船舶与海洋工程专业英语

Professional English in Naval Architecture and Ocean Engineering

主编 梁 霄 王 林
主审 张均东

大连海事大学出版社

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前　言

“船舶与海洋工程专业英语”是船舶与海洋工程本科专业基础课程之一。编者根据“船舶与海洋工程专业英语”教学大纲以及教学学时和以往的教学实践经验编写了这本书。

本书涉及船舶主尺度定义、船舶设计、船舶类型、船舶性能、船舶构造及建造工艺、船舶结构强度等内容，同时补充海洋工程和潜艇等特色内容。编者从基础知识、原理概念、发展历史等较新的资料中选择部分内容，并对专业词汇和术语进行解释，编成此书。此书可作为本科生教材使用，建议按36学时讲授，可按各课的长度和难度适当调节进度，部分内容可作为课后阅读资料。同时，也可作为船舶与海洋工程专业研究生专业英语阅读材料。

本书由大连海事大学梁霄副教授担任主编，大连外国语大学图书馆王林副教授负责全书的翻译和校对。本书由大连海事大学张均东教授担任主审。

由于编者水平有限，书中缺点、错误在所难免，望广大读者批评指正。

编　者

2015年7月

Contents

Lesson 1 Definitions, Principal Dimensions

It is important to define various terms before studying in detail the various technical branches of naval architecture. The purpose is to explain these terms and to familiarize the reader with them. In the first place, the dimensions by which the size of a ship is measured will be considered. They are referred to as "principal dimensions". The ship, like any solid body, requires three dimensions to define its size, and they are a length, a breadth and a depth. Each of them will be considered in turn.

Principal Dimensions

Length

There are various ways of defining the length of a ship, but first the length between perpendiculars will be considered. The length between perpendiculars (L_{BP}) is the distance measured parallel to the base at the level of the summer load waterline from the after perpendicular to the forward perpendicular. The after perpendicular is taken as the after side of the rudder post where there is such a post, and the forward perpendicular is the vertical line drawn through the intersection of the stem with summer load waterline. In ships where there is no rudder post the after perpendicular is taken as the line passing through the centre line of the rudder pintles. The perpendiculars and the length between perpendiculars are shown in Figure 1-1.

The length between perpendiculars is used for calculation purposes as will be seen later, but it will be obvious from Figure 1-1 that this does not represent the greatest length of the ship. For many purposes, such as the docking of a ship, it is necessary to know what the greatest length of the ship is. This length is known as the length overall (L_{OA}) and is defined simply as the distance from the extreme point at the after end to a similar point at the forward end. This can be clearly seen by referring again to Figure 1-1. In most ships the length overall will exceed by a considerable amount the length between perpendiculars. The excess will include the overhang of the stern and also that of the stem where the stem is raked forward. In modern ships having large bulbous bows the length overall may have to be measured to the extreme point of the bulbous bow.

A third length which is often used, particularly when dealing with ship resistance, is the length on the waterline (L_{WL}). This is the distance measured on the waterline at which the ship is floating from the intersection of the stern with the waterline to the intersection of the stem with the waterline. The length is not a fixed quantity for a particular ship, as it will depend upon the waterline at which the ship is floating and upon the trim of the ship.

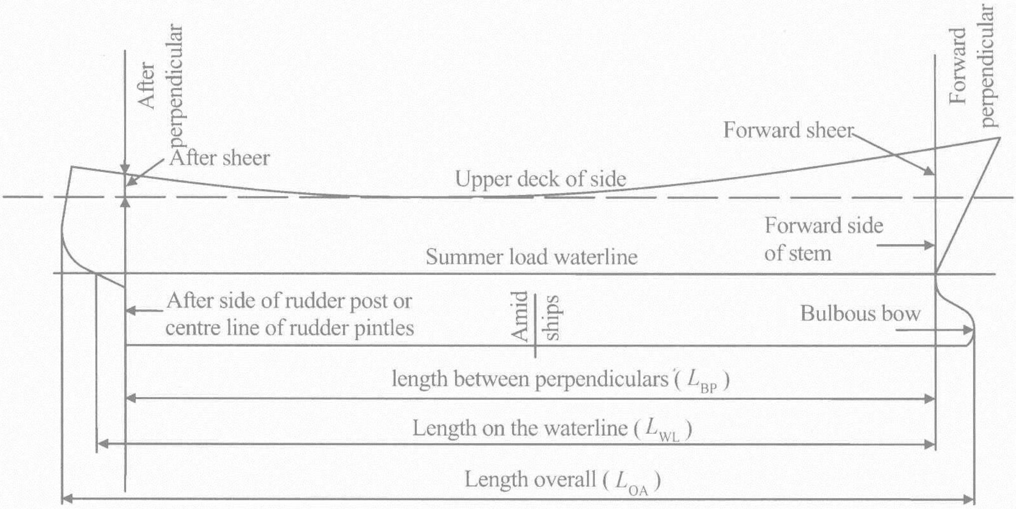

Figure 1-1 **Principal dimensions** (1)

