

# Failure Analysis of a Long-Span Pre-Stressed Concrete Box Girder Bridge

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## Summary

In recent years, there have been some certain accidents happened during the construction of continuous pre-stressed concrete box girder (rigid frame) bridges that the upper and lower concrete along the ducts in bottom slabs has been generally destroyed during the tension process of the closure pre-stressed tendons. With the precise numerical analysis of the destruction mechanism of bottom slabs considering the material non-linearity, this paper reproduces the failure process of a typical accident, and analyzes the mechanism of the occurrence and the path of cracks on bottom slabs and the function of vertical tie bars in bottom slabs. Here the method of test analysis has been firstly used in the research of the destruction mechanism of bottom slabs of the depth-variation box girder to further verify and improve the knowledge of the destruction mechanism of bottom slabs and the function of vertical tie bars in bottom slabs.

**Keywords:** long-span continuous girder bridge; continuous rigid frame bridges; curved bottom slab; destruction mechanism; numerical analytic method; model test

## 1. Introduction

Continuous rigid frame pre-stressed concrete bridges have been widely applied for the span between 100m and 300m in China due to their good integrality, large stiffness, low cost and the skilled design and construction technology etc. However, after the engineering practice of almost 30 years, various problems such as cracks on girders and the excessive deflection of main girder have appeared during the severing stage of this kind of bridges. To avoid the occurrence of the problems above, designers usually add sufficient longitudinal pre-stressing in curved bottom slabs in the middle span of continuous box girders. Due to the application of a mass of large tonnage pre-stressed tendons, bottom slabs of box girders are always in a high hole-rate and high-stress state. Hence in recent years, there have been some certain accidents happened in the construction of continuous pre-stressed concrete box girder (rigid frame) bridges that the bottom slabs of the box girder have been destroyed during the tension process of the closure pre-stressed tendons (*Fig. 1~2*).

With the precise numerical analytic method for the destruction mechanism of bottom slabs of the box girder in consideration of the material non-linearity, this paper reproduce the process of the destruction in one certain typical accident, analyze the mechanism of the occurrence and the path of cracks on bottom slabs and the function of vertical tie bars in bottom slabs. To obtain several more sensitive factors of the mechanical behaviour of bottom slabs, and to further verify and improve the knowledge of the destruction mechanism of bottom slabs and the function of vertical tie bars in bottom slabs, here the method of test analysis has been firstly used to analyze and compare those key parameters, which influence the mechanical behaviour of curved bottom slabs of the depth-variation box girder, such as the line shape of the bottom of the box girder, the compressive pre-stressing level, the width of bottom slabs, the net distance between ducts etc.