FIGURES

LIST OF FIGURES

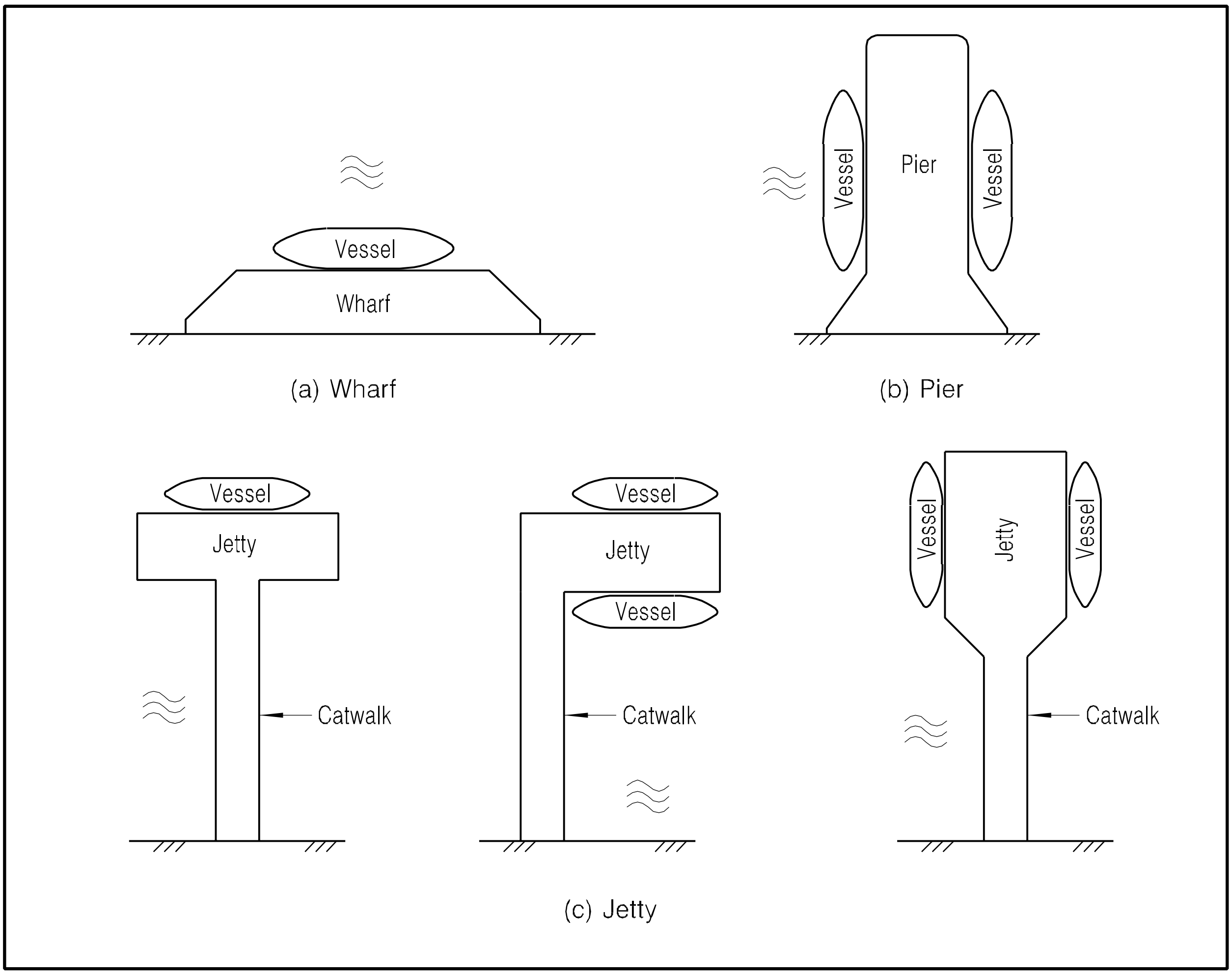


Figure 1 – Layout of Piers

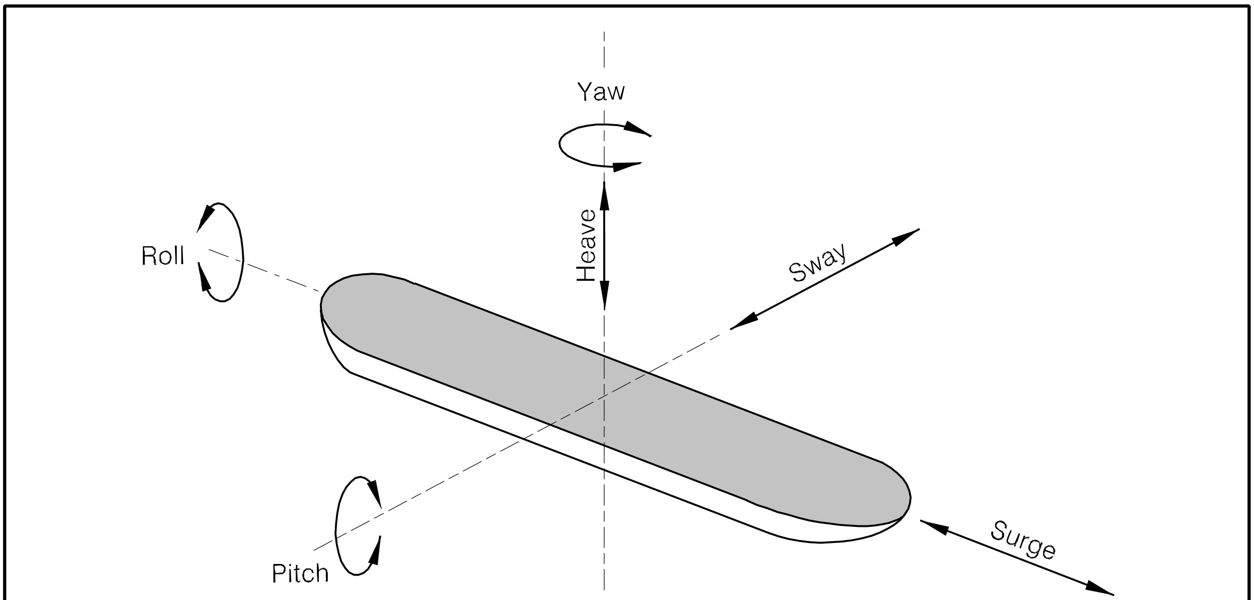
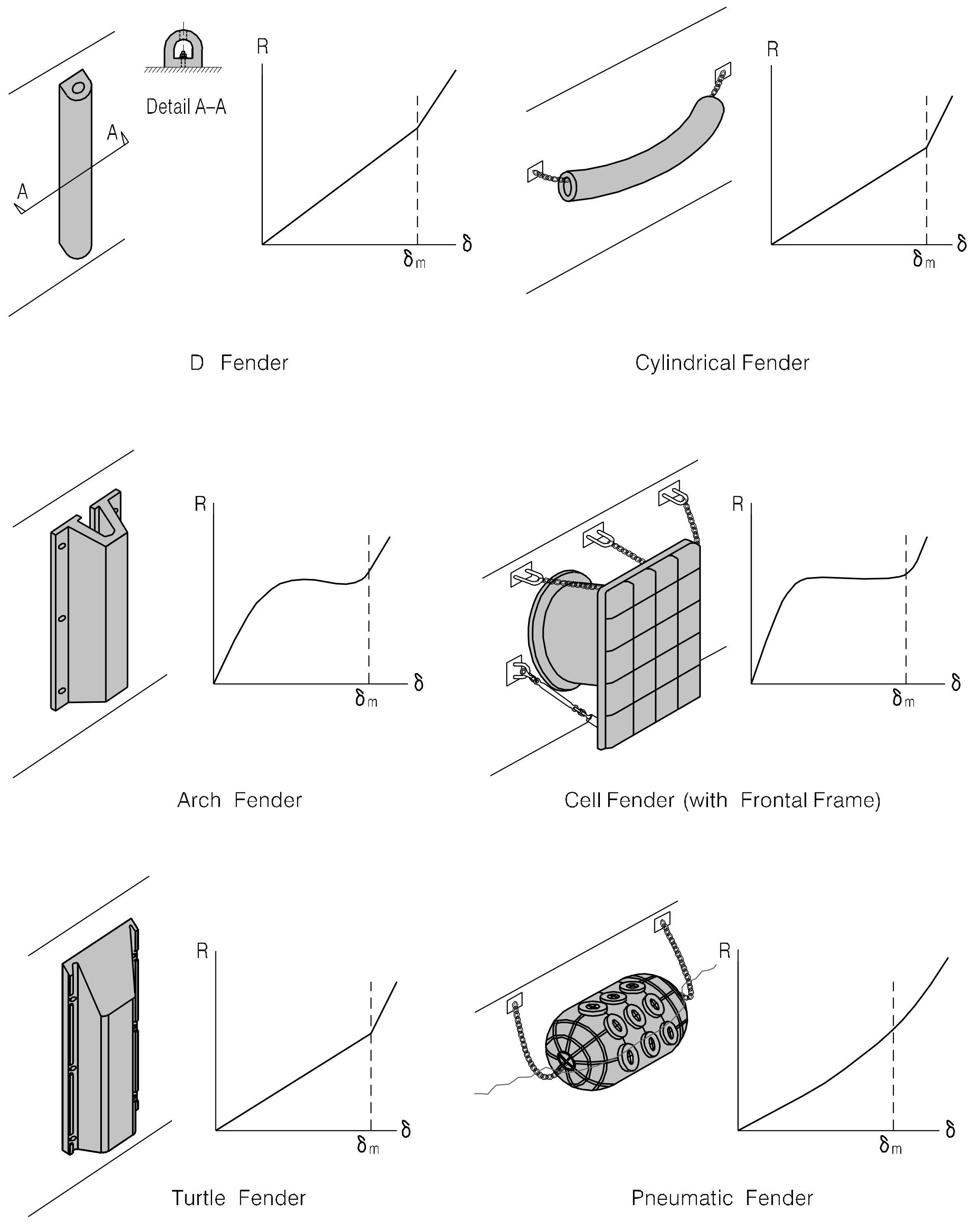


