CONNECTION FAILURES IN CONCRETE CONSTRUCTION

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Summary

The behavior of non-standard connections in concrete construction, particularly cast-in-place concrete construction, is often not as well-defined and sometimes not as well understood as other components of concrete construction. In situations such as these, a complete understanding of the connection mechanics is essential to analyze and design the connection. The lack of understanding can lead to underestimation of demand and/or overestimation of the capacity of a connection resulting in poor performance and/or failure. This paper examines the failure of two types of connections at expansion joints in concrete construction. In both cases, the failures of the connections compromised the structural performance.

The subject of the first case study is the failure of expansion joints on an automated people mover system, which occurred during commissioning of the system. The basic design flaw was that the statical behavior of the connection was misunderstood. This resulted in the incorrect resolution of forces and the underestimation of demand. In addition, two repairs were initially proposed after the failure based on the same misunderstanding. The analysis of the connection forces and the revised design of this connection will be discussed.

The subject of the second case study is the failure of a vertical expansion joint in a water treatment tank. The failure of this connection occurred after the tank was in-service for about five years. In this case, the underestimation of demand was the result of incorrect modeling of the joint behavior and the overestimation of capacity was the result of inappropriate application of design code provisions. The analysis and repair of the existing structure, as well as design recommendations will be discussed.

Keywords: Concrete construction, expansion joints, transportation structure, guide way, ride plate, anchorage to concrete, dowel behavior, connected elements in shear, concrete bearing, water treatment tank.

1. Failure in a Transportation Structure

1.1 Background

The subject of the first case study is the failure of expansion joints on an automated people mover (APM) system. The actual failure corresponded to the connection of the steel ride plate to the reinforced concrete running surface at the expansion joint. These failures occurred during commissioning of the system immediately prior to the system going into service.

The APM vehicles are rubber tired, electrically powered and automatically controlled. A general view of the guideway is shown in Figure 1. The running surface for the guideway consists of two 20 in. wide concrete plinths offset 39 3/4 in. on either side of the vehicle centerline to the centerlines of the plinths. The concrete running surfaces vary in nominal minimum depth from 8 in. to 17 in. The plinths are anchored to the guideway superstructure by hairpin reinforcement using post-installed adhesive anchors.

Expansion joints in the running surface correspond to expansion joints in the underlying superstructure. Two types of expansion joints were specified. Gaps normal to the centerline of the running surface (Type 1) were specified not to exceed 1 in. in width in all environmental conditions. When gaps larger than 1 in. were required, the joint face was specified at a 45 degree angle to the

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