Precast Concrete Connections  

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Abstract:  
Though the precast concrete structural systems are being widely used worldwide, Earthquakes are natural disasters which have caused a lot of infrastructural damage and loss to human lives. In the past earthquakes, the cost effective precast structural systems had not performed well. The failure of the precast structures was attributed to the poor performance of connections. Connections form the weakest link in the precast concrete structure. For the past four decades though a lot of research has been carried out on the behavior of precast structures, a complete understanding of the behaviour of precast beam-column connections to lateral loading has not been ed field calls for skills and abilities far beyond the construction engineering and has to be a balance amid advanced technology and trends, management, feasibility and economy. The specimens were classified into three groups with two numbers in each group. They are TYPE I connections - Bolt and Rod connections, TYPE II connections: Cleat Angle and Stiffened Cleat Connections and TYPE III connections: Dowel Connections. The TYPE I connection consisted of two connection details (i) Precast connection using J Bolt (PC-JB) and (ii) Precast connection using Tie Rod (PC-TR). The TYPE II connection consisted of three connection details (i) Precast connection using Cleat Angle (PC-CA) (ii) Precast connection using cleat angle and single Stiffener (PC-SS) (iii) Precast connection using cleat angle and Double Stiffener (PC-DS). The TYPE III connection consisted of two connection details (i) Precast connection using Dowel bar (PC-DW) and (ii) Precast connection using Dowel bar and Cleat Angle (PC-DWCL). The precast concrete beam and column near the joint were also detailed with confinement reinforcement. All the sixteen specimens were tested under constant axial load on the upper end of the column and with cyclic load at the end of the beam. The main objective of the study was to investigate the different detailing of joints in an exterior precast concrete beam-column joint subject to reverse cyclic loading. Analytical modeling was also performed on the monolithic specimen and seven precast specimens using finite element package ANSYS and the experimental results were validated with the results obtained from the finite element models. The experimental results matched well with the analytical results. From the study, it was observed that precast specimens PC-DS and PC-DWCL performed satisfactorily in terms of ductility and energy dissipation when compared to the reference monolithic specimen ML.

Keywords: Horizontal Force, Prestressed Concrete, Tensile Reinforcement, Concrete Creep.

I. INTRODUCTION

Precast is a modular building system based on components and connections. Some type of a precast connection is needed between each produced precast unit. Demands for precast connection types vary among different precast products, local building conditions and restrictions, and loads on the structure. Generally every country has its own system for precast connections. There are several pre-tested connection types for precast floor products, and seismic and support connections. Precast connections ensure safety and durability of a precast building. They carry the predefined loads in different building structures and resist fire and water. Industrially produced precast connections are fast and easy to install no matter what the precast product. Precating is great for producing large numbers of identical components. Let's say we are building an affordable housing project with 3,000 identical apartments. We could then use Precating to produce wall slabs and floor slabs for all apartments. and then lift them into place and connect them.

1- Precast connection design....
Typically precast connections can be done with an industrially produced connection part, wet connection, bolt, or weld connection. In precast connection design the key variables are strength, volume changes, ductility, durability including fire and corrosion, simplicity in production, installation and maintenance, temporary loading conditions, economy and appearance. Precast buildings suit well for hot, cold and also seismic areas, when the specific local requirements are taken into account in connection design. If planning a building for a seismic area, it is recommended to involve seismic connection design experts into the process.

2- Precast floor connections...
There are several pre-tested connections for hollow-core slab floors. Hollow-core slabs are normally installed on neoprene strips, that can also be used as part of the final connection. Neoprene strips ensure a uniform bearing of floors. Connections at longitudinal joints are used between the edges of the hollow-core floor unit and beams or walls running parallel with the floor. Their main function is to transfer horizontal shear on the precast units.

Specific precast connection sample drawings can be found for...
*HC slab on rectangular Beam  
*HC slab on concrete wall, wall-to-wall connection  
*HC slab on Sandwich wall  
*HC slab on wall corbel

3- Precast connections for sandwich walls...
Connecting loops, ties and fixing sockets are common safety solutions, when building with sandwich walls. Connecting loops connect the vertical joints of precast wall panels to each other. They are single-wire loops, which can be applied on wall-to-column joints as well. Connecting loops are easy to install by opening the wall cover, bending the loops to the...
operating position and connecting them to reinforcement. Ties connect a facade and an inner panel of a sandwich wall together. They are a connecting reinforcement of the wall including outer, inner and diagonal bars forming a lattice-type of ties. Outer and inner bars can be either normal or stainless steel, whereas diagonal bars are always of stainless steel. Fixing sockets are used for attaching and fixing objects to precast concrete such as guard rails, lighting fixtures, etc. Their main function is to carry axial load.

