Project Summary

Texas Department of Transportation

0-5830: Best Practices for Concrete Curb and Gutter

Background

Most of the research studies on Portland cement concrete (PCC) pavement focused on addressing distresses related to pavement structure itself. As a result, the design and construction of other structural elements of the concrete curb and curb and gutter (CCCG) system have been overlooked and not much research has been done in this area.

Given the limited maneuvering space allowed for traffic in some urban areas, especially in large districts, long vehicles (e.g., trucks, trailers, recreational vehicles, etc.) might disturb the curbs and gutters that delineate the traveling path. Two problems this creates include the restriction in space for vehicle turning operations and the damage caused to curbs and gutters.

The solution to the first of the problems would involve improvements in the geometric design, which is not always feasible or economically viable. However, the solution to the second problem is attainable.

Rather than being a trivial aspect of the pavement design area, CCCG could be an important feature of the whole pavement system. High quality design and construction of CCCG is especially needed for proper maneuvering in those areas where turning motorists might hit the curb unintentionally. Accordingly, these structural elements must be designed and constructed using better and more refined design standards and quality materials. Failure of the CCCG system might cause a safety problem as well as localized premature failures of the pavement.

What the Researchers Did

An extensive literature review was performed to investigate the previous research efforts on the structural aspect of the CCCG systems. Visual inspection on damaged CCCG systems was conducted in the field to find possible causes of the failure of CCCG systems. The costs calculation by the Federal Highway Administration (FHWA) to upgrade roadways to accommodate off tracking was reviewed.

The pullout tests for the dowel bars installed in the CCCG system were performed in order to investigate the ultimate bond strength of the vertical dowel bars.

Extensive finite element analysis was performed based on the new U-turn curb design from TxDOT's Houston District. Three design parameters were considered for calculations: the loading condition, the curb width, and the location of curb dowel.

What They Found

The literature search showed that not much research work had been done in the area of structural design of CCCG. Instead, most of the research effort has focused on the safety effectiveness of curbs and the use of curbs in conjunction with traffic barriers.

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From the field inspections, all damaged CCCG systems were the TxDOT Type II system and almost all damaged CCCG systems were found at U-turn curbs. Failure occurred regardless of vertical tie bar spacing and joint spacing.

The straight bar manually inserted into the fresh concrete showed the least bond strength, and the drilled and epoxy-grouted dowels showed the best performance in terms of bond strength. This is only true when the epoxy-grouted dowels are installed properly.

From the results of finite element analysis, the following conclusions can be made:

- The horizontal loading is the most critical loading condition to evaluate structural adequacy of a CCCG system.
- The structural capacity of CCCG can be enhanced by increasing the curb width and/or by inserting the curb dowel farther from the inner surface of CCCG.
- It is necessary to consider economic efficiency and constructability when designing the CCCG system because the curb width and the location of curb dowels are limited in their ability to enhance the structural capacity of CCCG.
- The changes in the stress of concrete are minimal if the curb widths of CCCG exceed 24 in.
- The effect of the location of the curb dowel becomes insignificant when the distance between the dowel and the traffic face of a CCCG exceeds 8 in.

What This Means

From the field inspection results, it is concluded that the off tracking of truck loadings was the main cause of the curb damage. The geometric changes of the curb design are the fundamental solutions for the off tracking failure, but it is not feasible in most cases due to economic and space limitations.

The use of epoxy grouted bars, as the vertical reinforcement of the CCCG systems is the best available and practical option for the new construction of CCCG systems.

Based on the research efforts in this study, the following recommendations are proposed by the researchers:

- The use of the new U-turn curb design from TxDOT's Houston District is highly recommended for areas effected by the off tracking of heavy vehicles.
- Although the current dowel bar location in the new U-turn curb design is found to be structurally adequate, it is recommended to change the location of the curb dowel to the farthest location from the traffic face of a CCCG system for better performance. A distance between the location of dowel and the traffic face of CCCG of 8 in. or higher is recommended.
- Curb width of 24 in. or higher is recommended to provide adequate structural capacity.
- It is also recommended to use an epoxy-grouted curb dowel instead of the manually inserted straight dowel bar to ensure better bond performance between dowel bar and concrete in a CCCG system.

For More Information:

0-5830-1 Optimized Design of Concrete Curb under Off Tracking Loads

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