EARTHQUAKE ANALYSIS OF IBS DOUBLE STOREY HOUSING

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UNIVERSITI TEKNOLOGI MALAYSIA

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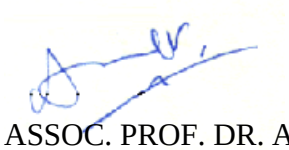

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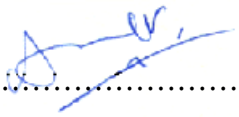
Signature : 

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EARTHQUAKE ANALYSIS OF IBS FOR DOUBLE STOREY HOUSING

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

Faculty of Civil Engineering
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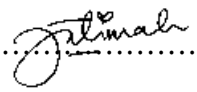
Signature : ……  ……....

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To my beloved.....

Father (Marwar Abd Kadir), Mother (Jasminah Hasim), Sister and Brothers (Nur Ain, Mohd Ashadi & Muhammad Amilin), Friends & Wan Muhammad Azrul Hezmi

Thank you for all loves, cares and supports....

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ABSTRACT

Industrialised Building System (IBS) application is being develop in Malaysia construction industry. This open building system is proposed as an alternative construction method to replace the conventional construction method and close building system (precast). The objective of upgrading the existing construction method is to produce more effective and standard construction as the IBS inherent its parent designed behaviour. These days, there is limited information of the IBS performance due to dynamic load as IBS is just being analyzed using static and conventional analysis. A study is carried out in order to determine the effectiveness of IBS due to seismic region. A model of IBS and conventional double storey housing are chosen and analyzed using static and earthquake analysis. The internal forces and deflection obtained from all analyses was compared and the performance and effectiveness of the systems was determined.

ABSTRAK

Penggunaan Sistem Pembinaan Berindustri (IBS) semakin meningkat dalam industri pembinaan di Malaysia. Sistem pembinaan terbuka ini disyorkan sebagai kaedah pembinaan alternatif bagi menggantikan kaedah pembinaan konvensional and sistem pembinaan tertutup (pratuang). Objektif menaik taraf kaedah pembinaan sedia ada adalah untuk menghasilkan pembinaan yang lebih efektif dan teratur kerana IBS berperanan mengikut rekabentuk yang telah ditentukan. Ketika ini, maklumat berkaitan kebolehan IBS terhadap beban dinamik adalah terhad kerana IBS hanya dianalisis menggunakan analisis statik dan konvensional. Kajian ini dijalankan bertujuan untuk mengenalpasti keberkesanan penggunaan IBS di rantau yang mengalami gempa bumi. Satu model rumah dua tingkat yang dibina menggunakan kaedah IBS dan kaedah konvensional telah dipilih dan dinalisis menggunakan analisis statik dan analisis gempa bumi. Daya dalaman dan pesongan yang diperolehi menerusi analisis-analisis yang dijalankan telah dibandingkan dan kebolehan serta keberkesanan sistem pembinaan yang dipilih dapat diketahui. Selain itu, kemerosotan kekukuhan dan penyebaran kerosakan bagi kedua-dua sistem pembinaan turut dikenalpasti.

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LIST OF SYMBOLS

u	-	Joint deformation
μ	-	Joint ductility
E_H	-	Hysteretic energy capacity of the system
ß	-	Dimensionless constant
K	-	Initial slope of the base shear-top deflection relationship
f_{cu}	-	Characteristic strength of concrete
f_y	-	Characteristic strength of steel
E_c	-	Elastic modulus of concrete
E_s	-	Elastic modulus of steel
$?_c$	-	Poisson's ration of concrete
$?_s$	-	Poisson's ration of steel

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Vision 2020 calls for the formation of a Malaysian society that is fully developed in all dimensions aspects of life. The aim is to create a united Malaysia nation with a confident society with strong moral and ethical values, living in a society that is democratic, liberal, tolerant in nature, economically progressive and socially cohesive. In order to ensure that all Malaysian to have better quality of life, the Malaysia Government has produces The National Housing Policy. The objective of this policy is to ensure that all Malaysians, particularly the low income groups to have access to adequate and affordable shelter and related facilities. The national housing policy is emphasized through housing program and strategies outlined in the country's development plan.

As Malaysia being develop, the high economic growth has created a high demand for construction activities especially for housing industry in Malaysia. Malaysia has been facing rapid urbanization and population growth. Towns and cities have

become more congested with rural migrants as well as natural population growth. Beside that, some parts of historic colonial cities like Georgetown, Kuala Lumpur and Melaka have started to decay with facilities which are old and inadequate to cope with the growing population. Due to these problems, the government would like to emphasis on the supply of affordable homes through the construction of low and medium cost houses.