4- Joints of the outer layer of the sandwich wall
Main variables of a high quality precast wall are ventilation in sandwich structures, water resistance and outlook. Most of the precast wall problems are caused by the joint deformations in the outer layer of facades and sandwich walls due to temperature and moisture variation. The right use of wall joints is essential to prevent these problem. Good wall joint material withstands stress caused by thermal movement in the units, solar ultraviolet and infrared radiation, external air temperature and impurities. Joints should be designed so, that they prevent rainwater entering between precast unit and the insulation. The key in a sustainable wall joint construction is provision of solid and smooth adhesion surface for the jointing mass in the edges of the wall units. By changing surface material, texture or color at the joints, it is possible to form surfaces, where junctions are seen as a natural parts of the facades.

II. BRIEF LITERATURE SURVEY
Precast concrete is a construction product, made by casting concrete in a reusable mold or "form", which is then cured in a controlled environment and transported to the construction site for installation. There are different types of precast concrete forming systems for architectural applications, which differ in size, function, and price. Usage of precast elements eliminates or highly reduces the need for conventional formworks and props. They also lower the generation of wastage and checks other environmental hazards. They further provide a safe working platform to the workers. Precast products are manufactured in a casting area where critical factors such as temperature, mix design, and stripping time can be closely checked and controlled, which ensures that the quality of precast products is better than that of cast-in-situ concrete. Moreover, it saves a considerable sum of money through eliminating rectification work. Furthermore, due to factory-controlled environment, different combinations of colors and textures can be applied easily to the architectural or structural pieces. A vast range of sizes and shapes of precast components can be produced, providing flexibility and fresh look to the structures. These are the advantages of using precast concrete. Precast concrete is primarily used in the construction of buildings with repetitive designs and elements, such as schools and apartments. It provides architects with an exciting medium while designing facades for a wide range of buildings, such as healthcare facilities, shopping malls, commercial buildings, and stadiums.

III. PROPOSED RESEARCH WORK
Precasting can be done at a casting yard, in or near the site, or in a factory. A key aspect of determining whether to use site or factory precasting are the transport costs. Factory work offers superior quality for obvious reasons, so if there is a factory close to the site, it makes sense to use it. If a precasting yard is to be created, space must be laid out for the following activities:

storing the raw materials, such as cement, aggregate, sand, admixtures, water, reinforcement bars, and steel or plywood sheets for formwork
A formwork making and maintenance yard
A concrete mixing plant
A steel reinforcement yard to make rebar cages to be placed inside the concrete
A casting area
A curing area
A stacking area for finished components

For infrastructure projects, a casting yard is created on a piece of open land in the city. It is important that this be located near a major highway, as the precast elements can be very large or heavy, and cannot be taken through narrow roads.

Precast concrete components can be connected in a number of ways:

1. They can be bolted together. In order to do this, steel connectors are embedded in the concrete at the time of casting. This must be done with great precision.
2. They can be grouted or concreted together. In this method, loops of steel reinforcement are left protruding out of the precast concrete members. Two members are placed in position, and reinforcement is threaded between the loops. Fresh concrete is then poured around this reinforcement, in a space left for this purpose.

IV. PROBLEM STATEMENT:

Typically precast connections can be done with an industrially produced connection part, wet connection, bolt, or weld connection. In precast connection design the key variables are strength, volume changes, ductility, durability including fire and corrosion, simplicity in production, installation and maintenance, temporary loading conditions, economy and appearance. Precast buildings suit well for hot, cold and also seismic areas, when the specific local requirements are taken into account in connection design. If planning a building for a seismic area, it is recommended to involve seismic connection design experts into the process, here are several pre-tested connections for hollow-core slab floors. Hollow-core slabs are normally installed on neoprene strips, that can also be used as part of the final connection. Neoprene strips ensure a uniform bearing of floors. Connections at longitudinal joints are used between the edges of the hollow-core floor unit and beams or walls running parallel with the floor. Their main function is to transfer horizontal shear on the precast units.

