

Chapter 7

Effect of free surface of liquids on stability

When a tank is completely filled with a liquid, the liquid cannot move within the tank when the ship heels. For this reason, as far as stability is concerned, the liquid may be considered a static weight having its centre of gravity at the centre of gravity of the liquid within the tank.

Figure 7.1(a) shows a ship with a double-bottom tank filled with a liquid having its centre of gravity at g . The effect when the ship is heeled to a small angle θ is shown in Figure 7.1(b). No weights have been moved within the ship, therefore the position of G is not affected. The centre of buoyancy will move out to the low side indicated by BB_1 .

$$\begin{aligned} \text{Moment of statical stability} &= W \times GZ \\ &= W \times GM \times \sin \theta \end{aligned}$$

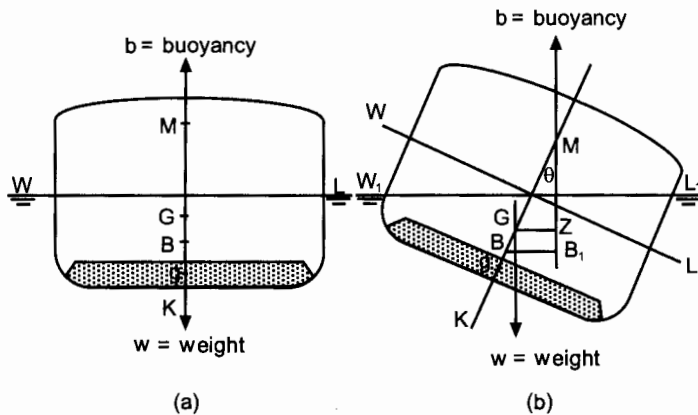


Fig. 7.1

Now consider the same ship floating at the same draft and having the same KG , but increase the depth of the tank so that the liquid now only partially fills it as shown in Figures 7.1(c) and 7.1(d).

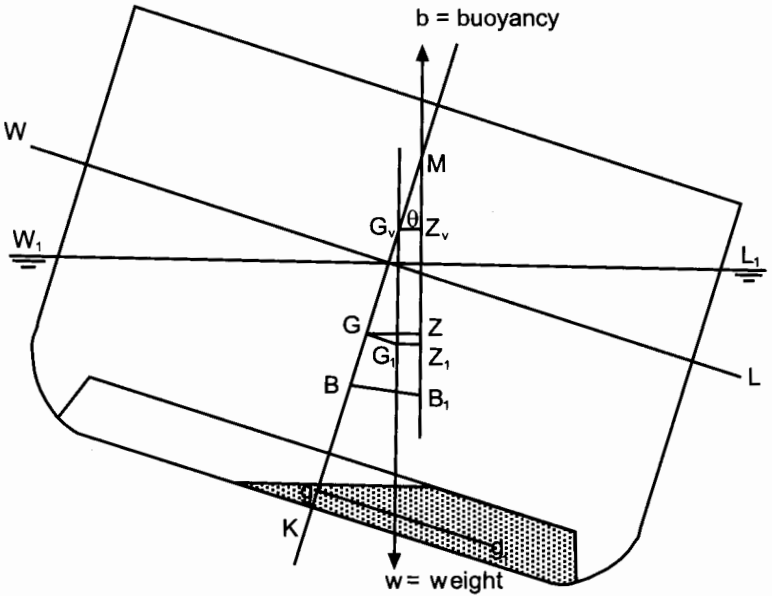


Fig. 7.2

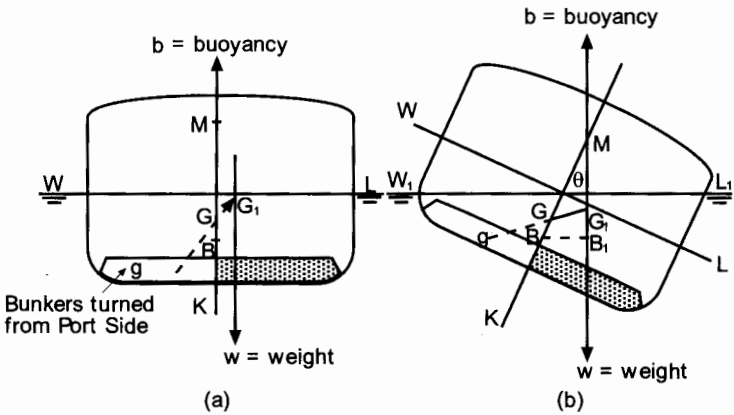


Fig. 7.3

Having satisfied oneself that the weights within the ship are uniformly distributed, one can assume that the list is probably due to a very small negative GM. To correct this it will be necessary to lower the position of the effective centre of gravity sufficiently to bring it below the initial metacentre. Any slack tanks should be topped up to eliminate the virtual rise of G due to free surface effect. If there are any weights which can be lowered within the ship, they should be lowered. For example, derricks may be lowered if any are topped; oil in deep tanks may be transferred to double bottom tanks, etc.

