POST TENSIONING EFFECT IN COLUMN TO BEAMS BY BOLTS OF INDUSTRIALIZED BUILDING SYSTEM (IBS) FOR SCHOOL BUILDINGS

HEWA QADER MUSTAFA

UNIVERSITI TEKNOLOGI MALAYSIA

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HEWA QADER MUSTAFA

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil-Structure)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JUNE 2014

Dedicated to my beloved mother,
wife and Children,
All my family members,
My course-mates and friends.

..Thank you for every thing..

Special thanks to my supervisor,
And every one who had involved
in this study.

.. .May God bless all of you...
Thank you

ACKNOWLEDGEMENT

Upon the completion of this master thesis, firstly, I would like to greatly thank ALLAH for allow use and providing me with patience and determination to finish this study. Secondly, I would like to express from deeps of my heart all the appreciation to my beloved supervisor, Associate Professor Dr. Abdul Kadir Bin Marsono for his continuous guidance, help, support, and encouragement throughout the work of my thesis. He supported me in every possible way to fulfill my research objectives and complete my study. Without his help it was going to be hard to achieve my objectives and complete my study in due time.

At the end I would like express appreciation to my beloved wife (Samar) and children (Salar, Sahand, and Abdullah) who spent sleepless nights with and was always my support in the moments when there was no one to answer my queries, and never give up in giving me encouragement and enthusiasm to finish my project.

ABSTRACT

Industrialized building system (IBS) is a construction term of Products, elements, or building system. In addition to capacity and behaviour of post tension system by bolts for the column to beam connection under cyclic lateral loads. A six cycle of a push over tests was carry out on a scaled model of 1:5 two-story one-bay specimen frame, four post-tensioned (PT) precast columns and two precast concrete beams components are fabricated. The main objectives of this study were to study the lateral strength of IBS assembled by using a post tensioned bars. It also examine the mechanism failure of the IBS post tension structures at various performance levels along the regime of lateral loads. The results of experimental work, at every cycle of loading are recorded the sway of IBS frame and found cracks or crushing of IBS components. The test was extended to the level of robustness of the system. During investigation, it was found that the maximum sway under cyclic lateral loading must align with the lateral stability and ductility. On the other hand the connection behavior indicated from the experimental give a merits to the post-tensioned IBS system under cyclic lateral loads. It capable to produce a more useful energy dissipation mechanism without the excess of residual displacements.

ABSTRAK

Sistem Bangunan Industri (IBS) adalah satu istilah pembinaan berdasarkan produk, pada sistem bangunan. Keupayaan dan kelakuan kejuruteraan sistem pasca tegangan di jangka meningkat dengan adanya sambungan bolt antara rasuk dan tiang pada beban sisi berulang. Enam siri tujahan berulang telah dijalankan ke atas model satu tingkat kerangkan bangunan berskala 1:5. Empat tiang pratuang pasca tegangan dan dua rasuk konkrit pratuang telah bina di makmal. Objektif utama kajian ini adalah untuk mengkaji kekuatan sisi IBS dipasang dengan menggunakan bar pasca tegangan. Ia juga mengkaji mekanisma gagal pada struktur IBS pasca ketegangan pada berbagai tahap sesaran beban sisi. Keputusan ujikaji mendapati tujahan pada rangka IBS menyebabkan retak dan penghancuran pada komponen ekstrem. Ujian pada had muktamad ini juga telah dilanjutkan ke tahap ujian kemantapan sistem. Hasil ujian mendapati bahawa sesaran maksimum pada beban sisi harus selaras dengan kestabilan sisi dan kemuluran sambungan. Mekasnisma gagal struktur ujian IBS menunjukkan bahawa sistem baru ini mampu menghasilkan mekanisma pelepasan tenaga tanpa sesaran yang berlebihan dan memberi kebaikkan kepada sistem bangunan IBS yang baru ini.

