BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

SELECTION AND DESIGN OF PRESTRESSED CONCRETE SECTIONS FOR FLEXURE

Introduction

The design procedure of Prestressed Concrete beams is not straightforward but tends to be tedious and time consuming, involving trial and error. This is primarily due to the fact that the code requires the satisfaction of permissible stresses at critical loading stages along with the requirement of specified ultimate load factors. In the first instance satisfaction of several 'ceilings' simultaneously appears to be difficult but the stipulation at ultimate load aids the designer in restricting the choice of sections to a limited few. A design procedure is set out here which minimises the designer's effort in the choice of a proper section. Further the method has been systematised so that the required section 'builds itself'.

Design Concept

The basic design concept is briefly stated. In a prestressed concrete member, the stresses result from the application of external loads and the prestressing force. The prestressing force is introduced so that the section remains uncracked and the entire section is effective.

A prestressed concrete member balances an externally applied moment, M_A, by internal resisting moment, M_R, represented by a C—T couple similar to a reinforced concrete section. The location of T remains fixed and coincides with the centroid of the prestressing steel, while 'C'—the centre of compression in concrete—gets displaced as the bending moment changes. The magnitudes of C and T remain practically constant. The external moment is thus balanced by a shift of the centre of action of the effective prestressing force. The range of displacement of 'C' is governed by zero or a small limiting tension allowed in the code. Considering the zero stress limit, the centre of compression should lie within the core limits to exclude the tensile stresses in the section. The distance between the kern points is then the maximum value of lever-arm for a case of no tension. To take advantage of the permissible tension, f_{tt} at the transfer stage, the centre of gravity of steel, CGS, is located below the bottom kern to an extent eb_1h; similarly when the tension f_{bt} is permitted at working stage the centre of pressure moves beyond the top kern to an extent et_1h. For the stress condition, where residual compression at working is desired, the centre of pressure lies below the top kern to an extent et_2h (Fig. 1). Thus the magnitude of lever-arm depends upon the desired stress-conditions.

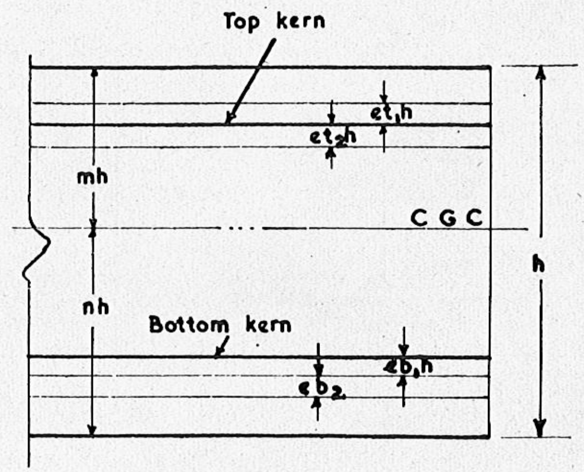


FIG. I.

Critical Conditions

Three critical loading stages are considered for the design of non-composite, simply supported members.

(i) Transfer : This condition exists immediately after the prestressing force is applied. The bending moment due to self weight will be effective.

(ii) Working : At this stage the initial prestressing force is reduced due to losses. The applied loads are carried by the member in addition to the self load.

(iii) Ultimate : The ultimate strength of the member is computed to check for the satisfaction of the load factors stipulated in the code.

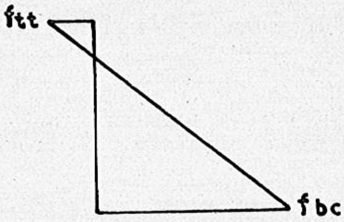
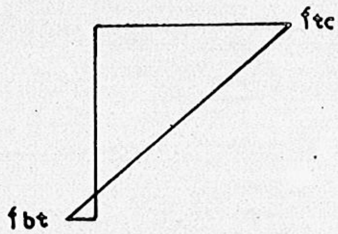
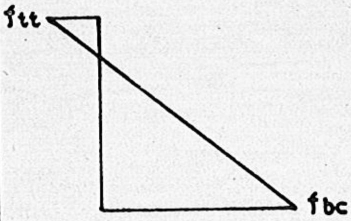
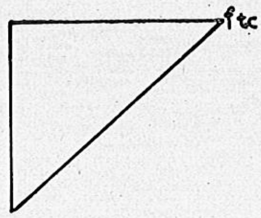
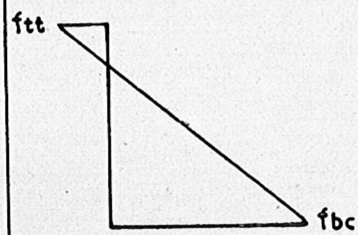
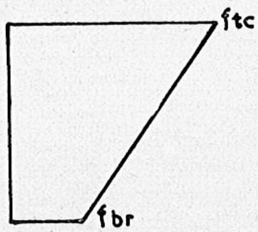
Permissible Stresses