Figure 2 – Degree of Freedom of Vessel Movement



Legend :

R = reaction force

δ = deflection

δ_m = deflection limit under normal impact conditions

Figure 3 – Rubber Fenders

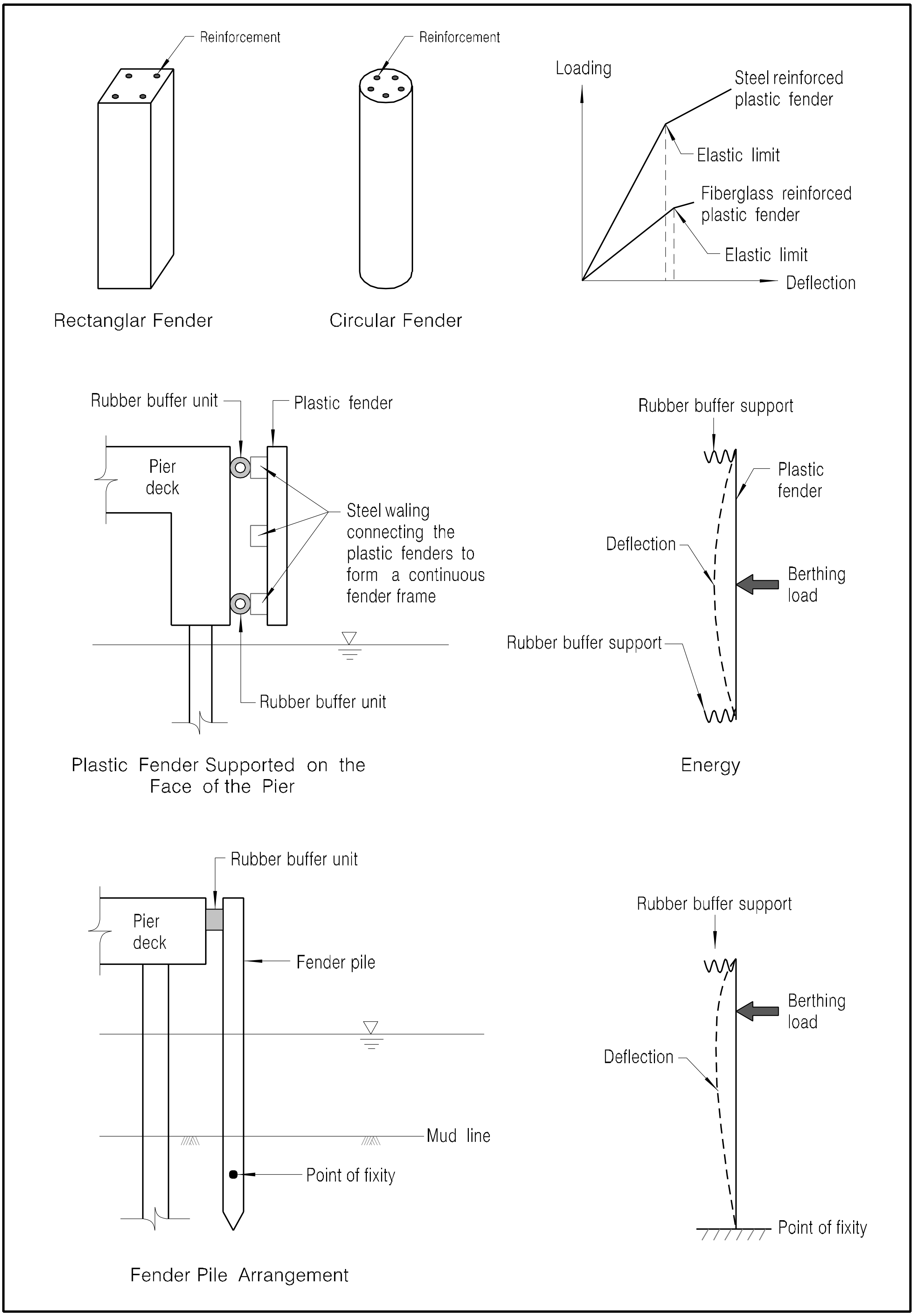


