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# Feasibility study using post tensioning in large span frames

*Divya Ouseph*
*dvdouseph111@gmail.com*
*Mar Athanasius College of Engineering, Kothamangalam, Kerala*

*Prabha C.*
*Cprabhac@gmail.com*
*Mar Athanasius College of Engineering, Kothamangalam, Kerala*

*Ijas Ahammed T. A.*
*ijasahammedta@gmail.com*
*Mar Athanasius College of Engineering, Kothamangalam, Kerala*

*Arunthathy A. R.*
*arunthathy2015@gmail.com*
*Mar Athanasius College of Engineering, Kothamangalam, Kerala*

*Sreelekshmi M.*
*sreelekshmimurali97@gmail.com*
*Mar Athanasius College of Engineering, Kothamangalam, Kerala*

## ABSTRACT

***The paper deals with the structural analysis and designing of an auditorium. In order to support column free large span structure, the auditorium is designed with post-tensioned beams. Equivalent static analysis of RC structure was done using ETABS. The post-tensioned structure was analyzed and designed using SAP2000. The paper does a comparison between RC structure and post-tensioned structure.***

***Keywords*** *— RCC framed structures, Post-tensioning, ETABS, SAP2000*

## 1. INTRODUCTION

Generally, the post-tensioning technique is used to see in large span bridge construction, girders, water tanks and stadiums. Now there are post-tensioning applications in almost all facets of construction Current architecture in this world continues to place emphasis on the necessity of providing large uninterrupted floor space, the flexibility of internal layout, the versatility of use and freedom of movement. All of these are facilitated by the use of post-tensioning in the construction of concrete floor slabs, giving large clear spans, fewer columns and supports, and reduced floor thickness. Post-tensioned structures can be designed to have minimal deflection and cracking, even under full load.

Use of post-tensioning reduces the amount of concrete required for a structure which offsets increased cost of labor and equipment, decreases the amount of formwork required, decreases the overall height of floors which allows more floors for a particular building height, decreases the weight of the building which is a advantage in seismic design, and increases the allowable span length, creating more open space in a structure. There are sophisticated, intuitive software's like ETABS, SAP2000, ADAPT, RAPT to study, analyse and design structural elements using post-tensioning Hence, the present study addresses the feasibility study of post-tensioning technique using soft ware's ETABS and SAP2000.

## 2. LITERATURE REVIEW

**Albert et. al.** (2006) discussed the determination of prestressing tendon profile using load balancing method. If the priestess force and tendon profile are designed such that the equivalent loads just balance or nearly balance the external loads, then there would be a relatively small net loading on the structure, leading to reduced flexural/shear stresses and lateral deflection.

**Ajinkya et. al.** (2017) in their study aimed to develop three-dimensional finite element modelling of the post-tensioned concrete beam. The scope of the study was limited to investigate the effect of eccentricity, prestressing force and cable profile and to determine the structural static properties such as deflections and stress distributions.

**Ankit et. al.** (2014) studied on the cost comparison of RCC beam with a post-tensioned prestressed beam of span 26m. The result shows that for span, 26m post-tensioned prestressed concrete beam is 34% cheaper than RCC beam.

## 3. METHODOLOGY

The structural element of RCC and post-tensioning is analysed using ETABS and SAP2000 respectively. Building details, post-tensioning details in the present study is given below:

### 3.1 Building details

No of stories: 3
Storey height: 5 m
Beam dimensions: (1.4x0.3) m, (0.4x0.3) m, (0.3x0.2) m, (0.2x0.2) m

### 3.2 Concrete grade for RCC and PT

Beam and slab:
The concrete grade for RC: M30
The concrete grade for PT: M45

 

### 3.3 Post-tensioning details

Nominal area of strands: 99mm$^2$
Ultimate tensile stress: 1861 N/mm$^2$
Jacking force: 90% of the ultimate tensile force
Ultimate tensile force: 184KN

