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Feasibility Analysis of Post-Tensioned Beam for Industrial Building: A Review

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Abstract: ***In recent years, due to corrosion and the constant demand for increased traffic flow, there is an eagerly need for an efficient system that can be used to repair or strengthen bridges and structures with steel-concrete composite sections. There have been so many strengthening techniques used to prevent such serious structural problems. One of these most useful techniques, which has successfully proven effective in repairing and strengthening structural members, is to use the externally post-tensioned tendons technique. The various study has also provided a recently completed experimental program on scaled bridge composite steel and concrete beams strengthened with external post-tensioning tendons to explore the fundamental cyclic loading behavior.***

This article summarizes the design of Post-Tensioned Beam for industrial building and a comparative study between PT Beam and RCC Beam based on a literature survey. We are analyzing such structure in our research having a large span. Manual design of PT Beam for three different span lengths without any intermediate supports and manual design of RCC Beam. We are doing a comparative study of PT Beam and RCC Beam based on the results. This report is based on a study of PT Beam that will aid future research and advances in the construction industry.

Keywords: Post-Tensioning Beam, RCC Beam, Industrial Building

I. INTRODUCTION

In the present scenario in the construction industry, the post-tensioning method is used world widely due to its too many advantages. As we know in developing countries like India, the benefit of post-tensioning slabs, and beams is yet to be recognized. By using the post-tensioning technique we can achieve the most economical and safe design for residential as well as industrial buildings. In a multistorey structure like the Residential building, a shopping mall post-tensioning method is mostly preferred. By application of this method in building construction, it increases the strength as well as durability of the structure. By using the post-tensioning technique, the structure gives a better aesthetic look as well as an economic solution than that of the conventional method. Nowadays it has been observed that the post-tensioning slab, the beam used is large scale due is its superiority and also it can be applied to various types of structures.

Fig. 1 Post Tensioned Beam Casting

The above figure shows the casting of a Post-Tensioned Beam at site Nimmaluru Andhrapradesh, As we can see Post-tensioning is a technique for reinforcing concrete. Post-tensioning tendons, have prestressed steel cables inside plastic ducts or sleeves and are positioned in the forms before the concrete is placed in it. Afterward, once the concrete has settled and started gaining strength but before the service loads have been applied to it, the cables are tensioned or pulled tight, and anchored against the outer edges of the concrete member. Post-tensioning is a form of prestressing. Prestressing is the term that simply means that the steel is stressed, pulled, or tensioned before the concrete has to support the service loads to members. Most prestressed, precast concrete is pre-tensioned the steel is pulled before the concrete is poured into it. Post-tensioned concrete means that the concrete is poured first and then the tension is applied but it is still stressed before the service loads are applied so it is still prestressed. Construction of post-tensioned slabs, beams, columns, or various structural members on grade is mostly similar to using reinforcing steel, except for the tensioning step. Cables have been arranged as indicated by the engineer and chaired to run through the center of the slab or beam or column. For the particular type of residential construction, tendons at 48 inches in the center are quietly common. Also, commercial foundations will have required a good amount of steel, tendons can be easily routed around impediments. Larger structural concrete members like slabs, beams, columns, etc, may also be post-tensioned, especially in bridges and floors and beams in parking structures as well as in the industrial structure. The process is nearly similar to that used for all slabs, beams, columns, or any other structural member, except on a bigger span scale. And it is found the most interesting difference is that the tendons will often be draped so that they have low at the midpoint of a beam member and high at the support member, this places the steel at the point of highest in tension where it may keep the concrete held together in a tight place. With any structural members, the duct is often thin mortar used for filling spaces full following stressing to bond the strand to the concrete along its entire length as well as width these are called the bonded tendons. Unbonded tendons, are used in residential slabs and beams to remain free to move within the duct space and are protected from corrosion by grease which has been applied before grouting. Post-tensioning tendon placement and stressing are usually done by companies with certified, skilled, experienced workers who specialize in this work to do so.