Breadth

The mid point of the length between perpendiculars is called "amidships" and the ship is usually broadest at this point. The breadth is measured at this position and the breadth most commonly used is called the "breadth moulded". It may be defined simply as the distance from the inside of plating on one side to a similar point on the other side measured at the broadest part of the ship.

As is the case in the length between perpendiculars, the breadth moulded does not represent the greatest breadth of the ship, so that to define this greatest breadth the breadth extreme is required (see Figure 1-2). In many ships the breadth extreme is the breadth moulded plus the thickness of the shell plating on each side of the ship. In the days of riveted ships, where the strakes of shell plating were overlapped the breadth extreme was equal to the breadth moulded plus four thicknesses of shell plating, but in the case of modern welded ships the extra breadth consists of two thicknesses of shell plating only.

The breadth extreme may be much greater than this in some ships, since it is the distance from the extreme overhang on one side of the ship to a similar point on the other side. This distance would include the overhang of decks, a feature which is sometimes found in passenger ships in order to provide additional deck area. It would be measured over fenders, which are sometimes fitted to ships such as cross channel vessels which have to operate in and out of port under their own power and have fenders provided to protect the sides of the ships when coming alongside quays.

Depth

The third principal dimension is depth, which varies along the length of the ship but is usually measured at amidships. This depth is known as the "depth moulded" and is measured from the underside of the plating of the deck at side amidships to the base line. It is shown in Figure 1-2(a). It is sometimes quoted as a "depth moulded to upper deck" or "depth moulded to second deck", etc. Where no deck is specified it can be taken the depth is measured to the uppermost continuous deck. In some modern ships there is a rounded gunwale as shown in Figure 1-2(b). In such cases the depth moulded is measured from the intersection of the deck line continued with the breadth moulded line.

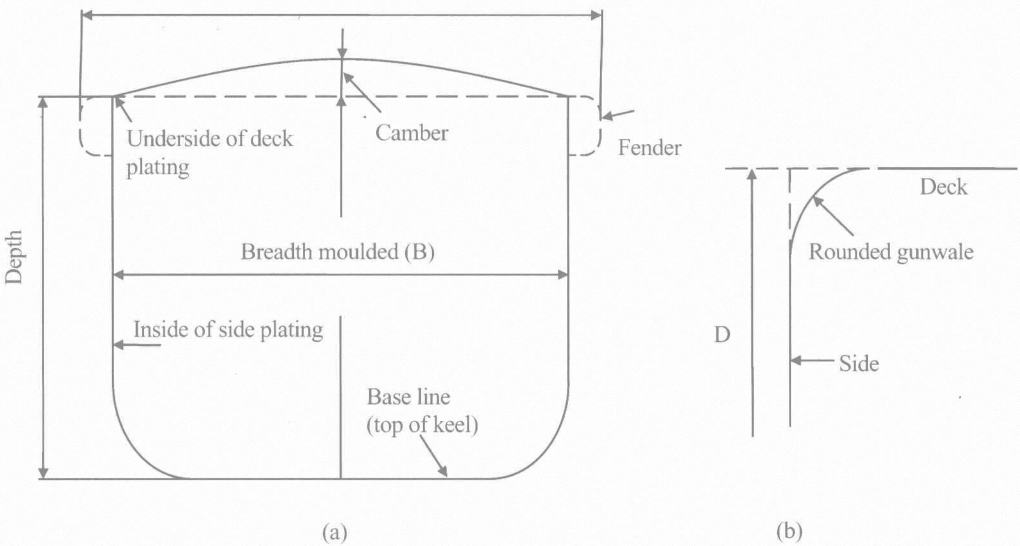

Figure 1-2 Principal dimensions (2)

Other Features

The three principal dimensions give a general idea of the size of a ship but there are several other features which have to be considered and which could be different in two ships having the same length, breadth and depth. The more important of these will now be defined.