Assume now that all the above action possible has been taken and that the ship is still at an angle of loll. Assume also that there are double bottom tanks which are empty. Should they be filled, and if so, which ones first?

Before answering these questions consider the effect on stability during the filling operation. Free surfaces will be created as soon as liquid enters an empty tank. This will give a virtual rise of G which in turn will lead to an increased negative GM and an increased angle of loll. Therefore, if it is decided that it is safe to use the tanks, those which have the smallest area can be filled first so that the increase in list is cut to a minimum. Tanks should be filled one at a time.

Next, assume that it is decided to start by filling a tank which is divided at the centre line. Which side is to be filled first? If the high side is filled first the ship will start to right herself but will then roll suddenly over to take up a larger angle of loll on the other side, or perhaps even capsize. Now consider filling the low side first. Weight will be added low down in the vessel and G will thus be lowered, but the added weight will also cause G to move out of the centre line to the low side, increasing the list. Free surface is also being created and this will give a virtual rise in G , thus causing a loss in GM , which will increase the list still further.

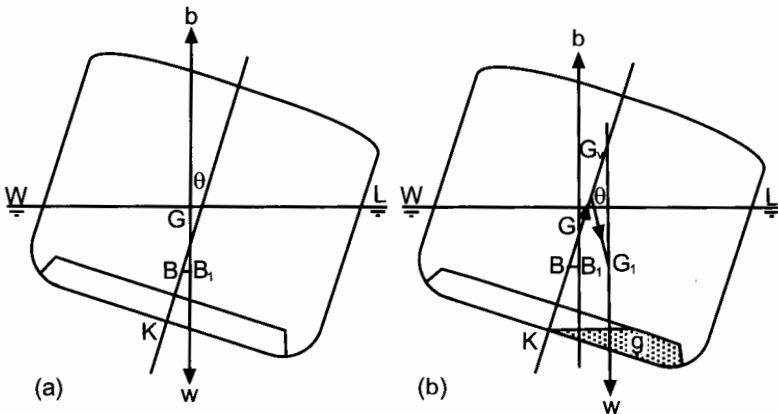


Fig. 7.4

Figure 7.4(a) shows a ship at an angle of loll with the double bottom tanks empty and in Figure 7.4(b) some water has been run into the low side. The shift of the centre of gravity from G to G_v is the virtual rise of G due to the free surface, and the shift from G_v to G_1 is due to the weight of the added water.

It can be seen from the figure that the net result is a moment to list the ship over still further, but the increase in list is a gradual and controlled increase. When more water is now run into the tank the centre of gravity of the ship will gradually move downwards and the list will start to decrease.

54 Ship Stability for Masters and Mates

As the list decreases, water may be run into the other side of the tank. The water will then be running in much more quickly, causing G to move downwards more quickly. The ship cannot roll suddenly over to the other side as there is more water in the low side than in the high side. If sufficient weight of water is loaded to bring G on the centre line below M, the ship should complete the operation upright.

To summarize:

- (a) Check that the list is due to a very small negative GM, for example -0.05 to -0.10 m.
- (b) Top up any slack tanks and lower weights within the ship if possible.
- (c) If the ship is still listed and it is decided to fill double-bottom tanks, start by filling the low side of a tank which is adequately sub-divided.
- (d) The list is bound to be increased in the initial stages.
- (e) Never start by filling tanks on the high side first.
- (f) Always *calculate the effects first* before *authorizing action* to be taken to ballast any tanks.

Exercise 7

- 1 With the aid of suitable sketches, show the effect of slack tanks on a ship's stability.
- 2 A ship leaves port upright with a full cargo of timber, and with timber on deck. During the voyage, bunkers, stores and fresh water are consumed evenly from each side. If the ship arrives at her destination with a list, explain the probable cause of the list and how this should be remedied.
- 3 A ship loaded with timber and with timber on deck, berths with an angle of loll away from the quay. From which side should the timber on deck be discharged first and why?

Chapter 8

TPC and displacement curves

Recapitulation

The TPC is the mass which must be loaded or discharged to change the ship's mean draft by 1 cm. When the ship is floating in salt water it is found by using the formula:

$$TPC_{SW} = \frac{WPA}{97.56}$$

where

WPA = the area of the water-plane in sq metres.

The area of the water-plane of a box-shaped vessel is the same for all drafts if the trim be constant, and so the TPC will also be the same for all drafts.

