STRUCTURAL PERFORMANCE OF CONTINUITY CONNECTION FOR DECKED BULB TEE GIRDERS

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ABSTRACT

In order to minimize on-site construction, a decked bulb tee (DBT) girder with full-depth concrete deck was proposed. As usage of the precast girder has been increased, interest of connection between girders has been grown in these days. Connection detail has become a critical issue to control girder performance in terms of crack control, strength and rotation capacity of connection part. The purpose of this paper is to suggest recommendation of suitable continuity connection detail for the DBT girders and to verify structural performance of transverse connection detail. Experiment of a small scale-model of DBT girder was performed and recommended connection detail in this paper was based on experimental verification which focused on efficiency of strength, ductility and rotational capacity

Keywords: Transverse joint, Decked Bulb Tee Girder (DBT), Precast Concrete, Continuous structure, Accelerated Construction

1. INTRODUCTION

Accelerated bridge construction has become a significant issue to optimize construction process and cost (Shim et al. 2000, 2001, 2003, 2008, 2010, 2011, Chung et al. 2010). It also has numerous benefits such as reduction of traffic disruption and improvement of working zone safety. One of promising girder’s shapes for rapid construction is a decked bulb tee (DBT) girder which is composite structure between deck and bulb tee girder (Ralls et al. 2005). This girder has both

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transverse joints and longitudinal joints that are connected with connection part of adjacent DBT girders. Development of longitudinal joint details for the girders was performed (Li et al. 2010 a,b). Main focus of this paper is structural performance of continuity connection of DBT girders. Experiment of a connection model of DBT girders was designed and experimental verification was performed to prove design requirements in current design codes for continuity connection in terms of cracking, flexural capacity and rotation capacity.

2. EXPERIMENTAL PROGRAM

Prestressed precast girders are connected without local prestressing in the continuity connection. A part of a DBT girder was designed to have the same reinforcements and tendon profile. The continuity connection utilized rebar couplers only for reinforcements in the concrete deck, which is in tensile zone in negative moment region. The continuity connection also had diaphragm section which can strengthen the connection.

2.1. Test specimen

Two DBT girder models were fabricated as presented in Figure 1. After prefabrication of the girders, reinforcements in the deck were connected with couplers and additional reinforcements were placed to simulate diaphragm details as shown in Figure 2. Prestressing tendons were extended and folded to contribute the connection detail. As shown in Figure 3, end surface of DBT girders had zigzag shape to enhance shear behavior and crack control. Cast-in-place concrete was poured in the connection with the same compressive strength as the girder concrete.
2.2. Test setup

Figure 4 shows the static test setup. The specimen was inverted to simulate negative bending moment by a simply supported condition. A line load was applied at midspan of negative moment part by displacement control method. Each constraint of supports was roller and hinge. Deflection gauges, concrete strain and steel strain, concrete gauges were installed, as shown Figure 5.

After cracking, crack width was observed by crack gauges and crack patterns were recorded. The load was applied to measure ultimate strength and rotational capacity of the connection. Especially, role of coupled reinforcing bars was estimated up to the ultimate load.
2.3. Result of experiment

2.3.1. Strength

Figure 6 present load-displacement curve of specimen until failure. Ultimate load of experiment is 512 kN and yield load is about 320 kN. Calculated flexural strength by the stress block concept is 416 kN which showed 23% conservative evaluation.
2.3.2. Ductility

Ductility is estimated by ratio using yield displacement and ultimate displacement according to the load-displacement curve in Figure 6. Ultimate displacement and yield displacement are 15 mm and 3 mm respectively and calculated ductility is 5.0. The proposed details showed good ductility.

2.3.3. Rotational capacity

The continuity connection needs to provide enough rotational capacity for plastic hinge mechanism of continuous structures. From the measured deflection, angle of rotation was estimated.

Angle of rotation of specimen, \( \theta \), is 0.172 degree calculated by Equation (1). The rotation capacity of the connection can provide enough moment redistribution for continuous structures.

\[
\theta = \tan^{-1}\left(\frac{\delta_{\text{max}}}{0.5L}\right)
\]

where:
\( \delta_{\text{max}} \) = Maximum displacement when maximum load was applied
\( L \) = Length of specimen

3. CONCLUSION

A connection detail for the continuity of DBT girders was proposed and its structural performance was evaluated by experiments. During the fabrication of the specimen, constructability issues were investigated.

Test results showed the proposed connection detail can provide enough flexural strength and rotational capacity for the continuous DBT girders. Even though there are joints between precast concrete and CIP concrete, observed crack patterns showed good crack distribution and crack width control.

Based on the test results, the DBT girder can be an economic choice for the bridge construction in terms of construction period and cost. Camber control for the different long-term deformation of each girder can be a critical issue in construction site. Further investigation on this long-term behavior needs to be performed.

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REFERENCES


