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STUDY ON PRE-FABRICATED STRUCTURE IN CONSTRUCTION ENGINEERING WITH ANCIENT HINDU ARCHITECTURE

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Abstract:
Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site, and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located Most of the Indian structures which one have more life cycle known as modern buildings have its own identity and construction techniques, this can explain the development of construction industry with civilization impact on present society. Some structures still known as ancient cultural objects, with different materials used in construction and the life time of the structures are more than normal construction. Technically pre fabrication is a technique used in past generations according to constructional design and architecture. It is an innovative creation of ancient people which showed path of development for future generations. The evolution of prefabricated construction is noticeable by strict observance of the original ancient models that continued over centuries together. The structures are prepared with the locally available materials with different processing techniques and design from structure using Stadd pro and with, becoming economical and echo friendly. Research required in broad way with study on structure life of modern building and its techniques adoption with present techniques

Key words: Prefabricated Structures, modern buildings, Staad pro software.

1.0 Introduction:

Prefab is related to prefabricated construction. The word "Prefab" is not an industry term like modular homes, manufactured homes, panelized home, or site-built home. The term is an amalgamation of panelized and modular building systems which is well planned & designed before the initiation of construction and placement of structure as per detailed design at work site. In industry these are called Pre Engineered Building (PEB). Prefabricated homes and modular homes are dwellings manufactured in a factory in advance, usually in sections that can be easily transported to the site and integrated. Prefabs are made of composite materials which are manufactured by combination of materials containing different properties such as plastics, concrete and steel. These are specifically designed for longer period of applications or usage. Pre Engineered Buildings (PEBs) are extremely durable, weather as well as termite proof. Due to their longer life of utility and affordable cost, manufactured homes can be used for permanent, semi- permanent or temporary applications.

Pre- historic

The earliest known civilizations, i.e. the Stone Age, Bronze Age and Iron Age had limited construction materials and little

construction experience. Thus, the Stone Age witnessed just the stone caves as shelters. Later civilizations had evolved tools like bone, stone, wood, grass and animal fibers. Thus, they were able to make the tents or the tupiqs. It was while making the tools, that the early man had realized the technique of fixing and jointing.

Figure: Vatadage Temple, Polonnaruwa

1.2 Indian architecture:

Prehistoric and primitive architecture Study of art and architecture in Indus Valley Vedic village social conditions and way of life Rockcut temples, viharas, caves limitations of implements Buddhist, Jain and Hindu architecture reflection of religious thought and way of life Islamic architecture: Cultural differences and similarities of local inhabitants and invaders. Influence of advanced technology—domes, arches, vaults, conversion of places of worship into new needs of invaders. Study of early buildings in India expressing vigour in the form of buildings

Prefabrication:

Prefabrication, by definition is a process of fabricating some or all components of a unit or structure elsewhere, assembling and fitting them together on site where the structure is actually meant to locate. It might sound like a result of technological advancement in the modern world, but the fact remains that this is one of the oldest known construction methodology that has persisted over ages and is so versatile that it has been practiced continuously through history till date. The simple reason for such a diverse acceptance and adaptation of prefabrication is that this construction practice has made the construction process go faster and more efficient over ages. The process of prefabrication helps speed up the construction procedure and also results in reduction of overall cost of construction. Prefabrication is successful because it rules out the impact of variables that may affect the construction work on site. It ensures the quality of construction material, conditions and thus the quality of the construction units.

Advantages of prefabrication:

- Self-supporting ready-made components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.
- Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capital invested.
- On-site construction and congestion of site is minimized.
- Better quality control can be achieved in a factory assembly line setting than at the construction site.

Disadvantages of prefabrication:

- Leaks can form at joints in prefabricated components.
- Transportation costs may be higher for voluminous prefabricated sections.
- Large prefabricated sections require heavy-duty cranes and precision measurement from handling to place in position.
- Larger groups of buildings from the same type of prefabricated elements tend to look drab and monotonous.

Historical development of Iron and Steel in India As mentioned earlier, there are numerous examples of usage of iron in our country in the great epics Ramayana and Mahabharata. However, the archaeological

evidence of usage of iron in our country is from the Indus valley civilization.

Objectives:

- To prefabricated modern structure designed by using stadd pro
- Study of design of various elements of building
- Planning of various components of a building with column positioning Introduction of STAAD.Pro

Scope of study

- The study focuses on use of prefabrication for modern building construction.
- To find out widely used prefabricated components, materials and their jointing available in India.
- To find out the method of production of prefabricated Alc Blocks and their properties.
- Case study of sufficient number of building systems will be undertaken to establish a differentiation between prefabrication and conventional style of construction as well as other prefabrication techniques used throughout the world.
- The scope of the study is to analyze the prefabrication technologies and the recent works.

