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..

Keywords: *Discrete crack formation, service loads, flexural cracks, Epoxy resins, retrofitting techniques*

INTRODUCTION

Over the past 20 years, extensive research has been conducted to study the causes and mitigation methods of bridge approach settlement or "the bump at the end of the bridge." The bridge approach settlement is defined as "the difference in elevation of approach pavements and bridge decks caused by unequal settlement of embankments and abutments." Many Departments of Transportation (DOTs) are significantly impacted by bridge approach settlement, as it causes unsafe driving conditions, rider discomfort, poor public perception of the state infrastructure, structural failure of bridges, and long-term maintenance costs. The bump is noticeable with about ½-inch of differential settlement between the bridge and approach (Wahls 1990), becomes problematic at 1 inch (Zaman et al. 1994), and causes serious riding discomfort at about 2 to 2.5 inches (Stark et al. 1995). In lieu of specifying tolerable movement as total settlement, Wahls (1990) indicated that tolerable movement should be measured as differential settlement over span length. A slope of less than or equal to 1 inch per 250 feet (1/250) for continuous spans and 1/200 for simply supported spans was considered acceptable. Once the bridge approach settlement becomes unacceptable, DOTs need to repair, provide maintenance, or reconstruct the bridge approach.

Briaud et al. (1997) indicated that at least 25 percent of the 600,000 bridges in the US, or about 150,000 bridges, are affected by bridge approach settlement. Similar statistics were shown by other studies. The Stark et al. (1995) study reported that 27 percent of the 1181 bridges in Illinois had significant differential bridge approach movement and that adjacent states such as Iowa, Wisconsin, Michigan, Ohio, Indiana, Missouri, and Kentucky exhibited similar percentages. Ha et al. (2002) reported that 24.5 percent of the Texas DOT bridges indicated a bump. Another study conducted by Luna et al. (2003) for Missouri DOT (MoDOT) reported that 17 percent of the bridges exhibited bridge approach settlement and an additional 15 percent required remediation.

The cost of repairing the bump ranges from $60 to $187 million with an average of $100 million per year (Briaud et al. 1997 and Schafer and Koch 1992). Other statistics were gathered from Kentucky DOT, which spends about $1000 per bridge per year (Dupont and Allen 2002), and Texas DOT, which reported spending a total of about $6.3 million per year (Ha et al 2002). If the bridge needs to be replaced, which Briaud et al. (1997) estimated to be another 35 percent of the 600,000 US bridges, $78 billion would be spent.

Because of the considerable amount of money spent on repairing bridge approach settlement, DOTs and the FHWA have funded numerous studies to determine the causes, mitigation methods, and maintenance techniques of bridge approach settlement. The present research "Evaluation of Bridge Approach Settlement Mitigation," sponsored by the Wisconsin Department of Transportation (WisDOT), is aimed at selecting the most cost-effective methods that can be competently executed during construction and that can reduce overall maintenance costs in Wisconsin. The purpose of this report is to document the performance and effectiveness of two mitigation techniques, geosynthetic reinforced fill and flowable fill, installed behind four Wisconsin bridge abutments. This report includes an extensive literature review, discussion of the field investigation, and performance evaluation of field results of these four bridges.

LITERATURE SURVEY

Writing examined in pertinence to the goals of the present investigation. There is different investigations done by the scientists on extension wharfs. The examination on adequacy of IRC live burden on scaffold dock is finished by M.G. Kalyanshetti and C. V.Alkunte. A parametric report is done for viability of IRC live burden for different stature of dock and range of scaffold for various state of wharf is considered. Another investigation is done by Premsai T. on scaffold wharf. They have done basic examination and enhancement of extension dock utilizing ANSYS. The investigation of extension wharf is to know the variety of relocations, stresses, amount of steel and amount of cement. A parametric investigation of solid projection connect is finished by JiminHuan and Carol K. In this a parametric report was directed to broaden the consequences of a test program on a solid indispensable projection (IA) connect in Rochester, MN to other fundamental projection spans with various structure factors including heap type, estimate, introduction, profundity of fixity, and sort of encompassing soil, fixity of the association between the projection heap top and projection stomach, connect range and length, and size.

