The Comparison between R.C.C and Post-Tensioned Beam Economically and the Comparison in Size of the Columns used in them

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Abstract— This project will be undertaken to analyze and design structural elements like beam, column, “T” beam in a commercial building and compare it with a post tensioned haunched beam. The analysis and design will be done manually. Though the use of the software offers saving in time, the calculations are not appropriate. The analysis of the building will be done manually for both lateral as well as vertical loads by substitute frame method and portal frame method respectively. Both earthquake loads and wind loads were considered as lateral loads acting on the building. Assuming both ultimate wind load and earthquake loads does not act simultaneously on the building. Critical loads among wind as well as earthquake loads are to be considered in the further design. The comparisons in both the beams are carried out and with respect to the span to cost ratio as well as the comparison in size of the column to be used to estimate the cost of construction.

Key words: Post Tensioned Haunched Beam, R.C.C Beam, Cost To Span Ratio, L Shaped 5 Storeyed Building

I. INTRODUCTION

The project is on analysis, designing, detailing of a multi-storeyed commercial building with post tensioned beams. The building is planned to serve the purpose of a commercial building, consisting of two basement floor + ground floor + five floors. The building is of L shape. All the floors are of reinforced concrete slab construction. Both the basement floors are intended for car parking. All the other floors are used as retail shops. The foundation given is the pile foundation. The speciality of the building is the placing of post-tensioned banded beams for longer spans throughout the building.

Surveys indicate vast differences in the use of post-tensioning among different countries. While the wide spread can largely be explained by differences in local needs, standards, education and habits it appears that the potential offered by post-tensioning is far from being exploited, especially in building structures. Post-tensioning in buildings is not limited to floor slabs. Post-tensioning of foundations, transfer beams and plates, post-tensioned masonry and the combination of precast elements with cast-in-place concrete by means of post-tensioning offer other interesting opportunities.

II. MATERIAL AND METHODOLOGY

The analysis of frames was done manually by using substitution frame method and portal frame method. The mix used for post-tensioned banded beams is M 40 and all other RCC works is M 30 and steel is Fe 415. During analysis, dead loads and live loads were calculated from IS: 875 (part 1) – 1987 and IS : 875 (part 2) – 1987 respectively. The load combinations were taken to obtain the maximum design loads, moments and shear forces. Wind force was calculated using IS : 875 (part 3) -1987.

The dimensions of the different members were fixed based on the preliminary analysis. The member properties were given as Indian. The beams were provided in such a way that torsion is released along the axis of the beam. The member properties assigned are as follows:

- Thickness of the slab = 200 mm
- The dimensions of the beams for all typical floors = 400 X600
- The dimensions of typical column= 700 mm x 700 mm
- Thickness of wall is taken as =200 mm
- The dimension of the post tensioned column = 480 mm x 480 mm
- The Cross sectional area of the Post tensioned haunched beam = 156800 mm²

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III. RESULTS AND DISCUSSIONS

A. Cost Comparison between T-Beam and Post-Tensioned Beam

1) Dimensions of the T-BEAM

Effective length of the T-Beam= 14.30m
Web Depth=900mm
Web width=450mm
Flange Width=4030mm
Flange Depth=200mm
Dimension of longitudinal reinforcement= 12nos 25mm Φbars
Dimension of the transverse reinforcement= 2legged 12mmΦbars
Cross- sectional dimenson of the T-Beam= 1211000mm²

2) Analysis of the T- BEAM

Cost of the T-Beam= = 14.30*0.45*1.10=7.0785cu.m
Rate as per pwd = 5603
Total cost for the T-Beam= Rs39660.8355/-
The Comparison between R.C.C and Post-Tensioned Beam Economically and the Comparison in Size of the Columns used in them

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Total cost of the R.C.C BEAM is RS 122599.159/-

3) Dimensions of the Post-Tensioned Beam

Depth of the POST TENSIONED BEAM =80cm

Cross- sectional area of the post-tensioned beam=156800mm$^2$

Dimensions of longitudinal reinforcement= 18.80Φbars

Dimension of transverse reinforcement =6mm Φbars

COST OF THE Post Tensioned beam = 16.60*0.80*0.32

Rate as per PWD= 5658

Total cost of post Tensioned Beam= Rs 24333.9264

IV. RESULTS AND DISCUSSIONS

A. Comparison of RCC Beam with Post Tensioned Beam

The project compare post tensioned beam with ordinary “T” shaped RCC beams. The comparisons are shown below.

1) Larger span:

Using post tensioned banded beams a span of 16.60 m can be constructed between two columns. but in actual RCC beam usually less than 3.5m span is provided between two columns. Longer span can be used to reduce the number of column. This result in larger column free floor areas which greatly increases the flexibility of use for the structure and can result in higher rental returns.

2) Reduce Floor to Floor Height

While designing “T” beams the depth of the beams are 1.1 m .An air conditioning duct and a ceiling is to be required below the beam. Thus a net 1.2 m depth should be provided.

But for the post tensioned beam only 0.75m depth is sufficient. thus for taller building it can allow more floors to be constructed within the original building envelope.

3) Reduce Total Dead Load Of Building

Due to reduction in floor to floor height and using thinner sections for beams it reduces the total dead load of building in great extent

4) Reduce Overall Structural Cost

Due to reduction in total dead load of building and lesser material used, the total cost of material ,labour, and form work required to construct a floor is reduced for spans greater than 7m. thereby providing superior economy

5) Deflection Free Beam

Undesirable deflections under service loads can be virtually eliminated

6) Water Proof Slab

Post tensioned slabs can be designed to be crack free and therefore waterproof slabs are slabs are possible.

Achievement of this objective depends on careful design, detailing and construction. The choice of concrete mix and curing method along with quality workmanship play a key role

7) Early Formwork Stripping

The earlier stripping of formwork and reduced back propping requirements tenable faster construction cycle and
quick re-use of formwork. this increases the speed of construction and hence the economy. 

8) Material Handling
The reduced material quantities in concrete and reinforcement greatly benefit on site craneage requirements. The strength of post-tensioning strand is approximately 4 times that of conventional reinforcement. Therefore total weight of reinforcing material is greatly reduced.

9) Column Design
The reduced floor dead loads may be utilised in more economical design of the reinforce concrete columns and footings. in multi storied buildings, reduced column sizes may increase the net area. The use of post tensioned haunched beam has resulted in the reduction of the size of the columns considerably. When we used the R.C.C T-Beam THE SIZE OF COLUMN IS 700MM X 700 MM
10) Size Of Column When We Used The Post Tensioned Beam Is 480 X480 Mm
Thus percentage change in the cross sectional area is 52.97. Thus its evident that the percentage saving in materials is enormous when we go for post tensioned haunched beams in long span multi storeyed building construction.

V. CONCLUSION
This project was undertaken to analyze and design structural elements like beam, column, “T” beam in a commercial building and compare it with a post tensioned banded beam. The analysis and design done manually.

All the structural components were designed manually. Though the use of the software offers saving in time, the calculations are not appropriate. It takes value on safer side than manual work. Hence manual design was adopted.

The post tensioned banded beam is more economical compare to ordinary RCC beam. Using post tensioned banded beam larger column free areas can be created, which greatly increases the flexibility to use the structure, and get more rental returns. Post tensioned beams return reduces floor to floor height, overall cost, total dead load. The span to cost ratio by comparing both the beams were plotted and it shows that the post tensioned haunched beam shows superior results when compared to R.C.C T-beam

REFERENCES
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