



314 Design Aids

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American Concrete Institute



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Members of ACI Committee 314, Simplified Design of Concrete Buildings, created and reviewed a series of helpful design aids for reinforced concrete.

Design Aid 1-1	Areas of Reinforcing Bars
Design Aid 1-2	Approximate Bending Moments and Shear Forces for Continuous Beams and One-way Slabs
Design Aid 1-3	Variation of ϕ with Net Tensile Strain in Extreme Tension Steel ϵ_t and c/d_t – Grade 60 Reinforcement and Prestressing Steel
Design Aid 1-4	Simplified Calculation of A_s Assuming Tension-Controlled Section and Grade 60 Reinforcement
Design Aid 1-5	Minimum Number of Reinforcing Bars Required in a Single Layer
Design Aid 1-6	Maximum Number of Reinforcing Bars Permitted in a Single Layer
Design Aid 1-7	Minimum Thickness h for Beams and One-Way Slabs Unless Deflections are Calculated
Design Aid 1-8	Reinforcement Ratio ρ_t for Tension-Controlled Sections Assuming Grade 60 Reinforcement
Design Aid 1-9	Simplified Calculation of b_w Assuming Grade 60 Reinforcement and $\rho = 0.5\rho_{max}$
Design Aid 1-10	T-beam Construction
Design Aid 1-11	Values of $\phi V_s = V_u - \phi V_c$ (kips) as a Function of the Spacing, s
Design Aid 1-12	Minimum Shear Reinforcement $A_{v,min}/s$
Design Aid 1-13	Torsional Section Properties
Design Aid 1-14	Moment of Inertia of Cracked Section Transformed to Concrete, I_{cr}
Design Aid 1-15	Approximate Equation to Determine Immediate Deflection, Δ_i , for Members Subjected to Uniformly Distributed Loads <i>Two Way Slabs – Direct Design Method, includes Design Aid 2.1 through D.8.</i>
Design Aid 2-1	Conditions for Analysis by the Direct Design Method
Design Aid 2-2	Definitions of Column Strip and Middle Strip
Design Aid 2-3	Definition of Clear Span, ℓ_n
Design Aid 2-4	Design Moment Coefficients used with the Direct Design Method
Design Aid 2-5	Effective Beam and Slab Sections for Computation of Stiffness Ratio, α_f
Design Aid 2-6	Computation of Torsional Stiffness Factor, β_t , for T- and L-Sections
Design Aid 2-7	Moment Distribution Constants for Slab-Beam Members without Drop Panels
Design Aid 2-8	Stiffness and Carry-Over Factors for Columns

DESIGN AID 1-1**Areas of Reinforcing Bars****Total Areas of Bars (in.²)**

Bar Size	Number of Bars									
	1	2	3	4	5	6	7	8	9	10
No. 3	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10
No. 4	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
No. 5	0.31	0.62	0.93	1.24	1.55	1.86	2.17	2.48	2.79	3.10
No. 6	0.44	0.88	1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40
No. 7	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
No. 8	0.79	1.58	2.37	3.16	3.95	4.74	5.53	6.32	7.11	7.90
No. 9	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
No. 10	1.27	2.54	3.81	5.08	6.35	7.62	8.89	10.16	11.43	12.70
No. 11	1.56	3.12	4.68	6.24	7.80	9.36	10.92	12.48	14.04	15.60