2.0 Literature review

Anumolu meher Prasad [1] The gopuram (multi-tiered entrance gateway) and the mandapam (pillared multi-purpose hall) are two representative structural forms of South Indian temples. Modelling and seismic analysis of a typical 9-tier gopuram and, 4- and 16-pillared mandapam of the 16th century AD Ekambareswar Temple in Kancheepuram, South India, are discussed.

Anisha Goswami, [2] The present study is included in the design of an Industrial Warehouse structure located at Nagpur. The structure is proposed as a Pre-Engineered Building of 30 meters width, 8 bays each of 7.5 meters length and an eave height of 6 meters. In this study, a PEB frame of 30 meter width is taken into account and the design is carried out by considering wind load as the critical load for the structure.

Jeng, B.; DiGiovanni, D.;Wan [3] The challenge further increases due to increased eye pleasing high rise structures with architectural problems. These architecturally pleasing structures with shape irregularity, when subjected to devastating earthquake are a matter of concern. The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground.

Lu, N [4] This dissertation focuses on the study of the Hindu temple. There has been a lot of research into Hindu temple architecture, still many aspects of this subject is still unexplored. This study attempts to collate all the existing research that has been undertaken in this field, and potentially contribute to the existing body of knowledge through a structural analysis of Hindu Temple architecture.

3.0 Methodology

The quality of construction is much higher when components are manufactured in a stable environment such as the factory. This is especially true in India where today, prefabrication has become synonymous with durable, modern, and western construction methods. Materials are used more efficiently, are safer from climatic damage, and can be reused in the material stream. Because of these benefits, a general consensus in India is to move prefabricated building systems beyond precast concrete for large-scale construction to additional market sectors including a resurgent interest in applying prefabrication technology to housing. Pre-Engineered Building (PEB) structures have emerged as a promising solution for eco-friendly construction, which is a very much on demand technology. PEB buildings are inherently green products and

have a very negligible impact on the environment as compared to traditional brick masonry and reinforced concrete structures. The only byproduct of such construction is metal scrap which is fully recyclable.

Figure: Pre-Engineered Building under construction

HINDUISM AND ITS RELEVANCE TO ARCHITECTURE

The main purpose of the early building art in the Indian sub-continent was the representation of the existing religious perception of the people in a tangible form. Therefore early Indian architecture in the form of various sacred monuments is essentially a representation of its religious beliefs. The earliest significant known buildings relate to Buddhism and Jainism. Those related to Hinduism were to follow soon after the beginning of the Christian era when the Vedic Gods were superseded by the Trimurthy of modern Hinduism.

Architect and New Construction Materials & Techniques:

The architect of today is both an artist and an engineer, who must synthesize his architectural ideas with scientific knowledge of design and construction of civil structures. He must be conversant with the available resources in labour, techniques and materials to produce a harmonious, durable and functional structure in line with his architectural concept. Architecture has always been constrained by the availability of materials and restricted by techniques of design and construction. Discovery of newer materials of construction along with the development of sophisticated design and construction technology, steel-framed superstructures and reinforced and pre stressed concrete have provided the architect an unlimited scope to use their creative imagination to put up structures which not only display architectural elegance but also meet the functional requirements without jeopardizing structural safety in any manner.

Modern constructions with traditional architecture

The advent of new technologies into a region with a rich history, culture and background in an area which has a rich background in art and architecture such as Iran can lead to a challenge between technology and architectural traditions of the region; one reason for the challenge between technology and the traditional architectural background is that the required infrastructure and the readiness for handling the concept of globalization does not exist. In the new millennium, a new globe is being constructed and in this process architecture is the most social art which can create temporal consistency and progression through unity and harmony in space. Such harmony and unity can help the development and expansion of a civilization. In modern times, we are witnessing the growth in a variety of fields.

The Structural System of the Hindu temples

The basic construction technique used in the Hindu temple was the trabeated system or the post and the beam method and which was extended by the use of corbelling techniques. This method was originally used for wooden construction in India and was later adopted for the stone structures as well.

The Trabeated System and the internal ceilings of the Hindu temple

The column-beam-corbel method of construction was the main structural principle governing the Construction of every Hindu temples. The principles of equilibrium of forces in action by means of arch, vaults and other forms of functional engineering rules never really played a part in the evolution of Hindu temple.

Production process of prefabricated concrete

The ALC (Autoclaved lightweight concrete) is available in the form of blocks, floor and roof slabs and wall panels for all type of modern structure buildings.

Figure: ALC blocks being manufactured in a plant

In case of blocks, the concrete is poured directly in the moulds whereas in case of slabs firstly the reinforcement is put in the moulds then the concrete is poured.

