RUNNING HEAD: ENGINEERING

Comparison of Inputs and Outputs Regarding Specialised Pre-Cast Concrete Structures against Regular Methodologies in Residential, Commercial, and Industrial Construction

[Name of the Writer]

[Name of the Institution]

**Table of Contents**

[Section 1 – Introduction 3](#_Toc33297976)

[Topic and Background Context 3](#_Toc33297977)

[Problem Statement 5](#_Toc33297978)

[Focus and Scope 6](#_Toc33297979)

[Relevance and Importance 7](#_Toc33297980)

[Hypothesis 8](#_Toc33297981)

[Research Objectives and Questions 8](#_Toc33297982)

[Overview of the Structure 9](#_Toc33297983)

[Section 2 – Literature Review 10](#_Toc33297984)

[The Concept of Precast 10](#_Toc33297985)

[The Concept of On-Site Cast (in-situ) 13](#_Toc33297986)

[Background of Precast Concrete 15](#_Toc33297987)

[Standard and Specialised Precast Designs 16](#_Toc33297988)

[Standard and Specialised Conventional Building Designs 18](#_Toc33297989)

[Overview of Pre-Cast Concrete Structure Process 19](#_Toc33297990)

[Overview of On-Site Cast (in-situ) Concrete Structure Process 20](#_Toc33297991)

[The Behaviour of Precast Concrete 21](#_Toc33297992)

[The Behaviour of On-Site (in-situ) Concrete 22](#_Toc33297993)

[Inputs of Precast and Conventional Methodology of On-Site (In-Situ) Concrete Structuring 24](#_Toc33297994)

[Outputs of Precast and Conventional Methodology of On-Site (In-Situ) Concrete Structuring 28](#_Toc33297995)

[Advantages 30](#_Toc33297996)

[Section 3 – Methodology 34](#_Toc33297997)

[Research Questions and Hypothesis 34](#_Toc33297998)

[Research Design 35](#_Toc33297999)

[Data Collection 36](#_Toc33298000)

[Research Procedures and Instruments 36](#_Toc33298001)

[Survey Questionnaire 38](#_Toc33298002)

[Section 4 – Research Results and Discussion 39](#_Toc33298003)

[Comparison of precast behaviour vs conventional methodologies in an apartment building 41](#_Toc33298004)

[Comparison of precast behaviour vs conventional methodologies in a complex building (prison) 43](#_Toc33298005)

[Section 5 – Conclusion 48](#_Toc33298006)

[Bibliography 49](#_Toc33298007)

Comparison of Inputs and Outputs Regarding Specialised Pre-Cast Concrete Structures against Regular Methodologies in Residential, Commercial, and Industrial Construction

# Section 1 – Introduction

Over time, a number of technological advancements and reforms occurred in the field of construction. Manufacturers and designers are constantly working to introduce innovation in construction materials and processes. With the help of modern technology, the concept of precast concrete is introduced in the market. It is created off-site using a mould in order to save time and energy. Precast concrete components are manufactured by industrial methods to construct a large number of buildings in relatively less period and at low cost (Liu et al. 2009). Precast concrete structure based on the load-bearing structure can be divided into four main categories; slab-column systems with walls, frame systems, large panel systems, and mixed systems. The central focus of this research project is to compare inputs and outputs in both cases of specialised precast concrete structures and regular methodologies referring to the forms of residential, commercial, and industrial construction.

## Topic and Background Context

In recent years, the construction sector experienced some extraordinary and massive developments that change the overall shape of creating different forms of physical buildings. This form of industry growth can clearly witness in case of the successful application of specialised pre-cast concrete structures. Undoubtedly, the initiative of this new method of construction turned as the major change in the scenario of constructing buildings in different forms such as in residential, commercial, and industrial construction. The effectiveness of the new construction method of pre-cast can only determine by deeply analysing the way it works in constructing structures. This form of consideration can be further helpful to compare this new method of construction from the traditional approach of developing structures. It is crucial to compare the process and outcomes of both traditional and pre-cast methods of constructions to evaluate the real effectiveness of the technological advancement of the pre-casting concrete structuring method. It is also crucial to mention that the appropriate comparison between specialised pre-cast concrete structure and regular methods is possible by assessing the features of inputs and outputs. A critical examination of inputs and outputs in the case of the pre-cast concrete structure and traditional methods of construction can be helpful to make better inferences about the suitability of the pre-cast method. The evolution of inputs and outputs of the pre-cast concrete structure is an integral condition to identify its main difference from the conventional approach of concrete construction.

It is important to briefly describe the nature and functioning of the pre-cast concrete structure method. This form of assessment is vital to determine its difference from the regular methods in the domains of residential, commercial, and industrial construction. Precast concrete is characterised as the product manufactured by casting concrete in the form of reusable mould or the form which is later preserved in a controlled environment and further shift towards the construction site. As the final steps, the moulded concreates further lifted into place to obtain the desired level of finished construction product. The approach of precast concrete is mainly different from conventional methods because, in the standard approach, concrete is poured into site-specific forms and created on-site. In simple words, precast is defined as the contemporary form of concrete that is prepared, case, and cured in the scenario of off-site and later dispensed on the actual site of construction.

Contrary to the new method of precast concrete, there is the consideration of the traditional form of construction. The regular methodology of concrete development is recognised as the site-cast method of construction (Jiansheng and Guoquan 2012). It is noticeable to indicate that the process of site-cast is also established with the title of in-situ that requires completion of all elements of construction on the site of the construction. The method of in-situ allows constructors to process the pouring liquid material in the form of concrete then decanted into the mould at the building site. The concrete used in the entire process is made with the combination of cement, sand, and the overall aggregate.

After defining both forms of construction as pre-casting and site-cast methods, the next step is to figure out the main difference that prevails in the case of these domains of construction. Cast-in-place concrete is a regular form of technology of construction where walls and slabs are directly cast at the actual site of construction in the formwork. Contrary to the method of the cast in situ, the precast concrete method permits constructors to develop slabs somewhere else preferably in controlled scenarios of construction factories. These off-site made slabs further brought to the real construction site in the form of different blocks and late assembled to establish the final form of construction.

## Problem Statement

The extensive trend of construction in the origin of Australia requires the adoption of some cost-effective and timely efficient procedures. The growing demand for constructing buildings in different forms such as in the case of residential, commercial, and industrial makes it critical for the stakeholders to think about some alternative ways. It is crucial to consider the need of adopting some methods as comparing to the traditional domain of regular methods of concrete structuring and constructing. This increasing demand ultimately enhances the practical trend to consider pre-casting concrete structure as the appropriated substitute of the traditional methods of construction such as on-site cast (in-situ). The changing scenario of concrete construction requires the industry to consider specialised recasting as the solution to cater to the growing need for developing new buildings and residential zones in different geographical regions (Zhu and Guo 2012). The increasing demand for the method of pre-casting concrete structure makes it essential to examine the overall suitability of this procedure. This examination also requires to figure out how the modern form of construction is different and more beneficial as compared to the regular method of on-site casting of the concrete material. This form of consideration requires a critical assessment of both the paradigms or standards of inputs and outputs for both the methods of pre-casting and on-site casting to examine the real significance and application of both the prospects. This approach of evolution is applicable specifically in the domains of residential, industrial, and commercial sectors.

## Focus and Scope

It is important to define the overall focus and scope of the research area to examine the overall significance of the pre-cast concrete and regular methods of construction. This form of consideration is vital to evaluate the effectiveness of the traditional and contemporary approach to pre-cast concrete structure development. This section of research work requires identification of the specific geographical area that is selected to determine the significance of research outcomes in the end. The geographical area of Australia is considered when it comes to comparing domains of inputs and outputs in both cases of pre-cast construction structure and regular form of methodologies(Fatema and Islam 2006).

It is also crucial to indicate that the practical implications of residential, commercial, and industrial construction are focuses to determine the prevailing difference in the case of both methods of construction. It is important to identify the prevalence of pre-cast and traditional forms of construction in the region of Australia to determine the overall implication and significance of these methods. The trend of the specialised pre-cast concrete structure is extensively grown in the region of Australia (Lu et al. 2017). This method of construction is recognised as popular practice referring to the domains of increased efficiency and sustainability of the structures. The growing development of the modern method of pre-cast concrete structure makes it significant to compare its effectiveness with the conventional form of construction.

## Relevance and Importance

Explaining the overall relevance of the research topic is necessary to condition to illustrate the overall importance of the topic. It is imperative to mention why it is crucial to examine the effectiveness of pre-cast structure construction and how the findings of this research work can be relevant to the current construction position in the country (Murthy et al. 2014). A comparison of the modern form of construction as a pre-cast construction structure and regular forms of construction is the only approach to determine the effectiveness of the new method of construction(Murthy et al. 2014). The growing trend of establishing pre-cast construction structure in various areas ultimately increase the importance of research work related to this specific area.