V. METHODOLOGY/PLANNING OF WORK
SQRIM is a full precast concrete method that eliminates cast-in-place (CIP) concrete on the building's main structural elements such as the columns, beams, and the beam-column joint core. In SQRIM, the beam and beam-column joint core are fabricated as a single precast element. These elements are vertically installed in the construction site. Grouted mechanical sleeves are used to join the precast elements. To emulate an RC structure, grout is injected into the joints and into the holes to rigidly connect the precast elements. The advantages of SQRIM application are: shorter construction period, high quality precast elements, elimination of formworks and temporary supports, and savings on labor. Since 2003, SQRIM has been applied to 40 building projects in Japan. Developed
from SQRIM, SQRIM-H is also full precast concrete method that eliminates cast-in-place (CIP) concrete and has the same characteristics and advantages of SQRIM. Grouted mechanical sleeves are also used to connect the precast elements. In SQRIM-H, the beams can be fabricated separately from the beam-column joint core and are simply shaped compared to the SQRIM's single beam and beam-column joint core element. Thus, beams are easily installed by sliding horizontally (indicates the "H") to join with the column. The method can be applied to any building with complicated shape and structural framing. SQRIM-H has been applied to 8 building projects since 2008. The I-SQRIM is specially intended for the overseas (international) market and was applied for the first time in a petrochemical plant pipe rack in Malaysia. The original design of the pipe rack was conventional precast which still required cast-in-place (CIP) concrete to rigidly connect the precast elements. The original design was changed with the application of SQRIM method. This includes changing the original lap reinforcement to mechanical joint, L-shaped hook anchor reinforcements to mechanical end anchors, and to rigidly connect the precast elements grout injection was applied instead of CIP. Since CIP concrete is also eliminated in I-SQRIM, it achieves the same characteristics and advantages of SQRIM. Production of precast elements has been done in casting yard. Moulds of adequate stiffness have been used and installed as per issued GFC drawings. The sequence of activities involved in the production of precast elements is as follows:

1. Mould cleaning and preparation
2. Shuttering / assembling the mould components
3. Fixing of rebars / cast-in-fittings
4. Pre-concrete check
5. Concreting
6. Curing
7. Demoulding
8. Final inspection
9. Stacking

VI. ENVIRONMENTAL AND EXPERIMENTAL

Precast construction method is recently developed method, still a lot of researches going on to improve its applications. Here few comparisons made with conventional construction system by studying the site work and analyzing the activities.

1. Precast construction method is purely based on shear wall concept and hence the typical floor doesn’t contain any type of columns but in conventional, columns are must to construct twelve floors of a tower.
2. Precast construction process carried out at site as production of elements along with simultaneous erection of the ready elements which considerably saves the time of construction whereas in conventional, block work and curing consume much time to complete.
3. Block work is limited to only 1 to 1.2m height per day to maintain proper alignment whereas; precast elements do not have any such restrictions.
4. In conventional method, block work must proceed further with proper curing and also plastering require curing period for sufficient hydration and to attain strength; but in precast method, no such intense curing required because, the main and final curing done at casting yard only to achieve maximum strength.
5. Plastering work is mandatory in conventional whereas precast method doesn’t require any kind of plastering work.
6. For slabs, shuttering work, reinforcement works consume more time in conventional method; but in precast, slabs also get manufactured in yard itself.
7. All parts of a structure cannot be fixed with precast elements; at few necessary locations block work is essential in precast construction also.
8. In precast method, slab should proceed further with screed of certain thickness to provide necessary electrical conduits; whereas conventional system contains the electrical conduit works in normal slab shuttering work itself.
9. No alterations in design are possible in precast construction; but in conventional, any kind of alterations are made without any problem.
10. Better quality control can be possible with precast construction but as the floor level increases, in conventional system it is very difficult to maintain good quality.
11. Precast construction system requires almost half the number of total man power that required for conventional system.
12. Construction activities take place at a faster rate in precast compared to conventional system.
13. Precast construction provides better alignment of structural elements than the conventional one.

VII. REFERENCE


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