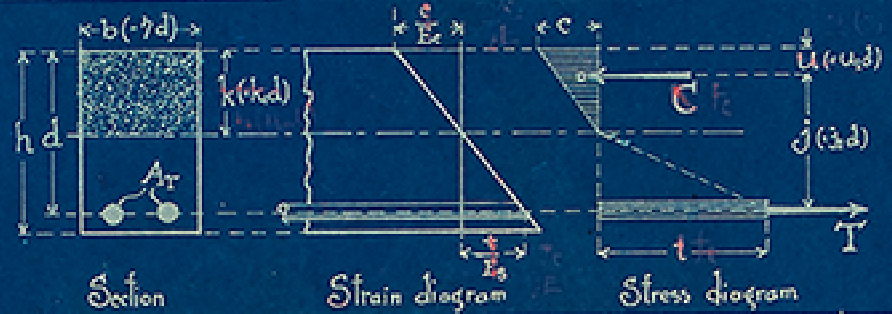
TABLE I

FORMULÆ FOR RECTANGULAR BEAM.



r	$\frac{A_r}{bd}$	$\frac{m}{2t_1(t_1+m)}$			1
t_1	$\frac{t}{c}$	$\frac{m}{2}\left(\sqrt{1+\frac{2}{mr}}-1\right)$			1′
k	$k_1 d$	$\frac{m}{t_1+m}\cdot d$			2
		$mr\left(\sqrt{1+\frac{2}{mr}}-1\right)\cdot d$			2′
u	$u_1 d$	$\frac{k_1}{3}\cdot d$	$\frac{m}{3(t_1+m)}\cdot d$		3
			$\frac{mr}{3}\left(\sqrt{1+\frac{2}{mr}}-1\right)\cdot d$		3′
j	$j_1 d$	$(1-u_1)\cdot d$	$\left(1-\frac{k_1}{3}\right)\cdot d$	$\frac{3t_1+2m}{3(t_1+m)}\cdot d$	4
				$\left\{1-\frac{mr}{3}\left(\sqrt{1+\frac{2}{mr}}-1\right)\right\}\cdot d$	4′
A_r	rbd	$\frac{1}{j_1\cdot t}\cdot\frac{M}{d}$	$\frac{1}{\left(1-\frac{k_1}{3}\right)\cdot t}\cdot\frac{M}{d}$	$\frac{3(t_1+m)}{(3t_1+2m)\cdot t}\cdot\frac{M}{d}$	5
				$\frac{1}{\left\{1-\frac{mr}{3}\left(\sqrt{1+2/mr}-1\right)\right\}\cdot t}\cdot\frac{M}{d}$	5′
		$\frac{1}{t_1 j_1\cdot c}\cdot\frac{M}{d}$	$\frac{1}{t_1\left(1-\frac{k_1}{3}\right)\cdot c}\cdot\frac{M}{d}$	$\frac{3(t_1+m)}{t_1(3t_1+2m)\cdot c}\cdot\frac{M}{d}$	6
				$\frac{1}{t_1\left\{1-\frac{mr}{3}\left(\sqrt{1+2/mr}-1\right)\right\}\cdot c}\cdot\frac{M}{d}$	6′
d	$\sqrt{\frac{M}{N_1 b}}$	$\sqrt{\frac{1}{rj_1\cdot t}\cdot\frac{M}{b}}$	$\sqrt{\frac{1}{r\left(1-\frac{k_1}{3}\right)\cdot t}\cdot\frac{M}{b}}$	$\sqrt{\frac{6t_1(t_1+m)^2}{m(3t_1+2m)\cdot t}\cdot\frac{M}{b}}$	7
		$\sqrt{\frac{2}{k_1 j_1\cdot c}\cdot\frac{M}{b}}$	$\sqrt{\frac{2}{k_1\left(1-\frac{k_1}{3}\right)\cdot c}\cdot\frac{M}{b}}$	$\sqrt{\frac{6(t_1+m)^2}{m(3t_1+2m)\cdot c}\cdot\frac{M}{b}}$	8
b	$\frac{M}{N_1 d^2}$	$\frac{1}{rj_1\cdot t}\cdot\frac{M}{d^2}$	$\frac{1}{r\left(1-\frac{k_1}{3}\right)\cdot t}\cdot\frac{M}{d^2}$	$\frac{6t_1(t_1+m)^2}{m(3t_1+2m)\cdot t}\cdot\frac{M}{d^2}$	9
		$\frac{2}{k_1 j_1\cdot c}\cdot\frac{M}{d^2}$	$\frac{2}{k_1\left(1-\frac{k_1}{3}\right)\cdot c}\cdot\frac{M}{d^2}$	$\frac{6(t_1+m)^2}{m(3t_1+2m)\cdot c}\cdot\frac{M}{d^2}$	10
$\left(\frac{b}{d}=\eta\right)$ d $(b=\eta d)$	$\sqrt[3]{\frac{M}{N_1\eta}}$	$\sqrt[3]{\frac{1}{rj_1\cdot t}\cdot\frac{M}{\eta}}$	$\sqrt[3]{\frac{1}{r\left(1-\frac{k_1}{3}\right)\cdot t}\cdot\frac{M}{\eta}}$	$\sqrt[3]{\frac{6t_1(t_1+m)^2}{m(3t_1+2m)\cdot t}\cdot\frac{M}{\eta}}$	11
		$\sqrt[3]{\frac{2}{k_1 j_1\cdot c}\cdot\frac{M}{\eta}}$	$\sqrt[3]{\frac{2}{k_1\left(1-\frac{k_1}{3}\right)\cdot c}\cdot\frac{M}{\eta}}$	$\sqrt[3]{\frac{6(t_1+m)^2}{m(3t_1+2m)\cdot c}\cdot\frac{M}{\eta}}$	12
t	$t_1 c$	$\frac{1}{rj_1}\cdot\frac{M}{bd^2}$	$\frac{1}{r(1-k_1/3)}\cdot\frac{M}{bd^2}$	$\frac{3}{mr^2(2-\sqrt{1+2/mr})}\cdot\frac{M}{bd^2}$	13
c	$\frac{t}{t_1}$	$\frac{2}{k_1 j_1}\cdot\frac{M}{bd^2}$	$\frac{2}{k_1(1-k_1/3)}\cdot\frac{M}{bd^2}$	$\frac{3(\sqrt{1+2/mr}-1)}{2r^2(2-\sqrt{1+2/mr})}\cdot\frac{M}{bd^2}$	14
T & C	$\frac{M}{j}$	$\frac{1}{j_1}\cdot\frac{M}{d}$	$\frac{1}{(1-k_1/3)}\cdot\frac{M}{d}$	$\frac{3(t_1+m)}{3t_1+2m}\cdot\frac{M}{d}$	15
				$\frac{1}{1-\frac{mr}{3}(\sqrt{1+2/mr}-1)}\cdot\frac{M}{d}$	15′
M	Tj	$rj_1\cdot t\cdot bd^2$	$r\left(1-\frac{k_1}{3}\right)\cdot t\cdot bd^2$	$\frac{3t_1+2m}{6t_1(t_1+m)^2}\,m\cdot t\cdot bd^2$	16
	Cj	$\frac{1}{2}k_1 j_1\cdot c\cdot bd^2$	$\left\{\frac{k_1}{2}\left(1-\frac{k_1}{3}\right)\right\}\cdot c\cdot bd^2$	$\frac{3t_1+2m}{6(t_1+m)^2}\,m\cdot c\cdot bd^2$	17
		a	b		

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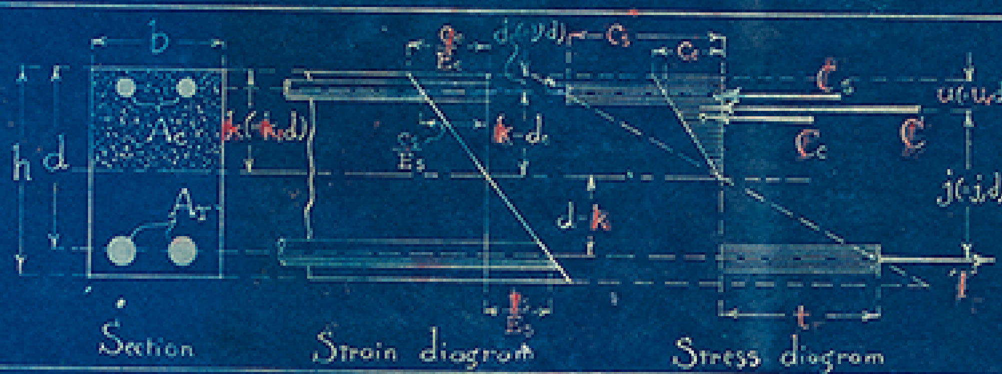
TABLE II

FORMULÆ FOR RECTANGULAR BEAMS, DOUBLE REINFORCEMENT.