In the case of a ship the area of the water-plane is not constant for all drafts, and therefore the TPC will reduce at lower drafts, as shown in Figure 8.1. The TPC's are calculated for a range of drafts extending beyond the light and loaded drafts and these are then tabulated or plotted on a graph. From the table or graph the TPC at intermediate drafts may be found.

TPC curves

When constructing a TPC curve the TPC's are plotted against the corresponding drafts. It is usually more convenient to plot the drafts on the vertical axis and the TPC' on the horizontal axis.

Example

(a) Construct a graph from the following information:

Mean draft (m)	3.0	3.5	4.0	4.5
TPC (tonnes)	8.0	8.5	9.2	10.0

(b) From this graph find the TPC's at drafts of 3.2 m; 3.7 m; and 4.3 m.

(c) If the ship is floating at a mean draft of 4 m and then loads 50 tonnes of cargo, 10 tonnes of fresh water, and 25 tonnes of bunkers, whilst 45 tonnes of ballast are discharged, find the final mean draft.

56 Ship Stability for Masters and Mates

- (a) For the graph see Figure 8.1
 (b) TPC at 3.2 m draft = 8.17 tonnes
 TPC at 3.7 m draft = 8.77 tonnes
 TPC at 4.3 m draft = 9.68 tonnes
 (c) TPC at 4 m draft = 9.2 tonnes

Loaded Cargo	50 tonnes
Fresh water	10 tonnes
Bunkers	<u>25 tonnes</u>
Total	<u>85 tonnes</u>

Discharged ballast	45 tonnes
Net loaded	40 tonnes
Increase in draft	$= \frac{w}{\text{TPC}}$
	$= \frac{40}{9.2}$
	$= 4.35 \text{ cm}$
Increase in draft	$= 0.044 \text{ m}$
Original draft	$= 4.000 \text{ m}$
<u>New mean draft</u>	<u>$= 4.044 \text{ m}$</u>

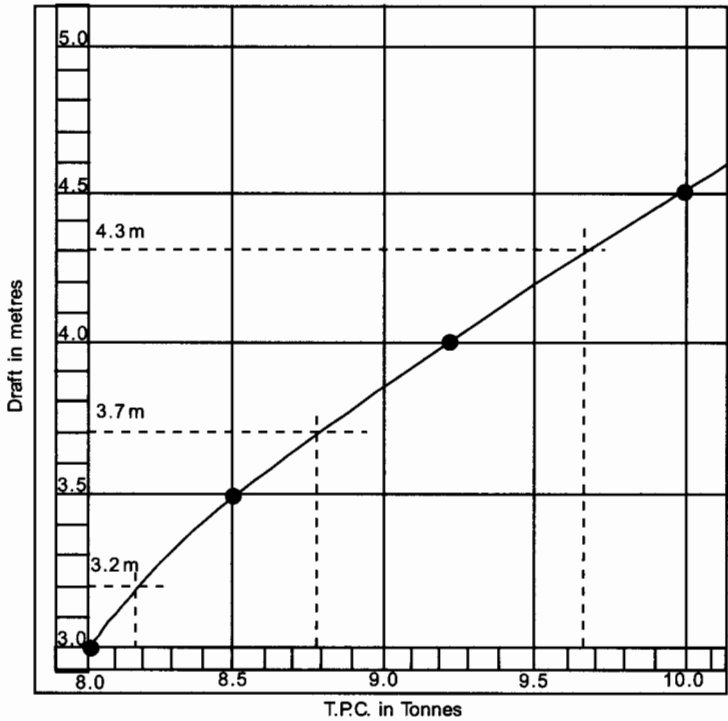


Fig. 8.1

Note. If the net weight loaded or discharged is very large, there is likely to be a considerable difference between the TPC's at the original and the new drafts, in which case to find the change in draft the procedure is as follows:

First find an approximate new draft using the TPC at the original draft, then find the TPC at the approximate new draft. Using the mean of these two TPC's find the actual increase or decrease in draft.

Displacement curves

A displacement curve is one from which the displacement of the ship at any particular draft can be found, and vice versa. The draft scale is plotted on the vertical axis and the scale of displacements on a horizontal axis. As a general rule the largest possible scale should be used to ensure reasonable accuracy. When the graph paper is oblong in shape, the length of the paper should be used for the displacement scale and the breadth for the drafts. It is quite unnecessary in most cases to start the scale from zero as the information will only be required for drafts between the light and load displacements (known as the boot-topping area).