The comparison of methods of the specialised pre-casting concrete structure and regular methods of construction is possible by considering the practical domains of inputs and outputs of these construction procedures. A comprehensive examination of the former research studies in this field indicates that there is no evidence of necessary research work to compare pre-casting and on-site concrete structures specifically referring to both forms of inputs and outputs. The existing research gap in this scenario requires a deep assessment of both the methods of pre-cast and on-site casting on the concrete structure. This form of evolution is possible by considering both the crucial domains of inputs and outputs referring to both the construction methods of pre-casting and on-site cast concrete structures.

## Hypothesis

*Ho:* There is a significant difference exists in case of inputs and outputs regarding specialised pre-cast concrete structures against regular methodologies in residential, commercial, and industrial construction.

H1: There is significant difference exists in case of inputs and outputs regarding specialised pre-cast concrete structures against regular methodologies in residential, commercial, and industrial construction.

## Research Objectives and Questions

Proper development and presentation of research objectives and questions are necessary to condition to successfully define the overall purpose of the research study. A concise form of research objectives defines the overall purpose of the exploratory research work referring to the specific timeframe. In simple words, the crafting of research objectives assists to summarize the main aims of the study targeted by the researcher. The approach of research questions is comprised of the questions crafted by the researchers they want to answer with the entire procedure of research.

Research Objectives

* To determine the significant difference between precast concrete and on-site cast concrete structures.
* To identify the behavioural domains of precast concrete and on-site cast concrete structures.
* To determine the inputs and outputs of specialised precast concrete in the forms of residential, commercial, and industrial construction.
* To determine the inputs and outputs of a regular form of on-site cast (in-situ) concrete in the forms of residential, commercial, and industrial construction.
* To compare inputs and outputs of pre-cast concrete structures against on-site cast (in-situ) concrete in residential, commercial, and industrial construction.

Research Questions

* How the practice of precast concrete structure is different from the regular method of the on-site cast?
* What are the significant differences between behaviour domains of precast concrete and on-site cast concrete structures?
* How the features of inputs and outputs of the specialised precast concrete structure are different from the regular method of the on-site cast (in-situ) in the forms of residential, commercial, and industrial construction.

## Overview of the Structure

The entire dissertation is comprised of five major sections named as an introduction, literature review, methodology, research results and discussion, and conclusion. The central aim of the introduction is to provide a brief and clear overview of the research topic to the target audience. The second chapter is characterised as the literature review that focuses to comprehensively explain the existing research work on the topic. This form of consideration can be helpful to identify and critically examine different horizons of both the methods of the pre-cast concrete structure and on-site cast (in-situ). The next section is a methodology which is one of the crucial parts of the entire research work. The focus of this phase of research is to illustrate specific modes or methods which are selected to conduct the research procedure. The next chapter is based on a comprehensive discussion based on the results obtained from the practical implication of research methods. The aim of the final section of this research is to summarise the overall scenario of the research topic to provide an overview of the entire research procedure.

# Section 2 – Literature Review

A literature review is one of the most crucial sections of the entire research process. The primary focus of this stage of research work is to identify and critically analyse existing research studies concerning the research topic. A comprehensive examination of the suitability of former research evidence and implications of the findings can be helpful to make better inferences on the research questions and objectives formulated for this research study. The existing association between different variables and their impact can better anticipate by focusing the previous research studies established in this discipline. In simple words, a literature review is characterised as the detailed survey work of different scholarly sources linked to the specific topic. Particularly referring to this research study, different scholarly sources are under consideration to enhance understanding in the scenario of inputs and outputs of the specialised pre-cast concrete structure and on-site cast (in-situ) construction. Different books, research reports, journal articles, and theses are considered as the available sources to increase knowledge in relation to existing research work.

## The Concept of Precast

The idea of precast is characterised as a new trend in the field of concrete construction referring to various aspects of consideration. It is important to mention that this practical idea of concrete construction also known with the term prefabricated (Ryntathiang et al. 2005). This idea of construction includes building structure where many structural elements are referred to as standardised form. Moreover, these components of the structure are produced in plants under the domain of the production environment away from the main building (Zhengxing 2012). Once different construction elements are structured in factories, the next step is to transport to the site for a further phase of assembling.

It is also established by the researchers that different and suitable industrial methods are adopted by the producers to manufacture different concrete elements by using various moulds. The central focus is the proper adoption of the entire scenario of mass production to build an extensive amount of building components in a short span of time (Zhu and Guo 2011). In their research study, researchers comprehensively explained the main features or characteristics of the growing construction procedure of precast concrete structuring. According to researchers referring to this field, a significant division of labour force is one of the prominent prospects of the practical implication of precast method of concrete structuring (Riva 2006). Moreover, it is also explained that the practical idea of precast of concrete structuring is also actively linked with the assuring proper specialisation of the workforce. The practical application of the precast method of concrete production requires the establishment of specialised work tasks by experts. This form of functioning eventually becomes the reason for the proper distribution of labour according to their expertise and assigned tasks (Xiao et al. 2012).

The general concept of precast also closely linked with the proper utilisation of different instruments and machines according to the requirement of creating different concrete elements. A critical consideration of advanced tools of construction is necessary to condition to successfully implement the notion of precast for the sake of concrete production (Magliulo et al. 2008). As it is mentioned by the researchers, following different standards of advanced production is an essential condition to ensure the successful structuring of concrete elements mainly in the forms of compatible parts and products.

Proper association between the design stage and the process of production planning is a mandatory condition to implement the perspective of the precast method of concrete structuring. It is recognised by the understanding of formal research studies that designing buildings with a regular configuration is one major perspective when it comes to achieving the objective of creating different parts of the one major form of a concrete building (Toniolo 2012). It is examined that urban residential buildings mostly consist of five to ten stories high to ensure proper application of entire precast building systems. It is categorised by the researchers that the approach of cost-effectiveness is a central element concerning the practical implication of the method of precast concrete structures (Ricci et al. 2013). The economic factor is a major factor that differentiates the method of precast concrete structuring from the traditional form of construction such as the approach of the on-site cast.

Precast concrete is highly effective in the modern world due to it reduces the overall time of construction. High-level performance in acoustic separation, thermal comfort, and durability make it an excellent choice for complex constructions. Various components of precast concrete are established away from the main construction area, which ensures low wastage rates on-site (Flynn et al. 2012). It is notable to mention that the inherent strength of precast concrete helps to meet engineering design standards for multi-story apartments as well as complex malls. The structural capacity of precast concrete increases its overall structural integrity. Unlike conventional methodologies, precast concrete construction is done on the ground inside a climate-controlled structure. With the help of this controlled environment, the chances of environmental degradation reduce up to a significant point (Jazzar 2006). Specialized apparatuses are used to effectively establish and pour liquid concrete. With the implementation of a climate-controlled environment, it is evident that the quality of precast concrete structures is relatively high.

For the construction of multi-story apartments and complex infrastructure projects, precast concrete can be used in multiple various ways such as making cladding panels for buildings, columns, floor slabs, beams, and other structural members for buildings (Elliott 2016). Furthermore, precast concrete walls and roofs can efficiently resist the seismic lateral loads with the aid of rocking motion that helps to re-centres the full structure and minimize damage. Precast concrete is not the only operative in low ductile class, but it is also effective in high ductile class as the joints between beams and columns are thoroughly fixed.

## The Concept of On-Site Cast (in-situ)

The specific term (in-situ) is a Latin phrase that is used in the practical scenario of the construction industry. The primary meaning of this approach is “on-site” or “in position.” Considering this perspective, this approach is identified as the construction work which is carried out on the construction place in the form of the final position. The most popular forms of on-site (in-situ) appeared as the specific elements of slabs, beams, and piles to ensure the successful application of the entire procedure of concrete structuring (Hossain 2005).

In the comparison of the precast concrete structure, the method of the on-site cast (in-situ) is ranked as the conventional method in the field of construction. The standard form of the on-site cast (in-situ) focuses on the application of specific standard concrete. This specific principle of construction characterised as standard concrete which is transferred into the formwork at the place of construction. According to the researchers, the main objective of adopting this specific approach of concrete structuring is to obtain the strength referring to the application of RCC factors (Ozden et al. 2014). The central difference between precast and on-site cast (in-situ) is that in the traditional procedure of on-site cast established as poured, moulded, and finally cured on the site of concrete construction. On the other hand, the existing similarity in both cases is that concrete is formed by adopting the option of mould and then lifted towards the desired places. According to researchers of this field, when it comes to establishing large-scale concrete buildings, on-site cast (in-situ) is a preferable process to efficiently handle extensive form of the concrete structure (Yee et al. 2011).

The practice of on-site concrete construction requires proper use of raw materials at the site of construction. It is established by the researchers that usually the scenario of on-site concrete is based on the proper mixture of aggregate elements such as the components of cement and clean water. The feature of aggregate comprised of the components of sand, gravel, and crumpled stone. It is defined by the researcher that the most prominent aspect of the on-site cast (in-situ) is that this concrete is recognised as a solid, durable, and constant form of concrete structure in the end (Korkmaz and Tankut 2005). It is also mentioned that lifetime conservation is another significant perspective that appeared in the case of the practical approach of the on-site cast (in-situ). It is argued by many former research studies that on-site cast is the ideal form of concrete construction referring to the objectives of proper control of form and shape.