INTRODUCTION TO STADD PRO

STAAD-Pro is a Structural Analysis and Design computer program developed by Bentley systems, Inc., which is a powerful tool for structural analysis and design. Complicated and high-rise structures need very time taking and cumbersome calculations using conventional manual methods. STAAD-Pro provides us a fast, efficient, easy to use and accurate platform for analyses and designing structures.

Grade of concrete and steel used: Used M30 concrete and Fe 415 steel modern building.

Properties

Generation of member property can be done in STAAD.ProThe member section is selected and the dimensions have been specified. The beams are having a dimension of 0.3 * 0.7 m and the columns are having a dimension of 0.3 * 0.6 m , 0.35*0.7 m,0.3*0.7 m.

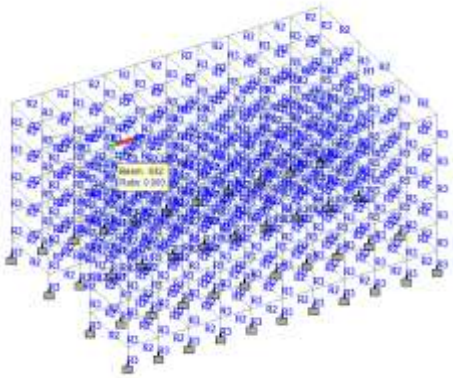

Figure: Member properties

Design of slabs

Slabs are plane members whose thickness is small as compared to its length and breadth. Slabs are most frequently used as roof coverings and floors in various shapes such as square, rectangle, circular, triangular etc in buildings. Slabs supports mainly transverse loads and transfers them to the supports by bending action in one or more directions. Beams or walls are the common supports for the slabs.

Effective Span

The effective span of a simply supported slab shall be taken as clear cover span plus effective depth of the slab or centre to centre

distance between the supports whichever is less The effective span of cantilever slab shall be taken as its length to the face of the support plus half the effective depth expect where it forms the end of a continuous slab where the length to the centre of support shall be taken.

Depth of Slab

The depth of slab depends on bending moment and deflection criteria. The trail depth can be obtained by using:

Effective depth $d=\frac{\text{span}}{\left(\frac{l}{d}\right)\text{basic X modification factor}}$

For obtaining modification factor, the percentage of steel for slab can be assumed from 0.2% to 0.5%. The effective depth d of two way slabs can be assumed using c l 24.1,IS 456 provided short span is <3.5m and loading class is<3.5kn/mm^2.

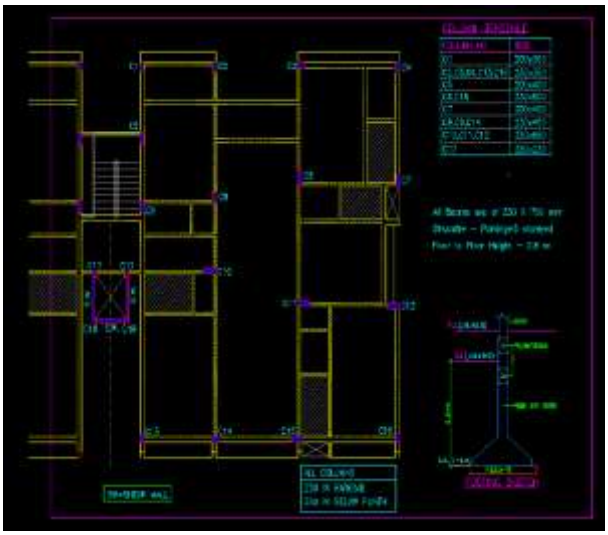

Figure: Pre-fabricated modern building geometrical view

4.0 RESULTS AND DISCUSSIONS

Materials for the Structure

The materials for the structure were specified as concrete with their various constants as per standard IS code of practice

Loading for modern Building structure

The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as:

- Self-weight
- Dead load from slab
- Live load
- Load combinations

Self-Weight

The self-weight of the structure can be generated by STAAD.Pro itself with the self-weight command in the load case column.

Dead load from slab

Dead load from slab can also be generated by STAAD.Pro by specifying the floor thickness and the load on the floor per sq m. Weight of beam, weight of column, weight of RCC slab, weight of terracing, external walls, internal walls and parapet over roof

The load was found to be:

Wall loads 14 kN/m^2

Floor load 5.5kN/m^2.

