

## Comparative Study of RCC and Prestressed Concrete Flat Slabs

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**Abstract**—This paper presents the comparison of R.C.C. and Prestressed Concrete Flat Slab. This work includes the design and estimates for R.C.C. and Prestressed Concrete flat slabs of various spans. The aim of this work is to design R.C.C. as well as prestressed concrete flat slabs for various spans and then compare the results. Programming in MS EXCEL is done to design both types of flat slabs. The idea is to reach a definite conclusion regarding the superiority of the two techniques over one another. Results reveal that a R.C.C. flat slab is cheaper than pre-stressed concrete flat slab for smaller spans but vice versa is true for larger spans.

**Index Terms:** Flat Slab, Prestressed Concrete, R.C.C., Column Strip, Middle Strip, Strand.

### I. Introduction

#### 1.1 Importance & Necessity

Without any semblance of doubt, reinforced cement concrete construction has been the most revolutionary construction technique of modern times. Combining the high compressive strength of concrete with high tensile strength and elasticity of steel has resulted in a composite material that is strong, durable and economical. Moreover, it is time tested.

One of the greatest assets of “homo-sapiens” is the quest for excellence. The human being has constantly refused to sit over his laurels and become complacent. This has often resulted in new invention and improved products and techniques. Very weak tensile strength of concrete led to discovery of R.C.C. Bulkiness of R.C.C resulted in the invention of shells. The problem of serviceability associated with the R.C.C. structures sent the human mind working over-time. The solution was found in prestressing. Like ordinary reinforced concrete, prestressed concrete consists of concrete resisting compression and reinforcement carrying tension. Prestressing became essential in many applications in order to fully utilize the compressive strength of reinforced concrete and to eliminate or control cracking and deflection.

The aim of this work is to design Flat Slab of R.C.C. as well as prestressed concrete variety and then compare the results. The idea is to reach a definite conclusion regarding the Superiority of the two techniques over each other.

#### 1.2 Scope

This work includes the design and estimate for Flat Slabs of various spans, ranging from 6.0 M to 12.0 M, by R.C.C. and Prestressed Concrete techniques. For smaller spans, associated with normal building works, prestressed concrete construction becomes too cumbersome, irrespective of the economics involved. Intensity of assumed loading is kept sufficient enough, so that the factored bending moment will be comparable to that developing in cases of commercial buildings. Post-tensioning is preferred as it is in vogue, in construction of large span slabs.

### II. Methodology

To begin with, an R.C.C. FLAT SLAB was manually designed by using the limit state method based on IS: 456-2000. Based on the steps & formulas involved, a design program was prepared in MS EXCEL. The veracity of the program was checked by first designing the manually designed SLAB by using the program & comparing the results. Since in field, a mix richer than M 30 is seldom used for R.C.C., the grade of concrete was maintained at M 30 for R.C.C.

An identical procedure was followed for PRESTRESSED CONCRETE FLAT SLAB. The manual design was based on the working stress method given in the book Prestressed Concrete by N Krishna Raju and checked by limit state method suggested by the IS: 1343-1980. The program for designing the same was developed by using MS EXCEL & its fidelity was checked by first solving the manual problem & comparing the results. Since the onus was on prestressing, the slabs were designed for various concrete grades between M 30 to M 50, Table 11 in IS: 1343 was incorporated into the program as a link so as to directly calculate the prestressing steel index. Design was carried out for parabolic strand profile only, which is the most popular one. Prestressed concrete flat slab of all concrete grades were designed for TYPE 2.

Programs were also prepared for estimating & costing. Rates are based on the latest CSR in Maharashtra. In case of prestressed concrete, some of the rates were obtained from a well-known private Infrastructure company such as IRB and LT.

### III. Results And Discussion

Table 1 below gives the cost in rupees for various spans for both R.C.C. Flat Slabs in M: 30 grade concrete & Prestressed Concrete Flat Slabs in M: 30 & higher grade concretes. Figure 1 below depicts the same statistics with the help of bar charts.

Figure 2 below is a short form of Figure 1 where R.C.C. Flat slabs are compared with prestressed concrete flat slabs of different grades of concrete. Figure 3 below give percent saving in cost of construction with respect to higher values.

The cost of prestressed concrete flat slabs includes the cost of accessories like split cones, bearing plates, sheathing tubes, grouting etc.

In our country, concrete grade higher than M 30 is generally not used in case of R.C.C. construction. But in prestressed concrete construction concrete grades such as M 40 and M 50 are used.

Traditionally, column spacing and floor spans in these buildings such as commercial complex, shopping mall and ware house etc has been in the range of 6 to 9 metres, to both contain costs and simplify construction. However, recently there is an increasing preference by building owners and tenants for large floor areas with column-free space and spans from 9 to 16 meters. This has focused the interest of designers and builders on methods of reducing costs and speeding construction of long-span floors.

