient buoyancy or stability can lead to serious accidents, such as sinking or capsizing, which pose major threats to life, property, and the marine environment)Francescutto, 2016 ;Asyabdareh, Moonesun & ,Adjami, 2024 ;Biran & López-Pulido, 2013(. Recognising these hazards, the International Convention for the Safety of Life at Sea (SOLAS) was established in 1914 to improve passenger ship safety (IMO, n.d.) and, since then, the stability of passenger vessels has remained a top design priority) Vanem & Skjong, 2006 .(The theoretical foundations of ship stability date back to Archimedes' principle of buoyancy and were later refined by Bouguer and Euler, whose work introduced concepts such as metacentric height (GM) and the GZ curve (Biran & López-Pulido, 2013; Bergholtz, et al., 2016). These principles continue to form the basis for modern stability assessments, yet they were developed primarily for conventional ships. A floating hotel barge, however, differs significantly from traditional passenger ships in both structure and function. These vessels often feature multiple decks with large superstructures, resulting in a higher vertical centre of gravity that can reduce static stability. Furthermore, in emergency situations, the simultaneous movement of passengers can induce severe heeling moments, increasing the risk of capsizing. Despite the growing number of floating hotels worldwide, from river-based barges in Europe to large offshore accommodations, there are no internationally standardised regulations specifically governing their stability. Some regional authorities, such as the Egyptian River Transport Authority (ERTA), have developed local guidelines, but globally recognised frameworks are still lacking. To address this gap, this study examines the static stability of a floating hotel barge through simulation using Maxsurf software. The analysis applies and adapts the existing marine stability criteria—derived from SOLAS, IMO, KR, and national classification rules—to determine safe deck configurations and design recommendations. The results provide practical guidelines for improving the stability and general arrangement of floating hotel barges under both international and local regulatory contexts.

2. GOVERNING EQUATIONS

2.1. Factors affecting stability

1) Waterplane area coefficient (Cwp)

Increasing Cwp raises the second moment of the waterplane, which in turn elevates $K\ B$ KB and KM. A larger Cwp also increases hydrodynamic resistance. Therefore, during early design stages, Cwp is minimised while ensuring adequate stability and favourable sheer plan design (Watson, 2002).

2) Lowering the centre of gravity

Lowering KG increases GM and consequently the righting arm (GZ) at small roll angles, expressed as:

$$GZ = GM.\sin\theta \qquad (1)$$

Heavy equipment can be installed at lower decks, lightweight materials used above, and ballast (solid or tanks) added at the bottom to achieve this effect)Clayton, 1982(.

3) Reserve of Buoyancy

Increasing the reserve of buoyancy enhances the overall stability by providing additional submerged volume to counteract heeling moments)Moonesun, 2012(.

4) Freeboard

Increasing freeboard raises the deck edge immersion angle, which increases the maximum roll angle at which stability is maintained. This affects the upper limit of the GZ curve without altering the initial slope (representing GM_0))Lewis, 2000(.

5) Length and beam (L and B)

Increasing the vessel's length or beam generally increases the initial metacentric height (GM), thereby increasing the initial slope of the GZ curve and the maximum GZ. The effect of beam changes on GM is expressed as:

$$d\overline{GM} = 2\overline{BM}\frac{dB}{B} \qquad (2)$$

where $\overline{BM}$ is the metacentric radius (Moonesun, 2012).

6) Draught and centre of gravity/buoyancy changes

Changing the draught may alter KG and KB. Two cases are generally considered)Lewis, 2000(. If both KB and KG change proportionally with draught:

$$d\overline{GM} = (4\overline{BG} + 3\overline{GM})\frac{dB}{B} \qquad (3)$$

If KG remains constant while KB changes (Moonesun, 2012):

$$d\overline{GM} = (4\overline{BG} + 3\overline{GM} - \overline{KG})\frac{dB}{B} \qquad (4)$$

2.2. Flooding of compartments and instability in damaged conditions

2.2.1. IMO and SOLAS considerations in damaged conditions

Damage stability is an important consideration for passenger vessels. However, this study focuses exclusively on the intact stability of floating hotel barges. No simulations or analyses for flooding or damaged conditions are performed, and such scenarios are outside the scope of this work. Historical developments in SOLAS and IMO regulations provide general context for ship safety, but detailed review and modelling of damage stability are not addressed in this article. The recommendations and results presented here apply only to intact conditions.

2.2.2. List angle caused by the movement of passengers

Transverse movement of passengers or other movable loads inside the vessel can cause a list angle by shifting the vessel's centre of gravity away from the centre of buoyancy. The list angle (ϕ) can be estimated using Equation 5, considering the changes in KG, BG, and GM:

$$d\overline{GM} = (4\overline{BG} + 3\overline{GM} - \overline{KG})\frac{dB}{B} \qquad (5)$$

This section focuses on the conceptual impact of transverse load shifts on vessel stability, without modelling specific passenger movement scenarios.

2.3. Marine Stability Standards and Their Application to Floating Hotel Barges

To ensure proper stability of floating hotel barges, key criteria have been selected from international and national regulations, including IMO (IS Code), SOLAS, and Iranian Classification Society. Only parameters directly relevant to the study have been adopted. Table 1 summarises these criteria, their required values, and the rationale for their selection.

Regulatory Source	Stability Parameter	Adopted in Study	Reason
IMO (IS Code)	GM0 ≥ 0.15 m	Yes	Minimum initial metacentric height
IMO (IS Code)	Area under GZ curve 0–30° ≥ 0.055 m·rad	Yes	Ensures sufficient righting lever
Iranian Class	GM ≥ 0.095B (full load)	Yes	Local barge stability requirement
Deck edge immersion	Angle limit	Yes	Prevents excessive heel under load

Table 1. Key Stability Criteria Applied in This Study

This approach condenses the regulatory lists and provides clear guidance on which standards are applied and why, improving clarity and focus for the reader.

3. A CASE STUDY: HOTEL BARGE

Considering the stability challenges of floating structures, passenger ships, and barges, this section investigates the stability of a hotel barge with dimensions 100 m × 28 m × 6.5 m using Maxsurf software. No dedicated regulations exist for hotel barges; however, stability regulations for passenger ships and barges have been considered to create a practical assessment framework, discussed further in the recommendations section. Barge specifications are summarised in Table 2, and the general plan is shown in Figure 1.

It should be noted that the Maxsurf modelling does not involve a full 3D modelling of the entire hotel superstructure. Instead, a simplified rectangular barge has been modelled, and the effect of adding decks has been simulated by applying incremental weights corresponding to each deck. This approach allows assessment of the impact of additional decks on the centre of gravity, metacentric height, and overall stability without modelling the entire complex structure.

Similar approaches to floating hotel barge design and stability assessment have been reported in recent studies, e.g., Redesigning a 300 ft Barge as a Floating Hotel to Support Tourism in the Thousand Islands (2023), highlighting the importance of weight distribution, centre of gravity control, and adherence to IMO stability criteria) Pusaka, Gunawan & , Octaviani, 2023(.