Sheer

Sheer is the height of the deck at side above a line drawn parallel to the base and tangent to the deck line at amidships. The sheer can vary along the length of the ship and is usually greatest at the ends. In modern ships the deck line at side often has a variety of shapes: it may be flat with zero sheer over some distance on either side of amidships and then rise as a straight line towards the ends. On the other hand, there may be no sheer at all on the deck, which will then be parallel to the base over the entire length. In older ships the deck at side line was parabolic in profile and the sheer was quoted as its value on the forward and after perpendiculars as shown in Figure 1-1. So called "standard" sheer was given by the formulae:

Sheer forward (in) $=0.2L_{ft}+20$

Sheer aft (in) $=0.1L_{ft}+10$

These two formulae in terms of metric units would give:

Sheer forward (cm) $=1.666L_{m}+50.8$

Sheer aft (cm) $=0.833L_{m}+25.4$

It will be seen that the sheer forward is twice as much as the sheer aft in these standard formulae. It was often the case, however, that considerable variation was made from these standard values. Sometimes the sheer forward was increased while the sheer after was reduced. Occasionally the lowest point of the upper deck was some distance aft of amidships and sometimes departures were made from the parabolic sheer profile. The value of sheer and particularly the sheer forward was to increase the height of the deck above water (the "height of platform" as it was called) and this helped to prevent water being shipped when the vessel was moving through rough sea. The reason for the abolition of sheer in some modern ships is that their depths are so great that additional height of the deck above water at the fore end is unnecessary from a sea-keeping point of view.

Deletion of sheer also tends to make the ship easier to construct, but on the other hand it could be said that the appearance of the ship suffers in consequence.

Camber

Camber or round of beam is defined as the rise of the deck of the ship in going from the side to the centre as shown in Figure 1-2(a). The camber curve used to be parabolic but here again often nowadays straight line camber curves are used or there may be no camber at all on decks. Camber is useful on the weather deck of a ship from a drainage point of view, but this may not be very important since the ship is very rarely upright and at rest. Often, if the weather deck of a ship is cambered, the lower decks particularly in passenger ships may have no camber at all, as this makes for horizontal decks in accommodation which is an advantage.

Camber is usually stated as its value on the moulded breadth of the ship and standard camber was taken as one-fiftieth of the breadth. The camber on the deck diminishes towards the ends of the ship as the deck breadths become smaller.

Bilge Radius

An outline of the midship section of a ship is shown in Figure 1-3(a). In many "full" cargo ships the section is virtually a rectangle with the lower corners rounded off. This part of the section is referred to as the "bilge" and the shape is often circular at this position. The radius of the circular arc forming the bilge is called the "bilge radius". Some designers prefer to make the section some curve other than a circle in way of the bilge. The curve would have a radius of curvature which increases as it approaches the straight parts of the section with which it has to link up.

Rise of Floor

The bottom of a ship at amidships is usually flat but is not necessarily horizontal. If the line of the flat bottom is continued outwards it will intersect the breadth moulded line as shown in Figure 1-3(a). The height of this intersection above base is called the "rise of floor". The rise of floor is very much dependent on the ship form. In ships of full form such as cargo ships the rise of floor may only be a few centimeters or may be eliminated altogether. In fine form ships much bigger rise of floor would be adopted in association with a larger bilge radius.

Flat of Keel

A feature which was common in the days of riveted ships what was known as "flat of keel" or "flat of bottom". Where there is no rise of floor, of course, the bottom is flat from the centre line to the point where the curve of the bilge starts. If there was a rise of floor it was customary for the line of the bottom to intersect the base line some distance from the centre line so that on either side of the centre line there was a small portion of the bottom which was horizontal, as shown in Figure 1-3(a). This was known as the "flat of bottom" and its value lay in the fact that a right angle connection could be made between the flat plate keel and the vertical centre girder and this connection could be accomplished without having to bevel the connecting angle bars.