From the statistics, it is cleared that up to 9 m, Reinforced Cement Concrete flat slabs are economical as compared to Prestressed Concrete Flat Slabs .Therefore in practice for spans up to 9 m, RCC flat slab dominates the Prestressed Concrete flat slab.

Form spans 9m to 12 m, Prestressed Concrete flat slab becomes economical and as the span increases its economical efficiency increases. This may not appeal much especially if we consider the hassles associated with prestressing like skilled workmanship & need for superior quality control. But we must not forget that along with these minor inconveniences prestressing delivers a structure that is better from limit state of serviceability & durability point of view.

Prestressed concrete flat slab were simultaneously designed in different grades for identical spans. The results show gradual increased in cost of flat slab with higher grades of concrete which differs in case of RCC. This is because of the large difference in cost of higher grades as compared to lower grades of concrete irrespective of the saving of concrete due to smaller depth of slab for higher concrete grades.

| Span (m) | Concrete Grade  | Estimated Cost of Prestressed Concrete Flat Slab (Rupees) | Estimated Cost Of RCC Flat Slab For M30 Grade Only(Rupees) | % Difference on the basis of Higher Value (%) |
|----------|-----------------|---|--|---|
| 6        | M <sub>30</sub> | 10,41,832.55  | 7,97,417.39  | 23.43   |
|          | M <sub>40</sub> | 11,49,725.88  |  |   |
|          | M <sub>50</sub> | 12,93,028.59  |  |   |
| 7        | M <sub>30</sub> | 15,47,927.56  | 12,75,258.64   | 17.58   |
|          | M <sub>40</sub> | 14,89,880.00  |  |   |
|          | M <sub>50</sub> | 16,76,070.00  |  |   |
| 8        | M <sub>30</sub> | 20,05,632.48  | 19,34,492.04   | 3.49  |
|          | M <sub>40</sub> | 21,57,895.70  |  |   |
|          | M <sub>50</sub> | 21,76,305.96  |  |   |
| 9        | M <sub>30</sub> | 27,28,601.36  | 26,87,130.5  | ≈ 0   |
|          | M <sub>40</sub> | 29,64,421.83  |  |   |
|          | M <sub>50</sub> | 30,26,162.00  |  |   |
| 10       | M <sub>30</sub> | 37,36,278.85  | 39,76,100.49   | -6.04   |
|          | M <sub>40</sub> | 40,66,529.37  |  |   |
|          | M <sub>50</sub> | 42,92,180.92  |  |   |
| 11       | M <sub>30</sub> | 43,88,401.82  | 52,58,044.6  | -16.54  |
|          | M <sub>40</sub> | 44,99,976.70  |  |   |
|          | M <sub>50</sub> | 48,48,999.00  |  |   |
| 12       | M <sub>30</sub> | 56,04,387.18  | 76,17,202.13   | -26.42  |
|          | M <sub>40</sub> | 57,64,089.07  |  |   |
|          | M <sub>50</sub> | 60,83,029.00  |  |   |

Table.1:“Cost Comparison of R.C.C. And Prestressed Concrete Flat Slab”

(+ve sign showing RCC Flat Slab is economical & -ve sign showing Prestressed Concrete Flat Slab is economical)



Figure 1: Variation of Cost with Span of Slab



Figure 2: Variation of Cost with Span of Slab

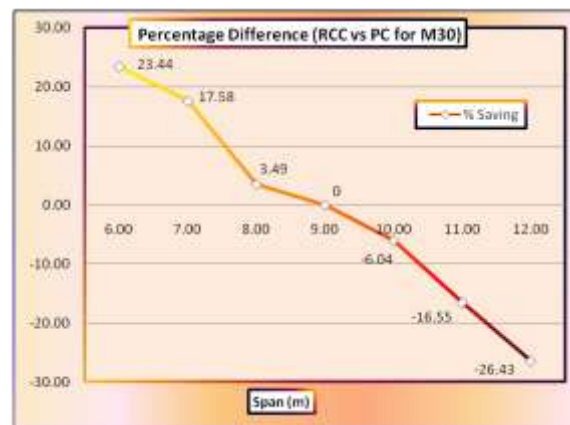


Figure 3: % difference on the basis of Higher value (RCC vs. PC for M30)

#### IV. Conclusions

Based on the study conducted, it could be concluded that RCC flat slabs are economical up to 9m span but beyond that pre-stressed concrete flat slabs become a better choice. The cost advantage in percentage terms goes on increasing in favour of prestressed concrete with increasing span. Besides, pre-stressed concrete flat slabs being thinner provide greater headroom & result in lesser seismic forces. Better durability of prestressed concrete structures is already a well established fact.

#### V. Future Scope

Cost comparison of RCC and prestressed concrete waffle slabs for spans above 10m.

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