International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 12 Issue 3 –JANUARY 2015.

Economical Design of Floating Bridges

R.M.Manoj kumar[*1] and J.Amit Binglesh[#2]

[*]*Department of Civil Engineering, Thiagarajar College of Engineering, Madurai-625015*

[1]manojramuk5@gmail.com

[2]amit.thekingofkings@gmail.com

***Abstract*— — Economy in construction is the ultimate need for today, so we go for suitable structures to fit the purpose. Pier-fewer bridges are not new to this world. During the Chola period for their invasion across rivers, they made use of trained elephants that swim on the surface, over which they transported all elements of battle by laying planks over elephants. Similarly in China, pontoons which float due to buoyancy similar to elephants used in chola period. This paper also includes floating bridges which are pierless and whose design has been modified to withstand more load and achieve more economy. These bridges are made of suitable concrete sections and are continuous in length so that they could connect island and mainland even over sea which eliminates the cost of pier and makes the bridges more economical**

Keywords- pierless, buoyancy, floating bridges

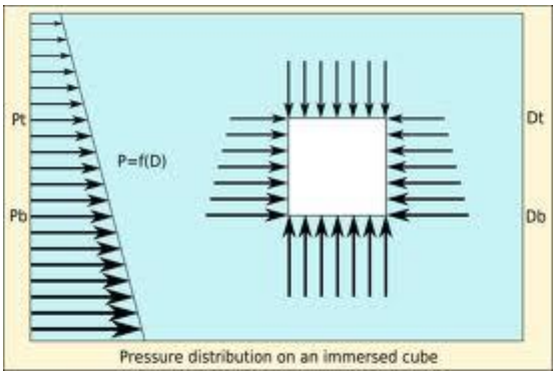
I. INTRODUCTION

Floating bridges were even built in olden ages with the help of boat like structures as supporting piers at regular intervals and decks were placed on it. Here the entire bridge transfers its load due to buoyancy.

As we propose to built a bridge across a natural drainage or some obstruction, we have to consider the height of piers constructed above the ground level as well as below the ground level. When we lay piers for bridges crossing deeper rivers then the height of piers would be very large. Even if the river bed is of soft bed rock then the depth up to which the piers have to be laid under the ground level is also so high. So as a whole it leads to a large excavation cost for drilling piles under water as well as constructing piers for such great heights. Even if we construct like this we must increase the dimensions of piers drastically to avoid buckling or go for many piers at shorter intervals to reduce the load over the piers. So in order to reduce the cost and make the bridge more economical we go for floating bridges now, which is made of concrete and it floats based on the principle of buoyancy.

II. BUOYANT FORCES

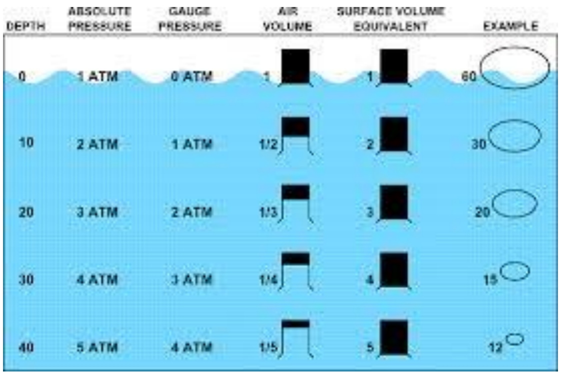
When an object is placed in a fluid, the fluid exerts an upward force we call the buoyant force. The buoyant force comes from the pressure exerted on the object by the fluid. Because the pressure increases as the depth increases, the pressure on the bottom of an object is always larger than the force on the top - hence the net upward force.The buoyant force is present whether the object floats or sinks. Let's consider a floating object, but the analysis is basically the same for a submerged object.



Pressure distribution on an immersed cube

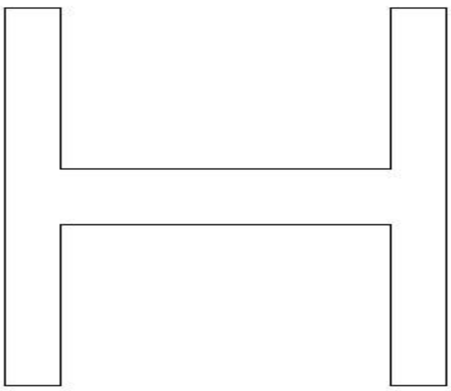
We'll also consider a cube, although a similar (more complicated) analysis leads to the same result for funny-shaped objects. The object experiences forces on each of its six sides. On each side, the force is the pressure multiplied by the area of the side, and is directed perpendicular to the side and toward the inside of the object.The force on the left side is tricky to calculate, because the pressure is different at different levels. Fortunately we don't have to calculate it because this force is equal-and-opposite to the force on the right side. Similarly, the forces on the front and back cancel.

