DESIGN AIDS FOR FLEXURAL MEMBER USING IS:1343-2012

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Abstract - In India RCC Structures are commonly used for Residential as well as commercial Buildings for short span and pre-stressed concrete for longer span. In India, presently there is a rapid need and increase in the number of high-rise buildings as a basic infrastructure for residential and commercial utility. As due to this cost effectiveness and so many advantages of pre-stressed concrete it is widely used in all over the world.

As the design aids for reinforced concrete is available as SP-16 but there is no design aids for pre-stressed concrete. Here by this work provides some design aids for pre-stressed concrete flexural member in the form of design charts.

1. INTRODUCTION

In modern office buildings nowadays it requires open space in such cases longer span system is necessary. The use of Pre stressed reinforced concrete slab results in thinner concrete sections and/or longer spans between supports. As the floor system plays an important role in the overall cost, performance and strength of a building, a pre stressed floor system is invented which reduces the time for the construction and the cost of the structure and finally give safe and economical structure.

By comparison with reinforced concrete, there is a considerable saving in concrete and steel since, due to the less cross sectional area or depth and use of high strength tendons and thus more slender designs are possible.

Like in ordinary reinforced concrete, pre-stressed concrete consists of concrete to resisting compression and reinforcement carrying tension. Pre-stressing 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 IS-1343 was first published in 1980 and the first revision was published in 2012 in between the Indian standard IS-456 was revised in 2000 as the fourth revision of Indian standard IS-456:2000. So the numbers of changes were made in the second revision of Indian standard IS-1343:2012.

As the design aids for reinforced concrete is available as SP-16 but there is no design aids for pre-stressed concrete. Here in this work some design aids for pre-stressed concrete in the form of design charts are provided for flexural member.

1.1 Advantages of Pre-stressed Concrete

Some advantages of pre stressed concrete slab as compared to the reinforced cement concrete are

- Smaller deflections compared to with steel and reinforced concrete structures.
- It offers great technical advantages in comparison with other forms of construction.
- The cross section is more efficiently utilized.
- Saving in the materials.
- Pre-stressed concrete member poses good resistance to the shearing forces and reduces the principal tensile stresses.

- Stiffer, lighter and slender members are possible.
- High strength concrete and freedom from crack contributes to the improved durability of the structure under the aggressive environmental conditions.
- In long span pre-stressed concrete is more economical than the reinforced concrete.
- Good crack behavior and therefore permanent protection of the steel against corrosion.
- Pre stressing results more economical structures with a very high tensile strength instead of normal reinforcing steels.
- It offers larger spans and greater slenderness which results in reduced dead load. Subsequently, the overall height of buildings reduces which enables additional floors to be incorporated in buildings of a given height.

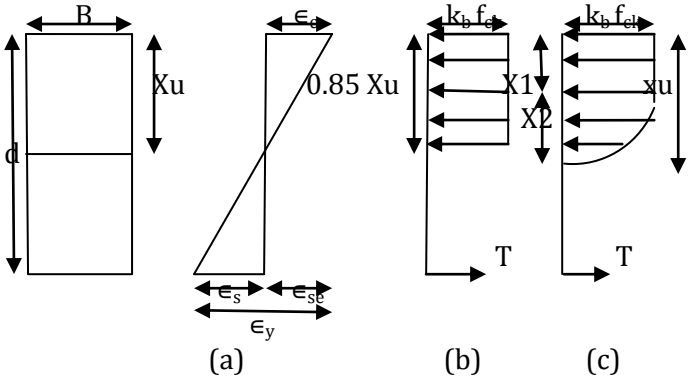

Fig 1 (a) Idealized stress blocks in compression (b)Rectangular (c)Parabolic cum Rerctangular

2. Design charts for pre-stressed concrete – Flexure

This work includes charts for concrete grades M40, M50, M60, M70 and M80 for the grade of steel f_p = 1500, 1600 and 1700 N/mm^2 as in IS: 1343-2012.