Post-tensioning, which has a form of prestressing, also has several advantages over standard reinforcing steel or rebars:

Post-tensioning reduces as well as eliminates shrinkage cracking-therefore no fewer joints, or joints, are needed.

Cracks that do form are held extremely tight together.

It allows slabs, beams, and other structural members to be thinner as possible.

It also allows us to build beams, and slabs on expansive or soft soils and any other types of soil.

It can be designed for longer spans in elevated members, like floors or beams.

Fig.2 Tendon (cable) tails after tensioning

A. Tendon Detailing for various Structural Members

Tendon (cable) tails after tensioning apply. The cables are pulled up to 33,000 pounds, as a result, we got 8 inches of elongation per 100-foot cable. A residential building's post-tensioned concrete slab and a beam will typically be 8 inches thick and use 3000 psi concrete into it. Once the concrete has gained strength up to 2000 psi, typically within the 3 days to 10 days recommended by post-tensioning codes, in this situation the tendons are stressed. Today tendons are seven high-strength steel wires wound together and placed inside a plastic duct or sleeves. At each end, a post-tensioning anchor is located and these are located in pockets embedded into the slab edge as well as the beam. When the wires will stretch the strands are stressed, up to about 4 inches per 50-foot strand to apply at least 33,000 pounds of load. Stressing must be only done by qualified and skilled workers as well as an experienced engineers. After stressing process, the tendon has been cut off and the pocket in which the anchors are located is filled with grout to protect them from corrosion.

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II. LITERATURE REVIEW

For this topic, have found some useful content or literature which gives the readers a piece of cognitive information about their research in the related field.

1) Sreenivasa Prasad

Studied post-tensioned slabs the method which has been prepared for various types of buildings viz. industrial, commercial, and residential floor slab construction and other structural members as well. The progressively immeasurable use of this method is due to its great advantages and its nature of easy execution to a wide variety of structural geometry and design solutions. The application of post-tensioned floor slabs and reinforced concrete core walls have flatter progressively popular in a high-rise as well as tall building construction. Despite resentment of the simplicity of it depends on the basic concepts and well-known advantages, the uses extent of post-tensioning solutions cannot be considered harmonized in the more areas and structural designing applications.

By considering these technical reasons, it appears that the high potential offered by pre-stressing is within limits from being utilized, especially in the building construction and structures field. In the various cases where post-tensioning will provide a condescending solution, it happens after all that a high conventional non-pre stressed solution is often selected. In the end, the author has also discussed the Economics of the post-tensioning slab system is discussed including relative material quality contents, speed of construction work, and factors affecting and the limitations of the cost of post-tensioning. Finally, this discussion has been concluded on the flexibility of post-tensioned tall building structures in terms of successful uses in the future, also as new floor penetrations, and also demolition has been presented.

2) Post-Tensioned Concrete Long-Span Slabs in Projects of Modern Building Construction

Rafal Szydlowski and Barbara Labuzek studied this paper, the author scrutinized that the design of modern architectural building structure members required the use of slender and free from numerous supports of beams, columns, and slabs. So the author has found that the most satisfactory solution for the above requirements is the post-tensioned slabs, beam, and column by using unbounded tendons. It has been prestressed by unbounded tendons that are successfully used all over the world for several decades. During that time many recommendations dealing with the forming of geometry, soil conditions, prestressing, dimensioning, and erection technology were issued.

And in recent years prestressed slabs set apart by longer or shorter span and slenderness substantially exceeding recommended restrictions were designed and erected with success. During the beam's or slab's erection and two years of their use, the deflection of three oversized slabs was kept track of. Despite designing the slabs, beam, and column significantly larger as well as shorter and slenderer than the recommended greater value of span and by using span to depth ratio, the deflection of the slabs is far from the exceeding limit value. So at the end of the paper, the author concludes that the research shows various geometry, characteristics, and deflection of erected slabs and conclusion. Elucidation of a tremendously large span slab nearly 21.3 meters, that has been designed regarded to the information obtained from the previous realization.

