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Distress Call for Maintenance and Repair of Bridges, a Case Study of Abakpa Bridge along Nike Road Enugu, Nigeria

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ABSTRACT
The study inspected the present conditions of bridges in Nigeria, a case study of the two Abakpa bridges and Abakpa flyover bridges along the 82 Division Headquarters of the Nigerian Army Enugu. The study aimed to inspect the contemporary conditions of the two aging bridges to make a distress call for maintenance and repair to avert imminent failure and collapse. The method designed in this investigative research involved identifying both external and internal factors happening on and within the vicinity of these bridges, which affect the stability and structural integrity of the two bridges. The identified factors, along with cross-examination and inspection of the various bridges' components, served as indicators for making distress calls for maintenance and repair on the bridges. The observed results indicated that flooding from runoff after rain together with scouring of the riverbed by the Ekulu River that flows under the two bridges, have continuously and progressively washed away concrete components and soil structures that protect the foundations thereby exposing the piles and abutments. The overloading and stimulation of stresses and fatigue on the aging bridges from increased population and activities to and from the two bridges were identified. The study concluded that there is a need for distress calls for maintenance and repair on the two bridges to prevent imminent failure and collapse. It recommended the inspection and maintenance of aging bridges in Nigeria.

Keywords: *Bridge scouring, flooding inspection, maintenance, collapse.*

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I. INTRODUCTION

The advancing age of infrastructures critical to development indicates that a good number of them, including bridges and highways, will require repair and maintenance, otherwise demolition and reconstruction as the case may be, as emphasized by **[1]**. In many Countries, information concerning the number of bridges in existence and functioning is lacking according to [**2**] submission, while in numerous instances, there is no available record on the aging infrastructures as stated by **[1]**.

Environmental degradation can occasionally affect the materials used in bridge construction, as noted by [**3**]. These environmental degradations have been a result of extreme climatic conditions. Concerning these adverse climate changes forecasted, [**4** and **5**] estimated a surge in the concentration of rainfall, which can increase the chances of washing away various components of bridges, imminent failure, and collapse in most adverse cases are probably going to be out-numbered as a result of overflowing of water bodies according to **[1]**.

According to [**6**], bridges spanning rivers have been built in Nigerian rural areas to connect communities. Many of the nation's bridges have collapsed as a result of increased traffic loads and wear on the structural elements of the bridges, which occurred years after the initial wave. However, Flooding is one of the major factors that contribute to bridge collapse. This happens when flooding from runoff after rainfall together with the flow of river under the bridge washes away the foundations and abutments of the bridges thereby exposing the bridge to partial or total collapse. This may have happened when the bridge does not undergo adequate maintenance to divert the direction of flow of the flood towards the bridge components, especially pilling and abutment foundations. [**6]**, flooding in Nigeria has resulted in the loss of life, interruption of social and economic activities, and deterioration of the fragile ecosystem

1.1 Problem Statement:

The increase in the number of cases of bridge failure and subsequent collapse partially or totally in Nigeria is alarming. So many factors, both external and internal, have been identified to have contributed to these causes of bridge failure and collapse in different parts of the country. These collapses of bridges have occurred with no signs or notice, just happened all of a sudden. The structural stabilities and integrities of most aging bridges in Nigeria are skeptical and need a thorough cross-examined. This study seeks to determine the structural stability and integrity of bridges in Nigeria, a case study of The two Abakpa bridge and fly-over bridge within the axis of 82 Divisions Headquarters Nigerian Army, Enugu.

Research Aim: The study aimed to determine the present conditions of the two aging Abakpa bridges and fly-over bridges to call a distress appeal for maintenance and repair on the bridge to prevent imminent failure and collapse.

Research Objectives:

1) To investigate the integrity of the Abakpa fly-over bridge along the Enugu-Onitsha Express in other to seek for distress call for maintenance and repair.
2) To investigate the integrity of the Abakpa bridge along Nike Road in other to seek for distress call for maintenance and repair.
3) To suggest remedies that can help reduce or eliminate the collapse of bridges in Nigeria

II. METHODOLOGY OF THE RESEARCH

The method adopted in the research involved direct observation and inspection of the two (2) bridges under consideration which include the Abakpa fly-over bridge (at 82 Division axis) along the Enugu-Onitsha Express and the Abakpa Bridge along Nike road Enugu.

