

STUDY ON CAUSES OF CRACKS AND ITS REMEDIAL MEASURES IN REINFORCED CONCRETE BRIDGE PIERS AND ABUTMENT OF MAJOR BRIDGE

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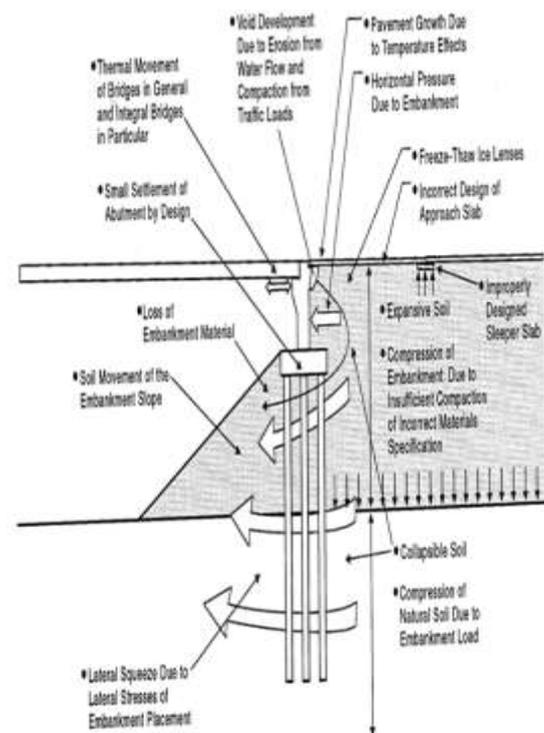
Abstract - The Useful life of a buried concrete, containment structure for low level nuclear strength may be controlled by the loss of its load-bearing capacity or an increase in permeability. The Latter factor is controlled by the general degradation of the concrete and by the presence of discrete cracks reducing from extremely applied loads or from restraint to normal volume changes. To be able to predict the effects of cracks on permeability, it is necessary to understand the causes and mechanisms of discrete crack formation in reinforced concrete structures. The Objective of this report is to provide an overview of the design and behavior of reinforced concrete members and to discuss the factors affecting the formation of cracks in hardened concrete. The Underlying philosophy of modern reinforced concrete design is presented, and it is shown that it allows for the formation of cracks of controlled widths under service loads. Models for predicting the width of flexural cracks are reviewed. Factors Affecting drying shrinkage cracks and approximate methods for considering them are discussed. An Example is provided to illustrate how to determine whether drying shrinkage cracks will develop under specific conditions. This is followed by a discussion of techniques to predict the number and widths of drying shrinkage cracks. The abutment and piers of a bridge shows different crack patterns when it's subjected to gravity loads and as well as moving loads, for that cracks in abutments and piers will be treats by using injectioning of Epoxy resins, retrofitting techniques etc

Key Words: Discrete crack formation, service loads, flexural cracks, Epoxy resins, retrofitting techniques

1. INTRODUCTION

Bridge abutment is a complicated substructure which requires a great deal of maintenance throughout its service life. Due to the considerable associated costs, reducing the maintenance required for bridge abutment is highly demanding and a topic of worldwide interest. The extensive maintenance required has been attributed partly to inadequacy of design procedures in terms of predicting the forces imposed on bridges during their surface life. Depending on the level of loads, this could lead to different degrees of failure, as characterized by limit state. The ultimate limit state occurs when the structure of abutment turns unstable. Example situations where this

type of limit applies include overall instability, sliding, overturning and capacity failure. Serviceability limit state, on the other hand, occurs when an abutment fails due to factors such as deterioration or deformation. The main situations involve vibration, cracking and lateral movement. Bridge abutments can be subjected to several kinds of failure and the failure can occur in a member of a structure or in the soil



2. LITERATURE REVIEW

Mohammed (2011) studied reinforced concrete members under impact loading and how carbon fiber reinforced polymers could be used to rehabilitate aging structures. The finite element code LS-DYNA was utilized to study the response behavior of vehicle collisions with bridge piers and reinforced concrete beams subjected to impact loads. The Chevy C2500 pickup truck and Ford F800 single-unit truck were used to impact a single hammerhead type pier in the simulations. The impact simulations were validated

by comparing the analytical results with rigid wall impact experiment data published by the NCAC to validate the C1500 vehicle model.

Adhikary et al. (2012) studied the behavior of reinforced concrete beams subject to various rates of concentrated loading through experimentation and finite element modeling. Reinforced concrete beams with varying transverse reinforcement layouts were constructed and subjected to low, medium, and high rates of loading. The finite element code LS-DYNA was used to simulate the experimental test. The Karagonzian and Case concrete model was used to represent the solid concrete elements. The piecewise linear plasticity model was used to represent the steel reinforcing bar elements. The simulation results were validated by comparing the load versus mid-span deflection and crack profile on the side surface of the beam

3. CASE STUDY

Inspection of bridge deck and approaches Problems attributed to the bridge deck and road approaches are often the most obvious to the inspecting engineer because they are easily identifiable and apparent. The extensive cracking occurs on both approach sections of road, and encompassing all four lanes and extending 30–40 m on the western approach and 25–30 m on the eastern approach (see Fig.). Individual cracks range from 3–15 mm wide and in some cases 50–60 mm deep (see Fig.). This type of cracking is attributed to a localized problem with the makeup of the road grade and sub-grade. The abutments movement is obvious upon inspection. The western approach section of road leading onto the bridge decking. It is observed that western side of the section joint is elevated significantly from the eastern side which is supported by the bridge abutment.