Figure 4 – Plastic Fenders

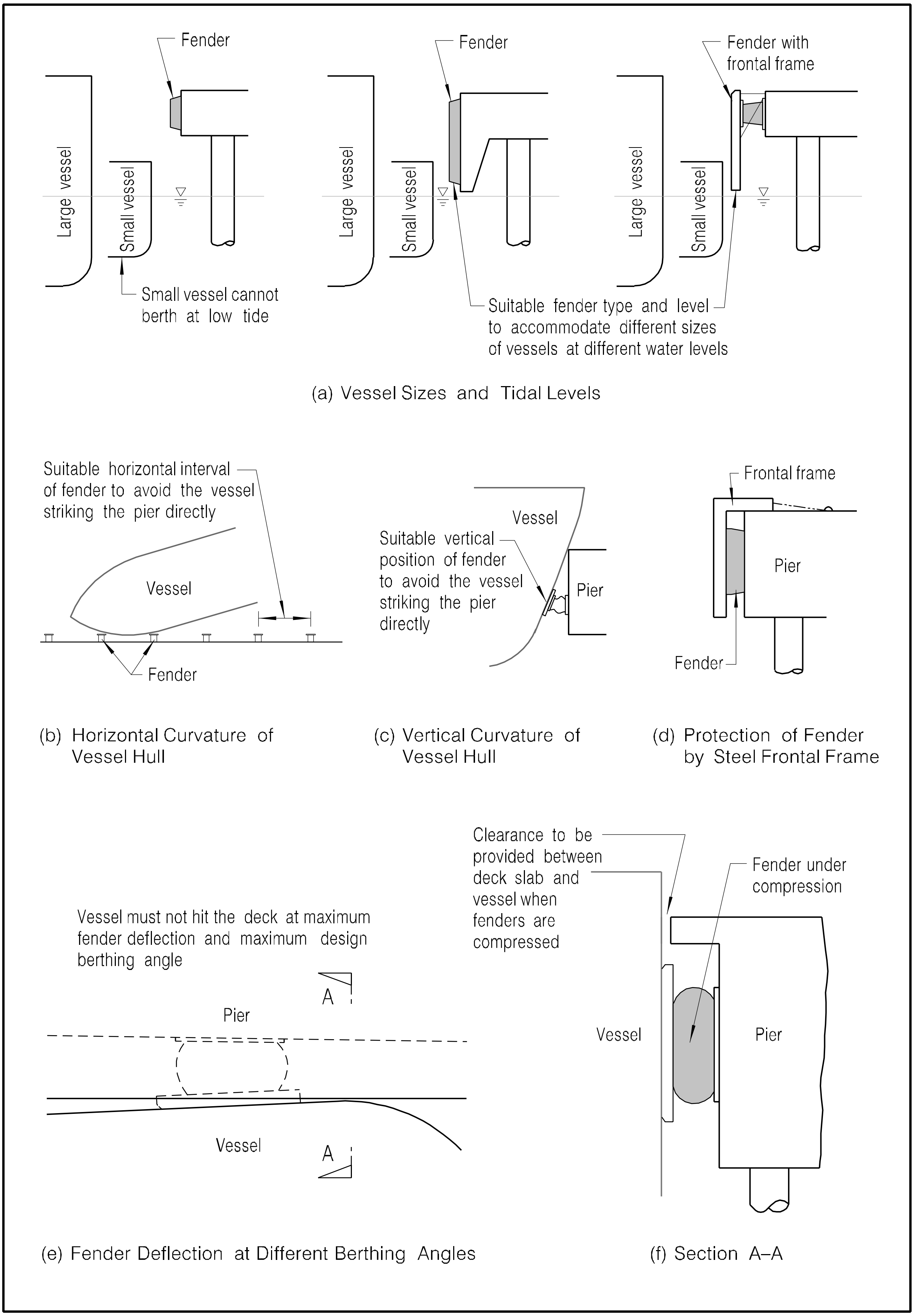


Figure 5 – Fender Arrangement

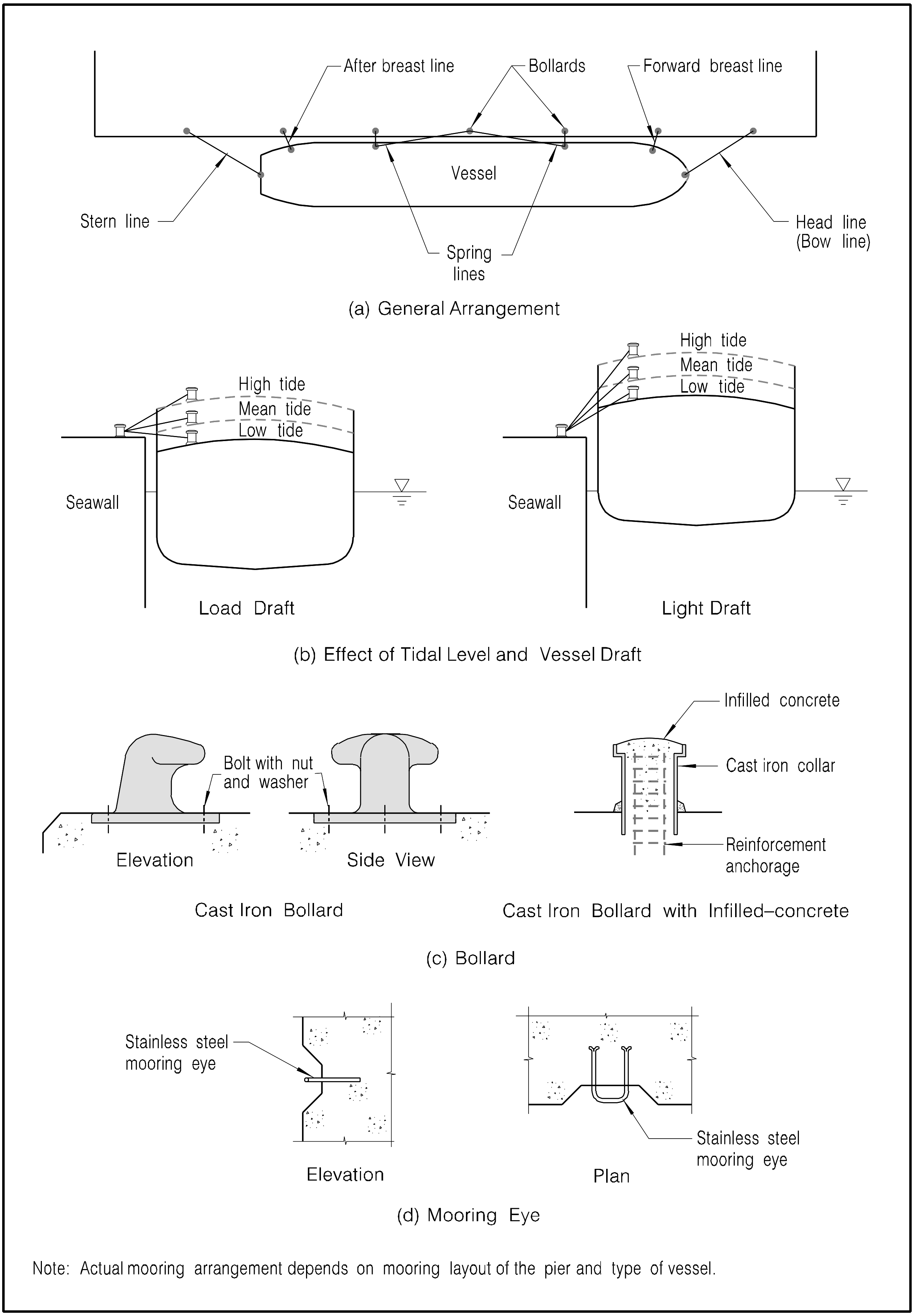
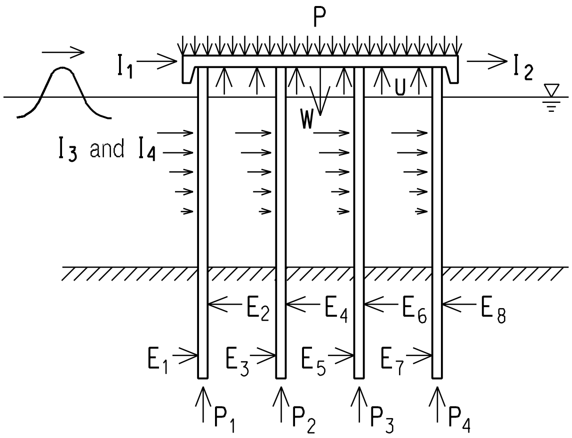
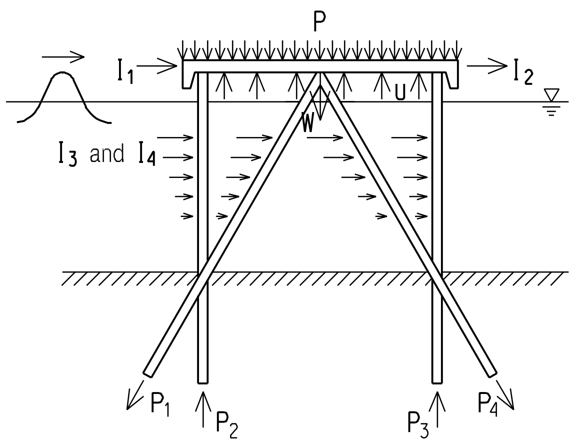