2.1 Research design method

In the design guide, the following components of the Bridges, internal and external factors that expose the Bridges to imminent failure and collapse were reviewed in other to seek distress calls for maintenance and repair of the Abakpa fly-over bridge and Abakpa bridge. These served as indicators and blueprints on what was inspected and observed while carrying out the cross-examination of the various components/elements of the Bridge and the impact of external factors acting on the bridges under review.

2.1.1 The Abakpa Bridge along Nike Road

The examination of the bridge aims to seek distress calls for maintenance and repair of the bridge to avoid failure or total collapse soon. The bridge was visited and detailed inspection, observation, and cross-examination of various components and external factors acting on, and threatening the integrity and stability of the bridge were analyzed, and pictures of the bridge were taken as well.

Figure 3.1: The Abakpa Bridge along Nike Road, Enugu

Description of the Bridge.

The Bridge is located about 1 km from the Abakpa junction and it intercepts the Enugu-Onitsha Express at 82 Division of the Nigerian Army. It is very close to the first Bus stop Abakpa, linking Thinker's Corner axis of Enugu and to Nike road, down to Ugwuogo, and Opi Nsukka. It has three (3) spans of lengths $16m, 18.2m, and\ 15.5m$ respectively with a clear width of $10.4m$ and height of $11.1m$(from water level to the girder beam). The bridge is a single-lane that can accommodate two vehicles at the same time. Ekulu River flows under the Bridge. However, the Bridge was constructed in the early 1970s with composite materials of reinforced concrete and structural steel beams.

2.1.2 The Abakpa fly-over Bridge at 82- Division axis, along Enugu-Onitsha Express

Figure 3.2: The Abakpa fly-over bridge, at 82- Division axis along the Enugu-Onitsha Express

Description of the bridge

The Bridge is located about 1km from Abakpa junction along the Enugu- Onitsha expressway. It is made up of reinforced concrete materials with four (4) spans of lengths $20m, 19.8m, 19.8m\ and\ 20m$ respectively with clear widths of $9.5m$ and height of $14.6m$ from water level to the girder beam. The bridge is a double-lane federal highway that can accommodate two vehicles at the same time. The first span is a fly-over with vehicles moving under it while the other three spans are for the flowing of the Ekulu River. The construction of the Bridge started during the Mid-1970's and was gradually improved upon by various government.

2.2 Design component/element of the bridge

Though the two bridges have not failed or collapsed, indicators that have shown the need for maintenance and repair were examined. The following components of the bridge were cross-examined to determine if there is a need for a distress call for maintenance and repair.

I. Slab deck
II. Girder beams
III. Bearing
IV. Columns and Piers
V. Abutment
VI. Pile foundation

The impact of external factors happening on and within the location of the bridge were examined which served as an indicator that led to a call for maintenance and repair to avoid the bridge from collapsing shortly. The following external factors may trigger and expose the Bridge to collapse:

a) Flooding from run-off after rainfall
b) Scouring of the river-bed by Ekulu River
c) Head-on collision of heavy-duty trucks and other vehicles making use of the Bridge
d) Material defect and fatigue
e) Design error and construction
f) Environmental degradation
g) Overloading
h) Inspection and maintenance History of the bridge

III. RESULT PRESENTATION AND DISCUSSION

The following results were observed from the investigation/cross-examination carried out on the two Bridges.

Figure 3.1 The effect of Environmental degradation on the Abakpa Bridge along Nike Road, Enugu

Figure 3.1displays the present condition of the Abakpa bridge. From the view, the column base cap and the piling foundations have been exposed by the scouring of the riverbed caused by the Ekulu River that flows under the bridge. In other words, the cross-examination carried out on the bridge indicated that the base of the foundation piles had been exposed to external factors like scouring and flooding. Some piles of foundations have been knocked out of position as indicated by the black arrow on the picture. This displacement of the piles out of their normal straight line position could lead to loss of stability and structural integrity of the bridge and subsequently to imminent failure and partial or total collapse of the Bridge, as the case may be. The results obtained from the cross-examination of the bridge, as indicated in Figure 3.1 above, also, showed that under/beside the bridge serves as a dump site for managing domestic and industrial wastes. The decomposition of various waste products dumped at the site may generate leaches and other chemical compositions that will attack the structural steel components of the bridge like the structural steel girder beams, leading to corrosion and rusting. This process will be gradual and progressive, which if unchecked, could trigger the bridge to failure or collapse. In other words, this can trigger corrosion or environmental degradation. Moreover, when this refuse decade, they tend to pollute the water and the environment, thereby, making the acidic content of the water to become high. When it comes in contact with the exposed steel beams, it may result in corrosion. As such, failure of the steel beams may lead to loss of structural integrity, strength, and stability of the bridge.