The primary forms of on-site concrete structure are defined as the establishment of columns, beams, walls, and floors. Combining different spectrums at the place of construction is defined as the fundamental form of constructing the building on site. Different processes are utilised by the constructors to achieve the desired level of on-site cast concrete structuring (Elliott and Jolly 2013). The significant procedures can figure out in the practical forms of timber or plywood formwork installation, steel fortification, and proper cast in situ. It is also vital to mention that mostly the option of reinforced concrete frames adopted by the constructors when it comes to the application of on-site concrete construction. The use of a wooden framework is another option of applying the entire process of on-site concrete (in-situ) (Liu et al. 2011). It is also important to identify that the establishment of a wooden framework is characterised as a costly approach as it requires extensive work and labour force.

## Background of Precast Concrete

The concept of precast concrete has been around for centuries. It is a high-performance construction material that ensures impressive results when it comes to safety, strength, integrity, design, quality, construction, and sustainability. It is essential to consider the fact that Ancient Romans builders were first to pour the concrete into moulds in order to construct dynamic structures of tunnels, culverts, and aqueducts. However, the first use of precast concrete in the modern world is pioneered in Liverpool, England(Bin et al. 2005). The idea for this process was presented by John Brodie at the beginning of the 20th century.

In Australia, the history of precast concrete is linked with the development of the construction industry. A critical examination of precast concrete in Australia indicates its vital role in the construction industry. The role of precast concrete in the improvement of quality of structures and in construction productivity is highly significant. When insitu concrete methods fail to achieve particular architectural finishes, precast concrete makes it possible to build such structures. It is important to mention that the pre-eminence of precast concrete can be found in Australia (Li et al. 2018). The technique of precast concrete was introduced in Australia in 1906 for the construction of historically known Harbour’s Bradleys Head Lighthouse. The overall concept of this process proved to be effective in terms of sustainable construction and easy instalment. In addition to this, the New South Wales Government Railways extensively used this practice to establish multiple stations and buildings. Due to the impressive properties of precast concrete, the railways' department managed to erect almost 145 stations and similar buildings in the region (Ataei et al. 2016). The precast concrete process has the potential to assemble entire buildings beyond cladding panels. A critical examination of notable properties of precast concrete ensures the fast completion of houses and multi-story buildings. As the precast slabs and panels are manufactured away from the main construction site, it provides ease during its assembly. Furthermore, the precast concrete requires minimal labour in the construction site to assemble these panels into commercial shops or residential plots.

The development and optimisation of precast concrete have passed through four major phases for the construction of residential, industrial, and commercial buildings. A critical examination of these four development phases is highly necessary to get a better understanding of the growth and expansion of precast concrete (Pampanin et al. 2011). The technological breakthrough of precast concrete is associated with prestressed concrete. Additional advancement was incorporated in the development of concrete for the optimisation of design and improvement in the strength of materials. The precast concrete is extensively used in the rebuilding of residential post-war Europe from 1945 to 1970. At that period, the reconstruction of buildings was mainly associated with precast concrete. Wall panels along with semi-automated floor slabs were used for the development of residential areas. In addition to this, slip-formed hollow core units and prestressed long-line extruded were also used for this particular purpose in Europe and South East Asia (Polder and De Rooij 2005). The production of leaner structures was made possible in the lightweight and long-span period at the end of the 20th century. To enhance the efficiency and effectiveness of precast concrete construction, the hybrid technique was applied (precast with timber or steel).

## Standard and Specialised Precast Designs

A detailed examination of the former research work in the context of precast concrete is also helpful to identify the potential standard and specialised precast designs. According to researchers, there is a need for applying a significant code of practice to successfully established the practical form of precast concrete structures. The scenario of the standard is mainly associated with the practice of on-site concrete structuring (Gordon and May 2006). It is important for the constructors and producers to follow specific standards to ensure the successful application of the precast concrete method for the buildings. According to relevant research reports, it is observed that AS 3850 is characterised as the basic standard when it comes to adopting the practice of precast concrete structure in order to meet the changing needs of the construction industry (del Mar Casanovas-Rubio and Ramos 2017). It is important to consider that the implication of this standard is updated with time considering the changing requirements of the industry.

The central objective of applying a standard form of the precast concrete structure is to successfully meet the aspects of building safety and protection for all the stakeholders. The standardised form of precast construction is identified as the development of concrete buildings after proper planning with the inclusion of standardised precast concrete components. The scenario of a specialised form of precast design requires consideration of a unique and site-specific approach of concrete development (del Mar Casanovas-Rubio and Ramos 2017). The application of a basic layout plan creates the basic difference that appears in the form of a specialised form of precast concrete designs. It requires creating and maintaining the necessary balance between conceptual design and the application of the central standard.

*Background of On-Site Cast (in-situ)*

It is important to identify the basic origin or main roots of the approach of regular methodologies. It is also vital to indicate that these methods of concrete construction mainly established in the practical form of the on-site cast (in-situ). Examination of the historical background of this perspective is an effective condition to make better inferences on the suitability and effectiveness of these methods of concrete structuring (Metelli et al. 2011).

Referring to the argument of former research studies, the phenomenon of the on-site cast (in-situ) is all started when Egyptian rulers were interested to build huge pyramids with the utilisation of heavy blocks. The earliest approach of on-site concrete is established over 5000 years ago that appeared in the forms of Egyptian buildings. It is also important to indicate that the practical method of on-site cast further developed with time and inclusion of different advancements. The production of Portland cement in 1824 by Joseph Aspdin of England also played a significant role in the overall developing procedure of on-site cast (in-situ) structure building (Aninthaneni and Dhakal 2014). The component of Portland cement used by the constructors to develop a solid form of concrete. The practical perspective of this innovative idea appeared with the establishment of incorporating reinforcement into it. The adoption of a practical approach in the form of different experiments by Joseph Monier also played an important role in successfully implement the notion of reinforcement.

## Standard and Specialised Conventional Building Designs

A proper assessment of the existing difference between standard and specialised forms of conventional building designs is necessary to condition to determine the effectiveness of this method. Application of basic building standards is a fundamental condition when it comes to considering the standard form of conventional building designs. The facet of design is used as the basic standard of the integrated system considering the existing link between basic design and construction (Chan 2011). In the standard scenario of On-site cast (in-situ), the practical features of metal, glass, brickwork, plastics, and timber are the fundamental forms of standard for this design of construction.

The complex scenario of a specialised form of conventional building designs requires the adoption of specific advanced tools according to the specific need. Extensive use of formwork requires the adoption of the related and unique perspective of a specialised form of traditional methods of building designs.

## Overview of Pre-Cast Concrete Structure Process

A comprehensive assessment of the former research studies helps to establish that pre-cast concrete structure is a wide-ranging procedure that is actively associated with various aspects of consideration. A proper application of all the phases is an important condition to achieve better outcomes from the construction facility of the pre-cast concrete structure procedure. The floor, wall, and frame are three central domains concerning the proper application of pre-cast concrete structure procedure (Lˇpez-Mesa et al. 2009). The significant involvement of primary elements of the pre-cast concrete structure procedure helps to execute the desired form of the entire building development. According to formal research studies on this subject, the time and cost-effective perspectives eventually help constructors to achieve the desired level of quality control and safe application of precast concrete structure.

The central idea of the pre-cast concrete structure associated with the active consideration of different and crucial characteristics. The identification of specific properties of this construction process is necessary to condition to successfully determine the overall suitability of this contemporary approach of concrete construction. According to the researcher, the overall functions of precast concrete construction are completed by adopting a significant process of structural development (Ji et al. 2018).

The entire structure of the precast concrete framework based on the adopted option of fabricated off-site concrete. The overall frame process also involves the supply of different but interrelated structural elements into an on-site position with the purpose of assembling. Frames under the scenario of precast concrete structure procedure have the tendency to obtain desired forms of structural and decorative design implications (Dong et al. 2015). The systematic process of pre-cast concrete structure also allows utilisation of a variety of physical combinations, colours, and final elements.

## Overview of On-Site Cast (in-situ) Concrete Structure Process

Former research studies defined the practical approach of the on-site cast (in-situ) as the simple concrete structure process that is practically established for many years. The fundamental idea of the on-site cast (in-situ) is simply required the adoption of a procedure that permits pouring liquid material which is established as concrete (Dineshkumar and Kathirvel 2015) . The created concrete based on the mixture of cement, sand, and the feature of aggregate concerning the specific amount according to the requirement. The process of the on-site cast (in-situ) further explained that liquid material poured into the mould or specific form-work such as slab formwork at the building area.