LOA (m)	B (m)	D (m)	Scantling draft (m)	DWT (ton)	Deck loading (ton/m2)
100	28	6.5	5.5	10000	**10**

Table 2. Specifications of the barge

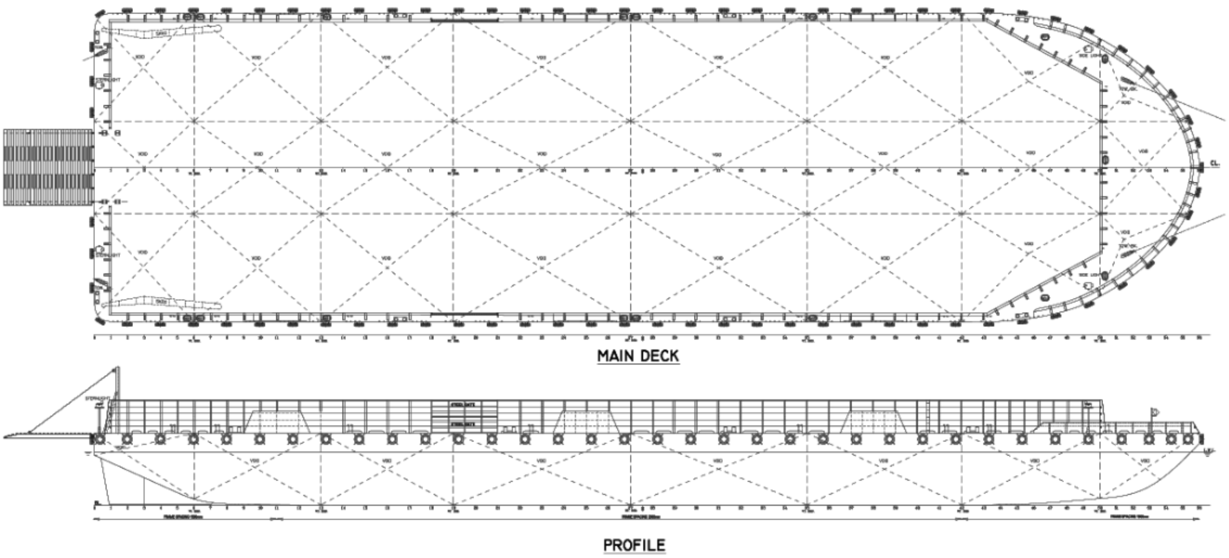


Figure 1. The barge plan

3.1. General Arrangement and Internal Architecture of Hotel Barge

The hotel barge is organised to optimise both functionality and stability. Deck layouts from the ground to the third deck are shown in Figures 2–15, with the corresponding weight distributions summarised in Table 3. To provide a clear overview of space usage, Figure 16 illustrates the percentage allocation of each functional area within the barge. Based on this figure, it is recommended that 24% of the total area is dedicated to corridors, lobby, stairs, and elevators; 2.2% to storage; 1.3% to the swimming pool; 4.7% to crew accommodation; 1.5% to laundry; 3.2% to galley; 8% to restaurant; 0.7% to prayer area; 1.4% to children's playground; 1% to cinema/theatre; 1% to sports hall; and 40% to passenger accommodation. Referencing this figure here allows readers to understand the spatial distribution before examining the detailed stability calculations in the recommendations section.

Recent studies on lightweight prefabricated floating buildings have demonstrated that the use of modular construction and low-density materials can significantly reduce the overall weight of the superstructure while maintaining adequate stability in shallow inland waters. For instance, a floating hotel apartment in Poland employed prefabricated modules with polyurethane insulation to optimise weight distribution and buoyancy, ensuring safe operation under limited draught conditions).)Lightweight prefabricated floating buildings for shallow inland waters. Design and construction of the floating hotel apartment in Poland, 2020(. These findings support the design approach adopted in the present hotel barge, where heavier components are placed in the lower decks and lighter materials in the upper decks to maintain a low centre of gravity.

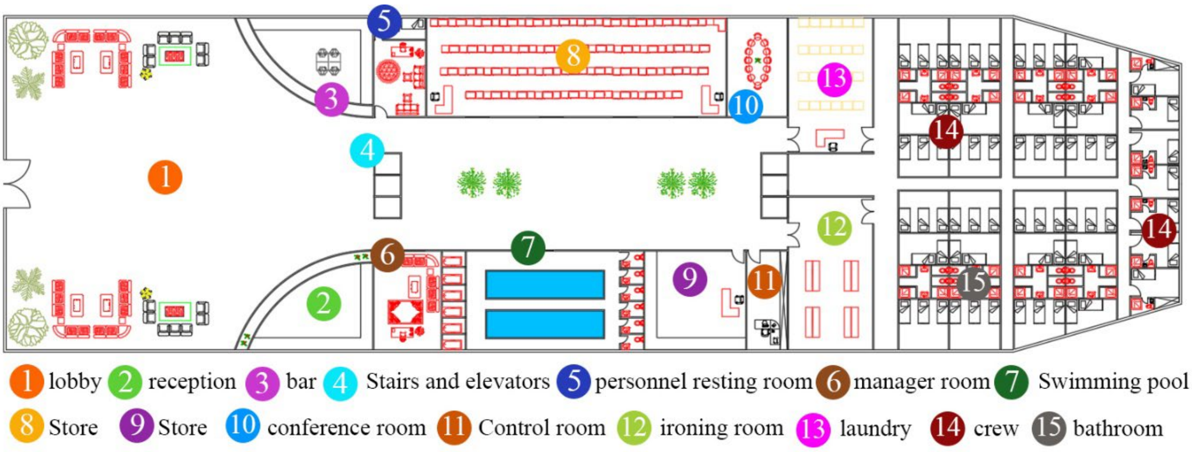
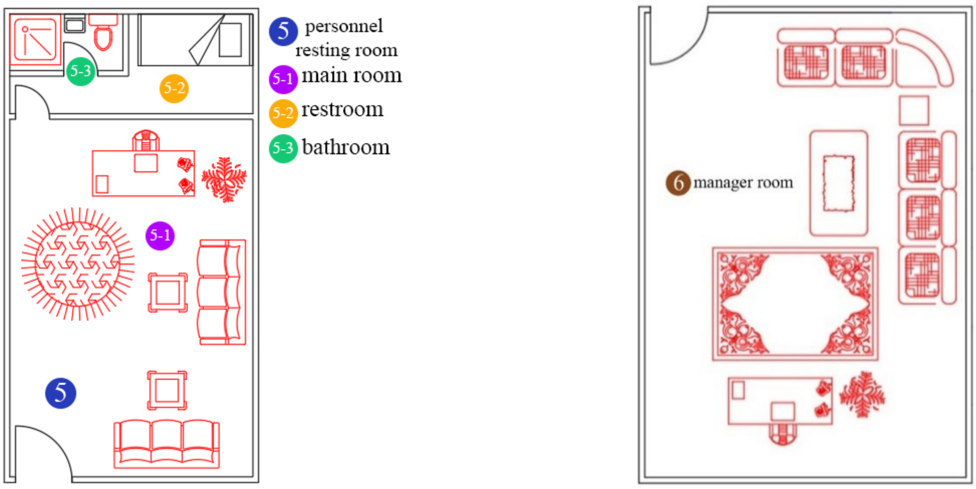


Figure 2. Ground deck plan



A: Personnel resting room

B: Manager room

Figure 3. Ground deck room plan

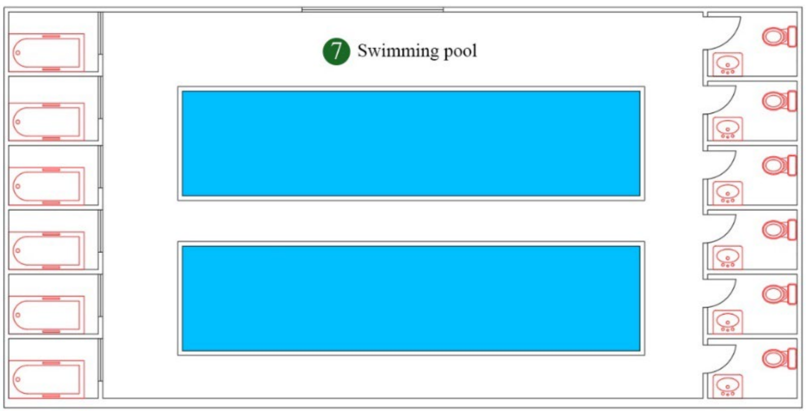
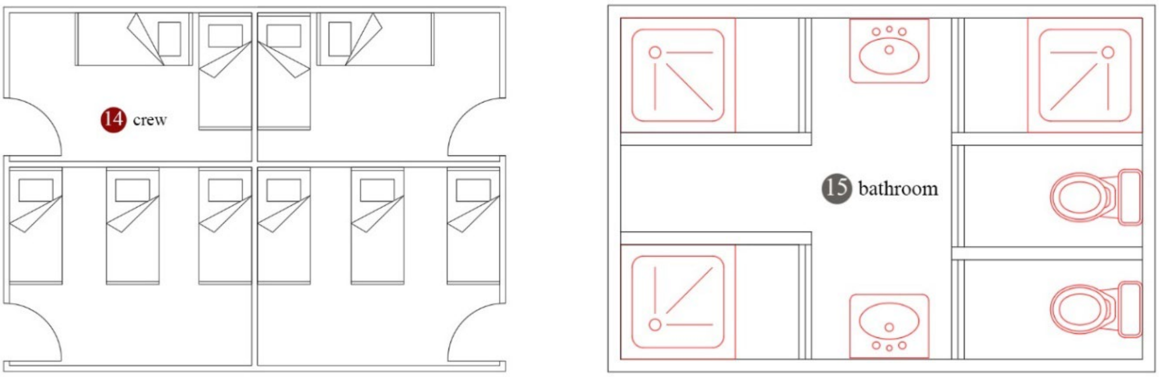