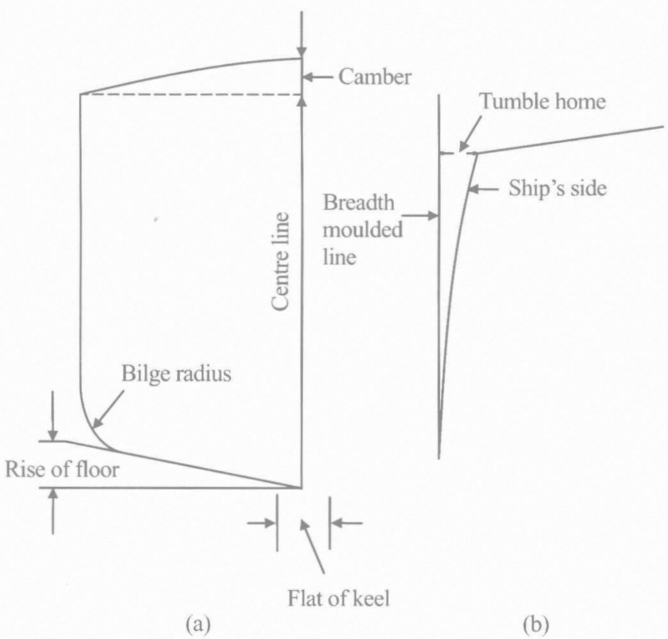

Figure 1-3 Principal dimensions (3)

Tumble Home

Another feature of the midship section of a ship which was at one time quite common but has now almost completely disappeared is what was called "tumble home". This is the amount which the side of the ship falls in from the breadth moulded line, as shown in Figure 1-3(b). Tumble home was a usual feature in sailing ships and often appeared in steel merchant ships before World War II. Ships of the present day rarely employ this feature since its elimination makes for ease of production and it is of doubtful value.

Rake of Stem

In ships which have straight stems formed by a stem bar or a plate the inclination of the stem to the vertical is called the "rake". It may be defined either by the angle to the vertical or the distance between the intersection of the stem produced with the base line and the forward perpendicular. When ships have curved stems in profile, and especially where they also have bulbous bows, stem rake cannot be simply defined and it would be necessary to define the stem profile by a number of ordinates at different waterlines.

In the case of a simple straight stem the stem line is usually joined up with the base line by a circular arc, but sometimes a curve of some other form is used, in which case several ordinates are required to define its shape.

Draught and Trim

The draught at which a ship floats is simply the distance from the bottom of the ship to the waterline. If the waterline is parallel to the keel the ship is said to be floating on an even keel, but if the waterline is not parallel then the ship is said to be trimmed. If the draught at the after end is greater than that at the fore end the ship is trimmed by the stern and if the converse is the case it is trimmed by the bow or by the head. The draught can be measured in two ways, either as a moulded draught which is the distance from the base line to the waterline, or as an extreme draught which is the distance from the bottom of the ship to the waterline. In the modern welded merchant ship these two draughts differ only by one thickness of plating, but in certain types of ships where, say, a bar keel is fitted the extreme draught would be measured to the underside of the keel and may exceed the moulded draught of by 15 ~ 23 cm (6 ~ 9 in). It is important to know the draught of a ship, or how much water the ship is "drawing", and so that the draught may be readily obtained, draught marks are cut in the stem and the stern. These are figures giving the distance from the bottom of the ship. In imperial units the figures are 6 in high with a space of 6 in between the top of one figure and the bottom of the next one. When the water level is up to the bottom of a particular figure the draught in feet has the value of that figure. If metric units are used then the figures would probably be 10 cm high with a 10 cm spacing.

In many large vessels the structure bends in the longitudinal vertical plane even in still water, with the result that the base line or the keel does not remain a straight line. The mean draught at which the vessel is floating is not then simply obtained by taking half the sum of the forward and after draughts. To ascertain how much the vessel is hogging or sagging a set of draught marks is placed amidships so that if d_a, $d_{\otimes}$ and d_f are the draughts at the after end amidships and the forward end respectively, then

$$\text{Hog or sag} = \frac{d_a + d_f}{2} = d_{\otimes}$$

When use is made of amidship draughts it is necessary to measure the draught on both sides of the ship and take the mean of the two readings in case the ship should be heeled one side or the other.

The difference between the forward and after draughts of a ship is called the "trim", so that trim $T = d_a - d_f$ and as previously stated the ship will the said to be trimming by the stern or the bow according as the draught after or the draught forward is in excess. For a given total load on the ship the draught will have its least value when the ship is on an even keel. This is an important point when a ship is navigating in restricted depth of water or when entering a dry dock. Usually a ship should be designed to float on an even keel in the fully loaded condition, and if this is not attainable a small trim by the stern is aimed at. Trim by the bow is not considered desirable and should be avoided as it reduces the "height of platform" forward and increases the liability to take water on board in rough seas.

