BEHAVIOR OF INTEGRAL ABUTMENT BRIDGE WITH SPRING ANALYSIS

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Abstract: Integral Abutment Bridges (IAB) are joint less bridges in which the deck is continuous and monolithic with abutment walls, due to this continuity in the bridge the bridge have less expensive, esthetically pleasing appearance, safe riding, economical in construction, prevent the corrosion. To get a better understanding of the behavior of IAB in different situation, a comparative study is carried out on a typical IAB and a simply supported bridge (SSB) of same geometry and loading conditions, and compares these bridges with spring and without spring analysis at both ends. A total of three bridges were analyzed for this work by using Midas Civil Software.

Keywords: Integral Bridge, Midas Civil, Comparison, Prevent The Corrosion.

I. INTRODUCTION

Highway bridges traditionally have a system of expansion joint, roller supports, abutment bearing and other structural releases to account for cyclic thermal expansion and contraction, creep and shrinkage. The earliest examples of IAB are masonry arch bridges. The construction of IAB has been pursued countries included U.S.A, Canada, U.K, Sweden, Poland, Germany and Japan.

Integral abutment type bridge structures are single or multiple span bridges that have their superstructure cast integral with their substructure. Integral abutment bridges accommodate superstore movements without conventional expansion joints. With the superstructure rigidly connected to the substructure and with flexible substructure piling, the superstructure is permitted to expand and contract. Approach slab, connected to the abutment and deck slab with reinforcement, move with superstructure. At its junction to sleeper slab is not utilized: the superstructure movement is accommodated using flexible pavement joints. Due to the elimination of the bridge deck expansion joints, construction and maintenance costs are reduced.

The integral abutment bridge concept is based on the theory that due to the flexibility of the piling, thermal stresses are transferred to the substructure by way of a rigid connection between the superstructure and substructure. The concrete abutment contains sufficient bulk to be considered a rigid mass. The end of the girders is provided by rigidly connecting the beams or girders and by encasing them in reinforced concrete. This provides for full transfer of temperature variation and live load moment to the abutment piling. Thus IAB are constructed continuous and monolithic with the abutment walls, enabling the superstructure and the abutment to act as a single structural unit and assuring a full moment transfer through a moment resisting connection between them. Single or multiple span IAB are generally supported by a single row of flexible H-piles driven into pre-augured holes beneath the abutment wall, and aligned such that the weaker axis of bending is along the transverse direction, thus allowing a higher flexibility.

II. RESEARCH WORK

The present work was done to observe the behavior of Integral Abutment Bridge while taking with and without spring analysis on the abutment wall and compare these two with the simply supported bridge, by using MIDAS CIVIL software.

III. SOFTWARE INFORMATION

Midas Civil is a new paradigm for engineering bridge and civil structures. It provides a distinctively easy user interface through its innovative graphics modules. Midas civil provides an optimal design solution, which analyses and designs all types of bridge structures in 3-D environments accounting for construction stages and time dependent properties.

IV. DESCRIPTION OF STRUCTURE

The bridge under consideration is an RCC Fly Over (T-beam) bridge of 150 m total length between two abutments excluding the length of approach slabs on either side. Further the bridge is divided into seven equal spans: each span is 21.5 m effective length i.e. center to center distance between two consecutive supports and 10.55 m wide in cross section (Two Lane Bridge with Footpath). The bridge deck is 300mm thick for inner panels to resist the traffic load as per IRC Class AA single train or two trains of Class A (IRC 6-2000). Portion of deck provided as a footpath is over hang for a clear length of 1.45 m on either side from the face of external girder rib. Thickness of overhang portion of the deck is 300 mm
at the face of external girder rib. Thickness of overhang portion of the deck is 300 mm at the face of external support which gradually reduces to 200 mm at free end. A parapet wall or anti crash barrier is provided at the free end of the footpath of 200 mm thickness and 900mm height while at the end of the overhang other side a median verge (divider) of 300 mm thickness and 240 mm depth is provided.