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LIST OF ABBREVIATIONS

ATC	-	Applied Technology Council
BS	-	British Standard
CIDB	-	Construction Industry Development Board
D.O.F	-	Degree of Freedom
Demec	-	Demountable mechanical gauge
E	-	Elastic modulus
EC2	-	European Code 2
FEM	-	Finite Element Method
GPa	-	Gega Pascal
IBS	-	Industrialized Building System
JKR	-	Jabatan Kerja Raya
kN	-	Kilo Newton
LVDT	-	Linear Variable Displacement Transducer
MMC	-	Modern Method Construction
MPa	-	Mega Pascal
NSP	-	Nonlinear Static Procedure
OSM	-	Off-Site Manufacturing
PDT	-	Pseudo Dynamic Test
PT	-	Post Tension
PVC	-	Polyvinyl Chloride
RC	-	Reinforced Concrete
SG	-	Strain Gauge
SLS	-	Serviceability Limit State
UBPT	-	Un Bonded Post-Tensioning

ULS - Ultimate Limit State
UTM - Universiti Teknologi Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Background

Maintaining life safety in engineering design is the primary concern to structures. After a structure can maintain life safety, the next goal is to reduce the amount of damage in the structure following large lateral deformations. Reducing the amount of damage to the structure will allow for rapid repairs and a reduction of closure time. Damage may be in the form of spalling concrete, buckling or fracture of column longitudinal reinforcement, and permanent lateral displacement.

1.1.1 Reinforced Concrete Frame Structures

Reinforced concrete (RC) frames consist of horizontal elements (beams) and vertical elements (columns) connected from the ranges of convent ally rigid to pinned joints. These structures are cast monolithically with; beams and columns are cast in a single operation to obtain unison act under loading. RC frames provide resistance to both gravity and lateral loads through bending in beams and columns.

Reinforced concrete is a combination of concrete, which is strong and relatively durable in compression with reinforcing and steel, which is strong and ductile in tension. In order to maintain the composite action, load transfer between the concrete and steel is essential. It is basically influenced by the bond, which is idealized as continuous stress field that develops in the vicinity of the steel reinforcing concrete interface.

1.1.2 Precast Concrete Structures

The concept of precast (also known as “prefabricated”) construction includes those buildings where the majority of structural components is standardized and produced in plants in a location away from the building, and then transported to the site for assembly. These components are manufactured by industrial methods based on mass production in order to build a large quantity of buildings in a short time at acceptable cost. The main features of this construction process are as follows:

- The Classification and specialization of the human workforce.
- The use of tools, machinery, and other equipment, usually automated, in the production of standard and interchangeable parts and products.

1.1.3 Industrialized Building System IBS

Industrialized building has been defined as the term given to building technology in which modern systematic methods of design, production planning and control as well as mechanized and automated manufacture are applied. Also The Industrialized Building Systems (IBS) which all building components such as the wall, slab, beam, column and staircase are mass-produced either in the factory or on the factory site under strict quality control and minimal wet site activities. The industrialized building system (IBS) can be generally interpreted as in which all building components are mass produced either in a factory or at site factory according to specifications with standardized shapes and dimensions, and transported to the construction project site to be rearranged with certain standard to form a building. Industrialization has demonstrated a high capacity to reduce the costs, improve the quality and get complex products available to the vast majority of people. It is the case for most products offered on the market today, including construction materials and components (roof trusses, prestressed concrete slabs, windows, curtain walls, etc.).

The development of an industrialized building system (IBS) is not new in the construction industry. The history of precast in UK housing dates from the middle 1900’s, when this and other forms of industrialized (prefabricated) construction were used to address the problem of widespread destruction of housing stock during the Second World War.

Today, many private companies in Malaysia have teamed up with foreign experts from Australia, Netherlands, United States and Japan to offer precast solutions to their projects. Numerous construction projects have utilized the precast components, especially to meet the requirement of time constraint and with high accuracy and quality. The precast components are mainly used in the construction of schools, colleges, quarters, apartments, hospitals, roads, port and other infrastructures.