III. EFFECT ON VOLUME BY INCREASE IN PRESSURE



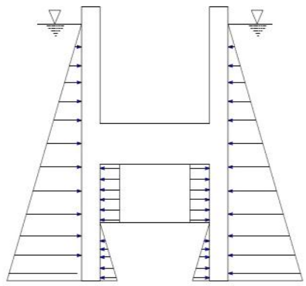
As we go deeper into water, the pressure due to water increases by the equation $P=\rho gh$. So according to Boyle's law, as pressure increases volume decreases, which is stated as PV=constant. If the air in a container of certain volume is exposed to atmosphere, it would experience a pressure of 1 atm. When the container is immersed to a depth of 10.4m the pressure due to water now is 2atm (since 1atm=10.4m of water). Now the pressure has doubled so that volume has become half so that PV remains still constant. But due to decrease in volume there is no loss of mass instead air in the container is compressed and density of air is also doubled.

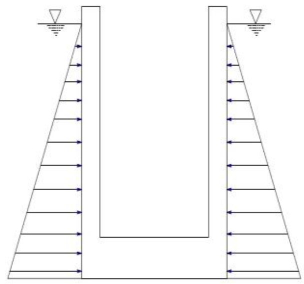
IV. COFFER DAMS WITH 'H' SHAPED DESIGN



This shows the 'H' shaped structure of cofferdam in which the upper portion of 'H' makes use of law of buoyancy to float and lower part floats due to the property that air compresses when immersed in water. Coffer dam is a large hollow section which floats based on law of buoyancy The lower part of cofferdam consists of air initially at 1atmospheric pressure. But when it is lowered into the water at a depth of 10m, the pressure acting on the air increases to almost 2atm which is equal to 10.4m of water. Since the pressure has doubled now volume should decrease according to Boyle's law. So now the volume decreases to half and this volume of air exerts a upward force equal to weight of water displaced by the halved volume of air.

V. ECONOMY IN DESIGN:





When we see through the pressure distribution on the walls of a 'U' shaped coffer dam, it is just a triangular distribution with max at the base of coffer dam. But in the case of 'H' shaped structure the maximum occurs only at the mid half and not at the base. When we construct a 'U' shaped coffer dam of height X then the maximum pressure on the walls of coffer dam would be ρgX where ρ is the density of water and g is the acceleration due to gravity. But in case of 'H' section, when the total height of the structure is X then the walls of coffer dam would experience a maximum pressure less than ρgX. This reduction in pressure is due to the air acting on the lower side of 'H' which would give a pressure in the direction away from the walls and this pressure would try to expand the lower part volume but water outside the lower part tries to compress the lower volume as a result of which stress acting at lower part is considerably reduced and economy is achieved.

Similarly the lower part contains some water upto a certain level which would oppose the force acting on the walls of dam due to water outside the lower part.

These changes in design would greatly reduce the pressure acting on walls of coffer dam as a result of which economy is achieved.

International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 12 Issue 3 –JANUARY 2015.

VI. MATERIALS USED:

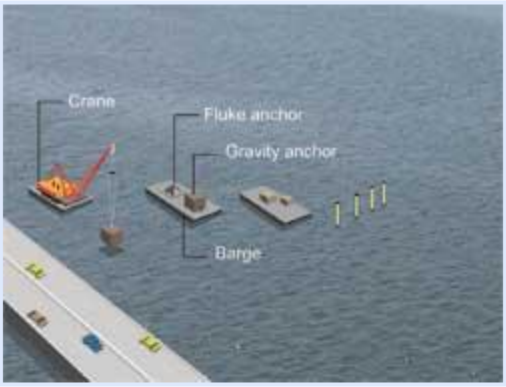
Here we use steel of grade used in ships which are resistant to corrosion due to water and have good compressive strength. The deck of the bridges can be of any type depending upon the strength and life time of bridge.

These coffer dams and deck are precasted and brought to erection point using heavy ships.

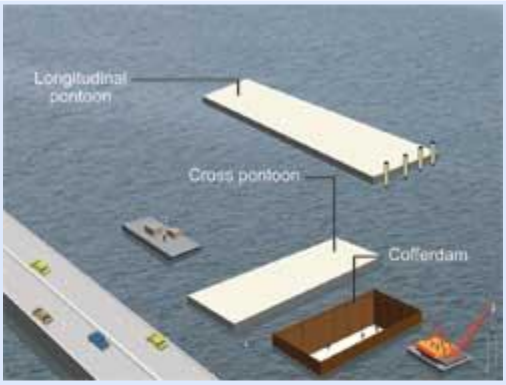
VII. ERECTION

Coffer dam has to be carried using heavy ships to the place where small piers have to be placed at regular intervals across the coffer dam. Over these piers deck of the bridge has to be placed and the traffic load over the bridge transfers to the coffer dam through the deck and small piers.