For the new millennium, those involve in housing industry face the challenges of how to produce affordable and high quality housing in shortest time so that residents can enjoy a higher standard of living in line with the nation's progress. Housing industry needs to cater to customer's needs. A challenge for the housing industry is how to adopt modern construction technology and management to cater for customization without sacrificing economies of scale.

The objective of the Seventh Malaysia Plan is to provide accessibility to the low income group to affordable and quality housing. In order to achieve better housing delivery and better quality housing, the housing construction process need to be changed because the present construction process is too slow. IBS close building system has been introduced in Malaysia since 1960’s to replace the conventional construction method. Due to some criteria that were not suitable for local culture, the technique did not take off as planned. However, with some adjustment of foreign building systems, the local precast application increased and widely used for housing projects, school, commercial building and infrastructure.

Today, Malaysia is in its way towards fully industrialized construction sector. The close building system’s components are non-standard prefabricated products. Meanwhile, the dimensional coordination of the building components with the design is paramount importance. The full benefit of industrialization is impossible without standardization, and the standardization is not effective without the dimensional

coordination. In order to develop coordination in the Malaysia's construction industry, the open building system can be applied. The idea of introducing the open building system with modular co-ordination was introduced in the 1980s. Since the Government interest's is to implement fully open building system in the year 2010, IBS Roadmap 2003-2010 has been introduced.

The Prime Minister, YAB Dato' Seri Abdullah Hj Ahmad Badawi in 2005 Budget Speech said that the government has intention to provide another 100 thousands units of affordable houses and it will be constructed using IBS. This method can ensure a high quality construction, cost effective, produce safer and cleaner work environment and to decrease the depending to the foreign manpower. In order to encourage the usage of IBS, the percentage of construction project that used IBS will be increased from 30 to 50% starting 2005. Besides, that, the developer that used more than 50% of IBS components will be fully exempt from CIDB's levy.

1.2 Problem Statement

House renovation can be considered as part of Malaysian culture. It can be translated as buyers' wish to participate in designing their houses. Such renovation raises the question how to adequately address the need by developing adaptable house designs within a systematic construction schedules. By using open building system, the renovation is possible to be done. Open building system makes housing construction system more flexible and replacement of parts less troublesome.

However, at present, there are obstacles for the introduction of this new technology. There are lacks of knowledge of IBS, product manufacturing and marketing and also funding. This tends to discourage anyone from introducing new technologies. Besides that, in Malaysia construction industry, the design engineer just considering the effect of dead and live load acting towards the building. In some cases especially for high rise building, wind load is considered in calculating the design load. However, they are neglecting other kinds of loads such as the environmental load, extreme load, static load and dynamic load.

Malaysia is located near to the Pacific Ring of Fire. It is known as a zone of frequent earthquakes and volcanic eruptions encircling the Pacific Ocean. In a 40,000 km horseshoe shape, it is associated with a nearly continuous series of oceanic trenches, island arcs, and volcanic mountain ranges and plate movements. Most of the world's largest earthquakes occur along the Ring of Fire. Due to the short distance to the Pacific Ring of Fire region, Malaysia experienced some vibration and tremor due the earthquake especially when it occurs in Sumatra Island, Indonesia.

Earthquake is a phenomenon that results from the sudden release of stored energy in the earth's crust that creates seismic waves. The seismic waves can cause dynamic load towards building in Malaysia. The main impacts of earthwork are shaking and ground rupture. It can result in more or less severe damage to buildings or other rigid structures. The severity of the local effects depends on the complex combination of the earthquake magnitude, the distance from epicenter, and the local geological and geomorphologic conditions of the location. Earthquakes can also cause landslides and avalanches, which may cause damage in hilly and mountainous areas. In several cases, earthquake can cause tsunamis that may lead to loss of life and destruction of property.

Due to the impact that created from the earthquake, the dynamic load produce from earthquake should be considered in the structural design process. It should produce stronger and more durable building. By doing more accurate analysis, it can also minimize the loss of life, general property damage, road and bridge damage, and collapse of buildings or destabilization of the base of buildings which may lead to collapse in future earthquakes.

