

Testing of full scale pre-stressed concrete beams

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Summary

This paper deals with testing of pre-stressed I-beams, the behaviour of the beams under loading, strengthening methods and their function.

In the near history in Finland large commercial buildings have been built using pre-stressed pre-fabricated beams. The cost efficiency has led to designing very slender beams with higher pre-stress forces. This has caused problems in pre-stressed beams around Finland. Damages has been so severe that immediate repair of the beams has been necessary in some cases. Tampere University of Technology helped develop and tested these strengthening methods.

The results of the tests led to development of a formula that estimates the beam's extra capacity after post-tensioned strengthening method.

Keywords: *Testing; Pre-stressing; Concrete beam; Repairing; Strengthening, Post-tensioned bars*

1. Introduction

There has been a growth in the construction of massive long span hypermarkets in Finland during the last 20 years. This has led to the use of precast and pre-stressed concrete I-ridge beams. In many cases large holes are made through the web so pipes could go through the beam instead of going underneath the beam. Very often these holes are situated on the ridge area. Normally the biggest bending moment occurs on the central area of the span. This, combined with a poor reinforcement method of the ridge area, has created some problems in Finland. During years 2005-2007 significant cracking has occurred around the holes and on the ridge area. In some cases the damages were so severe that immediate repairing and strengthening of the structure was necessary. [1]

In some cases the damaged ridge area was repaired and strengthened with a steel structure that applied both horizontal and vertical compression around the beam on the ridge area. The large holes in the web were reinforced and cast. However, the function and the capacity of the repaired beams were unclear. This led to testing of full scale pre-stressed I-profile ridge beams in laboratory conditions. The tests were done in Tampere University of Technology. [1]

2. Full scale pre-stressed concrete I-beam tests

The tests made in laboratory conditions included five pre-stressed concrete I-beams. Because of the test arrangement the tested beams had to be made five meters shorter than the original damaged beams. Four of the test specimens were similar. They had a big hole in the middle of the beam beginning right underneath the upper flange. The reinforcement and the pre-stressed tendons were similar to the damaged beams taking into account the scale modification. One specimen was made similar to what corresponds today's way of reinforce pre-stressed beams. This specimen had no holes. All the specimens had 20 tendons and the initial pre-stress was 1050 MPa [2].