Ain Shams University
Faculty of Engineering

# *BEHAVIOUR OF CONNECTION BETWEEN PRECAST HIGH STRENGTH CONCRETE BEAMS AND DECK SLABS*

By
**Eng. Karim Atef Hassan Sayed**

B.Sc. (٢٠٠٦)
Structural Division – Civil Engineering Departement
Faculty of Engineering – Ain Shams University

A Thesis
Submitted in Partial Fulfillment of the Requirements
of the Degree of Master of Science in Civil Engineering (Structural)

Under the supervision of:

**Prof. Dr. Amr Ali Abdelrahman**
Professor of Concrete Structures
Structural Engineering Dept.
Ain Shams University, Egypt.

**Dr. Khaled Mohammed Hilal**
Assistant Professor
Structural Engineering Department,
Ain Shams University, Egypt.

**November – ٢٠١٣**
**Cairo – Egypt**

## STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering (Structural).

The work included was carried out by the author at reinforced concrete laboratory of the faculty of engineering, Ain Shams University.

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

| | | |
|---|---|---|
| Date | : | ٢١/٠٤/٢٠١٣ |
| Name | : | **Karim Atef Hassan Sayed** |
| Signature | : | Karim Atef |

# AUTHOR

| | | |
|---|---|---|
| Name | : | Karim Atef Hassan Sayed |
| Date of birth | : | ٢٩ May ١٩٨٣ |
| Place of birth | : | Cairo, Egypt. |
| Academic Degree | : | B.Sc. in Structural Engineering |
| University | : | Ain Shams University |
| Date | : | July ٢٠٠٦ |
| Grade | : | Good |
| Current job | : | Civil / Structural Engineer at PARSONS. |

**EXAMINERS COMMITEE**

## Name and Affiliation Signature

**Prof. Dr. Amr Ali Abdelrahman**
Professor of Concrete Structures
Structural Engineering Dept.
Ain Shams University, Egypt.

**Prof. Dr. Ibrahim Galal Shaban**
Professor of Concrete Structures
Executive Projects Manager
High Education Authority, Egypt.

**Dr. Ahmad Hassan Galab**
Professor of Concrete Structures
Structural Engineering Department,
Ain Shams University, Egypt.

**Dr. Khaled Mohammed Hilal**
Assistant Professor
Structural Engineering Department,
Ain Shams University, Egypt.

# ACKNOWLEDGEMENT

First of all, I thank ALLAH who guided and helped me to finish this work in the proper shape.

I would like to thank my father, mother, my wife and my whole family for their continuous support. I would like to express my deep appreciation to Prof. Dr. Amr Ali Abd El-Rahman, professor of concrete structures, faculty of engineering, Ain Shams University, for his experienced advice, continuous support and deep encouragement through all phases of the work.

I am also extremely grateful to Dr. Khaled Mohammed Hilal, Assistant Professor at the Structural Engineering Department, Faculty of Engineering, Ain Shams University, for his experienced advice, continuous support and deep encouragement through all phases of the work.

I would like to thank the technicians of the reinforced concrete laboratory, Ain Shams University.

Finally, I would like to thank my dear friends and colleagues Medhat Tawfik and Moataz Mostafa, who helped and supported me in the completion of this work.

**Ain Shams University,**
**Faculty of Engineering**
**Structural Department**

## ABSTRACT

**Title of the thesis:**

**"BEHAVIOUR OF CONNECTIONS BETWEEN PRECAST HIGH STRENGTH CONCRETE BEAMS AND DECK SLABS"**

**Submitted by: Eng. Karim Atef Hassan Sayed**

**Supervised by: Prof. Dr. Amr Ali Abdelrahman**
**Dr. Khaled Mohammed Hilal**

Over the past three decades, bridge deck construction using precast components has become the system of choice for contractors and transportation officials. The choice for precast concrete is due to the rapid erection of its lightweight components, reduction in overall mobilization and equipment costs and its structural durability. Several precast elements are available to meet with all construction requirements. It is often preferable to transport beams and deck slabs separately to reduce the weight of each element. While precast panels perform well under large and highly repetitive loading, the transversal grouted connection between precast beams and deck slabs can become problematic.

The research program included in thesis, evaluate the structural performance of the different types of the connection between precast high strength concrete beams and deck slabs. The main variable in the study was the shear connectors' distribution along the transversal connection between the beams and deck slabs. The research also evaluates the chemical adhesion between the beams and deck slabs using epoxy resins and grout to connect the beams with the deck slabs without using shear connectors.

Six high strength concrete beam specimens with different shear connector's distribution were tested under static loading conditions, flexural tests were performed to study the parameters mentioned previously and to quantify peak and post-peak behavior of the interface between beams and deck slabs. The different series of tests investigated the surface treatment of the bottom of the slab, the distribution and amount of shear connector and several pocket details. In addition, the effect of chemical adhesion on the behavior of the connection was investigated by using epoxy resin without shear connectors at one of the six beam specimens.

The thesis also presents the analytical program that evaluates the different design approaches of the international standards like ACI-٣١٨M ٢٠٠٨, BS٨١١٠, ECP-٢٠٣ ٢٠٠٧ and AASHTO LRFD ٢٠٠٧ and comparing these approaches with the test results.

The research findings indicated that the studied shear connectors' distribution patterns; i.e. concentrated at beam edge or distributed along the beam length; had no significant effect on the load – deflection behavior or the ultimate capacity of the tested beam specimens. The beam specimens interface shear reinforcement was designed by the shear friction equation of the Egyptian code.

The research also indicated that Specimens with Dense shear connectors distribution achieved the full capacity as the monolithic control beam specimen, Specimens with light shear connectors distribution achieved ٩٠٪ of the full capacity of the monolithic control beam specimen. While The failure load of beam specimen without using mechanical connectors was ٨٥٪ of the monolithic control beam capacity.

Finally, the research indicated that, the grouted pockets technique is a promising alternative to the conventional cast-in-place concrete deck. They afford reduced construction time and fewer burdens on the motoring public. In addition, using high strength concrete has given smaller composite sections with the ability to carry larger loads.

Beam specimen B٦ give promising results for using epoxy resin only at the interfacial surface without using mechanical shear connectors. More researches are needed to evaluate this type of connection depending on epoxy only under cyclic loading. In addition, more researches are needed to evaluate and enhance the grouted pockets technique under cyclic loading.

# TABLE OF CONTENTS

# LIST OF FIGURES