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Review Integral Abutment Bridge Behavior in Different Condition

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Abstract— This paper presents findings of a literature review of behavior of Integral Abutment Bridge (IAB) , The purpose of the report is to identify problems and uncertainties, and to gain insight into the interactions between the foundation piles, the integral abutment, and the surrounding ground and Synthesize the information available on the general behavior of integral abutment bridges. Integral Abutment Bridge (IAB is joint less bridge in which the deck is continuous and monolithic with abutment walls. The outperform their non-integral counterparts in economy and safety. Their principal advantages are derived from the absence of expansion joints and sliding bearings in the deck, making them the most cost effective system in terms of construction, maintenance, and longevity. The main purpose of construction IAB is to prevent the corrosion of structure due to water seepage through joints. The simple and rapid construction provides smooth, uninterrupted deck that is aesthetically pleasing and safer for riding. The single structural unit increases the degree of redundancy enabling higher resistance to extreme events. To gain a better understanding of the mechanism of IAB, a comparative study is carried out on a typical IAB and a simply supported bridge. A literature review focusing on past numerical models of. A discussion on results of analysis of the IAB with different geometry and comparison with simply supported bridge and each experiencing same temperature change scenarios and same loading pattern is observed.

Index Terms— Integral Abutment Bridge, Simply Supported Bridge, Soil Interaction, Comparison.

I. INTRODUCTION

Highlight a section that you want to designate with a certain style, and then select the appropriate name on the style menu. The style will adjust your fonts and line spacing. Do not change the font sizes or line spacing to squeeze more text into a limited number of pages. Use italics for emphasis; does not underline Construction of Integral Abutment Bridge has been started in 1930's in U.S.A. Since then many countries have adopted this concept as a replacement for traditional bridges. In Integral Abutment Bridge the continuity achieved by monolithic construction results in thermally induced deformations. These in turn introduce a significantly complex and nonlinear soil structure interaction into the response of abutment walls and piles of the IAB. The unknown soil response and its effect on the stresses in the bridge, creates uncertainties in the design. With joint less bridge, all of the movement due to temperature changes takes place at the abutments and this approach system area require special attention to avoid development of a severe "bump at the end of the bridge".

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Many researchers have their own experience on this topic by various researchers. Observations of field performance of IAB and related issues reported by different researches are summarized in this literature review along with the detailed discussion of the previous finite element studies on IAB. Mourad et al. [8] compared deck slab stresses in IAB with those in simply supported (conventional) bridges by applying loading of HS20-44 trucks. A finite element analysis using computer program ALGOR was carried out for this purpose. The results indicated a more uniform distribution of loads and 25-50% lower maximum stresses in the transverse direction in IAB as compared to the corresponding simply supported bridges. IAB Alampalli et al [9] concluded that the higher the skew of the bridge deck, the lower the Condition and performance ratings were for the deck, approach slab and abutment stem. Arockiasamy et al. [1] conducted a parametric study for the response of laterally loaded piles supporting Integral bridges with an emphasis on predrilled holes, elevation of the water table, soil types and pile orientation by using finite-difference program LPILE and finite-element program FB-Pier. The study concluded that horizontal displacement at the pile top, maximum shear , axial force and moments in the pile significantly depend on the type of the soil around the pile, its degree of compaction and the orientation of pile axis: while the water table elevation has very little significance. Springman et al. [2] studied the behavior of abutments of IAB and how it differed from that of simply supported bridges subjected to cyclic loading conditions Effects of temperature variations on the soil-structure interaction were investigated by using the centrifuge modeling technique. Displacement –controlled loading was employed in the centrifuge model tests, which were conducted on a spread-base integral bridge abutment. This was done by imposing controlled cyclic displacements at the top of the abutment wall thereby simulating the thermal expansion and contraction of the bridge. According to Khondair et al [3] the secondary stresses in the bridge deck due to temperature changes and substructure settlement can be significantly higher than those permitted by current design specifications, thus highlighting the lack of sufficient knowledge base with reference to IAB based on the results of a literature review, field inspections, and a finite element analysis , the following conclusions are drawn concerning the behavior of integral abutment bridge.(3) Integral abutment bridges perform well with fever maintenance problems than conventional bridge. Without joints in the bridge deck, usual damage to girders and piers caused by water and contaminants from the roadway is not observed. Very few detailed analytical studies with focus on thermal loading have been carried out on IAB.

