ANALYSIS OF INDUSTRIALIZED BUILDING SYSTEM BLOCK WORK WITH ETABS

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To my beloved ***Father and Mother*** *for their endless love and support*

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ABSTRACT

Recently the application of IBS components in construction of many civil engineering projects is accelerating due to its simplicity for fabrication and saving in cost and time of construction process. This study is a software analysis of wall block work where the wall is non-load bearing infill. Hence, the concrete used in block works is normal weight concrete. The wall investigated here can be used as infill for structures up to 10 stories or 35 meter height. ETABS nonlinear version 9.1.4 is utilized, in order to model and analyze to investigate the behaviour of the system of block works under applied vertical loads. The loads applied are two vertical loads of 420 KN which are placed in 1 meter from each face of the columns. The models have been tested in full scale in the laboratory by other researcher in Faculty of Civil Engineering. After analyzing the system, the results obtained are shown in proportional sketches. It includes the study of the stresses, deflection, mechanisms of failure and deformation shapes of assembling multiple frame cut-off components that suit industrial dimension to be fitted for industrialize building system.

ABSTRAK

Baru-baru ini, aplikasi komponen IBS dalam pembinaan awam semakin bertambah kerana kemudahan fabrikasi, penjimatan kos dan tempoh pembinaan. Kajian ini merupakan satu analysis perisian kerja blok dinding di mana dinding adalah pengisi tanpa-beban. Oleh itu, konkrit yang digunakan adalah konkrit yang sederhana. Dinding yang dikaji boleh digunakan sebagai pengisi untuk struktur setinggi 10 tingkat atau ketinggian 35 meter. ETABS tak linear versi 9.1.4 telah digunakan bagi menganalisis system ini dengan kenaan-beban-menegak. Beban yang dikena adalah dua beban 420 KN menegak diletakkan satu meter dari setiap muka lajur. Model ini telah diuji secara scala penuh di dalam makmal kejuruteraan awam. Selepas menganalisis system, keputusan yang diperolehi ditunjukkan dalam lakaran berkadar yang meliputi tekanan, pesongan, mekanisme kegagalan. Yang memenuhi keperluan industrialisasi sistem bangunan.

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IBS	Industrialized Building System
ETABS	Extended 3D Analysis of Building Systems
PVC	Polyvinyl Chloride
f_{cu}	Characteristic strength of concrete
E_c	Elastic modulus of concrete
f_{cy}	Characteristic strength of steel
E_s	Elastic modulus of steel reinforcement
M	Moment
V	Shear force
v_c	Poisson`s ratio of concrete
v_s	Poisson`s ratio of steel
θ	Bar diameter
%	Percent

CHAPTER 1

INTRODUCTION

1.1 Introduction

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of geometrical nonlinear behaviors, making it the tool of choice for structural engineers in the building industry *(Computers and structures Inc. 2003).*

The accuracy of analytical modeling of complex Wall Systems has always been of concern to the Structural Engineer. The computer models of these systems are usually idealized as line elements instead of continuum elements. Single walls are modeled as cantilevers and walls with openings are modeled as pier and spandrel systems. For simple systems, where lines of stiffness can be defined, these models can give a reasonable result. However, it has always been recognized that a continuum

model based upon the finite element method is more appropriate and desirable. Nevertheless this option has been impractical for the Structural Engineer to use in practice primarily because such models have traditionally been costly to create, but more importantly, they do not produce information that is directly useable by the Structural Engineer. However, new developments in ETABS using object based modeling of simple and complex wall systems, in an integrated single interface environment, has made it very practical for Structural Engineers to use finite element models routinely in their practice *(Ashraf Habibullah, 2002).*

Wall is a vertical load-bearing member whose length exceeds four times its thickness. Un-braced wall is designed to carry lateral loads (horizontal loads) in addition to vertical loads. Braced wall does not carry any lateral loads (horizontal loads). All horizontal loads are carried by principal structural bracings or lateral supports. Reinforced wall contains at least the minimum quantities for reinforcement. Plain walls contain either no reinforcement or less than the minimum quantity of reinforcement.