Figure 4. Ground deck swimming pool plan



A. Crew resting space

B. Bathroom

Figure 5. Ground deck crew and bathroom plan

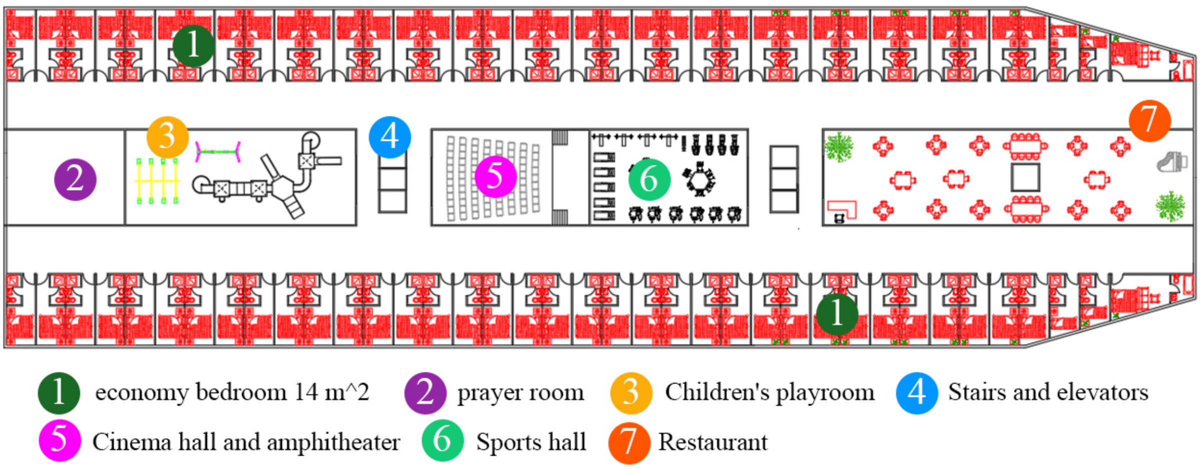


Figure 6. First deck plan

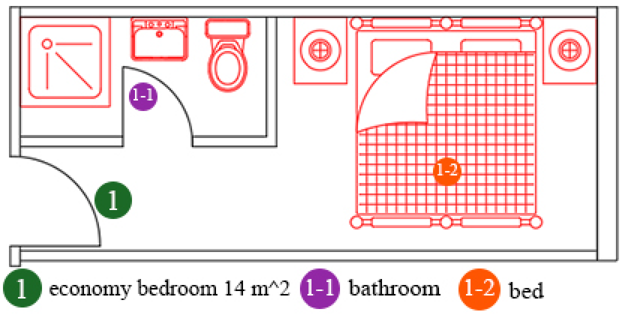


Figure 7. First deck room plan

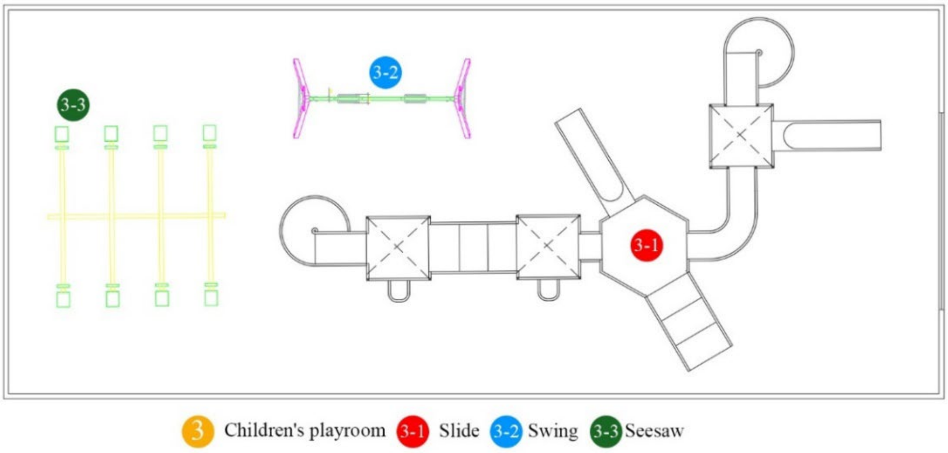
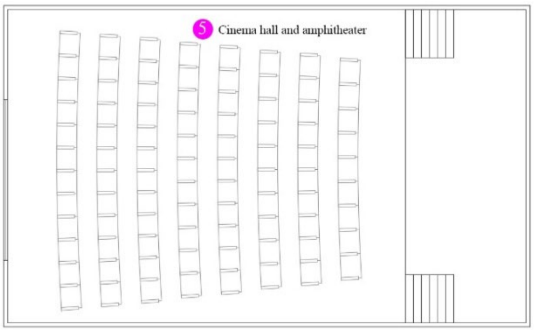
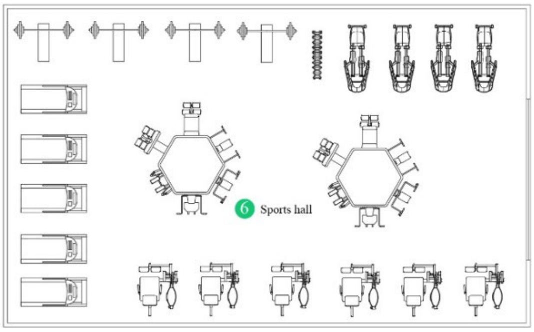