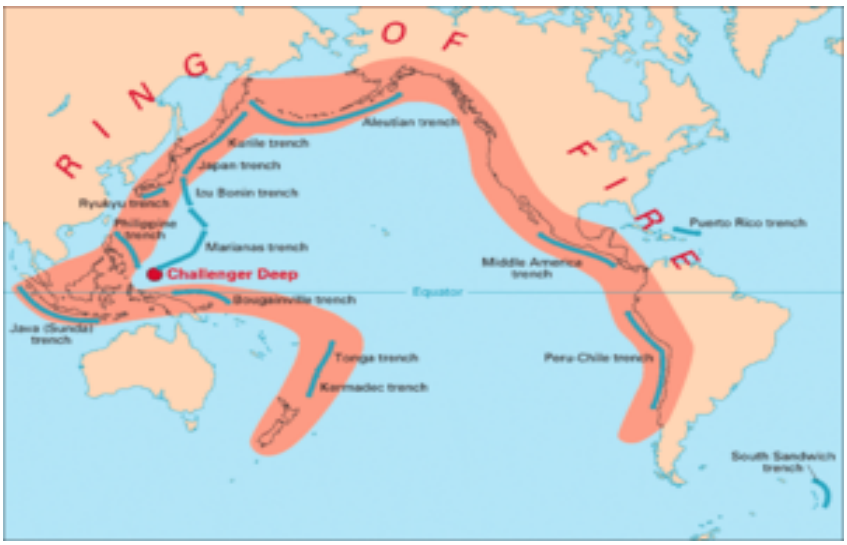

Figure 1.1: The Pacific Ring of Fire

1.3 Objectives of Study

The objectives of this study are as follows:

1. To perform static analysis and design check of conventional and IBS double storey building.
2. To perform seismic analysis and design check of conventional and IBS double storey building.
3. To evaluate both output using damage index analysis.

1.4 Scope of Study

The scope of this study is focused on the housing building. The type of housing building chosen is double storey house that is built using the IBS. The analysis consist conventional method with and without the damage index / reliability index. All analysis will be carried out using computer software, Multiframe 4D.

1.5 Expected Findings

There some expected findings that may be drawn from this study. At the end of this study, the internal forces and deflections of conventional and IBS double storey housing structural member can be determine. Both internal forces and deflections can be checked using static and earthquake analysis. Besides that, the ability of IBS in reducing the earthquake damage can be obtained using damage index assessment due to the joint behavior. It is also expected that this study can proof the damage index for IBS construction method is better than the conventional construction method.

CHAPTER 2

LITERATURE REVIEW

2.1 Industrialized Building Systems

The typical construction method can be classified due to several criteria. It is categorized according to the fabrication of the components, the construction activities involve during the construction, etc. Considering the main criteria, there are two major categories of construction method. The construction method can be categorized as conventional method and non-conventional method as shown in Figure2.1. Based on the type of construction method, all types of IBS are categorized under the non-conventional category (Badir and Razali 1998).

Industrialized Building Systems (IBS) may be defined as incorporating a total integration of all subsystems and components into an overall process; one fully utilizing industrialized production, transportation and assembly techniques. This integration is achieved through the exploitation of the underlying organizational principles (Albert G.H Dietz, 1970).

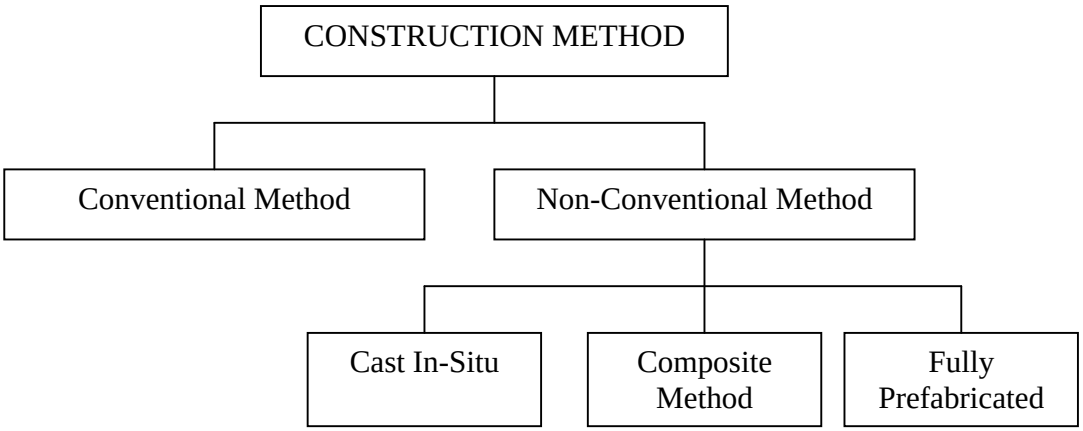

Figure 2.1: Types of construction method

While according to Zuhairi A.H and M. Sarshar (2003), IBS is a construction process that utilizes techniques, products, components or building system, which involve prefabricated components and on-site installation.

