International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

A Literature Review on Comparative Study of Deflection Behaviour of RCC and Pre-stressed Concrete Beams

Zeeshan Adib Ahmed[1], Dr.S.H.Mahure[2], Sufiyan Adib Ahmed[3]

[1]*M.E (Structural Engg.) Student, Department of Civil Engineering, B.N.College of Engineering, Pusad (M.S), India*
[2]*Professor and Head, Department of Civil Engineering, B.N.College of Engineering, Pusad (M.S), India*
[3]*B.E.Student, Department of Civil Engineering, B.N.College of Engineering, Pusad (M.S), India*

Abstract - *Serviceability of a structure is generally defined as the clients' acceptance for continuous use of the structure for its lifetime under given loading condition without fear or any inhabitation. In reinforced concrete or prestressed concrete structures, cracking and deflection under service loads define the confident use of the structure at a given point of time. The deflections of structures are important for ensuring that the designed structure is not excessively flexible. The large deformations in the structures can cause damage or cracking of non-structural elements. Increased use of high strength concrete with reinforcing bars and prestressed reinforcement, coupled with more precise computer-aided limit state serviceability designs, has resulted in lighter and more material-efficient structural elements and systems. This in turn has necessitated better control of short-term and long term behavior of concrete structures at service loads. The aim of this paper is to highlight the literatures which focus primarily on comparison of RCC and prestressed concrete elements in terms of their deflection behaviour.*

***Key Words*: Serviceability of a Structure, Prestressed Concrete, R.C.C, deflection, Concrete structures**

1. INTRODUCTION

The man made material concrete is first thought as equivalent to stone. Unlike stone, concrete can be given any shape one wants because of the facility of casting.

But the tensile capacity is found to be far too low in comparison to stone. Hence it requires to be strengthened by reinforcement. Even then it is susceptible for disintegration by cracking. Instead of curing the deficiency in tensile capacity by introduction of steel, pre-compression by prestressing is thought of as preventive measure. Similarly, providing reinforcement is considered as defense against tension and that could be resisted by an opposite step of prestressing as an offence measure before the external loads are applied on it.

Wide availability of personal computers and design software, plus the use of higher strength concrete with steel reinforcement has permitted more material efficient reinforced concrete designs producing shallower sections. More prevalent use of high-strength concrete results in smaller sections, having less stiffness that can result in larger deflections. Consequently, control of short-term and long-term deflection has become more critical. In many structures, deflection rather than stress limitation is the controlling factor. Deflection computations determine the proportioning of many of the structural system elements. Member stiffness is also a function of short-term and long-term behavior of the concrete.

Excessive deflection of beams and slabs causes cracking of finishes, loss of strength of members, improper drainage and unsightly appearance. Sometimes, the excessive sag may be visually unacceptable.

IS 456 (2000) Clause 23.2 and BS 8110 limit allowable deflection under service loads as follows:

i. The deflection in the members due to all causes (namely. loads as well as effects of temperature, creep. shrinkage. etc.) should not exceed span/250.

ii. The deflection which will take place after completion of the main construction (including erection of partitions and applications of finishes) due to long-term effects of the permanent loads (i.e. due to creep and shrinkage) together with the deflection due to the transient load (that pan of applied load which is applied and removed intermittently) should not exceed span/ 350 according to IS 456 and span/500 according to BS 8110 or 20 mm. whichever is less.

The first condition refers to the deflection that can be noticed by the eye and the second condition is to prevent damages to the finishes. The empirical method to limit deflection is to limit span/depth ratio as given in IS 456 Clause 23.2.1. However, in marginal casts and in the case of special structures, deflection may have to be calculated.

1.1 RCC and Prestressed Concrete

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. Some of them are as follows:

1. Tee beam and slab floor

2. Continuous beam and slab floors

3. Flat slab floors

4. Trussed and framed roofs

5. Composite construction using prestressed and reinforced concrete.

The aim of this paper is to highlight the literatures which focus primarily on comparison of RCC and prestressed concrete elements in terms of their deflection behaviour.