Figure 6 – Mooring Arrangement



(a) Pier on Vertical Piles Only

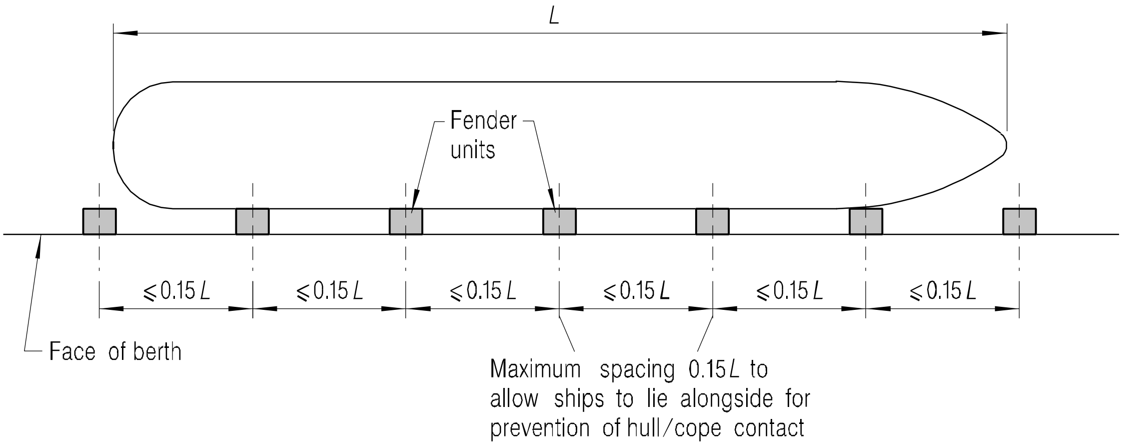


(b) Pier on Vertical and Raking Piles

Legend:

W	Dead load
P	Vertical load
I_1, I_2	Horizontal load on deck (e.g. wave load, wind load transferred from superstructure, berthing load, mooring load)
I_3, I_4	Horizontal load on piles (e.g. wave load, cement load)
E_i	Soil reaction (i=1, 2, ...)
P_i	Axial load on pile (i=1, 2, ...)
U	Uplift (e.g. buoyancy, wave uplift)

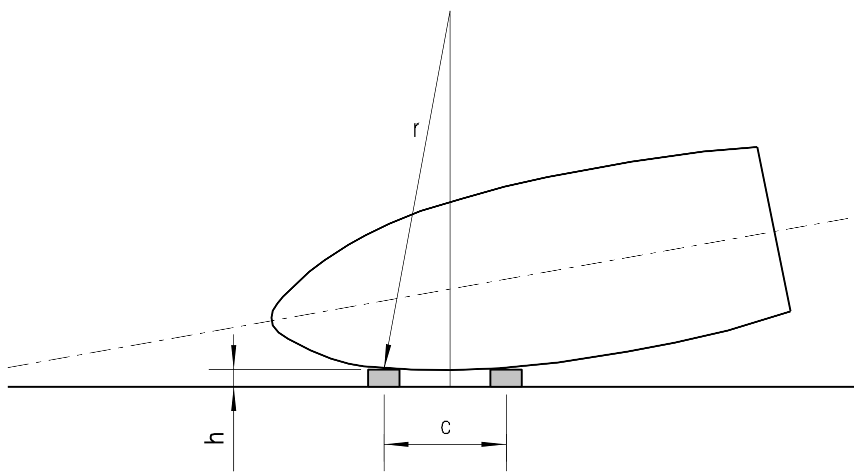
Figure 7 – Flexible and Rigid Piled Deck Structures



Legend :

L = Length of vessel

(a) Horizontal Spacing



The spacing of fenders (c) to be adjusted to avoid direct contact of vessel and structure :

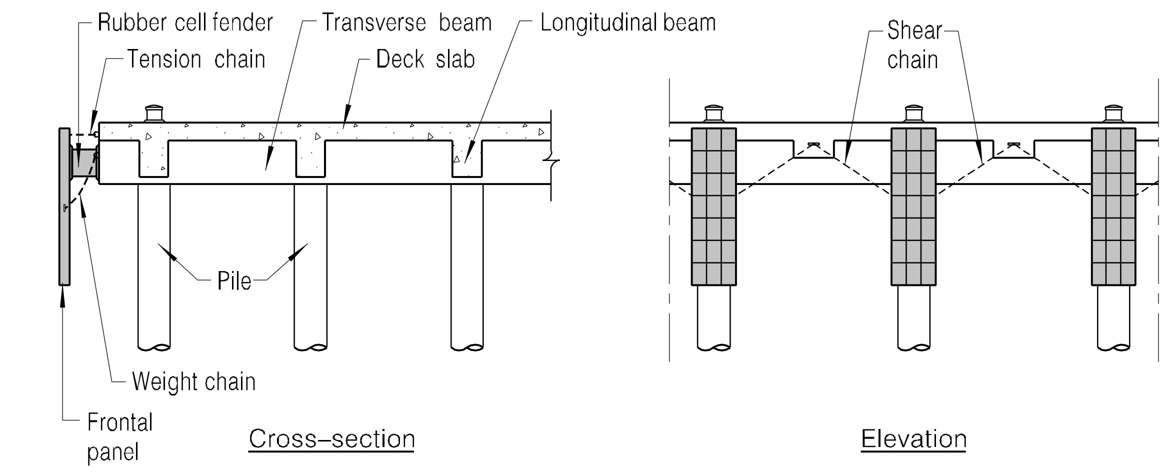
maximum spacing = $2\,[r^2-(r-h)^2]^{1/2}$

r = bent radius of the vessel

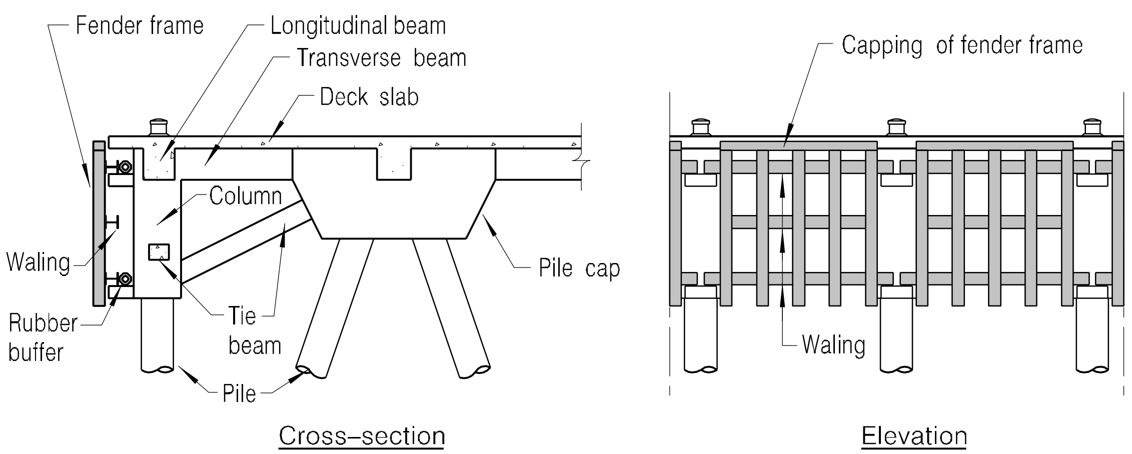
h = height of fenders when design berthing energy is absorbed