Example

- (a) Construct a displacement curve from the following data:
- | | | | | | | |
|-----------------------|------|------|------|------|------|------|
| Draft (m) | 3 | 3.5 | 4 | 4.5 | 5.0 | 5.5 |
| Displacement (tonnes) | 2700 | 3260 | 3800 | 4450 | 5180 | 6060 |
- (b) If this ship's light draft is 3 m, and the load draft is 5.5 m, find the deadweight.
- (c) Find the ship's draft when there are 500 tonnes of bunkers, and 50 tonnes of fresh water and stores on board.
- (d) When at 5.13 m mean draft the ship discharges 2100 tonnes of cargo and loads 250 tonnes of bunkers. Find the new mean draft.
- (e) Find the approximate TPC at 4.4 m mean draft.
- (f) If the ship is floating at a mean draft of 5.2 m, and the load mean draft is 5.5 m, find how much more cargo may be loaded.

- (a) See Figure 8.2 for the graph
- | | | | |
|----------|-------------|--------------|-------------|
| (b) Load | Draft 5.5 m | Displacement | 6060 tonnes |
| Light | Draft 3.0 m | Displacement | 2700 tonnes |

Deadweight = 3360 tonnes

- | | |
|------------------------|--------------------|
| (c) Light displacement | 2700 tonnes |
| Bunkers | +500 tonnes |
| Fresh water and stores | <u>+50 tonnes</u> |
| New displacement | <u>3250 tonnes</u> |

\therefore Draft = 3.48 m

- | | |
|----------------------------|---------------------|
| (d) Displacement at 5.13 m | 5380 tonnes |
| Cargo discharged | <u>-2100 tonnes</u> |
| | 3280 tonnes |
| Bunkers loaded | 250 tonnes |

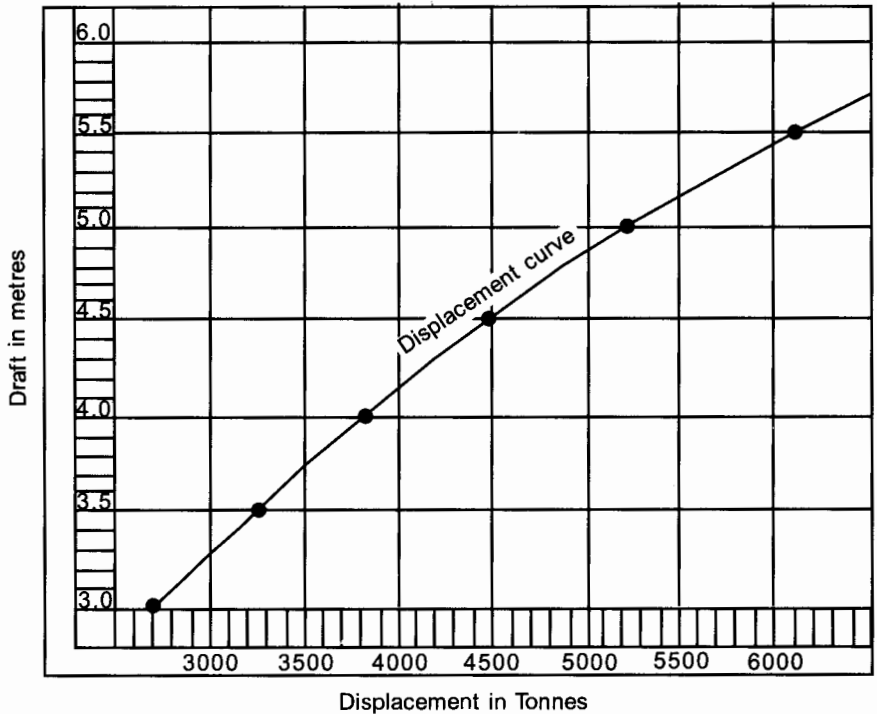


Fig. 8.2

New displacement 3530 tonnes

\therefore New draft = 3.775 m

(e) At 4.5 m draft the displacement is 4450 tonnes

At 4.3 m draft the displacement is -4175 tonnes

Difference to change the draft 0.2 m $\frac{275 \text{ tonnes}}{20}$

Difference to change the draft 1 cm $\frac{275}{20}$ tonnes

\therefore TPC = 13.75 tonnes

(f) Load draft 5.5 m Displacement 6060 tonnes

Present draft 5.2 m Displacement -5525 tonnes

Difference 535 tonnes

\therefore Load 535 tonnes

In fresh water, the TPC is calculated as follows

$$\text{TPC}_{\text{FW}} = \frac{\text{WPA}}{100}$$

$$\text{or } \text{TPC}_{\text{FW}} = \text{TPC}_{\text{SW}} \times \frac{1.000}{1.025}$$