2. LITERATURE REVIEW

In many structures, deflection rather than stress limitation is the controlling factor. Deflection computations determine the proportioning of many of the structural system elements. Member stiffness is also a function of short-term and long-term behavior of the concrete. Hence, expressions defining the modulus of rupture, modulus of elasticity, creep, shrinkage, and temperature effects are prime parameters in predicting the deflection of reinforced concrete members.

Current literature survey includes comparative analysis of RCC and prestressed concrete beams for various spans. Some of the literatures emphasized on analysis of multistory building with floating columns.

2.1 Analytical Studies

2.1.1 Suchitra De & Shraddha Sharma

Analyzed two-span continuous RCC and Prestressed (Pre-tensioned and Post- Tensioned) beam of 6 m each having cross section of 200mm X 300mm with M-40 grade of concrete manually in MS-Excel and in STAAD.pro software. RCC continuous beam has been analyzed based on IS 456:2000 and prestressed concrete beam has been analyzed based on three-Moment theorem and codal provisions of IS 1343:2012. Economics of both the types of beam have been studied and found that the conventional method i.e. RCC construction is cheaper than newly evolved Prestressed because of the later requires great instruments like pulleys, weights, blocks, screw jacks, pressure gauges along with high tensile steel and skilled manpower to operate these to impart the prestressing force

2.1.2 Suchitra De & Shraddha Sharma

Highlighted study of reinforced and prestressed concrete beams using finite element analysis to understand their load-deflection response. A reinforced concrete beam model is studied and compared to experimental data. The parameters for the reinforced concrete model were then used to model a prestressed concrete beam. Characteristic points on the load deformation response curve predicted using finite element analysis were compared to theoretical (hand-calculated) results. Conclusions were then made as to the accuracy of using finite element modeling for analysis of concrete. The results compared well to experimental and hand calculated.

2.2.3 A.R. Mundhada & Mohmmad Shahezad

Investigated the design and estimates of continuous R.C.C beams and continuous pre-stressed concrete beams of various spans. To begin with, an R.C.C. beams was manually designed by using limit state method based on IS 456:2000. Based on the steps & formula involved, a design program was prepared in MS-Excel. For spans up to 10-15m, R.C.C. beams are preferable. For spans between 15 to 20m the decision should be based on other factors like the size & location of the project and for spans beyond the 20m spans, prestressed concrete beams are decidedly superiors as compared to conventional R.C.C. beams.

2.1.4 V.K.Rahman & Prof. A.R. Mundhada

Presented the comparative study of R.C.C. and prestressed concrete flat slab. In the project design and estimates of R.C.C. and pre-stressed concrete flat slab for various spans was carried out. The main aim of the work was to design large span R.C.C. flat slab as well as prestressed concrete flat slab variety and then compare the results. Firstly the manual design of R.C.C. and prestressed concrete slab was done and then a computer program in MS-Excel was developed for designing both R.C.C. and prestressed concrete flat slab and a separate program was developed for estimating. The study concluded that RCC flat slabs are economical up to 9m span but beyond that prestressed concrete flat slabs become a better choice.

2.1.5 Vishal D. Dhore, Dr. S.H.Mahure

Presented the comparative study of R.C.C. and prestressed concrete frame, which include the design and estimates of R.C.C. and Pre-stressed concrete portal frame of various spans. The aim of this work was to design large span R.C.C. portal frame as well as prestressed concrete portal frame and then compare the results. The idea was to reach a definite conclusion regarding the superiority of the two techniques over one another. A couple of cases were comprehensively analyzed by ETABS 2015 software and manually designed both R.C.C. and Prestressed concrete portal frame. Based on the manual design procedure, a computer program in MS EXCEL was developed for designing both R.C.C. and prestressed concrete portal frame member like beam, slab and column. A separate program was developed for estimating. A number of cases were studied from 10m, 12m, 15m and 18m span.The study concluded that R.C.C portal frame is suitable for small to medium span but the superiority of prestressed concrete portal frame is undisputable for longer spans.