(b) Hull Geometry and Fender Spacing

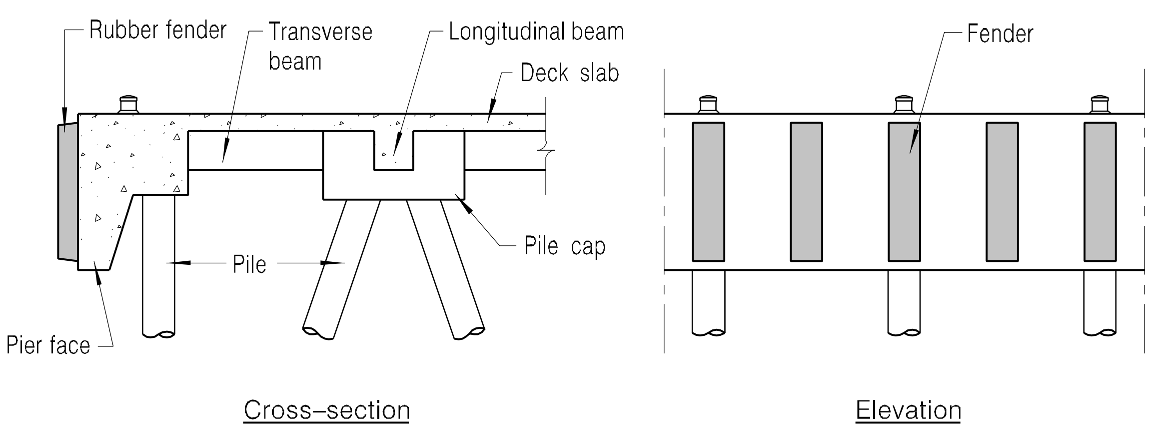
Figure 8 – Fender Spacing



(a) Pier Deck with Cell Fenders and Frontal Panels



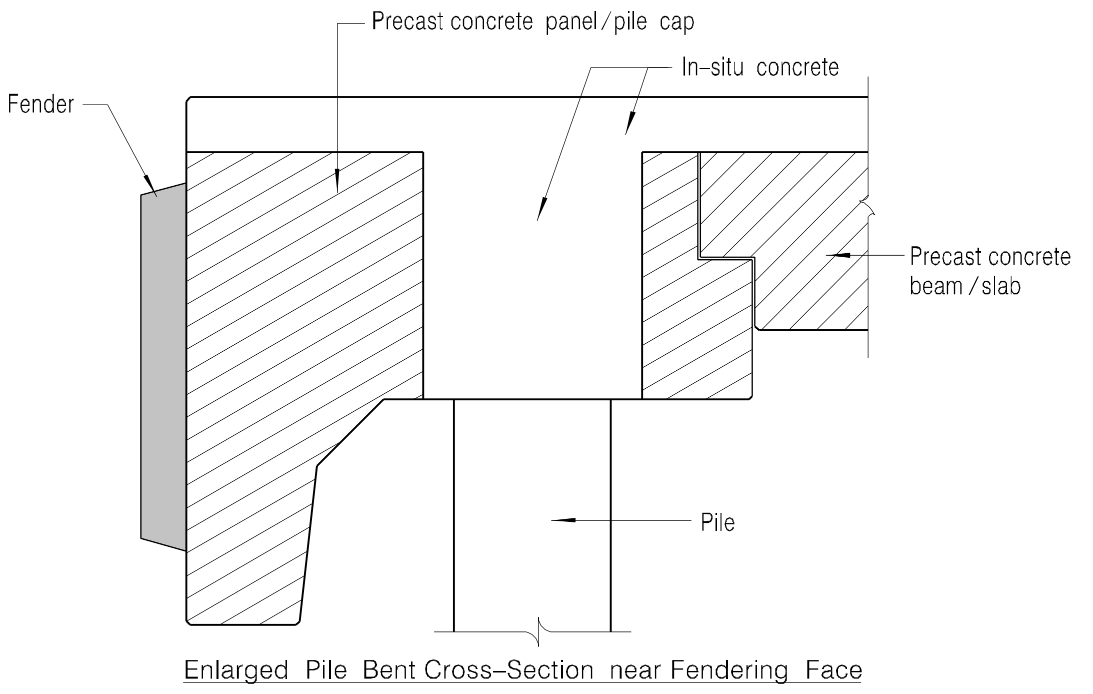
(b) Pier Deck with Continuous Fender Frames



(c) Pier Deck with Long Strip Rubber Fenders

Note: The above details are for illustration only. Actual structural and fender arrangement of the pier deck is subject to detailed design.

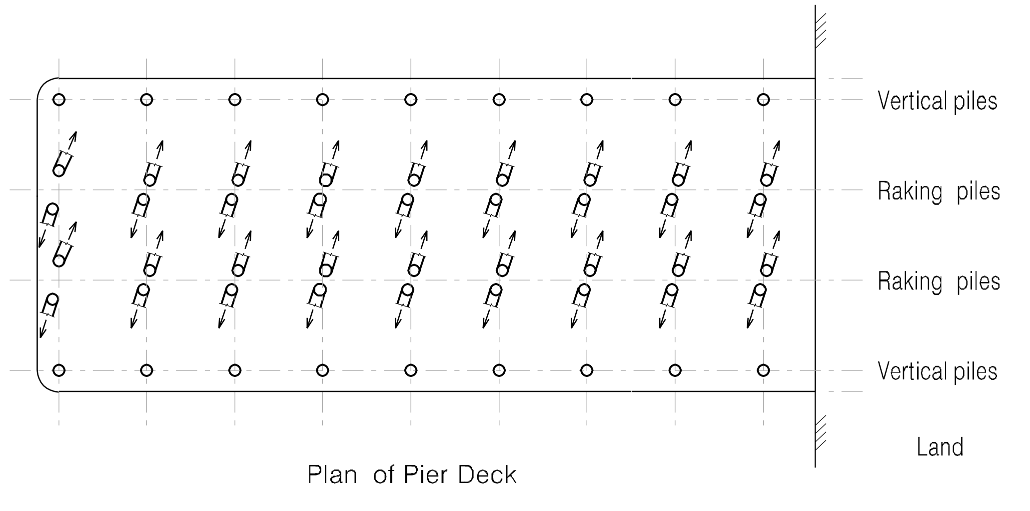
Figure 9 – Cross–section of Reinforced Concrete Piled Deck Pier



Notes:

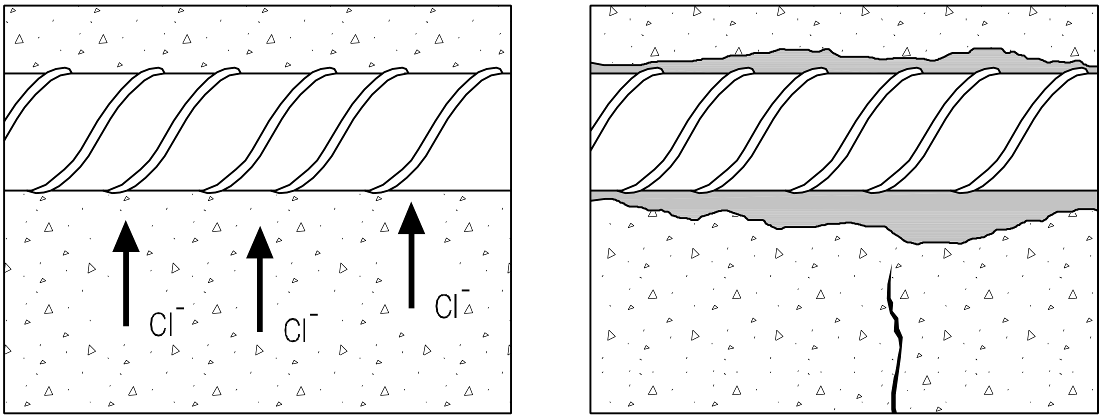
1. The actual arrangement of precast concrete construction is subject to detailed design.
2. Structural connections for precast units should be designed to B.S. 8110.