r_t	$\frac{A_T}{bd}$	$\frac{r_c c_1(m-1)}{t_1 m}+\frac{m}{2t_1(t_1+m)}$			18
r_c	$\frac{A_c}{bd}$	$\frac{r_t t_1 m}{c_1(m-1)}-\frac{m^2}{2c_1(m-1)(t_1+m)}$			18′
t_1	$\frac{t}{c_c}$	$\frac{1}{\nu}(m-c_1)-m$			19
c_1	$\frac{c_s}{c_c}$	$m-\nu(m+t_1)$			19′
k	$k_1 d$	$\frac{m}{t_1+m}\cdot d$			20
		$\frac{m}{m-c_1}\nu\cdot d$			20′
		$m(r_t+r_c)\left\{\sqrt{1+2\frac{r_t+r_c\nu}{m(r_t+r_c)^2}}-1\right\}\cdot d$			20″
u	$u_1 d$	$\frac{r_c\nu(m-1)(1-\nu/k_1)+k_1^2/6}{r_c(m-1)(1-\nu/k_1)+k_1/2}\cdot d$			21
j	$j_1 d$	$(1-u_1)\cdot d$	$\frac{r_c(1-\nu)(m-1)(1-\nu/k_1)+k_1(3-k_1)/6}{r_c(m-1)(1-\nu/k_1)+k_1/2}\cdot d$		22
d	$\sqrt{\frac{M}{C_2 b}}$	$\sqrt{\frac{1}{r_t(1-\nu)-k_1(k_1/3-\nu)/(2t_1)}\cdot\frac{M}{t\,b}}$		$\sqrt{\frac{6t_1(t_1+m)^2m}{(3t_1+2m)m^2+6r_c c_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{t\cdot b}}$	23
		$\sqrt{\frac{1}{k_1(1-k_1/3)/2+r_c\{c_1-(k_1-\nu)/k_1\}(1-\nu)}\cdot\frac{M}{c_c d^2}}$		$\sqrt{\frac{6(t_1+m)^2m}{(3t_1+2m)m^2+6(t_1+m)^2r_c c_1(m-1)(1-\nu)}\cdot\frac{M}{c\cdot b}}$	24
b	$\frac{M}{C_2 d^2}$	$\frac{1}{r_t(1-\nu)-k_1(k_1/3-\nu)/(2t_1)}\cdot\frac{M}{t\,d^2}$		$\frac{6t_1(t_1+m)^2m}{(3t_1+2m)m^2+6r_c c_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{t\,d^2}$	25
		$\frac{1}{k_1(1-k_1/3)/2+r_c\{c_1-(k_1-\nu)/k_1\}(1-\nu)}\cdot\frac{M}{c_c d^2}$		$\frac{6(t_1+m)^2m}{(3t_1+2m)m^2+6r_c c_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{c\,d^2}$	26
c_s	$c_1 c_c$	$t\frac{k_1-\nu}{1-k_1}\cdot d$	$m c_c\frac{k_1-\nu}{k_1}\cdot d$	$\frac{m(k_1-\nu)}{r_t(1-k_1)(1-k_1/3)m+r_c(m-1)(k_1/3-\nu)(k_1-\nu)}\cdot\frac{M}{bd^2}$	27
t	$t_1 c_c$	$m c_c\frac{1-k_1}{k_1}\cdot d$	$c_s\frac{1-k_1}{k_1-\nu}\cdot d$	$\frac{2m(1-k_1)}{2m r_t(1-\nu)(1-k_1)-k_1^2(k_1/3-\nu)}\cdot\frac{M}{bd^2}$	28
c_c	$\frac{t}{t_1},\ \frac{c_s}{c_1}$	$\frac{t}{m}\frac{k_1}{1-k_1}\cdot d$	$\frac{c_s}{m}\cdot\frac{k_1}{k_1-\nu}\cdot d$	$\frac{2k_1}{k_1^2(1-k_1/3)+2r_c(m-1)(k_1-\nu)(1-\nu)}\cdot\frac{M}{bd^2}$	29
M	$\frac{f_t}{f_c}$	$\left\{r_t\frac{t_1}{c_1}\left(1-\frac{k_1}{3}\right)+r_c\left(1-\frac{k_1-\nu}{c_1k_1}\right)\left(\frac{k_1}{3}-\nu\right)\right\}c_s\cdot bd^2$		$\left\{r_t\frac{1-k_1}{k_1-\nu}\left(1-\frac{k_1}{3}\right)+r_c\left(\frac{m-1}{m}\right)\left(\frac{k_1}{3}-\nu\right)\right\}c_s\cdot bd^2$	30
		$\left\{r_t(1-\nu)-\frac{k_1}{2t_1}\left(\frac{k_1}{3}-\nu\right)\right\}t\cdot bd^2$		$\left\{\frac{3t_1+2m}{6t_1(t_1+m)^2}m+r_c\frac{c_1(m-1)}{t_1 m}(1-\nu)\right\}t\cdot bd^2$	31
				$\left\{r_t(1-\nu)-\frac{k_1^2}{2m(1-k_1)}\left(\frac{k_1}{3}-\nu\right)\right\}t\cdot bd^2$	31′
		$\left\{\frac{k_1}{2}\left(1-\frac{k_1}{3}\right)+r_c\left(c_1-\frac{k_1-\nu}{k_1}\right)(1-\nu)\right\}c\cdot bd^2$		$\left\{\frac{3t_1+2m}{6(t_1+m)^2}m+r_c c_1\frac{m-1}{m}(1-\nu)\right\}c\cdot bd^2$	32
				$\left\{\frac{k_1}{2}\left(1-\frac{k_1}{3}\right)+\frac{r_c(m-1)(k_1-\nu)(1-\nu)}{k_1}\right\}c\cdot bd^2$	32′

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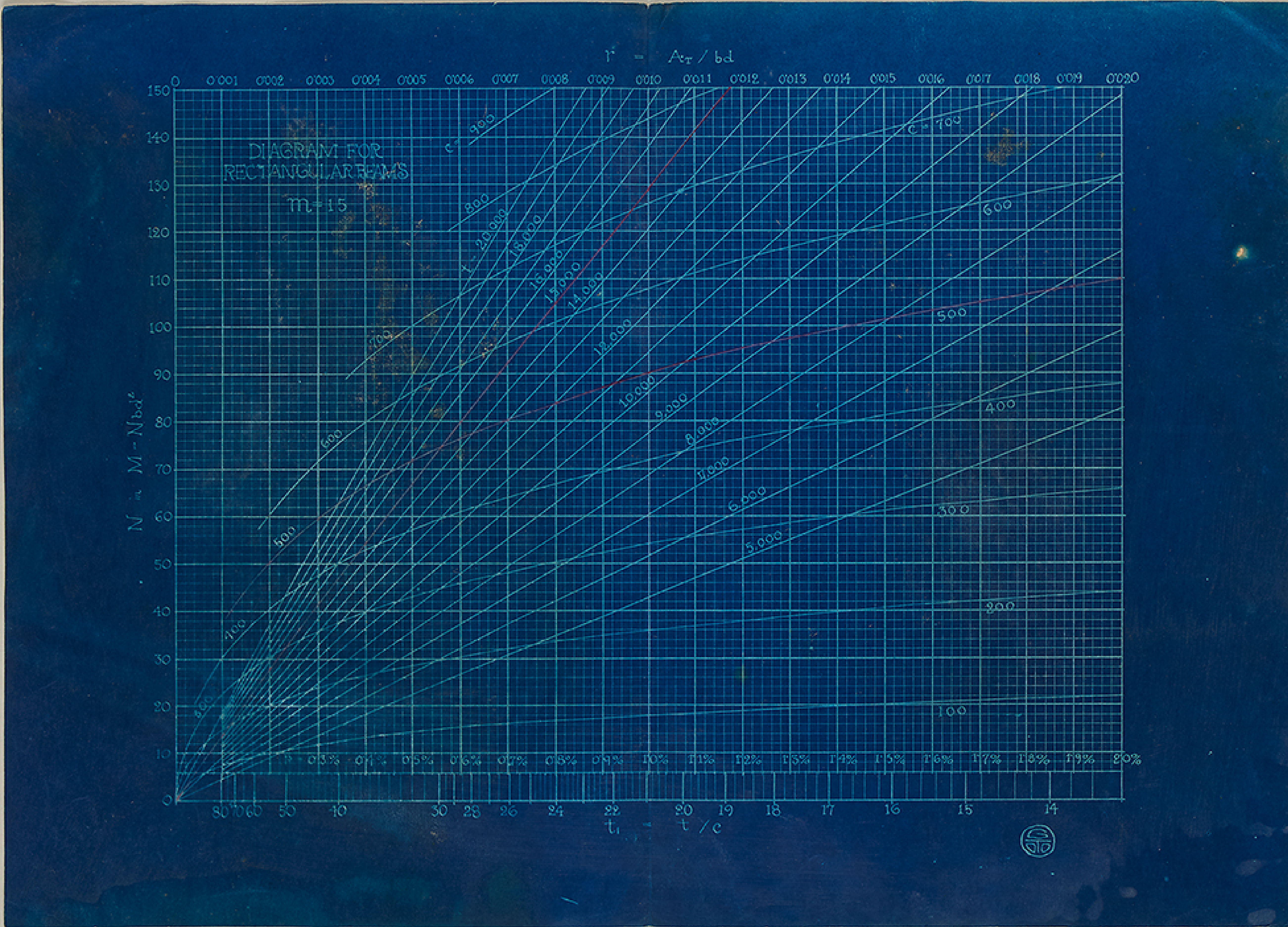

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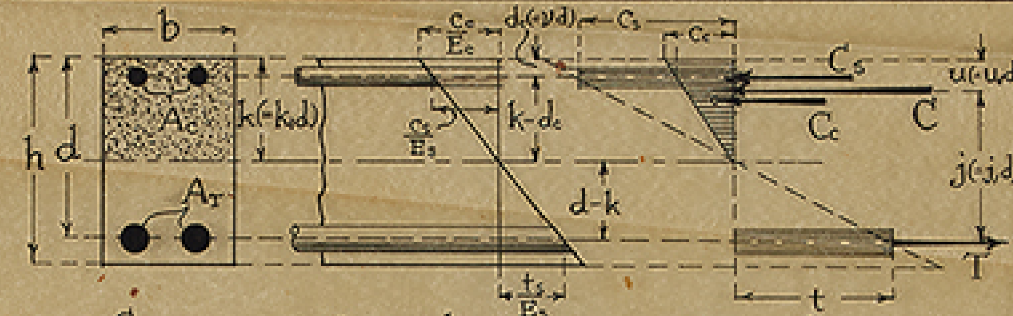
TABLE II

FORMULÆ FOR RECTANGULAR BEAMS, DOUBLE REINFORCEMENT.



Section   Strain diagram   Stress diagram

r_t	$\frac{A_T}{bd}$	$\frac{r_c c_1(m-1)}{t_1 m}+\frac{m}{2t_1(t_1+m)}$			18
r_c	$\frac{A_c}{bd}$	$\frac{r_t t_1 m}{c_1(m-1)}-\frac{m^2}{2c_1(m-1)(t_1+m)}$			18′
t_1	$\frac{t}{c_c}$	$\frac{1}{\nu}(m-c_1)-m$			19
c_1	$\frac{c_s}{c_c}$	$m-\nu(m+t_1)$			19′
k	k_1d	$\frac{m}{t_1+m}\cdot d$			20
		$\frac{m}{m-c_1}\nu\cdot d$			20′
		$m(r_t+r_c)\left\{\sqrt{1+2\frac{r_t+r_c\nu}{m(r_t+r_c)^2}}-1\right\}\cdot d$			20″
u	u_1d	$\frac{r_c\nu(m-1)(1-\nu/k_1)+k_1^2/6}{r_c(m-1)(1-\nu/k_1)+k_1/2}\cdot d$			21
j	j_1d	$(1-u_1)\cdot d$	$\frac{r_c(1-\nu)(m-1)(1-\nu/k_1)+k_1(3-k_1)/6}{r_c(m-1)(1-\nu/k_1)+k_1/2}\cdot d$		22
d	$\sqrt{\frac{M}{N_1b}}$	$\sqrt{\frac{1}{r_t(1-\nu)-k_1(k_1/3-\nu)/(2t_1)}\cdot\frac{M}{t\cdot b}}$		$\sqrt{\frac{6t_1(t_1+m)^2m}{(3t_1+2m)m^2+6r_cc_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{t\cdot b}}$	23
		$\sqrt{\frac{1}{k_1(1-k_1/3)/2+r_c\{c_1-(k_1-\nu)/k_1\}(1-\nu)}\cdot\frac{M}{c_cd^2}}$		$\sqrt{\frac{6(t_1+m)^2m}{(3t_1+2m)m^2+6(t_1+m)^2r_cc_1(m-1)(1-\nu)}\cdot\frac{M}{c_c b}}$	24
b	$\frac{M}{N_2d^2}$	$\frac{1}{r_t(1-\nu)-k_1(k_1/3-\nu)/(2t_1)}\cdot\frac{M}{td^2}$		$\frac{6t_1(t_1+m)^2m}{(3t_1+2m)m^2+6r_cc_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{td^2}$	25
		$\frac{1}{k_1(1-k_1/3)/2+r_c\{c_1-(k_1-\nu)/k_1\}(1-\nu)}\cdot\frac{M}{c_cd^2}$		$\frac{6(t_1+m)^2m}{(3t_1+2m)m^2+6r_cc_1(m-1)(t_1+m)^2(1-\nu)}\cdot\frac{M}{c_cd^2}$	26
c_s	c_1c_c	$t\frac{k_1-\nu}{1-k_1}\cdot d$	$mc_c\frac{k_1-\nu}{k_1}\cdot d$	$\frac{m(k_1-\nu)}{r_t(1-k_1)(1-k_1/3)m+r_c(m-1)(k_1/3-\nu)(k_1-\nu)}\cdot\frac{M}{bd^2}$	27
t	t_1c_c	$mc_c\frac{1-k_1}{k_1}\cdot d$	$c_s\frac{1-k_1}{k_1-\nu}\cdot d$	$\frac{2m(1-k_1)}{2mr_t(1-\nu)(1-k_1)-k_1^2(k_1/3-\nu)}\cdot\frac{M}{bd^2}$	28
c_c	$\frac{t}{t_1},\frac{c_s}{c_1}$	$\frac{t}{m}\frac{k_1}{1-k_1}\cdot d$	$\frac{c_s}{m}\cdot\frac{k_1}{k_1-\nu}\cdot d$	$\frac{2k_1}{k_1^2\ 1-k/3)+2r_c(m-1)(k_1-\nu)(1-\nu)}\cdot\frac{M}{bd^2}$	29
M		$\left\{r_t\frac{t_1}{c_1}(1-\frac{k_1}{3})+r_c(1-\frac{k_1-\nu}{c_1k_1})(\frac{k_1}{3}-\nu)\right\}c_s\cdot bd^2$		$\left\{r_t\frac{1-k_1}{k_1-\nu}(1-\frac{k_1}{3})+r_c(\frac{m-1}{m})(\frac{k_1}{3}-\nu)\right\}c_s\cdot bd^2$	30
		$\left\{r_t(1-\nu)-\frac{k_1}{2t_1}(\frac{k_1}{3}-\nu)\right\}t\cdot bd^2$		$\left\{\frac{3t_1+2m}{6t_1(t_1+m)^2}m+r_c\frac{c_1(m-1)}{t_1m}(1-\nu)\right\}t\cdot bd^2$	31
				$\left\{r_t(1-\nu)-\frac{k_1^2}{2m(1-k_1)}(\frac{k_1}{3}-\nu)\right\}t\cdot bd^2$	31′
		$\left\{\frac{k_1}{2}(1-\frac{k_1}{3})+r_c(c_1-\frac{k_1-\nu}{k_1})(1-\nu)\right\}c\cdot bd^2$		$\left\{\frac{3t_1+2m}{6(t_1+m)^2}m+r_cc_1\frac{m-1}{m}(1-\nu)\right\}c\cdot bd^2$	32
				$\left\{\frac{k_1}{2}(1-\frac{k_1}{3})+\frac{r_c(m-1)(k_1-\nu)(1-\nu)}{k_1}\right\}c\cdot bd^2$	32′