3) Rahul Singhet. al. (2018)

Stated that in this expeditious and also in today's competitive world, the building and also construction sector has at the apotheosis of the growth of any country. High-rise buildings or tall buildings have been always admired by every human being worldwide. Predominantly the construction of a building is done by Reinforced Cement Concrete but in the present world, construction of high-rise buildings has been done by post-Tensioning. In Reinforced Cement Concrete, the economic squandering has very high in case of the various construction sectors like industrial, commercial, residential, and institutional buildings because of more material required in the construction field hence, Post Tensioned building proves to be more economic and also gives the strength as well as its most durable.

In Post-Tensioned construction, these buildings would save more quantity of steel bars and concrete as compared to Reinforced Cement Concrete and also increases the clear (distance) span in rooms and also give more quality than earlier. Through this paper, the author has the emphasis is to design a post-tensioned building using ETABS and SAFE software. ETABS stands for Extended Three-Dimensional Analysis of building systems and is used for the loading as well as the behavior of each section. The authors also said that the main purpose of this software is to design the multistoried building in a structured process would be by Indian Standard design codes.

4) Analysis and Design of RCC and Post-Tensioned Flat Slabs Considering Seismic Effect

Boskey Bahoria and Dhananjay K Parbat studied that in the present study, the post-tensioned design for a flat slab has be done by using two methods, the first method is the load balancing method and the second method deals with the equivalent frame method. Technically this study of the post-tensioned flat slab by differing the span by a 0.5-meter interval has been done and the results of the various structural parameters like the thickness of the slab, grade of concrete used, loss due to stress and deflection, normal reinforcement size as well as spacing, reinforcement for the shear and bending occur on it. Member of tendons stressing force per tendons and deflection occurs as per tendons, etc. has been also presented in the graphical form. A design of a post-tensioned beam has been also done. The authors also said that for the study of the post-tensioned flat beams and slab a case study of a multistoried office building would be taken and this building has been designed for four different cases to know the differential condition that occurs in it, the post-tensioned flat slab, post-tensioned beams, the Reinforced Cement Concrete flat slab, and the Reinforced Cement Concrete slab and Reinforced Cement Concrete beams. In last the authors conclude that, after the design of these four cases, a modified study about the economy has been carried out. The analysis, design, and estimation of the office building of the four floors systems have also been done.

5) Comparison of Continuous RCC & Prestressed Concrete Beams by Using Limit State Method

Mugalkishor Sahu, R S Mishra & Dr. Rakesh Patel stated that the structural beam is a horizontal structural member which has been subjected to various loading due to which shearing and straining forces act on the lateral and axial cross-section of the respective beam. The reinforced concrete beam is the beam, when it is subjected to loading it also changes due to applied different loads. The steel bar has also provided the depth known as effective depth and it is in the overall depth available; the effective depth must have coincided with the neutral axis, axial, or lie above it. In this paper, the author said that the new method used for better results in the deflection and economic design is introduced namely Prestressed and Post tension. There are various methods of reinforcing the structure at various stages of concrete hardening viz. initial and final setting time. Before setting and hardening or before its final setting time, it is known as Prestressing, and after it has posted tensioning. The author said that in this new technique, the eccentric number of loading should be assumed and applied for reinforcing bars, wires, and different steel or tendons. Here the structural member of the beam has been taken as a continuous beam is a type of beam and the continuous beam is the indeterminate beam in the section, therefore its design must be done as per Indian standard code of practice IS 1343-2012 and IS 456-2000, with the help of Staad pro Software tools which has used for, to calculating the various structural loads and consideration of properties.