Figure 10 – Precast Concrete Construction for Piled Deck Pier



Note: The actual piling layout is subject to site condition and detailed design.

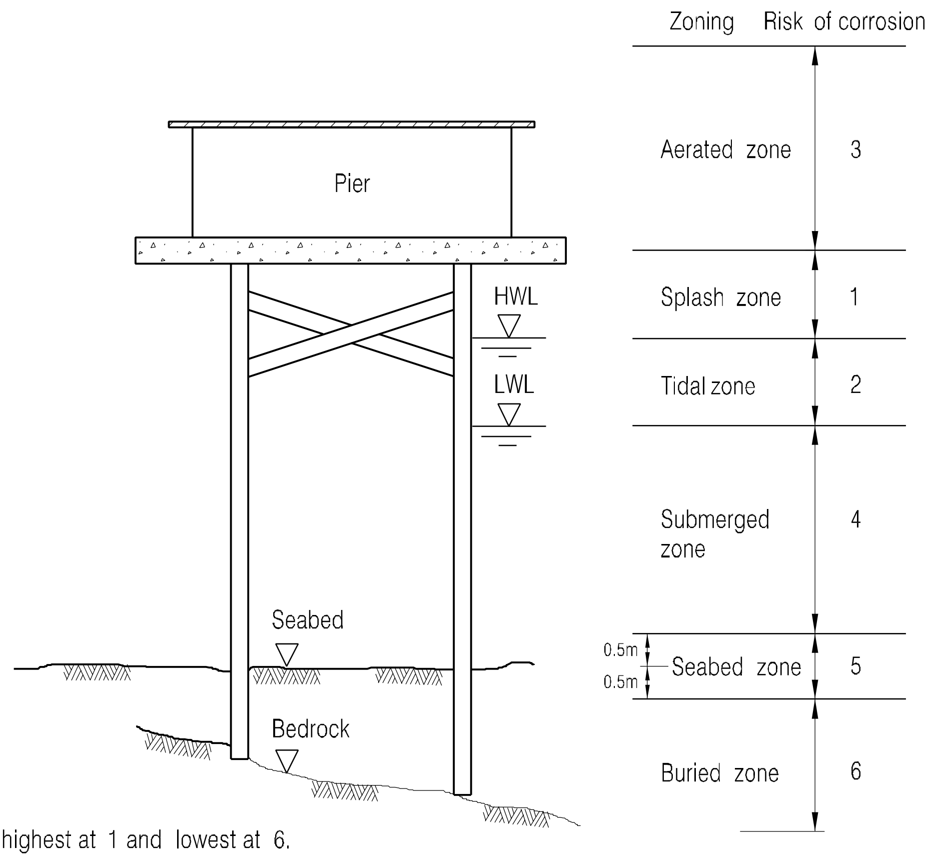
Figure 11 – Piling Layout



(a) Intrusion of Chloride Ions to the Steel Surface

(b) Corroded Steel Causes Concrete Cracking

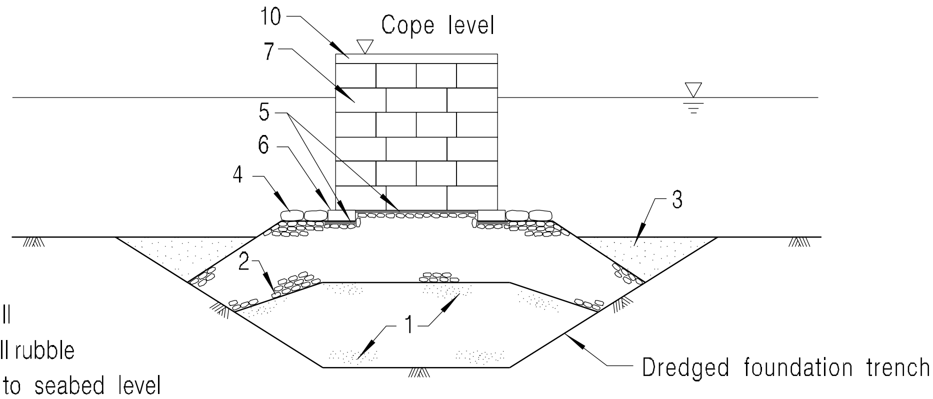
Figure 12 – Corrosion Process of Reinforcement



Notes:

1. Risk is highest at 1 and lowest at 6.
2. The risk indicated is approximate only and may vary subject to actual site conditions.

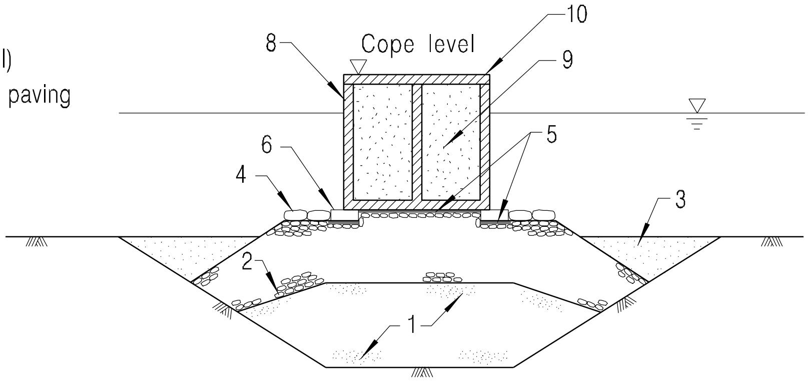
Figure 13 – Vertical Zoning of Marine Environment



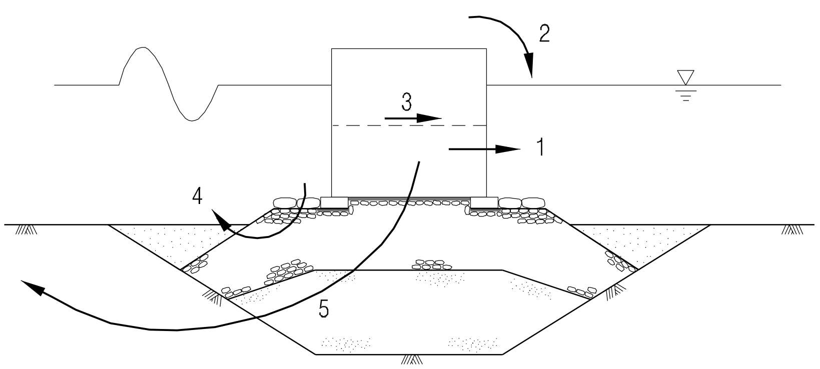
(a) Concrete Blockwork Solid Pier

Key :

1. sand fill
2. pell mell rubble
3. backfill to seabed level
4. bermstones
5. levelling stones
6. toe block
7. precast concrete blocks
8. precast reinforced concrete caisson
9. fill (e.g. public fill)
10. in–situ concrete paving



(b) Caisson Solid Pier



(c) Failure Mechanism

Key :

1. overall sliding
2. overall overturning
3. block instability (for concrete blockwork)
4. toe scour
5. foundation failure

Note: The pier may be founded on seabed deposits strengthened by a ground treatment process such as deep cement mixing or stone columns, instead of dredged foundation trench.