### 3.4 Modeling in ETABS

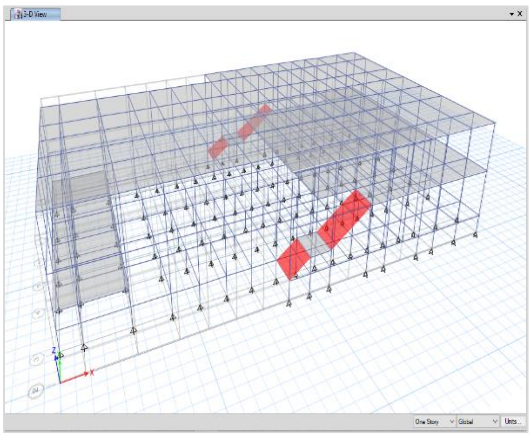

**Fig. 1: 3-D Model of the auditorium**

### 3.5 Modeling in SAPS

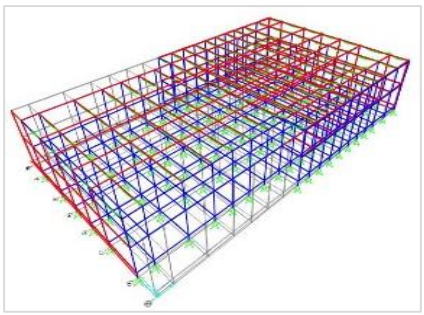

**Fig. 2: Model of the auditorium**

## 4. ANALYTICAL STUDY

In the present study, ETABS and SAP2000 are used to analyze and RCC and PT beams respectively. RCC structure was designed and checked in ETABS based on limit state design given by IS: 456 – 2000. Likewise, PT beams were also designed and it was checked with the limit state procedure given by IS 1343-1980. The details of the reinforcements are obtained from these designs and they are converted in quantities and the corresponding cost for each system is calculated. Finally, the cost comparison chart, deflection diagrams, shears force diagrams are obtained for RCC and Post Tensioned systems.