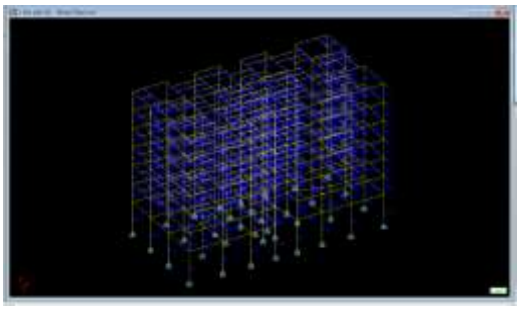

Figure: Modern building whole structure line plain view

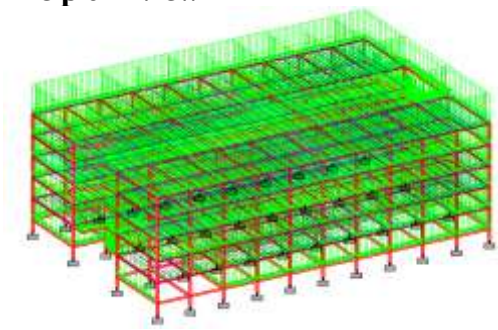

Figure: Structure under DL from slab

Live Load

Live load is taken as 4kN/m^2 (as per is standards for educational buildings from IS 875).

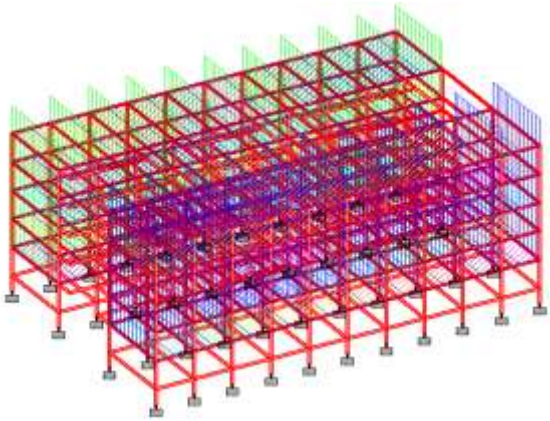

Figure: Structure under live load

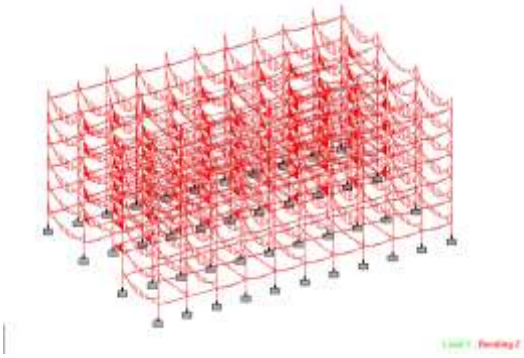

Figure: Structure under bending

Dead load from slab

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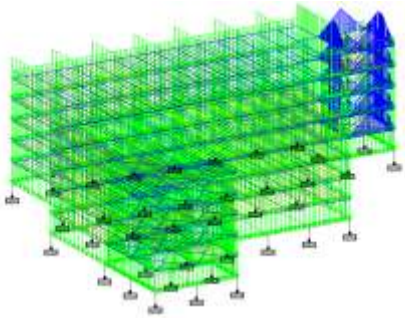

Figure: Structure under DL from slab

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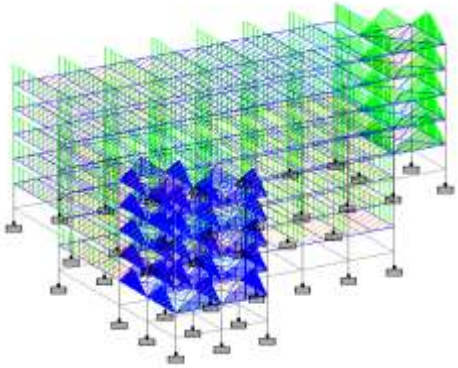

Figure: Structure under live load

the footing are designed by considering the maximum axial load which come from columns and this design is checked for one way shear and two way shear and development length hence founded it is a safe design.

Conclusion:

In this project the structural members like slabs, stair case, footings, are designed manually and the beams and columns are designed by using software STAAD pro which gives very accurate values as compared to manual design the structural members are checked for shear and deflection. Prefabrication technology has not transferred as easily when compared with other technologies because it is a production technology or knowledge based and not a consumption technology or product based. Technology transfer of prefabrication is not as pertinent to architects as it is to manufacturers of building products, but we are caretakers of culture in the AEC industry. The use of prefab can help to achieve results for the society's immediate needs because the fast changing environment, business, economics, industrialization, residential needs, settlements and many other factors of transportation like bridges, towers, railways calls for fast settlement and requirement for buildings, offices and industries, hence

prefabrication is the solution for fast and time saving construction.

Future scope:

The developing infrastructure can be anticipated to remain the foundation of Economic growth. Industry and infrastructure segments are expected to be the key demand drivers for steel structures in India over the next 5 years. Presently, structural steel industry employs the on-site model of fabrication for industry and infrastructure segments. Workshop delivery model is popular in PEB and buildings segment. On the whole, there is good prospective for steel structures in India owing to strong economic growth, enhanced government spending on infrastructure and change in approach regarding the utilization of structural modern in building.

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