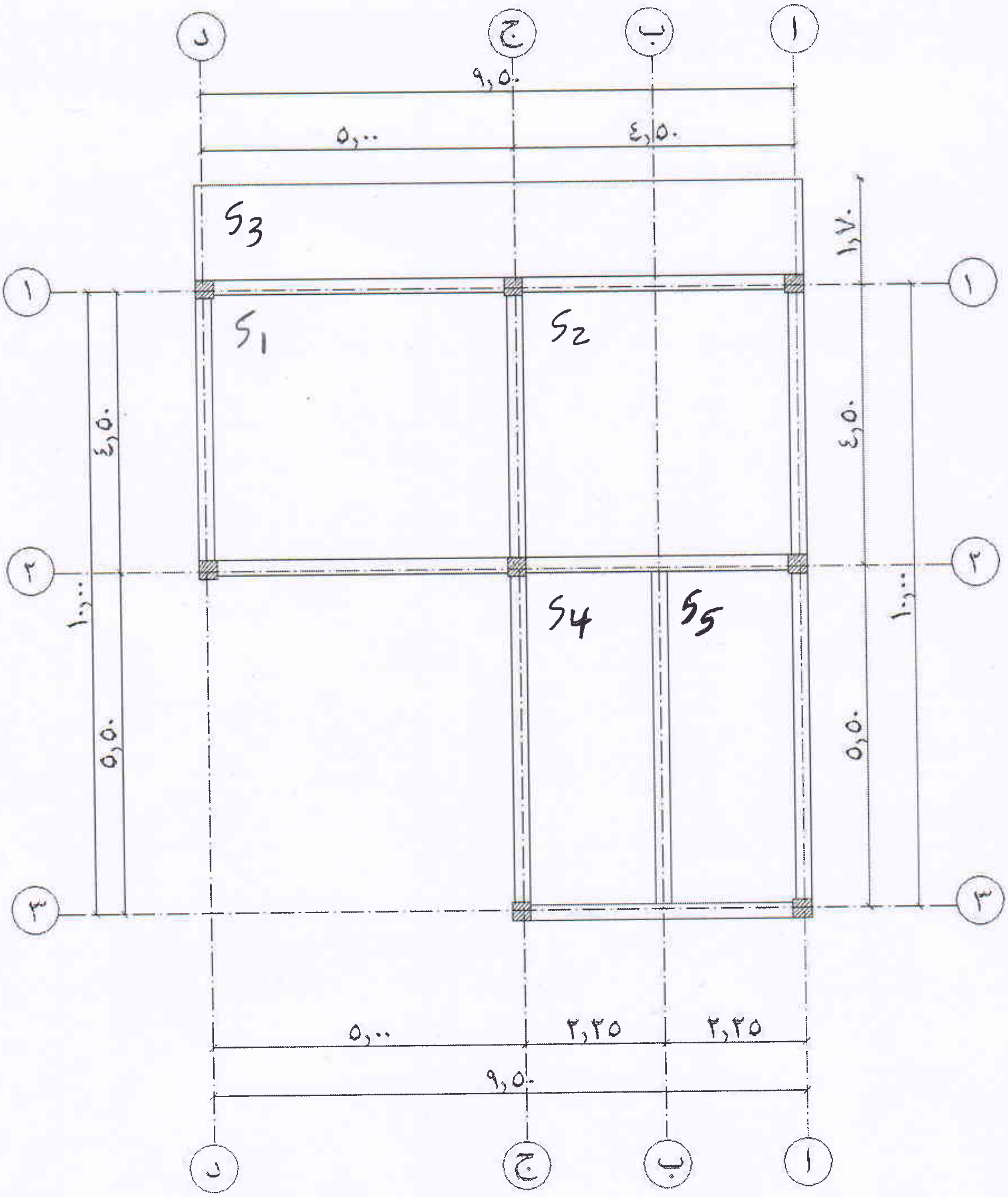
REINFORCED CONCRETE I

EXAMLLE 1 :



-Live Load = 200 kg/m2

-Flooring = 150 kg/m2

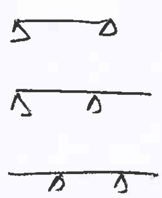
- Fcu = 250 kg/cm2 & Fy = 3600 kg/cm2

-It is required to Design all slabs and Draw neat sketches showing your design result for slabs.