Exercise 8

TPC curves

- 1 (a) Construct a TPC curve from the following data:
- | | | | | | |
|----------------|------|------|------|------|------|
| Mean draft (m) | 1 | 2 | 3 | 4 | 5 |
| TPC (tonnes) | 3.10 | 4.32 | 5.05 | 5.50 | 5.73 |
- (b) From this curve find the TPC at drafts of 1.5 m and 2.1 m.
 (c) If this ship floats at 2.2 m mean draft and then discharges 45 tonnes of ballast, find the new mean draft.
- 2 (a) From the following information construct a TPC curve:
- | | | | | | |
|----------------------------|-----|-----|-----|-----|-----|
| Mean draft (m) | 1 | 2 | 3 | 4 | 5 |
| Area of water-plane (sq m) | 336 | 567 | 680 | 743 | 777 |
- (b) From this curve find the TPC's at mean drafts of 2.5 m and 4.5 m.
 (c) If, while floating at a draft of 3.8 m, the ship discharges 380 tonnes of cargo and loads 375 tonnes of bunkers, 5 tonnes of stores, and 125 tonnes of fresh water, find the new mean draft.
- 3 From the following information construct a TPC curve:
- | | | | | |
|----------------|-----|------|------|------|
| Mean draft (m) | 1 | 3 | 5 | 7 |
| TPC (tonnes) | 4.7 | 10.7 | 13.6 | 15.5 |

Then find the new mean draft if 42 tonnes of cargo is loaded whilst the ship is floating at 4.5 m mean draft.

Displacement curves

- 4 (a) From the following information construct a displacement curve:
- | | | | | | | |
|-----------------------|-----|-----|------|------|------|------|
| Displacement (tonnes) | 376 | 736 | 1352 | 2050 | 3140 | 4450 |
| Mean draft (m) | 1 | 2 | 3 | 4 | 5 | 6 |
- (b) From this curve find the displacement at a draft of 2.3 m.
 (c) If this ship floats at 2.3 m mean draft and then loads 850 tonnes of cargo and discharges 200 tonnes of cargo, find the new mean draft.
 (d) Find the approximate TPC at 2.5 m mean draft.
- 5 The following information is taken from a ship's displacement scale:
- | | | | | | | |
|-----------------------|-----|------|------|------|------|------|
| Displacement (tonnes) | 335 | 1022 | 1949 | 2929 | 3852 | 4841 |
| Mean draft (m) | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 |
- (a) Construct the displacement curve for this ship and from it find the draft when the displacement is 2650 tonnes.
 (b) If this ship arrived in port with a mean draft of 3.5 m, discharged her cargo, loaded 200 tonnes of bunkers, and completed with a mean draft of 2 m, find how much cargo she discharged.
 (c) Assuming that the ship's light draft is 1 m, find the deadweight when the ship is floating in salt water at a mean draft of 1.75 m.
- 6 (a) From the following information construct a displacement curve:
- | | | | | | | |
|-----------------------|-----|-----|------|------|------|------|
| Displacement (tonnes) | 320 | 880 | 1420 | 2070 | 2800 | 3680 |
| Draft (m) | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 |
- (b) If this ship's light draft is 1.1 m, and the load draft 3.5 m, find the deadweight.

60 Ship Stability for Masters and Mates

- (c) If the vessel had on board 300 tonnes of cargo, 200 tonnes of ballast, and 60 tonnes of fresh water and stores, what would be the salt water mean draft.
- 7 (a) Construct a displacement curve from the following data:
- | | | | | | | |
|-----------------------|-----|-----|------|------|------|------|
| Draft (m) | 1 | 2 | 3 | 4 | 5 | 6 |
| Displacement (tonnes) | 335 | 767 | 1270 | 1800 | 2400 | 3100 |
- (b) The ship commenced loading at 3 m mean draft and, when work ceased for the day, the mean draft was 4.2 m. During the day 85 tonnes of salt water ballast had been pumped out. Find how much cargo had been loaded.
- (c) If the ship's light draft was 2 m find the mean draft after she had taken in 870 tonnes of water ballast and 500 tonnes of bunkers.
- (d) Find the TPC at 3 m mean draft.
- 8 (a) From the following information construct a displacement curve:
- | | | | | | | |
|-----------------------|-----|------|------|------|------|------|
| Draft (m) | 1 | 2 | 3 | 4 | 5 | 6 |
| Displacement (tonnes) | 300 | 1400 | 3200 | 5050 | 7000 | 9000 |
- (b) If the ship is floating at a mean draft of 3.2 m, and then loads 1800 tonnes of cargo and 200 tonnes of bunkers, and also pumps out 450 tonnes of water ballast, find the new displacement and final mean draft.
- (c) At a certain draft the ship discharged 1700 tonnes of cargo and loaded 400 tonnes of bunkers. The mean draft was then found to be 4.5 m. Find the original mean draft.

