CHAPTER 4

IMPROVISED RAFT

SECTION 7

BUOYANCY AND IMPROVISED RAFT DESIGN CALCULATION

0701. **Introduction.** All of us know that there are certain substances which float on the water and some of which do not. Whether or not a substance will float on water depends on a property or characteristics called buoyancy. So, by knowing the buoyancy we can find out whether a particular substance will float in the water or sink. By this we can also find out the amount of load or weight required to sink a floating substance. The basic principle which is used in finding out the buoyancy is the Archimedes principle. Basing on this improvised raft sare made. Improvised rafts are simple in construction and are made from materials that are easily available. As a matter of fact, any material having a certain degree of buoyancy and strength such as logs, planks, bamboo, barrels, fascines, floating bags etc can be utilized for constructing improvised rafts.

0702. **Definition.**

a. **Buoyancy**. Buoyancy is the capacity of floating due to loss of weight of an object owing to immersion in a fluid.

b. **Net Buoyancy**. Net buoyancy of a float is the weight of water that it will displace minus its own weight. Net buoyancy equals the volume of the float multiplied by the weight of a cubic feet of water (62.5 lbs) minus the weight of the float.

c. **Safe Buoyancy**. It is usually taken as nine tenths of the net buoyancy minus its own weight.

0703. **Formula.**

a. **Net Buoyancy**. Net buoyancy equals the volume of the float X weight of one cft of water (62.5 Ib) – weight of the float.

b. **Safe Buoyancy**. Safe buoyancy is:

(1) 9/10 of net buoyancy (closed float).
(2) 2/3 of net buoyancy (open float).

c. **Volume of Cylinder**. $\frac{11}{14}$ x d^2 x l

d. **Volume of Rectangular Solid**. I x b x h

0704. **Important Data.**

a. The weight of timber per cft vary in accordance with the species and whether it is green or seasoned. Some approximate figure are given below:

(1) Soft wood, sawn, as used in small
‘‘housing estate” building ------------------------------40
(2) Hard wood, sawn, as used in old
mansions, factory floors, or fencing posts --------------- 45

(3) Soft wood, green, such as standing
Treesofire, pine, or hazel-------------------------------------- 45

(4) Hard wood, green, such as standing
trees of oak, beech, or chestnut------------------------------- 40

b. The safe buoyancies of some stores commonly available as floats are shown in table.

Safe Buoyancies of Common Stores

Serial	Item	Safe Buoyancy	Remarks
1.	Recce boat, Mark-2	700	Completely submerged
2.	Recce boat, Mark-3	1100	Completely submerged
3.	Assault boat, Mark-3	4400	-
4.	Assault boat, Mark-4	4400	-
5.	Pontoon of aluminum floating footbridge	440	-
6.	Jerrican	36	-
7.	Inner tube, 6.50-16	72	$\frac{1}{4}$ton GS Land Rover-II
8.	Inner tube, 7.50-16	100	$\frac{1}{4}$ton GS Austin
9.	Inner tube,9.00-20	180	1 ton GS all makes
10.	Inner tube, 10.50-20	260	3 ton GS all makes
11.	40-gal oil drum	350-400	-7.

0705. **Buoyancy Calculation example.**

a. Calculate the buoyancy of a float made from the inner tube of a motor tyre (6"-15") enclosed in a frame of two 9" x 3" and six 6" x 1" timber all from a demolished garage. Weight of the tube is 4 lb.

(1) **Given Data**

(a) Diagram of tyre when inflated 6"
(b) Diagram of wheel rim 15"
(c) No of 9" x 3" timber =2
(d) No of 6" x 1" timber =6
(e) Weight of tube 4 lb.

(2) **Volume of Inflated Tube.**

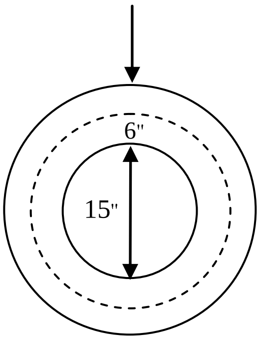

Figure 7.1: Volumeof Inflated Tube

To find out the volumeof the inflated tube imagine the tube to be cut at B-B to get a cylinder. Diagram of the cylinder =60"=5 ft

length of the cylinder = 2 r

$$= \frac{22}{7} \text{x } (15+\frac{6}{2} \quad +\frac{6}{2}) \text{ x } \frac{1}{12} \text{ ft}$$
$$= 5.5 \text{ ft}$$

So, the volumeof the cylinder $= \frac{11}{14} \text{x } d^2 \text{ x l}$

$$= \frac{11}{14} \text{ x } (.5)^2 \text{ x } 5.5$$
$$= 1.08 \text{ cft}$$
$$= 1 \text{ cft}$$

