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Solutions to minimize flood damage to Bridges

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Abstract – *Bridge is a structure that crosses a water body to connect 2 parts of land. These bridges are subjected to heavy damages caused by the floods and the debris the water brings along. With floods being frequent in Southern, Western and South-western parts of Maharahstra. The remotely located bridges in hilly regions are often deprived of maintenance and repairs. These bridges can be the only way of connecting a village to the rest of the world. Hence, through our project we suggest solutions to minimize flood damage to the bridge. Firstly, we suggest the lenticular shape of bridge piers so that water passes without forming vertices. Further we suggest use of steel plates for bridge deck as it requires less time for maintenance. Lastly, we suggest rotating the bridge deck during the floods so that the debris does not get deposited at the bridge and flows away easily.*

Key Words: Bridge, Lenticular shaped piers, Steel plate deck, Scouring, Less damage, Floods. Erosion, Deposition.

1. INTRODUCTION

As we know that bridge is a structure built across a water body or valley to connect two parts of land. Observing the flood conditions in 2019, 2020, 2021 in southern, western & south-western part of Maharashtra, we came up with solutions to reduce damage caused by debris & excess water brought by flood.

Bridges built over rivers that flood frequently are exposed to damage caused by debris brought by floods. During the post flood period these bridges play a vital role in rescue & relief operations.

Why we choose this project ?

At remote locations bridges play a very important role as they are the only way of connecting a certain village to the rest of the world. If that bridge is damaged, the connection is lost until the bridge is repaired, which might take weeks or even months. The damage is mostly suffered by the piers and deck of the bridge. Hence, here we have studied the main causes of damage and suggested some solutions in order to reduce them.

2. Objectives

- To suggest a shape for pier with minimum scour.
- To suggest solutions to minimize flood damage to the bridge.
- To suggest solutions to minimize repair time of the bridge.

3. Study Work

3.1) What is the bridge failure?

A bridge is constantly subjected to loads applied by the flow of water. This flow dramatically increases at the times of flood. After a certain limit the structure weakens completely and it can no longer hold the force of water. As a result, it the bridge drowns away in water.

Fig -1: Bridge Failure

3.2) Main causes of Bridge Failure

A) Scouring:

When water passes through the bridge, it comes in contact with the piers. When water hits the piers and passes around the piers, it forms vertices. These vertices don't do much damage during normal times. But during the floods as the speed of water is high these vertices cause heavy erosion of structural members as well as the foundation bed. This action of erosion due to formation of vertices is called as Scouring. Scouring weakens the structure and leads to failure

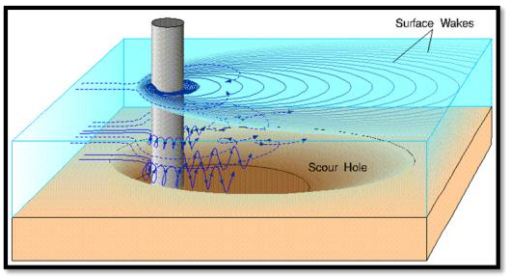

Fig -2: Scour Hole

B) Not so hydrodynamic Piers:

Shape of piers is responsible for formation of vertices when the water is moving around the piers, which further leads to scouring.

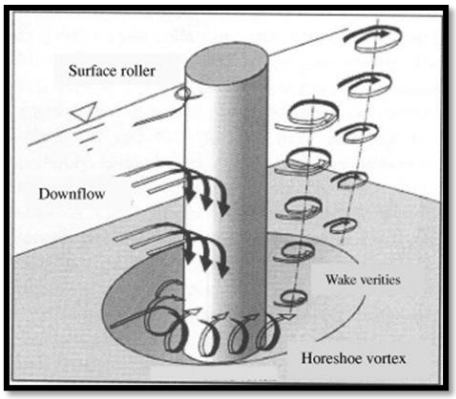

Fig -3: Formation of vertices around the pier

C) Blocked Debris:

Floods bring along a lot of debris with them. This debris easily flows away when the water level is several feet below the bridge deck. But as the flood level rises the debris gets deposited at the bridge adding more pressure to the already struggling structure. When this force exceeds a certain limit, the bridge collapses.

Fig -4: Debris deposited at the bridge

4.Solutions to minimize flood damage.