Overloading of the Bridge beyond its initial design load, cannot be ignored. It does happen on this Bridge because no device or agency of the government monitors and checks the values of loads from heavy-duty trucks crossing to and fro on the bridge. This puts a lot of traffic pressure on the Abakpa Bridge which many fears would collapse anytime soon.

Figure 3.1 above, also indicated an extra load on the bridge from the water supply pipeline system whose load was not put into consideration initially during the analysis, design, and construction of the bridge. The loads from flowing water may as well, induce extra stresses on the various components of the bridge which could trigger failure due to fatigue and subsequently collapse.

Figure 3.2 The exposed pile foundations of the center columns of the Abakpa bridge

Figure 3.2 above displays a pictorial view of the column base cap and the pile foundation. The base cap is already being suspended, as a result of flooding and scoring of the riverbed caused by the Ekulu River flowing under the bridge. This washes away the concrete components and soils protecting the column base cap and foundation. For this reason, this bridge is likely to collapse in the near future. The exposed piles of the foundation have been clogged by debris carried by the flowing Ekulu river which obstructs the free flow of water. However, there are possibilities of the river carrying heavy wood logs and massive loose concrete components and colliding with the exposed pile base cap and piles of the foundation. This can lead to instability and loss of structural integrity of the bridge. From the cross-examination exercises carried out on this bridge, there is a serious distress call for maintenance and repairs on the bridge to evade imminent failure and collapse.

Other components of the bridge, like the slab deck, the steel girder beams, the bearing, the column, and its caps are in good shape. However, the instability that is gradually setting in on the foundation of the bridge, is putting more stress and fatigue on other components of the bridge. Failure and collapse of this bridge can only be avoided through planned further inspection, detailed maintenance design, and repair programs on the foundation. The dumping of refuse on and beside the bridge should be stopped due to the environmental impact it has on the bridge and the contamination of the Ekulu River. The clogged items should be removed to enable free flow of the Ekulu River.

3.2 Maintenance and repair history on the bridge: From available information obtained from the state ministry of works and people residing within the Nike road axis of the bridge, the only maintenance carried out on this bridge has been on the asphalting of the slab deck. However, no major maintenance and repairs have been done on any other component of the bridge. This study has reviewed the need for distress calls for maintenance and repair on the bridge to avoid imminent failure and consequently collapse very soon.

The run-off water, after rainfall, increases the volume of the Ekulu River as it flows under the bridge. This increased volume makes the flowing water to be able to carry heavy wood logs and loose concrete components which may collide with the columns, piles base cap, and/or the exposed piles of the foundation. This could lead to failure of the bridge. Nevertheless, the increased volume of water increases every chance of scouring of the riverbed which washes away the concrete components and soils protecting the abutments/foundation piles.

Figure 3.3 The Scouring of River-bed at Abakpa fly-over bridge

Figure 3.3 above shows the falling off of concrete components that protect the abutment and pile caps together with some soils of the bridge's foundation as a result of the scouring of the riverbed. The scouring of the riverbed by the Ekulu River that flows under the other two spans of the bridge is gradually washing away concrete components protecting the foundations of the abutment and piles base caps. This external factor caused by scouring is a progressive activity that may lead to failure and subsequently collapse of the bridge, if this distress calls for maintenance and repair made by this research, is not answered on time. This was exactly one of the main causes of the partial collapse of the new artisan bridge as reviewed in this study.

The results obtained from cross-examination of the various components of the bridge indicated that they are all intact. However, overloading of the bridge beyond the initially designed load, as a result of an increase in population and activities of transporting goods to and fro on the bridge, may induce more stress and fatigue that can trigger the bridge to failure. This puts a lot of traffic pressure on the Abakpa Bridge which many fears would collapse anytime soon.

The need for load monitoring devices and control of those heavy-duty trucks making use of the bridge cannot be overemphasized. This exercise will help in maintaining the integrity and structural stability of the bridge as well as prolonging its design lifespan.

Figure 3.4 The effect of Run-off from rainfall on the concrete components protecting the abutment foundation at the Abakpa fly-over bridge.

