STRENGTHENING OF REINFORCED CONCRETE BEAMS BY ADDING NEW CONCRETE

by

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B.Sc. ,civil Engineering, Assiut University, Horsi,1982

A THESIS

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MASTER OF SCIENCE

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Strengthening of Reinforced Concrete Beams by Adding New Concrete

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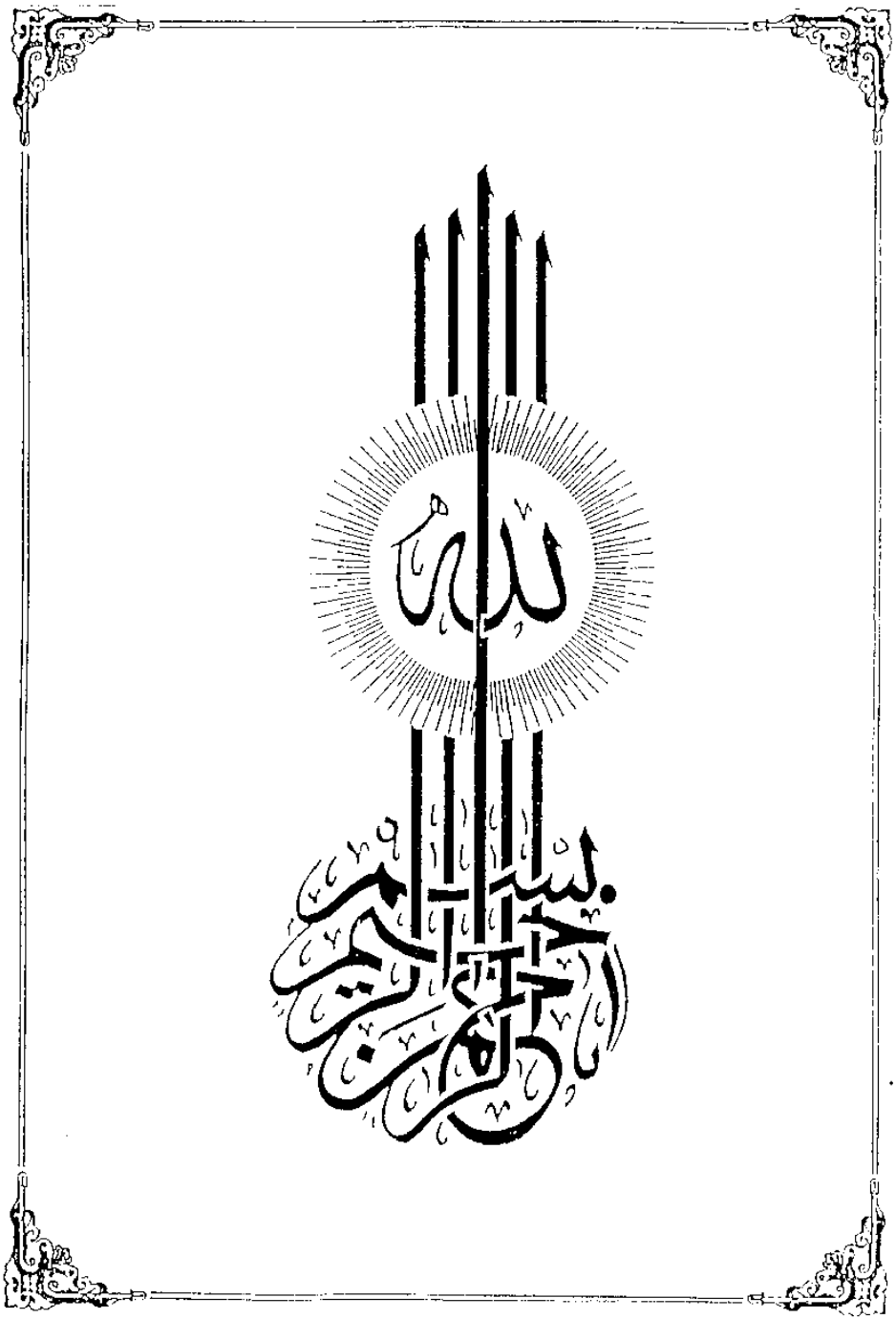

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master in Structural Engineering.

