NON-LINEAR TEST OF PRECAST SUBFRAME SUBJECTED TO CYCLIC LATERAL LOADINGS

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Specially dedicated to my beloved family and friends

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ABSTRACT

The demand for new building has been increased significantly, which can sustain loads whether lateral loads as well as gravity load. So far concrete has proven its reliability on most of structural system but it has a big drawback which is the slow construction rate. To eliminate this issue precast concrete has been introduced to the construction since it is prefabricated in the factory and then transferred to the construction site for assembly. The use of precast concrete systems offers several advantages such as speedy assembly, higher quality, lower project cost, better sustain, and enhanced occupational health and safety. The major concern in the precast concrete system is the rigidity of connections or joints. In this research a laboratory test was carried out on a precast concrete frame with post-tension joints (scaled prototype 1:5) which have been subjected to lateral cyclic loading. The beam-to-column connected to each other by threaded rod and nuts. The investigation is to find out the natural frequency of the frame before the testing and after each cyclic loading, maximum sway of the frame to check the lateral stability and ductility. The precast system was found to be more ductile than the conventional subframe and the test yield all the characteristic of system failure at ultimate limit state of cyclic loadings.

ABSTRAK

Permintaan untuk bangunan baru telah meningkat dengan ketara terutama, yang boleh menampung beban sisi dan juga beban graviti. Jadi konkrit ini telah membuktikan keupayaan nya pada kebanyakan sistem struktur tetapi ia mempunyai kelemahan yang besar ia itu kadar pembinaan yang perlahan. Sebagai penyelesaian, konkrit pratuang isu telah diperkenalkan ke dalam pembinean dengan ia dibuat di kilang dan kemudian dipindahkan ke tapak pembinaan untuk pemasangan. Penggunaan sistem konkrit pratuang menawarkan beberapa kelebihan seperti pemasangan cepat , kualiti yang lebih tinggi, kos projek yang lebih rendah, dan dipertingkatkan keselamatan dan kesihatan pekerjaan . Kebimbangan utama dalam sistem konkrit pratuang adalah ketegaran sambungan atau sendi. Dalam kajian ini ujian makmal telah dijalankan pada rangka konkrit pratuang sendi (prototaip berskala 1:5) pada beban sisi muatan berulang. Rasuk disanag dengan sekeru dan nat. kajian itu adalah untuk mengetahui frekuensi semula jadi bingkai sebelum ujian dan selepas setiap beban beralang, untuk mencari kestabilan sisi dan kemuluran. Hasil kajuan menhapati behawa ketangka adalah lebih mulur dari struktur kerangkr biasa dan ciri-ciri kagagalan juge telah diperolehi dari beban berulang di makmal.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1. Introduction

It has been proven that the concrete is strong in compression but weak in tension. In order to improve its strength, steel reinforcement has been introduced to the concrete and called reinforced concrete.

Prefab which is also known as prefabricated concrete is a concrete which is cast in the mould inside the manufacturing plant that located away from the construction site. Concrete is cured in a controlled environment and then transport to the construction site for assembly.

This controlled environment will give the manufacturing precision and proper curing monitored by the plant employee. This is one of the advantages of precast concrete over the cast in-situ concrete.

1.1.1 Background

Precast concrete has been used since Ancient Roman civilization to build buildings. They used it to build their complex network of buildings, canals, drains and tunnels. After Second World War especially in Europe there was a huge demand for new buildings for reconstruction purposes. Economic and social development caused the demand and a large number of buildings in the 80`s. During this reconstruction and development period, an important portion of industrial building was invented by using the precast system due to the advantage of its fabrication and speed of assembly.

Precast panelled building were developed in Liverpool England in 1905. The method was designed by city engineer John Alexandra Brodie. Later on the idea was adopted all over the world especially Eastern Europe and Scandinavia.

1.1.2 Application of precast concrete construction

Precast concrete has a wide range of application in civil engineering where is not limited to building industries only. It is also used in agricultural industry, transportation and traffic and railway industry, sanitary and water treatment plant.

Precast concrete can be used in most of industries as it can withstand in most extreme weather conditions and still durable after decade of use for structural members like foundations, beams, column, floors, shear walls, retaining walls or non-structural members like fireplace mantels, curtain walls, barriers, accropode, manhole and pedestrian furniture.