Figure 3.4above indicates the effect of run-off after rainfall, flooding at the center of the two fly-over bridges, directly from the top to the concrete made to protect the abutment. There is no drainage channel constructed to divert or control the run-off water down to the Ekulu River. The flooding also contributes to the gradual washing away of the concrete components and soils protecting the abutment. This external factor will progressively expose the piles' foundation which may subsequently lead to partial or total collapse soon when not corrected on time. In other words, it causes erosion along the abutment base due to the high flowing velocity of the run-off water. Thereby, exposing the abutment base to failure.

On the maintenance and repair history of this fly-over bridge, information collected from the cross-examination on the bridge indicated that there is ongoing maintenance and repair on the asphalting of the slab deck at the moment (2024). However, no major maintenance has been carried out on other components of the bridge since it was constructed. There is every need to divert the direction of flow of flooding from run-off water, away from the abutment and pile caps foundation of the Bridge.

The flow of traffic on bridges after construction, does not mark the end of its construction engineering wise. Lack of integration routine maintenance and repair (during the design and construction stage) on most of the infrastructures constructed in Nigeria has posed a big challenge, at every level of government, in sustaining the designed life-span of those infrastructures. There are many bridges constructed in Nigeria without consideration of how to maintain and repair them. Failure to carry out a routine inspection (to obtain feedback) on the present conditions of each bridge that will detect any fault due to external and internal factors that expose bridges to collapse, as reviewed in the literature, followed by a detailed maintenance design program that will rectify and remedy the defects discovered, bridges will continue to fail and subsequently collapse in Nigeria.

IV. CONCLUSION AND RECOMMENDATION

The research, after systematic cross-examination and the identification of both internal and external factors acting on and exposing the Abakpa bridge and the Abakpa fly-over bridge to imminent collapse (‘which serves as an indicator’) for distress calls for maintenance and repair, the following conclusions and recommendations were reached.

Conclusion:

The Abakpa bridge serves as a dump site for managing domestic and industrial wastes. The decomposition of various waste products dumped at the site may generate leaches and other chemical compositions that are likely to attack the structural steel components of the bridge like the structural steel girder beams, leading to corrosion and rusting. This process will be gradual and progressive, which if unchecked, could trigger the bridge to imminent failure or collapse.

Overloading of the two bridges, (considered in this research) beyond their initially designed loads, as a result of an increase in population and activities of transporting goods to and fro on the Bridges, may be inducing more stresses and fatigue that can trigger the bridge to failure and subsequently collapse.

Other components of the Abakpa Bridge and Abakpa fly-over Bridge, like the slab deck, the steel girder beams, the bearing, the column, and its caps are in good shape. However, the instability that is gradually setting in on the foundation of the Abakpa bridge whose piles foundation have been exposed, is putting more stress and

fatigue on other components of the bridge. Failure and collapse of this Bridge can only be avoided through planned further inspection, detailed maintenance design, and repair programs on the foundation.

The pile base cap and the pilling foundations of the Abakpa bridge have been exposed by the scouring of the riverbed caused by the Ekulu River that flows under the Bridge. In other words, the base of foundation piles had been exposed by external factors like scouring and flooding. Some piles of foundations have been knocked out of position and clogged with debris carried by the flowing river.

Flooding from run-off after rainfall, at the center of the two Abakpa fly-over Bridges, flows directly from the top to the concrete section made to protect the abutment foundation. There is no drainage channel constructed to divert or control the run-off water down to the Ekulu River. The flooding also contributes to the gradual washing away of the concrete components and soils protecting the abutment. This external factor will progressively expose the piles' foundation which may subsequently lead to partial or total collapse soon when not corrected on time

Recommendations

- The two Bridges (Abakpa Bridge and Abakpa fly-over Bridge) require immediate inspection and proper maintenance and repair to avoid imminent collapse soon. This distress calls for maintenance and repair of aging Bridges is very important to ensure that bridges serve their designed lifespan.
- Modern monitoring devices should be mounted at both points of entering bridges in Nigeria to check the quantity of loads carried by each heavy-duty truck moving to and fro the bridge to avoid fatigue and loss of integrity of the various components of the bridge.
- There is need for a well-designed drainage channels for the diversion of run-off water flooding directly to the foundations of the bridges. This will help prevent the washing away of the concrete components and soils meant to protect the abutment and pile cap foundations.
- The Federal Ministry of Works or state Ministry of Works should integrate detailed maintenance and repair design programs on every infrastructure they wish to construct, especially roads and bridges for them to serve their design life-span purposes. Hence, the development of a rational method of evaluation for these bridges will help in extending their service life at an acceptable risk level.

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