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Failure of Bridge Structures in Extreme Floods

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ABSTRACT

Transportation plays an important role in people's daily livesin both urban and as well as rural areas which were linked by highways and bridges. All the road networks and critical cross drainage structures such as bridges, culverts and floodways have vital role before, during and after extreme events to reduce the vulnerability being served. The performance of the bridge is dependent on the strength and durability of its components. Since bridges cannot resist indefinitely all the natural forces and hazards including time-related degradation of materials, these structures have limited service life. The bridges have to maintain in order to have better and longer service life and in order to prevent premature failure. The service life expectancy of a bridge may generally be about 70 years for superstructure and about 100 years for substructure. But many bridges fail before service 20 year life term due to lack of maintenance.

Key words: Bridge maintenance, inspection, waterway of bridges, failure of bridges.

INTRODUCTION

A bridge is an important element in a transportation system, as its capacity governs the capacity of the system, its failure or defective performance will result in serious disruption of the traffic flow. It is well known that absolute safety is the criteria in building bridges as there are risks of failure associated with the bridges. Its failure will result in loss of lives and will affect the people. Bridges constructed over rivers, seas and waterways are vulnerable to disaster such as tsunami and flooding. Bridges build over the rivers and seas are facing unexpected loadings due to floods and tsunamis. Displacement of the bridges due to erosion and collapsing of the abutments, lateral pressure generated by the water and floating debris are common. Since bridges cannot resist indefinitely all the natural forces and hazards including time related degradation of materials, these structures have limited service life. 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.

FAILURE OF BRIDGES AND CONSEQUENCES OF THE FAILURE

Maintenance of transportation facilities is a major industry. Transportation is an important requirement in people's daily lives. Both urban and rural areas are linked by highways and bridges. Global civilization is now dependent upon the use of automobiles and the public transport system. . The performance of the bridge is dependent on the strength and durability of its components.The service life expectancy of a bridge may generally be about 70 years for superstructure and 100 years for substructure. But many bridges fail before serving 20 year term due to lack of the maintenance and proper inspection. 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.

RESEARCH OBJECTIVE

The objective of the research was to identify the strategies and technologies to restore the damaged bridges. The damaged bridges are studied keenly and their cause of the failure is studied. Then the possible retrofit solution is analyzed. As on September 2014, the valley of Kashmir suffered huge loss and about 60 major and minor roads were dammed and over 30 bridges were washed away. Some bridges were only 11 year old and

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yet they fail in the floods. The flood was worst since 109 years and it damaged the infrastructure badly. The necessity of this research is to analyze one of the failed bridge and also to find the cause of their failure. The possible methods to retrofit the bridge are also explained

CASE STUDY OF CAHDOORA BRIDGE

The Chadoora Bridge as so called is located at tehsil chadoora in district budgam, Kashmir, India. This bridge connects the two important tehsils .The trade, communication and public transport wholly depend on this bridge .Originally constructed by R and B division Kashmir in 2001 – 2002 year, the bridge is a balanced cantilever bridge with 108.3mtr length. This is the image of the Chadoora Bridge taken after floods.

Figure 1 Chadoora Bridge

BRIDGE SUBSTRUCTRURE

The bridge deck system is 108.3mtr in length and was supported by four Nos piers in river section as 2Nos Dummy abutment structures placed behind major deep drains/Nallahs located beyond both river banks. The piers were solid wall type Reinforced cement concrete construction with circular ends having open foundation. The Dummy abutment structures are located on the bank of the river.

BRIDGE SUPERSTRUCTURE

The bridge superstructure consists of 2NOs Balanced Cantilever type deck units each supported on two piers, formed by four longitudinal precast Pre-stressed girders in tandem with cast in situ RCC diaphragms and deck slab forming the composite girder system. The cantilever arms of these units with articulation provision support shore span on one end and central suspended span on the other end.POT bearings are provided at seating of girders of shore span/central span. Strip seal movement joints are provided at ends of the bridge deck and at one end of the central suspended span only and all other three joints were hinged/rotation joints only for improved riding comfort.

