EXPERIMENTAL STUDY OF SHEAR BEHAVIOR OF SHALLOW WIDE BEAMS

By

Kloge Kamal Kamel

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under The Supervision

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Title of Thesis:

EXPERIMENTAL STUDY OF SHEAR BEHAVIOR OF SHALLOW WIDE BEAMS

Key Words:

Wide beam, normal strength concrete, high strength concrete, shear strength, shear reinforcement

Summary:

Shallow wide beams are frequently used as transfer elements where the total structural depth must be kept to a minimum. The experimental program consisted of fifteen simply supported reinforced concrete shallow wide beams subjected to two concentrated loads to examine parameters. The studied parameters are volumetric ratio of vertical stirrups, concrete compressive strength, specimen width, and the contribution of web shear reinforcement to shear strength.

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This research project was carried out in the department of structural engineering at Cairo University, and could not have been completed without the help and support of many people.

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Nomenclature

Latin Lower Case Symbols

a	Shear Span Length
b	Width of the Section
b_v	Width of the Section
b_w	Width of the Web on T, I or L Beams
d	Effective Depth of Section
f_c'	Concrete Cylinder Compressive Strength
f_{cd}	Design value of concrete cylinder compressive strength
f_{ck}	Characteristic Compressive Cylinder Strength of Concrete at 28 days
f_{cu}	Concrete Characteristic Strength
f_t	Tensile Strength of the Concrete
f_y	Yield Strength of Stirrups
f_{yk}	Characteristic Yield Strength of Reinforcement
f_{ywd}	Design Yield Strength of the Shear Reinforcement
q_{cu}	Concrete Shear Stress in Beams
q_{su}	Ultimate Shear Stress Provided by Shear Reinforcement
q_u	Nominal Ultimate Shear Stress
q_{umax}	Nominal Ultimate Shear Stress Maximum
s	Spacing Between Stirrups
s_v	Spacing Between Stirrups
t	Thickness of Section
v	Design Shear Stress Due to Ultimate Loads
v_c	Nominal Shear Strength Provided by Concrete
v_{Ed}	Design Shear Stress Due to Loads
v_n	Nominal Shear Strength
v_s	Nominal Shear Strength Provided by Steel
z	Lever Arm of Internal Forces

Latin Upper Case Symbols

A_s	Area of Steal
A_{sl}	Area of the Longitudinal Reinforcement
A_{st}	Area of All Vertical Branches in One Stirrup
A_{sv}	Area of Vertical Branches in One Stirrup
A_{sw}	Cross – Sectional Area of the Shear Reinforcement
A_v	Area of Shear Reinforcement
M_u	Corresponding ultimate Moment at the Same Section
Q_u	Ultimate Shear Force

V	External Shear Force Due to Ultimate Load
V_{ay}	Vertical Component of the Aggregate Interlock
V_{cz}	Shear Resistance of the Uncracked Concrete
V_{Ed}	Design Shear Force in the Section
V_d	Dowel Force in the Tension Reinforcement
$V_{Rd,ct}$	Concrete Shear Resistance
$V_{Rd,max}$	Concrete Shear Resistance Maximum
V_s	Shear Resistance Carried by the Shear Reinforcement
V_u	Factored Shear Force at the Section

Greek Symbols

γ_c	Partial Safety Factor for Concrete
γ_m	Partial Safety Factor for Concrete
γ_s	Partial Safety Factor for Steel
θ	Angle Between Concrete Compression Struts and the Main Tension Chord
μ_{min}	Minimum Web Reinforcement Ratio
ρ_l	Reinforcement Ratio for Longitudinal Reinforcement
ρ_w	Longitudinal Steel Ratio
Φ	Strength Reduction Factor

Abstract

Shallow wide beams are considered a simple solution to avoid architectural constrains in the design of buildings. Using shallow wide beams also gives time saving in construction due to simplicity of formwork and reinforcement placement that means more economy can be achieved, so that engineers prefer using it.

The ECP 203-2007 requires that the applied shear strength in the shallow wide beams be less than the concrete shear strength without any shear reinforcement contribution, and the shear strength provided by concrete for shallow wide beams equals two thirds of the concrete shear strength of shallow projected beams. Consequently, large cross-sectional areas of the concrete shall be provided for these members to resist shear demands, which seem uneconomic conservative design provisions. The above-mentioned requirements by the Egyptian Code were not found in most recognized international codes or standards.

The objective of the research was to study the influence of specific parameters on the shear behavior of shallow wide beams, and to determine the contribution of web shear reinforcement to shear strength. The studied parameters are volumetric ratio of vertical stirrups, concrete compressive strength, and specimen width. The experimental program consisted of fifteen simply supported reinforced concrete shallow wide beams subjected to two concentrated loads to examine the above-mentioned parameters.

A comparison between the observed shear capacities of beams and the calculated values using ECP 203-2007, ACI 318-11, and CSA A23.3-04 shear provisions was also presented in the research.

Based on the results of the current experimental program, it is recommended that the ECP 203 code is to consider the contribution of steel shear reinforcement (vertical stirrups) in the calculation of shear strength of shallow wide beams.