6) Post-Tensioned Building Analysis and Design- – A Case Study

Rahul Singh, Amarjeet Chauhan, Yash Chonkar, Apurva Rati, and Arbaz Kazi, in this fast-paced and competitive world, the building sector is at the apex of growth of any country. Highrise buildings or tall buildings are commended by every human being in today's century. As traditionally the construction of a building or any structure is done by Reinforced Cement Concrete but in the present world, the construction of high-rise buildings is done by post-tensioning technique as well. In Reinforced Cement Concrete, if want to talk about the economy, so for this case the economic expenditure is exceedingly high in institutional as well as commercial buildings because of more material required in construction and hence, Post Tensioned building proves that it is the most economic and durable as compared to others. In this paper, the author considers a dimension of the beam and analyses its results manually and by using the software. So, this survey concluded that our project deals with the provision of earthquake and wind resistance structures. It has also been found that the minimum sizes of column and beam provided were C500*500 and B300*500. The author has found the Seismic analysis which was done by using ETABS software. In this design, all the members were passed in design. As the author considers building a post-tensioned one, it proves to be economical.

7) Analysis and Design of Post Tension Slab Using ETABS Software"

Shubham Nighot, Sopan Chinchole, Rohan Kapgate, Sujesh D. Ghodmare, in this paper, the author deals with the study of post-tension flat slabs concerning a cost estimate, strength, and serviceability. The design was investigated by using ETABS software. For this application of design procedure, a commercial building is considered a case study. In this paper, they have considered a building structure having the plan of a commercial building (G+7). This paper, also said that by applying the post-tensioning technique, the structure gives a better aesthetic look and economic solution than that of the conventional method. As per this article, the author concludes the section with that, for post-tensioned slabs, the system of Flat slab, Flat slab with banded beams, and Flat slab with drop caps have been used to reduce the economics of the beam and slab.

Still, some considerations like total height between the two-floor usage type, two consecutive floors, as well as its architectural requirements and point of view, etc. are taken into consideration deciding the type of the slab and total floor height between two consecutive floors according to the result obtained for the 8th story, the structure may reduce the cost of construction because of the lesser thickness of the slab and as slab thickness is reduced the number of columns and beams required is less which gives results in reduced quantity of steel and concrete. Hence post-tensioning method is the economical method of having a slab with a large span. For slabs and beams which is having a span of greater than 8 meters post-tensioning technology has been an effective as well as an economy-saving method.

8) Analysis of Bonded Post-tensioned Partially Prestressed Concrete Beams under Sustained Loads

Rajeh Z.Al-Zaid stated that in this paper, we got the justification for a simple and rational analytical model which allows the determination of the history of stress and strain distribution in uncracked bonded post-tensioned Reinforced Cement concrete typical structural members sections have been proposed. The analysis has been performed at points in time satisfying the conditions of the moment in the end or any other point in beam or slab and force equilibrium as well as the strain compatibility between all layers of steel and also the surrounding concrete. The authors have also taken a numerical example of a precast post-tensioned beam is given to demonstrate the method. After taking the numerical approach for post-tension prestress concrete beam, the authors conclude that the analysis can be performed at points in time satisfying various conditions of force and at all point moment equilibriums condition for horizontal load and vertical loads as well as the strain compatibility between all-steel layers and the surrounding concrete. The algorithm has taken into account the effects of the time-variant modulus of elasticity of concrete and they have also changed in geometric properties due to the grouting of tendon ducts into it. To unify the treatment of both the non-prestressed and prestressed steel in the model formulation, the concept of decompression stress (strain) instead of the initial prestressing stress is introduced.

9) Analysis and Design of Flat Slab By Using Etabs Software

B.Anjaneyulu, K Jaya Prakash in this paper the author gave an introduction about a flat slab, which has more advantages than a conventional slab it provides more structural stability to the building and gives an aesthetic view of the building. For designing the purpose of a flat slab we can use post-tensioning as well as conventional reinforced concrete. The cost of post-tensioning for designing a flat slab is higher than the reinforced concrete design. Design of conventional reinforced concrete. flat plate or slab and beam in India, utilizing Indian codes as well as IRC codes, has many shortcomings, which have to be addressed and revised soon S. N. Utena, H. B. Dahake Volume 5, Issue 2, March (2016).