CAUSE OF THE FAILUREOF THE BRIDGE

The bridge is located at chadoora area on doodganga nallah. The source of the doodganga Nallah is PirPanchal catchment. Bed grade of the Nallah is 1 in 39.Longitudnal slope of the Nallah is 1 in 1659.Catchment area is 300 to 630sqkm.Upon visiting the site, some points were noted which are the basic reasons of the failure of the bridge.

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The length of the bridge is 108.3 meter long before flooding. The main cause of the failure of the bridge was scour type failure. According to the reports, the discharge which was recorded earlier on 1973 was 5000 cusecs. But during the floods i-e on 9 September 2014, it was 9504 cusecs.

Most common cause of the failure of the bridge on rivers is scour. Scour is the result of the erosive action of the running water, excavating and carrying away material from stream beds and banks. Small brooks, streams, oceans, rivers etc. all possess different kinetic energy. Scour or soil erosion at a bridge is caused by the dynamic effects of the water in motion. Therefore the aim should be to design the bridges for all times and for all occasions. Foundation of new bridges, bridges to be widened, replaced shall be designed to resist the scour for 100 year flood criteria, which may create the deepest scour at foundations.

1. Back in 1973, the discharge recorded at doodganga Nallah was 5000 cusecs. On September 2014 the discharge was 9504 cusecs. But this high discharge is hardly a criterion for the failure of the Chadoora Bridge. The length of the bridge is 108.3mtrs, but during floods the linear waterway was recorded only 36.6mtrs which is negligible for such a major bridge.

Figure 3 - Failure of the Bridge

This is the picture of Chadoora Bridge again and shows the doodganga Nallah on which it is constructed. As we can clearly see the how waterway is reduced. We can see is that there are no river training works on this particular bridge which also play its part in failure of the bridge.

2. Scouring around the foundation was taken place removed the fines from sand, gravel, boulder matrix. The scouring was predominant on upstream side and slightly less on the downstream side. That is why the pier first tilted towards upstream side and settled by about 30 – 40 cm.

3. The scouring of the bridge has also taken place due to massive slides on river side of left abutment. The obvious cause of the scouring has been encroachment of almost 75% of total waterway, both on upstream and downstream side by the way of the creation of the eidgah and sumo stand respectively. This cause the scour of the pier. The pictures below will tell us the condition of the bridge and will indicate how waterway was reduced. The pictures were taken after the floods on the site.

Figure 4 Bridge after the Floods

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The above figure clearly shows how the construction of the shed, taxi stand etc. reduced the waterway of the bridge and thereby not giving free and full passage of the flood to pass which lead to scour failure of the bridge.

4. The discharge of 9504 cusecs which should be pass through at least 91.5mtr width, only passed through 36.6m, thereby causing the scour failure of the bridge.

REHABILITATION OF THE CHADOORA BRIDGE

1. **Need for Rehabilitation:**The Chadoora Bridge is 108.3mtrr long .So, it is a major bridge. This bridge is located in the heart of the district, connecting villages to each other. Further the economy of the area is dependent on this bridge. So, restoration of the bridge is important in every aspect.
2. **Methods of the Restoration:**While different restoration methods can be put forward for the bridge .But some of the methods which were analyzed while studying the details of the flood and bridge are put forward in this study. These methods can be helpful in the restoration of the bridge within short span of the time.

DATA COLLECTION FOR RECONSTRUCTION WORK

12.1. Geotechnical Investigation of Pier P1 of Chadoora Bridge

12.1.1. Introduction

Kashmir valley during September 2014 experienced one of the worst floods ever recorded in modern Kashmir history. The flood has caused wide spread heavy damages to residential buildings, commercial complexes, bridges etc. In the same flood one bridge called Chadoora Bridge over Nallah Doodganga at chadoora also got damaged. The J and K govt. has embarked upon massive restoration plan to rehabilitate the damaged bridges. This chadoora bridge is one of them. In this study, methods to restore the bridge were analyzed and some soil investigations were also done for the Pier P1 of the bridge.