The maximum permissible stresses in a given concrete at transfer and working are to be determined from straight line relationships as given in the code. Tables 1 and 3 give the values of the stresses both for pretensioned and post-tensioned members.

Stress Conditions

Consideration of the stress conditions at transfer and at working leads to the determination of the centroid of the section*. Three typical stress condi-

CHETTY, S.M.K., "Design of Prestressed Concrete Sections for flexure". Indian Construction News Vol. 7, No. 8, 1958, 99-109.

STRESS CONDITION	TRANSFER	WORKING	EXPRESSIONS DEFINING CGC.
A			$m = \frac{f_{tt} + r f_{tc}}{(f_{tt} + f_{bc}) + r(f_{tc} + f_{bt})}$ (1) $n = (1-m)$ (2)
B			$m = \frac{f_{tt} + r f_{tc}}{(f_{tt} + f_{bc}) + r f_{tc}}$ (3) $n = (1-m)$ (4)
C			$m = \frac{f_{tt} + r f_{tc}}{(f_{tt} + f_{bc}) + r(f_{tc} - f_{br})}$ (5) $n = (1-m)$ (6)

tions designated as A, B and C are envisaged to cover most of the practical cases encountered in the design. Expressions for evaluating 'm' and 'n' for these stress conditions are as shown above.

The numerical values of m and n pertaining to different concrete strengths for these stress conditions are tabulated (Tables 2 and 4).

Prestressing force

The initial prestressing force, P_o undergoes losses due to elastic shortening, shrinkage and creep of concrete and relaxation of steel. Although the losses should be determined for each individual case separately as per the code, for the purposes of design, the loss factor $\left(r = \frac{P_o}{P}\right)$ is assumed to be 1.33 for pretensioned and 1.25 for post-tensioned work. The expressions relating the effective prestressing force, P and A_c for the three typical stress conditions are :

(A) $(nf_{tc} - mf_{bt})\,A_c$ (7)

(B) $(nf_{tc})\,A_c$ (8)

(C) $(nf_{tc} + mf_{br})\,A_c$ (9)

Say $P = pA_c$ The values of p are tabulated (Tables 2 and 4).

Lever-arm

The lever-arm depends upon the section property 'k' and is denoted by 'akh' where k is related to the moment of inertia

thus : $$k = \frac{I}{A_c mhnh} \qquad (10)$$

The expressions for the lever arm corresponding to the three stress conditions are.

(A) $kh + eb_1h + et_1h + eb_2$ (11)

(B) $kh + eb_1h + eb_2$ (12)

(C) $kh + eb_1h - et_2h + eb_2$ (13)

where eb_2 is the additional eccentricity provided in the case of post-tensioned members to counter the self weight bending moments, M_G.

Hence, $$eb_2 = \frac{M_G}{P_0} = \frac{qL^2}{rp} \qquad (14)$$

where $q = \frac{2400}{8 \times 100} = 3$, assuming density of concrete 2400 kg/m³ and span L in meters. In the case of pretensioned members with straight tendons however, the value of eb_2 is zero.

Area of Cross Section. (A_c)

Consideration of the moment equilibrium equation namely $M_R = M_A$ (Total)$+M_G$ leads to the following expression for A_c

$$A_c \text{ (Pretensioned)} = \frac{M_A}{snkh - q_L^2} \qquad (15)$$

$$A_c \text{ (Post tensioned)} = \frac{M_A}{snkh - (1 - \frac{1}{r})qL^2} \qquad (16)$$

where $s = f_{tc} + \frac{f_{tt}}{r}$ for all the three stress conditions A, B & C.