The process of on-site cast established in open spaces where constructors are interested to develop concrete structure buildings with the involvement of different related components. The systematic procedure of on-site cast (in-situ) concrete structure consists of some specific and systematic phases that help contractors to achieve a final version of the concrete building (Shen et al. 2009). These stages or practical steps are identified as appropriate estimation of available materials, site preparation, excavation, levelling, compaction, development of framework, reinforcement placement, mixing of concrete, pouring of concrete, finishing of concrete, and finally curing of concrete to achieve the desired level of concrete building under the broader domain of on-site (in-situ) concrete.

It is established by many previous research studies that the adoption of different steps referring to the main properties of on-site (in-situ) concrete procedures. Concrete strength and quality are established as two fundamental aspects under the entire scenario of the curing process in the form of on-site cast concrete. Both these aspects are dependent to achieve the primary objective of a durable concrete structure in the end as the desired form of building location. The regular method of concrete construction requires vigilant adoption of all these stages to ensure the successful development of the desired form of the concrete building (Shen et al. 2009). The overall quality of concrete is a central condition defined by the experts when it comes to achieving the objective of the concrete structure after completing different steps of the whole procedure of on-site (in-situ) concrete structure as the regular method of concrete structuring.

## The Behaviour of Precast Concrete

The behavioural domain of precast concrete can determine by critically focusing the central properties of this practical scenario of concrete structuring. According to experts, all these domains requires significant attention to obtain the behavioural overview of the method of precast concrete. Furthermore, this form of consideration can be viable to examine the existing difference between the specialised approach of pre-cast concrete structures against regular methodologies in the forms of residential, commercial, and industrial construction.

* The good procedure of concrete construction that ensures rapid programming of the entire process (Metelli and Riva 2008). Furthermore, the pre-cast concrete scenario is not influenced by the appearance of any change in weather conditions.
* The practical implications of pre-cast methods helped to improve the overall approach of the buildability. This scenario is associated with the practical domain of dry envelop that permits constructors to start the entire procedure earlier.
* A viable production of the high standard of working is possible considering the basic objectives of creating precast concrete construction procedures. It is necessary to consider that overall practical perspective of the factory environment and construct models of concrete construction accordingly (Xiao et al. 2015).
* Another significant property of precast concrete construction is that it contained a high probability of delivering quality outcomes in the form of final construction product.

## The Behaviour of On-Site (in-situ) Concrete

A comprehensive consideration of specific characteristics of the on-site (in-situ) concrete structure is an essential condition to effectively determine its behavioural domain. This form of understanding is vital to make better inferences when it comes to the suitable application of this construction method according to the need for the structuring requirements. The unique properties of this facet of construction can define mainly in the form of the following points:

* The central objective of on-site (in-situ) can only successfully be achieved by critically focusing when it comes to a suitable selection of materials and required labour. The entire procedure of on-site (in-situ) reinforcement concrete and structural steel mostly applied in the case of the framing market of the multi-story structures (Breccolotti et al. 2016). In this scenario, an appropriate selection of the material is an integral condition to ensure the successful execution of the entire process of construction.
* The approach of cost is closely linked with the overall application of on-site concrete structuring in the case of different types of geographical areas. Framing options need to be consistent with the available financial resources. The overall framing process of on-site (in-situ) is categorised as a cost-effective method as compared to other procedures of concrete structuring.
* The implication of the on-site (in-situ) method can also be examine referring to the factor of construction speed. In the scenario of executing the entire construction plan in the form of on-site (in-situ), it requires plenty of time to meet the standards (Ryntathiang 2005). Lead time for higher in the practical procedure of the on-site (in-situ) as the regular approach of concrete structuring.
* One major significance of the practical method of on-site (in-situ) concrete structuring is that it has the tendency to achieve the desired level of standardisation. Flexibility is a prominent feature that appeared due to the regular practice of the regular framing method of concrete construction. The adoption of any alteration during the process of construction procedure is possibly referring to the domain of in-situ reinforced concrete frame. The adoption of any change would not much influence the entire form of construction sequence and the entire practical procedure (Lu et al. 2016). Maintenance of standardisation is easy and feasible considering the practical perspective of the construction process of the traditional method of on-site (in-situ).
* The higher level of resistance to external factors is another significant property or characteristic of on-site (in-situ). Consideration of this specific component is vital because it is helpful to examine the behavioural prospect of this specific procedure. It is observed that concrete structuring is a good mechanism referring to different environmental challenges such as the issue of fire. The fire resistance in the case of the on-site method of the concrete construction process is high.
* The size and specific nature of the site are two critical aspects related to the practical implications of the on-site (in-situ) construction process. The extensive size of the place is an advantage for the constructors to develop and reinforce frames at the spot by assuring a successful form of the site management system.

## Inputs of Precast and Conventional Methodology of On-Site (In-Situ) Concrete Structuring

Economic Inputs of Precast

Economic elements assume a significant job in the decision of an appropriate structure framework. This has most prominently an impact on lodging if enormous quantities of houses are manufactured. Development with precast solid components offers an extraordinary number of points of interest right now.

**Short construction time compared to traditional building methods**

Additionally, you possibly need a short development time when working in precast in contrast to other structure strategies. In divergence with the in-situ fabricating strategy, you are up to multiple times quicker (Yardim et al. 2013). A short development time implies lower costs acquired by the structure proprietor for financing and site offices

**Less coordination on site**

The industrialized development with precast concrete requires less observation and coordination on location. The precast components are just gathered nearby and the inside work is executed. In this way, fewer organizations are nearby and less coordination between these organizations is essential.

**Limited personnel**

Since the 1980s, worker hours per square meter have been decreased by multiple thirds as computerization has continually expanded since that time. This implies only 33% of the laborers are expected to deliver a similar measure of precast concrete components and work expenses can be decreased altogether.

**Building material and construction costs savings**

Reserve funds in support and concrete are conceivable because of the precise creation of precast concrete components and the usage of thin structure components. These material reserve funds decline the creation expenses of precast concrete components (Jin-rong 2009). The PC controls and screens the creation office. In this manner, materials like concrete, development steel, and so on can be utilized in an asset sparing way and ideally utilized. The concrete compound is balanced precisely and blended in the clumping plant of the manufacturing plant.

**Reduced maintenance costs for precast concrete buildings**

Precast concrete structures do not require any sustenance for almost half a century as the material is solid and tough. This lessens support costs essentially

**Lower construction costs**

The concrete board development comprises of dividers and floors and substitutes casing and skeleton structures that would bear heavy loads. No extra supporting framework is essential and development costs decline.

Technical Inputs of Precast

The modern conceptions of precast concrete components target conserving development forms and the utilization of building material and thusly upgrading it. The entire development process is reclassified and composed proficiently in modern creation

To implement the usage of a precast concrete cost-proficiently, the arranging and execution stages are significant. Constructors have to concentrate on the objectives - the last all-out expenses and effective creation (Girhammar and Pajari 2008). Precast concrete creation is anything but an instant item and essentially purchasing machines doesn't prompt the fruitful creation of precast concrete components

Physical Inputs of Precast

The framework proposed right now laborer usage and procedure holding up time components to be persuasive variables that influence work allotment cost. Be that as it may, the multi-layer development was considered in past examinations, which concentrated on the decay of issues into a few sub-issues: each sub-issue being put away in a layer; the reason for such deterioration being to encourage the arrangement of complex issues. Right now, a multi-layer idea is not the same as past or equal endeavors, since it utilizes a multi-layered chromosome putting away various arrangements of information factors. Plus, there is a necessity for cutting edge frameworks that can address the usage of laborers and its relationship to process-holding up a time to recognize the consolidated effect on distribution cost. The methodology has right now been intended to be adaptable as far as its relevance in taking care of group portion issues and applies to any profoundly tedious procedure creation framework. Monotonous procedures happen in a few assembling framework designs, for example, work focus creation frameworks, equal redundant creation frameworks, equal shared asset creation frameworks, and U-molded creation line framework formats, which can all be tended to utilizing this methodology. These sorts of designs can be found in a few activity shop precast creation frameworks utilized in delivering level controls, connect pillars, concrete sleepers, sewer vents, and other structural and embellishing concrete items. The following area depicts the examination issue in more detail.

Economic Inputs of On-Site (In-Situ)

The framework proposed right now laborer usage and procedure holding up time components to be persuasive variables that influence work allotment cost. Be that as it may, the multi-layer development was considered in past examinations, which concentrated on the decay of issues into a few sub-issues: each sub-issue being put away in a layer; the reason for such deterioration being to encourage the arrangement of complex issues. Right now, a multi-layer idea is not the same as past or equal endeavors, since it utilizes a multi-layered chromosome putting away various arrangements of information factors. Plus, there is a necessity for cutting edge frameworks that can address the usage of laborers and its relationship to process-holding up a time to recognize the consolidated effect on distribution cost. The methodology has right now been intended to be adaptable as far as its relevance in taking care of group portion issues and applies to any profoundly tedious procedure creation framework. Monotonous procedures happen in a few assembling framework designs, for example, work focus creation frameworks, equal redundant creation frameworks, equal shared asset creation frameworks, and U-molded creation line framework formats, which can all be tended to utilizing this methodology. These sorts of designs can be found in a few activity shop precast creation frameworks utilized in delivering level controls, connect pillars, concrete sleepers, sewer vents, and other structural and embellishing concrete items. The following area depicts the examination issue in more detail.