Figure 8. Children's playroom plan



A. Cinema hall and amphitheatre



B. Sports hall

Figure 9. Cinema hall and amphitheatre and sports hall plan

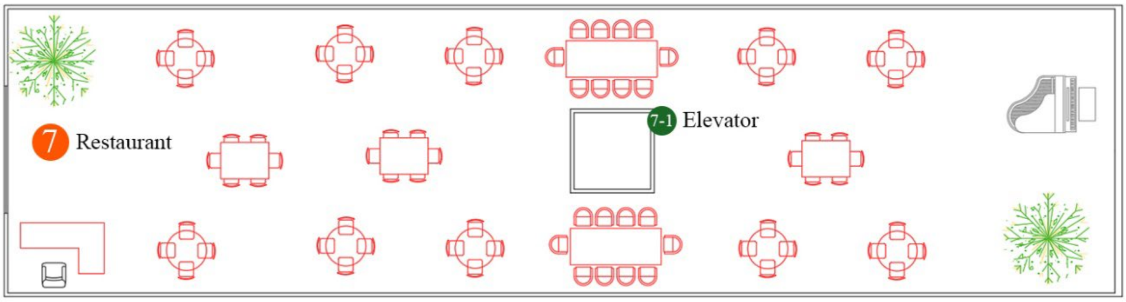


Figure 10. Restaurant

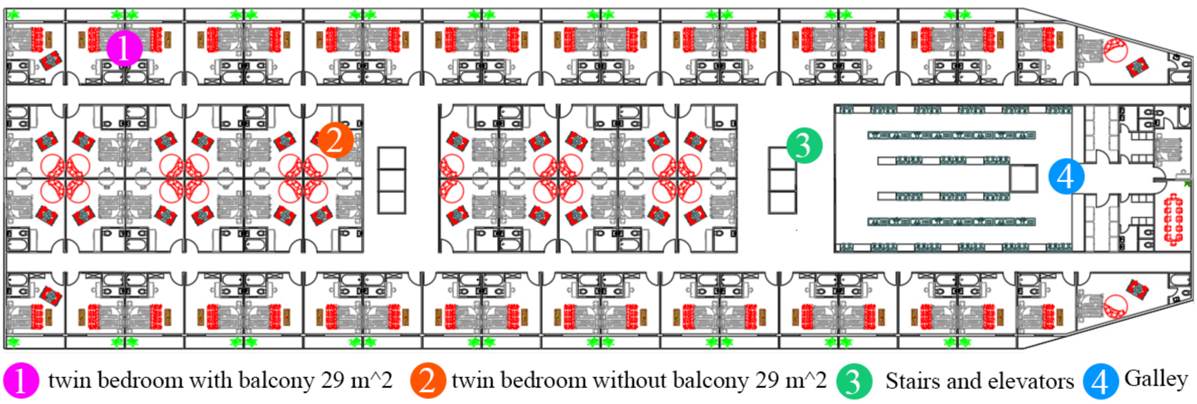
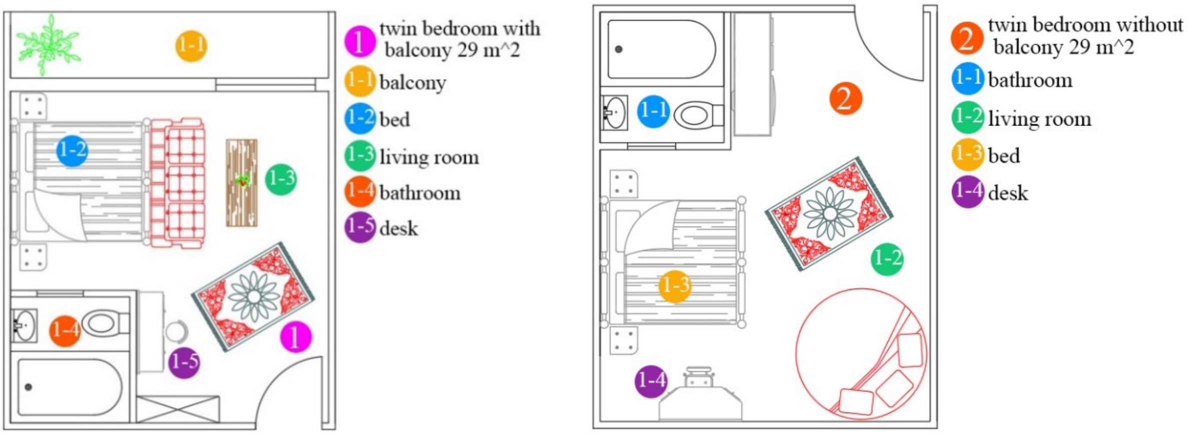


Figure 11. Second deck plan



A. twin bedroom with balcony

B. twin bedroom without balcony

Figure 12. Second deck twin bedroom with and without balcony plan

Figure 13. Galley

Figure 14. Third deck plan

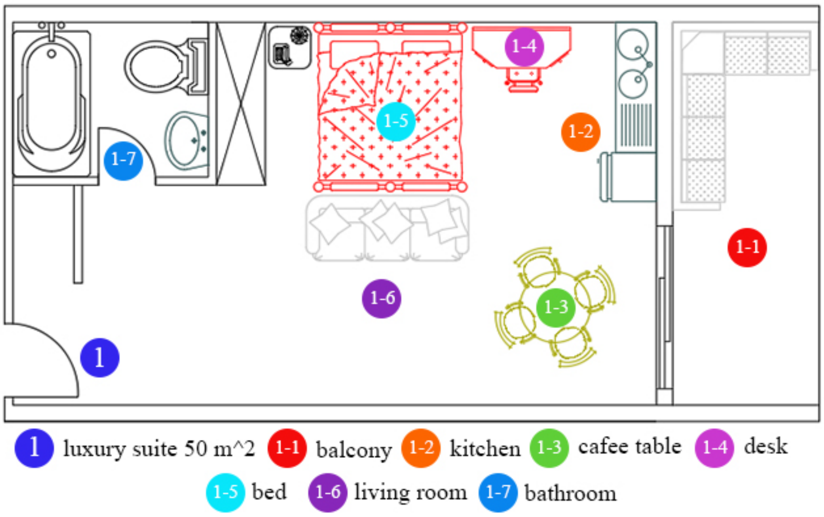


Figure 15. Third deck room plan

Item	Weight (ton)	Percent %	consideration
Barge	5000	85	
Fuel consumption for 10 days	6	0.1	
Diesel generator	1.8	0.03	
The steel structure of the decks	0.165	0.003	
The stairs	7.14	0.123	Live load 500 kg/m^2
Elevators	5.4	0.1	
Aluminium wall structure	32.3	0.6	40 kg/m^2
Wood or composite veneer	4.03	0.1	5 kg/m^2
Deck structure of each deck	768.3	13.1	280 kg/m^2
Flooring of each deck plus the carpet	19.21	0.33	7 kg/m^2
Mechanical and electrical installations of each deck + piping and cabling	3.5	0.1	3.5 ton
Beds	2.1	0.04	
Cupboards, tables and chairs	5	0.1	
Sanitary systems (bathroom and toilet)	0.8	0.02	
Passenger weight of each deck	10.13	0.2	each person 75 kg
Total	5865.88		