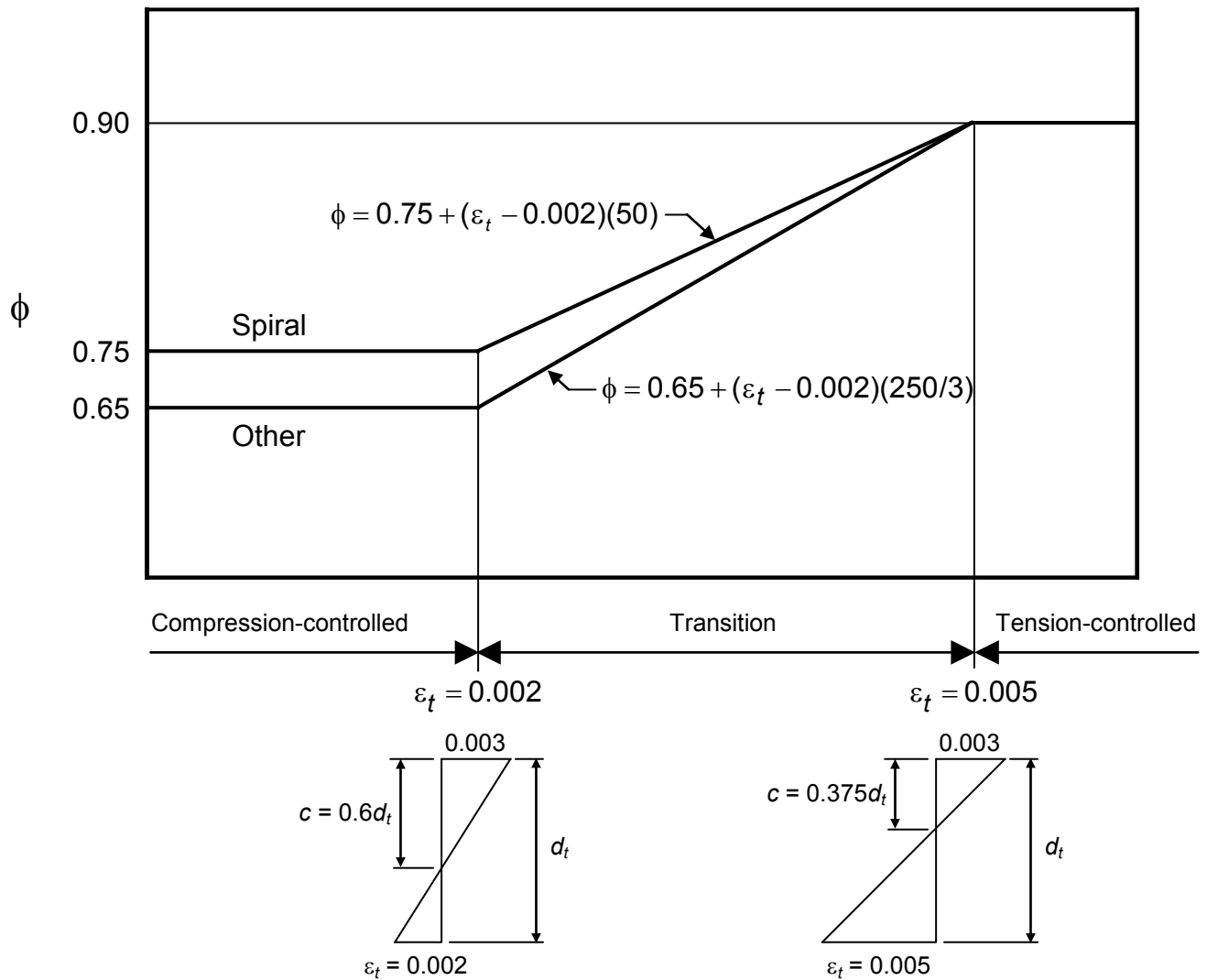
Areas of Bars per Foot Width of Slab (in.²/ft)

Bar Size	Bar Spacing (in.)												
	6	7	8	9	10	11	12	13	14	15	16	17	18
No. 3	0.22	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07
No. 4	0.40	0.34	0.30	0.27	0.24	0.22	0.20	0.18	0.17	0.16	0.15	0.14	0.13
No. 5	0.62	0.53	0.46	0.41	0.37	0.34	0.31	0.29	0.27	0.25	0.23	0.22	0.21
No. 6	0.88	0.75	0.66	0.59	0.53	0.48	0.44	0.41	0.38	0.35	0.33	0.31	0.29
No. 7	1.20	1.03	0.90	0.80	0.72	0.65	0.60	0.55	0.51	0.48	0.45	0.42	0.40
No. 8	1.58	1.35	1.18	1.05	0.95	0.86	0.79	0.73	0.68	0.63	0.59	0.56	0.53
No. 9	2.00	1.71	1.50	1.33	1.20	1.09	1.00	0.92	0.86	0.80	0.75	0.71	0.67
No. 10	2.54	2.18	1.91	1.69	1.52	1.39	1.27	1.17	1.09	1.02	0.95	0.90	0.85
No. 11	3.12	2.67	2.34	2.08	1.87	1.70	1.56	1.44	1.34	1.25	1.17	1.10	1.04

