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Investigation Of Successive Design Form Of Precast Beam For Cost Effective Buildings

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ABSTRACT :- It should not be puzzling to have 55% of the Indian population lack proper housing facilities, there is a great need to develop lower cost housing at a much faster rate so that people wouldn't have to stay in unsafe houses. This project looks at different methods of low cost housing and some case studies relating to it. This study is also an endeavour to investigate structurally safe and economical forms of precast beam. Hence a new plane truss forms of precast beam is investigated and compared to the practicing space truss form of precast beam. The new model, though it has relatively shorter length of span for the similar sizes of bar, it is found reducing the cost by around 25% and mass (weight) of the beam by 33% for relatively similar span lengths. This type beam can be be used in many different types of structures, the precast fabrication allows us to reduce production costs and the ease and swiftness of installation reduces labour and time associated costs. The aim here is to develop the precast concrete beam that would reduce the cost and time in producing low cost affordable housing for all.

Key word: Puzzling, Lower cost, Precast beam

I INTRODUCTION

It's estimated that 40% of the urban dwellers are living in dilapidated area where proper public facilities like access to potable water, electric power supply and emergency access etc are not properly available. This compelled the government to enhance the construction of residential apartments in slum area in different cities of the country. Since construction projects demand higher investment, it's usually difficult to curb the problem with limited resources. Still many endeavours have yet been made to introduce relatively low cost design so that to build as many houses as possible. The LCH-MH[10], which is claimed to be cost saving from the total project cost of comparable conventional building type, has put forward six integrative approaches to come up with relatively low cost houses, these are:

- Construction management consultancy system Phased construction system
- Modular or grid design system
- Specialized(labour based) construction system
- Manufacturing and assembling construction system Waste reduction system

Naturally construction industry involve many professionals of different disciplines, its known that effective implementation of one or more of the above cost reduction approaches, crystal change will be achieved.

To take part in the endeavour of making the houses more cost effective, it is intended to investigate the existing model of pre-cast beam and slab block arrangements. Good experience of other countries has been taken to implement in the design and construction of grand housing development program of the country, which is still open for further investigation to enhance quality of work that meet the intended purpose.

Objectives

The objectives of this project are as follows:

- To search for other alternative for the existing pre-cast ribbed beam and floor system to make the design more cost effective and increase efficiency.
- To introduce simple and light weight pre-cast beam and slab block types so that to increase quality of work and speed of construction.
- To increase productivity and minimize waste during production and construction of pre-cast beam and slab block floor system.
- To check effectiveness of the current practice of pre-cast beam and floor system design and construction.
- To examine the structural designs of the practicing LCH-MH approaches for the existing projects and devise the mechanism to bring about a better alternative.
- To have more methods of achieving low cost housing for all.

II LITERATURE REVIEW

F. Lazzali, S. Bedaoui. Seismic Performance of Masonry Buildings in Algeria. The authors have categorized data of numbers and types of house construction in Algeria. They have observed following types of damages after the 21st May 2003, Boumerdas earthquake :Horizontal cracks between walls and floors, Vertical cracks at wall intersections, Out of plane collapse, diagonal cracks in piers, Cracks in spandrel walls, Partial or complete disintegration of walls, partial or complete collapse of building. In the conclusion they point out the vulnerability is due to, Heavy weight of construction material, Substandard workmanship, Inferior quality of mortar.

Rajandre Desai, Rupal Desai. Housing Technology and Its Impact : Latur Earthquake Rehabilitation (Case Study). (www.ncpdpindia.org). The authors have submitted this case study paper at," Workshop of low cost housing and community participation in construction," at Cebu Philippines, in reference to 1992 Latur earthquake. They have pointed out the fact of majority of houses collapsed, were from low cost category. About reasons of the collapse, they strongly opine that, these traditionally constructed were, with broader stone masonry, in poor mortar, and heavy roof improperly clamped to peripheral walls. Further, they enlightened the issue, why the houses in rural area are built in 'traditional manner' They state that, the use of Socio-Eco friendly pattern and materials, in the construction of these houses, is evolution based on wisdom and experience of centuries of respective areas, not only in Kachchh but all over the country. Most of the material used in construction of traditional buildings are more economical, easily recyclable and produces no or less pollution. The day in and day out, use of cement and steel is skyrocketing, leading to very high rate of exploration, which will generate a situation, of scarcity of the recourses, in the coming decades, in our country. Authors therefore are calling for the attention of, researchers and designers and suggest that it is the need of the hour to develop a methodology which will upgrade the traditional methods to comply seismic resistivity specifications.

