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Retrofitting of Damaged Satapewadi Bridge Affected Due to Flood at Krishna River: A Case Study

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Abstract - *A Bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. It is one of the oldest instruments of our civilization. In pre historic times the first bridges were made by spanning the small streams with the help of fallen trees or logs of wood. In ancient India the period of Ramayana construction of bridges was well known. Even today the portion of sea where the bridge was built is popularly known as 'SetuSamudra'. As per Ramayana by C. Rajgopalachari, "Nala, the son of Viswakarma was the first bridge engineer who successfully constructed the 'Great Causeway' which 'shone across the sea like a milky way in the sky'... The Gods and rishis offered benedictions"[10]. Today, bridges are considered as symbols of economic power and leadership. As environmental conditions changes, the Frequencies of flood events are increased. It is noted that flood event causes the most damage to infrastructure compared to any other natural hazards in the world. The performance of the bridge is dependent on the strength and durability of its components. This paper presents an analysis of the case study of 2019 floods in Western Maharashtra to identify the failure mechanism of the bridge exposed to flood events. Major failure mechanism of the bridges were identified as damage to bridge decks due to urban debris, and in some areas due to continuous striking of the heavy stones with the bridges and more water pressure. Some bridges were closely analyzed and causes of the failure were studied also. Due to flood events bridge components were damaged. Quality in bridge engineering has to be achieved through innovative planning, diligent designs, intelligent directions, and timely maintenance. Since bridges cannot resist indefinitely all the natural forces and hazards including time related degradation of materials, these structures have limited service life.*

***Key Words*: Bridge, Flood, Retrofitting, River, Damage.**

1. INTRODUCTION

Bridges are important components of highway and railway transportation systems. Failure of bridges due to natural or manmade hazards may cause significant disruption of transportation system performance, and thus may result in major economic and social losses to the urban and rural societies. Therefore, safety and serviceability of bridges have always been great concerns to the civil engineering profession. Throughout history many bridges collapsed and damaged due to different reasons which are classified into two broad categories, namely natural factors and human factors. Natural disasters such as flood, scour, earthquake, etc. are often unavoidable and account for nearly half of all bridge failures. Due to heavy precipitation, flooding may induce phenomena such as scour, erosion, river convergence, insufficient embedment depth, stability aspect, etc. As bridges are one of the most critical parts of the transportation infrastructure, their retrofitting is of great value and concern. There are several approaches to retrofitting and repair of damaged bridge, but these approaches are based on the case and type of damage. The bridges have to be maintained in order to prevent premature failure and to extend the service life. Proper inspection and maintenance is necessary to maintain the life of the bridges. In August 2019 due to flooding deck slab of bridge uplift by high water pressure and displaced. Damages bridge components which are expansion joint, wearing coat, railing, bearing, etc.

2. RESEARCH METHODOLOGY

The methodology adopted for this study is primary data research, where the primary data was collected. Objective of research are as follow-

1) To study causes of different damages of different bridges affected due to flood through literature review.
2) To investigate behavior and causes of damages of different structural element affected due to flood in the Satapewadi Bridge.

The necessity of this research is to analyze one of the failed bridges and also to find the cause of their failure. As per literature study different causes of bridges failure due to flood are studied.

Causes of different damages of different bridges affected due to flood through literature review-

1. Water, salt, or debris damages critical parts of the structure.
2. Pressure from water or debris breaks apart the bracing system.
3. Water lifts the structure off its supports.

4. Piers or abutments are knocked out by large debris, such as boats or vehicles that get caught in rapidly flowing water.
5. Extreme scour compromise the foundation.
6. Approach roads are cut, weakening structural supports.

3. A CASE STUDY

This proposed work involves the retrofitting of damaged bridge structure. Assessment and observation of the existing situation of bridge lay a platform for suggestion of different retrofitting techniques. A real life problem of an existing 15 years old bridge is under consideration. This is completely inundated during the Western Maharashtra flood 2019.

In Sangli District on Krishna River downstream of Takari side 500m away from pump house Bridge located at village Satapewadi which was constructed in 2005. A Satapewadi barrage cum Bandhara length 278m (L.H.S.= 118.50 m + Spillway= 113.50 m + R.H.S.= 46 m). Maximum height of Bandhara is 37.50. Overall width of bridge is 6.402m. The bridge location is illustrated in Google map Fig.1.

Fig -1: Google Map of Bridge

In 2005 due to flood bridge deck displaced due to high water flow. Some bearing are also damaged. In 2006 bridge deck slab repositioning in its original position. In August 2019 flood level increase up to 6 m above deck slab. Due to high flood discharge deck slab was displaced to water flow direction and expansion joint, bearing pad, pipe railing, and approach road totally got damaged. The damage to the bridge depends on the length of time it was submerged as well as the types of debris collected around or passing the bridge components.