Technical Inputs of On-Site (In-Situ)

There is a threat that as the liner tube is pulled back it will lift the upper part of the in-situ concrete, subsequently leaving a void or necking in the upper bit of the heap. This can be maintained a strategic distance from by great quality control of the concrete and moderate withdrawal of the packaging.

Driven cast-in-situ concrete heaps can end up being economic for sand, free rock, delicate sediments, and muds, especially when huge quantities of heaps are required. For little quantities of heaps, the on-location expenses can demonstrate costly.

Physical Inputs of On-Site (In-Situ)

There is a threat that as the liner tube is pulled back it will lift the upper part of the in-situ concrete, subsequently leaving a void or necking in the upper bit of the heap. This can be maintained a strategic distance from by great quality control of the concrete and moderate withdrawal of the packaging.

Driven cast-in-situ concrete heaps can end up being economic for sand, free rock, delicate sediments, and muds, especially when huge quantities of heaps are required. For little quantities of heaps, the on-location expenses can demonstrate costly.

## Outputs of Precast and Conventional Methodology of On-Site (In-Situ) Concrete Structuring

Economic Outputs

There could be seen reduced construction time in contrast to other building method. On sit, lack of coordination while there is a short number of personnel. Both construction and building costs savings. In comparison to precast concrete, maintenance cost is reduced. Cost of construction of also less.

**Technical Outputs**

Economic opportunities are being presented along with the physical advantages in the precast concrete construction technology as in this type of construction convenient pre-tensioning of the concrete is allowed. Labor and material requirement seem to be minimized greatly in this construction in case of equivalent structural adequacy in contrast to other methods of construction.

* Design-Build Efficiency in case of precast concrete supports in time delivery of the model in a project that allows the construction of the building even when the design is developed.
* It is versatile aesthetically
* Cost is reduced
* Environment is being resisted
* Low cost of the maintenance
* Thermal efficient
* Good sound controlling
* Wi-Fi compatible.

**Physical Outputs**

It has could be seen that Precast concrete is readily available in various sizes and shapes that includes structural elements as well as unreinforced pieces. In the building construction, one of the most common members being used are the panels that would be serving the purpose of as the cladding, structure or both. As the structural-architectural panels, they provide cost effective solutions for building enclosures. Full-sandwich panels because of the provision of the two durable faces is quite popular and always it allows filling of the space between, with insulation. Taking a look at the half-sandwich panels it has been seen that they just have one concrete face due to which they require additional working such as additional insulate as well finishing after erection. For walls, mostly hollow core panels are used but they especially suit to the floors. Cores could be used as ducts for heating, air conditioning and ventilation and it could be used for the utility chases.

For low-rise buildings following are the points describes in the precast concrete

* Size and additional advantages
* Connections, installation and finishes
* Energy and sustainability
* Physical properties and manufacturing
* Codes for building
* Comparative costs
* Project

**Advantages**

Concrete sandwich panels have many advantages because they are highly engineered and provide rugged and durable surfaces for all sorts of walls which could be used for floors too. In factory settings precast concrete panels are made and this helps in improving the quality but also polishing the controlling factors. There is a possibility of manufacturing year around during any sort of weather. In the designing buildings one predominant panel size and panel manufacturing becomes like a repetitive process that has gained efficiency. It follows two step casting process so that the resulting void between the panels could be filled in the insulation that also play an important role in protecting the panels. Another most common and prominent advantage of precast is its ability to quickly erect panels at the site. Right after the making of the footings, panels could be placed from the enclosure and may requires some lead time for ordering the panels. It is believed that construction could be completed within a small footprint which may allow building in the weather that may affect negatively the other types of construction. Construction of solid-high quality concrete with is built with effective use of labors makes structures that are cost effective.

Precast just like all other construction, provide resistance to termite, fire and mold. The role of the exterior walls is to withstand against tornado-force walls. Occupants are protected through the solid construction from all-natural disasters and weathers which could be threatening for them.

*On-site Cast (in-situ) Outputs*

Specialized Outputs

Understanding of in-situ non-destructive test outcomes are not just their averaging and afterward processing the corresponding compressive quality by methods for a developing quality relationship. It is important to structure a solid blend to have a mean competitiveness or strength more noteworthy than the indicated characteristic strength, by a sum named the margin, so as to represent the variability in production underway. The in-situ trademark quality of the test area can be assessed from in-situ test results by the utilization of standard factual systems that take into thought the quality control, number of tests and the necessary certainty level in the forecasts. The utilization of as not many as three or four test results, similar to the standard during development, brings about excessively preservationist evaluations of the in-situ trademark/tenth percentile quality. This is exacerbated by the way that the methodology accepts that the inconstancy of the set up compressive quality is equivalent to the inconstancy of the set-up test results when it has been recognized that the last has an inside test inconstancy by and large more prominent than the previous.

Physical Outputs

The impact of Reinforcement ratio on the breaking of the tried sections was very obvious. By contrasting the splits of the initial five sections to the staying four chunks of each solid extent, it tends to be seen that the pieces with a higher fortification proportion endured less serious breaking. The modulus of versatility of the fortifying bars is a lot higher than that of the solid; subsequently, the strengthening bars imparted the worries to the solid at a generally low strain level, along these lines keeping away from solid breaking.

**Profundity of Control Joint**

The impact of the profundity of the control joint was explored dependent on the breaks of the second and fourth sections, or the third and fifth chunks, of each solid extent, etc. The outcomes infer that the profundity of control joint didn't influence the splitting conduct of the sections tried right now. The profundity of the control joints (in excess of 10 mm) was moderately enormous contrasted with the thickness of the tried pieces (30 mm). Hence, expanding the joint profundity from 10 mm to 30 mm may not influence the splitting of the chunks, as much as expanding it from 5 mm to 10 mm, for instance.

Economic Outputs

The cast in situ piles are installed through pre-execution which eliminate the vibration because of driving in the case driven piles. Through hammering in driving in the housing regions may lead to cause a huge sound pollution. And cast in situ piles are found highly effective and useful. Beyond this and in the areas of water logged, the cast in situ with a long time or permanent casing would be more and highly suitable. While, skin function can be fully used by the cast in situ with the ground in the process and design stages that cannot be considered as in the case of riven piles that just utilize the very end bearing.

The cast in situ concentrate piles cannot be found always or usually requiring the foreign materials and resources or equipment that would suffice the requirement if a project which making the cast in situ piles highly adoptable and much cheaper of the pile foundation. On the other side, cast in situ is also used for the purpose to manage the handling and driving stresses and matters. This thereby enhances the support and empowerment needed that is not in the cast of casts in situ piles hence decreasing the required amount of support and reinforcement. It is connected above with the pile cap by using a monolithic system. The top ground is excavated up to pile cut off stage from where the slushy quality concrete gets removed through hand hilty for the purpose of rebars in the pile cap. Because of this monolithic connection, cast in situ ensure a benefit of having higher resistance to earth quake and forces of wind and not material is required when piles are casted. As the machinery and other resources such as material used are mainly from local contractors can do it and a highly skilled labor is not needed so far. As well as, no critical attention is needed for the joints in the cast in situ piles when compared with precast driven piles.

# Section 3 – Methodology

A research methodology is recognised as the most critical section of the entire process of research. The stage of research methodology allows the researcher to select the most suitable practical procedures and statistical techniques to identify and critically analyse information about the research topic. Application of appropriate research methods is a critical condition analyse the entire scenario and proper suitable solutions to the research problem. Furthermore, the comprehensive development of research methodology allows the audience to figure out the overall validity and reliability of this research problem and relevant findings.

## Research Questions and Hypothesis

Research Questions

* How the practice of precast concrete structure is different from the regular method of the on-site cast?
* What are the significant differences between behaviour domains of precast concrete and on-site cast concrete structures?
* How the features of inputs and outputs of the specialised precast concrete structure are different from the regular method of the on-site cast (in-situ) in the forms of residential, commercial, and industrial construction.

Hypothesis

*Ho:* There is a significant difference exists in case of inputs and outputs regarding specialised pre-cast concrete structures against regular methodologies in residential, commercial, and industrial construction.

H1: There is significant difference exists in case of inputs and outputs regarding specialised pre-cast concrete structures against regular methodologies in residential, commercial, and industrial construction.

## Research Design

The focus of this investigative research work is to adopt the statistical approach of mixed methods designs. Under the practical scenario of the mixed research process, both the domains of qualitative and quantitative techniques are considered to examine the practical implications of specialised pre-cast and regular methods of concrete structuring. Both forms of qualitative and quantitative research works are under consideration to make inferences on the performance of different methods of concrete construction.