Nicolas Hurtado Tecnica. The author has explained the necessity of retrofitting the structure with deficient seismic resistivity. The benefits as explained are safety to occupants in and around the structure, property, secondary benefits of the saving in cost, such as medical expenditure, temporary relocation cost,loss of building use, litigation cost and the time that would have required to face these situations. The retrofitting need be done with advice and under supervision of a qualified and experienced engineer in the field, otherwise the work will suffer as well as cost will be escalate, and finally, has cautioned, that there is nothing like full proof earthquake resistant structure, but the retrofitting will enhance the performance of the structure.

M.Haseeb, Xinhailu, Aneesa Bibi, Jahan ZabKhan.. The authors are referring to 8th Oct. 2005 earthquake in Pakistan. The majority of the houses collapses were located on the hill slopes or in vicinity hence, when earthquake struck; land slides, rock slides and subsidence followed it, they automatically became culprit of not single but quadraphonic attack. Un-engineered structures constructed in traditional stone masonry pattern, with poor quality cement or mud mortar, and without use of steel reinforcement, as the causes of such large scale of massacre. They therefore compared the provisions of earthquake resistant cods of Pakistan with Japan.

BACK GROUND

Specimen SA1 was designed to be largely precast to reduce erection time and labour requirements. Furthermore, it was important to the project to assess the practicality of construction using the slotted beam detail, especially when compared to a traditional detail. Hence, the manufacture of the precast units was undertaken by a reputable commercial precast company.

The feedback from the precast company was invaluable and, on the whole, it was very positive. The issues encountered were often around forming the slot itself and tolerance, especially concerning the diagonal hanger bars and stirrups. This location and sealing of the unbonding steel tubes around the lower longitudinal reinforcement was sometimes an issue due to the accessibility once the reinforcement cage was in the forms. The assembled reinforcement cage in the form can be seen in Figure 3.23 (a). The employees of the precast company commented that the job was challenging, but not as difficult as some other traditional details that they have worked on.

The prestressed precast floor units were sourced from a local supplier, and are no different to that used in a traditional monolithic structure. It can be concluded that the slotted beam can be effectively manufacturer by reputable precast companies in a similar manner to traditional details.

The specimen, being completely precast, was delivered in components and joined together through grouting Drossbach tubes and casting mid-beam splices. The precast components for the first storey can be seen arriving outside the laboratory in Figure 3.23 (b). The size of these components was dictated by the width of a standard truck and the door to the laboratory. The construction stages are shown in Figures 3.24 (a) – (d). This method of construction enables rapid erection with a smaller workforce. However, care must be taken in assuring the quality of connections.

The erection of this specimen took place during a seismically active period in Christchurch. As such, significant time and cost were expended on the propping design. This conservative approach was validated during the February 22nd aftershock, and following sequence of aftershocks. Only minor displacement of ungrouted precast components was observed and some minor cracking.

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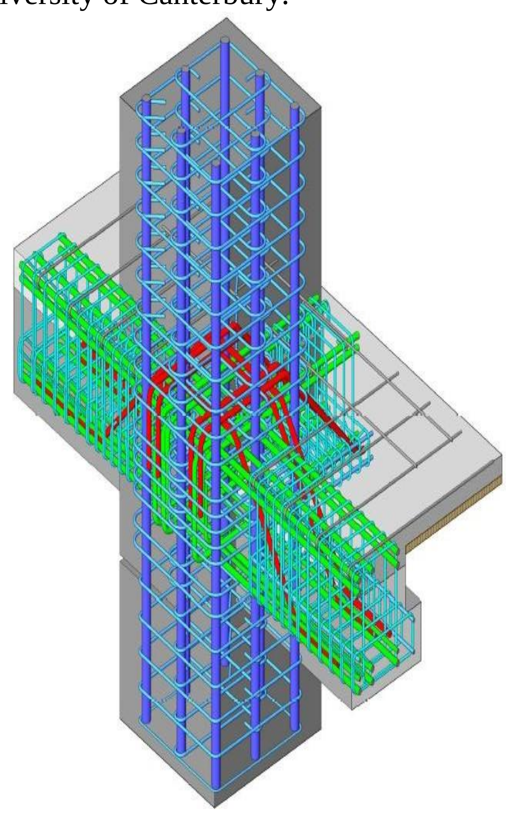
III SPECIMEN DESIGN

Research to date has focussed on the connection mechanics. This has been investigated parametrically, numerically and experimentally using beam-column joint subassemblies or two-dimensional frame systems. These types of specimens are purposefully simplified to prevent the data being influenced by outside factors that are not being examined. This configuration lends itself well to trialling many details in a time and cost effective manner in order to develop satisfactory performance and refine design recommendations. However, to be able to fully evaluate the performance of the reinforced concrete slotted beam system, complex three-dimensional interactions between the lateral load resisting system and the floor diaphragm need to be assessed.