The value Xu can be obtained from the compatibility of strains consideration. (refer fig 1)

$$\frac{\epsilon_c}{\epsilon_c + \epsilon_s} = \frac{X_u}{d} \qquad \text{.....(a)}$$

Where,

ϵ_c = Compressive strain in extreme fibre of the concrete

ϵ_s = Compatible strain in steel

The total strain in the pre-tensioned steel is

$$\epsilon_y = \epsilon_s + \epsilon_{se} \qquad \text{.....(b)}$$

Where,

ϵ_{se} = effective pre-strain in steel

Therefore,

$$Xu = \frac{\epsilon_c\, d}{\epsilon_c + \epsilon_y - \epsilon_{se}} \qquad \text{.....(c)}$$

The normally accepted strains at failure of a balanced section are,

ϵ_c =0.0035, $\epsilon_y = 0.0020 + \frac{0.87\, f_p}{E_s}$, ϵ_{se} =0.004, E_s=200000 MPa.

By substituting all this value we get

$$Xu = \frac{35\, d}{15 + 0.0435\, f_p} \qquad \text{.....(1)}$$

Xu max/d can be calculated from these equation which is mentioned in table A.

TABLE-A VALUES OF Xu max/d FOR DIFFERENT GRADE OF STEEL

fp N/mm2	1500	1600	1700
Xu max/d	0.436	0.414	0.393

Limiting percentage of steel can be calculated from the following equation.

T = C (Refer fig. 1)

$$0.87\ f_p\ A_p = 0.36\ f_{ck}\ b\ X_u$$

Therefore,

$$p_{s\,lim} = \left[0.414\ \frac{f_{ck}}{f_p}\frac{x_u}{d}\right] \times\ 100 \qquad \text{.....(2)}$$

By using this equation we are getting different values of Ps lim for different grades of pre-stressing steel. (refer table B)

TABLE-B LIMITING REINFORCEMENT INDEX FOR SINGLY REINFORCED RECTANGULAR SECTIONS			
fp N/mm2	1500	1600	1700
Ps lim*fp/fck	18.06	17.13	16.29
Mu lim/(fck b d2)	0.128	0.123	0.118

And the maximum percentage of steel can be further calculated as in table C.

TABLE-C MAXIMUM PERCENTAGE OF TENSILE REINFORCEMENT Ps lim			
fck N/mm2	**fp N/mm2**		
	1500	**1600**	**1700**
40	0.48	0.43	0.38
50	0.60	0.54	0.48
60	0.72	0.64	0.57
70	0.84	0.75	0.67
80	0.96	0.86	0.77

Design charts for pre-stressed concrete section for flexure for M40 are drawn below.

For preparing this charts the equation used for finding out the percentage steel is,

$$Ps = 50\left[\frac{1.005 - \sqrt{1.005 - \frac{4.6}{fck}\frac{Mu}{bd^2}}}{\frac{f_p}{fck}}\right] \qquad \text{.....(3)}$$

From above equation design charts for M40 are prepared for characteristic strength of steel f_p= 1500 N/mm^2 for different depth of 50 to 300 mm, 300 to 550 mm and 550 to 800 mm.