For this particular topic, both qualitative and quantitative methods are used. Mix method is useful to acquire better results in terms of comparing inputs and outputs of specialised pre-cast concrete structures against regular methodologies in residential, commercial, and industrial construction. Furthermore, the comparison of precast behaviour with conventional methodologies is analyzed in a simple building, apartment building, and complex building.

Under the approach of the mixed research process, the triangulation method is selected as the research design for this study. The primary purpose of considering this research design is to deliver equal weightage to both forms of qualitative and quantitative research work. The central aim of selecting this research design is to attain different but relevant data from both the options of qualitative and quantitative forms of data collection. This approach is adopted to make better inferences on the involvement and establishment of both the processes of a specialised form of pre-cast and regular method of concrete structuring. The one-phase design of triangulation assists research to consider both qualitative and quantitative methods during the constant timeframe to obtain the desired form of information on the research problem.

## Data Collection

Data collection is the most crucial stage of the entire process of research work to evaluate the behavioural significance of both the domains of specialised precast concrete structuring and regular method in the form of on-site cast (in-situ) construction. To successfully achieve the process of data collection, two particular methods are selected to ensure the consideration of relevant and useful forms of information for this exploratory research work. These data collection methods are recognised as a critical investigation of the existing literature review on this topic and the conduction of structured interviews with main stakeholders of the construction industry. The central rationale of considering these two data collection methods is to obtain the most suitable and reliable forms of knowledge in order to make better inferences about the main research problem. To obtain the domain of quantitative research work, the survey method is conducted to attain relevant information from the industry shareholders.

## Research Procedures and Instruments

There are plenty of research procedures and specific instruments available for the researcher to conduct the process of research. Hence, the primary focus of researcher is to consider specific research procedure referring the nature of the research problem. The phase of hypothesis development for this study indicates that there is need of comparing performance of both the procedures of precast concrete structuring and regular method of on-site cast (in-situ). The domain of comparison is helpful approach to determine the significance of both the procedures mainly in the forms of commercial, residential, and industrial domains.

To meet the objective of comparing inputs and outputs of both the forms of precast concrete structuring and regular method of on-site cast (in-situ), the statistical procedure of comparing percentages is adopted. The core objective of selecting this approach is to compare percentage values in case of both the procedures of precast and on-site (In-situ) concrete structuring to determine the effectiveness of both the methods. The application of percentage analysis is helpful to make necessary comparison between the two procedures of precast concrete structuring and the regular method of on-site cast (in-situ) concrete constructing.

*Data Analysis*

The procedure of data analysis is identified as a comprehensive approach to critically inspect, transform, and model data to make unbiased outcomes in the end. This process involves various forms of consideration and adoption of suitable methods of data analysis. For this study, structured interviews from industry stakeholders and assessment of former research work on topic are adopted as the procedure of data analysis in the scenario of qualitative research work. On the other hand, the wide-ranging tool of survey is applied to make inferences about the spectrums of inputs and outputs for both the approaches of precast concrete structuring and regular method of on-site cast (in-situ) as the traditional process of concrete construction.

*Validity of Data*

An appropriate form of data analysis requires assurance of validity in order to obtain unbiased and authentic statistical outcomes in the end. To obtain objective of proper validity of entire form of data, information is gained from the credible sources such as scholarly articles, research reports, industrial forms of information etc. The main purpose of this practice is to ensure the authenticity and reliability of the collected data to ensure correct industrial trend in the end.

## Survey Questionnaire

The following survey for this research work was mailed to 50 different construction industry stakeholders operating in the city to collect knowledge about their experiences with different forms of concrete structuring. Diverse entities are selected under the three major domains of residential, commercial, and overall industrial. Forty-five responses were received for the ten survey questions related to the input and output domains of specialised precast concrete structuring and regular method of on-site cast (in-situ) method.

Q1. Do you believe, adopting precast concrete is good option to build house in cost effective manner as compare to traditional methods of structuring?

1. Yes B) No C) Unsure to decide between new and old construction method

Q2. Is precast concrete being speedy method irrespective of the entire process of transporting from some other place?

1. Yes B) No C) Neutral

Q3. Is the growing trend of precast concrete method is going to replace approach of human workforce, and it is going to the be alarming for the industry?

1. Yes B) No C) Not sure

Q4. Can construction cost be reduced by focusing traditional method of cast on-site as compare to advance form of precast?

1. Yes B) No C) Not sure

Q5. Will you prefer stable operation under the approach of precast concrete process as compare to standarised domain of on-site cast structure?

1. Yes B) No C) Not sure

Q6. Is desired level of erection being possible through the wide-ranging method of on-site cast concrete?

1. Yes B) No C) Neutral

Q7. At the small-scale construction such as the approach of building apartments, On-site cast concrete structuring is suitable method to maintain desired control level of quality.

1. Yes B) NO C) Neutral

Q8. On-site concrete method is convenient approach when it comes to catering different shapes of commercial buildings.

1. Yes B) No C) Neutral

Q9. The objective of durability can easily be achieved by adopting the practice of precast concrete structuring.

1. Yes B) No C) Not Sure

Q10. Is transportation cost being major reason to never consider the option of precast concrete structuring for the residential buildings?

1. Yes B) No C) Neutral

# Section 4 – Research Results and Discussion

*Comparison of precast behaviour vs conventional methodologies in a simple building*

A critical examination of precast concrete in a simple building indicates its overall integrity and accessibility. It is evident that the population is growing at an alarming rate. The rapid growth of the population demands an increased number of houses in the residential area. It requires a far most approach to build houses by optimising both cost and duration. The precast concrete construction method proved to be effective as it is one of the speediest construction processes with minimal labour. The construction of residential houses is far most feasible through the technique of precast concrete construction. The primary advantage of precast concrete construction in the construction industry is a reduction in the overall time of construction. As the concrete slabs and panels are developed away from the construction site, it is easy to manage waste and to optimise cost. It is one of the most ideal solutions for residential buildings, especially a simple building due to structural benefits. If the production of the entire process is in bulk, then the cost of construction is significantly saving. The structure of the simple house such as residential buildings is somewhat standard due to its durability. In a simple house, the precast concrete tends to provide sound durability and flexibility. The structural elements of the precast concrete tend to enhance the overall stability of the structure of a building, which is less likely visible in the conventional methods. In the cast insitu, the concrete is cast in the construction site and it requires a certain amount of time in order to create stability. Therefore, it is obvious that cast insitu doesn’t provide such stability as delivered by the precast concrete. With the help of precast concrete slabs or panels, construction workers can easily fix each slab with each other without even worrying about the stability factor. During the rainy season, the precast construction of the simple house also provides an edge in comparison to the cast insitu construction technique. The precast concrete construction slabs and panels are already dried up and in perfect condition to be used even in the rainy season; however, one cannot use cast insitu construction technique due to its limitation. It requires a certain amount of time to acquire its strength and steadiness. The rainy season often makes it hard for cast insitu to obtain its firmness. It is notable to consider the fact that precast concrete construction is highly effective in financing costs as it usually requires less construction process. In addition to this, it is highly essential to mention about the seismic properties of precast concrete slabs and panels as compared to the cast insitu construction methods. The precast concrete construction technique has an innovative seismic resisting system. With the help of this seismic resisting system, the overall safety of the house is significantly increased. The verification of precast concrete construction by using a spectrum indicates that it reduces the overall effect of seismic waves over the house. While in the case of cast insitu, the overall effect of seismic waves is significantly higher as compared to precast concrete construction. There is no significant resisting system in the cast in situ techniques that can decrease the overall impact of seismic waves in case of an earthquake. In the seismic prone regions, the constructors should need to adopt the technique of precast construction in order to ensure the stability, flexibility, and durability of the residential house.

Findings and educated decision on what would be more appropriate to use

A critical analysis of all the findings in terms of simple buildings indicates both the pros and cons of precast concrete construction and cast insitu. The precast concrete construction process proved to be one of the most significant and effective construction products due to its rapid programming of the entire process. It further ensures continuous and speedy work done without any interruption from the weather. The overall technique of precast concrete helps to improve the approach of buildability in a simple house. Furthermore, the comparison of seismic properties of precast concrete and cast insitu in simple building and also indicate the effectiveness of precast concrete construction. It is well known that the precast concrete construction in a simple house construction has specific seismic resisting properties that reduce the overall to and fro movement of the entire house. Therefore, it is evident to say that precast concrete construction technique is effective and efficient in the residential construction sector as compared to the cast insitu.