Chapter 9

Form coefficients

The coefficient of fineness of the water-plane area (C_w)

The coefficient of fineness of the water-plane area is the ratio of the area of the water-plane to the area of a rectangle having the same length and maximum breadth.

In Figure 9.1 the area of the ship's water-plane is shown shaded and ABCD is a rectangle having the same length and maximum breadth.

$$\begin{aligned} \text{Coefficient of fineness } (C_w) &= \frac{\text{Area of water-plane}}{\text{Area of rectangle ABCD}} \\ &= \frac{\text{Area of water-plane}}{L \times B} \end{aligned}$$

$$\therefore \text{Area of the water-plane} = L \times B \times C_w$$

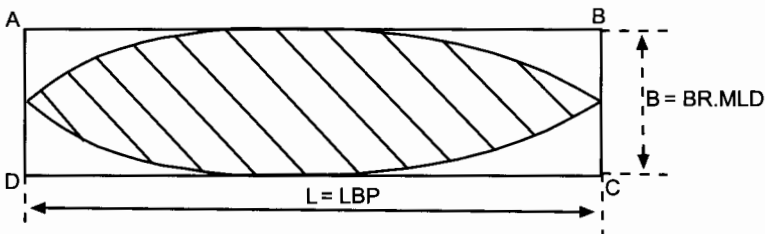


Fig. 9.1

Example 1

Find the area of the water-plane of a ship 36 metres long, 6 metres beam, which has a coefficient of fineness of 0.8.

$$\begin{aligned} \text{Area of water-plane} &= L \times B \times C_w \\ &= 36 \times 6 \times 0.8 \end{aligned}$$

Ans. Area of water-plane = 172.8 sq m

Example 2

A ship 128 metres long has a maximum beam of 20 metres at the waterline, and coefficient of fineness of 0.85. Calculate the TPC at this draft.

$$\begin{aligned}\text{Area of water-plane} &= L \times B \times C_w \\ &= 128 \times 20 \times 0.85 \\ &= 2176 \text{ sq metres}\end{aligned}$$

$$\begin{aligned}\text{TPC}_{\text{SW}} &= \frac{\text{WPA}}{97.56} \\ &= \frac{2176}{97.56}\end{aligned}$$

Ans. $\text{TPC}_{\text{SW}} = 22.3$ tonnes

The block coefficient of fineness of displacement (C_b)

The block coefficient of a ship at any particular draft is the ratio of the volume of displacement at that draft to the volume of a rectangular block having the same overall length, breadth, and depth.

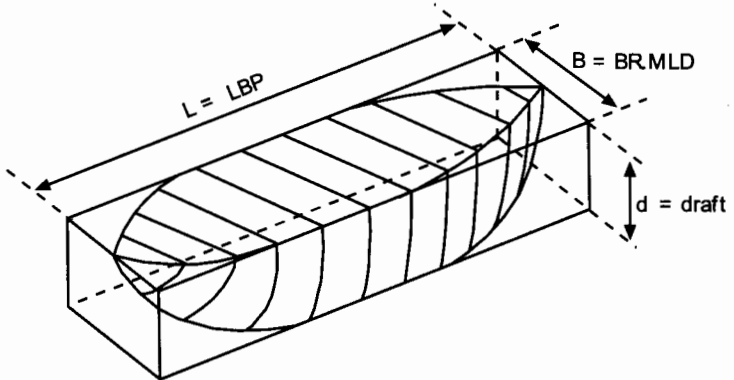


Fig. 9.2

In Figure 9.2 the shaded portion represents the volume of the ship's displacement at the draft concerned, enclosed in a rectangular block having the same overall length, breadth, and depth.

$$\begin{aligned}\text{Block coefficient } (C_b) &= \frac{\text{Volume of displacement}}{\text{Volume of the block}} \\ &= \frac{\text{Volume of displacement}}{L \times B \times \text{draft}}\end{aligned}$$

$$\therefore \text{Volume of displacement} = L \times B \times \text{draft} \times C_b$$

Ship's lifeboats

The cubic capacity of a lifeboat should be determined by Simpson's rules or by any other method giving the same degree of accuracy. The accepted C_b for a ship's lifeboat constructed of wooden planks is 0.6 and this is the figure to be used in calculations unless another specific value is given. Thus, the cubic capacity of a wooden lifeboat can be found using the formula:

$$\text{Volume} = (L \times B \times \text{Depth} \times 0.6) \text{ cubic metres.}$$

The number of persons which a lifeboat may be certified to carry is equal to the greatest whole number obtained by the formula V/x where 'V' is the cubic capacity of the lifeboat in cubic metres and 'x' is the volume in cubic metres for each person. 'x' is 0.283 for a lifeboat 7.3 metres in length or over, and 0.396 for a lifeboat 4.9 metres in length. For intermediate lengths of lifeboats, the value of 'x' is determined by interpolation.