Cracking and pavement damage on western approach

This indicates two things; first, the surrounding soils have pushed up against the abutment, and second, that the abutment reduced level has fallen. Aside from the obvious problem of the bridge deformation, this causes problems in itself as the road is no longer a smooth riding surface for traffic (see Fig. 5). As a result of this the traffic almost falls onto the decking platforms which will further increase the resulting load particularly dynamic loads created by impact. The abutment movement has a collateral effect on the various elements of the system. The expansion gap has also completely closed. Typically, this gap is sufficient to allow for the average change in length due to temperature and typical loading. As the gap no longer exists, further movement cannot be allowed for and damage to the structure occurs, most obviously shown in the bridge abutments. During the inspection it was confirmed that all such expansion gaps had closed to a similar extent, indicating that the movement that has occurred is substantial and has occurred for a significant time period.



Fig.: Cracks observed

4. ABUTMENTS FAILURE

Rotational movement of abutment

- Scouring.
- Backfill material saturated with water.
- Backfill erosion on the side of abutment.
- Inadequate design.
- Consolidation settlement.
- Thermal movement
- Change in Characteristics of soil.
- Slope failure.
- Time consolidation of original soil.
- Seepage on backfill.
- Excessive lateral pressures.

— Swelling pressure from expansive soil

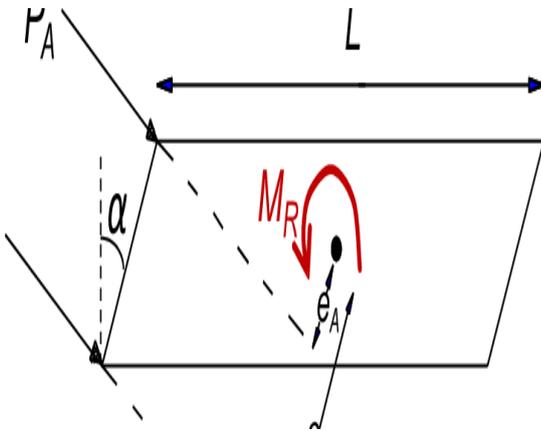


Fig: Rotational movement of abutment

Sliding movement of abutment (Lateral movement)