10) Feasibility study using post-tensioning in large-span frames

Divya Ouseph, Prabha C., Ijas Ahammed T. A., Arunthathy A. R., Sreelekshmi M., studied in this paper the author deal with the determination of the effects of loads on physical structures and their components and the designing of an auditorium. To support types of column-free large-span structures, the auditorium has been designed with post-tensioned beams. Equivalent static analysis of Reinforced Concrete structure was done by using ETABS software. The post-tensioned structure has been inspected and designed using SAP2000 software. The author has done a comparison between Reinforced Concrete structures and post-tensioned structures. The author also said that in the present study, an attempt was made to compare the beams in both Reinforced Concrete structures with post-Tensioning. In this paper, the depth of the beams was reduced considerably by the post-tensioning system. The amount of concrete required is more for Reinforced Concrete structures whereas it is least for the post-tensioned system. The structural element of RCC and post-tensioning is analyzed using ETABS and SAP2000 methods. The structural element of Reinforced Concrete structure and post-tensioning is analyzed by various software.

11) A Review of Comparative Study on R. C. C. and Post Tensioned Flat Slab Considering Seismic Effect

Maulik G. Kakadiya, Hitesh K. Dhamaliya, and Jashmin Gadhiya* studied that in this paper, the author studied post-tensioning as a method of reinforcing (strengthening) concrete or other materials with high-strength steel strands or bars, mild steel specially referred to as tendons. The use of post-tensioned construction is used more and more in the industry today because it has great advantages. The use of post-tensioned flat slabs is now a day becoming an economic-effective solution for improving the seismic performance of the construction industry. This review paper is focused on post-tensioned and flat slabs. In this paper, an attempt has been made to review a comparative study on R.C.C and post-tensioned flat slabs as well as beams considering the various seismic effect. For that, the past papers related to the post-tensioned and flat slab have been studied and a fruitful conclusion has been made.

In the conclusion, the author observed that in shorter plans use of flat slabs with drops results in an increase in drift values, and from the analysis, the use of flat slabs with drops in place of beam and slabs causes an increment in the percentage of reinforcement in columns, as well as beam, slab and shorter plans increment observed, is not significantly affected by the using of shear walls. Results reveal that in the case of column design reinforcement percentage is more with the master-slave approach as compared to the realistic case that is consideration of slabs along with frames.

12) Study and Analysis of Post Tension Flat Slab for Different Tendon Layouts

Arshad A. Pathan, and P. M. Mohite, the author said that the main purpose of this paper is to study post-tension flat slabs and study of their various tendon profiles. In this paper, the exploration of various tendon layouts with various sizes has been done. In this paper, different sizes of the slabs and beams are considered and an investigation is done with the help of SAFE software. With help of these analyses, we know the deflection of post-tension slabs and beams for various layouts. In this paper tendon layouts are banded tendons in the main direction, banded tendons in both directions, distributed tendons in both directions, and banded and distributed tendons in both directions are considered with different sizes. This paper also includes a PT strip stress diagram and layouts. After examining the above article, it has been concluded that from the above-proposed project work-study of post-tension flat slab and study of the different tendon, layouts are done. Also, an analysis of different tendon layouts is done. Here compare the results of deflection of different tendons for transfer and the final stage is done. After analysis, we get a result at the transfer stage deflection is minimum and at the final stage, deflection is maximum.

13) A case study on pre-tensioning & post-tensioning systems of a prestressed concrete

Veerat Srilaxmi, K.Manju, M.Vijaya in this paper, the author said that in the Present days the pre-tensioning and post-tensioning systems are very much popularly used in the major constructions of a post-tensioning structure. Pre-tensioning and Post-tensioning both methods are used during the pre-stressing process. It has few edges over the orthodox non-stressed structures like greater span to depth ratio, higher moment, and shear capacity. These pre-tensioning & post-tensioning methods are generally adopted in the making of PSC girders, sleepers, Bridges, Slabs in buildings, Concrete piles, Repair and Rehabilitation, Nuclear Power Plant, etc.
It concludes that among all types of concrete as well as reinforced cement concrete structures such as generally normal concrete, reinforced cement concrete, prestressed concrete is the best concrete for gaining more strength in the major constructions of a structure and also for the increased life span of these types of structure. The relative advantages and disadvantages of post-tensioning as compared to pre-tensioning are the requirements of an anchorage device and the injection of pumpable materials into a soil or rock formation to change its physical characteristics equipment.