Figure 14 – Key Elements and Failure Mechanism of Solid Pier

$$W = \frac{w_r H^3}{N_s^3 (s_r - 1)^3}$$

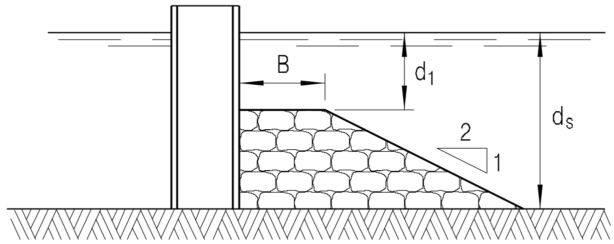
$B \geqslant 0.4 d_s$

B = 2H or 4 times size of rock whichever is greater

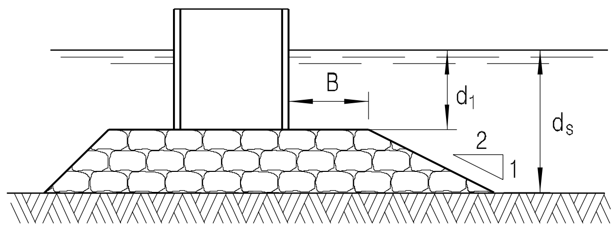
H = Design wave height

w_r = Unit weight of rock

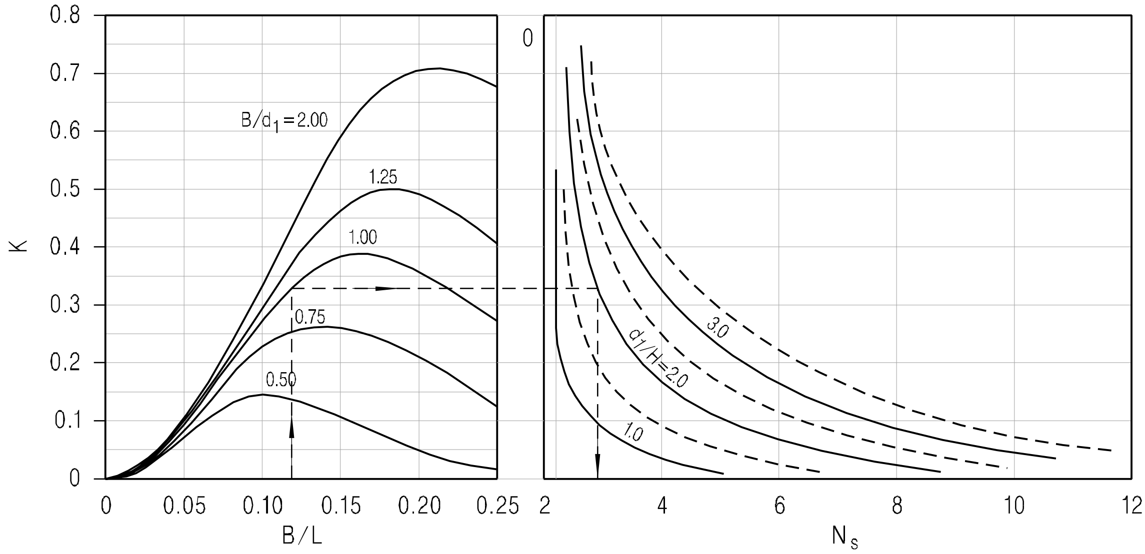
$$s_r = \frac{\rho_{rock}}{\rho_{water}}$$



(a) Rubble Toe Protection



(b) Rubble Foundation



where:

K = parameter representing the combined effects of the relative water depth and the relative distance from the vertical wall on the maximum horizontal velocity at the bottom.

H = design wave height associated with depth d_s

L = wavelength associated with the depth d_1

d_s = depth at structure

B = toe apron width

Note:

1. For critical structures at open exposed sites where failure would be disastrous, and in the absence of reliable wave records, the design wave height should be the $H_{1/100}$ during an extreme event at the structure corrected for refraction and shoaling. If breaking might prevent the $H_{1/100}$ wave from reaching the structure, the maximum wave that could reach the structure should be taken for the design value of H. For less critical structures, design wave height could be taken between $H_{1/10}$ and $H_{1/100}$.

Source: CETN (1988) and Tanimoto et al (1982)