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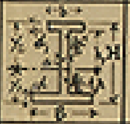
Cross Section.	Sectional Area. A	Dist. of Extreme Fibre from N.A. Y	Moment of Inertia. I	Section Modulus. S	Radius of Gyration r
	$\pi\bar{r}^2=\frac{\pi d^2}{4}$ $=3.1416\bar{r}^2$ $=0.7854d^2$	$\bar{r}=\frac{d}{2}$	$\frac{\pi d^4}{64}=\frac{\pi\bar{r}^4}{4}$ $=0.0491d^4$ $=0.7854\bar{r}^4$	$\frac{\pi d^3}{32}=\frac{\pi\bar{r}^3}{4}$ $=0.0982d^3$ $=0.7854\bar{r}^3$	$\frac{d}{4}=\frac{\bar{r}}{2}$
	$\pi(R^2-\bar{r}^2)$ $=\frac{\pi}{4}(D^2-d^2)$ $=3.1416(R^2-\bar{r}^2)$ $=0.7854(D^2-d^2)$	$R=\frac{D}{2}$	$\frac{\pi}{64}(D^4-d^4)$ $=\frac{\pi}{4}(R^4-\bar{r}^4)$	$\frac{\pi}{32}\frac{D^4-d^4}{D}$ $=\frac{\pi}{4}\frac{R^4-\bar{r}^4}{R}$	$\frac{\sqrt{D^2+d^2}}{4}$
	$\frac{\pi}{4}\bar{A}B$ $=\pi ab$ $=0.7854\bar{A}B$ $=3.1416ab$	$a=\frac{\bar{A}}{2}$	$\frac{\pi}{64}B\bar{A}^3=\frac{\pi}{4}ba^3$ $=0.0491B\bar{A}^3$ $=0.7854ba^3$	$\frac{\pi}{32}B\bar{A}^2=\frac{\pi}{4}ba^2$ $=0.0982B\bar{A}^2$ $=0.7854ba^2$	$\frac{\bar{A}}{4}$
	$\frac{\pi}{4}(bh-b_1h_1)$ $=0.7854(bh-b_1h_1)$	$\frac{h}{2}$	$\frac{\pi}{64}(bh^3-b_1h_1^3)$ $=0.0491(bh^3-b_1h_1^3)$	$\frac{\pi}{32}(bh^2-b_1h_1^2)$ $=0.0982(bh^2-b_1h_1^2)$	$\frac{\sqrt{h^2+h_1^2}}{4}$
	$\frac{\pi\bar{r}^2}{2}$ $=1.577\bar{r}^2$	$y_1=0.4244\bar{r}$ $y_2=0.5756\bar{r}$	$\bar{r}^4\left(\frac{\pi}{8}-\frac{8}{9\pi}\right)$ $=0.1098\bar{r}^4$	$S_1=0.2587\bar{r}^3$ $S_2=0.1908\bar{r}^3$	$\bar{r}\sqrt{2\left(\frac{1}{8}-\frac{8}{9\pi^2}\right)}$ $0.2312\bar{r}$
	$\frac{\pi}{2}(R^2-\bar{r}^2)$	$y_1=\frac{4}{3\pi}\frac{R^2+R\bar{r}+\bar{r}^2}{R+\bar{r}}$ $y_2=R-y_1$	$0.1098(R^4-\bar{r}^4)$ $-\frac{0.283R^2\bar{r}^2(R-\bar{r})}{R+\bar{r}}$ $=0.35\bar{r}^3$	$S_1=\frac{I}{y_1}$ $S_2=\frac{I}{y_2}$	$0.264\sqrt{R^2+\bar{r}^2}$
	$2b(h-d)+\frac{\pi d^2}{2}$	$\frac{h}{2}$	$\frac{1}{12}\left[\frac{3\pi}{16}d^4+b(h^3-d^3)+b^3(h-d)\right]$	$\frac{1}{6h}\left[\frac{3\pi}{16}d^4+b(h^3-d^3)+b^3(h-d)\right]$	$\sqrt{\frac{I}{A}}$

Cross Section.	Sectional Area A	Dist. of Extreme Fibre from N.A. Y	Moment of Inertia. I	Section Modulus $S=\frac{I}{Y}$	Radius of Gyration. $r=\sqrt{\frac{I}{A}}$
	$2b(h-h_1)$ $+b_1h_2+b_2h_1$	$\frac{h}{2}$	$\frac{[illegible]}{12}$	$\frac{[illegible]}{6h}$	$\sqrt{\frac{I}{A}}$
	$BH-(B-b)(Y_2+h)$	$Y_1=\frac{1}{2}\frac{Bd^2+bd(2H-d)}{Bd+bd}$ $Y_2=H-Y_1$	$\frac{1}{3}\{B(Y_1^3-h^3)+b(Y_2^3-h_1^3)\}$	$S_1=\frac{I}{Y_1}$ $S_2=\frac{I}{Y_2}$	$\sqrt{\frac{I}{A}}$
	$BH-B_1(h_1+h)$ $-d_1(B-b)$	$Y_1=\frac{1}{2}\times\frac{[illegible]}{[illegible]}$ $Y_2=H-Y_1$	$\frac{1}{3}(BY_1^3-B_1h^3+bY_2^3-b_1h_1^3)$	$S_1=\frac{I}{Y_1}$ $S_2=\frac{I}{Y_2}$	$\sqrt{\frac{I}{A}}$
	$HB-hb$	$\frac{H}{2}$	$\frac{1}{12}(BH^3-bh^3)$	$\frac{1}{6H}(BH^3-bh^3)$	$\sqrt{\frac{I}{A}}$
	$HB+hb$	$\frac{H}{2}$	$\frac{1}{12}(BH^3+bh^3)$	$\frac{1}{6H}(BH^3+bh^3)$	$\sqrt{\frac{I}{A}}$

6

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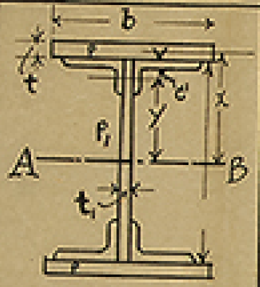
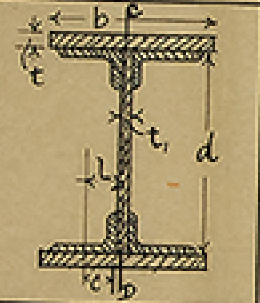
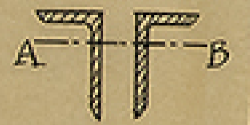
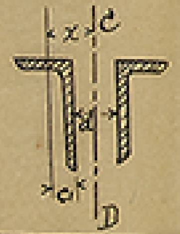
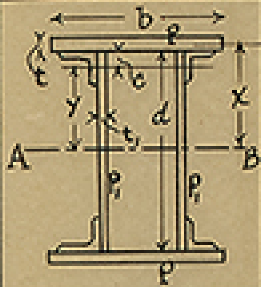
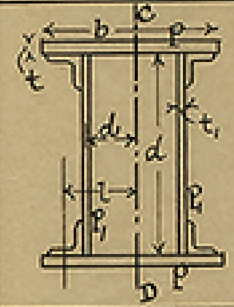
	Sum of $\begin{cases} I' \text{ for plates } P = \left(\frac{bt^3}{12} + btx^2\right) \times 2 \\ I' \text{ for four angles} = 4 \times \left(I' \text{ of one angle} + \text{area of one angle} \times y^2\right) \\ I \text{ for plate } P_1 = \frac{t_1 d^3}{12} \end{cases}$ $y = \frac{1}{2}c' - l$
	Sum of $\begin{cases} I \text{ for plates } P = \frac{2tb^3}{12} \\ I \text{ for four angles} = 4 \times \left(I \text{ of one angle} + \text{area of one angle} \times l^2\right) \\ I \text{ for plate } P_1 = \frac{d t_1^3}{12} \end{cases}$ $l = c + \frac{1}{2}t_1$
	$2 \times I$ of single angle
	$2 \times \left(I' \text{ of one angle} + \text{area of one angle} \times x^2\right)$ $x = \frac{1}{2}d + c'$

10

	Sum of $\begin{cases} I' \text{ for plates } P = \left(\frac{bt^3}{12} + btx^2\right) \times 2 \\ I \text{ for four angles} = 4 \times \left(I \text{ of one angle} + \text{area of one angle} \times y^2\right) \\ I \text{ for plates } P_1 = \frac{2 t_1 d^3}{12} \end{cases}$ $y = \frac{1}{2}d - c$
	Sum of $\begin{cases} I \text{ for flang plates } P = \frac{2tb^3}{12} \\ I \text{ for four angles} = 4 \times \left(I \text{ of one angle} + \text{area of one angle} \times l^2\right) \\ I' \text{ for Web-Plates} = 2 \times \left(\frac{d t_1^3}{12} + d t_1 d_1^2\right) \end{cases}$ $l = d_1 + \frac{1}{2}t_1 + c$

11

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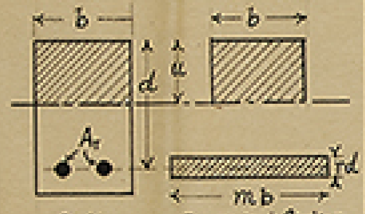
II. Rectangular Beam. No Tension.