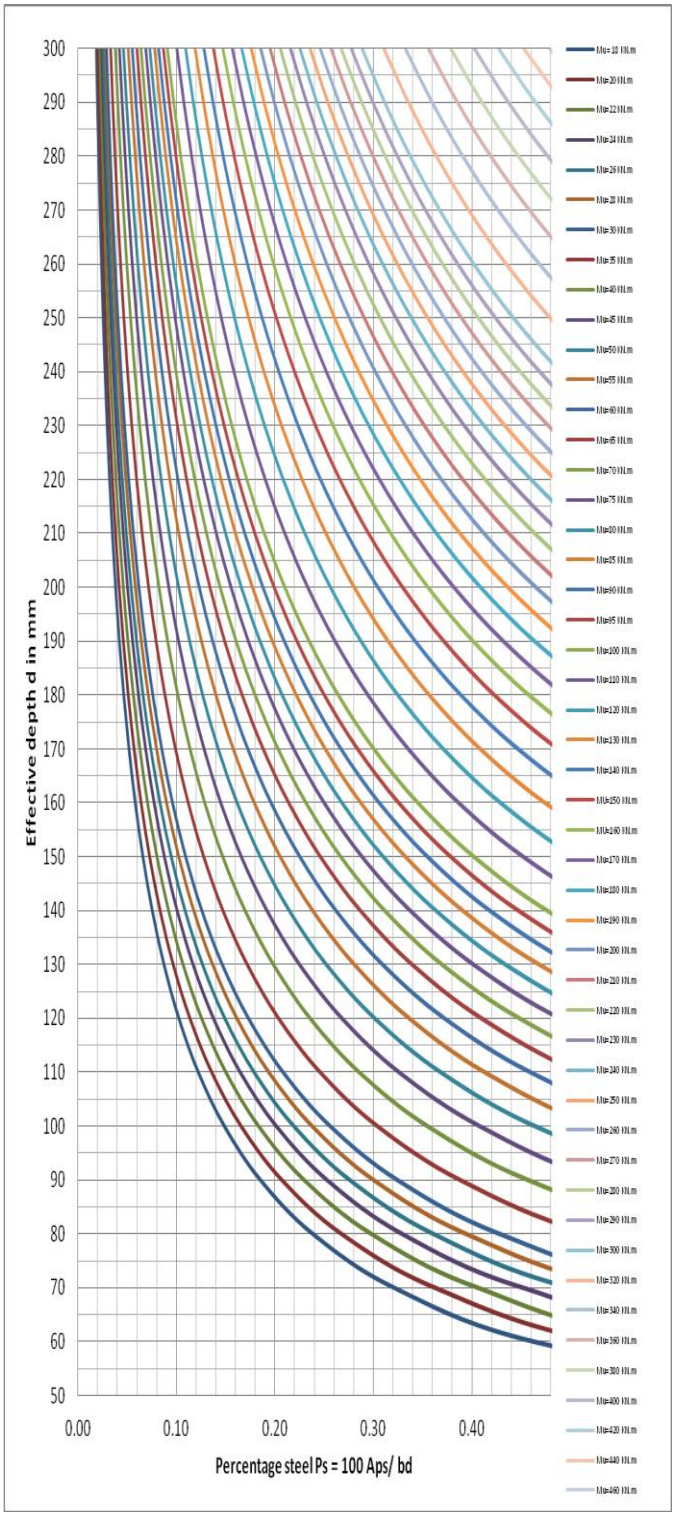

Chart -1:

Fp = 1500 N/mm²

Fck = 40 N/mm²

d = 50-300 mm

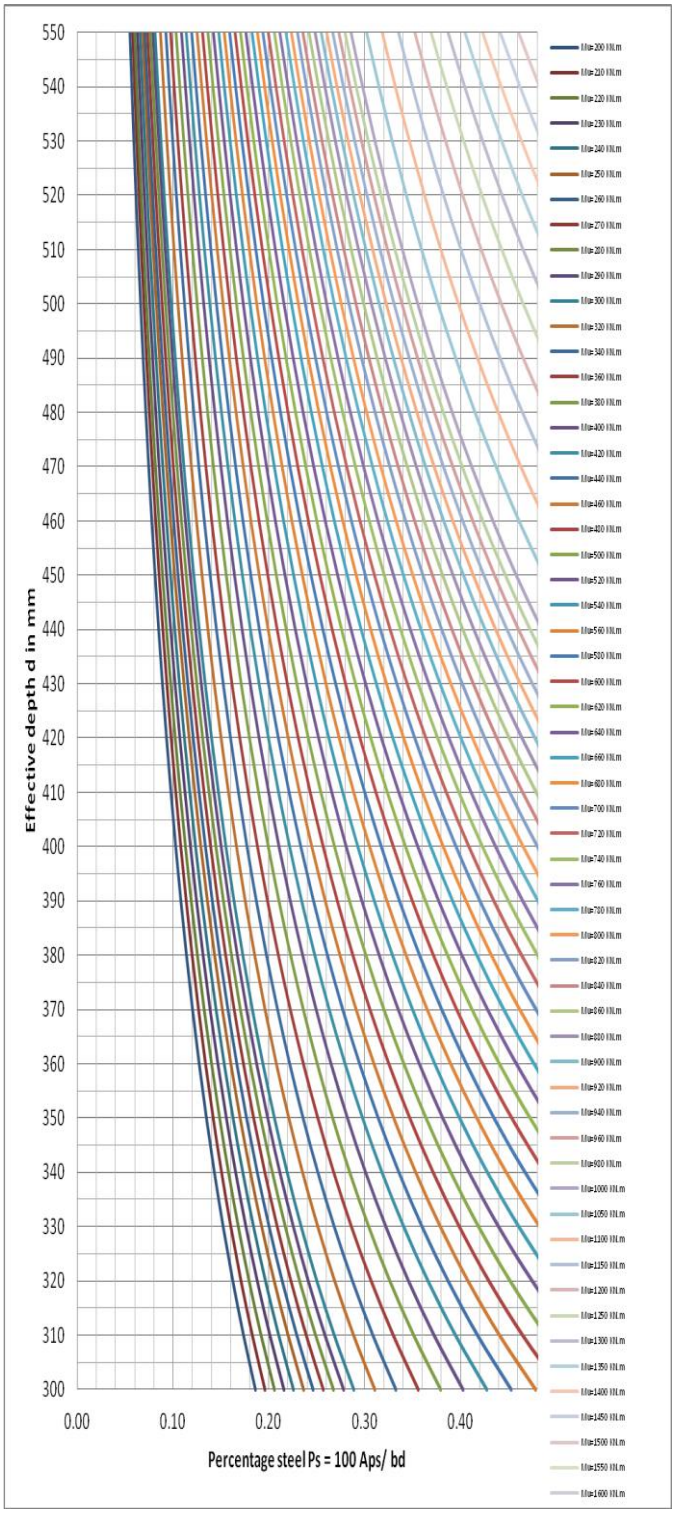

Chart -2:

Fp = 1500 N/mm²

Fck = 40 N/mm²

d = 300-550 mm

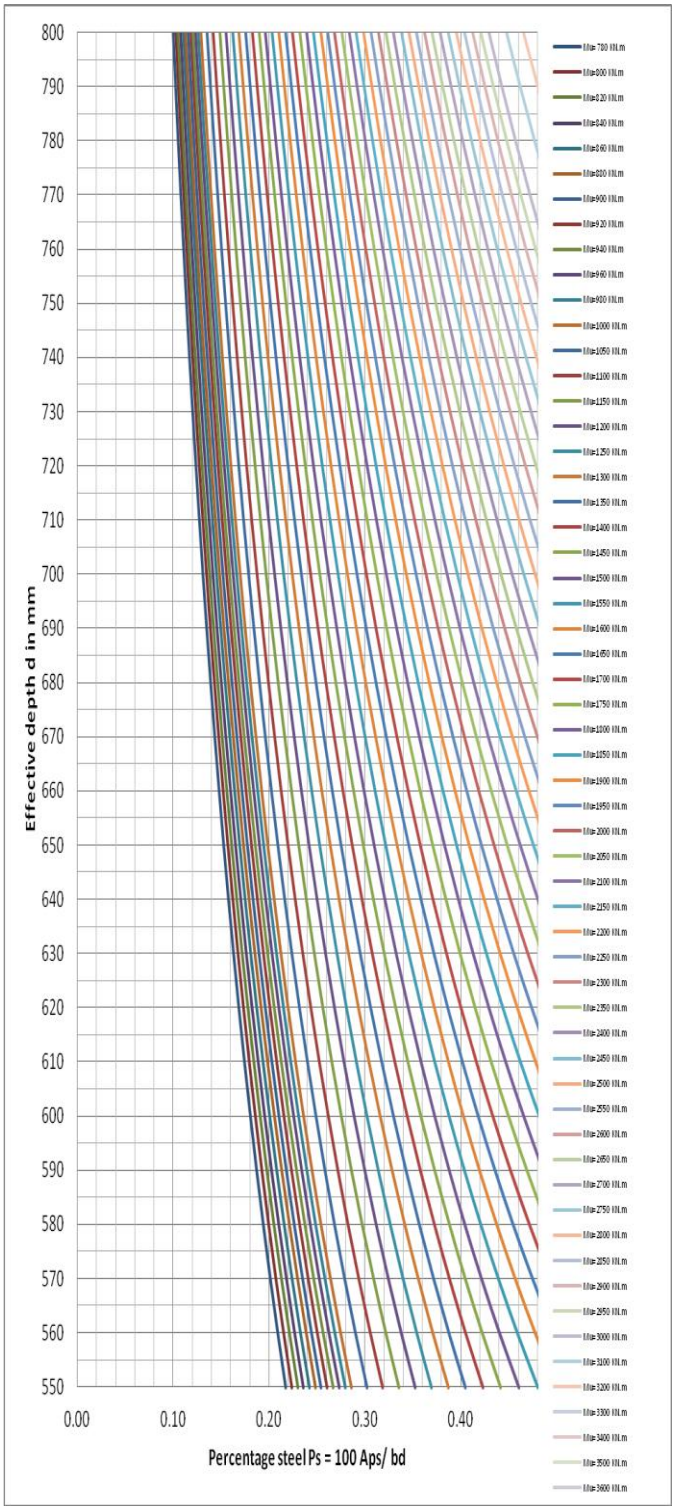

Chart -3:

Fp = 1500 N/mm^2

Fck = 40 N/mm^2

d = 550-800 mm

3. METHOD OF REFFERING THE DESIGN CHARTS

Determine the main tension reinforcement required for a rectangular beam section with the following data:

Size of beam 30x60cm

Concrete mix M 40

Characteristic strength of pre-stressing steel 1500 N/mm^2

Factored moment 250 kN.m

Assuming 25 mm clear cover,

Effective depth = 60 - 2.5 = 575 mm

From Table C,

for f_p = 1500 N/mm^2 and f_{ck} = 40 N/mm^2

Mu lim/(fck b d^2) = 0.128

Therefore Mu lim = 0.128*40*300*600^2= 553 KN.m. > 250 KN. m.

Therefore the section is therefore to be designed as singly reinforced (under-reinforced) rectangular section.

METHOD OF REFFERING THE DESIGN CHARTS

For referring to Chart no 1, we need the value of moment per metre width.

Mu/b **=** 834 kN.m per metre width.

Referring to chart, corresponding to Mu = 834 kN.m and ***d*** **=** 575 mm,

Percentage of steel ***pt*** **=** 0.22

Ap **=** 0.22*300*600/100 = 396 mm^2

4. CONCLUSIONS

As shown the design charts for flexural member of pre-stressed pre-tensioned concrete can be prepared and which can be used in designing office to quickly find the percentage required for the given sectional dimensions and for desired moments.
One can use this design charts to find percentage of pre-stressing steel required instead of going for so many and trials and errors method. This will save the time of designer.

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Standard specifications

4. SP: 16 FOR REINFORCED CONCRETE by bureau of Indian standards.
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6. IS 1343: 2012 “CODE OF PRACTICE FOR PRESTRESSED CONCRETE”.
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BIOGRAPHIES

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