### 4.1 ETABS

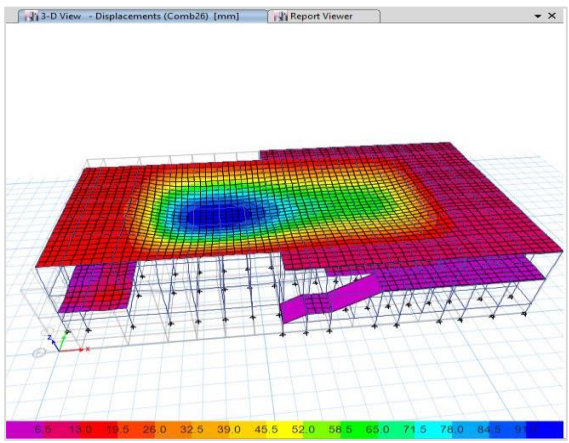

**Fig. 3: Deflection diagram**

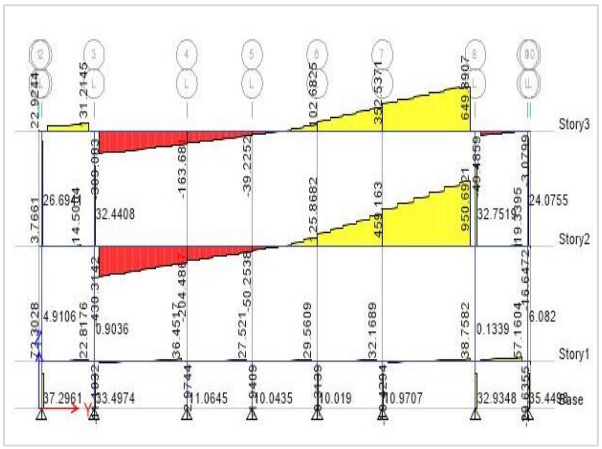


**Fig. 4: shear force diagram**

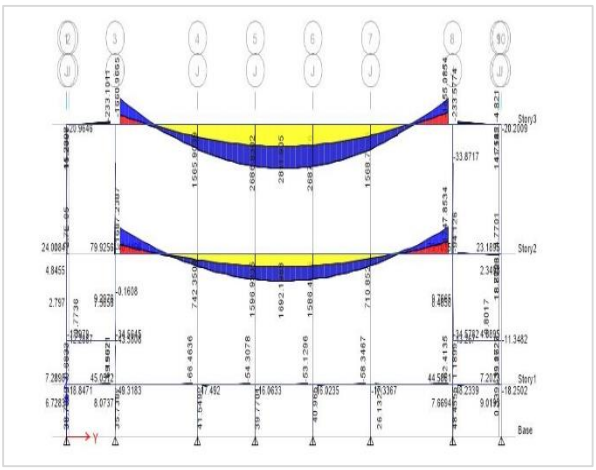


**Fig. 5: Bending moment diagram**

### 4.3 SAP2000

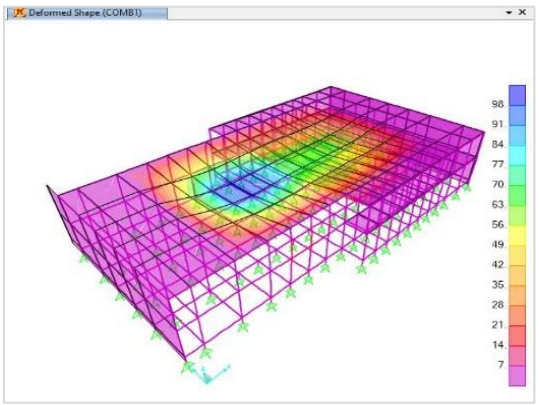


**Fig: 5 Deflection diagram**

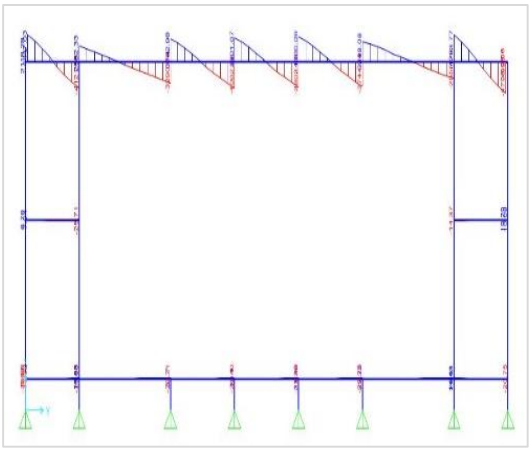

**Fig. 6: Shear force diagram**

 

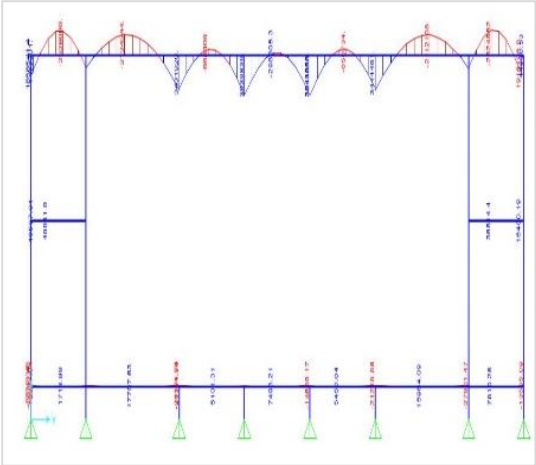

**Fig. 6: Bending moment diagram**

## 5. RESULTS AND DISCUSSIONS

**Table 1: Results**

| | RCC | PT |
|---|---|---|
| Depth of beam | 1.5 m | 0.85 |
| Bending moment | 2811.9 ken | 2134kNm |
| Shear force | 680.6kN | 412 ken |
| Deflection | 91mm | 98 mm |
| Quantity of concrete | 10.8 $m^3$ | 6.12$m^3$ |
| The total cost of material | Rs. 131107 | Rs.95546 |

## 6. CONCLUSION

In the present study, an attempt was made to compare the beams in both RCC with Post- Tensioning. The conclusion arrived from the work is stated below:

- For the large span beam sizes considered, Post-Tensioning floor systems have proved to have smaller deflection compared to Reinforced concrete floor systems.
- The depth of the beams was reduced considerably by post-tensioning system
- The amount of concrete required is more for RCC whereas it is least for the post-tensioned system.
- There obtained 28% reduction in the cost of material

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