Height

The height is determined from the considerations of the ultimate load requirements as per the code. In the first instance the effective depth, 'd' is computed so that the member is balanced or preferably under-reinforced. The ultimate moment of resistance of a balanced section is C x lever arm (ultimate). In a flanged beam, the bulk of the compression zone is provided by the top flange. Hence, the dimensions of the top flange have great influence on the depth of the member. For a well proportioned section, thickness, t_1 of the top flange varies between 0.20 to 0.25d. Setting $t_1 = \alpha d$ and ignoring the contribution of the web towards ultimate resisting moment.

$$d = \sqrt{\frac{\text{Mult (Applied)}}{0.35(2\alpha - \alpha^2)F_c b_1}} \qquad (17)$$

where, Mult. (Applied) can be computed in each individual case using the appropriate load factors given in the code. Regarding breadth of the top flange b_1 it is suggested that a value equal to or greater than L′/30 be adopted to avoid the beam becoming a slender one where L′ is the distance between effective lateral restraints for the beam. Having determined 'd', the overall height 'h' can be computed using the formula

$$h\text{(Pretensioned)} = \frac{d + 1.2\, eb_2}{m + kn + eb_1} \qquad (18)$$

$$h\text{(Post tensioned)} = \frac{d + 0.13\, eb_2}{m + kn + eb_1} \qquad (19)$$

The section property 'k' may be set equal to 0.5 in the above expressions while evaluating the required height.

Web

Dimensions of the web are generally governed by practical considerations, such as ease of concreting, cover etc. The breadh of the web, 'bw' has great influence upon the shear stress developed in the member. To avoid premature failure due to shear, the breadth of the web is determined by limiting the principal tensile stress developed under ultimate load within the prescribed value as per the code. The minimum value of bw at the support section for pretensioned members with straight tendons is given by the empirical formula:

$$bw \geqq \frac{V_{ULT}}{hf_{tr}} \qquad (20)$$

where $f_{tr} = 1.9\sqrt{F_c}$

This value of bw. may be maintained or altered for the centre section consistent with the practical requirements.

In the case of post-tensioned members the value of bw at the centre Section is given by the empirical formula :

$$bw = \frac{h}{36} + 6 + \text{diameter of tendon} \quad \ldots \qquad (21)$$

Choice of shape

Several shapes are adopted for prestressed concrete members in practice e.g. box, channel, T, symmetrical and asymmetrical I etc. From the designers' point of view, the various shapes can be approximated to a section consisting of three rectangles (Fig. 2)

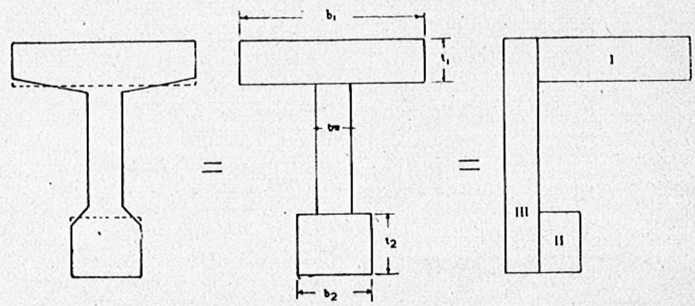


FIG. 2

The procedure for the evaluation of the dimensions of the rectangles I and III have been indicated in the foregoing. Regarding the dimensions of rectangle II, the thickness, t_2, is chosen from the practical considerations. A value ranging from 0.20 to 0.25h is recommended. The breadth b_2 is then computed to satisfy the appropriate 'm' and 'n' values. The section thus sketched may not have the required resisting moment under working loads. To meet this requirement, the elastic equation (15 or 16) is used for computing the required area. While doing so, the value of section properly 'k' of the section sketched above is adopted. If the area thus computed is more than that of the section sketched above, the top and bottom flanges are suitably increased without disturbing the CGC, thereby arriving at the required section.

The prestressing force is then determined using expression (7,8 or 9) and its eccentricity is given by $knh + eb_1h + eb_2$ for post tensioned members and $knh + eb_1h$ for pretensioned members with straight tendons.

The various design parameters are tabulated (Tables 2,4). The design procedure is illustrated in the following examples with the aid of the tables.