3.1 Damaged Elements

To investigate behavior and causes of damages of different structural element affected due to flood in the Satapewadi bridge:

1. The flood water has carried the filler on both sides of the bridge. On the left side of the bridge, 200 meters long farm land is transported around 70 meters in width, while 200 meters on the right side and 50 meters in length on the right.
2. Due to the heavy flow of flood water as well as the pressure of trees and debris flowing along the water, except for the first three to the left of the bridge and the last one to the right, the other 15 deck slabs are oriented towards the stream as shown in table-1:

Table- 1: Girder and slab slipped distance

Deck Slab Panel Number	Girder and Slab Slipped Distance (mm)	
	Left Side	Right Side
1	-	-
2	-	-
3	-	-
4	-	110
5	130	225
6	225	225
7	230	390
8	300	300
9	115	200
10	160	260
11	240	260
12	160	30
13	230	135
14	85	130
15	100	110
16	100	170
17	170	130
18	140	80
19	55	-

3. Due to the heavy flow of flood water as well as the pressure of plants and debris carried by the water, the deck slabs have been shifted due to the total loss of the 15 expansion joints and the bearing pads in 16 deck slab.
4. The wearing coat on the slab is broken in place of 14 joints due to flood water and sliding of deck slabs.
5. On the deck slab, both sides of the embankment have 3RCC railing rails secured and the pipe railing for the other 13rails is broken and the railing 190 meters on the upper side and 80 meter on the upper side are broken.

6. A 200 meter long approach road on both sides of the bridge has been damaged by the flood.

3.2 Behavior of Satapewadi Bridge Checking using Stadd Pro Software:

1) Geometry: Showing support condition. (fig.2)

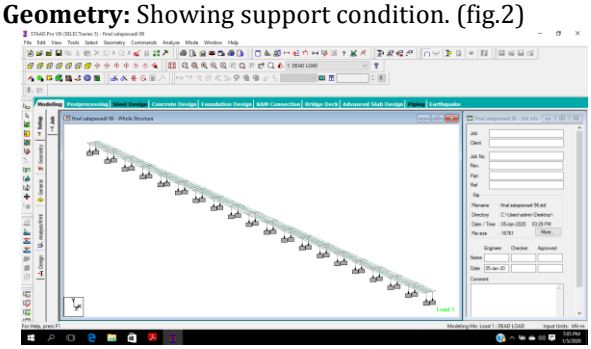

Fig.2: Geometry of structure

2) All beams are safe: No deflection and it is in within permissible limit. (fig.3)

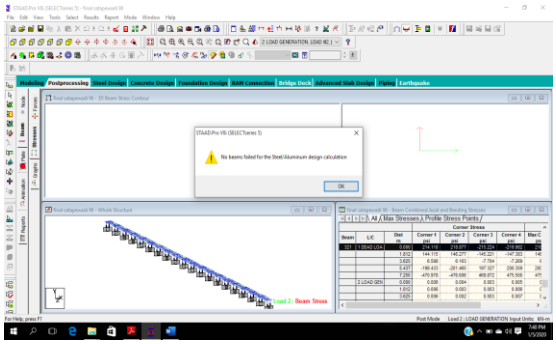

Fig.3: All beams are safe

3) Respected moving load value and bending moment: Vehicle moving load and their bending moment within permissible limit. (fig.4)

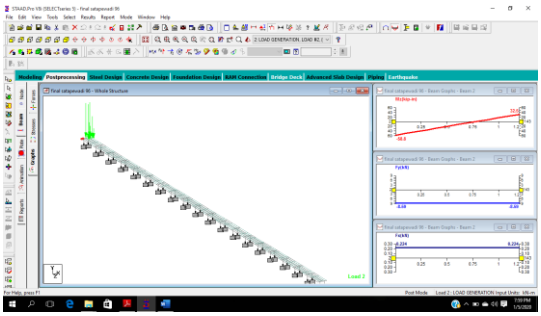

Fig.4: Respected moving load value and bending moment

4. RESULTS

After analysis of bridge model in Stadd Pro for dead load and moving load, the deflection of slab is within permissible limit.

5. CONCLUSION

By the recent failures in the bridges, the future planning can be better. In future, structures can be saved from such disasters. Need of inspection is necessary for the bridges. Using advanced methods the bridges can be monitored anywhere. Periodical inspection and regular maintenance is necessary to keep the bridges functional.

REFERENCES

[1] A.G. Cohn, H. Peel, S. Luo, R.Fuentes: "Localisation of a mobile robot for bridge bearing inspection"Automation in Construction 94 (2018) 244–256.

[2] Abolfazl Eslami, Reza Jamshidi Chenari, Sara Heidarie Golafzani: "Assessment of Babolsar Concrete Pedestrian Bridge Failure for 1964 Flood Event and Retrofitting Practice"Engineering Failure Analysis 68 (2016) 101–112.

[3] Alessandra Aprile, Andrea Benedetti, Luca Pelà: "Experimental study of retrofit solutions for damaged concrete bridge slabs" Composites: Part B 43 (2012) 2471–2479.

[4] Charles E. Reynolds, James C. Steedman: "Reinforced Concrete Designer's Handbook" 10ThEdition.

[5] Chung-Chan Hung, Wen-Gi Yau: "Behavior of scoured bridge piers subjected to flood-induced loads"Engineering Structures 80 (2014) 241–250.

[6] Chung-Chan Hung, Wen-Gi Yau: "Vulnerability evaluation of scoured bridges under floods"Engineering Structures 132 (2017) 288–299.

[7] Edwin H.Gaylord , Jr. Charles N. Gaylord, James E. Stallmeyer: "Structural Engineering Handbook" 4ThEdition.

[8] Ismail M.I. Qeshta, M. Javad Hashemi, Rebecca Gravina, Sujeeva Setunge :"Review of resilience assessment of coastal bridges to extreme wave-induced Loads" Engineering Structures 185 (2019) 332–352.

[9] K. Kalman, Muhammad Fawad, Muhammad Usman, R.A. Khushnood: "Retrofitting of damaged reinforced concrete bridge structure" Procedia Structural Integrity 18 (2019) 189–197.

[10] S.P. Bindra: "Principles and practices of Bridge Engineering" 11thEdition.