POST-TENSION COLUMN FOR IBS BLOCKWORK BUILDING SYSTEM

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I dedicate this piece of my hard work to the person that I love most.

Especially My Mother and Father

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ABSTRACT

Industrialized Building System (IBS) is now a common remark in construction industry. The used of this system have grown rapidly around develop country including Malaysia. This research is mainly focused on the interlocking blockwork system for the residential building house. The concrete blocks were assembled by stacking up and jointed together, by the bolt only without the interlocking void in the blocks. The assembly of beam and column are by bolts only. This study focuses on the pretension bolt at the column only. The stress value at the bolt is needed in order to apply pretension or preloading to the bolt. The purpose of this study is to investigate the behaviour of the frame structure of the blockwork system under point loads in both experimental which is constructed in the laboratory and analysis of the structure modeled in finite element analysis software (Abaqus/CAE). The behaviour of the structure observed during the testing was merely the pattern of the crack occurred when the frame is loaded. Based on the analysis that has been performed, the residual stress in the bolt is determined and the actual pretension bolt value in the column is calculated which gives 0.251 kN, while the torque that need to be applied at the nut is 0.102 kNmm.

ABSTRAK

Sistem Bangunan Perindustrian (IBS) kini merupakan perkataan yang tidak asing lagi dalam industri pembinaan. Penggunaan sistem ini telah berkembang dengan pesat di seluruh negara membangun termasuk Malaysia. Kajian ini lebih tertumpu pada sistem blok konkrit saling mengunci untuk bangunan rumah kediaman. Blok konkrit ini telah dipasang dengan meletakkan dan menysusun secara bertingkat melalui bolt tanpa ruang kosong saling mengunci di dalam blok konkrit. Pemasangan tiang dan rasuk adalah melalui bolt sahaja. Kajian ini hanya memfokuskan bolt prategangan pada tiang sahaja. Nilai tegasan pada bolt adalah perlu supaya prategangan boleh diaplikasikan pada bolt tersebut. Tujuan kajian ini adalah untuk menyiasat tingkah laku struktur kerangka sistem blok konkrit di bawah beban tumpu pada kedua-dua eksperimen yang dibina di makmal dan analisis dari perisian unsur terhingga (Abaqus/CAE). Kelakuan struktur yang diperhatikan semasa ujian yang dilakukan adalah semata-mata corak retak yang berlaku apabila beban diletakkan. Berdasarkan analisis yang telah dijalankan, tegasan baki dalam bolt telah ditentukan dan nilai sebenar prategangan bolt dalam tiang adalah 0.251 kN, manakala tork yang perlu diaplikasikan pada nat adalah 0.102 kNm.

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F_p		Preload force
f_{ub}	-	Ultimate tensile strength of the bolt
A_s	-	Tensile stess area
T	-	Torque
p	-	Pitch diameter
μ_t	-	Coefficient of friction between nut and bolt threads
r_t	-	Effective of contact radius of the threads
β	-	Half angle of the threads
μ_n		coefficient of friction between the face of the nut and the upper surface of the joint
r_n	-	Effective radius of contact between the nut and joint surface
fcu		Design compressive strength of concrete

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CHAPTER 1

INTRODUCTION

1.1 Background

The Government intends to provide an adequate supply of affordable houses especially for the low income. For this, 78,000 affordable houses will be built during the plan period. Related laws will also be tightened and enforcement enhanced to ensure the quality of affordable houses built (Tenth Malaysia Plan 2011-2015). Low to medium cost housing in Malaysia has been demanded to be develop. Construction materials such as timber, steel and cement have become costly for a large scale project and due to that reason, contractors are not eager to construct these houses with a firm and constraint construction budget.

Alternatively, industrialized building system (IBS) has to be implemented due to many benefits. The government also has promoted and encourages the construction industry to use IBS for their projects. Adopting IBS will reduce completion time of construction, cut cost in terms of manpower and quality of affordable houses can be control hence, projects will be completed faster in projected schedule.

A generic classification for IBS can be derived as the followings (Mohd Kamar *et al*. 2011):

1) Frame System (pre-cast or steel)
2) Panellised System
3) Onsite fabrication
4) Sub-assembly and components
5) Block work System
6) Hybrid System
7) Volumetric and Modular System

The classification is based on current Construction Industry Development Board’s (CIDB’s) IBS classification well known in Malaysia with an important addition of hybrid and volumetric and modular system.

Block work system is the idea to implement the low cost housing. The blocks will be fabricated in the factory with the standardize dimension and materials used. These blocks then transported to the construction site and ready to be installed in a short time. The construction method of using conventional bricks has been revolutionized by the development and usage of interlocking concrete masonry units (CMU) and lightweight concrete blocks. The tedious and time –consuming traditional brick-laying tasks are greatly simplified by the usage of these effective alternative solutions (Mohamed Ali. N *et al* 2009).

1.2 Problem Statement

Blockwork has considerable economic advantages over brickwork in respect of speed of construction in such example; the lightweight blocks can be lifted in one hand. Concrete blocks can be defined as solid, cellular or hollow. They are manufactured to various workface dimensions in an extensive range of thickness, offering a wide choice of load-bearing capacity and level of insulation (Lyons, A. 2008). The main idea in blockwork system is to build up houses from interlocking blocks. The interlocking blocks are different from conventional brick; they do not require masonry (mortar) layer during bricklaying work. They are very dependent on the interlocking bond between the blocks. Structure element such as column, beam and wall are totally using interlocking blocks except for the roof and others. However, to maintain the stability of the structure also need the clamping system.

1.3 Objective of the Study

i. To test the frame structure constructed by blockworks system using concrete grade 30 blocks to seek its behavior upon loading vertically

ii. To model the frame structure constructed by blockworks system using software Finite Element Analysis, ABAQUS/CAE

iii. To verify the response of the frame structure in laboratory with the model in ABAQUS/CAE

iv. To determine the preloading bolt value for the column

1.4 Scope of the Study

Structures in general can be strengthened and stabilize under load by using different mechanism such as direct reinforcement, pre-stressed reinforcement, post-tensioning, interlocking and etc. In post-tension structures, the tension is only applied after the beam or structure had been produced. The load is applied to the tendons inside the structure via bolts and nuts arrangement. Thus, the resulting stress in the structure depends on the level of torque being applied to the nuts. The concept of post-tensioning are applied in this research. The concrete blocks were assembled by stacking up and jointed together, and then the bolt will keep them bonded by tightening the nut. The installation of the bolt is at the column and beam. This study only considers the pretension bolt at the column only. The stresses values at the bolt are needed in order to apply pretension or preloading bolt. The frame structure will be analyzed by Finite Element Analysis (FEA) software.

1.5 Importance of the Study

This study is aimed to determine the survivability (robustness) of models. It also checks its ability to resist extreme loadings events and to produce the most effective and feasible interlocking blocks that to be standardized in design and construction. In addition, this will give benefits in a sense of faster completion of construction, reduce cost and manpower in a large scale project. This study is to give benefits for both contractor and client as this study is to develop and upgrade our construction industry towards the standard of IBS in Malaysia and to provide a secure, modifiable and affordable house.

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