= 5 meters. Pretentioned beam.
= 1500 kg/m DL+1200 kg/m LL
= Total 2700 kg/m.
= 500 kg/cm²
ondition 'A' to be adopted.
: lateral restraints are provided at the

$'00 \times 5^2 \times \frac{100}{8} = 84.25 \times 10^4$ kg cm.
(Applied) $= 2 \times M_A = 168.5 \times 10^4$ kg cm.
op flange and height.
$'= L$ from data.
$_1 = \frac{5 \times 100}{30} = 16.6$ cm. Adopt 18.0 cm.
: $\alpha = 0.23$.
quation (17)

$$d = \sqrt{\frac{168.5 \times 10^4}{0.35\,(2 \times 0.23 - 0.23^2)\,500 \times 18.0}}$$
$= 36.1$
$t_1 = 0.23 \times 36.1 = 8.3$ cm., say 8.0 cm.
able (2)
).5116 ; $n = 0.4884$; $eb_1 = 8.130 \times 10^{-2} k$;
$eb_2 = 3.570 \times 10^{-2}\ L^2$
equation (18)

$$h = \frac{36.1 + 1.2 \times 0.03570 \times 5^2}{0.5116 + 0.5\,(0.4884 + 0.08130)}$$
$= 43.8$ cm. Adopt 44.0 cm.

Web.
equation (20)

$$bw > \frac{2 \times 2700 \times 2.5}{44.0 \times 1.9\,\sqrt{500}}$$
> 7.24 Adopt 7.5 cm.

Sketching the section
e $t_2 = 0.23\,h = 10.1$ say 10 cm ; compute x,

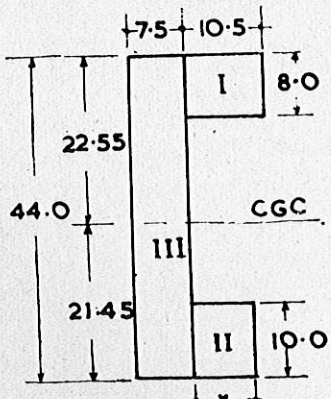


FIG. 3

Rectangle No.	b	t	A (b×t)	r	Ar
I	10·5	8	10.5×8= 84.0	18.55	1560
III	7.5	44	7.5×44=330.0	0.55	182
II	$\frac{106}{10} = 10.6$	10	$\frac{1742}{16.45} = 106.0$	16.45	1742
			520.0 sq. cm.		

Step 4. Section property

No.	*I about own axis*	Ar^2
I	$84 \times \frac{8^2}{12} = 448.0$	$1560 \times 18.55 = 28900.0$
III	$330 \times \frac{44^2}{12} = 53200.0$	$182 \times 0.55 = 100.0$
II	$106 \times \frac{10^2}{12} = 885.0$	$1742 \times 16.45 = 28650.0$
	54533.0	57650.0

$I_0 = 54533.0 + 57650.0 = 112183.0$ cm⁴
From equation (10)

$$K = \frac{112183.0}{520 \times 22.55 \times 21.54} = 0.447$$

Step 5. Elastic Area, 'building' of section

Assume $k = 0.460$; from table (1) $s = 154.7$
From equation(15)

$$A_c = \frac{84.25 \times 10^4}{154.7 \times 0.4884 \times 0.46 \times 44 - (3 \times 25)}$$
$= 579.0$ sq cm.
Excess area to be provided $= 579 - 520 = 59.0$ sq cm.
Say 'a' sq cm.
Referring fig. (4)

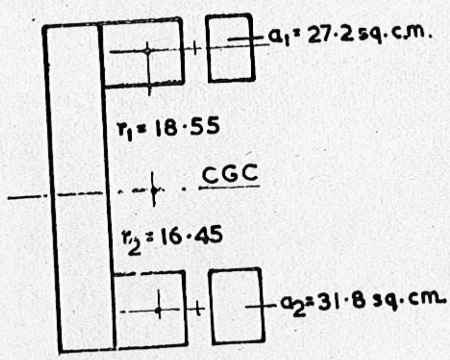


FIG. 4

$$a_1 = a \times \frac{r_2}{r_2 + r_1}$$
$$= 59 \times \frac{16.45}{16.45 + 18.55}$$

$=27.2$ sq cm.

$a_2 = 59.0 - 27.2$

$= 31.8$ sq cm,

$I = I_0 + 27.2 \times 18.55^2 + 31.8 \times 16.54^2$

$= 112183.0 + 9300.0 + 8600\ 0$

$= 130083.0$ cm^4

$$K = \frac{130083.0}{579 \times 22.55 \times 21.45}$$

$= 0.464$

Against 0.460 assumed. Satisfactory.