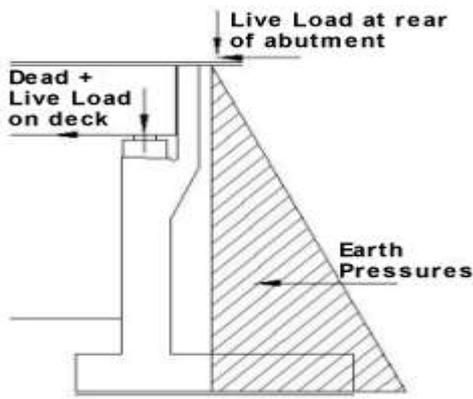


Fig: Abutment

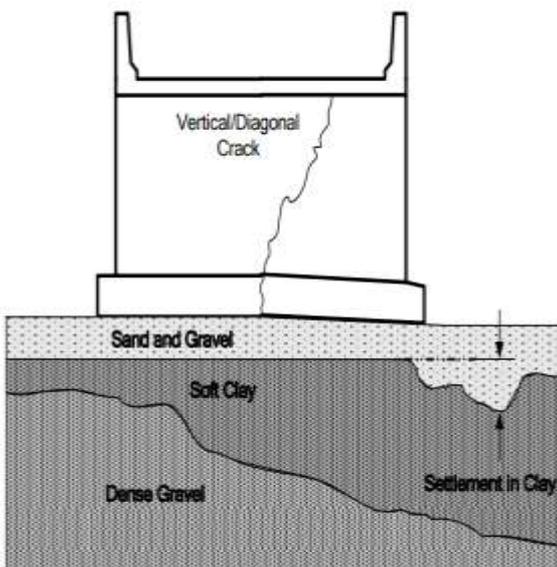


Fig: Differential Settlement



Fig: Differential Settlement Under an Abutment Drilling and plugging

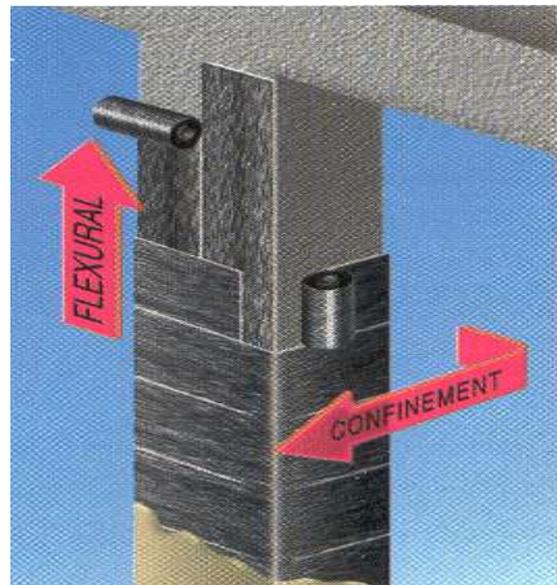


Fig.: Column Piers

5. REMEDIAL PLANNING

Feasible options

The remedial treatment of a bridge structure must first be analyzed by the investigation of the problems at hand. Through the case study of the bridge, these problems have been identified and potential solutions are generated. Combining the broad base of knowledge, the system for the remedial works of bridge abutment movement has been created.

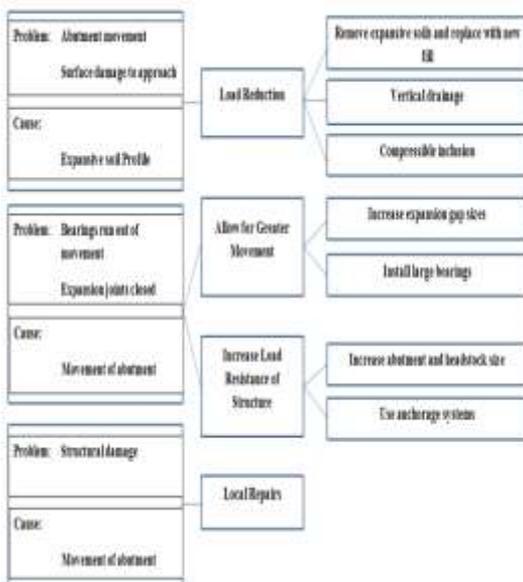


Fig.: Problems, causes and remedial options for bridge abutment movement.

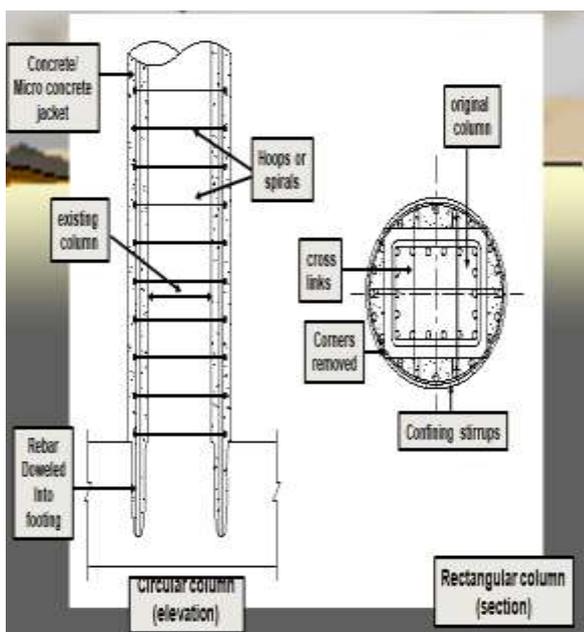


Fig.: CONFINEMENT OF COLUMNS BY CONCRETE JACKETING

Decision analysis

Numeric scoring models such as Weighted Constraint Matrix have been developed to allow multiple constraints to be used for concept feasibility studies. These models can combine economic evaluation output with technical and subjective constraint to create a decision making environment that is more holistic (and realistic) in nature. A Weighted Constraint Model is defined by a set of variables, their associated domains of values and a set of binary constraints governing the assignment.

6. CONCLUSION

This paper analyzes the design and behavior of bridge abutments and bridge decks when subjected to lateral movement. Theoretical analysis states that the bridge abutment itself should be adequate to withstand the lateral pressures imposed, however, investigation into bridge. Abutment movement has the potential to cause substantial damage to the bridge structure, resulting in high costs of repair and maintenance. The research undertaken has led to the conclusion that abutment movement is a problem of largely unknown quantity and despite investigation, movements may still occur unanticipated. However, these movements can be addressed and rectified through the use of specific actions. M. Rashidi et al. The results of the case study highlighted that the problems identified in surrounding soils, road approaches, bridge abutment, and expansion and bearing joints are interconnected. As the soil profile expands, excess loads are placed on the bridge abutment and road approaches. This in turn causes the movement of the abutment into the bridge deck which creates the structural problems seen in the expansion and bearing joints and also the structural cracking of the concrete in the wingwall of the abutment. These problems, while not immediately critical, will continue to worsen if left untreated as the abutment continues to move, thereby placing increasing amounts of load on the structure.

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