4.1) Solution to reduce Scouring:

As studied earlier, we know that, scouring is mainly occurred due to formation of vertices as the water moves around the piers. To overcome this, we suggest to use Lenticular shaped piers. We are suggesting Lenticular shape because it allows water to move around smoothly without forming vertices. Hence, as the water moves around without forming vertices, it will also minimize scouring and the structure will be less affected.

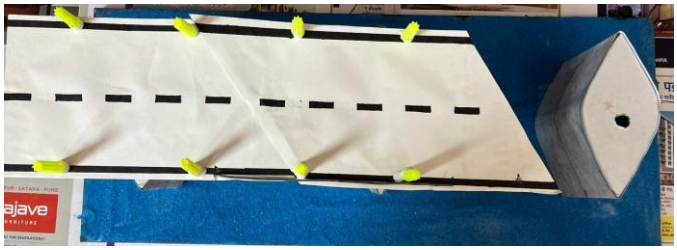

Fig -5: Lenticular Shape of Pier

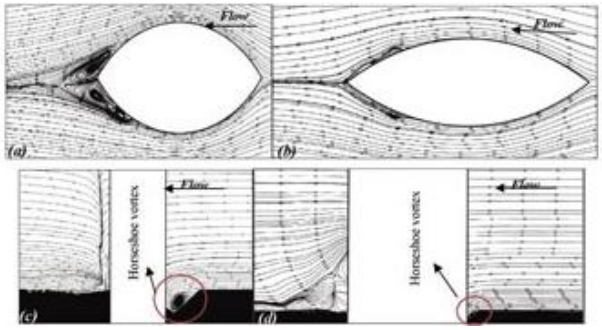

Fig -6: Water flow around Lenticular Shaped Pier

4.2) Solution to avoid deposition of debris:

As the debris collected is dangerous for the bridge, we will have to allow it to flow away. For this we suggest rotating the piers. As the water level rises up to the bridge deck the piers can be rotated in order to make way for the debris.

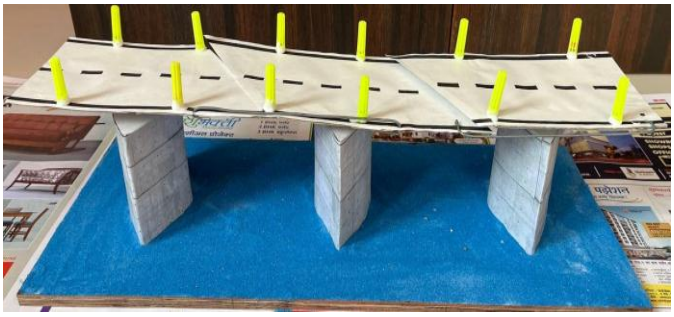

Fig -7: Bridge when water level is Safe

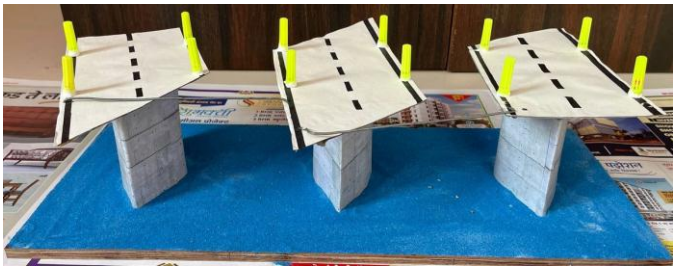

Fig -8: Bridge when water level rises

4.3) Solution to avoid deposition of debris:

To reduce repair time of the bridge we suggest to use steel plates instead of concrete slabs. If a par if steel plate deck is damaged it can be cut out and a new part can be welded in the same place within hours or a day. But in case of concrete slabs, we have to wait for the flood situation to get normal and demolish the damaged part. Later we have to construct the damaged section which might take a week or more. The bridge cannot be used till the concrete sets. This means the bridge will not be in use for 2-3 weeks. This may also cause delay in rescue operations and may lead to loss of life.

Advantages of steel decks:

a. It could make the decks light weight.

b. Cheaper than concrete slabs.

c. Easy to maintain/repair.

d. Less time of repairing than concrete.

5) Conclusion

Through the project we conclude that,

1. Lenticular shaped piers have less scour as water flows without forming vertices around the pier.

2. Less scour leads to less damage, hence increased life span.

3. Rotating decks will not block the debris.

4. Damage to the bridge can be reduced.

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