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End Diaphragm Cracking of Box Girder Bridges due to Post-tensioning: Case Study

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Abstract

Adequate dimensioning and detailing of box girders end diaphragm is critical for proper performance of post-tensioned bridges. Current design methods have led to highly congested anchorage zones with construction issues and cracking problems. In order to study the performance of anchorage zones, box girders end diaphragms were instrumented in the field. Strain gauges were used in order to capture stresses in reinforcing bars and strains within the concrete elements. End diaphragm cracking was observed during post-tensioning for one of the investigated bridges. These cracks were not noticed during regular inspection because they occurred on the inner face of the diaphragm inside the box section. Skew angle of the end diaphragm is a governing factor affecting cracks distribution. The paper will discuss reasons for the developed cracks and highlight design recommendations.

Keywords: anchorage zone; general zone; field investigation; post-tensioned box girder; end diaphragm; concrete cracking.

1 Introduction

The anchorage zone for any prestressed member consists of two zones, local zone and general zone. The end diaphragm is a part of post-tensioning general anchorage zone; it needs to have adequate reinforcement and proper concrete placement. Sufficient reinforcement must be provided to handle force spreading in the general zone of the end anchorage. It is essential that concrete stresses remain sufficiently low to prevent crushing, especially in areas immediately ahead of the anchorage device and at changes in geometry.

Field monitoring was performed for the end diaphragms of four bridges. The main criterion in the field instrumentation was not to make an obstacle in the time schedule of the bridge construction. Several safety cautions were considered to make sure the instrumentation was not interfering with construction. The field investigation led to the measurement of the actual flow of strains in the general anchorage zone. Through these strains, the flow of forces was determined.

Cracking was observed in one of the instrumented bridges. This bridge had a skew end diaphragm with large block-outs. Prestressing block-outs are a part of concrete section that is removed in order to be capable of stressing. The block-out dimension increases with the increase of skew angle. Increasing dimensions of these block-outs decrease the remaining effective thickness of the end diaphragm. Cracking of bridges especially during construction will affect bridge serviceability life. Conventional design of the end diaphragm may cause cracking if the post-tensioning effects are not taken into account. Developing realistic models are

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