Step 6. Final section, Prestressing force and eccentricity

From table (2), $p = 63.27$

$P = p\,A_c = 63.27 \times 579$

$= 36600$ kg

And $e = Knh + eb_1h$

$= 0.464 \times 21.45 + 0.08130 \times 0.464 \times 44$

$= 11.645$ cm.

i.e. CGS from bottom fibre $= nh - e$

$= (21.45 - 11.645)$

$= 9.805$ cm.

Fig. (5) gives the final section.

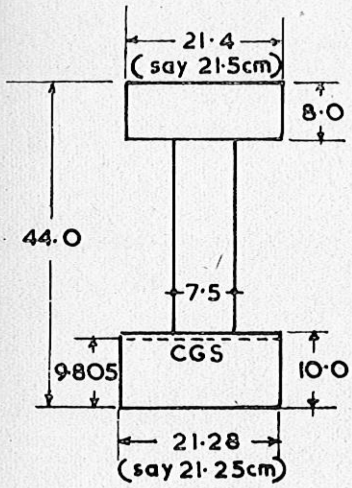


FIG. 5

Example 2

DATA

Span — 12 metres. Post tensioned beam

$M_A = M_D + M_L = 275 \times 10^4 + 225 \times 10^4 =$ Total 500×10^4 kg cm.

$F_C = 450$ kg/cm^2.

Stress condition 'A' to be adopted.

Effective lateral restraints are provided at the supports.

DESIGN

$M_A = 500 \times 10^4$ kg cm.

M_{ULT} (Applied) $= 2\,M_A = 1000 \times 10^4$ kg cm.

Step 1. Top Flange and height.

$L' = L$ from data

$$b_1 = \frac{12 \times 100}{30} = 40 \text{ cm.}$$ Adopt 45 cm.

Assume $\alpha = 0.22$

From equation (17)

$$d = \sqrt{\frac{1000 \times 10^4}{0.35\,(2 \times 0.22 - 0.22^2)\,450 \times 45}}$$

$= 60.0$

Then, $t_1 = 0.22 \times 60.0 = 13.2$ cm. say 14.0 cm.

From table (4)

$m = 0.4500$; $n = 0.5500$; $eb_1 = 6.26 \times 10^{-2}k$;

$eb_2 = 3.41 \times 10^{-2}\,L^2$

From equation (19).

$$h = \frac{60.0 + 0.13 \times 3.41 \times 10^{-2} \times 12^2}{0.4500 + 0.5\,(0.5500 + 0.0626)}$$

$= 80.2$ cm. Adopt 80.0 cm.

Step 2. Web

12×5 mm. cables are proposed. Diameter of tendon $= 3.5$cm.

So, from equation (21)

$$bw = \frac{80}{36} + 6 + 3.5$$

$= 11.7$ cm. Adopt 11.5 cm.

Step 3. Sketching the section

Assume $t_2 = 0.25\,h = 20$ cm., compute x, fig. (6)

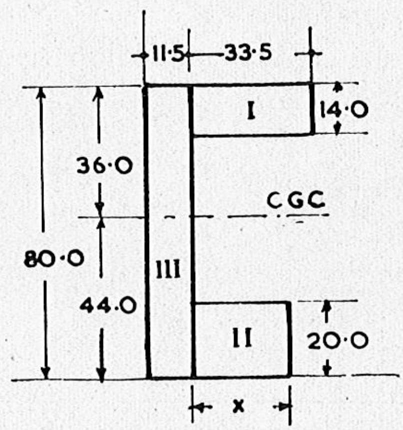


FIG. 6

Rectangle No.	b	t	A (b×t)	r	Ar
I	33.5	14	$33.5 \times 14 = 469$	29	13600
III	11.5	80	$11.5 \times 80 = 920$	−4	−3680
II	$\frac{292}{20} = 14.6$	20	$\frac{9920}{34} = 292$	34	9920
			1681 sq cm.		