1.1.3 Advantages of the precast construction

The advantages of the precast concrete are

- It has good quality control since it is manufactured in the controlled manufacturing plant.
- Curing can be accelerated by heating the precast part in a steam room and it increases strength significantly and also reduce the time between casting of the components.
- Precast will be extremely durable as the control process start from materials selection to curing of concrete.
- Pre-stressed precast concrete reduces the size and number of structural members due its strength.
- In construction site, the construction process is rapid since it can be installed immediately assembly upon arrival of component in bulk.
- It can be assembled on any weather condition.

1.1.4 Disadvantages of the precast construction

The disadvantages of precast concrete are:

- The weight of precast members as the lifting cranes are required consistently on assembly area.
- The connection between the members of precast may be difficult assemble and fabricated.
- Precast has limitation in architectural layout and dimension as it have the fixed shape and size.
- The margin of errors is very small since incorrect dimension of precast may result into the change of entire layout not as designed.

- Precast panel cannot be used for two-way structural system as the size of the panel is limited.
- Skilled workers are required for manufacturing and assembly.

1.2 Statement of problem

There are several questions that need to be solved in order to complete the verification of the system and they are:

- The propose shape and design of precast beam and column is relatively new on precast system. It must have a sufficient strength vertically and laterally to subside the earthquakes.
- The post-tensioning effect the discontinuity in the whole system strength.
- The strength and ductility need to be sufficient to implement the system in constructions for long service life.

1.3 Objective

The objectives of this study are listed as below:

- To conduct a laboratory test to find out the real behavior and performance of the column to beam connection of the post-tension precast connected concrete subframe.
- To find the natural frequency of the frame before and after the damage of the model at several cycles of lateral loads.
- To obtain the ductility of the frame due to lateral cyclic load.

1.4 Scope of Study

The scopes of this study are listed as follows:

- The laboratory test on the precast beam-to-column frame model of reduce scale 1:5 are carried out in the laboratory with reference to BS8110:1985.
- The main span size of beam of this frame is 1600mm × 60mm × 120mm with two sides cantilever size of 400mm × 60mm × 80mm, the size of the column is 80mm × 80mm × 600mm and stump is 80mm × 80mm × 250mm (Figure 1.1).
- The frame is subjected to lateral cyclic lateral loads to find the load-displacement relationship, moment-rotation relationship and shape of the deformation.
- The grade of steel is S275 ($p_y = 275$) and grade of concrete is 50($f_{cu} = 50$)
- The analysis of ductility and natural frequency only.

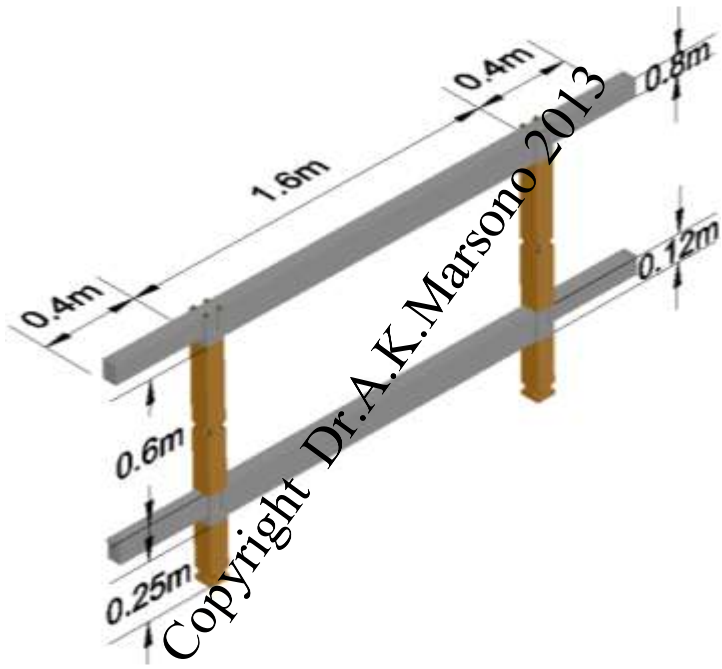

Figure 1.1 Post-tension connected of the precast frame

1.5 Importance of Study

This study gives a clear understanding of the behavior and failure mechanisms of the new post-tensioned precast concrete connection. The behavior of the connection includes load-displacement relationship, moment-rotation relationship, stress distribution and shape of the deformation. 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 precast structures. It enables frame to resist from lateral load in other words to gain stability, increase the rate of construction significantly. The scaled model test saves the time and cost of the investigation.

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