2.1.6 Shaheenjaham, Prof. Sachin S Kulkarni et.al.

Compared the cost of R.C.C and Pre-stressed concrete beam and also carried out design and estimate of R.C.C. and Post tensioned beams of 16.2 m and 4.3 m spans. The analysis was done with SAP 2000 and design was done by manually. The idea was to reach the superiority of the two techniques over one another. They concluded that cost of construction of PSC is economical as compare to R.C.C. for different span.

2.2 Experimental Studies

2.2.1 Rajamoori Arun Kumar & B. Vamsi Krishna

Studied the behavior of Pre-stressed concrete beam, how they are stressed, percentage of elongation; pressure applied for stressing was studied. The study on a major bridge having 299 m span, 36 nos. of PSC beam and 8 nos. RCC beam was carried out. The paper concluded that bending moments and shear force for PSC T-beam girder are lesser than RCC T-beam bridge girder which allows designer to have less heavier section for PSC T-beam girder than RCC T-beam girder for 24 m span. Deflection for PSC T-beam girder is less than RCC T-beam Girder Bridge.

2.2.2 M.K.Maroliya

Studied the structural behavior of reinforced concrete and prestressed concrete flexure member. It was proposed to cast the beams of 2.5 m and 3.0 m span of each type with the same cross section of 100 mm width and 150 mm overall depth. From the experimental investigation conclusion can be made was the casting of precast prestressed beam is feasible with the designed mould. The ultimate deflection in case of prestressed beam was 60% less than the ultimate deflections in case of reinforced concrete beam.

2.2.3 V. Kavitha, K.P. Nandhini, P.Prakash, Dr.N.Arunachalam.

Investigated four hundred and forty simply supported PSC beams designed for span in the range of 5m to 25m considering the load in the range of 5 to 20 kN/m. The grades of concrete adopted were M30-M60. In order to study the effects of grades of concrete on the total cost of beams, the relative cost of simply supported beams of rectangular section and Symmetrical I section have been studied. The design of beam and estimation of cost have been carried out using MS-Excel. The conclusion were drawn for beams of rectangular and symmetrical I section like volume of required concrete is found to be least when M60 grade of concrete was used and the quantity of steel is found to be least when M30 grade of concrete was used.

3. CONCLUSIONS

i) Analytical study carried out by Suchitra De & Shraddha Sharma concluded that the conventional method i.e. RCC construction is cheaper than newly evolved Prestressed

ii) Investigation by A.R. Mundhada & Mohmmad Shahezad have suggested prestressed concrete beams are decidedly superiors as compared to conventional R.C.C. beams for spans greater than 20m.

iii) V.K.Rahman & Prof. A.R. Mundhada have concluded that RCC flat slabs are economical up to 9m span but beyond that prestressed concrete flat slabs become a better choice.

iv) Analytical study by Vishal Dhore and Dr.S.H.Mahure has concluded that R.C.C portal frame is suitable for small to medium span but the superiority of prestressed concrete portal frame is undisputable for longer spans.

v) Shaheenjaham, Prof. Sachin S Kulkarni et.al. concluded that cost of construction of PSC is economical as compare to R.C.C. for different span

vi) Experimental investigation by Rajamoori Arun Kumar & B. Vamsi Krishna revealed that the deflection for PSC T-beam girder is less than RCC T-beam Girder Bridge.

vii) M.K.Maroliya has concluded that the ultimate deflection in case of prestressed beam was 60% less than the ultimate deflections in case of reinforced concrete beam.

viii) V. Kavitha, K.P. Nandhini, P.Prakash, Dr.N.Arunachalam have concluded that for beams of rectangular and symmetrical section like I section, volume of concrete required is found to be least when M60 grade of concrete was used and the quantity of steel is found to be least when M30 grade of concrete was used.

REFERENCES

[1] Suchitra De & Shraddha Sharma " Economics of Continuous RCC and Prestressed Concrete beam and design in MS-Excel" , International Journal of Innovations in Engineering and Technology, vol.7, Issue 2 August 2016.