Step 4. Section property

No.	*I about own axis*	*Ar²*
I	$469\times\frac{14^2}{12}=$ 7680.0	$13600\times29=394000.0$
III	$920\times\frac{80^2}{12}=491000.0$	$3680\times4=$ 14730.0
II	$292\times\frac{20^2}{12}=$ 9730.0	$9920\times34=337000.0$
	508410.0	745730.0

$I_0=508410.0+745730.0=1254140.0\ cm^4$

From equation (10)

$$k=\frac{1254140.0}{1681\times36\times44}=0.471$$

Step 5. Elastic area, 'building' of section

Assume $k=0.475$; from table (3) $s=144$

from equation (16)

$$A_c=\frac{500\times10^4}{144\times0.55\times0.475\times80-\left(1-\frac{1}{1.25}\right)3\times12^2}$$

$=1710$ sq cm.

Excess area to be provided $=1710-1681=29.0$ sq cm.

Say a sq cm,

Referring fig. (7)

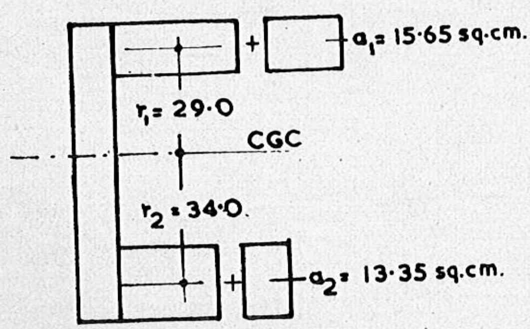


FIG. 7

$$a_1=a\frac{r_2}{r_2+r_1}$$

$$=29\times\frac{34}{34+29}$$

$=15.65$ sq cm.

$a_2=29-15.65$

$=13.35$ sq cm.

$I=I_0+15.65\times29^2+13.35\times34^2$

$=1254140.0+13150.0+15450.0$

$=1282740.0\ cm^4$

$$K=\frac{1282740.0}{1710\times36\times44}$$

$=0.474$

Against 0.475 assumed, Satisfactory.

Step 6. Final Section, Prestressing force and eccentricity from table (4), $p=70.30$

$P=pA_c=70.3\times1710$

$=120200$ kg.

and $e=knh+eb_1h+eb_2$

$=0.474\times44+6.26\times10^{-2}\times0.474\times80+0.0341\times12^2$

$=28.1$ cm.

i.e. CGS from bottom fibre

$=(nh-e)$

$=44.0-28.1$

$=15.9$ cm.

Fig. (8) gives the final section.

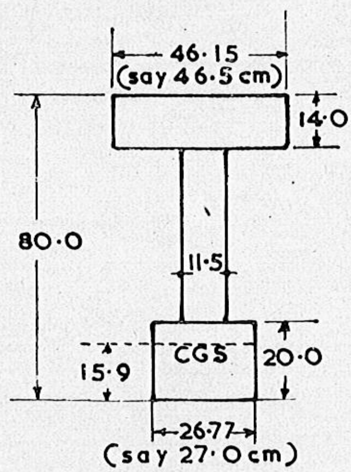


FIG. 8

NOTE : *In the above examples, stress conditions at transfer and working and the resisting moments at ultimate loads have not been computed, but they will be satisfactory.*

STRESSES PRETENSIONED CGS SYSTEM

($r=1.33$)

TABLE 1

Cube Strength (F_c, kg/cm²)	Permissible Stresses				s (kg/cm²)
	f_{bc}	f_{tc}	f_{tt} or f_{bt}	f_{br}	
420	157.5	130.4	13.0	7.9	140.2
450	165.5	136.0	13.6	8.3	146.2
500	177.8	144.2	14.0	8.9	154.7
550	188.9	150.9	14.0	9.4	161.6
600	198.8	156.3	14.0	9.9	166.8
636	205.1	159.4	14.0	10.3	169.9

NOTE :—Transfer is assumed to have been effected when 0.75 F_c is attained.

DESIGN PARAMETERS PRETENSIONED CGS SYSTEM

($r=1.33$)

TABLE 2

Cube Strength (F_c, kg/cm²) 1	Parameters 2	Stress Conditions 'A' 3	'B' 4	'C' 5
420	m	0.5161	0.5421	0.5591
	n	0.4839	0.4579	0.4409
	$\left(\frac{eb_1}{k}\right)\times 10^2$	8.39	7.50	6.94
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	11.90	—	7.13
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	4.00	3.78	3.64
	p	56.39	59.71	61.91
450	m	0.5144	0.5403	0.5573
	n	0.4856	0.4597	0.4427
	$\left(\frac{eb_1}{k}\right)\times 10^2$	8.41	7.52	6.98
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	11.85	—	7.13
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	3.82	3.61	3.48
	p	59.05	62.52	64.83