The work included in this thesis was carried out by the author in the Department of Structures, Ain Shams University, from Sept. 1985 to August. 1988.

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

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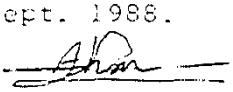
Signature: 

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بسم الله الرحمن الرحيم

" سبحانك لا علم لنا الا ما علمتنا انك أنت العليم الحكيم "

صدق الله العظيم

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To My PARENTS

&

MY WIFE

Strengthening of Reinforced concerete Beams By Adding New Concrete

M.Sc Thesis in Civil Eng.,
Structural Eng. Dept.,Ain Shams Univ.

By
Ahmed Moussa Abd El Rahman Mohamed.

ABSTRACT

Direct shear transfer should be considered at the interface between concrete surfaces cast at different times. Many researches had been made using different types of interface treatments and shear connectors. Most of these treatments were made during casting of concrete to simulate the case of precast units. The situation is different in case of strengthening of exisiting structures .

This thesis presents an experimental study on 44 push-off specimens, each consisting of two parts cast at different times representing 22 different interface shear connections. Also 16 reinforced concrete beams were tested, three of them were reference beams and the other thirteen were strengthened by adding new concrete layer to the compression flange. All the surface treatments were made after the hardening of concrete . The variables studied are the surface roughness, ratio and distribution of concrete keys, ratio and fixation method of steel dowels, steel angles, epoxy painting, distribution of dowels over shear span and adding longitudinal reinforcement to the new layer. The obtained results were compared with calculated values using available codes and previous works. The shear strength of different interface connections were evaluated .

Key words : beam ; building cods ; composite construction; contact surface roughness; failure; friction; horizontal shear; joint ; key; precast concrete; reinforced concrete ; research; roughness; shear key ; shear span; shear strength; slab;slippage; static test. ; strengthening .

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CONTENTS

NOTATION

The following symbols are used in this thesis .Other symbols not listed below are defined where they are used.

A_c Cross sectional area.

A_k Total area of concrete keys.

A_s Area of tension reinforcement.

A_{sd} Total area of steel dowels

A_{sh} Area of shear surface.

B Breadth of T-beam flange.

b Breadth of R.C. beam web.

C Compressive force in the flange of the beam.

C_j Compressive force in the new concrete layer .

C_u Ultimate compressive force in the flange of the beam.

C_{ju} Ultimate compressive force in the new concrete layer.

d Effective depth of reinforced concrete beam .

f_c 28 -day compressive strength determined from cubes of 15 cm.side length.

f_c 28-days cylinderical compressive strength.

f_{su} Ultimate tensile strength of steel reinforcement.

f_{sy} Yield tensile strength of steel reinforcement.

L Span length of the beam

M_u Ultimate bending moment for the beam.

ΔM Increase of the beam flexural strength

ΔM_{ref}^{cal} Difference between the calculated flexural strength of the reference beam and that of original beam $= M_{u\ ref}^{cal} - M_{u\ original}^{cal.}$

P Applied load.

P_{cr}	Initial cracking load.
P_u	Ultimate load.
Q	Shearing force.
Q_f	Failure shearing force
q	Average shear stress = Q/A_{sh}
q_c	Cohesion shear strength .
q_f	Average shear stress at failure.
$q_{f\ cor}$	Average shear stress at failure corrected for concrete strength.
q_m	Ultimate shear strength of concrete (monolithic).
q_u	Ultimate shear strength of the connection.
q_u^{cal}	Calculated ultimate shear strength of the connection.
S	Total slip between two concrete layers.
S_m	Total slip for reference specimen .
t	Over all beam depth.
W	Average interface crack width.
W_m	Average interface crack width for reference specimen.
Y_{ct}	Internal lever arm.
α	Angle between shear reinforcement across the interface and the shear plane
ϕ	Angle of internal friction for concrete.
μ	Coeffecient of internal friction for concrete ($\mu = \tan \phi$).
ε_c	Concrete strain.
ε_s	Steel strain.
γ_m	Partial Factor of safety for material