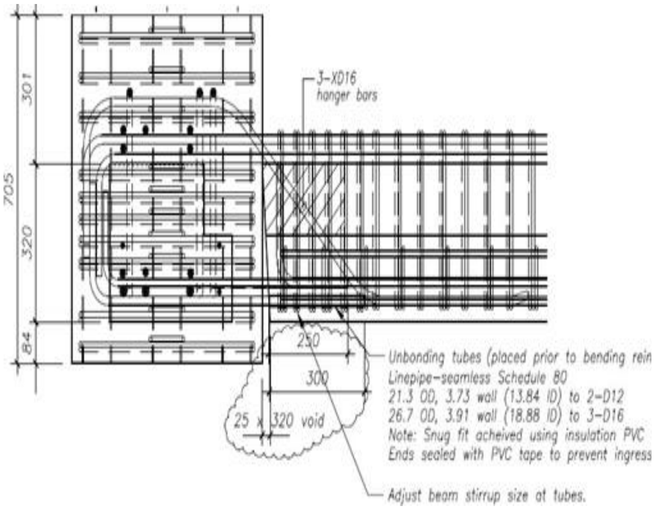
Prototype structure

Specimen SA1 is a large scale three-dimensional reinforced concrete slotted beam superassembly designed to provide data on interaction between structural elements in a realistic New Zealand building geometry. An oblique of the superassembly is shown in Figure 3.1 (b). It will also allow the development of connection details intended to improve performance and robustness. It will serve to confirm whether the damage to the floor diaphragm is reduced, and to what extent, when the slotted beam detail is used. The project will also allow the practicality of the system to be assessed and serve as a showpiece to increase familiarity of the construction industry with this emerging detail.

The two-storey, two-by-one bay, superassembly was extracted from the first and second stories of the prototype building shown in Figure 3.1 (a). The specimen is scaled geometrically at 2/3 according to a 'practical real model' philosophy (Harris & Sabnis, 1999). This was the maximum size that could be accommodated within the structural extension laboratory at the University of Canterbury.



Three-dimensional rendering of reinforcement detail



Precast drawing of exterior first storey connection

IV SPECIMEN CONSTRUCTION

Specimen SA1 was designed to be largely precast to reduce erection time and labour requirements. Furthermore, it was important to the project to assess the practicality of construction using the slotted beam detail, especially when compared to a traditional detail. Hence, the manufacture of the precast units was undertaken by a reputable commercial precast company.

Reinforcement cage in form prior to concrete pour

Level one precast components arriving outside laboratory.

The feedback from the precast company was invaluable and, on the whole, it was very positive. The issues encountered were often around forming the slot itself and tolerance, especially concerning the diagonal hanger bars and stirrups. This location and sealing of the unbonding steel tubes around the lower longitudinal reinforcement was sometimes an issue due to the accessibility once the reinforcement cage was in the forms. The assembled reinforcement cage in the form can be seen in Figure 4.1 (a). The employees of the precast company commented that the job was challenging, but not as difficult as some other traditional details that they have worked on.

The prestressed precast floor units were sourced from a local supplier, and are no different to that used in a traditional monolithic structure. It can be concluded that the slotted beam can be effectively manufacturer by reputable precast companies in a similar manner to traditional details.

The specimen, being completely precast, was delivered in components and joined together through grouting Drossbach tubes and casting mid-beam splices. The precast components for the first storey can be

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seen arriving outside the laboratory in Figure 4.1 (b). The size of these components was dictated by the width of a standard truck and the door to the laboratory. The construction stages are shown in Figures 4.2 (a) – (d). This method of construction enables rapid erection with a smaller workforce. However, care must be taken in assuring the quality of connections

First floor precast components set out

First floor in-situ topping pour complete

Second floor precast components being grouted.

Completed specimen SA1

The erection of this specimen took place during a seismically active period in Christchurch. As such, significant time and cost were expended on the propping design. This conservative approach was validated during the February 22nd aftershock, and following sequence of aftershocks. Only minor displacement of ungrouted precast components was observed and some minor cracking.

This paper is intended to be read in conjunction with the companion paper on the experimental methods and results presented at this conference by Muir et at., (2012).

V CONCLUSIONS

The background to the development of the reinforced concrete slotted beam has been described. The design and construction of the slotted beam super assembly has been presented. It has been demonstrated that design and construction of reinforced concrete structures using the slotted detail is comparable to using traditional details. The detail can be manufactured accurately and economically by reputable precast companies. Extensive use of precast can reduce erection time and labour demand.

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