DESIGN CONSIDERATIONS FOR INTEGRAL ABUTMENT BRIDGES IN FLORIDA

PROBLEM STATEMENT

Expansion joints at the abutments in conventional bridges cause the water from the backfill and roadway to penetrate into the bearing areas and onto the bridge seats. The joints could potentially be forced to close, resulting in broken backwalls, sheared anchor bolts, and damaged roadway expansion devices. The problems and the maintenance costs associated with the joints have accelerated the need and development of integral abutment bridges in the U.S.

Integral abutment bridges provide an economical and attractive design alternative to traditional bridges with thermal expansion joints. When such construction is used to eliminate joints, the continuity achieved by such construction will subject the superstructure to secondary stresses as the result of the restraint provided by the abutment foundations and backfill against the cyclic movement of bridge superstructures. The fundamental problems that need to be addressed are the following:

i. Instantaneous and time dependent behavior of composite superstructure.
ii. Moments due to temperature change, prestressing, creep, shrinkage, and restraints provided by abutment foundation and backfill.
iii. Effect of the pile-soil interaction with varying soil strata, temperature, creep and shrinkage effects.
iv. Guidelines for analysis and design procedures.

OBJECTIVES

The objectives of this research were as follows:

1. Develop analytical models and numerical procedures for predicting instantaneous linear behavior and non-linear time dependent long-term behavior of composite superstructure.
2. Determine the distributions of moments due to temperature change, prestressing, creep, shrinkage, and restraints provided by abutment foundation and backfill.
3. Carry out the pile-soil interaction analysis with varying soil strata, temperature, creep and shrinkage effects.

CONCLUSIONS AND RECOMMENDATIONS

A comprehensive literature review and analytical investigation of the integral abutment bridges was carried out and the study resulted in the following findings:

- The movement associated with integral abutment bridge can be largely associated with seasonal thermal expansion and contraction of the superstructure. One dimensional linear thermal expansion model can be used to account for seasonal temperature effects on the superstructure.
- Adjacent prestressed box beams, prestressed concrete girders and structural steel beams may be used for integral abutment designs. Pretensioned or post tensioned concrete should have a provision for creep, shrinkage, and elastic shortening.
- Integral abutment bridges shall be designed to resist all the vertical and lateral loads acting on them. The load effects at various stages of construction should be considered in the design. The stages at which the structure is simply supported, then made integral with abutments and backfill are of primary importance.
- The primary features of the piers for an integral abutment bridge involve their ability to accommodate potentially large superstructure movements and the sharing of lateral and longitudinal forces among the substructure units. Piers should be flexible and supported on the flexible foundations, if made integral with the deck diaphragms.
- Piles can be modeled using equivalent cantilever idealization approach based on Winkler soil idealization. Since the sub-soils are not always homogeneous, soil stiffness may not be constant and vary with depth. Hence, for a non-uniform soil, equivalent soil stiffness can be assumed.
- Steel H-piles are preferred due to its ductility and durability. There is no universally accepted pile orientation for steel H piles. The orientation of piles along weak or strong axis depends on the laterally loaded pile stresses. A weak axis orientation is more flexible and allows larger lateral movements.

BENEFITS

The present study has shown the feasibility of using integral abutment bridges that offer advantages of lower initial and maintenance costs. The study presents methods of analysis for the design of integral abutment bridges considering the temperature effects, creep and shrinkage, abutment and pier stiffnesses, soil pressure and pile capacity.

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