14) Review: Design of Post Tensioned Slab

Mohammed Irfan Hussain stated that in this paper, the author clarifies the objective of the present report to recapitulate the experience available today in the field of post-tensioning in building construction like residential, industrial as well as commercial buildings and in particular to discuss the design and construction of post-tensioned slab structures. About the detailed explanation of the post-tensioned beam slab has been given of the checks to be carried out, the characteristic to be considered in the design and analysis, and the step-by-step construction procedures and sequences of a post-tensioned beam. The author also explains the execution of the design will be explained concerning an example in this paper. In addition, it is also, already built structures will be described. In all the literature, both bonded and unbundled post-tensioning has been dealt with it.
The author concludes that, in slabs which has lengths of more than 30 meters, a uniform, homogeneous deformation behavior of the slabs and walls in the longitudinal direction should be set eyes on. In closed types of buildings with concrete beams, walls, or columns and any other structural members, a single material behavior for shrinkage and expansion, and creep must be achieved. In thermal effects of temperature, however, the concreted external walls behave differently due to thermal effect as compared to the internal structure. The axial, as well as tensile stresses, should also be compensated for by the post-tensioning method.

15) A review of studies on the post-tensioned concrete beam

Taha K. Mohammedali, Kamaran S. Abdullah, Abbas H. Mohammed, Raad D. Khalaf, and Ali K. Hussin, this paper authored found that the post-tensioned method is a modern technique commonly used all over the world to prevent cracks and minimize deflections produced by externally applied loads like dead load, live load, etc. In pre-tensioned, stress and strain have been added after concrete placement comes in the initial position of 24 hours and appropriate hardness comes after the final position up to 28 days, and strength is achieved.

By a post-tensioned method greater load, greater spans, control of the cracks, and smaller size of members can be achieved. The author concludes that this paper reviews some previous important research studies on post-tensioned concrete beams. And also from this literature; it has been concluded that the maximum ultimate load capacity for a beam with a bonded tendon is higher if compared to the same beam with an unbonded tendon. The higher ultimate capacity for the bonded beam is due to the additive stiffness obtained by the tendon-concrete bond. For the external prestressed beam, the results showed that using draped tendon profile increases the flexural resistance as compared to a straight tendon profile.

16) A review paper on bonded & unbonded post-tensioning systems for the building floor system

Harshit Upadhyay, Jyoti Yadav, the author said that the principal design problems statement and major objectives, as well as major priorities for every structural engineer, have been safety, functionality as well as the economy, and now a day's legality of design. When selecting any structural building system, the engineers, as well as architects, need to recognize the appropriate application of post-tensioned concrete and the effects that may result. If properly explore and congregate, concrete structures from high-quality materials can provide a superior combination of durability, sound control, and fire safety needed in today's building market. Considering the above-given factors of the post-tensioning slab systems have been considered for the present study. Prestressing of concrete is called the use of compressive stresses on concrete members. Here are two types of prestressing named pre-tensioning and post-tensioning. Post-tensioning has too many reasons which can increase the use of the post-tensioning given, such as increased span to depth ratio resulting in a reduction in construction materials and a subsequent reduction in overall economy, positive and negative deflection control, design and analysis of flexibility, minimum and maximum construction joints, improve durability, and increase span length.

It concludes that the post-Tensioning reinforcement requires a bonded system that is approximately greater than for the unbonded technique. This should be ascribed to the losses in coefficient of friction due to any circumstances. The coefficient of friction for unbonded as well bonded tendons has been more than for other types of tendons, resulting in the loss of effective strain and stress in the post tendons which gives ultimately results in the loss of effective prestress force in the section. Hence the various number of tendons required for bonded post-Tensioning system as compared to an unbonded post-Tensioning system is more for the same axial force as well as pre-stress force.

