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Health Monitoring of Mundhwa Bridge

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Abstract - *This paper review conditions of concrete bridge by taking visual inspection and non-destructive test. In India most of bridges was constructed after 1950. So, regular inspection of bridge is necessary. However, various factors such as large infrastructure development, the growth of population, has led to accelerated to detection of damage. Hence heavy traffic, the bridges are subjected to very high dynamic loading, to avoid Collapse Bridge it is mandatory to assess the conditions of existing bridge or health monitoring of bridge. Through this paper we recommending corrective measure for operation and maintenance. NDT method is to be use for verification of visual inspection in bridge management where measure damage occurred in the structure but cannot determine by visual. These techniques will allow inspector to locate damages earlier before any possible tragedies just like mahad bridge collapse in India, there exists a correlation between results of non-destructive test and condition states on visual inspections. There are many methods for non-destructive test (NDT) but every method has its own boundaries and which mean the method cannot afford an accurate and consistence result for difference cases and to detect different defect. The study also show that Ultrasonic pulse velocity test is the ideal NDT method to predict the deterioration in the structures and to determine the service life of the structures. The concept of non-destructive testing is to obtain material properties of in place specimens without the destruction of the specimen or the structure from which it is taken.*

Key Words: *visual inspection, Non-destructive test, concrete bridge.*

1. INTRODUCTION

Bridges are the critical component of the transportation infrastructure. Regular inspections and maintenance are the essential components of any bridge management program to ensure structural integrity and user safety. This is a grand challenge due to enormous number of existing bridges. Health monitoring of bridge concept is widely applied to various forms of infrastructure, ranging from bridge to skyscraper. Health monitoring is used for detecting the existence of damage on the infrastructure, locating the damage, identifying the types of damage and quantifying the severity of damage. The area of health monitoring process that receives the most attention in the technical literature is the identification of data features that allow one to distinguish between the damaged and undamaged structure.

1.1 Problem Statement

The transportation infrastructure is quickly aging. Traffic and variable loading conditions greatly influence the performance, durability, and safety of the bridge structure throughout its service life. Continuous monitoring can provide basis for determining the deterioration rate and for estimating the remaining service life, thus assisting in making important decisions regarding bridge maintenance. Bridge engineers need a reliable way to assess structural integrity of bridges to maintain the continuous operation of the road network while ensuring the safety of the public. Traditional visual inspection techniques are both time consuming and expensive. They are also qualitative and can only assess outward appearance. Any internal damage may go unnoticed for a long period of time. Many old highway bridges are rated as structurally deficient or obsolete. How does a bridge engineer keep track of these problems? Are inspections conducted every other year enough? A possible solution to these issues is to conduct health monitoring of bridges. This technique can detect changes in bridge superstructure and in some cases predict impending failures.

1.2 Need for Study

In India many of bridges was constructed during the period of 1950‟s i.e. the age of bridge is more than 55 years. The maintenance of bridge was not carried out compared when compared to other western countries. Due to infrastructure development and heavy traffic, the bridges are subjected to very high dynamic loadings. To avoid collapse of bridge it is mandatory to assess the condition of existing bridge. Aging phenomenon of concrete in bridges is difficult to predict and this can lead to accidents and losses. It is important to make sure that they are in good condition. This is where health monitoring of bridges has a role to play. It gives a way to overcome these drawbacks with minimum damage and loss. This report provides an overview of the issues related to the inspection, condition assessment, evaluation and maintenance of highway bridges. Thus, the condition of bridge can be determined my various health monitoring techniques.

2. LITERATURE REVIEW

Masoumi [2013] [1**]** In some countries, collapse of bridges initiated the formal requirements for the inspection of highway bridges. This paper discusses visual inspections of 200 reinforced concrete bridges in Turkey and non-destructive testing applications performed on 10 bridges,

which were most deficient. Penetration resistance, ultrasonic pulse velocity, rebar locating and reinforcement corrosion tests are performed on decks, piers and beams of reinforced concrete bridges and the results are compared with the results of visual inspections.

Mr.S.N. Ahmed (2015) [2] the process of implementing a damage detection and characterization strategy for bridges is referred to as health monitoring of bridges. Here damage is defined as changes to the material or geometric properties of structural system which adversely affect the performance of bridges. Many of the reported collapses of in-service structures can be attributed to strength degradation caused by environmental stressors. In recent studies deteriorating bridge structures under various environmental stressors have been evaluated in a reliability context. There are several degradation mechanisms are present in concrete highway bridges as, sulphate attack, alkali-silica reaction, freeze-thaw cycle attack, and corrosion, etc

Azlan (2006) [3] This paper presents a non-destructive testing method in evaluating bridge condition in comparison with visual inspection that has been used for ages. While condition ratings are all qualitative and defined primarily as sets of visual indicators in routine inspection, non-destructive testing are more quantitative and has large potential in determining damages inside the structure that are not visible.