Table 3. Weight distribution table

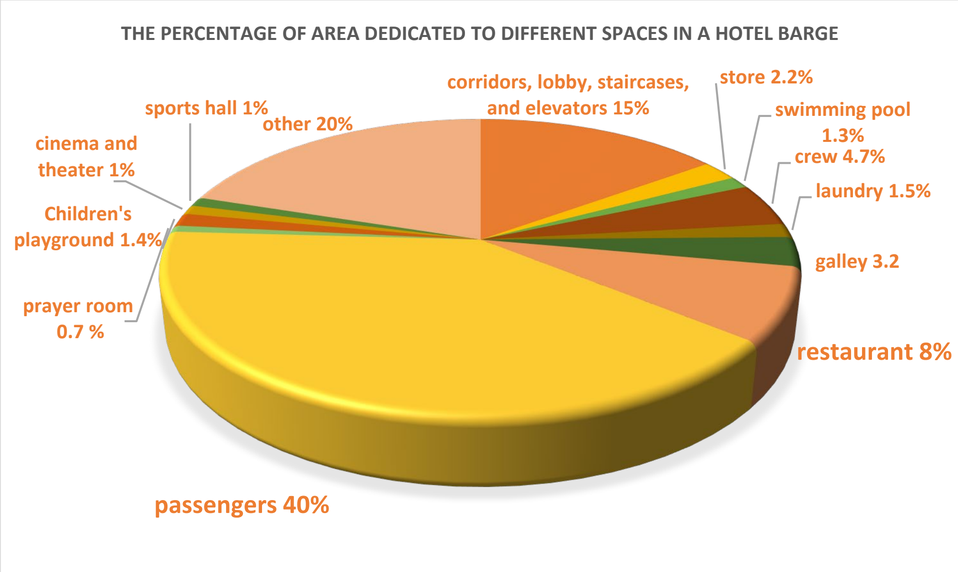


Figure 16. The percentage of area dedicated to different spaces in a hotel barge

3.2. Evaluation of stability conditions by modelling in Maxsurf software

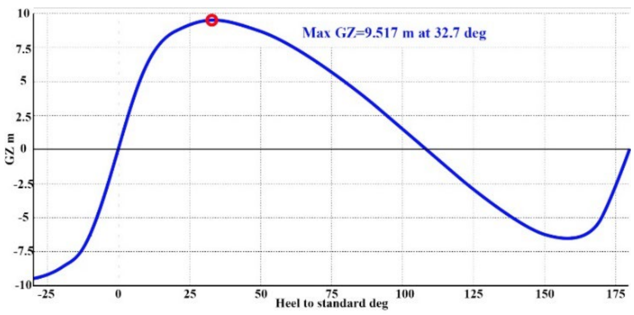
The stability of the single barge was first analysed, then hotel decks were gradually added. At each stage, the stability was recalculated and assessed using international standards and IMO criteria. Modelling results are summarised in Table 4 and Figure 17 (GZ curves). Compliance with criteria is confirmed in Table 5. A minimum reserve of buoyancy (ROB) of 30% was set as the safety threshold; any configuration reducing ROB below this value is considered unsafe. According to Table 4B, the ROB drops below the minimum SOLAS limit of 30% when 10 and 11 decks are added (ROB = 22% and 14%, respectively). Therefore, although the barge may still float, only configurations up to 9 decks fully comply with international stability standards.

No	Condition	Displacement (ton)	Draft (m)	VCG (m)	KB (m)	BM (m)
16-A	Barge without any deck	5007.8	1.74	3.25	0.87	**37.4**
16-B	Barge with 1 deck	6030.6	2.1	3.35	1.05	**31.1**
16-C	Barge with 2 deck	7065.8	2.5	3.45	1.25	**26.1**
16-D	Barge with 3 Deck	8100	2.8	3.55	1.4	**23.3**
16-E	Barge with 4 Deck	9135	3.18	3.65	1.59	**20.5**
16-F	Barge with 5 Deck	10170	3.54	3.75	1.77	**18.5**
16-G	Barge with 6 Deck	11205	3.90	3.85	1.95	**16.7**
16-H	Barge with 7 Deck	12240	4.27	3.95	2.13	**15.3**
16-I	Barge with 8 Deck	13275	4.63	4.05	2.31	**14.1**
16-J	Barge with 9 Deck	14310	4.99	4.15	2.49	**13.1**
16-K	Barge with 10 Deck	15345	5.35	4.25	2.67	**12.2**
16-L	Barge with 11 Deck	16380	5.71	4.35	2.85	**11.5**

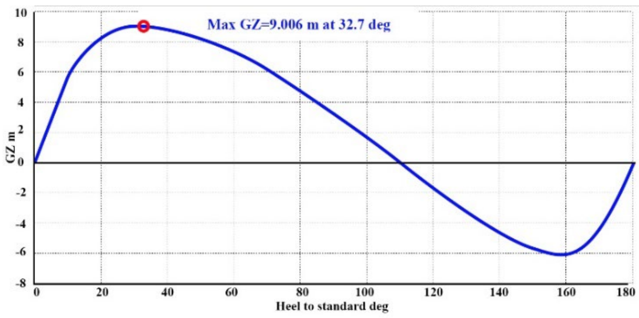
Table 4.A. Modelling results under different conditions as shown in Figure 17

No	Condition	KM (m)	GM (m)	Freeboard (m)	ROB (%)	DEW (deg)
16-A	Barge without any Dec	38.3	35.1	4.755	273	**18.8**
16-B	Barge with 1 Deck	32.2	28.8	4.40	210	**17.2**
16-C	Barge with 2 Deck	27.2	23.9	4	160	**16.2**
16-D	Barge with 3 Deck	24.7	21.2	3.7	130	**14.6**
16-E	Barge with 4 Deck	22.12	18.5	3.32	104	**13.5**
16-F	Barge with 5 Deck	20.23	16.48	2.96	84	**11.9**
16-G	Barge with 6 Deck	18.69	14.84	2.60	66	**10.8**
16-H	Barge with 7 Deck	17.45	13.5	2.24	52	**9.1**
16-I	Barge with 8 Deck	16.44	12.39	1.88	41	**7.41**
16-J	Barge with 9 Deck	15.60	11.45	1.51	30	**6.28**
16-K	Barge with 10 Deck	14.89	10.64	1.15	22	**4.6**
16-L	Barge with 11 Deck	14.30	9.95	0.79	14	**3.43**

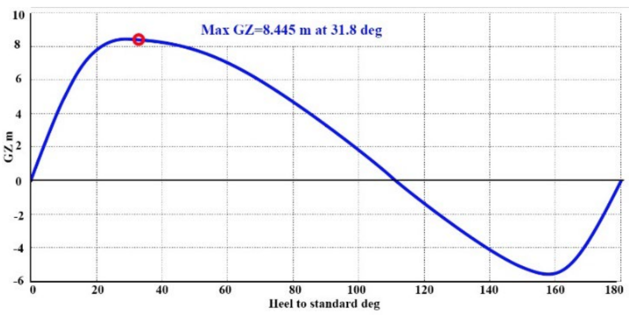
Table 4.B. Modelling results under different conditions as shown in Figure 17



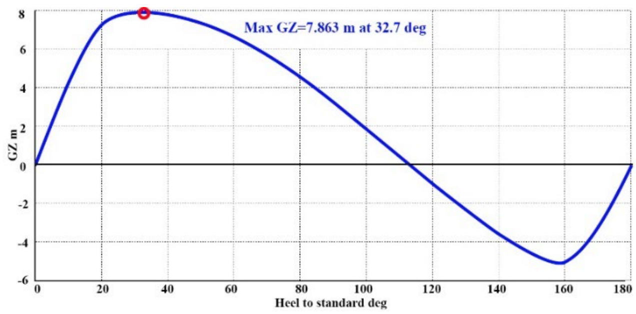
17-A) GZ curve when barge supports only its own weight: Max GZ=9.517 m at 32.7 deg



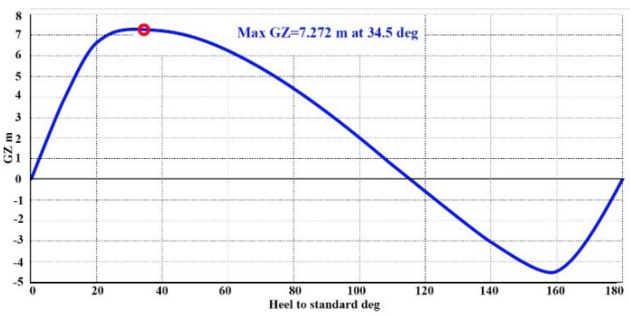
17-B) GZ curve when barge supports the weight of 1 deck in addition to its own weight: Max GZ=9.006 m at 32.7 deg



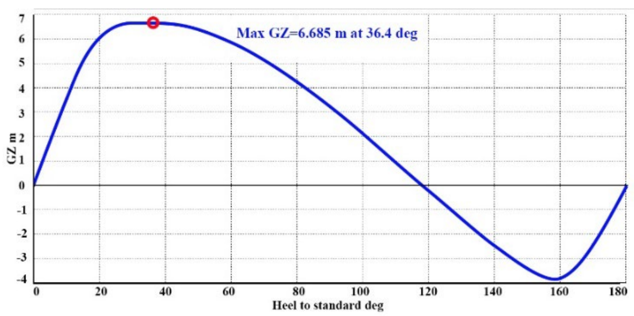
17-C) GZ curve when barge supports the weight of 2 decks in addition to its own weight: Max GZ=8.445 m at 31.8 deg



