Comparative Study of RCC And Prestressed Concrete Beams For Various Spans

Dr. S.H.Mahure[1], Mr.Vishal D. Dhore[2]
[1, 2] BABASAHEB NAIK COLLEGE OF ENGINEERING PUSAD

Abstract- *This paper presents the Comparative Study Of R.C.C. And Prestressed Concrete Beams, which include the design and estimates of R.C.C. and Pre-stressed concrete beams of various spans. The aim of this work is to design large span R.C.C. beam as well as prestressed concrete portal beams variety and then compare the results. The idea is to reach a superior conclusion regarding the superiority of the two techniques over one another. A couple of cases were comprehensively analyses by ETABS 2015 software and designed manually of both the R.C.C. and Prestressed concrete beams. Based on the manual design procedure, a computer program in MS EXCEL was developed for designing both R.C.C. and prestressed concrete portal beam. A separate program was developed for estimating. A number of cases were studied from 10m, 12m, 15m and 18m span. In India R.C.C structures are commonly used for residential as well as commercial buildings or we can say for short span buildings. In R.C.C. beams depth of beam increases with increase with span because of deflection limitation. To surmise, R.C.C beams shall be the suitable for small to medium span but the superiority of prestressed concrete beam undisputable for longer spans.*

Keywords- Beams, R.C.C, Prestressed concrete, ETABS, MS EXCEL

I. INTRODUCTION

A. Importance & Necessity:

Concrete frame structures are a very common or perhaps the most common type of modern building internationally. As the name suggests, this type of building consist of a frame or skeleton of concrete. Horizontal members of this frame are called beams, and vertical members are called columns. A human walks on flat planes of concrete called slab. To construct a frame we used Reinforced Cement Concrete commonly called as RCC, this is one of the construction technique that made construction very easy and brought a boom to field of construction. In RCC structure cement concrete can take up immense compression but weak in tension whereas steel is good in withstanding both tension and compression. No doubt, RCC framed structure is very easy to construct when the span ranging from 3 m to 7.5 m but it is not suitable when the span is large and it becomes very cumbersome for large span as the span increased the cross sectional dimension of member is also increases and it directly increases the self-weight of the member.

Prestressed concrete is the most recent major form of construction introduced in the structural engineering because it has its own advantage like, the size or dimension of structural members are reduced, which may increase the clearances or reduce storey heights. It also permits the use of large spans (greater than 30 m) with shallow members, even when heavy load are encountered. The prestressing technique has eliminated the weakness of concrete in tension and hence crack free members of structure are obtained.

High strength concrete is necessary in prestressed concrete, as the material offers high resistance in tension, shear, bond and bearing. In the zone of anchorages, the bearing stresses being higher, high –strength concrete is invariably preferred to minimize costs. High –strength concrete is less liable to shrinkage cracks, and has a higher modulus of elasticity and smaller ultimate creep strain, resulting in smaller loss of prestress in steel. The use of high – strength concrete results in a reduction in the cross sectional dimensions of prestressed concrete structural elements. With a reduced deadweight of the material, longer span become technically and economically practicable. As we considered the high rise structure which is in the case of large floor and roof covering using prestressed concrete as material, there are several types of structural forms for adoption. The aim of this work is to design a frame of RCC as well as prestressed concrete variety for various spans and then compare the results. This idea is to reach a definite conclusion regarding the superiority of the two techniques over each other.

B. Scope :

This work include the design and estimate for beams of various spans, ranging from 10 m, 12 m, 15 m, 18 m by R.C.C and Prestressed concrete techniques. For smaller spans, associated with normal building works, prestressed concrete construction become too cumbersome, irrespective of the economics involved. Post- tensioning is preferred as it is popular in construction for large span slabs.

II. METHODOLOGY

BUILDING DESCRIPTION

The study is carried out on reinforced concrete moment resisting frame and prestressed concrete moment resisting frame with various spans. The plan of the building is shown in figure.3.1. The building considered is single storey commercial building. The columns provided are rectangular columns. Height of storey is kept 4.5m excluding depth of foundation and other concerned data is given in tabular form in table 1

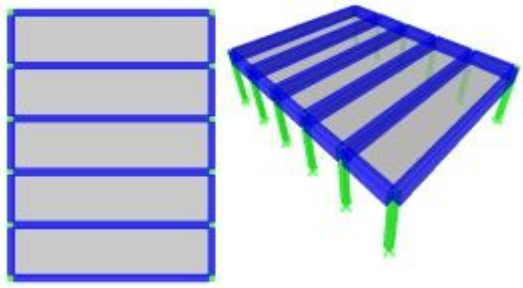


Fig 1. Typical Plan of building

Table 1. Details of specification for model

Plan dimensions	10x22.5 m
Total height of building	6.0 m
Height of storey	4.5m
Depth of foundation	1.5m
Size of beams	300x750 mm
Size of columns	500x500 mm
Thickness of slab	150 mm
Thickness of external walls	230 mm
Floor finishes	1.5 kN/m^2
Live load at floor	4 kN/m^2
Grade of Concrete	M35
Grade of Steel	Fe500
Density of Concrete	25 kN/m^3
Density of brick masonry	20 kN/m^3

Table 2. Comparison of maximum shear force for different span

SHERA FORCE		
Span (M)	**Shear Fore(kN)**	**% Increase**
10	365	---
12	462	26.57
15	657	80.00
18	907	148.493

Table 3. Comparison of maximum bending moment for different span

BENDING MOMENT		
Span (M)	**Bending Moment (kN.m)**	**% Increase**
10	619	---
12	1011	63.32
15	2082	236.34
18	3773	509.53

III. RESULT AND DISCUSSION

Table 4 to Table 8 below gives the result obtained for R.C.C. and Prestressed Concrete frame structure with respect to the different span. The results contains the comparison of various elements of R.C.C. frame structure for different span, comparison of various elements of prestressed concrete frame structure and the comparison of R.C.C and Prestressed Concrete frame structure for different span.