There are four longitudinal girders provided across the width of the bridge, each of them is spaced 2.45 m center to center from each other, and the longitudinal girder is a T-beam of 2.45 m flange width, 0.3 m web thickness, provided with a bottom bulb of trapezoidal section with base width 0.55 m. In addition to the longitudinal girders there are some cross girders provided to distribute the loads from the deck to the longitudinal girders. These cross girders are provided at a center-to-center distance of 3.75 m it means there are five cross girders between two consecutive piers, and it is 300 mm wide and 450 mm deep in section.

There are four circular piers of 1.2 m diameter provided to support the superstructure of the bridge, which rest on spread foundation. On either end of the bridge, the super structure rests on abutments, rigidly connected to the deck slab in Integral Abutment Bridge, and simply supported in case of conventional bridge.

4.1 Spring Analysis
Soil structure interaction was modeled using horizontal spring restraints the length of the bridge which were rigidly restrained at the ends of the abutment wall, because of the soil interaction with the end abutment the spring action is taken out in the ends of the bridge and the interaction provide the flexibility to the bridge.

V. DESCRIPTION OF VARIOUS LOAD

Dead load
Dead load consists of weight of various structural components of the bridge superstructure and substructure.

Live Load
Live load consists of moving IRC Class A wheeled train+ dead load of structure.

Temperature forces
This load consists of stresses developed due to temperature variations in the vicinity of the bridge because of variation in top and bottom of the deck slab.

Backfill Pressure
This load consists of stresses developed due to soil placed behind the abutments to prevent the scouring of the abutments, and provide the support to the approach slab.

Spring Analysis
Soil structure interaction was modeled using horizontal spring restraints the length of the bridge which were rigidly restrained at the ends of the abutment wall.

Notations:-
IAB: - Integral Abutment Bridge
SSB: - Simply Supported Bridge
IAB WSA: - Integral Abutment Bridge With Spring Analysis

![Fig 1 Simply Supported Bridge Bending Moment Diagram](image1)
![Fig 2 Integral Abutment Bridge Bending Moment Diagram](image2)
![Fig 3 Integral Abutment Bridge (Spring Analysis at Both End Abutments Bending) Moment Diagram (IAB WSA)](image3)
VI. RESULTS

<table>
<thead>
<tr>
<th>Span</th>
<th>Dead Load Case</th>
<th>SSB</th>
<th>IAB</th>
<th>IAB WSA M(KNm)</th>
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Fig 4 Dead Load Hogging Bending Moment

Fig 5 Dead Load Sagging Bending Moment

Fig 6 Live Load Hogging Bending Moment

FUTURE SCOPE

There is much scope for further work in the area of IAB. Some of which are as below.

Nonlinear material models of concrete need to be implemented to study the long term effects of cyclic loading during the lifespan of the IAB. This will help in understanding cracking of concrete deck, girders and piles.

IAB could be analyzed for longer and number of traffic lanes, considering skew ness of the substructure, it can be analyzed for bridges with horizontal curves because many times it is not possible to have straight bridges especially in urban areas.

APPLICATIONS

Integral Abutment Bridge can be easily used in place of small bridges and culverts because of its strength, faster rate of construction, lower maintenance cost, improve driving and aesthetic conditions and resistance to seismic forces. It can also be used for rehabilitation of existing bridges. IAB can be constructed as Structural steel, RCC, or Composite bridge.

CONCLUSIONS

Near the junction of deck slab and abutment IAB has lesser stresses than SSB, because of rigid connection between abutment and deck slab, there is transfer of stresses, but in case of IAB WSA (Integral Abutment Bridge With Spring Analysis) the stresses is more as compare to SSB and less as compare to IAB because at ends abutments a spring force is develop. Bending moment is more in SSB as compare to IAB and bending moment is less in IAB WSA as compare to both. Overall we can say that moment and shear stress developed in various components of IAB is higher than SSB, so it can be concluded that moments, stresses and forces developed in IAB is higher than the equivalent SSB because of monolithic connection between various components of the bridge, but if we provide spring analysis at both ends.
of the end abutment then the shear force, bending moment and forces will reduce as compare to IAB.

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REFERENCES


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