SAFE SUPERIMPOSED LOADS ON REINFORCED CONCRETE FLOOR SLABS.

Computed According to Building By-laws of the City of Toronto.

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The following table gives the safe loads on concrete floor slabs reinforced in one direction with at least one quarter of the reinforcement continuous over the beams, and within one inch of the top of the slab over the beams. As nearly all methods of beam and slab concrete construction involve the carrying of practically all the reinforcement over the beams this condition is easily fulfilled:

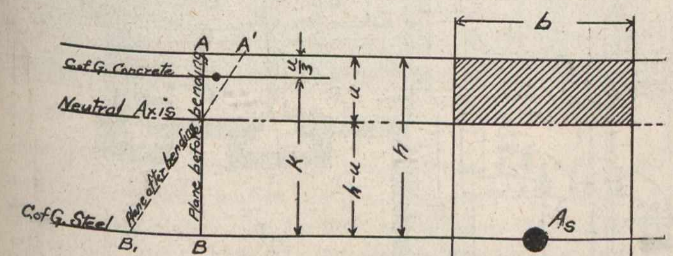
These assumptions give the loads shown in the table which are the safe load per square foot of slab exclusive of the weight of the concrete itself. For a square slab reinforced both ways the loads will be twice those given in the table, plus the weight of the slab.

The method of computation is well-known and gives the economic percentage of steel.

The formula $w = \frac{619h^2}{l^2}$ was derived from the above constants and may be used to extend the table, or for any rectangular beam twelve inches wide, and by simple proportion may be used for beams of any width and even for T beams provided the depth of slab is not less than .273, the effective depth of beam, but for these cases the shearing stresses would have to be considered and provided for.

Depth in Inches	Area of Steel in sq. ins. per ft. width.	Wt. per sq. ft. of Slab.	SPAN IN FEET																
			2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10	11	12	13	14
2.5	.078	30	310	190	125	85													
3.0	.103	35	585	360	240	165	120	85	65										
3.5	.129	45	920	575	385	280	200	145	110	85									
4.0	.155	50	1340	840	570	405	300	225	170	135	105	65							
4.5	.181	55		1160	785	565	420	320	250	200	155	100	65						
5.0	.206	60			1040	750	560	430	335	270	215	140	95	60					
5.5	.232	65				970	720	555	435	350	285	195	135	90	60				
6.0	.258	70					900	695	550	440	360	250	170	120	85	60			
6.5	.284	80					1090	845	670	540	440	305	215	150	105	75	50		
7.0	.310	85						1015	805	650	535	370	265	190	140	100	70	50	
7.5	.335	90							955	780	640	445	320	230	175	125	90	65	45
8.0	.362	95								910	755	525	380	280	210	155	115	85	60

The depths given are the total depth of the slab, and the centre of gravity of reinforcing steel is considered to be one



inch from the bottom of the slab at the centre of the span.

The units and constants used are as follows:

	Symbol.
Unit stress in steel (tension), 16,000 lbs. per sq. in....	(f)
Unit stress in concrete (compression), 500 lbs. per sq. in.	(c)
Modulus of elasticity—Steel.......30,000,000..........	Es
" " " Concrete .. 2,500,000..........	Ec
Ratio.................... $\frac{Es}{Ec} = 12$	e
Effective depth of slab	h
Width of slab considered (12 inches for table)	b
Constant for moment arm of resistance	k
Height from neutral axis to top of slab	u
Area of Steel	As
Load in pounds per square foot	w
Span in feet	l

The strain in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

The modulus of elasticity of the concrete remains constant with the limits of the working stresses.

The steel takes all tension, the concrete all compression.

The derivation of the formula is as follows:—

Let $\lambda c = A\text{-}A'$ = (shortening of Concrete under stress)

$\lambda s = B\text{-}B'$ = (lengthening of Steel under stress)

then $\frac{\lambda c}{\lambda s} = \frac{u}{h-u}$ (I) now $\lambda c = \frac{c}{Ec}$ and $\lambda s = \frac{f}{Es}$

substitute in (I). Then $\frac{\frac{c}{Ec}}{\frac{f}{Es}} = \frac{c}{Ec} \times \frac{Es}{f} = \frac{u}{h-u}$

but $\frac{Es}{Ec} = e \quad \therefore \frac{c}{f}\, e = \frac{u}{h-u}$ (II)

i.e. $\frac{500 \times 12}{16000} = \frac{u}{h-u} = \frac{3}{8}$

If $h = 1$, then $u = \frac{3}{11} = 0.273$ (distance from top of beam to N.A.)

$k = 1 - \frac{.273}{3} = 0.909$ (constant for length of moment arm)

Percentage of Steel

(Total compression) = (Total tension)

$$b \times u \times \frac{c}{2} = As \times f$$

$$\therefore As = \frac{b.\ u.\ c.}{f.\ 2} \quad (\text{but } u = .273h)$$

$$= \frac{b \times .273\ h \times 500}{16000 \times 2} = .00427\ b\ h$$

say $.0043\ b\ h$

To find safe uniform load on slab consider strip 12 inches wide.

$As = .0043 \times 12 \times h = .0516\ h$ sq. ins. per ft. width of slab.

$$\text{Bending Moment} = \frac{w\ l\ (12\ l)}{10}$$

Resisting Moment = h. k. 16000. As

Resisting Moment = Bending Moment

$$w = \frac{h.\ k.\ 16000.\ As\ .10}{12\ l^2}$$

$$= \frac{619\ h^2}{l^2}$$

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