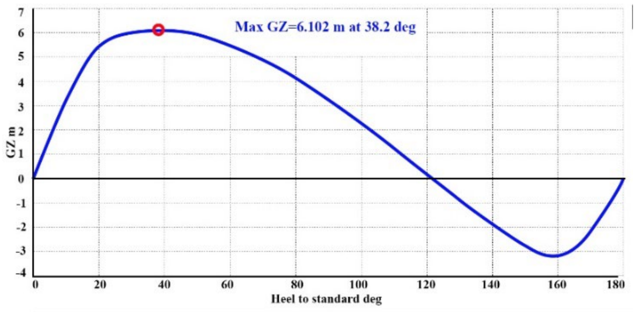
17-D) GZ curve when barge supports the weight of 3 decks in addition to its own weight: Max GZ=7.863 m at 32.7 deg



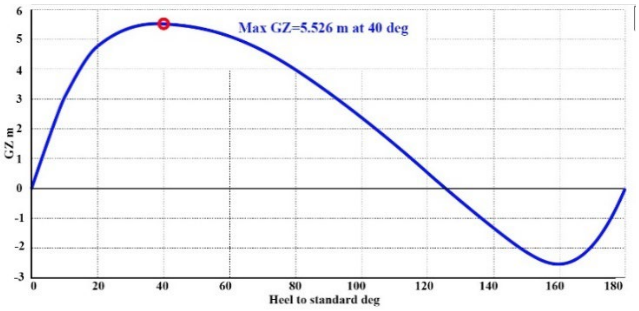
17-E) GZ curve when barge supports the weight of 4 decks in addition to its own weight: Max GZ=7.272 m at 34.5 deg



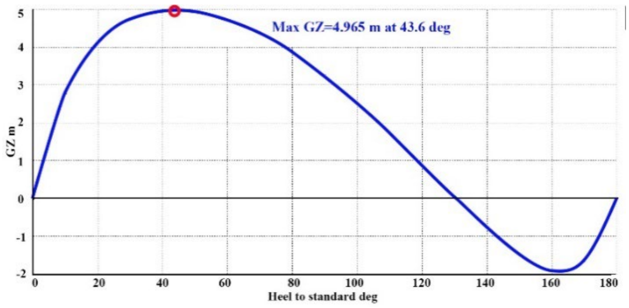
17-F) GZ curve when barge supports the weight of 5 decks in addition to its own weight: Max GZ=6.685 m at 36.4 deg



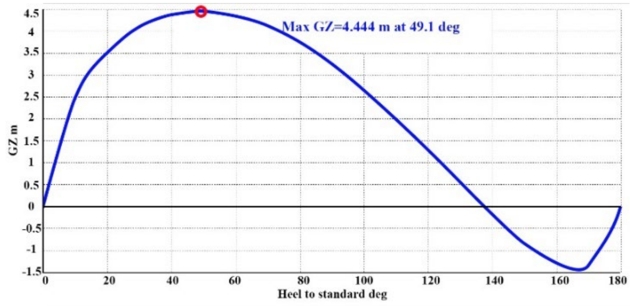
17-G) GZ curve when barge supports the weight of 6 decks in addition to its own weight: Max GZ=6.102 m at 38.2 deg



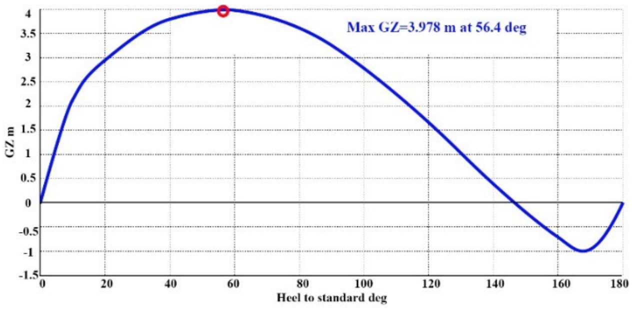
17-H) GZ curve when barge supports the weight of 7 decks in addition to its own weight: Max GZ=5.526 m at 40 deg



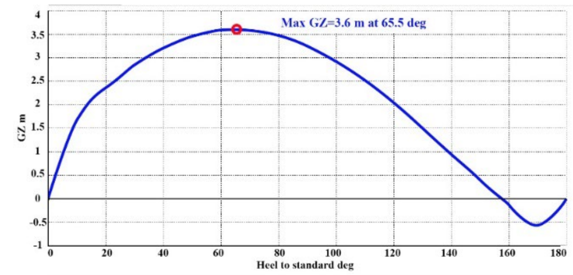
17-I) GZ curve when barge supports the weight of 8 decks in addition to its own weight: Max GZ=4.965 m at 43.6 deg



17-J) GZ curve when barge supports the weight of 9 decks in addition to its own weight: Max GZ=4.444 m at 49.1 deg



17-K) GZ curve when barge supports the weight of 10 decks in addition to its own weight: Max GZ=3.978 m at 56.4 deg



17-L) GZ curve when barge supports the weight of 11 decks in addition to its own weight: Max GZ=3.6 m at 65.5 deg

Figure 17. Righting arm (GZ) curves at different stages of hotel deck additions

Criteria		17-A	17-B	17-C	17-D	17-E	17-F
SOLAS & IMO	$GM_0 \geq 0.15\,m$	35.1	28.8	23.9	21.2	18.5	16.5
	$\mathrm{GZ}_{30\mathrm{deg}} \geq 0.20\,m$	9	8.7	8.3	7.5	6.9	6.5
	$\mathrm{Angle}_{\mathrm{GZmax}} \geq 25\,deg$	32.7	32.7	31.8	32.7	34.5	36.4
	$\mathrm{Area}_{0-30\mathrm{deg}} \geq 0.055\,m.rad$	5.04	4.9	4.65	4.2	3.86	3.64
	$\mathrm{Area}_{0-40\mathrm{deg}} \geq 0.09\,m.rad$	6.7	6.4	6.13	5.5	5.1	4.8
	$\mathrm{Area}_{30-40\mathrm{deg}} \geq 0.03\,m.rad$	1.62	1.56	1.5	1.33	1.22	1.14
	$\mathrm{Angle}_{\mathrm{passenger}} < 10\,deg$	0	0.02	0.02	0.115	0.02	0.3
	$\mathrm{Angle}_{\mathrm{turning}} < 10\,deg$	_*	_*	_*	_*	_*	_*
	φ_0 16◦ and 80% of angle of deck edge immersion, whichever is less	0.5	0.7	1.2	1.2	1.3	1.5
Iranian Classification Society Rulesm & 2022 KR-Rules & Guidance	Lightship condition GM ≥ 0.164B	35.1≤4.6	_	_	_	_	_
	Full load condition GM ≥ 0.095B	_	28.8≤2.7	23.9	21.2	18.5	16.5
Passenger Ship Rules (S. I. No. 1216)	Margin line not to be immersed	76 mm	76 mm	76 mm	76 mm	76 mm	76 mm
	GM at least 0.05m in equilibrium position after flooding	0.1	0.1	0.1	0.1	0.2	0.2
	positive GZ > 5 deg	108	110	112	114	116	118
	$GZ_{max} \geq 0.03\,m$	9.52	9.01	8.45	7.9	7.3	6.7
1990 Passenger Ship Rules (One compartment flooding)	Area under GZ curve up to 22 deg > 0.015 m.rad	3.3	3.16	3	2.7	2.42	2.3
	$GZ_{max} \geq 0.05\,m$	9.52	9.01	8.45	7.9	7.3	6.7
USSR 1987 PASSENGER SHIPS	Final equilibrium angle for DECK EDGE IMMERSED < 15 degrees	1	1	2	2	2	3
	Final equilibrium angle for DECK EDGE NOT IMMERSED < 17 degrees	1	1	2	2	2	3
	positive GZ > 20 deg	108	110	110	115	115	118
	Maximum GZ to be at least 0.1 metre within the 20 degree range	8.7	8	7.8	7	6.5	6
	Deck edge not immersed at equilibrium angle	Pass	pass	pass	pass	pass	pass