⇒ **S_1**

$L_1 = 5\,m$, $L_2 = 4.5\,m$

1 = M
0.87 = M
0.76 = M



$r = \frac{L_1 m}{L_2 m} = \frac{5 * 0.87}{4.5 * 0.87} = 1.11 < 2$

Two way

$r = 1.11 \rightarrow \alpha = 0.4$
$\quad\quad\quad\;\; \rightarrow \beta = 0.29$

ملحوظة
أقل t_s = 10cm

$t_s = \frac{L_2}{40} = \frac{4.5}{40} = 0.11 \simeq 0.12\,m$

$t_s = 0.12\,m = 12\,Cm$

يكون دائما t_s رقم زوجي (10, 12, 14, 16)
او مضاعفات ال 5 (15, 20, 25)

$w_u = 1.4\,(t_s * \gamma_c + F.L) + 1.6 * L.L$

$w_u = 1.4\,(0.12 * 2.5 + 0.15) + 1.6 * 0.2$

$w_u = 0.95\ t/m^2$

⇒ short span

$w_\alpha = \alpha\, w_u = 0.4 * 0.95 = 0.38\ t/m'$

$$M_\alpha = \frac{w_\alpha L^2}{K}$$

$\Rightarrow K = 10$ 

$$M_{u\alpha} = \frac{0.38 * (4.5)^2}{10} = 0.7695 \; t.m$$

$\Rightarrow$ Design $C_1 - J$ curve

$$d = C_1 \sqrt{\frac{M_u}{F_{cu} . B}}$$

$$d = t - 1.5\,cm = 12 - 1.5 = 10.5\,cm$$

$$10.5 = C_1 \sqrt{\frac{0.7695 * 10^5}{250 * 100}}$$

$C_1 = 6 \Rightarrow J = 0.826$

$$A_s = \frac{M_{u\alpha}}{F_y . J . d} = \frac{0.7695 * 10^5}{3600 * 0.826 * 10.5}$$

$A_s = 2.46\ cm^2$

The $A_s = 5\ \phi 10/m$

* Longspan: + check As [struck out] Asmin ok Take Asmin

$$w_B = B\, w_u = 0.29 * 0.95 = 0.2755$$

$$M_B = \frac{w_B L^2}{K} = \frac{0.2755 * 5^2}{10} = 0.688 \; t.m$$

⇒ Design C1–J

$d = 12 - 2.5 = 9.5\,cm$

$$9.5 = C_1 \sqrt{\frac{0.688 * 10^5}{250 * 100}}$$

$C_1 = 5.75 \Rightarrow J = 0.826$

$$A_s = \frac{0.688 * 10^5}{3600 * 0.826 * 9.5} = 2.43\,cm^2$$

Take $5 \phi 10 / m$

check $A_s > A_{s\,min}$

⇒ Design S_2 ⟹ مثل S_1

Design S_3

$$r = \frac{9.5}{1.7 * 0.37} > 2$$

one way

ملحوظة
البلكونه على طول
one way

لبلاد
البلكو
Cantilever

$$t_s = \frac{L_s}{10} = \frac{1.7}{10} = 0.17 \simeq 0.18\,cm$$

$w_u = 1.4\,(t_s * \gamma_c + F.L) + 1.6 * L.L$

$w_u = 1.4\,(0.18 * 2.5 + 0.15) + 1.6 * 0.2 = 1.16\,t/m^2$

* short span:

$w_\alpha = w_u$

$$M_\alpha = \frac{w_\alpha L^2}{2} = \frac{1.16 * (1.7)^2}{2} = 1.676\ t.m$$

$C_1 \Rightarrow J$

$d = 18 - 1.5 = 16.5\ cm$

$$16.5 = C_1 \sqrt{\frac{1.676 * 10^5}{250 * 100}} \Rightarrow C_1 = 6.39 \Rightarrow J = 0.826$$

$$A_s = \frac{1.676 * 10^5}{3600 * 0.826 * 16.5} = 3.4\ cm^2$$

Take $5 \phi 10 / m$

$A_s > A_{s\,min} = \frac{0.15}{100} . B . d$

⇒ longspan:

use $A_{s\,min} = 5 \phi 10 / m$

⇒ S4

$$r = \frac{5.5 * 0.87}{2.25 * 0.87} = 2.4 > 2$$

One way

أقل سمك

$$t_s = \frac{L}{35} = \frac{2.25}{35} = 0.06 \simeq 0.1\,m = 10\,cm$$

$$w_u = 1.4\,(0.1 * 2.5 + 0.15) + 1.6 * 0.2 = 0.88\ t/m$$

⇒ short span

$$w_u = w\alpha$$

$$M_\alpha = \frac{w L^2}{10} = \frac{0.88 * (2.25)^2}{10} = 0.445\ t.m$$

$$d = 10 - 1.5 = 8.5\,cm$$

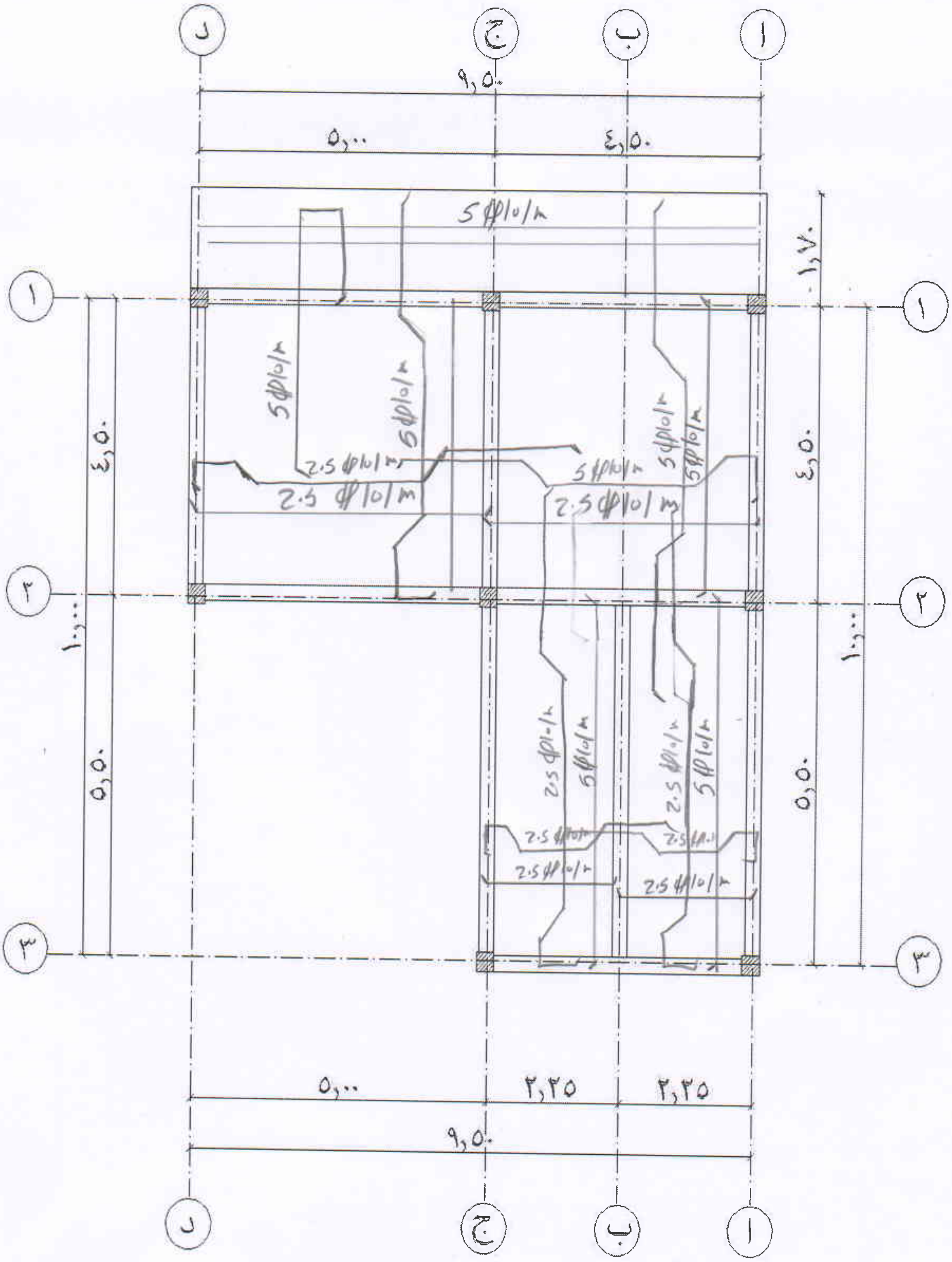
$$8.5 = C_1 \sqrt{\frac{0.445 * 10^5}{250 * 100}} \Rightarrow C_1 = 6.39 \Rightarrow J = 0.826$$