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This section of the literature review discusses those in details. One of the most complete finite element studies of IAB was performed by Faraji et al [10] with the aim to design and construct longest span bridges and to evaluate their performance during seismic loads. A 3D finite element model of "Bemis Road Bridge: F-4-20" in Fitchburg, Massachusetts was analyzed using the finite: elehttp://www.youtube.com/watch?feature=player_detailpage&v=x0TPcryPBTAmt code GT-STRUDL. Non-linear soil behavior, modeled using non-linear springs, was incorporated in the model. The nonlinear force-deflection relations for the soil adjacent to the abutment walls were based on the recommendations by the National cooperative Highways Research Program (NCHRP. 1991) design manual. The "p-y" design curves recommended by American Petroleum Institute (API) were used for nonlinear force-deflection relations for the soil adjacent to the piles. According to Khodair et al. [3] ABAQUS/Standard6.3.1 was used to develop a 3D FE model of the HP piles embedded into a 1.97 feet diameter sand filled galvanized steel sleeve. Both, pile and soil were modeled using eight-node solid continuum elements with a non-linear response. While an elastic-plastic response was adopted for the pile elements. Mohr-coulomb model with strain hardening idealized the non-linear soil response. Surface-to-surface contact algorithm was employed to model the sand-pile interaction .To model the tangential contact, friction coefficient for the interaction between pile and soil materials was calculated.

II. Design Guidelines and Practice

A. Abutment

In Integral abutment bridges the ends of the superstructure girders are fixed to the integral abutments. When integral bridges is supported either by a flexible capped pile pier or freestanding pier with movable bearings, all longitudinal forces are taken by abutment backfill, pavements, and to a slight extent by the flexible abutment piles . Resistance to thermal movements is shared among all the substructure units and must be considered in the design of integral abutments. The most desirable type of abutment is the stub type, in which the abutment is supported by single row of piles. The piles are driven vertically without any batter. This arrangement of piles permits the abutment to move in a longitudinal direction under temperature effects.

B. Piles

The analysis of a pile under lateral loads in the integral abutment should consider soil-structure interaction. Because the deflected shape of the loaded pile is dependent upon the soil response and, in turn, the soil response is a function of pile deflection, the system response cannot be determined by the traditional rule of static equilibrium. Further soil response is a nonlinear function of pile deflection. Determination of the practical point of fixity of the buried pile is rather complex in structural engineering. A rational design method is developed for integral abutment piles considering the inelastic redistributions of the thermally induced moments. This method is based upon the ability of steel piles to develop plastic hinges and undergo inelastic rotation without local buckling failure. The laterally loaded pile may be modeled as an equivalent beam column without transverse load between the member's ends and with a base fixed at a specific soil depth. The soil depth, called the equivalent embedded length, is the depth from the soil surface to the fixed base of the equivalent cantilever Abendroth and Greimann [12] either a fixed head or a pinned head for the beam column approximates the actual rotational restrains at the pile head.

C. Approach Slab

Due to the difficulties in obtaining proper embankment and backfill compaction Around abutments, approach slabs are recommended. Approach slabs offer many benefits other than acting as a bridge between the abutment and the more densely compacted embankments. Approach slabs provide a transition from the approach to the bridge. If embankment settlement occurs. Such transition provides a smooth ride, thereby reducing impact loads to the bridge. They also provide greeter load distribution at bridge ends which aid in reducing damage to the abutments, especially from overweight vehicles. Finally properly drained approach slabs help control roadway drainage , thus preventing erosion of the abutment backfill or freeze and thaw damage resulting from saturated backfill at American Iron and Steel Institution (AISI). Approach slabs are poured separately from the superstructure slab, but joined together.