Table 5.A. Comparison of software modelling results with international standards

Criteria		17-G	17-H	17-I	17-J	17-K	17-L
SOLAS & IMO	$GM_0 \geq 0.15\ m$	14.8	13.5	12.4	11.5	10.6	10
	$\mathrm{GZ}_{30\mathrm{deg}} \geq 0.20\ m$	5.8	5.2	4.5	4	3.5	2.7
	$\mathrm{Angle}_{\mathrm{GZmax}} \geq 25\ deg$	38.2	40	43.6	49.1	56.4	65.5
	$\mathrm{Area}_{0-30\mathrm{deg}} \geq 0.055\ m.rad$	3.25	2.91	2.52	2.24	1.96	1.51
	$\mathrm{Area}_{0-40\mathrm{deg}} \geq 0.09\ m.rad$	4.3	3.8	3.3	2.91	2.5	1.9
	$\mathrm{Area}_{30-40\mathrm{deg}} \geq 0.03\ m.rad$	1.01	0.9	0.8	0.67	0.6	0.42
	$\mathrm{Angle}_{\mathrm{passenger}} < 10\ deg$	0.34	0.4	0.52	0.6	0.7	0.745
	$\mathrm{Angle}_{\mathrm{turning}} < 10\ deg$	_*	_*	_*	_*	_*	_*
	φ_0 16◦ and 80% of angle of deck edge immersion, whichever is less	2	1.6	1.7	2	2	2.5
Iranian Classification Society Rules & 2022 KR-Rules & Guidance	Lightship condition GM ≥ 0.164B	–	–	–	–	–	–
	Full load condition GM ≥ 0.095B	14.8	13.5	12.4	11.5	10.6	10
Passenger Ship Rules (S. I. No. 1216)	Margin line not to be immersed	76 mm	76 mm	76 mm	76 mm	76 mm	76 mm
	GM at least 0.05m in equilibrium position after flooding	0.2	0.3	0.3	0.3	0.4	0.4
	positive GZ > 5 deg	120	125	130	138	145	158
	$GZ_{max} \geq 0.03\ m$	6.1	5.53	4.97	4.44	3.98	3.6
1990 Passenger Ship Rules (One compartment flooding)	Area under GZ curve up to 22 deg > 0.015 m.rad	1.97	1.7	1.44	1.23	1.03	0.7
	$GZ_{max} \geq 0.05\ m$	6.1	5.53	4.97	4.44	3.98	3.6
USSR 1987 PASSENGER SHIPS	Final equilibrium angle for DECK EDGE IMMERSED < 15 degrees	3	4	4	4	5	5
	Final equilibrium angle for DECK EDGE NOT IMMERSED < 17 degrees	3	4	4	4	5	5
	positive GZ > 20 deg	120	126	130	138	148	158
	Maximum GZ to be at least 0.1 metre within the 20 degree range	5.4	4.7	4	3.5	3	2.3
	Deck edge not immersed at equilibrium angle	pass	pass	pass	pass	pass	pass

Table 5.B. Comparison of software modelling results with international standards

* The turning angle criterion in IMO/SOLAS regulations accounts for the heeling moment generated when a vessel actively manoeuvres under its own propulsion. Since the hotel barge is stationary and moored, it does not experience turning-induced heeling moments; therefore, this criterion is not applicable.

3.3. Analysis of results obtained from modelling

With increasing load and deck additions, draught increases and reserve of buoyancy decreases (Figure 17). While the superstructure is relatively light, the centre of gravity does not increase significantly with each additional deck (Figure 18).

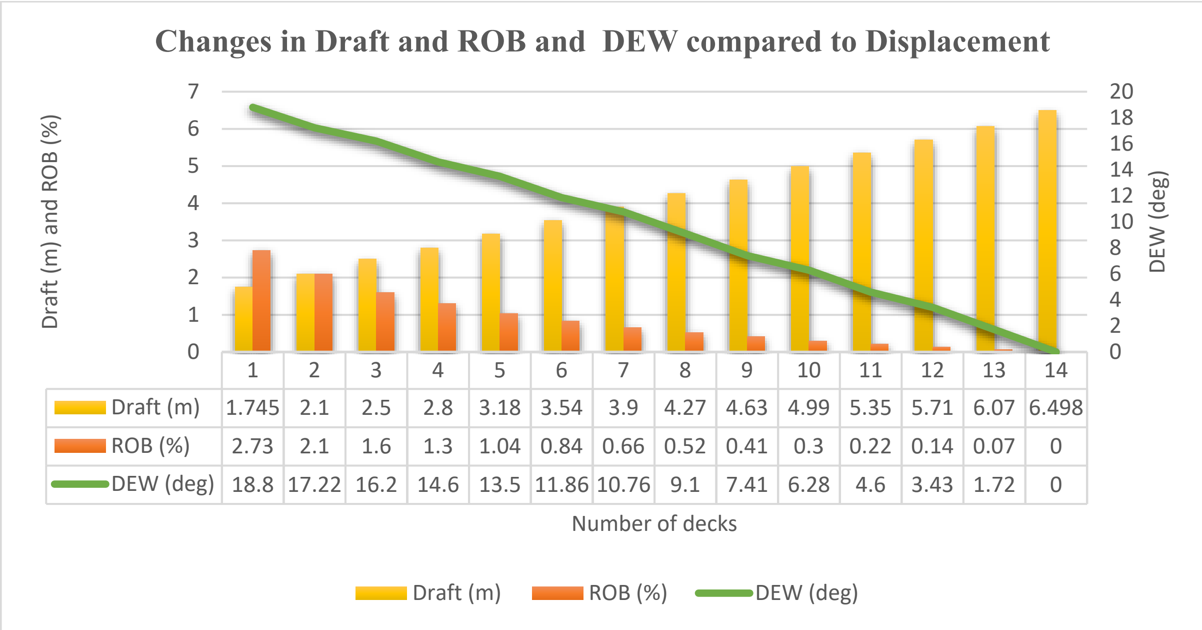


Figure 17. Graph of changes in draught, reserve of buoyancy, and deck edge wetness with displacement according to Table 4.

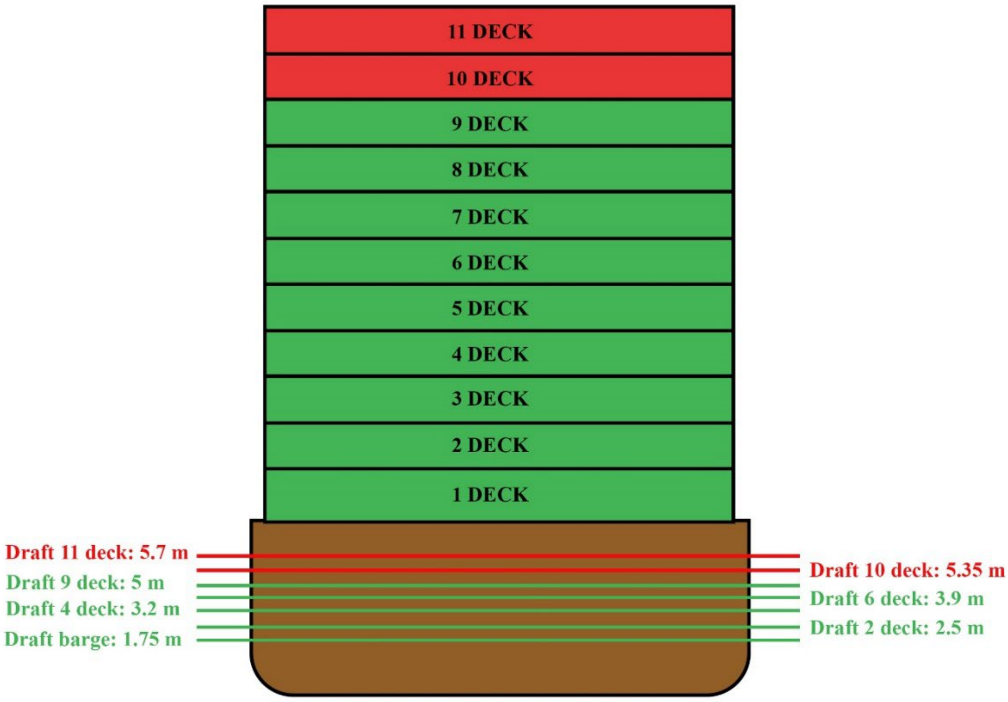


Figure 18. Increasing draught based on increasing number of decks

Although initial modelling suggested that the barge could remain stable with up to 11 decks, the ROB falls below the minimum 30% threshold beyond 9 decks. Therefore, the hotel barge can safely accommodate up to 9 decks while meeting all safety criteria. This adjustment resolves the previous contradiction between Table 6B and the conclusions. Recommendations for achieving appropriate stability are provided in the next section.