The wall which is investigated in this research is consisting of several separated blocks which are placed in such a way that they form an infill wall for IBS construction. Recently the application of precast components in construction of many structures is accelerating due to its simplicity for fabrication and saving in time and labor force of many construction projects.

IBS is a construction technique where components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works *(CIDB, 2003).*

IBS is the new way forward in the construction industry. In 2012, the Malaysian government mandated that any governmental project should comprise of 70% IBS components *(Kamarul Anuar Mohamad Kamar, Ir. Dr. Zuhairi Abd. Hamid, Mohd Khairolden Ghani and Ahmad Hazim Rahim, 2007).*

Precast frame which is made by combining beam and column is not new, but block work system research must be check to ensure the safety and reliability of the system before put into use for industrialize housing *(Sharifah Faeza Binti Syed Abdul Rahim, 2012).* Hence, many research centres and universities turned to contribute to this new born science field and consequently a thorough analyzing with ETABS is also necessary.

Figure1.1: Bukit Jalil Sport Complex

1.2 Problem Statement

An early effort by the government of Malaysia to promote usage of Industrialized Building System (IBS) and develop an Open Building System (OBS) concept as an alternative to conventional and labor intensive construction method has yet to make headway.

Although members of the industry are open to the idea, a major portion of the industry stakeholders are indifferent, perhaps due to resistance towards change, insufficient information and lack of technology transfer method to support feasibility of change to IBS. In this case, it has proven that it is difficult to introduce new technologies and method in the construction sector when compared to other sectors. According to *Hervas et. al (2007)* construction sector is known as a traditional sector that can be characterized as reluctant and even resistant to change.

For the purpose of overcoming on this problem and simplifying and increasing the application of IBS components in industry field, many research already has been done in all around the world including analysis of IBS components with several computer softwares namely ABAQUS, LUSAS, Multi frame etc. But ETABS analysis is overlooked; although it has many advantages in comparison with other civil engineering softwares such as lower cost to create and also producing more usable information for structural engineer, which makes it merit for widely use in this era. Therefore the necessity of using this sleek software to analyze the components and to contribute to previous research trend is highly recommended or rather say inevitable.

1.3 Objectives of study

The objectives of the study are:

- An investigation of the mechanism of failure of IBS block work wall in laboratory and using software ETABS modeling to build a model to validate its mechanism of failure.
- To compare the results of modeling with actual laboratory test.

1.4 Scope of study

The scope of the study are to carry out an ETABS software analysis on IBS wall block work components and investigate the mechanism of failure due to applied external vertical loads. Stresses induced from early mentioned loads that will stream in components, resulting in crack and spalling of the whole system. The scope is to include the behavior and strength, deflection and pattern of failure of the models.

1.5 Expected Finding

The expected findings from the research are to expand and contribute to the knowledge about deflection and stresses of an IBS wall block work component system with aid of ETABS computer software. At the end of this study, the failure behavior,

deflections, modes of failure and stresses of new IBS wall infill components will be illustrated. The failure behavior and deflection obtained from the analyses was investigated for performance and effectiveness of the components to comply with Codes of Practices.

1.6 Significance of Study

Various construction techniques have been utilized in construction industry with regard to the analytical analysis parts. However, among all those methods, Industrialized Building System (IBS) is the most popular and efficient system that becomes the priority choice of the clients due to a certain advantages on the environment and economy. Thus, a more advanced and economic system like the use of precast components will be extremely essential for this country to move fast forward to a successful developed country.

Due to some shortcomings of IBS system, it is important to improve productivity and quality of IBS. Therefore, this research is precious in improving the quality of IBS structure in order to promote this technology and increase the level of confidence among the society. On the other hand, this study will implement new way of construction of Industrialize Building System that resembled an interlocking building block work system.

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