Seni ALFIO, thought about live loads utilized in expressway connect plan in North America and Western Europe. He had talked about for the most part three points. - Provisions for live burden in U.S, Canada, Great Britain and France. - Quantitative correlation of minutes and responses for various cases. - Qualitative correlation of determinations with respect to their straightforwardness and simplicity of utilization. He found that the benefits of stacking from AASHO (American Association of State Highway and Transportation Officials) code and French loadings are near one another in spite of the fact that stacking design are extraordinary. Among all loadings, AASHO and CSA loadings demonstrate the lower esteems. Seni Found a few varieties quantitatively in regards to the accompanying. - For piece connect, contrast is 25% to 40% - For basically upheld shafts, minute changes from 32% to 110% and response shifts from 51% to 148%. - For constant two range braces, positive minutes differ from 20% to 93% and response on center help from 84% to 120%. Europe and North America both are profoundly industralised, so the scaffolds and parkways couldn't be so unique. So the creator recommended that the loadings given by North American codes appear to be deficient and ought to be overhauled.

BRIDGE VISUALIZATION

INTRODUCTION

The structure which is made upon the river or a gap without closing the way beneath is known as a bridge. it is required for the passage of roadways, railways and carriage way. In the beginning men used the fallen trees or wooden logs for making bridges over the river or gap.

Components of Bridges

Superstructure:

The part of the bridge on which the loads are directly applied is called the superstructure. Deck slabs. Beam Girders and Trusses are example of the superstructure.

Substructure: The portion of the bridge structure below the level of bearing and above the foundation is called as sub-structure. Piers and Abutments are called sub-structure.

Pier and Abutment Cap: The pier or abutment cap is the block resting over the top of the pier or the abutment. It provides the immediate bearing surface for the support of the superstructure at the pier or abutment location, and disperses the loads from the bearings to the substructure evenly.

Piers: Piers are the structures located at the ends of bridge spans at the intermediate points between the abutments. The function of the pier is two-fold: to transfer the vertical loads to the foundation and to resist all horizontal forces and transverse forces acting on the bridge.

Abutment: An abutment is the substructure which supports one terminus of the superstructure of a bridge and at the same time, laterally supports the embankment which serves as an approach to the bridge.

Bearing: Bearings are provides in bridges to transmit the load from the superstructure to the substructure in such a manner the bearing stresses induced in the substructure are within permissible limits.

Footing/foundation: The part of the bridge which is in direct contact with the earth and transmits all the loads directly to the earth is called the footing/foundation.

Wing wall: Wing walls are provided at both ends of the abutments to retain the earth filling of the approaches. The soil and fill supporting the roadway and approach embankment are retained by wing walls, which can be at right angles to the abutment or splayed at different angles.

Bed block: A reinforced concrete bed block resting over the top of the piers & abutments is generally provided to evenly distribute the dead and live loads on the pier and abutments.

Superelevation: Super elevation is tilting the roadway to help offset centrifugal forces developed as the vehicle goes around a curve. Along with friction it keeps a vehicle from going off the road. Super elevation is required on curved path.

Camber: Camber is the cross slope provided to the road surface in the transverse direction to drain off the rain water from the road surface.

SELECTION OF SITE

Normally selection of site for bridges is guided by road alignment.

The most suitable sites for bridge location are

• Narrow width of the channel.

• Cross section having large average depth.

• Straight reach of the channel upstream and downstream.

• Having right angled crossing.

• Avoidance of curves in approach roads.

• Presence of high stable banks.

• Free from obstruction or an island in river bed u/s and d/s.

LOADING:

While designing road bridges and culverts, the following loads, forces and stresses should be considered, where applicable.

Dead Load- The dead load carried by a bridge member consists of its

•own supported by the member.

Live Loads- Live loads are those caused by vehicles which pass over the

•bridge and are transient in nature.

There are four types of standard loadings for which road bridges are designed:

(a) IRC Class AA Loading,

(b) IRC Class 70R Loading,

(c) IRC Class A Loading, and

(d) IRC Class B Loading.