Section. Equivalent Section.

$$u = mr\left\{\sqrt{1+\frac{2}{mr}}-1\right\}d$$

$$I_E = \frac{bu^2}{2}\left(d-\frac{u}{3}\right)$$

The total first moment of cross-section about N.A. is zero.

$$\frac{bu^2}{2} - mA_r(d-u) = 0$$

or $bu^2 + 2mA_r u - 2mA_r d = 0$

let $\frac{A_r}{bd} = r$

$$u^2 + 2mrdu - 2mrd^2 = 0$$

$$\therefore\ u = mr\left\{\sqrt{1+\frac{2}{mr}}-1\right\}d$$

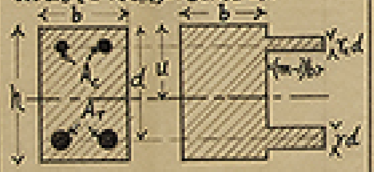
And $I_E = \frac{bu^3}{3} + mA_r(d-u)^2$

substitut the last term

$$I_E = \frac{bu^3}{3} + \frac{bu^2}{2}(d-u)$$

$$= \frac{bu^2}{2}\left(d-\frac{u}{3}\right).$$

III. Rectangular Beam with double Reinforcement.



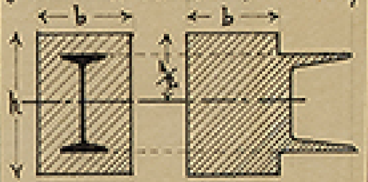
$$A_E = bh + (m-1)(A_r + A_c)$$

$$u = \frac{bh^2 + 2(m-1)(A_r d + A_c d_c)}{2\{bh + (m-1)(A_r + A_c)\}}$$

$$I_E = \frac{b\{u^3 + (h-u)^3\}}{3} + (m-1)\{A_r(d-u)^2 + A_c(u-d_c)^2\}$$

These are obtained similary the case II.

VIIa Beam with Large Reinforcement. Situated symmetrically.



$$u = \frac{h}{2}$$

$$I_E = \frac{bh^3}{12} + (m-1)I'$$

In this case

$$d = u = \frac{h}{2}$$

VII Beams with Large Reinforcement. No Tension.

section Equivalent section

$$u = mr\left\{\sqrt{1+\frac{2}{mr}}-1\right\}d$$

$$I_E = \frac{bu^3}{3} + (m-1)\left\{I' + A_r(d-u)^2\right\}$$

Position of N.A. is exactly same as the case II. but this reasoning neglects the diminution in the area of the concrete caused by the insertion of the reinforcement itself. it could be allowed for above by subtracting from $\frac{bu^2}{2}$. the moment about N.A. of the portion of the reinforcement above the N.A. and making a similar allowance below in the moment of inertia. but this is seldom done.

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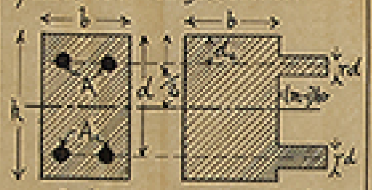
IIIa Rectangular Beam with symmetrical Reinforcement.



Section Equivalent Section

$A_E = bh + 2(m-1)A$

$u = \frac{h}{2}$

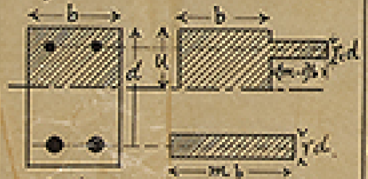
$I_E = \frac{bh^3}{12} + (m-1)(d-d_c)A$

In this case

$A_r = A_c$

$u = \frac{h}{2}$

IV Rectangular Beam with double Reinforcement. No Tension.



Section Equivalent Section

$u = \left\{\sqrt{m^2(r+r_c)^2 + 2m(r+r_c\alpha)} - m(r+r_c)\right\}d$

where $\alpha = \frac{d_c}{d}$

$I_E = \frac{bu^3}{3} + m\left\{A_r(d-u)^2 + A_c(u-d_c)^2\right\}$

Sum of the first moment of cross-section about N.A. is zero.

$\frac{bu^2}{2} + (m-1)A_c(u-d_c) - mA_r(d-u) = 0$

since A_c is small

$bu^2 + 2mu(A_r+A_c) - 2mu(A_r+A_cd_c) = 0$

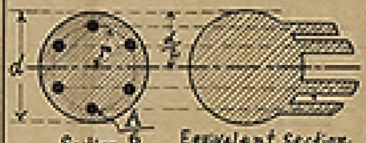
put $\frac{A_r}{bd} = r$, $\frac{A_c}{bd} = r_c$ & $d_c = \alpha d$

$u^2 + 2m(r+r_c)du - 2m(r+r_c\alpha)d^2 = 0$

Solving the equation for u,

$u = \left\{\sqrt{m^2(r+r_c)^2 + 2m(r+r_c\alpha)} - m(r+r_c)\right\}d$

IX Cicular Section.



Section Equivalent Section

$A_E = \frac{\pi d}{4} + (m-1)A$

$I_E = \frac{\pi d^4}{64} + (m-1)\frac{Ar^2}{2}$

where A = total area of reinforcement.

$I_s = 2\left(r^2 + 2\left(\frac{r}{2}\right)^2\right)\frac{A}{6}$

$= \frac{Ar^2}{2}$

X Circular Section with reinforcement arranged at short distances apart in a circle.

Section. Modified section.

$A_E = \frac{\pi d^2}{4} + (m-1)A$

$I_E = \frac{\pi d^2}{64} + (m-1)\frac{Ar^2}{2}$

Reinforcement can be considered as replaced by a ring of steel of the same total area, then

$I_s = \frac{Ar^2}{2}$

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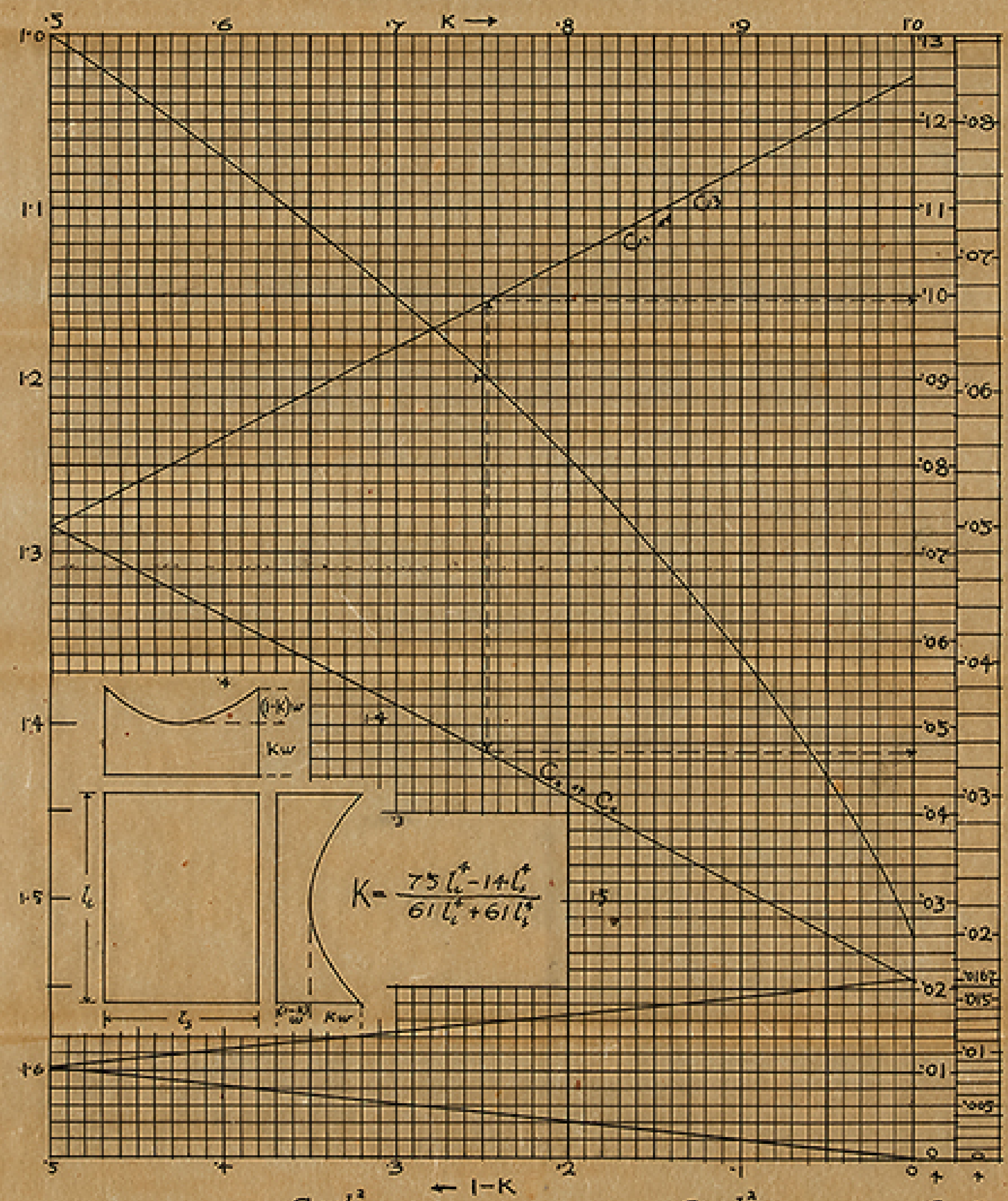
BENDING MOMENT OF RECTANGULAR SLAB



FREE SIDES.

$$M = \begin{cases} C_1 w l_1^2 \\ C_2 w l_2^2 \end{cases}$$

$$C_1 = \frac{K}{8} + \frac{1-K}{48}$$

$$C_2 = \frac{1-K}{8} + \frac{K}{48}$$

FIXED SIDES.