DESIGN AID 1-3

Variation of ϕ with Net Tensile Strain in Extreme Tension Steel ε_t and c/d_t –
Grade 60 Reinforcement and Prestressing Steel

9.3.2



Spiral: $\phi = 0.75 + 0.15[(1/c/d_t) - (5/3)]$

Other: $\phi = 0.65 + 0.25[(1/c/d_t) - (5/3)]$

DESIGN AID 1-4Simplified Calculation of A_s Assuming Tension-Controlled Section and Grade 60 Reinforcement

f'_c (psi)	A_s (in. ²)
3,000	$\frac{M_u}{3.84d}$
4,000	$\frac{M_u}{4.00d}$
5,000	$\frac{M_u}{4.10d}$

M_u is in ft-kips and d is in inches

In all cases, $A_s = \frac{M_u}{4d}$ can be used.

Notes:

- $$A_s = \frac{M_u}{\phi f_y \left(1 - \frac{0.5 \rho f_y}{0.85 f'_c} \right) \times d}$$
- For all values of $\rho < 0.0125$, the simplified A_s equation is slightly conservative.
- It is recommended to avoid $\rho > 0.0125$ when using the simplified A_s equation.

DESIGN AID 1-5¹

Minimum Number of Reinforcing Bars Required in a Single Layer

10.6.4

Assumptions:

- Grade 60 reinforcement ($f_y = 60,000$ psi)
- Clear cover to the tension reinforcement $c_c = 2$ in.
- Calculated stress f_s in reinforcement closest to the tension face at service load = 40,000 psi

Bar Size	Beam Width (in.)												
	12	14	16	18	20	22	24	26	28	30	36	42	48
No. 4	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 5	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 6	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 7	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 8	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 9	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 10	2	2	3	3	3	3	3	4	4	4	5	5	6
No. 11	2	2	3	3	3	3	3	4	4	4	5	5	6

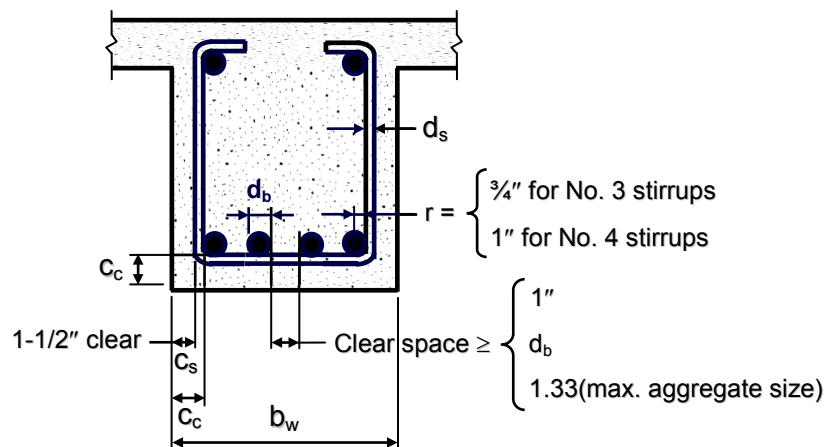
Minimum number of bars, n_{min} :

$$n_{min} = \frac{b_w - 2(c_c + 0.5d_b)}{s} + 1$$

where

$$s = 15 \left(\frac{40,000}{f_s} \right) - 2.5c_c$$

$$\leq 12 \left(\frac{40,000}{f_s} \right)$$



¹ Alsamsam, I.M. and Kamara, M. E. (2004). *Simplified Design Reinforced Concrete Buildings of Moderate Size and Heights*, EB104, Portland Cement Association, Skokie, IL.