Freeboard

Freeboard may be defined as the distance which the ship projects above the surface of the water or the distance measured downwards from the deck to the waterline. The freeboard to the weather deck, for example, will vary along the length of the ship because of the sheer of the deck and will also be affected by the trim, if any. Usually the freeboard will be a minimum at amidships and will increase towards the ends.

Freeboard has an important influence on the seaworthiness of a ship. The greater the freeboard the greater is the above water volume, and this volume provides reserve buoyancy, assisting the ship to rise when it goes through waves. The above water volume can also help the ship to remain afloat in the event of damage. It will be seen later that freeboard has an important influence on the range of stability. Minimum freeboards are laid down for ships under International Law in the form of Load Line Regulations.

Technical Terms

1. principal dimension 主尺度
2. naval architecture 造船(工程)学
3. naval architect 造船工程师
4. length between perpendiculars (LBP) 垂线间长

5. summer load waterline　夏季载重水线
6. forward/after perpendicular　艏/艉垂线
7. rudder post　舵柱
8. stem post　艏柱
9. rudder pintle　舵栓
10. length overall (LOA)　总长
11. overhang　悬伸部分(水线以上)
12. bulbous bow　球鼻艏
13. length on the waterline (LWL)　水线长
14. amidship　船中
15. breadth moulded　型宽
16. breadth extreme　最大船宽
17. shell plating　船壳板
18. rivet　铆接
19. weld　焊接
20. strake　列板(船壳板)
21. fender　护舷木
22. deck area　甲板面积
23. cross channel vessel　海峡船
24. port　港口,船的左舷
25. side　舷侧
26. quay　码头
27. depth moulded　型深
28. plating of deck　甲板板
29. base line　基线
30. deck　甲板
31. the uppermost continuous deck　最上层连续甲板
32. rounded gunwale　圆弧舷边顶部
33. moulded line　型线
34. sheer　舷弧
35. ends　船端
36. deck line at side, deck at side line, deck at side　甲板边线
37. profile　纵剖面(图),轮廓
38. sheer forward/after　艏/艉舷弧
39. platform　平台
40. rough sea　强浪,汹涛海面
41. seakeeping　耐波性
42. appearance　外形,出现
43. camber, round of beam　梁拱

44. weather deck 露天甲板
45. drainage 排水
46. upright 正浮,直立
47. at rest 在静水中
48. accommodation 居住舱,适应
49. bilge radius 舭半径
50. midship section 船中剖面
51. rise of floor 船底升高
52. flat of keel 龙骨宽
53. flat plate keel 平板龙骨
54. vertical center girder 中桁材
55. bevel 折射角,将直角钢改为斜角
56. connecting angle 连接角钢
57. tumble home 内倾
58. sailing ship 帆船
59. steel merchant ship 钢质商船
60. bar 棒,巴(气压单位)
61. draught 吃水,草图,通风
62. even keel 等吃水,正浮
63. trimmed by the stern/bow 艉/艏倾
64. moulded draught 型吃水
65. extreme draught 最大吃水
66. bar keel 棒龙骨
67. drawing 吃水
68. imperial unit 英制单位
69. metric unit 公制单位
70. spacing 间距
71. hogging 中拱
72. sagging 中垂
73. heel 横倾
74. dry dock 干船坞
75. fully loaded condition 满载状态
76. freeboard 干舷
77. seaworthiness 适航性
78. reserve buoyancy 储备浮力
79. range of stability 稳性范围
80. Load Line Regulations 载重线公约

Lesson 2 Ship Types

The development of ship types over the years has been dictated very largely by the nature of the cargo. The various designs can, to some extent, be divided into general cargo, bulk cargo and passenger vessels.

The general cargo carrier is a flexible design of vessel which will go anywhere and carry anything. Special forms of the general cargo carrier include container ships, roll-on/roll-off ships and barge carriers. Bulk cargo may be liquid, solid, or liquefied gas and particular designs of vessel exist for the carriage of each. Passenger-carrying vessels include cruise liners and ferries. Many special types of vessel exist which perform particular functions or are developments of particular aspects of technology. These include multi-hull vessels, hydrofoil and hovercraft. These various ship types will now be examined in further detail.

General Cargo Ship

The general cargo ships (as shown in Figure 2-1) have several large clear open cargo-carrying spaces or holds. One or more separate decks may be present within the holds and are known as "tween decks". These provide increased flexibility in loading and unloading and permit cargo segregation as well as improved stability. Access to these holds is by openings in the deck known as hatches.