Example 1

Find the number of persons which a wooden lifeboat 10 metres long, 2.7 metres wide, and 1 metre deep may be certified to carry.

$$\begin{aligned} \text{Volume of the boat} &= (L \times B \times D \times 0.6) \text{ cu. m} \\ &= 10 \times 2.7 \times 1 \times 0.6 \\ &= 16.2 \text{ cu. m} \end{aligned}$$

$$\begin{aligned} \text{Number of persons} &= V/x \\ &= 16.2/0.283 \end{aligned}$$

Ans. Number of persons = 57

Example 2

A ship 64 metres long, 10 metres maximum beam, has a light draft of 1.5 metres and a load draft of 4 metres. The block coefficient of fineness is 0.6 at the light draft and 0.75 at the load draft. Find the deadweight.

$$\begin{aligned} \text{Light displacement} &= L \times B \times \text{draft} \times C_b \text{ cu. m} \\ &= 64 \times 10 \times 1.5 \times 0.6 \\ &= 576 \text{ cu. m} \end{aligned}$$

$$\begin{aligned} \text{Load displacement} &= L \times B \times \text{draft} \times C_b \text{ cu. m} \\ &= 64 \times 10 \times 4 \times 0.75 \\ &= 1920 \text{ cu. m} \end{aligned}$$

$$\begin{aligned} \text{Deadweight} &= \text{Load displacement} - \text{Light displacement} \\ &= (1920 - 576) \text{ cu. m} \end{aligned}$$

$$\begin{aligned} \text{Deadweight} &= 1344 \text{ cu. m} \\ &= 1344 \times 1.025 \text{ tonnes} \end{aligned}$$

Ans. Deadweight = 1377.6 tonnes

The midships coefficient (C_m)

The midships coefficient to any draft is the ratio of the transverse area of the midships Section (A_m) to a rectangle having the same breadth and depths.

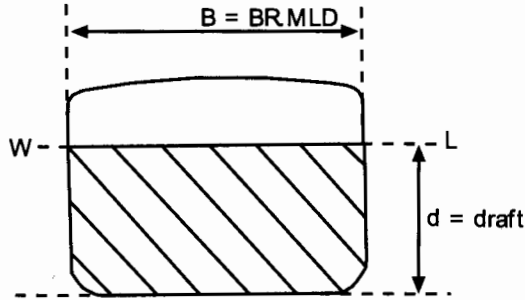


Fig. 9.3

In Figure 9.3 the shaded portion represents the area of the midships section to the waterline WL, enclosed in a rectangle having the same breadth and depth.

$$\begin{aligned} \text{Midships coefficient } (C_m) &= \frac{\text{Midships area } (A_m)}{\text{Area of rectangle}} \\ &= \frac{\text{Midships area } (A_m)}{B \times d} \end{aligned}$$

or

$$\text{Midships area } (A_m) = B \times d \times C_m$$

The prismatic coefficient (C_p)

The prismatic coefficient of a ship at any draft is the ratio of the volume of displacement at that draft to the volume of a prism having the same length as the ship and the same cross-sectional area as the ship's midships area. The prismatic coefficient is used mostly by ship-model researchers.

In Figure 9.4 the shaded portion represents the volume of the ship's displacement at the draft concerned, enclosed in a prism having the same length as the ship and a cross-sectional area equal to the ship's midships area (A_m).

$$\begin{aligned} \text{Prismatic coefficient } (C_p) &= \frac{\text{Volume of ship}}{\text{Volume of prism}} \\ &= \frac{\text{Volume of ship}}{L \times A_m} \end{aligned}$$

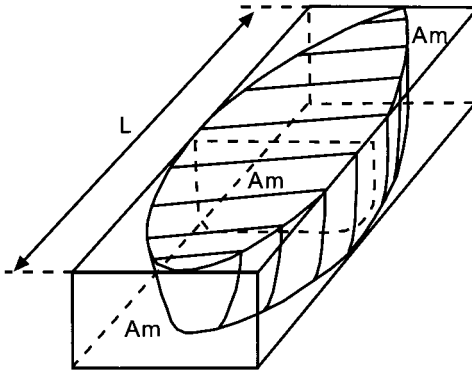


Fig. 9.4

or

$$\text{Volume of ship} = L \times A_m \times C_p$$

Note

$$\begin{aligned} C_m \times C_p &= \frac{A_m}{B \times d} \times \frac{\text{Volume of ship}}{L \times A_m} \\ &= \frac{\text{Volume of ship}}{L \times B \times d} \\ &= C_b \end{aligned}$$

$$\therefore C_m \times C_p = C_b$$

or

$$C_p = \frac{C_b}{C_m}$$

Note. C_p is always slightly higher than C_b at each waterline.