17) Review Paper on Post-Tensioned Flat Slab with Drop Panels and Its Comparison with Conventional Slab

Veerat Srilaxmi, K.Manju, M.Vijaya according to the author of this publication nowadays step by step construction procedures of high-rise buildings Post tension slabs and Flat slabs are both important causes of structure. Post-Tensioning slabs should carry almost all amounts of dead load due to their tensioned tendons, which help to carry out live load acting on the slab and makes it safer than conventional slabs. On the second side Flat slabs with drop panels as well as beams are having advantages and disadvantages like reduced tall building height, ease of formwork and scaffolding, and increasing faster construction procedure. Combinations of a Pretension, as well as a post-tensioned slab and a Flat slab, will be much more effective than usual slabs, columns, and beams. Here those types of slabs also have more advantages over conventional as per recent defined projects like high rise structures, tall building structures, columns, long-span frames, and beams as those are major concerns about the safety as per designing and have been given an aesthetic and architectural view for commercial, industrial or residential projects.

Comparing conventional slab to post-tensioned flat slab, we get results as PT flat slab is much more beneficial over beam-column type conventional slab structures. It's economical, easy to construct, better for long-span slabs, gives an aesthetic view, slab thickness maintained, more resistant towards live load, more seismic resistant and durable than conventional.

At present days new projects of tall buildings as well as high-rise industrial, commercial or residential buildings, it's necessary to construct as per safety and as per workability of structure. The post-tensioned flat slab has more overall benefits as compared to other types of columns, slabs, and beams.

III. CONCLUSIONS

After studying the above research paper, we conclude that: -

1) In terms of cost-effectiveness, time-saving, and future scope post-tensioned systems are used for industrial buildings.
2) Post-Tension Beam design is becoming increasingly popular due to its benefits like it is suitable for large spans, for large loading, durability is higher, and it is economical.
3) Design of Reinforced Cement Concrete Beam for a large span is not suitable and economically not possible.
4) In replace of Reinforced Cement Concrete Beam for large spans nowadays post-tensioning systems are used.
5) AS compared to Reinforced Cement Concrete Beam Post-Tensioning Beam system is safe.

6) IS Code:1343-1980 Code of practice for prestressed concrete we are using in the design of Post-tensioning Beam. The method used is the limit state method. Also, we are using British Code BS:8110.

7) IS Code 456:2000 Code of practice for reinforced cement concrete we are using in RCC Beam design.

8) For manual calculation different codes with little variation in values, factors, and assumptions we are adopting.

9) Absence of beams component section allows for lower story heights of the building like load-bearing structures and as a result cost saving in vertical cladding, partition walls, mechanical systems, plumbing, other structural members, and a large number of other items of construction, especially for medium and high-rise buildings.

10) For the large span beam sizes considered, post-tensioning floor systems have proved to have smaller deflection compared to Reinforced concrete floor systems, there obtained a 28% reduction in the cost of the material.

11) Reinforced Concrete Cement building reduces the period of construction formwork so labor charges will bring down in the case of the post-tensioned flat slab to compare the Reinforced Concrete Cement beam.

12) Post-tensioned flat plate slab and beam moment have been minimum as compared to the moment of Reinforced Concrete Cement flat slab by equivalent frame method as well as moment distribution method because as the depth of post-tensioned flat slab and beam are up to 30 to 35% less than Reinforced Concrete Cement slab, due to which self-weight and live a load of slab gets reduced.

13) To enlarge shear force and moment of post-tensioning of flat plate slab on the column so there is not much effect on axial force on a shorter and longer column

14) The Non-Post-Tensioning reinforcement requirement for bonded PT systems than unbonded post-tensioning system comes out to be more, comparatively.

15) The load-carrying capacity of the structural member beam, column, and slab has been enhanced by the eccentric loading method as this bending moment resistance in the pre-stressing method.

16) The moment carrying capacity has been greatly enlarging as the positions of the moment get shifted from the loading position area towards the restraints span as mentioned in the Indian Standard Code.