[2] A. R. Mundhada & Mohmmad Shahezad "Economics of continuous R.C.C. Beams Vis-à-vis Continuous Pre-Stressed Concrete Beams", International journal of Scientific & Engineering Research, volume 3, Issue 7, July 2012

[3] Vakas K.Rahman & Prof. A.R. Mundhada " Comparative study of R.C.C. and Prestressed Concrete Flat Slab", International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue. 3, May.-June. 2013 pp-1727-1730

[4] Anthony J.Wolanski "Flexural Behavior Of Reinforced And Prestressed Concrete Beams Using Finite Element Analysis" M.Tech Thesis.

[5] Dr. S.H.Mahure & Mr.Vishal D. Dhore, "Comparative Study of RCC And Prestressed Concrete Beams For Various Spans" IJSART - Volume 3 Issue 9 – SEPT. 2017

[6] Mr.Vishal D. Dhore ,Dr. S.H.Mahure "Comparative Study of R.C.C. and Prestressed Concrete One Way Continuous Slab for various spans", International Journal For Engineering Applications and Technology, vol 3 Issue 9

[7] Sukumar Behera (2012), "Seismic analysis of multistory building with Floating Column", Department of Civil Engineering NIT, Rourkela- 769008 May 2012.

[8] Shaheenjaham, Akshata C Sureban, Megha Chappalagaon, Mudassar Sharif, "Comparative Study on Design of RCC and PSC Beams", International Journal of Advanced Research in Science, Engineering and Technology Vol. 3, Issue 6 , June 2016

[9] Rajamoori Arun Kumar, B. Vamsi Krishna, "Design of Pre-Stressed Concrete T-Beams" International Journal of Scientific Engineering and Research (IJSER), Volume 2 Issue 8, August 2014

[10] M.K.Maroliya "Comparative study of Flexural behavior of Reinforced Concrete Beam and Prestressed Concrete Beam", International Journal of Engineering Research and Applications, Vol. 2, Issue 6, November-December 2012, pp.230-233

[11] V. Kavitha , K.P. Nandhini, P.Prakash, Dr.N.Arunachalam "Economical Design of Prestressed Concrete Beams" , International Journal of Innovative Research in Science, Engineering and Technology, Vol.5, Issue3, March 2016.

[12] Ankit Sahu, Prof. Anubhav Rai, Prof. Y.K. Bajpai "Cost Comparison Between Rcc & Post-Tensioned Prestressed Beams Spanning 26m", International Journal of Computational Engineering Research (IJCER), Vol.4, Issue6, June 2014

[13] Lin, T.Y, and NED H BURNS "Prestressed Concrete", Third Edition, John Wiley & Sons [ASIA] Pt e Ltd., Singapore 129809.

[14] N. Krishna Raju, (2007). "Prestressed Concrete", Fourth Edition, Tata McGraw- Hill Company Ltd., New Delhi.

[15] B.N Dutta, (2009) "Estimating and Costing In Civil Engineering", Twenty- Sixth Revised Edition UBS Publishers' Distributors Pvt. Ltd. New Delhi.

[16] "Control of Deflection in Concrete Structures" (Reapproved 2000), ACI 435R-95, American Concrete Institute,

[17] "Code for Structural use of concrete" BS 8110-1:1997, Standards Board of publication, BSI

[18] "Code of practice for plain and reinforced concrete" (Fourth Edition).IS 456:2000, Bureau of India standard, New Delhi.

[19] "Code of Practice for Prestressed Concrete" (First Revision). IS: 1343- 1980, Bureau of India standard, New Delhi.

BIOGRAPHIES

Zeeshan Adib Ahmed

- Completed B.E(Civil Engg.) and currently is final year student in M.E.(Structural Engg.) from B.N.College of Engineering, Pusad
- Published 04 papers in International Journals and presented 01 paper in International Conference

Dr.S.H.Mahure

- Obtained Ph. D in (Civil Engg.) from Amravati University.
- Presently working as Professor and Head of Civil Engg. Department at B. N. College of Engineering, Pusad
- Has teaching experience of 32 years
- His No. of research publications are 20

Sufiyan Adib Ahmed

- Currently pursuing B.E (Civil Engg.) from B.N.College of Engineering, Pusad. He has Presented 01 paper in National Level Paper Presentation Competition and was awarded first prize.