$$M = \begin{cases} C_3 w l_1^2 \\ C_4 w l_2^2 \end{cases}$$

$$C_3 = \frac{K}{12} + \frac{1-K}{60}$$

$$C_4 = \frac{1-K}{12} + \frac{K}{60}$$

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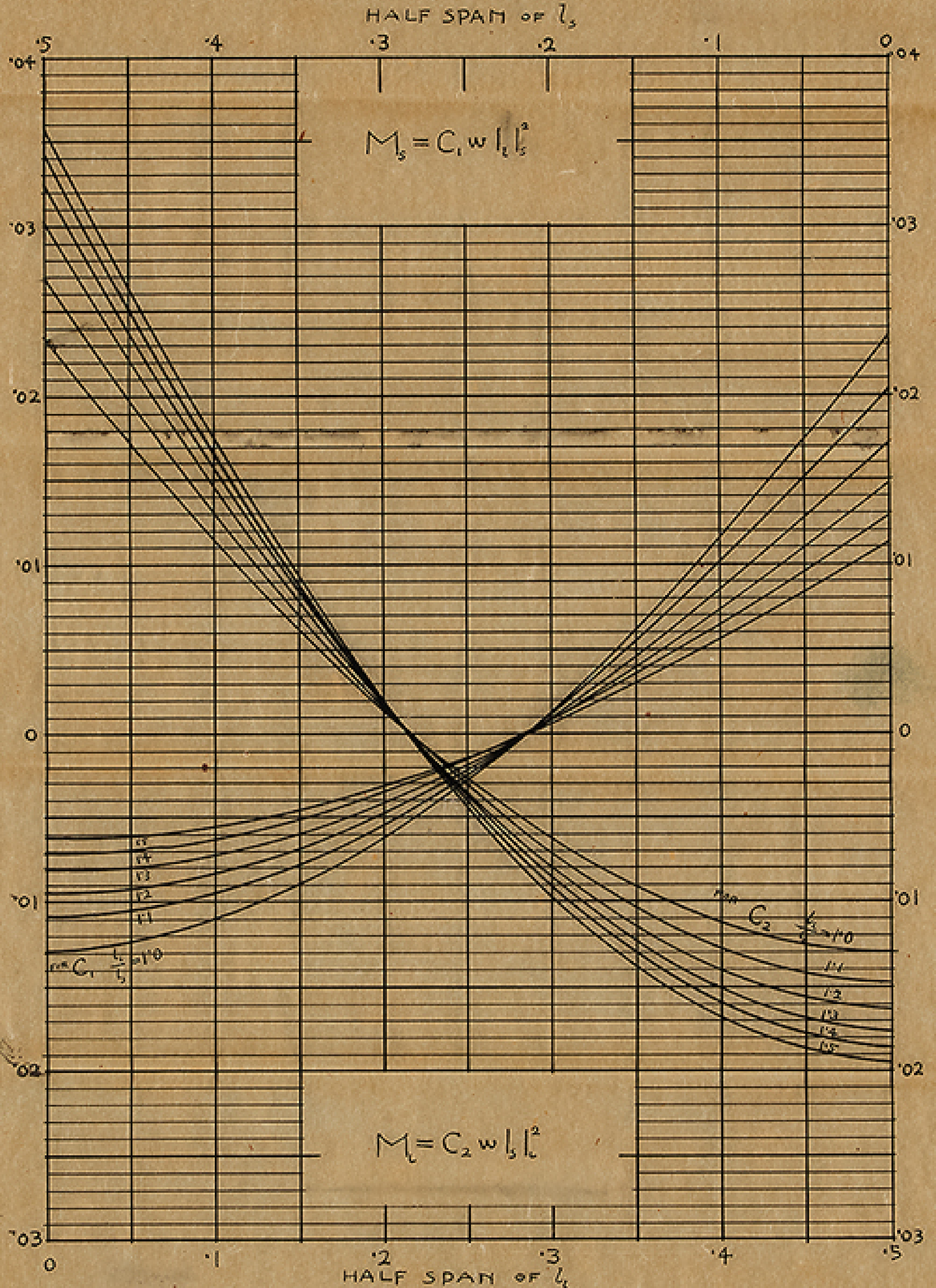
BENDING MOMENT OF BEAM SUPPORTING RECTANGULAR SLAB.

FIXED SIDES.



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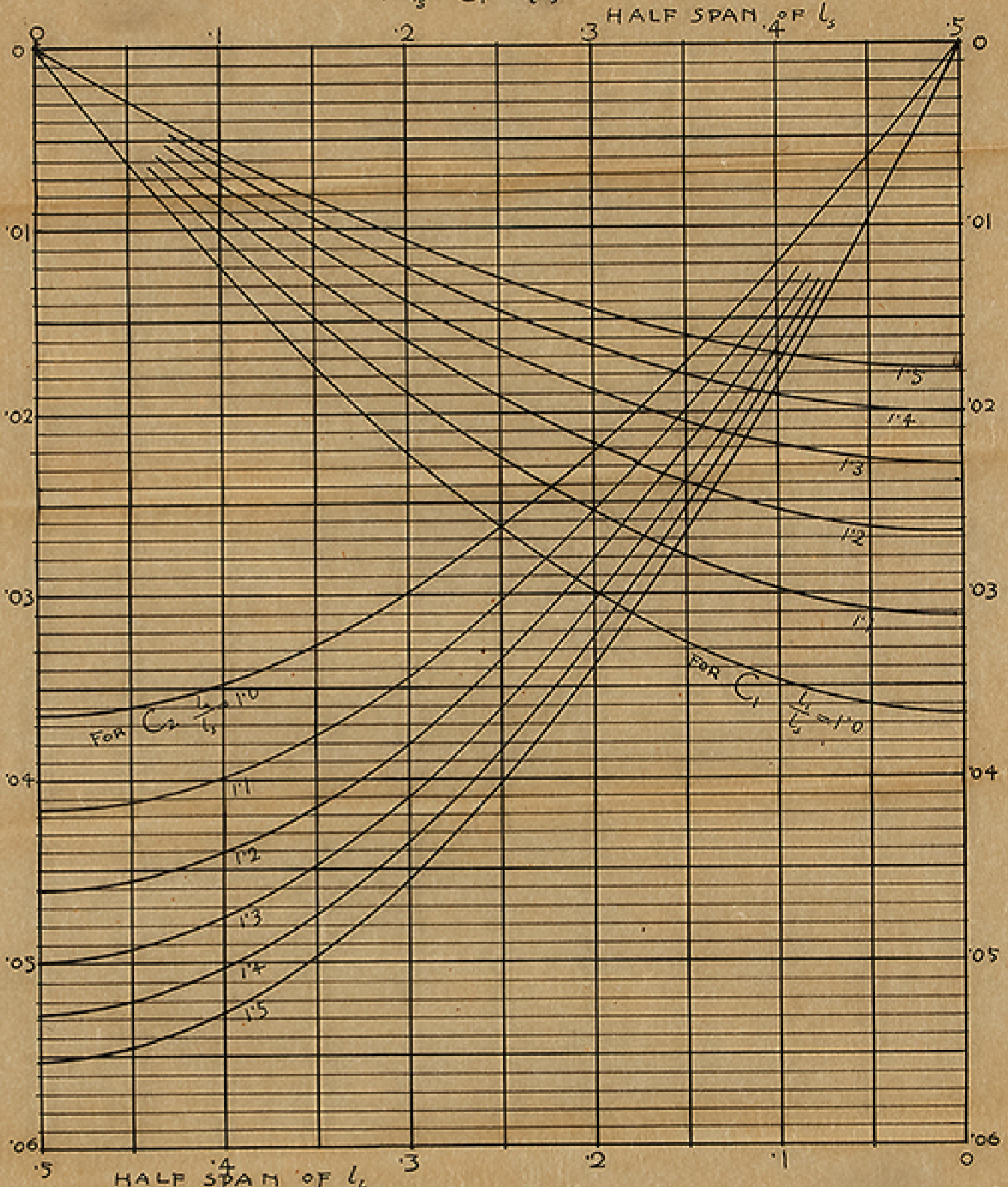
BENDING MOMENT OF BEAM
SUPPORTING RECTANGULAR SLAB
FREE SIDES.

$M_s = C_1 w l_l l_s^2$



$M_l = C_2 w l_s l_l^2$

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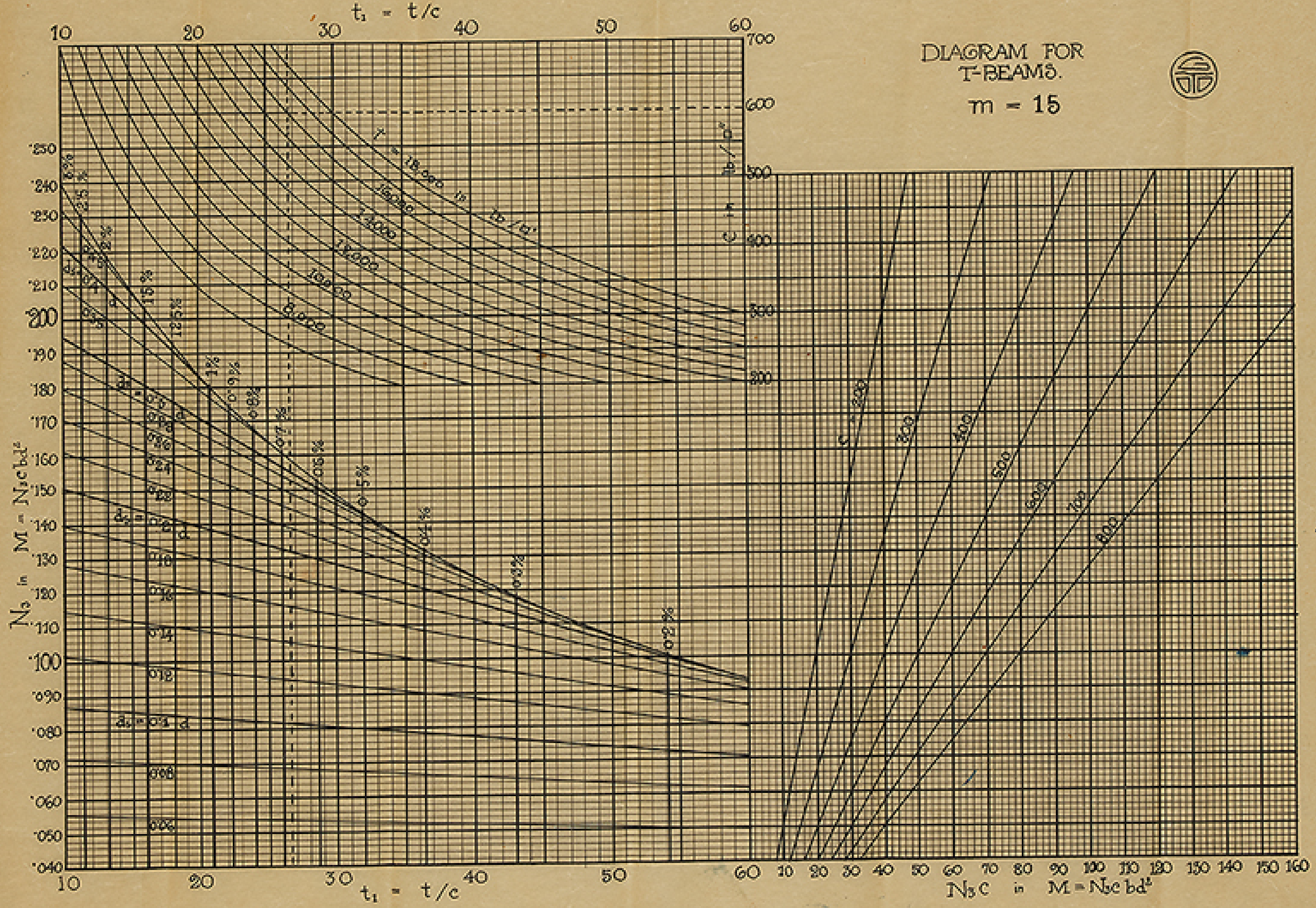
DIAGRAM FOR T-BEAMS.