Figure 15 – Toe Protection

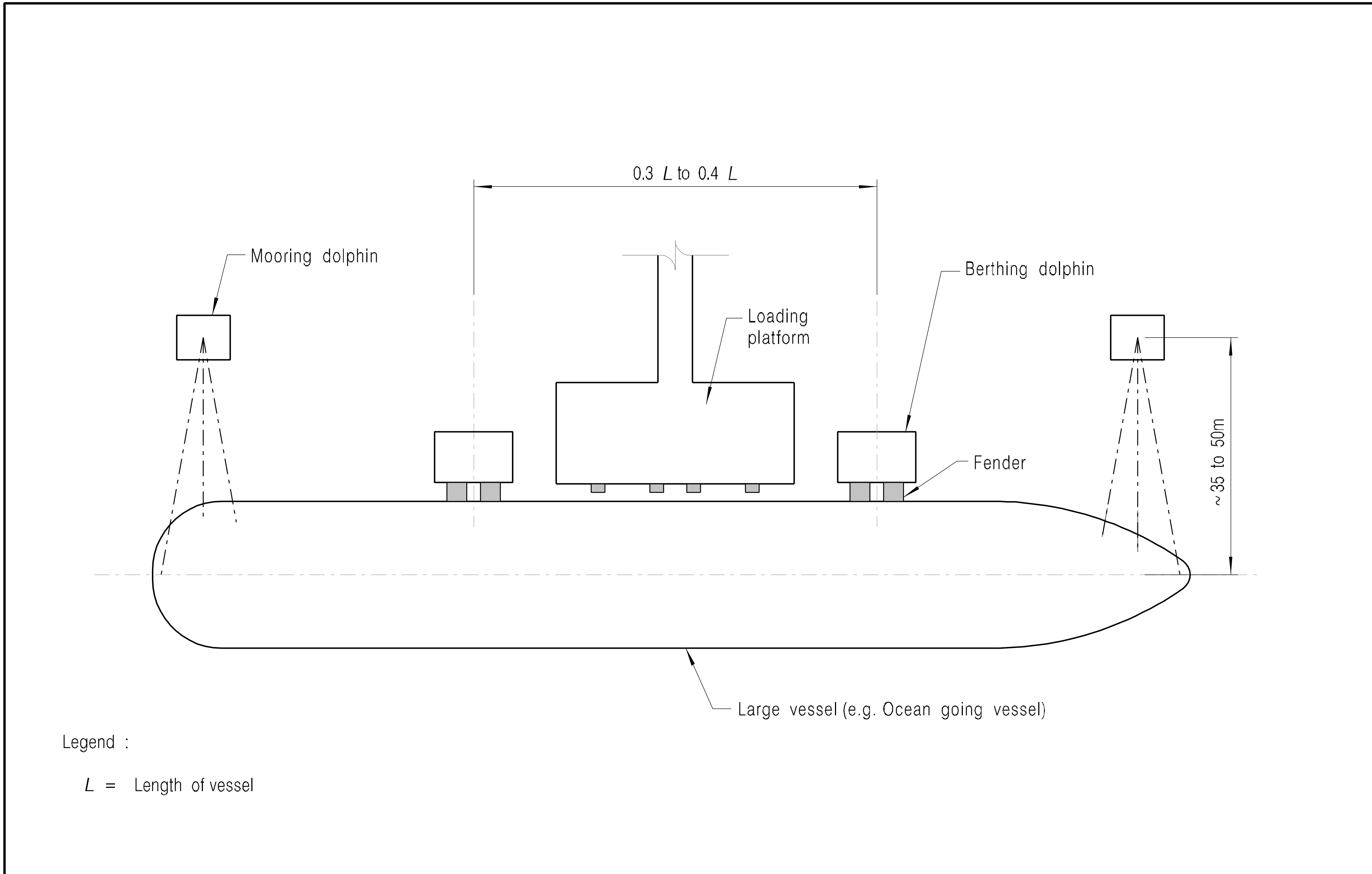


Figure 16 – Layout of Dolphin

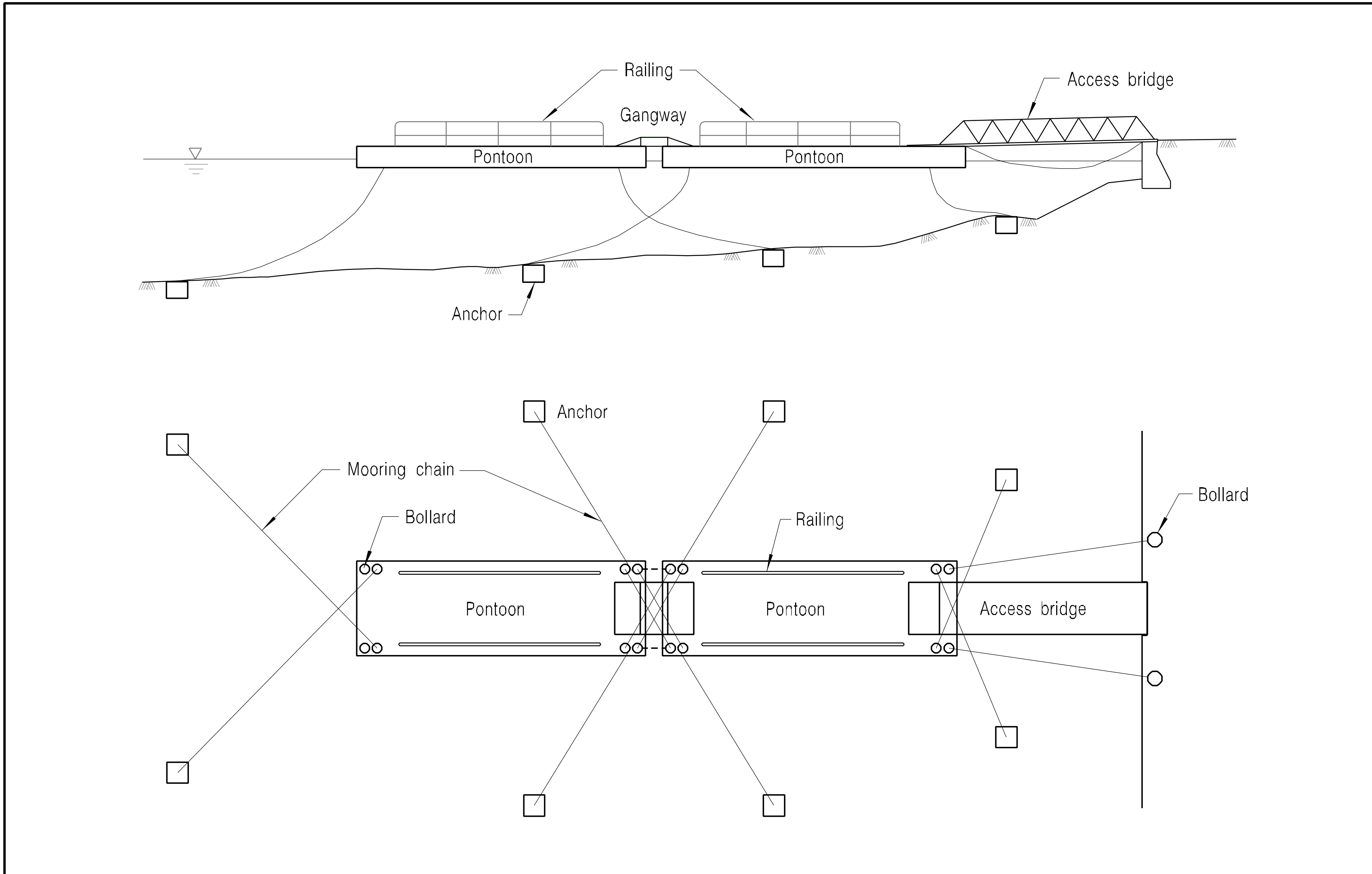


Figure 17 – Floating Pier with Anchor Chain

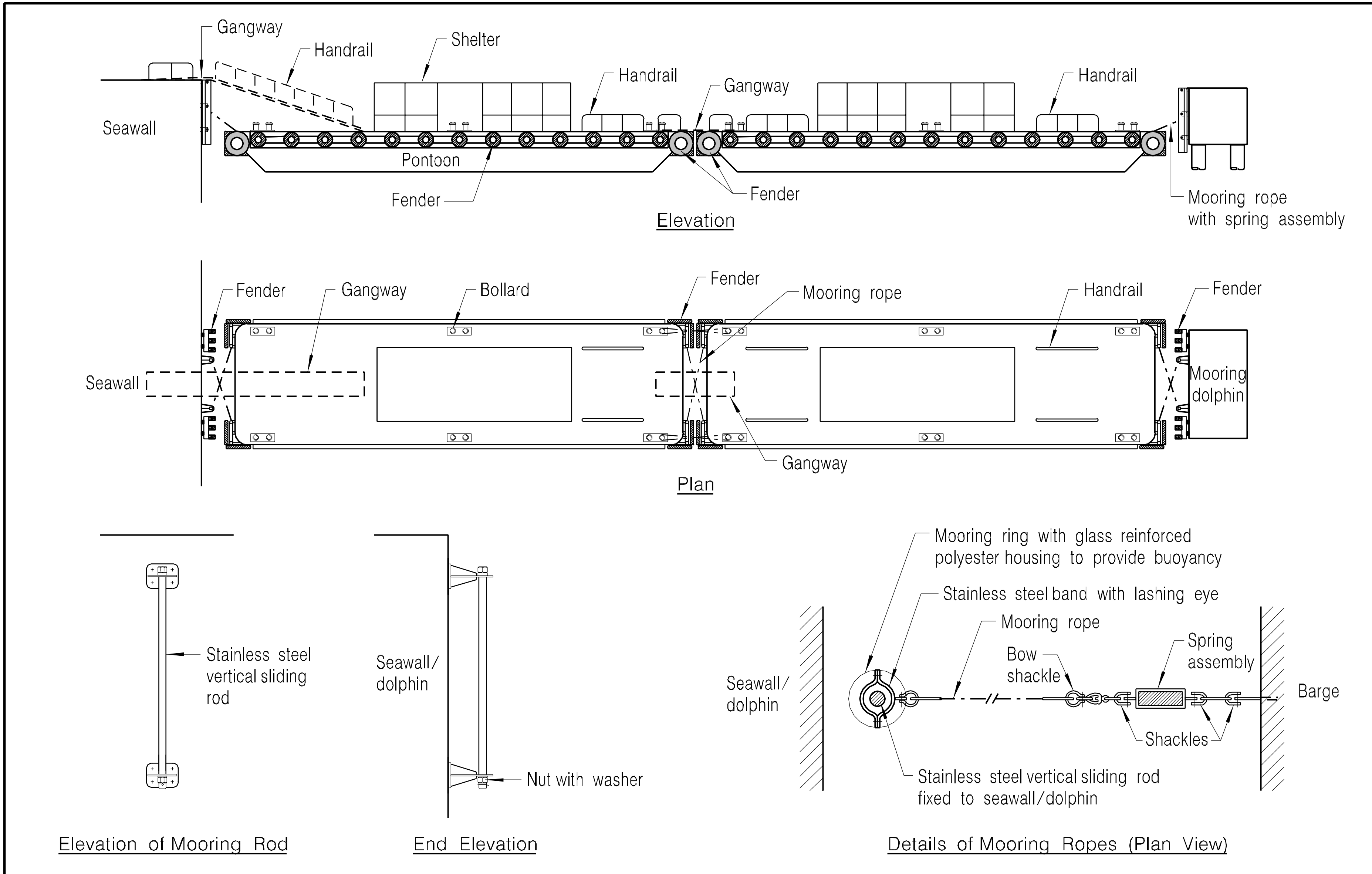


Figure 18 – Floating Jetty