TABLE 2 (*Contd.*)

1	2	3	4	5
	m	0.5116	0.5365	0.5536
	n	0.4884	0.4635	0.4464
	$\left(\frac{eb_1}{k}\right)\times 10^2$	8.13	7.30	6.78
500	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	11.32	—	7.11
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	3.57	3.38	3.26
	p	63.27	66.84	69.30
	m	0.5085	0.5320	0.5490
	n	0.4915	0.4680	0.4510
	$\left(\frac{eb_1}{k}\right)\times 10^2$	7.72	6.98	6.48
550	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	10.62	—	7.05
	$\left[\frac{eb_2}{L^2}\right)\times 10^2$	3.36	3.19	3 08
	p	67.05	70.62	73.22
	m	0.5051	0.5274	0.5445
	n	0.4949	0.4726	0.4555
	$\left(\frac{eb_1}{k}\right)1\times 0^2$	7.41	6.73	6.26
600	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	10.06	—	7.04
	$\left(\frac{et_2}{L^2}\right)\times 10^3$	3.21	3.05	2.95
	p	70.28	73.87	76.59
	m	0.5025	0.5242	0.5414
	n	0.4975	0.4758	0.4586
	$\left(\frac{eb_1}{k}\right)\times 10^2$	7.25	6.60	6.14
636	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	9.74	—	7.09
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	3.12	2.97	2.87
	p	72.27	75.84	78.68

STRESSES POST TENSIONED CGS SYSTEM

r=1.25

TABLE 3

Cube Strength (F_c, kg/cm²)	Permissible Stresses				s (kg/cm²)
	f_{bc}	f_{tc}	f_{tt} or f_{bt}	f_{br}	
350	175.0	115.6	10.0	8.8	123.6
400	192.2	126.4	10.0	9.6	134.4
450	207.5	136.0	10.0	10.4	144.0
500	220.8	144.2	10.0	11.0	152.2
530	227.9	148.4	10.0	11.4	156.4

NOTE :—Transfer is assumed to have been effected when F_c is attained.

DESIGN PARAMETERS POST TENSIONED CGS SYSTEM

(r=1.25)

TABLE 4

Cube Strength (F_c, kg/cm²) 1	Parameters 2	Stress Conditions 'A' 3	'B' 4	'C' 5
350	m	0.4518	0.4689	0.4851
	n	0.5482	0.5311	0.5149
	$\left(\frac{eb_1}{k}\right)\times 10^2$	7.45	6.92	6.46
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	7.68	—	6.69
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	4.08	3.91	3.76
	p	58.85	61.40	63.79
400	m	0.4508	0.4664	0.4825
	n	0.5492	0.5336	0.5175
	$\left(\frac{eb_1}{k}\right)\times 10^2$	6.77	6.33	5.91
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right)\times 10^2$	6.95	—	6.61
	$\left(\frac{eb_2}{L^2}\right)\times 10^2$	3.70	3.56	3.43
	p	64.91	67.45	70.04

1	2	3	4	5
450	m	0.4500	0.4645	0.4806
	n	0.5500	0.5355	0.5194
	$\left(\frac{eb_1}{k}\right) \times 10^2$	6.26	5.88	5.49
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right) \times 10^2$	6.40	—	6.61
	$\left(\frac{eb_2}{L^2}\right) \times 10^2$	3.41	3.30	3.17
	p	70.30	72.83	75.64
500	m	0.4492	0.4628	0.4789
	n	0.5508	0.5372	0.5211
	$\left(\frac{eb_1}{k}\right) \times 10^2$	5.88	5.55	5.18
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right) \times 10^2$	6.00	—	6.55
	$\left(\frac{eb_2}{L^2}\right) \times 10^2$	3.20	3.10	2.99
	p	74.93	77.46	80.41
530	m	0.4485	0.4617	0.4778
	n	0.5515	0.5383	0.5222
	$\left(\frac{eb_1}{k}\right) \times 10^2$	5.70	5.39	5.04
	$\left(\frac{et_1}{k} \text{ or } \frac{et_2}{k}\right) \times 10^2$	5.80	—	6.57
	$\left(\frac{eb_2}{L^2}\right) \times 10^2$	3.10	3.01	2.89
	p	77.36	79.88	82.94

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the Twenty fifth in the series.

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