m = 15



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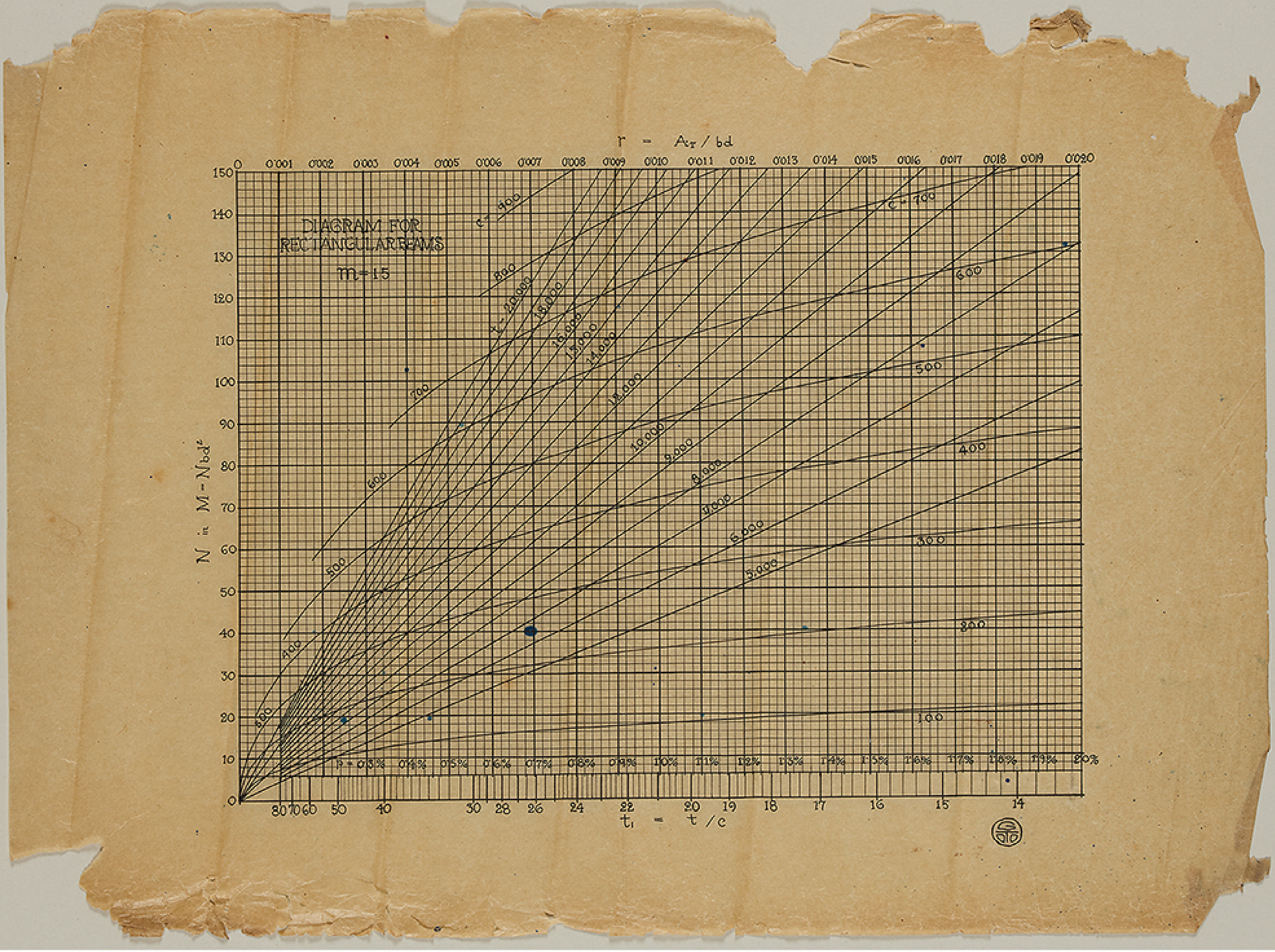

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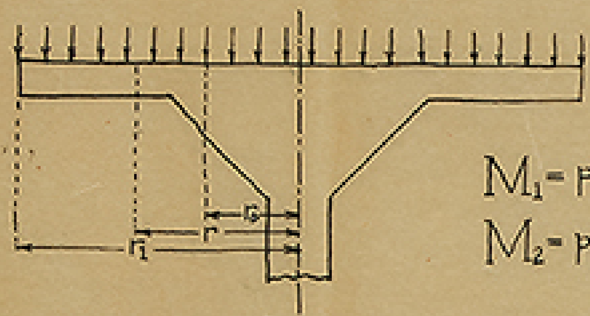
STRESSES IN CIRCULAR SLABS.

Based upon the analysis presented by Prof. H.T. Eddy for homogeneous plates.

Poisson's Ratio = 0·1

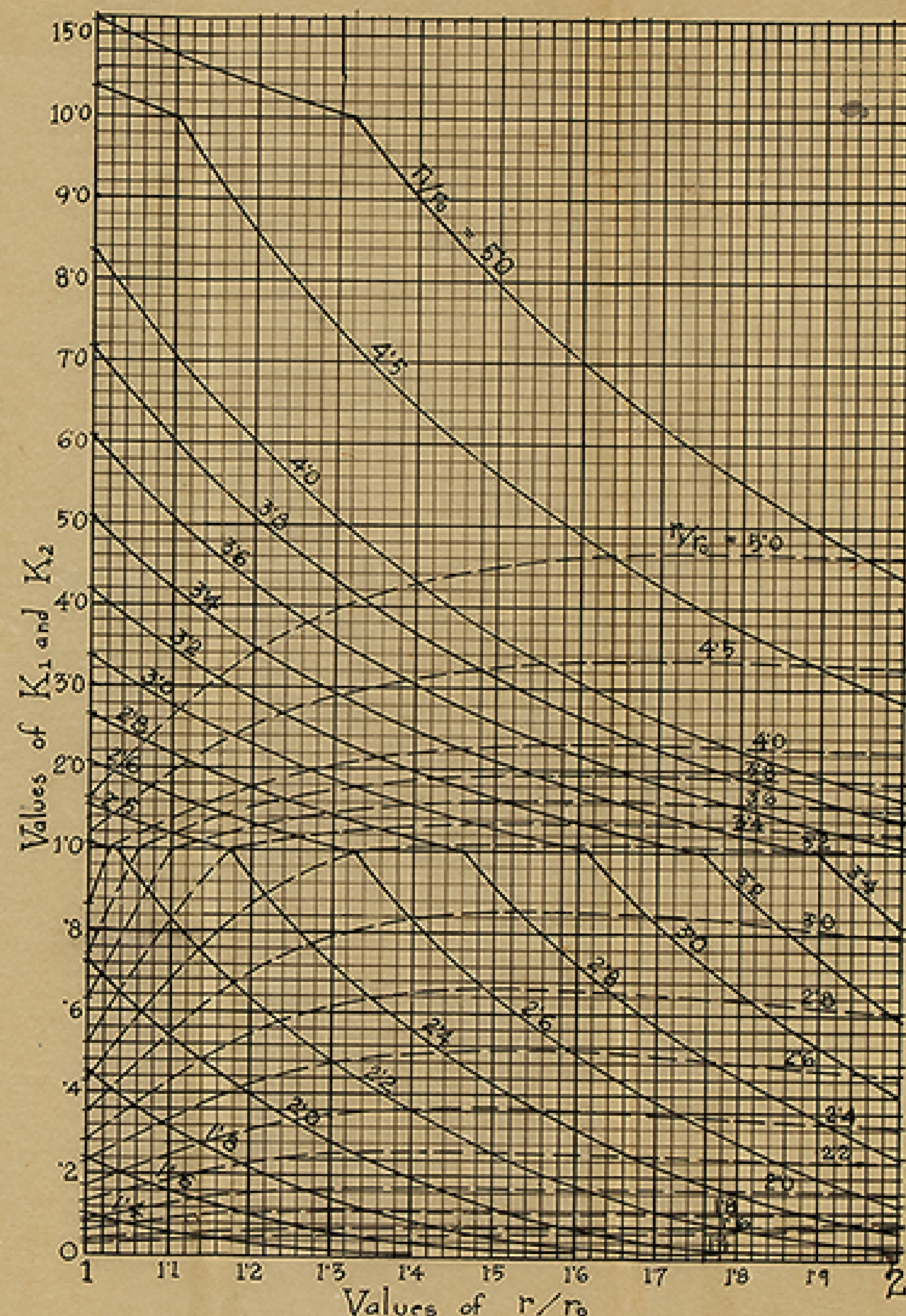


$M_1 = p r_0^2 K_1$

$M_2 = p r_0^2 K_2$

M_1 —— moment causing radial fibre stress
M_2 —— moment causing circumferential fibre stress } — for loading uniformely distributed over plate.
K_1 —— ordinate to proper solid curve.
K_2 —— ordinate to proper dotted curve.
p —— uniformely distributed load on surface of plate.
r —— any radius where moment is to be comuted.
r_0 —— radius to line of maximum bending moment (which is within the column head)
r_1 —— outer radius of assumed plate.

If p is expressed in lbs. per sq. ft. and r_0 in ft., then M_1 and M_2 will be in ft.-lbs. per ft.



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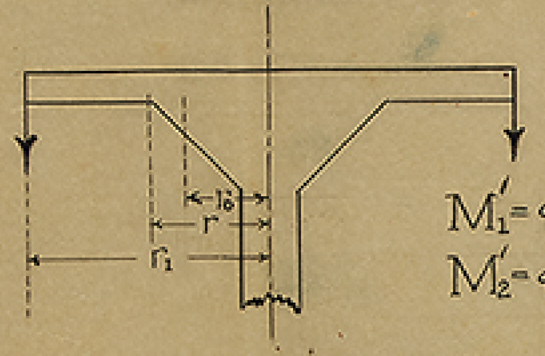
Stresses in Circular Slabs.

Based upon the analysis presented by Prof. H.T. Eddy for homogeneous plates.