## Comparison of precast behaviour vs conventional methodologies in an apartment building

It is highly necessary to get a better understanding of the precast behavior in an apartment building as compared to the behavior of the cast insitu technique. It is notable to consider the fact that many construction companies are currently using precast construction techniques for building their methodology. The overall behavior of precast concrete construction in an apartment building is highly significant due to the viable production of the high standard of work. The frame concrete solution of the precast concrete in service has been analyzed in an apartment building to determine its overall effectiveness and behavior. The frame solution of the precast concrete is often very flexible and stiffer as compared to the other methodologies. The precast concrete frame solution is usually utilized in an apartment building in order to create a flexible system. The spatial frames in the precast concrete frame solution are highly effective to resist the vertical and lateral loads in an apartment building. Such kind of frame solution is hard to maintain and manage in the cast insitu technique. Furthermore, the wall solution of the precast concrete construction helps to provide a ductile wall system in an apartment building. In an apartment building, it is highly necessary to maintain a ductile wall system so that the lateral and vertical loads are easily supported with the vertical structural wall. The overall integrity of these vertical structural walls is often kept high in order to acquire shear resistance of the whole structural system. Maintaining proper shear resistance in the cast insitu technique is usually problematic for engineers as the shear resistance of the apartment building often exceeds 65 percent of the total shear resistance. From a structural point of view, the precast concrete construction technique tends to offer a highly secure and highly utilized solution to maintain the overall integrity of the building. The precast concrete construction is highly effective for apartment buildings due to its both low ductility and high ductility. High ductility is usually managed when all the joints between columns and beams are fixed. So, it is a possible option when it comes to the construction of an apartment building.

Findings and educated decision on what would be more appropriate to use

A critical examination of the behavior of precast concrete and conventional methodologies helps to provide better insight into the effectiveness and usefulness of both techniques. After a thorough analysis of precast concrete behavior and cast insitu behavior in an apartment building, it is found that the precast concrete construction method has the upper hand. Effective speed and flexibility of the entire system are more likely to enhance the structural integrity of the apartment building. The structural components of precast concrete make it a vital option to be used for the construction industry. The significance of precast concrete in terms of construction cost and overall construction timing greatly reduces the expenses of an apartment building project. The high utilized solution along with high safety makes precast concrete construction a potential option for the apartment building. A critical examination of the shear resistance of precast concrete slabs and panels as compared to the conventional cast insitu methodologies indicate its efficiency. It has been observed that the precast concrete construction of an apartment building helps to acquire a ductile wall system in the building due to the considerable strength of the vertical structural wall. These vertical structural walls are highly durable, flexible, and ductile and they can easily manage the lateral and vertical loads of the entire apartment building. Loading bearing capacity of the precast concrete slabs and panels is high as compared to the rest of the cast insitu processes. Therefore, it is safe to say that precast concrete construction techniques should be utilized in order to construct an apartment building.

## Comparison of precast behaviour vs conventional methodologies in a complex building (prison)

It is highly beneficial to consider the role of precast concrete behavior in a complex building such as a prison as compared to the conventional methodologies. It is one of the obvious challenges for all the management and authorities of the prison to ensure fast and speedy construction without any delay. The most visible challenge in this fast-growing prison population is the construction of more rooms for inmates. In these critical situations, it is highly necessary to adopt a reliable and effective construction technique that ensures speedy construction with minimal labour. In Australia, a number of prisons have utilized the concept of precast concrete construction to rapidly increase their overall construction speed. Experts in the construction sector are more likely to adopt the idea of precast concrete construction for the manufacturing of prison cells in no time. The construction of modular steel cells in Australian prisons helps to incorporate exact site specifications in order to ensure a high level of security of the prison cells. The construction of these prison cells is faster and at a low cost as compared to other conventional methodologies of construction. It is notable to mention that precast concrete cells in the prison are prefinished so it enhances the overall process of buildability. These modular steel cells are more highly effective, yet low cost as compared to the rest of the construction methodologies. When it comes to conventional construction methods, the construction of the prison cell is a long and lengthy process with a lot of environmental waste generation. These conventional construction methodologies fail to provide overall project efficiency due to increased construction time and cost. Furthermore, the construction of complex buildings such as a prison usually requires proper certification from Australian authorities in terms of strength. It is evident that a complex building such as a prison must fulfill the national standardized tests. The majority of precast concrete modular cells pass ASTM F2322-03 standard test. Furthermore, the floors of precast concrete also provide effective slip resistance characteristics as compared to the regular concrete floors. The prefinished concrete floors in a prison are incorporated with an engineered concrete floor system that maintains the overall safety of the structure. The high probability of delivery quality of the precast concrete structure is highly effective to provide quality outcomes. One of the most essential aspects that should be considered during the construction of complex structures such as prison is its size variation. Most of the prisons in Australia usually have limited space, which cannot be exceeded. The utilization of cast insitu techniques for the construction of certain rooms or cells is usually difficult to achieve due to the limitations of cast insitu construction techniques. In order to overcome this scenario, the precast concrete can be designed in order to meet any exact dimensions that are needed for the construction of more rooms for inmates. Furthermore, the critical examination of the precast concrete construction technique in prison ensures the maximum safety of inmates and other safety officers.

The structural elements of precast concrete decrease the probability of any damage in the prison cell. It has been observed that precast prison cells prevent equipment in the cell to be used as weapons against any inmate. Prefinished prison cells do not leave any piece of concrete that can be later used for attacking. It is noteworthy to mention that a shared precast mechanical service known as the chase is present in between each pair of cells. The main function of this chase is to hold the plumbing for the stainless-steel combination. It is also used to house the electrical conduit for alarms, intercoms, smoke detectors, and lights. These characteristics are hard to be found in conventional methodologies. It has been observed that precast concrete construction techniques can be utilized for the creation of an L-shaped precast bunk bed in the cells. The supply air duct is usually set in the L-shaped precast bunk bed in order to provide air conditioning. The plastic pipes are buried in the concrete in order to provide a radiant underfloor system for proper heating. Due to the incorporation of plastic pipes in the precast concrete, there are no visible radiators that can be ripped off by inmates in order to be used as weapons. However, when it comes to conventional methodologies, there is an increased chance that the inmates rip off radiant and use it as a weapon. The cat insitu fails to properly cover these pipes and radiant as compared to the precast concrete construction.

Findings and educated decision on what would be more appropriate to use with reasoning

A thorough examination of both precast concrete construction and conventional methodologies in complex buildings such as a prison determines their effectiveness. Regardless of the pros and cons of both construction techniques, it has been observed that precast concrete construction is highly effective and durable as compared to conventional methodologies. The utilization of precast concrete construction technique in the prison is capable of withstanding extreme physical abuse as compared to the cast insitu technique. The prison is more likely to be victimized by the inmates through concealment attempts, clever entry, and tampering. It has been observed that there are no visible joints in the precast concrete construction method, which ensure the maximum safety of inmates. Through cast insitu methodology, the inmates are more likely to commit hanging due to visible joints at the ceilings and between the walls. However, the incorporation of the precast concrete process eliminates hanging due to its monolithic design. The preparation of the precast concrete method is done by keeping in mind the monolithic design, which deters inmates from picking away at a joint. The absence of joints at the ceiling and between the walls deters inmates to use the debris as a weapon. Furthermore, the utilization of the precast concrete construction in complex buildings like prison is also effective due to its speedy construction. As prison is a crowded place with a lot of distractions at every point, it is essential to utilize a construction technique that requires less time. The utilization of the precast concrete construction process will require minimal labour as the slabs, panels, and frames are pre-prepared in the factory. Consequently, it is safe to say that precast construction should be utilized for the construction of complex buildings such as a prison as compared to the utilization of conventional methodologies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Questions | Option 1(Agree) | Option 2 (Disagree) | Option 3 (Neutral) | % of Total (Agree) | % of Total (Disagree) | % of Total (Neutral) |
| 1 | 35 | 8 | 2 | 77.77777778 | 17.77777778 | 4.444444 |
| 2 | 40 | 5 | 0 | 88.88888889 | 11.11111111 | 0 |
| 3 | 15 | 25 | 5 | 33.33333333 | 55.55555556 | 11.11111 |
| 4 | 15 | 25 | 5 | 33.33333333 | 55.55555556 | 11.11111 |
| 5 | 35 | 6 | 4 | 77.77777778 | 13.33333333 | 8.888889 |
| 6 | 20 | 18 | 7 | 44.44444444 | 40 | 15.55556 |
| 7 | 35 | 9 | 1 | 77.77777778 | 20 | 2.222222 |
| 8 | 15 | 24 | 6 | 33.33333333 | 53.33333333 | 13.33333 |
| 9 | 40 | 5 | 0 | 88.88888889 | 11.11111111 | 0 |
| 10 | 17 | 26 | 2 | 37.77777778 | 57.77777778 | 4.444444 |

The overall trend of the respondents’ response is examined by adopted the statistical tool of percentage analysis. It is applied for all the ten questions asked from the 45 respondents through the approach of survey method. Referring to the overall approach of the analysis, it is estimated that precast concrete structuring is preferable method of construction in the industrial scenario. This trend is established by exploring percentage of responses against question 1 and 5 of the survey questionnaire. It is established that 77% respondents agreed to this argument that precast concrete structuring is effective method when it comes to achieve objective of operational stability. On the other hand, the procedure of on-site cast (in-situ) is popular procedure of construction when stakeholders are interested to develop commercial building in different shapes and sizes. In response to question 8 in survey, 53% of respondents agrees to this statement that on-site cast (in-situ) in more convenient option to gain objective in the form of highest standardisation.