(3) **Buoyancy of Tube**. (1 x 62.5)-4
= 58.5 lb
= 58 lb(approximate)

(4) **Value of Timber Frame Work.**

Volumeof 2 lengths of 9" x 3" x 27"= .84 cft

Volume of 6 lengths of 6" x 1" x 33" = .687 cft

So, total volume = (.84 + .687) cft
= 1.527cft

Weight of timber = 1.527 x 40 = 61lb

(5) **Buoyancy of Timber Frame.**

= 1.527 x 62.5-61) Ib
= 34.4 Ib = 34 Ib

(6) Total Buoyancy = (58 + 54) lb= 92 lb
(7) Safe Buoyancy = 82.8 =82 lb

b. Calculate the buoyancy of a float made of fascine of 2inch dia bamboos, 12 feet long with 3-ton truck inner tube encircling the ends. The water line is to correspond to the top of the fascine. Bamboo weighs about 25 lb per cft.

c. **Solution.**

(1) Considering the whole fascine as large bamboo the volume would be

$$\frac{11}{14} \text{ x } d^2 \text{ x } l$$

$=11/14 \text{ x } \frac{20}{12} \text{ x } \frac{20}{12} \text{ x } 12$
= 26.1 cft
=26 cft.

As the fascine is made up of number of bamboos with air space between them, the effective volume may be taken as four-fifth.

So, the effective volume= 26 x $^4/_5$
= 20.8 cft
= 21 cft

(2) The net buoyancy of the fascine = 21 x 62.5-21 x 25
=787 lb.

(3) The safe buoyancy = $\frac{9}{10}$x 787
= 708 lb (approximate.)

(4) The safe buoyancy of one tube= 260 lb.

Since 3/4 of the tube to be immersed, the effective buoyancy is about 200 lb.

(5) If two tubes are used, the total safe buoyancy= 708 + (200 x 2)= 1108 lb

0706. **<u>Principles of Construction of Rafts</u>.** Construction will vary greatly with different types of vessel but following principles will always to be applied:

a. Enclosed boats orfloats make better piers than open boats as they cannot be swamped.

b. If boats or open barges are used the load must be spread over the floor of the boat and not taken on the gunwales.

c. A two pier raft is the easiest to handle on the water, and it provides buoyancy where it is most wanted, i.e. at either of the deck where the load is concentrated during loading.

d. Loading the raft is usually the most difficult operation and thought must be given to the design of the suitable ramps.

e. The buoyancy of the piers must be calculated on the worst case, which is during loading it must be assumed that the inshore pier will take the entire load of the vehicle at a moment.

f. The safe buoyancy required for one pier should be calculated by multiplying the load 10/9 in the case of a closed container and 2/3 in the case of an open boat.

g. For stability the length of the piers should be at least twice the width of the deck of the raft.

h. The deck platform is constructed in the same manner as the roadway of a bridge i.e. with longitudinal road bearers and transverse planks and rebinds.

j. Regular inspectionto ensure that fastenings are secure and floats are watertight.

0707. **Design of Improvised Raft**. Following steps for the design of improvised rafts to be followed:

a. Preliminary planning and assumptions.

b. **Size of Raft**.

(1) Length of Deck = Length of the load + 6' for safety (may be varied).

(2) Width of Deck = Width of load + 3' for safety (may be varied).

c. **Total Load on Raft**.

(1) Weight of the load to be carried.
(2) Weight of super structure.
(3) Weight of crew.
(4) Weight of other material (anchor, ropes and fastenings).
(5) Total load = a+ b + c + d

d. **Pier.**

(1) Number of Pier.
(2) Load per pier = Total load x 10/9 (closed container).
Total load x 3/2 (open float).

e. Net buoyancy of one drum or float = volume of float x 62.5 weight of each drum or float.

f. Safe buoyancy of each float or drum =
Net buoyancy x 9/10 (closed container)
Net buoyancy x 2/3 (open float)

g. Number of drum per pier = load per pier÷ Safe buoyancy of each float or drum.

h. Total no of float or drum = no of drum per pier x number of pier.

j. **Check for Stability**.

(1) Total length of floats or drums of one pier= No of drum or float x diagram or length of each drum or float.

(2) Minimum length of piers = 2 x width of Deck.

(3) Length of one pier = Total length of pier - Number of pier.

(4) Number of Rows per pier = $\frac{\text{Total length of floats or drums of one pier}}{\text{Length of one pier}}$

(5) Exact no of drums per pier = (Length of one pier – diagram/length each float or drum) x no of rows pier.

(6) Depth of Water. Depth of Water Required = Height of pier + 1;

0708-0800 Reserve.