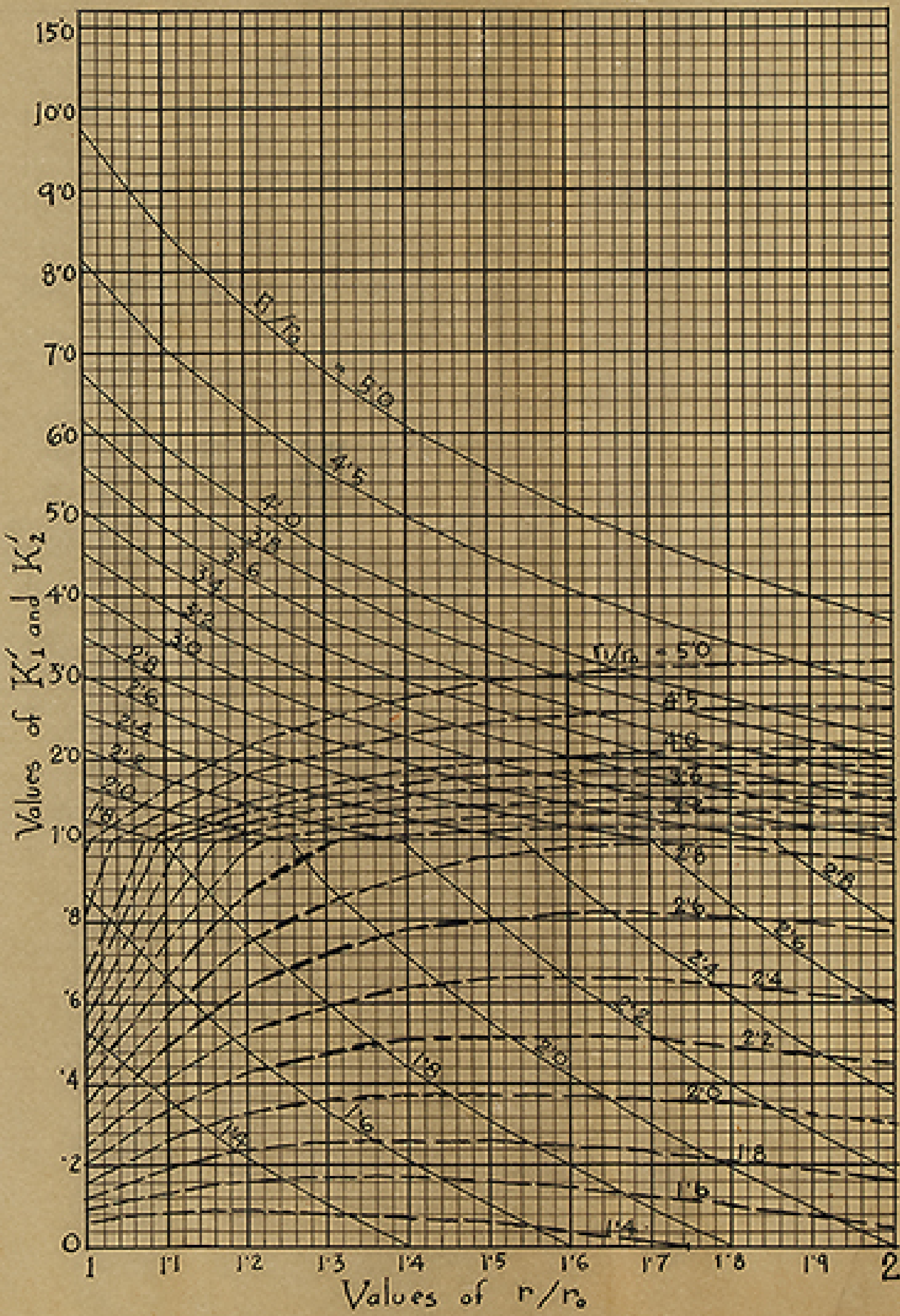
Poisson's Ratio = 0·1



$$M_1' = q r_0 K_1'$$
$$M_2' = q r_0 K_2'$$

M_1' — moment causing radial fibre stress.
M_2' — moment causing circumferencial fibre stress } — for loading distributed along edge of plate.
K_1' — ordinate to proper solid curve.
K_2' — ordinate to proper dotted curve.
q — uniformely distributed load around the outer edge of the plate.
r — any radius, where moment is to be computed.
r_0 — radius to line of maximum bending moment (which is within the column head)
r_1 — outer radius of assumed plate.

If q is expressed in lbs. per sq. ft. and r_0 in ft., then M_1' and M_2' will be in ft-lbs. per ft.



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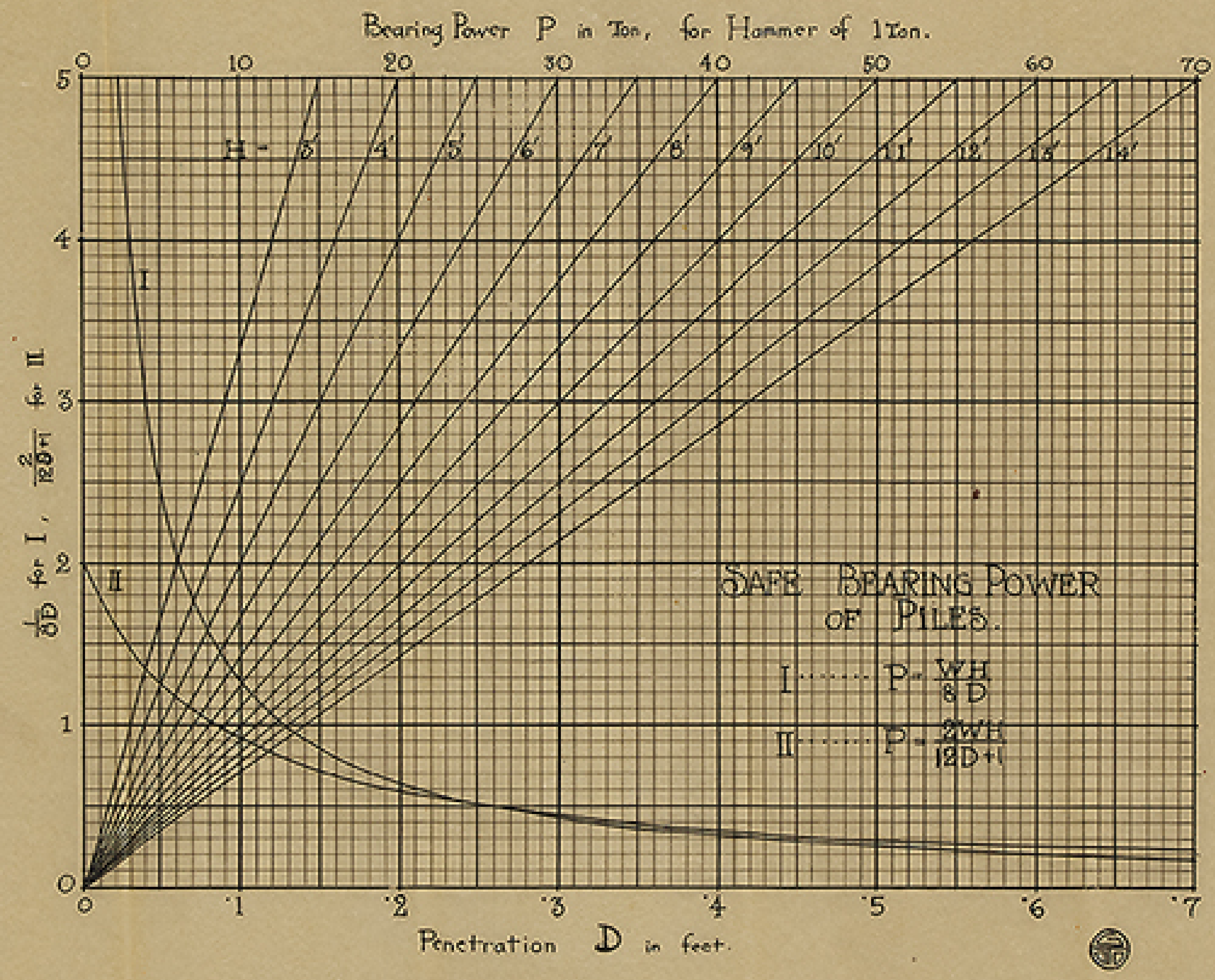

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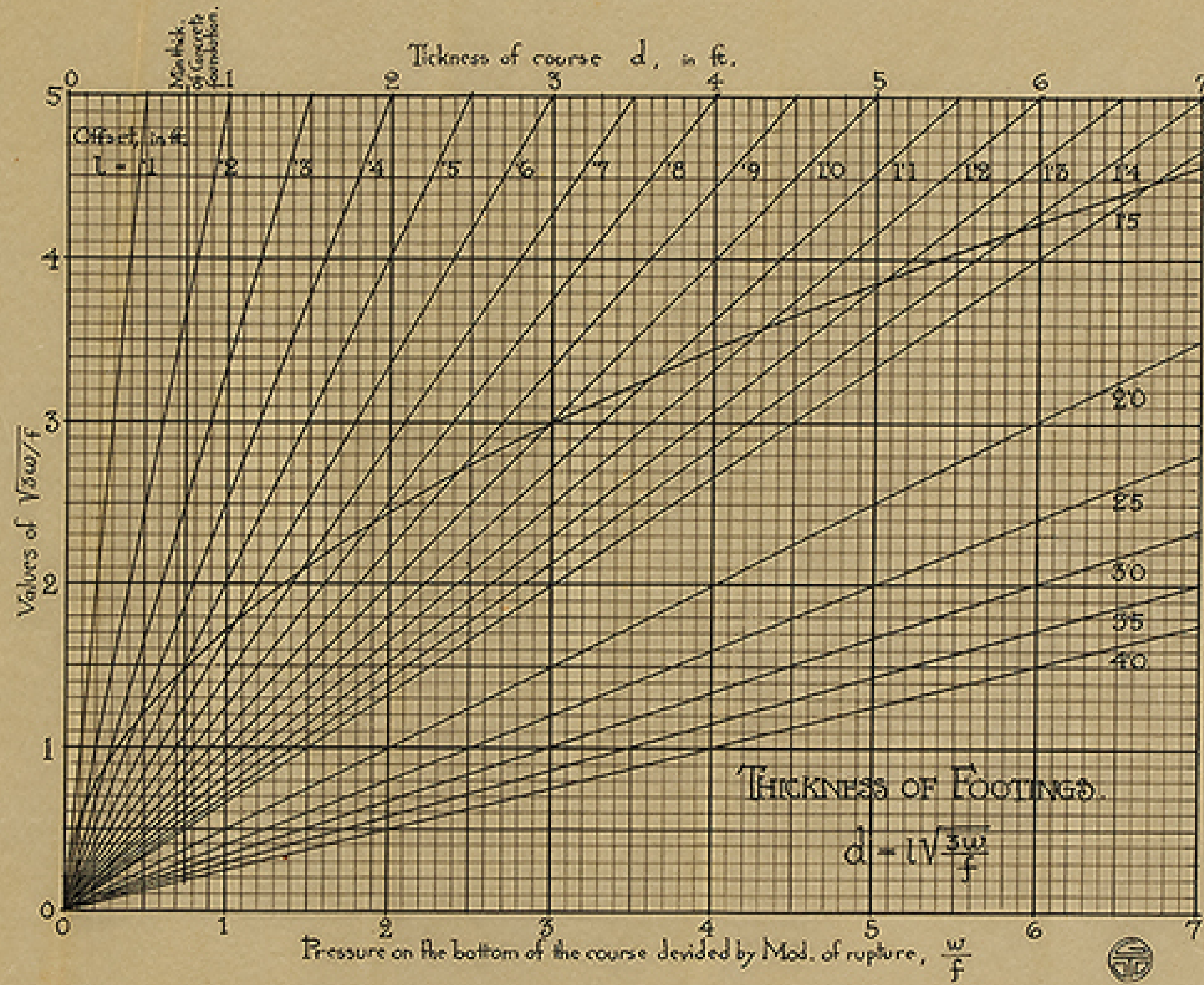