Ann Maria Johnson (2016) [4] The case study from India determines the quality and strength of a T-beam girder bridge. 75 concrete bridges under the supervision of Public Works Department, Malaysia and 10 out of 200 reinforced concrete bridges (i.e. 10 most deficient bridges) in Turkey were selected to determine the strength and to establish a correlation between visual inspection rating and the non-destructive testing results. The investigation shows that the use of non-destructive testing methods can help reduce the backlog of deficient bridges in two ways. First, these techniques will allow inspectors to get a more accurate view of the condition of a bridge. The second way is by allowing inspectors to locate damages earlier. The studies also show that Ultrasonic pulse velocity Test is the ideal NDT method to predict the deterioration in the structures and to determine the service life of the structures. And there exists a correlation between results of non-destructive tests and condition states based on visual inspections.

3. OBJECTIVES

[1] To ensure bridge safety and to identify its damages or deterioration.

[2] It helps to improve the knowledge on various health monitoring techniques used in bridges.

[3] This technique will extend the lifetime of deficient bridge method can monitor bridges in real time and warn engineers about possible problems to avoid tragedies.

[4] it optimises operation and maintenance costs.

4. METHODOLOGY

In the present work, a detailed study on literature regarding the study on health monitoring of bridges have been done. Health monitoring on bridges are most important since most bridges are becoming old, generally sensor-based method of health monitoring is performed but assessment of bridge condition using NDT can also be used for that purpose. A large range of Non-Destructive Testing (NDT) techniques are employed for a wide variety of applications within Civil Engineering. To inspect existing structures, visual inspection is the easiest and the most fundamental method. But this method may not be applicable for inspecting defects which does not appear on the surface. For such defects, Non-destructive inspection is the only method which can be applied. Non-destructive testing plays an important role for quality evaluation. India has been producing concrete structures since long times. And now it is becoming important problem to maintain these existing concrete and steel structures. This presentation aims on the explanation of NDT techniques and their application to structures. Non-Destructive Testing (NDT) techniques can be used effectively for investigation and evaluating the actual condition of the structures. These techniques are relatively quick, easy to use, and cheap and give a general indication of the required property of the concrete without damaging the structure.

5. VISUAL INSPECTION

Health monitoring is used for detecting the existence of damage on the Mundhwa Bridge, locating the damage, identifying the types of damage and quantifying the severity of damage.

Site location: Mundhwa Bridge (no.15) over Mutha River, Pune.

Table -1: General Description

1	Name of bridge/No. of bridge/Name of river	Mundhawa bridge over Mutha river
2	Name of highway/ Location of bridge	Kharadi Bypass Road, Mundawa
3	Type of bridge	High level
4	Span arrangement:	2 End spans of 15m + 15 spans of 16.0m Total length of the bridge is 270m.
5	Width:	4 lane divided carriageway, 18m overall width
6	Carriageway:	6.608 m each
7	Deck	RCC T-beam & Slab, there are 7 beams

8	Bearings	RCC roller rocker bearings
9	Year of construction / Date of inauguration	1980-81.
10	Footpath	1.4 m on both the sides.
11	Height of parapet railing	1.3 m
12	Median width	1.5 m
13	Height from top of the slab to the top of water level	12.79 m
14	Water spouts	5 m c/c
15	Electric poles	26 m c/c

5.1 Traffic intensity [latest census]:49830 PCU. [Source: Traffic Forecast for the Proposed Metro Rail Project in Pune

Metropolitan Area by Transportation Systems Engineering Group, Civil Engineering Department, Indian Institute of Technology Bombay, Powai, Mumbai]

5.2 Condition of

[a] Approaches: The approaches are in good condition.

[b] Protective works: There are no protective works like pitching or flooring or toes or aprons.

5.3 State

[a] H.F.L.: RL 539.920 m

[b] Inadequacy of waterway: By local enquiry it is ascertained that the bridge is not overtopped in floods. Therefore, waterway below the bridge is adequate.

[c] Erosion of banks as evident: No erosion is observed.

5.4 Foundation and substructure: At Pier No.1 from the abutment on kharadi side the river bed is nearly 4.5m below the ground level, therefore the pier is subjected to one sided earth pressure, this will have to be strengthened. Buttresses are required on the river side on Pier No.1.

It is difficult to excavate and study the foundation. But there is no settlement or tilting of the foundation. It was difficult to ascertain the depth of foundation. However, since many bridges are in progress in the town, has investigated the foundation levels. These are found to be within 3 m below the bed level. However, in some cases the maximum depths are found to be 6 m. In large river bridges, exposed rock is also available.

5.5 Bearings: RCC roller rocker bearings are provided. The bearings are in very poor condition.

5.6 Superstructure

[a] Concrete [RCC and PSC]: No deflection in the deck appears anywhere. There are minor surface defects in concrete. From the surface it appears that earlier there was stone masonry which has been plastered which can be verified by opening a portion of masonry and removing plaster.