D. Wing wall

In-line wing walls cantilevered from the abutment are preferred. When the alignment and velocity of streams make in –line walls subject to possible scour, or when right of way to other traffic poses a problem the flared walls cantilevered from the abutment or U-type wing walls can be adopted.

E. Backfill

It is important to provide and effective maintainable drainage system below the surfacing and at the bottom of the backfill. Porous granular backfill is widely used. The advantages of granular backfill are easy compaction in narrow space and drainage of water from the abutment. Because uniformly graded material does not compact well and provides less interlocking of particles, acting more like marbles, well-graded material is desirable. Backfilling of the abutment is not allowed until the abutments have cured to attain sufficient strength.

III. Recommended Design Details for Integral Abutments

- Use embankment and stub-type abutments.
- Use single row of flexible piles and orient piles for weak axis bending.
- Use steel piles for maximum ductility and durability.
- Embed piles at least two pile sizes into the pile cap achieve pile fixedly to abutment to Provide abutment stem wide enough to allow for some miss alignment of piles.
- Provide an earth bench near superstructure to minimize abutment depth and wing wall lengths.
- Provide minimum penetration of abutment into embankment.

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- Make wing walls as small as practicable to minimize the amount of structure and earth that have to move with the abutment during thermal expansion of the deck.
- For shallow superstructures, use cantilevered turn-back wing walls (parallel to center line of roadway) instead of transverse wing walls.
- Provide loose backfill beneath cantilevered wing walls.
- Provide well-drained granular backfill to accommodate the imposed expansion and contraction.
- Provide under-drains under and around abutment and around wing walls.
- Encase stringers completely by end-diaphragm concrete.
- Paint ends of girders.
- Caulk interface between beam and back wall.
- Provide holes in steel beam ends to thread through longitudinal abutment reinforcement.
- Provide temporary support bolts anchored into the pile cap to support beams in lieu of cast bridge seats.
- Tie approach slabs to abutments with hinge type reinforcing.
- Use generous shrinkage reinforcement in the deck slab above the abutment
- Pile length should not be less than 10 ft. to provide sufficient flexibility.
- Provide pre bored holes to a depth of 10 feet for piles if necessary for dense and/or cohesive soils to allow for flexing as the superstructure translates.
- Provide pavement joints to allow bridge cyclic movements and pavement growth.
- Focus on entire bridge and not just its abutments.
- Provide symmetry on integral bridges to minimize potential longitudinal forces on piers and to equalize longitudinal pressure on abutments.
- Provide two layers of polyethylene sheets or a fabric under the approach slab to minimize friction against horizontal movement.
- Limit use of integral abutment to bridges with skew less than 30 deg

IV. CONCLUSION

The ground around the piles moves along with the movement of the abutment. The relative movement between the pile and ground is therefore reduced, resulting in relatively low shear forces at the top of the pile. Integral abutment bridges perform well with fewer maintenance problems than conventional bridges. Without joints in the bridge deck, the usual damage to the girders and piers caused by water and contaminants from the roadway. There is no significant effect of stresses to the abutment due to vertical load. There are many successful examples of integral abutment bridges in North America and a lesser number in Australia. This form of bridge construction has been used for steel, concrete and prestressed concrete bridge superstructures over range bridge lengths and for a limited range of bridge skews embankment settlement occurs. Such transition provides a smooth ride, thereby reducing impact loads to the bridge. They also provide greeter load distribution at bridge ends which aid in reducing damage to the abutments, especially from overweight vehicles. Finally properly drained approach slabs help control roadway drainage , thus preventing erosion of the abutment backfill or freeze and thaw damage resulting from saturated backfill at American Iron and Steel Institution (AISI). Approach slabs are poured separately from the superstructure slab, but joined together.

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