Figure 2-1 General cargo ship

Hatches are made as large as strength considerations permit in order to reduce the amount of horizontal movement of cargo within the ship. Hatch covers are, nowadays, made of steel although older vessels used wood. The hatch covers must be watertight and rest upon coamings around the hatch. The coamings of the upper or weather deck hatches are a reasonable height above the deck to reduce the risk of flooding in heavy seas.

Some form of cargo handling equipment is always fitted which may take the form of derricks and winches or deck cranes. Deck cranes are fitted to many vessels since they reduce cargo handling times and manpower requirements. Some ships have a special heavy-lift derrick fitted which may serve one or more holds.

A double bottom is fitted along the ship's length and is divided into various tanks. These tanks may be used for fuel or lubricating oil, fresh water or ballast sea water. Fore and aft peak tanks are also fitted and may be used to carry ballast or to suitably trim the ship. Deep tanks are often fitted and can be used to carry liquid cargoes or water ballast. The water ballast tanks may be filled when the ship is only partially loaded in order to provide a sufficient draught for stability and total propeller immersion.

There is usually one hold aft the accommodation and machinery space. This arrangement improves the trim of the vessel when it is partially loaded. The range of size for general cargo ships is currently from 2,000 to 15,000 displacement tones with speeds from 12 to 18 knots.

Refrigerated Cargo Ship

The refrigerated cargo ship differs from the general cargo ship in that it carries perishable goods. A refrigeration system is therefore necessary to provide low temperature holds for these cargoes. The holds and the various tween decks are insulated to reduce heat transfer. The cargo may be carried frozen or chilled and various holds may be at different temperatures according to the cargo requirements.

This type of vessel is usually faster than a general cargo ship, having speeds up to 22 knots. It is essentially a cargo liner having set schedules and sailing between fixed terminal ports. Up to twelve passengers may be carried on some of these vessels.

Container Ship

A container (as shown in Figure 2-2) is a reusable box of 2,435 mm by 2,435 mm section, with lengths of either 6,055, 9,125 or 12,190 mm. Containers are now used for most general cargoes and liquid carrying versions also exist. Refrigerated versions are also in use which may have their own independent refrigeration plant or be supplied with cooled air from the ship's refrigeration system.

The cargo-carrying section of the ship is divided into several holds each of which has a hatch opening the full width and length of the hold. The containers are racked in special frameworks and stacked one upon the other within the hold space. Cargo handling is therefore only the vertical movement of the containers by a special quayside crane. Containers may also be stacked on the flush top hatch covers. Special lashing arrangements are used to secure this deck cargo.

Figure 2-2 **Container ship**

The various cargo holds are separated by a deep web-framed structure to provide the ship with transverse strength. The ship structure outboard of the container holds on either side is a box-like arrangement of wing tanks which provides longitudinal strength to the structure. These wing tanks may be used for water ballast and can be arranged to counter the heeling of the ship when discharging containers. A double bottom is also fitted which adds to the longitudinal strength and provides additional ballast space.

The accommodation and machinery spaces are usually located aft to provide the maximum length of full-bodyed ship for container stowage. Cargo-handling equipment is rarely fitted, since these ships travel between specially equipped terminals to ensure rapid loading and discharge. Container ship sizes vary considerably, with container carrying capacities from 1,000 to 2,500 TEUs or more. The twenty foot equivalent unit (TEU) represents a 20 ft (6,055 mm) "standard" container. Container ships are much faster than most cargo ships, with speeds up to 30 knots. They operate as liners on set schedules between fixed ports.

Roll-on/Roll-off Ship

This vessel (as shown in Figure 2-3) was originally designed for wheeled cargo, usually in the form of trailers. The cargo could be rapidly loaded and unloaded by stern or bow ramps and sometimes sideports for smaller vehicles. The loss of cubic capacity due to undercarriages and clearances has resulted in many roll-on/roll-off vessels being also adapted to carry containers.

The cargo-carrying section of the ship is a large open deck with a loading ramp usually at the after end. Internal ramps lead from the loading deck to the other tween deck spaces. The cargo may be driven aboard under its own power or loaded by straddle carriers or fork lift trucks. One or more hatches may be provided for containers or general cargo and will be served by one or more deck cranes. Arrangements may be provided on deck for stowing containers. Some roll-on/roll-off (Ro-Ro) vessels also have hatch covers to enable loading of lower decks with containers. Where cargo (with or without wheels) is loaded and discharged by cranes the term lift-on/lift-off (Lo-Lo) is used.