The advantages of using Industrialized Building Systems (IBS) are:-

a) Reduction of unskilled workers
b) Reduce wastage
c) Increase in quality
d) Safer working environment in a construction site
e) Reduce construction period

1.1.4 Post-Tensioning in Construction

During the construction, the post tensioning which has been widely used in building superstructures, but has seen only limited applications in building substructures. There are many possible situations where post-tensioning can be used in building substructures to provide structural and economical benefits such as control of deflections, increased stiffness, improved crack control (higher cracking moment, fewer cracks smaller crack widths), reduced reinforcement congestion, continuity of reinforcement, efficient utilization of high strength steel and concrete, quick, efficient joining of precast elements, continuity between existing components and additions.

1.2 Problem Statement

Although IBS in one side have good quality for saving time in constructing buildings especially for tall buildings or normal buildings such as (schools , hospitals and industrial buildings) which is save more time during the period of construction of Projects. The effect of the post tensioned beam of columns is due to the demand for shorter construction periods and the desire for innovative designs that yield safe, economical and efficient structures. However, there is a lack of knowledge of the behavior and performance of precast segmental columns during earthquakes, and consequently their widespread use in seismic regions is yet to be realized. Also, only limited research has previously been carried out on the seismic response of precast concrete segmental IBS columns, the behavior of a precast segmental column under seismic loading differs fundamentally from that of a conventional reinforced concrete column.

The failure of a structure can occur from many types of situation. Most of these problems are unique to the type of structure or to the various industries. However, most can be traced to one of five main causes.

The first cause is, whether due to size, shape, or the choice of material, is that the structure is not strong and tough enough to support the load. If the structure or component is not strong enough, catastrophic failure can occur when the overstressed construction reaches a critical stress level. All of these individual variations of components that have been prefabricated in the factory need to be transported to construction site for final stage of erection. The connection and joint of the separated components have become the major problem during the construction as the speed and integrity of the structure is directly affected by the design and fabrication of the connection

The second causes are instability, whether due to geometry, design or material choice, causing the structure to fail from fatigue or corrosion. These types of failure often occur at stress points, such as squared corners or from bolt holes being too close to the material's edge, causing cracks to slowly form and then progress through cyclic loading. Failure general occurs when the cracks reach a critical length, causing breakage to happen suddenly under normal loading conditions.

The third types of failure are caused by manufacturing errors. This may be due to improper selection of materials, incorrect sizing, improper heat treating, failing to adhere to the design, or shoddy workmanship. These types of failure can occur at any time, and are usually unpredictable.

The fourth cause is due to the use of defective materials. The material may have been improperly manufactured, or may have been damaged from prior use.

The fifth cause of failure is from lack of consideration of unexpected problems. Vandalism, sabotage, and natural disasters can all overstress a structure to the point of failure. Improper training of those who use and maintain the construction can also overstress it, leading to potential failures

1.3 Objectives

In this study the main objectives of effect of post tension in IBS Columns are summarized in two points:

- To experiment in discovering the failure mechanism of columns in IBS post tension structures to enhance the performance of the system.
- To study the effect of column post-tensioned cycle on ductility of structure due to lateral cyclic loads.

1.4 Case Study

The study aim is to develop precast segmental post tensioned concrete columns for moderate seismic regions. This study will gives a clear understanding of the behavior and failure mechanisms of the new type of post tensioned precast concrete connection. The behavior of the connection includes load-displacement relationship, moment-rotation relationship and steel reinforcement stress–strain relationship. The proposed beam-to-column connection should withstand the lateral load in order to get the stability, strength and ductility of the frame. The result of this test will be beneficial in the development of unbounded post tensioned for building constructions. It enables frame to resist from lateral load in other words, to gain stability, and increase the rate of construction significantly. The scaled model test also saves the time and cost of the investigation.

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