RECOVERING THE DAMAGED INDUSTRIALISED BUILDING SYSTEM BEAM FLEXURAL STRENGTH FOR RE-USE

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

Faculty of Civil Engineering
University Technology Malaysia (UTM)

JANUARY 2014

To my beloved parents (father, mother), Dr.brothers and sisters, family, my boys Mohamad, Ali, Jafar, Ahmad, Fatimah, Noor who have been my Inspirations in whole my life.

ACKNOWLEDGEMENT

First, I would like to Sincerest thanks to Associate Professor Dr. Abdul Kadir Marsono for their patience and support for guide me in this research and taught me the concept of structures and theories.

Besides, I would like to thank to laboratory staff for their helping, they provided suitable area and equipment for doing experimental part in the laboratory of Civil-Engineering Faculty.

Finally, this thesis is dedicated to my father and mother who have given me the opportunity of an education from the best institutions and support throughout my life and *Dr.hadi, Dr.Sajed* my brothers ‘and my sister and my family who have always stood by me.

In addition, I could not be successful Without God's kindness. I thank Him for my health and my success in all of steps during these years

ABSTRACT

Industrialized Building System (IBS) is a construction method where components are manufactured in factory or on-situ in a controlled and monitored environment, transported and assembled with minimum workforce. This system is widely used in the worlds. Upgrading of reinforced concrete structures may be required for many different reasons. The concrete may have become structurally inadequate due to deterioration of materials, poor design, or construction, lack of maintenance, upgrading of design loads or accidental events such as earthquakes. Therefor in such conditions there are two possible solutions: replacement or retrofitting. Full structure replacement might have includes some disadvantages such as high costs for material, labor and in addition to more using time. This research details the experimental work of two case of reinforced concrete IBS beams (previously has been tested to failure) retrofitted by using external steel plate placed at the bottom soffit level of the beam, and the outer steel stirrup is covering the concrete to increase its stiffness and flexural strength have been tested under two point loading at three steps of loading. The objectives of this study were to investigate the behaviour of retrofitted beams experimentally, and be cord the mechanism of re-failure of retrofitted IBS beams in laboratory environment. The result shows that the beams recover its capacity by 60% of their original capacities.

ABSTRAK

Sistem Bangunan Berindustri (IBS) merupakan satu kaedah pembinaan dengan komponen diperbuat di kilang dalam persekitaran yang dikawal dan dipantau, diangkut dan dipasang dengan tenaga kerja yang minimum. Sistem ini telah digunakan secara meluas. Konkrit mungkin menjadi struktur yang leman kerana bahan, reka bentuk etenomi, kurangnya penyelenggaraan , peningkatan beban reka bentuk atau berlakunya perkara yang tidak dijangk, seperti gempa bumi . Pada keadaan igi terdapat dua penyelesaian yang mungkin dangan cara penggantian .atau pemulihan. Penggantian struktur sepenuhng, akan meudser kos yang tinggi bagi bahan, buruh dan masa . Kajian ini adalah kerja eksperimen dua konkrit bertetulang rasuk IBS yang telah diuji secara kegagalansepenulang semula dipasang dengan menggunakan plat keluli diletakkan di tampang bawah rasuk , dan keluli plat tipis vjian membalut konkrityang rosak untuk meningkatkan kekuatan lenturan telah diuji. di bawah dua titik pada tiga langkah pembebanan. Objektif kajian ini adalah untuk menyiasat kelakuan rasuk aiperkuat,dan pengeliaikan mekanisme kegagalan semula rasuk IBS rasuk dalam persekitaran makmal. Hasilnya menunjukkan bahawa rasuk boleh dipulihkan kapasitinya sebanyak 60 % daripada kapasiti asal .

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CHAPTER 1

INTRODUCTION

1.1 Background

The Industrialised Building System (IBS) is a construction system that is built using prefabricated components that are systematically done using dedicated machine, formworks and special jointing mechanism.

IBS offers benefits to the adopters in term of cost and time, attaining better construction quality and productivity, reducing risk related to occupational safety and health, alleviating issue on unskilled workers and dependency on manual foreign labour and achieving ultimate goal of reducing overall cost of construction (Taherkhani, 2006).

Industrialised Building System (IBS) has proven that it can contribute many advantages in construction project. The Industrialised Building System (IBS) can reduce the number of unskilled and foreign workers on site. Its presence can increase cost and wastage in construction industry. In addition, IBS can make the time period of construction progress become shorter and it can be finished before or on tithe. The quality of the structural works can be guaranteed because the size and the dimensions of the components had been specified through the design. The safe environment

platform can be provided to the workers since the site is clean from the mess of construction tools, prevent the congested environment that full with too many workers and prevent social problems among the workers (Hassim, 2009)

There are five commended types of IBS, precast concrete system , steel frame system , block work system , timber frame system , system formwork (Taherkhani, 2006) .

Reinforced concrete structures often are subject to change and improve the efficiency of their performance during her life in service. The main contributing factors are change in their use, new design standards, deterioration due to corrosion in the steel caused by exposure to an aggressive environment and accident at events such as earthquakes.

In such conditions there are two possible solutions: replacement or retrofitting. Full structure replacement might have carries some disadvantages such as high costs for material and labour, a bigger environmental impact and inconvenience due to interruption of the function of the structure. When possible, it is often better to repair or upgrade the structure by using retrofitting.

In this research an experimental investigations is carried out in two case of reinforced concrete IBS beams which previously has been tested to a complete failure. Each case consisting of two columns were in good condition with box steel plate for connection, and one beam with box steel plate in the ends to connect with the columns. Beams in each case where retrofit using external steel plate at the bottom soffit level of the beam and outer stirrup steel strap around the beam length to increase the strength capacity. This work is a study on the behaviour of retrofitted IBS beams that reloaded until the ultimate failure repeated.

1.2 Problem statement

In case of an earthquake in an area where constructions are composed of units IBS, it leads often to damage and destruction in buildings and leaving population from their homes. It's very necessary to rebuild these buildings as soon possible. The re-construction of damage buildings certainly required more cost time and effort for re-design of these units.

Among the solutions are in this study is the having an IBS components to re-create, restoration and retrofitting of damaged parts such as beams in the site without transported to the factory but partially disassembly or us disassembly at all. Repair is perform using inexpensive materials, available and requires less time and effort beside re-manufacturing and construction.

1.3 Objective of the Study

The objectives of this study are:

1. To identify the opportunity to reclaim IBS strength of severely damaged IBS beams.

2. To identify new strength mechanism repaired IBS beams.

3. To carry out a test to determine the mechanism of failure of repaired IBS beams in laboratory environment.

1.4 Case Study

The case study is a full scaled to rally damaged IBS beams. The beam is repaired to regain flexural and shear strength parameters that affecting the ultimate strength of the retrofitted IBS beams.

1.5 Scope of Study

The scopes of study are the evaluation of

1. Mechanism of failure in cladding flexural and shear

2. Re strengthening instrumentation to restore original strength.

1.6 Significance of study

The study is to propose a better alternative for re-use the damage IBS building due to events such as earthquake risk minimal tooling on sites

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