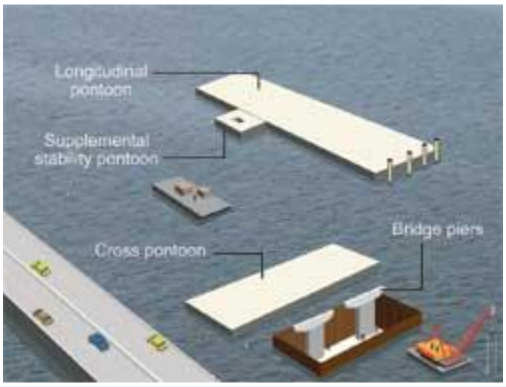
Like this we place many coffer dams at regular intervals and decks are placed over it. These decks are connected by tension cables to make it stand still and coffer dams are connected to the river bed by means of tie rods in four directions to avoid toppling of the 'H' shaped structure. The decks are made of pre stressed concrete using these tension cables to provide pre stress and these tension cables are also used connect the decks.



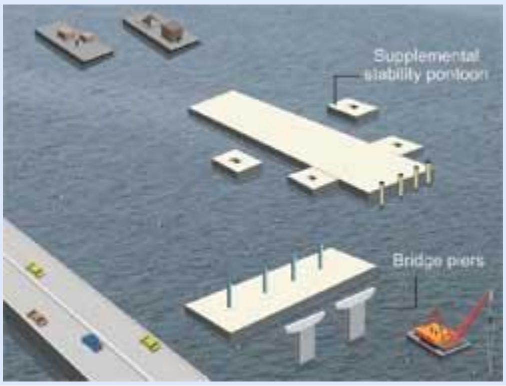
Step 1: **Install** anchors for the floating bridge.



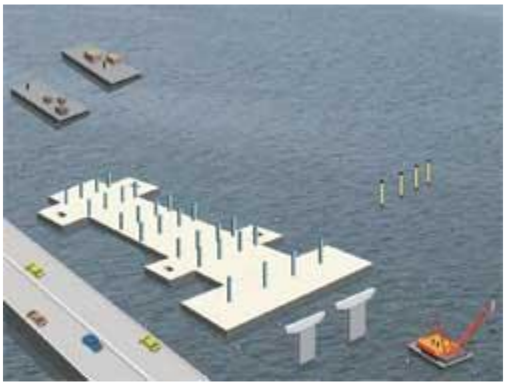
Step 2: Install cofferdams to build bridge piers. Move pontoon into staging area.



Step 3: Build bridge piers in cofferdams and begin pontoon assembly in staging area.



Step 4: Join supplemental pontoons to longitudinal pontoons at staging area. Begin installation of columns on cross pontoon.



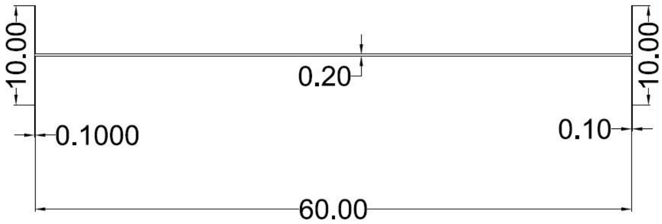
Step 5: Move assembled pontoons into position. Begin installation of columns on longitudinal pontoon.

Step 6: Begin installation of superstructure on pontoons. Continue assembling pontoons in staging area.

International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 12 Issue 3 –JANUARY 2015.

Step 7: Complete roadway superstructure in final alignment.

VIII. APPROXIMATE LOAD CALCULATION



Consider a section of unit length :

The downward force

due to H section= (60 x 0.2m) + (10 x 0.1)(2)

= 14m3=14x7900=110.6ton

Consider the upward force

due to buoyancy = (5-0.1)x60m

= 294m3 of water

= 294x1000kg of water force

= 294 ton force

Consider upward force

due to compressed air = ((5-0.1)/2)x60m3 of air

= 147m3 of compressed air

= 147x1000kg of water

= 147 ton force

Total upward force =294+147=441ton force

Total downward force= 110.6 ton force

Therefore the section can be acted upon by a load of (441-110.6)=330.4 ton per metre of section.

IX. PERFECTIONS:

Since the stress would be more concentrated at the corners of coffer dam we fillet the corners to avoid stress concentration. In addition to these perfections, sensors have to provided to ensure that the volume of air inside the lower part is above a particular level so that the force exerted by the air in the lower part remains potential.

X. CONCLUSION

Thus we have designed an economical section which could withstand more compressive stress compared to normal boat like structures of Chinese and U shaped coffer dams which float on lakes. Hence the capacity of sections to withstand load has improved considerably and it can be used to control the traffic these days . These bridges could be built across large lakes which would avoid a long ride around the river and reaching the other side of lake. Hence it again proves to be economical.