Having described exactly what C_w , C_b , C_w and C_p are, it would be useful to know what their values would be for several ship types.

First of all it must be remembered that all of these form coefficients will never be more than unity.

For the C_b values at *fully loaded drafts* the following table gives good typical values:

Ship type	Typical C_b fully loaded	Ship type	Typical C_b fully loaded
ULCC	0.850	General cargo ship	0.700
Supertanker	0.825	Passenger liner	0.625
Oil tanker	0.800	Container ship	0.575
Bulk carrier	0.750	Coastal tug	0.500

medium form ships (C_b approx. 0.700), full-form ships ($C_b > 0.700$), fine-form ships ($C_b < 0.700$).

66 Ship Stability for Masters and Mates

To estimate a value for C_w for these ship types at their *fully loaded* drafts, it is useful to use the following rule-of-thumb approximation.

$$C_w = \left(\frac{2}{3} \times C_b\right) + \frac{1}{3} \text{ @ Draft Mld only!}$$

Hence, for the oil tanker, C_w would be 0.867, for the general cargo ship C_w would be 0.800 and for the tug C_w would be 0.667 in fully loaded conditions.

For merchant ships, the midships coefficient or midship area coefficient is 0.980 to 0.990 at fully loaded draft. It depends on the rise-of-floor and the bilge radius. Rise of floor is almost obsolete nowadays.

As shown before;

$$C_p = \frac{C_b}{C_m}$$

Hence for the bulk carrier, when C_b is 0.750 with a C_m of 0.985, the C_p will be:

$$C_p = \frac{0.750}{0.985} = 0.761 \text{ @ Draft Mld}$$

C_p is used mainly by researchers at ship-model tanks carrying out tests to obtain the least resistance for particular hull forms of prototypes.

C_b and C_w change as the drafts move from fully loaded to light-ballast to lightship conditions. The diagram (Figure 9.5) shows the curves at drafts below the fully loaded draft for a general cargo ship of 135.5 m LBP.

'K' is calculated for the fully loaded condition and is *held constant* for all remaining drafts down to the ship's lightship (empty ship) waterline.

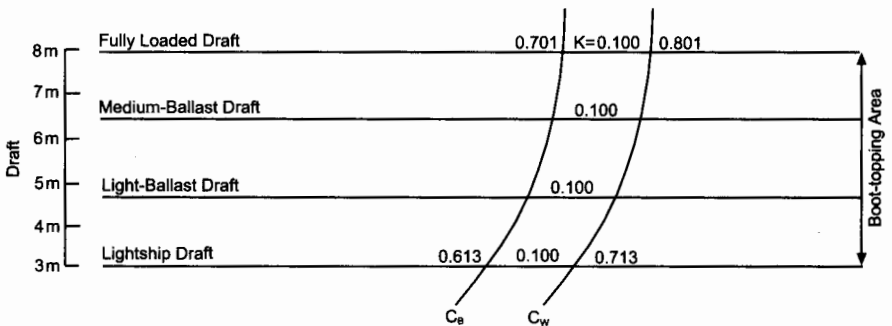


Fig. 9.5. Variation of C_b and C_w values with draft. (Note how the two curves are parallel at a distance of 0.100 apart).

Exercise 9

- 1 (a) Define 'coefficient of fineness of the water-plane'.
(b) The length of a ship at the waterline is 100 m, the maximum beam is 15 m, and the coefficient of fineness of the water-plane is 0.8. Find the TPC at this draft.
- 2 (a) Define 'block coefficient of fineness of displacement'.
(b) A ship's length at the waterline is 120 m when floating on an even keel at a draft of 4.5 m. The maximum beam is 20 m. If the ship's block coefficient is 0.75, find the displacement in tonnes at this draft in salt water.
- 3 A ship is 150 m long, has 20 m beam, load draft 8 m, light draft 3 m. The block coefficient at the load draft is 0.766, and at the light draft is 0.668. Find the ship's deadweight.
- 4 A ship 120 m long \times 15 m beam has a block coefficient of 0.700 and is floating at the load draft of 7 m in fresh water. Find how much more cargo can be loaded if the ship is to float at the same draft in salt water.
- 5 A ship 100 m long, 15 m beam, and 12 m deep, is floating on an even keel at a draft of 6 m, block coefficient 0.8. The ship is floating in salt water. Find the cargo to discharge so that the ship will float at the same draft in fresh water.
- 6 A ship's lifeboat is 10 m long, 3 m beam, and 1.5 m deep. Find the number of persons which may be carried.
- 7 A ship's lifeboat measures 10 m \times 2.5 m \times 1 m. Find the number of persons which may be carried.