17) It has been also concluded that the economic design is based on the discussion and results from the overall cost of a normal reinforcing structure beam would be minimal as compared to pre-stressed beams, which has been due to specific special methods and instruments required in forming a pre-stressed beam.

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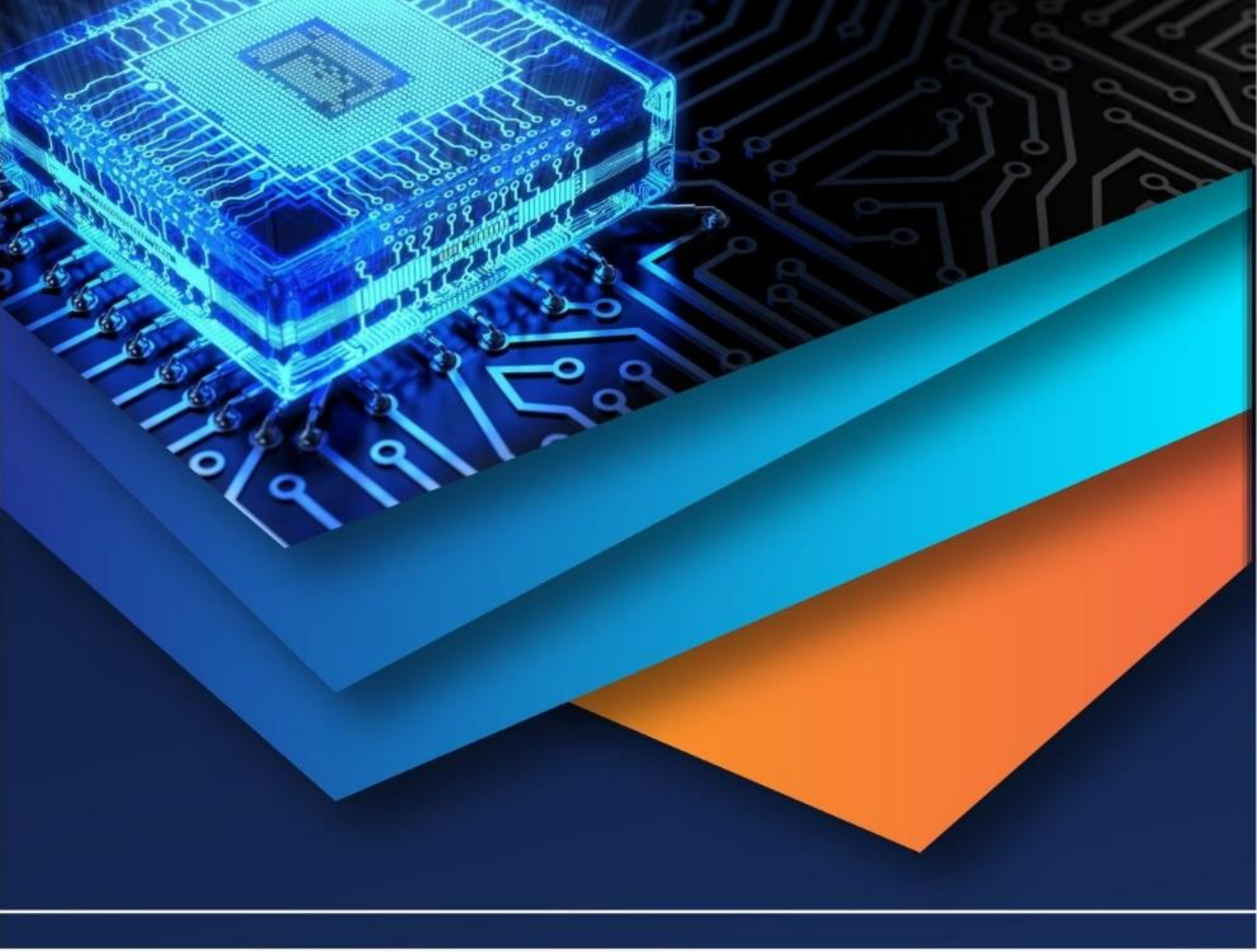

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