Graph 1 and Graph 2 below where R.C.C beam are compared with prestressed concrete beam with different span and cost comparison shows. While calculating the cost of prestressed beam cost of accessories like spilt cones, bearing plates, sheathing duct and skilled labor rates are consider.
From spans 10 m to 18 m, prestressed concrete beam makes it economical as the span increases its economic efficiency is also increases. The deflection of beam also gets reduced as in the case of prestressed concrete beam that satisfy the limit state of serviceability & durability. The result also shows the saving of reinforcement and concrete quantity for both the structure with different span. There is huge saving of material in prestressed concrete structure but on the other hand to execute the prestressed concrete work one require skilled labor and accessories.

Now a day's in India Prestressed Concrete structure is more popular as it will give the more storey heights in commercial building and industrial building. For small span R.C.C. structure is more suitable but where column spacing is more and space requirement is essential then prestressed concrete structure is most suitable for large span.

Table 4) Comparison of size of beam for RCC and Prestressed concrete frame structure for different span

RCC FRAME			PRESTRESSED FRAME		
Span (M)	Width (B) mm	Depth (D) mm	Width (B) mm	Depth (D) mm	% Reduction
10	300	750	300	600	25
12	350	900	350	650	38.46
15	450	1100	450	850	29.41
18	600	1350	600	1000	35

Table 5. Comparison of reinforcement of beam for RCC and Prestressed concrete frame structure for different span

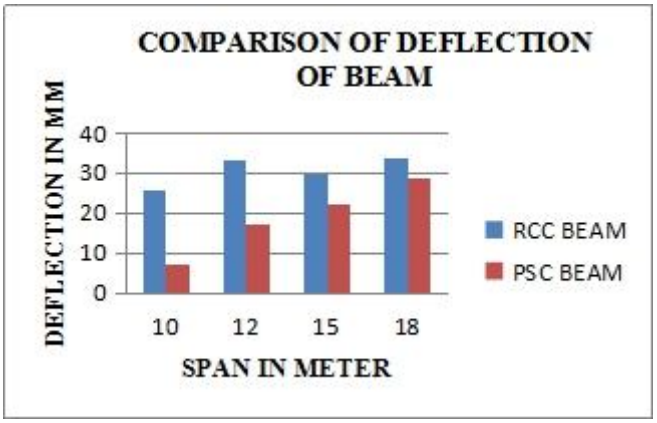
Span (M)	RCC	Prestressed	% Reduction
	Quanity (KG)	Quanity (KG)	
10	495	88.4	460
12	788	109.1	622
15	2028	203.2	898
18	2443	349.4	599

Table 6. Comparison of quantity of concrete in beam for RCC and Prestressed concrete frame structure for different span.

Span(M)	RCC	PRESTRESSED	% Reduction
	Concrete QTY M^3	Concrete QTY M^3	
10	14	11	25
12	23	16	42
15	45	34	31
18	87	65	35

Table 7) Comparison of deflection of beam for RCC and Prestressed concrete frame structure for different span

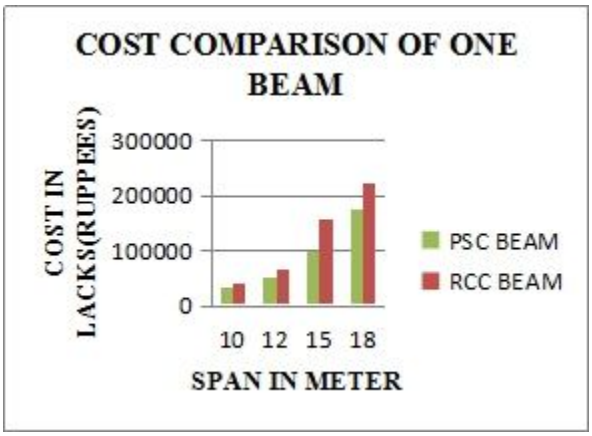
Span (M)	RCC	PRESTRESSED	Allowable Short Term Deflection (mm)	% Reduction
10	25.5	7.32	40	284
12	33.41	17.2	48	94
15	29.69	22.19	58	34
18	33.99	28.68	70	19



Graph 1. Comparison of Deflection of beam

Table 8. Comparison of total cost of One R.C.C. beam and One Prestressed concrete beam for different span.

SPAN (M)	RCC BEAM	PRESTRESSED BEAM	% REDUCTION
	Cost In Lack	Cost In Lack	
10	41178.38	33182	24.09
12	66936.45	50714.21	31.98
15	156185.70	100543.50	55.34
18	223726.70	174879.60	27.93



Graph 2. Cost Comparison of one Of beam

IV. CONCLUSION

Based on the study conducted, it could be concluded that the prestressed concrete beam is economical for span 10 m to 18 m in terms of cost. As the span is increasing the cost percentage also goes on increasing with reduction in beam section. In prestressed concrete the beam section is reduced and it will give more headroom and results in lesser deflection as compared to R.C.C. beam.

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