AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

CONTRIBUTION OF INNER STIRRUPS WITH THE HANGER STEEL REINFORCEMENT ON THE BEHAVIOUR OF LEDGE BEAM

BY
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A Thesis
Submitted in partial fulfillment for the requirements of the
Degree of doctor of philosophy in Civil Engineering (Structural)

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STATEMENT

This thesis is submitted to Ain Shams University, Cairo, Egypt, on for the degree of doctor of philosophy in Civil Engineering (Structural).

The experimental work included in this thesis was carried out by the author at the Housing and Building National Research Center lab, Giza, Egypt

No part of this thesis has been submitted for a degree or qualification at any other University or Institute.

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AIN SHAMS UNIVERSITY
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Abstract of the PHD. Thesis Submitted by
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Title of the thesis:

CONTRIBUTION OF INNER STIRRUPS WITH THE HANGER STEEL REINFORCEMENT ON THE BEHAVIOUR OF LEDGE BEAM

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ABSTRACT

Ledge beams are commonly used as spandrels in precast concrete structures. The design of ledge beams according to the ACI Building code and PCI assumes that the outer branches of vertical stirrup are resisting torsion stress and acting as a hanger for the ledge part. The contribution of the inner vertical branches of stirrups as a hanger for the ledge part is neglected. Therefore, the outer vertical stirrups have a great amount with respect to the internal stirrups.

The experimental program was designed to study the contribution of the internal vertical stirrups on the hanging action of the ledge. The test specimens consisted of six simply supported beams with 2700 mm span. All beams have a total height of 380 mm and a web width of 250 mm. The heights of the ledge part were 140 mm and their projection was 250 mm.

The main variables are the distribution of internal vertical stirrups and the eccentricity of vertical loads. The specimens were designed to ensure that the ultimate failure load of the ledge part due to yielding of the vertical hanger outer stirrups according to the ACI and PCI was smaller than the ultimate flexural and punching shear failure loads of the specimens.

To evaluate the results of the tested beams, a finite element program was used to simulate the beams by using ABAQUS program. Both the properties of steel reinforcement and concrete were simulated to represent the actual behavior of the tested beams.

The finite element models results were verified against the experimental results and showed a good agreement with the tested beam results.

A parametric study was established to take other variables which are not considered in the experimental program.

Research findings were used to propose equations; for the estimation of the effective width of inner stirrups, and to predict the hanger steel capacity of the ledge beam considering the contribution of the inner stirrups.

Key Words: Hanger steel reinforcement, Shear reinforcement, Ledge beam & Reinforced concrete.

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