12.1.2. Scope of the Work

The scope of the work involved geotechnical evaluation of the pier P1 of the bridge over doodganga Nallah through 2 exploratory boreholes one on the U/S side and one on the D/S of the pier P1 of the bridge in place. The objective of this investigation was to evaluate the stratigraphy that exists at pier site and to develop geotechnical recommendations for foundation design and construction based on the site characterization, field borehole data, field tests and laboratory test data of samples collected during the period of the investigation.

12.1.3. Methodology Adopted for Sub Surface Exploration and Tests Conducted

In accordance with IS:1892-1979 exploratory boreholes BH-1through BH-2 of Nx/Bx size have to drilled to depth up to 15m using heavy duty diamond core drilling machine. Wherever gravel and cobbles and sandy matrix are met with, it is not possible to collect undisturbed samples to find out the shear and consolidation characteristics of the material. However in-situ tests are carried out for this purpose in such materials. Standard penetration tests were conducted in the bore holes at various depths or wherever possible in accordance with IS: 2131-1981. These tests are beyond our scope.

12.1.4. Test Results

The borehole logs are given in this report and laboratory test results not done.

- Undisturbed samples could not be obtained from the borehole.

12.1.5. Bearing Capacity

The subsurface in general can be considered as cobble –Gravel with sandy matrix with occasional boulders exhibiting N value as this neither falls in rocks nor under the soil and investigation for establishing design parameters has to be carried out in accordance with IS :10042 which necessities conducting in situ plate load tests, block shear tests and in-situ density measurement.

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FOUNDATION LEVEL PREPERATION

All lose material in case of the open foundation should be removed and the exposed foundation bearing surface shall be watered and rolled to ensure stable foundation .In case of cavities the same may be grouted. The surface should then be protected from disturbances due to construction activities so that the foundation may bear on natural undisturbed ground. For open foundation, place 100mm thick binding layer of lean concrete to facilitate placement of reinforcing steel and to protect the soils form disturbance.

CONCLUSION

By analyzing the recent failures in the bridges, the future planning can be better. In future, structures can be saved from such disasters. Since bridges cannot resist indefinitely all the natural forces andhazards including time-related degradation of materials, these structures have limited service life. So the 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. Otherwise disasters can come anytime as they are unpredictable and sometimes uncontrollable.

REFERENCE

[1] Prabhat Dahal, Dongming Peng, yaoqing (Lamar) yang, Hamid Sharif: RSS Based scour measurement using underwater acoustic sensor networks.

[2] Yong Bai, M.ASCE, William R.Burkett, P.E, and Phillip T.Nash, P.E: Rapid bridge replacement under emergency situation.

[3] Johnson Victor: Essentials of bridge engineering

[4] Krishna Raju: Design of bridges.

[5] Hudson, S., Comie, D., Tufton, E., Inglis, S.: Engineering resilient infrastructure. Civil Engineering special issue.

[6] Blong, R (2003): A new damage index. Natural hazards 30, 1-23.

[7] Ponnuswamy: Bridge Engineering.

[8] Narayan, S.K.B, Ashok K: Foundation failure of bridges in Orissa: two case studies.

[9] Dr. K.V. Ramana Reddy, “Aerodynamic Stability of a Cable Stayed Bridge”. *International Journal ofCivil Engineering and Technology (IJCIET),* 5(5), 2014, pp.88–96.

[10] Azmat Hussain, Saba Bashir, Saima Maqbool: Damage detection in bridges using image processing

[11] Azmat Hussain, Saba Bashir and Saima Maqbool, “Damage Detection in Bridges using Image
Processing”. International Journal of Civil Engineering and Technology (IJCIET), 7(2), 2016, pp.215–225.