Impact effect-

• Live load trains produce higher stresses than those which would be caused if the loading vehicles were stationery. In order to take into account the increase in stresses due to dynamic action and still proceed with the simpler static al analysis, an impact allowance is made. Wind **Loads-**

• Though the wind forces are dynamic in nature, the forces can be approximated as equivalent static loads. These forces are considered to act horizontally and in such a direction as to cause the maximum stresses in the member under consideration.

Longitudinal Forces-

• These forces are caused in road bridges due to the following.

(a) Tractive effort caused through acceleration of driving wheels.

(b) Breaking effect due to application of brakes to the wheels.

(c) Frictional resistance offered to the movement of free bearing due to change of temperature or any other cause.

Buoyancy Effect

• Whenever submersion in water of a part or whole of a structure is possible, the forces due to buoyancy should be considered.

For high level bridges, buoyancy forces due to submerged part of the substructure and foundations should be taken into account.

Temperature effects-

• Daily and seasonal variations in temperature occur causing material to shorten with a fall in temperature and lengthen with a rise in temperature.

DESIGN OF PIER WITH OPEN FOUNDATION PIER:

DESIGN OF WING WALL

Grade of concrete = VCC

M15 RCL = 102.190 M

Sill Design = 98.000 M

Foundation = 96.000 M

Top width = 0.500 M

Earth side batter = 0.900 M

Other side batter = 0.000 M

Base width at sill = 1.400 M

Ht.oftrap.footing = 1.500 M

Footing off set (earth side) = 0.500 M

Footing off set (other side) = 0.500 M

Thickness of footing = 0.500 M

Base width at FL = 3.900 M

Coef.of earth pr.above sill for f = 36o = 0.287

Kah = 0.163 KavCoef.of earth pr.below

sill = 0.235 KahHt.of wall = 4.190 M

Total height = 6.190 M

Unit wt.of earth = 1.800 T/cum

Unit wt.of concrete = 2.300 T/cum

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.

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.

CONCLUSION

The achievement of extension development on delicate ground depends on appropriate arranging, investigation, plan, development control and site supervision. Be that as it may, from the two case accounts exhibited in this paper, clearly they are fundamentally the same as in nature and can be arranged to be brought about by the accompanying elements:- - Inadequacy of geotechnical plan for the methodology dikes or projections. - Lack of comprehension of the subsoil condition and mindfulness on the conceivable issues/disappointment that could occur amid development. - Lack of development control and site supervision by the Consultant To avoid bank and projection disappointment because of flimsiness, both roundabout and non-roundabout (wedge) disappointment surfaces will be checked utilizing limit balance investigations. A fast primer beware of the dependability of the bank is conceivable utilizing adjusted bearing limit condition of

qallow = (su. Nc/FOS)

It is additionally essential for plan advisor, specialist's site agents and contractual worker to have some key geotechnical learning so any anomalies at site can be spotted and prudent activities did before disappointment happens. At long last, legitimate full-time site supervision by the expert's delegates with satisfactory encounters and information are likewise essential to avoid disappointment because of un-built brief works.

- This paper investigates the structure and conduct of extension projections and scaffold decks when exposed to sidelong development.
- Theoretical examination expresses that the scaffold projection itself ought to be sufficient to withstand the sidelong weights forced, in any case, examination concerning span. Projection development can possibly make generous harm the extension structure, bringing about mind-boggling expenses of fix and support.
- The inquire about attempted has prompted the end that projection development is an issue of to a great extent obscure amount and in spite of examination, developments may at present happen unexpected. In any case, these developments can be tended to and redressed using explicit activities. M. Rashidi et al.
- The consequences of the contextual investigation featured that the issues distinguished in encompassing soils, street approaches, connect projection, and extension and bearing joints are interconnected.
- As the dirt profile extends, abundance loads are set on the extension projection and street approaches.
- This thusly causes the development of the projection into the extension deck which makes the auxiliary issues found in the development and bearing joints and furthermore the basic breaking of the solid in the wingwall of the projection.
- These issues, while not promptly basic, will keep on intensifying whenever left untreated as the projection keeps on moving, along these lines putting expanding measures of burden on the structure.

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