$$A_s = \frac{0.445 * 10^5}{3600 * 0.826 * 8.5} = 1.7\,Cm^2$$ Tak $5\phi 10/m$

* Long span

Take $A_s = 5\phi 10/m$

⇒ S4 مثل ⇒ S5



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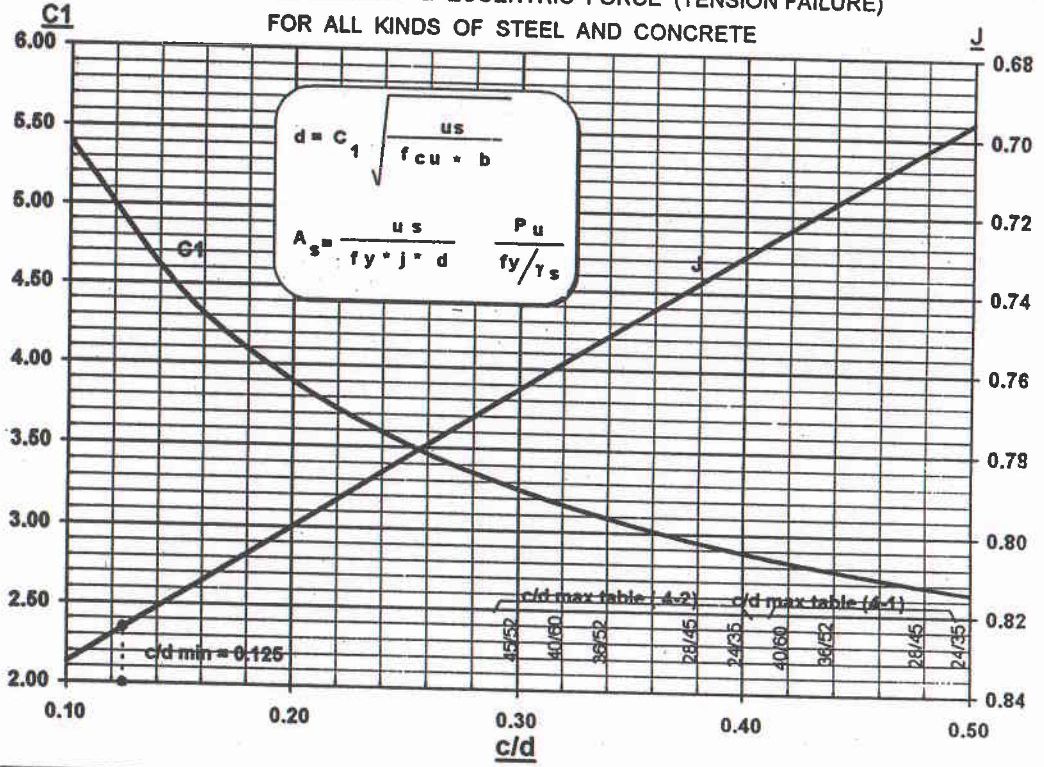
ULTIMATE LIMIT DESIGN CHARTS

FOR SIMPLE BENDING & ECCENTRIC FORCE (TENSION FAILURE)
FOR ALL KINDS OF STEEL AND CONCRETE



$$d = C_1 \sqrt{\frac{M_{us}}{f_{cu} \cdot b}}$$

$$A_s = \frac{M_{us}}{f_y \cdot j \cdot d} - \frac{P_u}{f_y/\gamma_s}$$

c/d	C1	J
0.1250	4.854	0.826
0.1375	4.640	0.821
0.1500	4.455	0.817
0.1625	4.291	0.813
0.1750	4.146	0.808
0.1875	4.016	0.804
0.2000	3.899	0.800
0.2125	3.793	0.795
0.2250	3.697	0.791
0.2375	3.608	0.786
0.2500	3.526	0.782
0.2625	3.451	0.778
0.2750	3.381	0.773
0.2875	3.316	0.769
0.3000	3.255	0.765
0.3125	3.199	0.760
0.3250	3.146	0.756
0.3375	3.096	0.752
0.3500	3.049	0.747
0.3625	3.004	0.743
0.3750	2.963	0.739
0.3875	2.923	0.734
0.4000	2.885	0.730
0.4125	2.850	0.726
0.4250	2.816	0.721
0.4375	2.784	0.717
0.4500	2.753	0.713
0.4625	2.724	0.708
0.4750	2.696	0.704
0.4875	2.670	0.700
0.5000	2.645	0.695

$$J = \frac{1}{\gamma_s}(1 - 0.4c/d)$$

$$C1 = \frac{1}{\sqrt{0.3573\, c/d\, (1 - 0.4c/d)}}$$

Chart (C)

VII.1. LOAD DISTRIBUTION ON TWO WAY SLABS

1. *Load Distribution According to U.A.R.*

r	1.00	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.00
α	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85
β	0.35	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.11	0.09	0.08