# Section 5 – Conclusion

In a nutshell, precast concrete is highly beneficial in construction. Whether it is the construction of a simple house or a complex building, the precast concrete ensures high structural integrity. The high thermal mass of precast concrete makes it a viable option in terms of saving energy costs. Impressive beam to column joint linkage makes it operative in both low ductile class and high ductile class. It has been observed that the precast concrete is highly effective as compared to the other conventional methodologies due to its high construction speed, fire resistance, flexibility, durability, and effectiveness.

# Bibliography

Aninthaneni, P.K. and Dhakal, R.P. 2014. Conceptual development: Low loss precast concrete frame building system with steel connections. In: *Nzsee Conference*.

Ataei, A. et al. 2016. Experimental study of composite beams having a precast geopolymer concrete slab and deconstructable bolted shear connectors. *Engineering Structures* 114, pp. 1–13.

Bin, Z. et al. 2005. Experimental study on seismic behavior of precast concrete beam-column subassemblage with fully assembled joint [J]. *Earthquake Engineering and Engineering Vibration* 1

Breccolotti, M. et al. 2016. Beam-column joints in continuous RC frames: Comparison between cast-in-situ and precast solutions. *Engineering Structures* 127, pp. 129–144.

Chan, T.K. 2011. Comparison of precast construction costs–case studies in Australia and Malaysia. In: *Procs 27th Annual ARCOM Conference*., pp. 5–7.

Dong, Y.H. et al. 2015. Comparing carbon emissions of precast and cast-in-situ construction methods–A case study of high-rise private building. *Construction and Building Materials* 99, pp. 39–53.

Elliott, K.S. 2016. *Precast concrete structures*. Crc Press.

Elliott, K.S. and Jolly, C. 2013. *Multi-storey precast concrete framed structures*. Wiley.

Fatema, T. and Islam, T. 2006. Study on connection between precast concrete beam and cast-in-situ column in prefabricated building frames. *Journal of Engineering and Applied Sciences* , pp. 33–38.

Flynn, K.N. et al. 2012. Residual load development in cast-in-situ piles–a review and new case history. In: *Proceedings of the 9th International Conference on Testing and Design Methods for Deep Foundations (IS Kanazawa), Kanazawa, Japan*., pp. 18–20.

Girhammar, U.A. and Pajari, M. 2008. Tests and analysis on shear strength of composite slabs of hollow core units and concrete topping. *Construction and Building Materials* 22(8), pp. 1708–1722.

Gordon, S.R. and May, I.M. 2006. Development of in situ joints for pre-cast bridge deck units. In: *Proceedings of the Institution of Civil Engineers-Bridge Engineering*. Thomas Telford Ltd, pp. 17–30.

Hossain, K.M. 2005. Performance of volcanic ash based precast and in situ blended cement concretes in marine environment. *Journal of materials in civil engineering* 17(6), pp. 694–702.

Jazzar, O.A.L. 2006. *Reinforced concrete building system*.

Ji, Y. et al. 2018. Comparing greenhouse gas emissions of precast in-situ and conventional construction methods. *Journal of Cleaner Production* 173, pp. 124–134.

Jiansheng, Z.W.Q.J.Y. and Guoquan, Q.H.L. 2012. Tests on seismic behavior of precast shear walls with cast-in-situ boundary elements and vertical distributed reinforcements spliced by a single row of steel bars [J]. *China Civil Engineering Journal* 10

Jin-rong, D. 2009. Enhanced and weakened effect of skin friction of cast-in-situ piles. *Chinese Journal of geotechnical engineering* 31(5), pp. 658–662.

Korkmaz, H.H. and Tankut, T. 2005. Performance of a precast concrete beam-to-beam connection subject to reversed cyclic loading. *Engineering Structures* 27(9), pp. 1392–1407.

Lˇpez-Mesa, B. et al. 2009. Comparison of environmental impacts of building structures with in situ cast floors and with precast concrete floors. *Building and Environment* 44(4), pp. 699–712.

Liu, B. et al. 2011. Experimental study on seismic performance of post-tensioned precast prestressed concrete frame. *Jianzhu Jiegou Xuebao(Journal of Building Structures)* 32(2), pp. 24–32.

Liu, H.-L. et al. 2009. Use of large-diameter, cast–in situ concrete pipe piles for embankment over soft clay. *Canadian Geotechnical Journal* 46(8), pp. 915–927.

Lu, X. et al. 2016. An innovative joint connecting beam for precast concrete shear wall structures. *Structural Concrete* 17(6), pp. 972–986.

Lu, Z. et al. 2017. Studies on seismic performance of precast concrete columns with grouted splice sleeve. *Applied Sciences* 7(6), p. 571.

Magliulo, G. et al. 2008. Seismic assessment of existing precast industrial buildings using static and dynamic nonlinear analyses. *Engineering Structures* 30(9), pp. 2580–2588.

Del Mar Casanovas-Rubio, M. and Ramos, G. 2017. Decision-making tool for the assessment and selection of construction processes based on environmental criteria: Application to precast and cast-in-situ alternatives. *Resources, Conservation and Recycling* 126, pp. 107–117.

Metelli, G. et al. 2011. Cyclic behaviour of a column to foundation joint for concrete precast structures. *European journal of environmental and civil engineering* 15(9), pp. 1297–1318.

Metelli, G. and Riva, P. 2008. Behaviour of a beam to column “dry” joint for precast concrete elements. In: *The 14th World Conference on Earthquake Engineering October*., pp. 12–17.

Murthy, A.R. et al. 2014. Structural performance of precast and cast-in-situ ultra high strength concrete sandwich panel. *Int. J. Comput. Mater. Continua* 44(1), pp. 59–72.

Ozden, S. et al. 2014. Performance of precast concrete structures in October 2011 Van earthquake, Turkey. *Magazine of concrete research* 66(11), pp. 543–552.

Pampanin, S. et al. 2011. Expectation meets reality: seismic performance of post-tensioned precast concrete southern cross endoscopy building during the 22nd Feb 2011 Christchurch earthquake. In: *NZ Concrete Industry Conference, Rotorua*.

Polder, R.B. and De Rooij, M.R. 2005. Durability of marine concrete structures: field investigations and modelling. *Heron, 50 (3)*

Ricci, I. et al. 2013. Results of pseudo-static tests with cyclic horizontal load on cast in situ sandwich squat concrete walls. *Engineering structures* 54, pp. 131–149.

Riva, P. 2006. Seismic behaviour of precast column-to-foundation grouted sleeve connections. In: *Advances in Engineering Structures, Mechanics & Construction*. Springer, pp. 121–128.

Ryntathiang, T.L. 2005. *An investigation on precast and cast in-situ concrete block pavements for low volume roads*. PhD Thesis, IIT, Kharagpur.

Ryntathiang, T.L. et al. 2005. Structural behavior of cast in situ concrete block pavement. *Journal of transportation engineering* 131(9), pp. 662–668.

Shen, L. et al. 2009. Benefit analysis on replacing in situ concreting with precast slabs for temporary construction works in pursuing sustainable construction practice. *Resources, conservation and recycling* 53(3), pp. 145–148.

Toniolo, G. 2012. SAFECAST project: European research on seismic behaviour of the connections of precast structures. In: *15th World conference on earthquake engineering (15WCEE), Lisbon, Portugal*., p. 8.

Xiao, J. et al. 2012. Seismic behavior of semi-precast column with recycled aggregate concrete. *Construction and Building Materials* 35, pp. 988–1001.

Xiao, Q.D. et al. 2015. Behavior of double-wall precast concrete shear wall under low-cyclic reversed loading test. In: *Advanced Materials Research*. Trans Tech Publ, pp. 354–358.

Yardim, Y. et al. 2013. AAC-concrete light weight precast composite floor slab. *Construction and Building materials* 40, pp. 405–410.

Yee, P.T.L. et al. 2011. Performance of IBS precast concrete beam-column connections under earthquake effects: a literature review. *American Journal of Engineering and Applied Sciences* 4(1), pp. 93–101.

Zhengxing, Z.Z.G. 2012. Seismic test and analysis of joints of new precast concrete shear wall structures [J]. *China Civil Engineering Journal* 1

Zhu, Z. and Guo, Z. 2011. Seismic performance research on wall-slab joints of new precast concrete shear wall structure. *Dizhen Gongcheng yu Gongcheng Zhendong(Earthquake Engineering and Engineering Vibration)* 31(1), pp. 35–40.

Zhu, Z.-F. and Guo, Z.-X. 2012. Test research on seismic performance of plane model of new precast concrete short-limbed shear wall. *Harbin Gongye Daxue Xuebao(Journal of Harbin Institute of Technology)* 44(4), pp. 94–99.