2.1.1 Fully Prefabricated Construction Method

One of the non-conventional IBS construction methods is fully prefabricated construction method. It is widely used in the construction industry. According to Badir and Razali (1998), the fully prefabricated construction method can be either on-site or off-site prefabricated.

For on-site prefabricated the building components at or near the construction site. Once the column in place, other components will be assemble using jacking equipment. On-site precasting method has some advantages. It is more economic in terms of the

transportation cost of the component and it is organizationally the most satisfactory method.

Meanwhile, for the off-site prefabricated or precasting, some or all components of the building are casting or preparing away at the factory. Then, it will be transported to the construction site. Due to the quality controlled, the prefabricated components will have better quality, easy to attain and it can transfer in economically large loads to the construction site.

The fully prefabricated construction method consist four types of IBS. Those types are precast concrete, sandwich panel, load-bearing block, and steel frame (Figure 2.2)

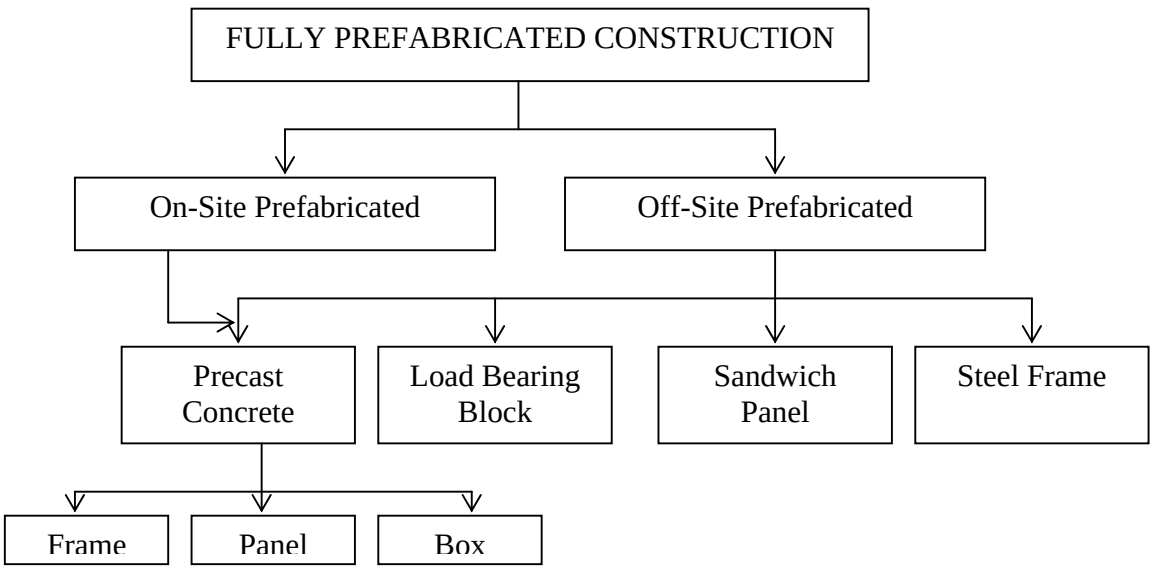

Figure 2.2: Classification of fully prefabricated construction method

The close building system is commonly used precast concrete as the structural elements. A precast concrete component can be defined as a component cast in a formwork in a position other than the place it will finally occupy in the completed structure. Once the components is hardened and matured, it will be removed from the forms. Then, it will be place and fix in position. There are various precast concrete building systems used throughout the world. Precast concrete can be classified into three major groups (Majzub, 1977). It might be frame system, panel system, and box system. These three groups can be constructed either on- or off-site.

2.1.2 Advantages and Disadvantages of Industrialized Building Systems

By using IBS, the manufacturer can provide quality controlled end products through the controlled prefabrication process. The IBS required simple on-site installations. Besides that, it can provide faster completion of construction. It is because IBS using the standardized prefabricated components. Another benefit of IBS is it will produce neater, cleaner and safer sites. By using the prefabricated components, it will reduce the construction debris, site workers and materials involved on the construction site. It is also a cost saving construction method.

Besides that IBS also have the flexibility of design. It can provide some additional aesthetic value to the project design. But at the same time, produce a good quality building. The IBS construction method required less use of heavy equipment during the construction. The heavy equipment is just needed for the erection purpose.