4. "HASANI RECOMMENDATIONS" FOR STABILITY CRITERIA OF HOTEL BARGES

At the end of this study, a set of stability recommendations, referred to as "Hasani Recommendations," is proposed for hotel barges. These recommendations are based on hydrostatic principles, the conceptual case study barge, and an assessment of passenger ship and barge stability criteria. They provide practical guidance for naval architects and designers to ensure safe operation while maintaining adequate metacentric height (GM) and reserve of buoyancy (ROB).

1) A minimum of 30% reserve of buoyancy (ROB) is required to maintain stability under loading and potential flooding.

2) Minimum ratio of ROB to the number of decks: 3.3, ensuring that each additional deck does not excessively compromise stability.

3) GM considered to be at 40% of the beam (B).

4) Ratio of the height of the entire structure to the breadth of the barge: approximately 1.1 (Figure 19).

5) Minimum ratio of freeboard to superstructure height: 0.06 (Figure 19).

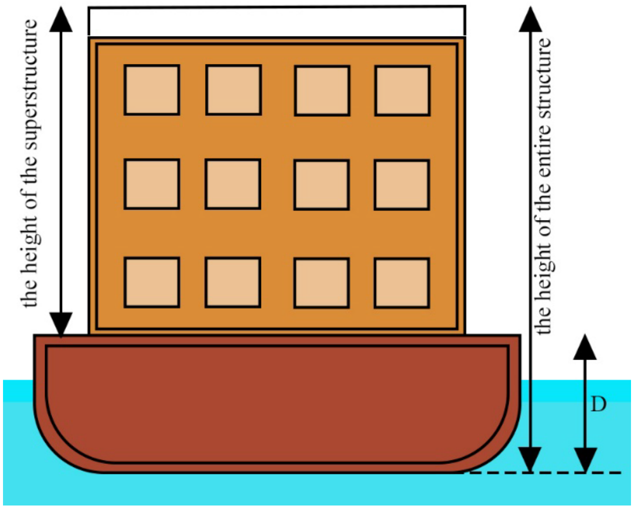


Figure 19. Introducing the depth, height of the entire structure and the height of the superstructure of the hotel barge

6) Deck loading: 0.38 ton/m² recommended to maintain low centre of gravity.

7) Derivation of Equations 8 and 9:

$$n = \left(\frac{10LD}{B^2}\right) + 1 \qquad (8)$$

Equation 8estimates the maximum number of decks n for a barge of length L, breadth B, and depth D. This approximation assumes a uniform distribution of weight and typical deck loading, ensuring that GM and ROB remain within safe limits.

$$h = \frac{L}{B} * 1.4D \qquad (9)$$

Equation 9 provides a simplified estimate of the total height of the structure h, derived to maintain a low centre of gravity relative to the barge breadth and to respect standard L/B ratios for stability.

Now, applying these recommendations to the case study barge (L = 100 m, B = 28 m, D = 6.5 m) yields the results shown in Table 6.

Recommendations	Calculations
The minimum ratio of reserve of bouyancy to the number of decks is considered to be 3.3.	30/9=3.3
GM is considered to be 0.4B	0.4*28=11.2
The ratio of the height of the entire structure to the breadth of the barge is considered to be about 1.1	32.1/28=1.1
The minimum ratio of freeboard to the height of the superstructure is considered to be 0.06	1.51/25.6=0.06
The ratio of weight per square metre on each deck of the hotel barge should be recommended to be $\mathbf{0.38\ ton/m^2}$	1035/2744=0.38
$\boldsymbol{n = \left(\frac{10LD}{B^2}\right) + 1}$	$n = \left(\frac{10 * 100 * 6.5}{28^2}\right) + 1 = 9.3$
$\boldsymbol{h = \frac{L}{B} * 1.4D}$	$h = \frac{100}{28} * 1.4 * 6.5 = 32.5$

Table 6. Summary of recommended stability parameters

5. CONCLUSION

This technical note presents static stability considerations for determining the number of decks and general arrangement of a floating hotel barge according to standard rules. Excessive deck additions increase the vertical centre of gravity (KG), potentially affecting stability. In the studied barge, KG rises only slightly with added decks because the main weight is concentrated in the steel hull, while upper decks and superstructure are relatively light. A minimum reserve of buoyancy (ROB) of 30% is necessary to mitigate the risk of loss of stability under emergency conditions, such as uneven passenger movement or flooding. Modelling results indicate that, although initial calculations suggested the 11-deck configuration might float, the ROB falls below the 30% threshold beyond 9 decks. Therefore, the hotel barge is considered stable for up to 9 decks, satisfying all defined safety criteria. To maintain stability, heavier decks and tanks are positioned in lower parts of the barge, and lighter components are placed higher. Stability criteria were verified against marine standards, including initial metacentric height (GM), area under the GZ curve, ROB, and deck edge immersion. Based on the case study, the following design recommendations are proposed for floating hotel barges: Minimum ROB: 30%. Minimum ratio of ROB to the number of decks: 3.3. Metacentric height (GM): 0.4B. Height-to-breadth ratio of entire structure: ~1.1. Minimum freeboard-to-superstructure height ratio: 0.06. Deck loading: 0.38 t/m². Deck number estimation: n = 10 L D B 2 + 1 n= B 2 10LD +1. Overall barge height estimation: h = L B · 1.4 D h= B L ·1.4D.

It is also suggested that 24% of the total barge space of the hotel be allocated to the corridors, lobby, stairs, and elevators and 2.2% to the store. 1.3 percent to the swimming pool, 4.7 percent to the accommodation of the crew, 1.5 percent to the laundry and ironing room, 3.2% to the dining room, 8% to the restaurant, 0.7% to the place of prayer, 1.4% to the children's playground, 1% to the cinema and theatre, 1% to the sport hall, and 40% to accommodate passengers (Younis, Ramadan, Mostafa, & El-Barbary, 2016).

These recommendations are based on the modelled case study and should be adapted to specific operational and design conditions of real-world hotel barges. The methodology provides a practical framework for stability analysis of similar floating hotel structures.

CONFLICT OF INTEREST

Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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NOMENCLATURE

IMO	International Maritime Organisation
GZ	the "righting moment" or "righting arm" acting to restore a tilting ship to vertical
RO-RO	Roll On-Roll Off
C_{wp}	area of waterplane coefficient
I_{xx}	Moment of inertia of the draft plate
KM	The distance between the keel and the metacentric center
KB	The distance between the keel and the buoyancy center
B	The centre of the body's underwater volume
K	Keel of ship
GM	metacentric height
SOLAS	International Convention for the Safety of Life at Sea
VLCC	Very Large Crude Carrier
LOA	Length Overall
B	Breadth
D	Depth
DWT	Dead Weight Tonnage
LWT	Light Weight Tonnage
Δ	Displacement
VCG	Vertical Centre of Gravity
ROB	Reserve Of Buoyancy
DEW	Deck Edge Wetness
margin line	a line that is 75 mm below the bulkhead deck side