[b] Steel: Not applicable.

[c] Masonry Arches: Not applicable.

5.7 Miscellaneous

[a] Wearing coat: The condition of wearing coat is good.

[b] Drainage: Water spout pipes are being clean; some pipes are existing and others are gone.

[c] Parapets and handrails etc.: Initially the steel railing was continuous over the joint later the pipes were cut to make a joint at expansion gap.

[d] Footpath: The kerb at the footpath is damaged.

[e] Expansion joints: Concrete at the expansion joint is deteriorated. Whenever the vehicles travel over the bridge, a thudding sound coming from the expansion joints & bearings indicating upward or downward or longitudinal movement, due to movement of joint. It is not merely a sliding phenomenon. The vertical movement is more prominent. Initially the steel railing was continuous over the joint later the pipes were cut to make a joint at expansion gap. In the service pipe line there is one expansion joint, gap for expansion does not appears to be adequate.

[f] Utilities: There is a pipe line passing from the centre of the bridge. Which also acts as a median. Pipe line has leaked and this has cause several damages, it is therefore advisable to have arrangement at the joints in pipe to collect leaking water & let it be released out. In the pipe line there is one expansion joint, gap for expansion does not appears to be adequate. There is another service line going over the footpath which is not covered. A service line is passing outside the railings, fixed to the bridge by steel brackets.

Image-1: General view of Mundhwa Bridge across Mula-Mutha river

Image-2: service lines in footpath are not covered

Image-3: Expansion joint are to be damaged

Image-4: Damaged bearing

Image-5: damage to the structure at bearing location

Image-6: Damage in deck slab, steel is open in slab

6. NON-DESTRUCTIVE TEST

6.1 Ultrasonic pulse velocity test analysis

Sr no	location	member	Distance mm	Time micro sec	velocity
1	Damage bearing location	RCC girder	245	57.2	4.28
2	Damage bearing location	RCC girder	245	67.2	3.65
3	Damage bearing location	RCC girder	400	104.7	3.82
4	Damage bearing location	RCC girder	500	121.8	4.11
5		RCC girder	400	110.7	3.61
6		RCC girder	220	49.8	4.42

Remarks:

[1]. Velocity below 3.00 km/sec indicates “DOUBTFUL” quality concrete.

[2]. Velocity between 3.00 to 3.50 km/sec indicates “MEDIUM” quality concrete.

[3]. Velocity between 3.50 to 4.50 km/sec indicates “GOOD” quality concrete.

[4]. Velocity above 4.50 km/sec indicates “EXCELLENT” quality concrete.

7. RECCOMMONDATION

[1] The width and the span being equal there is expansion and contraction in central and longitudinal direction, however the bearing and expansion gaps are designed only for longitudinal direction. It is therefore necessary to provide such type bearings and expansion joints which can move in both directions i.e. lateral and longitudinal. POT-PTFE bearings and strip seal expansion joints are ideal for such situations.

[2] Replace the bearings by POT-PTFE bearings as RCC roller rocker bearings are not permitted by MORTH, since many such bearings have cracked.

[3] All expansion joints are to be replaced by strip seal expansion joints.

[4] Return walls parallel to the river is done with Random Rubble masonry with very large joints on Kharadi side bank. It is advisable to rack the joints and provide neat pointing or plaster the masonry. The top coping over the wall should be provided with 75mm thick M25 concrete with joint grooves at 1.2m c/c. The best thing will be to provide 75mm thick 'Shahabad' coping over the masonry, this will last longer. Two buttresses are provided in stone masonry. The wall is used for sitting by the visitors and nearby residents. It appears the earlier long wall collapsed and replaced by the existing shabby Random Rubble masonry.

[5] The kerb should be replaced by M25 concrete RCC kerb and 75mm thick flooring of M35 concrete is to be provided over the footpath. Better to accommodate services in footpath zone. Tiles should be provided on the footpath.

[6] A cover should be provided over the water spouts and a pipe projecting from there is required at all water spout locations.

[7] The service line going over the footpath should be covered.

[8] Shabbily done concrete pillars for lamp posts should be neatly finished.

7. CONCLUSIONS

Health monitoring of bridges are most important since most bridges are becoming old, assessment of bridge condition using non-destructive tests and visual inspection can be used for that purpose. This technique will allow inspectors to get a more accurate view of the condition of the bridge and to locate damage earlier. To save the human life's by warn earlier to any tragedies.

The above result shows that the pulse velocity is between 3.61 to 4.28 km/sec means that good quality concrete at damage location.

Through, the ultrasonic pulse velocity test indicates good quality of concrete, but the visual observation indicates that their major construction damage.

By visual inspection it shows that water line passing through the centre line of bridge, its harmful to traffic movement, need to be shift.

8. REFERENCES

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