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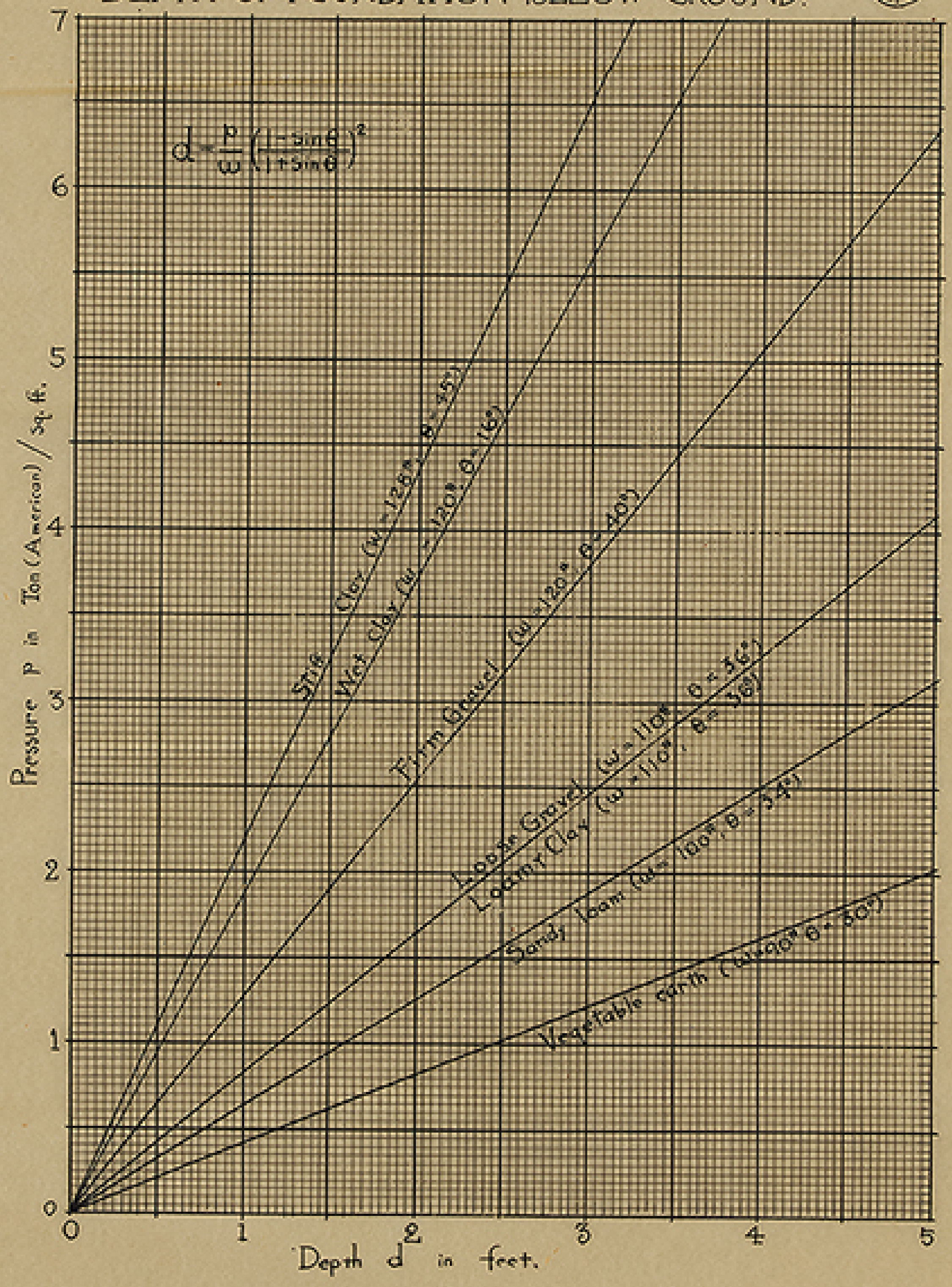
DEPTH OF FOUNDATION BELOW GROUND.



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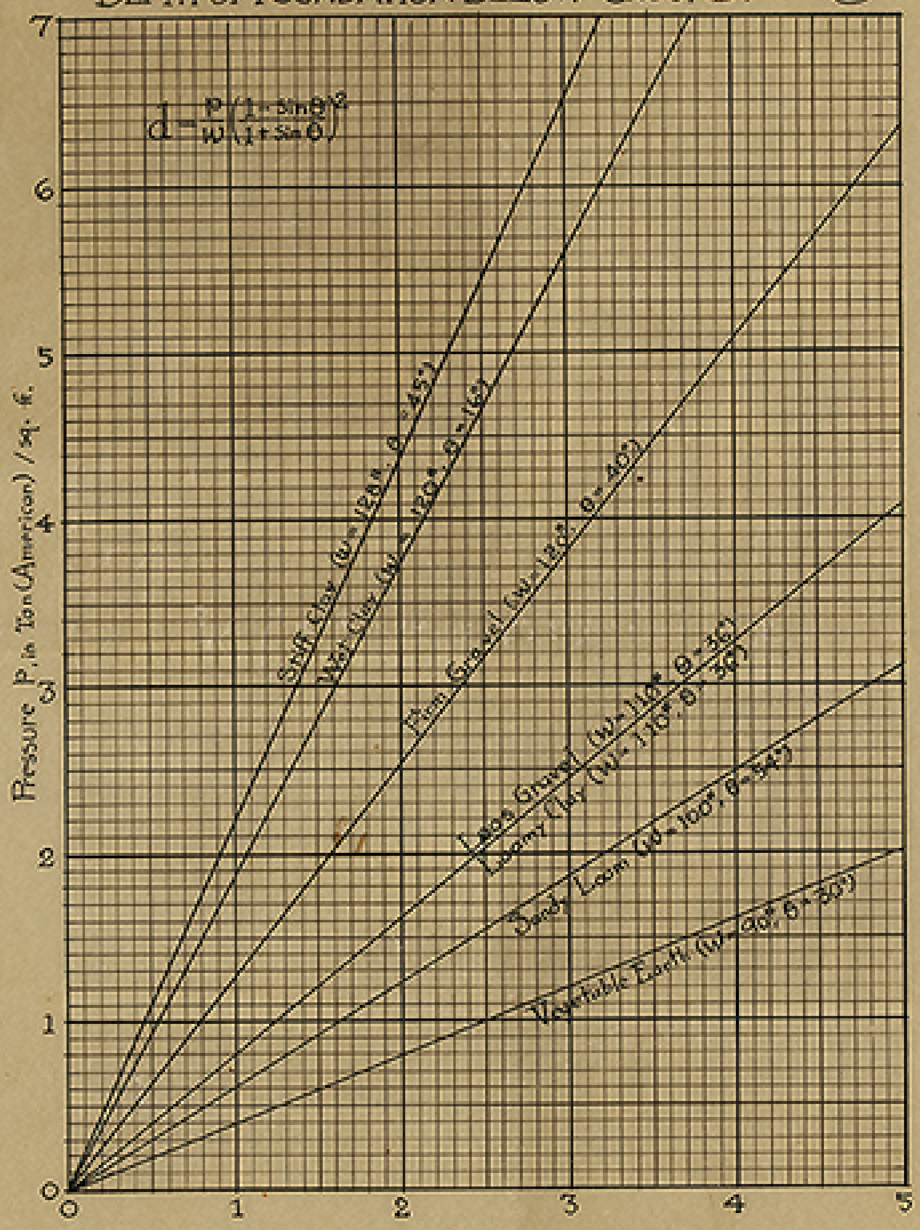
DEPTH OF FOUNDATION BELOW GROUND.



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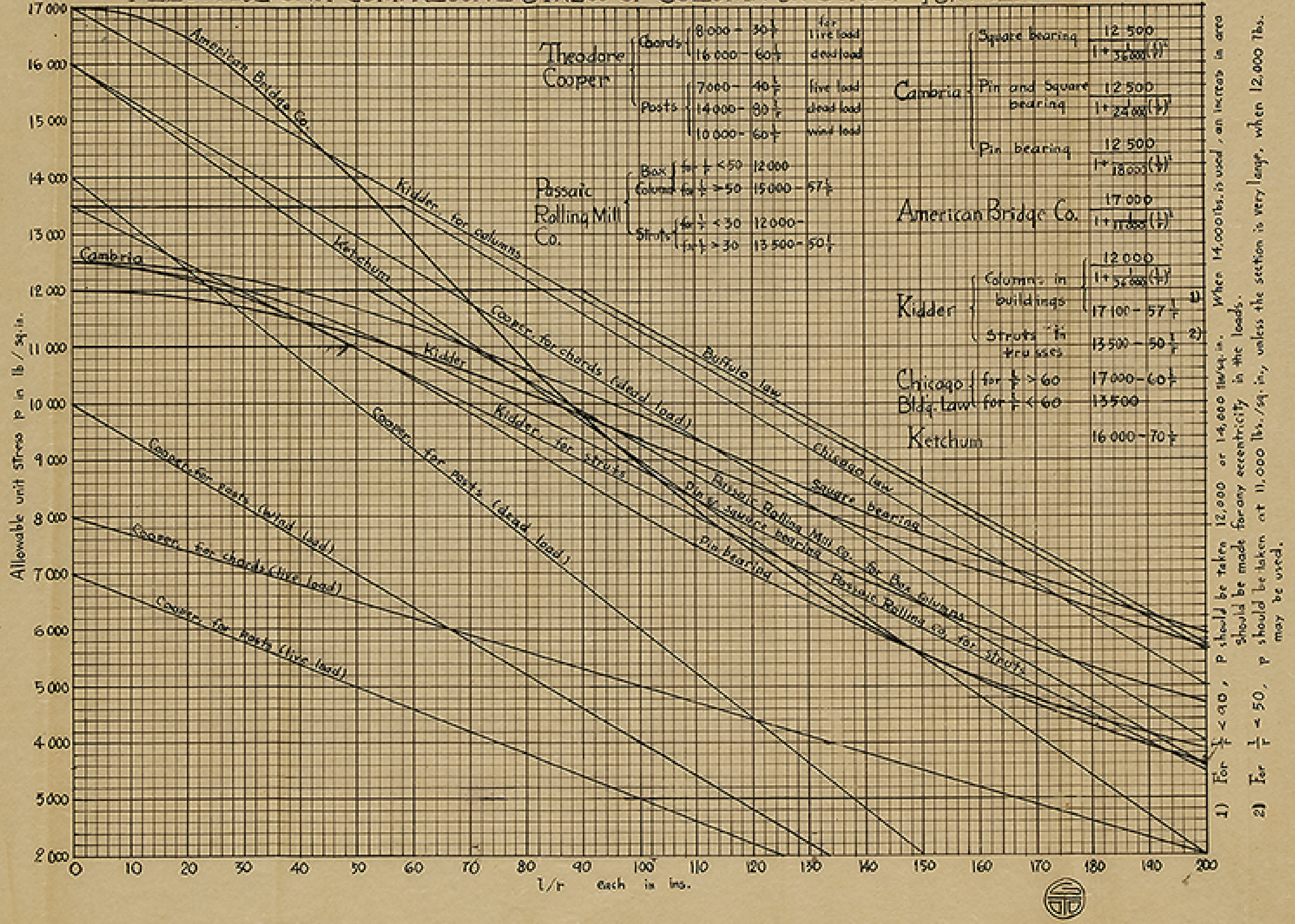
ALLOWABL UNIT COMPRESSIVE STRESS OF COLUMN OR STRUT. FOR MEDIUM STEEL.



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