Experiment 2

To determine the Metacentric height of a floating body (i.e. a model of ship) and to locate the position f center of Buoyancy, Matacenter and Center of Gravity.

Apparatus

Metacentric Height Apparatus, Water Tank

Related Theory

Buoyancy

It is the tendency of fluid to lift a submerged body.

Force of Buoyancy (F_B)

It is the resultant upward force or thrust exerted by a fluid on submerged body. According to Archimedes Principle, F_B = weight of volume of liquid displace by the body.

Center of Gravity (c)

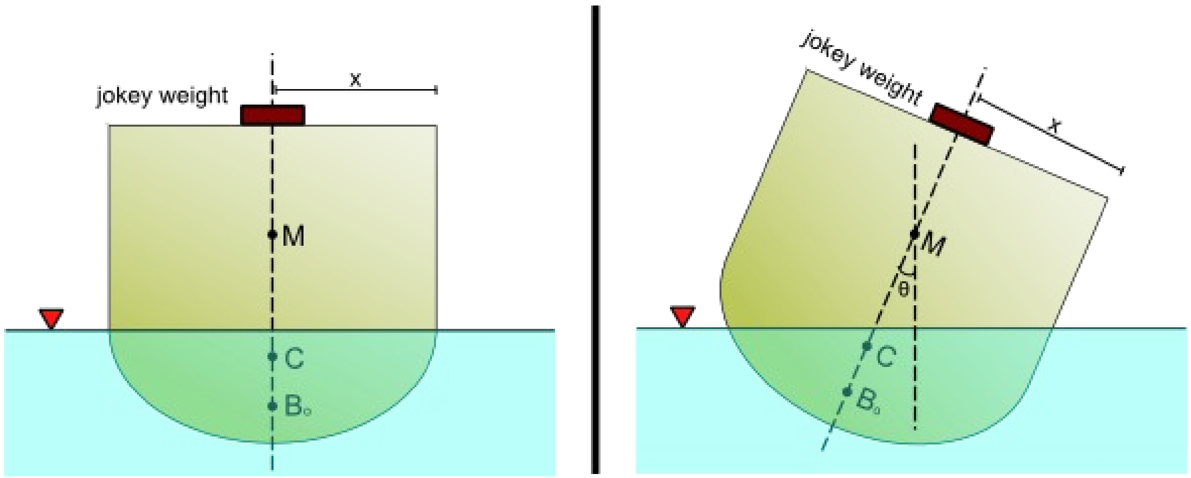
It is the point where is weight of the body is acting.

Center if Buoyancy (B_o and B)

It is the point to which force of Buoyancy is acting. Center of Buoyancy is center if gravity of volume of liquid displace by the body. Or in 2D case, we can say that center if Area if immersed section.

Metacenter

It is the point of intersection of symmetrical axis of floating body and the new line of action of force of Buoyancy.


jokey weight
x
M
C
B_o
jokey weight
x
M
θ
C
B_o

Metacentric Height (CM)

It is the distance between center of gravity (c) and Metacenter. It is the measure if static stability of floating body. Large the metacentric height more is the stability. Very large Metacentric height means shorter period of rolling that would be uncomfortable for the passengers in the ship. That is why ship meant for passengers are designed for relatively small metacentric height, (but sufficiently metacentric height). So, that both stability and comfort can be provided.

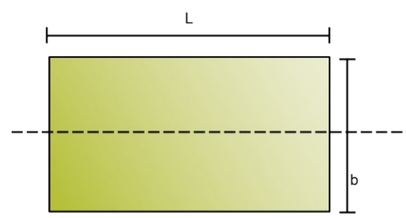
Metacentric Radius/Buoyant Radius (B_oM)

B_oM = distance between original point of buoyancy and Metacenter. BoM= IV.
V= volume of liquid displaced by body, I = second moment of waterline area about longitudinal axis.
Conditions of Stability if Floating Body
$F_B = W$
Metacenter must be above the center of Gravity.
(Resistance couple is form by F_B and W only when Second condition is true.)

Procedure

1. Place the model of ship in the water tank.
2. Shift the jockey weight to zero position and note the corresponding angle of rotation.
3. If it is on zero then its correct if not then notes the error and its direction.
4. Now shift the jockey weight to either left or right side by 0.5 inches. Note the angle against that reading.
5. Similarly shift the jockey weight to 1 inch, 1.5 inches, 2' inches, 2.5 and 3 inches and note the corresponding value of angle.
6. Similarly, move the jockey weight weight to the other side and take at least 6 readings accordingly.
7. Take mean of left and right angle and make a table of it.

Observations and Calculations



Jockey weight = W_o = 0.75 lbs
Length of ship = L = 20 inches
Breath of ship = b = 10 inches
Radius of semi-circle = r = 5 inches
Volume of liquid displaced by body = V = πr22L = 785.375 in^3
Weight of volume of liquid displaced by the body = F_B = γwater.V= 62.4123 X 785.375=28.360 lbs (γ=WV)
Second moment of waterline area about longitudinal axis = I = Lb312=1666.67 in4

CM= Wox/W. tanθ

Table 1					
No of obs	Displacement of Jokey	Angle of rotation			$CM = \frac{W_o x}{W . \tan\theta}$
	inches	R	L	Mean	inches
1	0.5	3	3	3	
2	1.0	6	6	6	
3	1.5	8	8	8	
4	2.0	11	11	11	
5	2.5	13	12	12.5	
6	3.0	15	15	15	

W= F_B, B_oM = IV= 1666.67785.375=2.122 inches

Position of center of Buoyancy = 4r3π=2.122 inches

Position of Metacenter = B_oM – Position of center of Buoyancy = 2.122 – 2.122 = 0

Position of center of gravity = CM – position of Metacenter = CM – 0 = CM

Comments

1. In figure CM is above fluid but in actual it is on fluid i.e. CM = 0
2. As CM is directly proportional to stability, so in case of ships meant to carry baggage, the CM may be kept as high as needed.
3. The application of force of Buoyancy is applied on submarines. Water is filled in containers and weight becomes greater thank force of buoyancy and sub-marine sinks. Now, whenever there is a need to get upwards the containers get empty and force of buoyancy become greater than weight.