2. *Load Distribution According to Marcus :*

r	1.00	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.00
α	.396	.473	.543	.606	.660	.706	.746	.778	.806	.830	.849
β	.396	.323	.262	.212	.172	.140	.113	.093	.077	.063	.053

3. *Load Distribution According to Grashoff :*

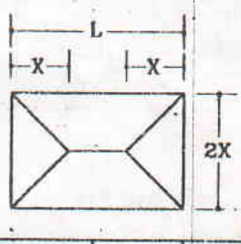
r	1.00	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.00
α	.500	.595	.672	.742	.797	.834	.869	.893	.914	.928	.941
β	.500	.405	.328	.258	.203	.166	.131	.107	.086	.072	.059

$r = \frac{m.b}{m.a}$; where m= 0.87 for continuity at one end of the slab

=0.76 for continuity at both ends of the slab

VII.2. EQUIVALENT LOAD FOR DESIGN OF BEAMS :

supporting two way Slabs :



$\frac{L}{2x}$	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
α	.667	.725	.769	.803	.829	.852	.870	.885	.897	.908	.917
β	.500	.545	.583	.615	.643	.667	.688	.706	.722	.737	.750

Area of Steel Bars in cm^2 (used in Egypt)

Φ	Weight	Cross sectional area (cm^2)											
mm	kg/m'	1	2	3	4	5	6	7	8	9	10	11	12
6	0.222	0.28	0.57	0.85	1.13	1.41	1.70	1.98	2.26	2.54	2.83	3.11	3.39
8	0.395	0.50	1.01	1.51	2.01	2.51	3.02	3.52	4.02	4.52	5.03	5.53	6.03
10	0.617	0.79	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8.64	9.42
12	0.888	1.13	2.26	3.39	4.52	5.65	6.79	7.92	9.05	10.18	11.31	12.44	13.57
14	1.208	1.54	3.08	4.62	6.16	7.70	9.24	10.78	12.32	13.85	15.39	16.93	18.47
16	1.578	2.01	4.02	6.03	8.04	10.05	12.06	14.07	16.08	18.10	20.11	22.12	24.13
18	1.998	2.54	5.09	7.63	10.18	12.72	15.27	17.81	20.36	22.90	25.45	27.99	30.54
20	2.466	3.14	6.28	9.42	12.57	15.71	18.85	21.99	25.13	28.27	31.42	34.56	37.70
22	2.984	3.80	7.60	11.40	15.21	19.01	22.81	26.61	30.41	34.21	38.01	41.81	45.62
25	3.853	4.91	9.82	14.73	19.63	24.54	29.45	34.36	39.27	44.18	49.09	54.00	58.90
28	4.834	6.16	12.32	18.47	24.63	30.79	36.95	43.10	49.26	55.42	61.58	67.73	73.89
32	6.313	8.04	16.08	24.13	32.17	40.21	48.25	56.30	64.34	72.38	80.42	88.47	96.51
38	8.903	11.34	22.68	34.02	45.36	56.71	68.05	79.39	90.73	102.1	113.4	124.8	136.1

Area of Other Steel Bars in cm^2

Φ	Weight	Cross sectional area (cm^2)											
mm	kg/m'	1	2	3	4	5	6	7	8	9	10	11	12
6	0.222	0.28	0.57	0.85	1.13	1.41	1.70	1.98	2.26	2.54	2.83	3.11	3.39
8	0.395	0.50	1.01	1.51	2.01	2.51	3.02	3.52	4.02	4.52	5.03	5.53	6.03
10	0.617	0.79	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8.64	9.42
13	1.042	1.33	2.65	3.98	5.31	6.64	7.96	9.29	10.62	11.95	13.27	14.60	15.93
16	1.578	2.01	4.02	6.03	8.04	10.05	12.06	14.07	16.08	18.10	20.11	22.12	24.13
19	2.226	2.84	5.67	8.51	11.34	14.18	17.01	19.85	22.68	25.52	28.35	31.19	34.02
22	2.984	3.80	7.60	11.40	15.21	19.01	22.81	26.61	30.41	34.21	38.01	41.81	45.62
25	3.853	4.91	9.82	14.73	19.63	24.54	29.45	34.36	39.27	44.18	49.09	54.00	58.90
28	4.834	6.16	12.32	18.47	24.63	30.79	36.95	43.10	49.26	55.42	61.58	67.73	73.89
32	6.313	8.04	16.08	24.13	32.17	40.21	48.25	56.30	64.34	72.38	80.42	88.47	96.5
38	8.903	11.34	22.68	34.02	45.36	56.71	68.05	79.39	90.73	102.1	113.4	124.8	136.1