Chapter 12

Concrete Construction

Part 3

12-4 REINFORCING STEEL

- **Concrete Reinforcing Steel**
- **Placement of Reinforcing**

Concrete Reinforcing Steel

- Concrete reinforcing steel is available as:
  - standard reinforcing bars,
  - spirals (for column reinforcing), and
  - welded wire fabric (WWF).
- Deformed bars -American Society for Testing and Materials (ASTM) standard sizes listed in Table 12-1.

TABLE 12-1: ASTM standard reinforcing bar sizes

Size Number	Weight		Diameter		Section Area	
	lb/ft	kg/m	in.	mm	sq in.	mm^2
3	0.376	0.560	0.375	9.52	0.11	71
4	0.668	0.994	0.500	12.70	0.20	129
5	1.043	1.552	0.625	15.88	0.31	200
6	1.502	2.235	0.750	19.05	0.44	284
7	2.044	3.042	0.875	22.22	0.60	387
8	2.670	3.973	1.000	25.40	0.79	510
9	3.400	5.059	1.128	28.65	1.00	645
10	4.303	6.403	1.270	32.26	1.27	819
11	5.313	7.906	1.410	35.81	1.56	1006
14	7.650	11.384	1.693	43.00	2.25	1452
18	13.600	20.238	2.257	57.33	4.00	2581

Concrete Reinforcing Steel

- Two marking systems are used to identify ASTM standard reinforcing bars, (Figure 12-28),
  - the continuous line system and
  - the number system.

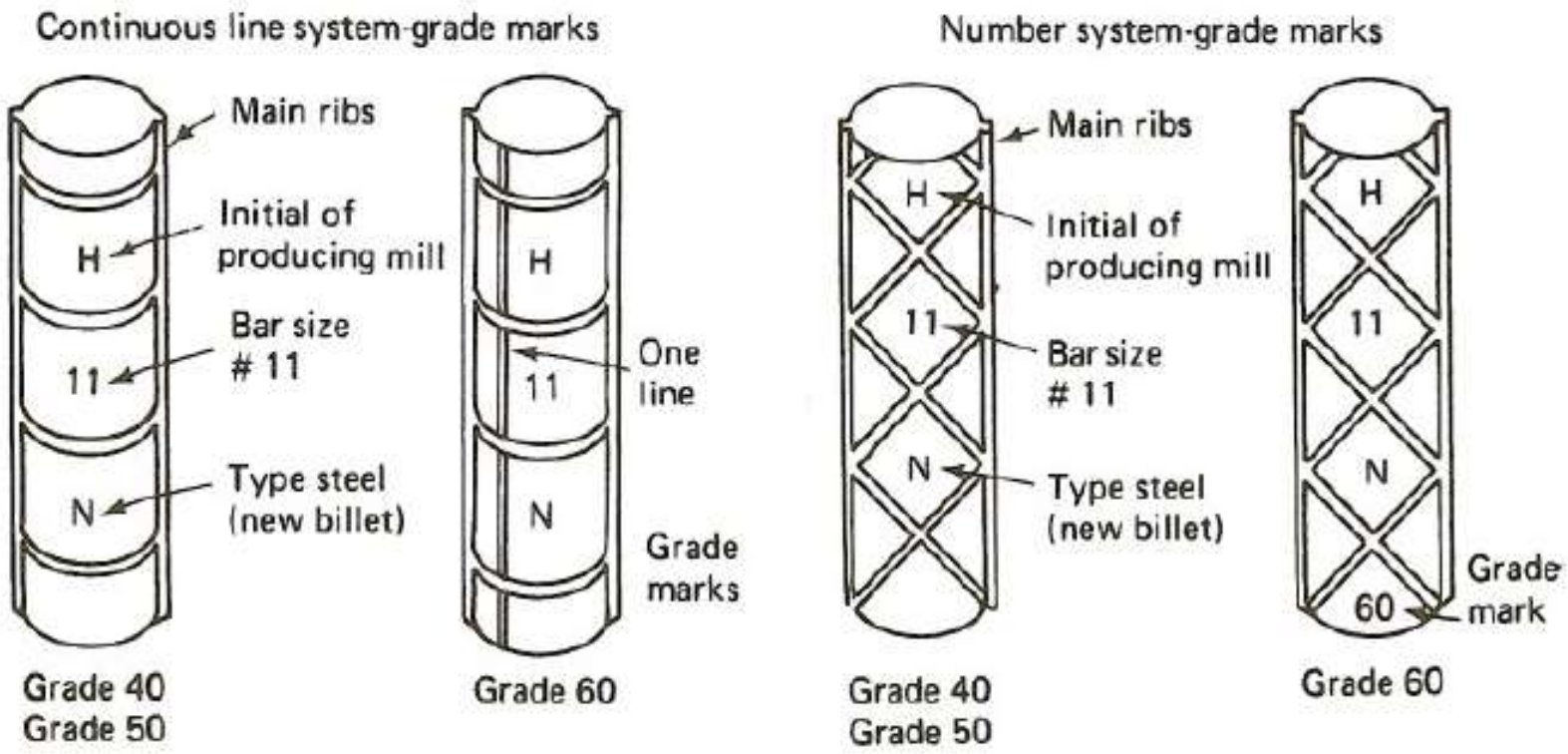


TABLE12-2: Steel wire data for welded wire fabric

Wire Size Number		Diameter		Area		Weight	
Smooth	Deformed	in.	mm	sq in.	mm^2	lb/ft	kg/m
W31	D31	0.628	16.0	0.31	200	1.054	1.568
W28	D28	0.597	15.2	0.28	181	0.952	1.417
W26	D26	0.575	14.6	0.26	168	0.934	1.390
W24	D24	0.553	14.1	0.24	155	0.816	1.214
W22	D22	0.529	13.4	0.22	142	0.748	1.113
W20	D20	0.505	12.8	0.20	129	0.680	1.012
W18	D18	0.479	12.2	0.18	116	0.612	0.911
W16	D16	0.451	11.5	0.16	103	0.544	0.810
W14	D14	0.422	10.7	0.14	90	0.476	0.708
W12	D12	0.391	9.9	0.12	77	0.408	0.607
W11	D11	0.374	9.5	0.11	71	0.374	0.557
W10	D10	0.357	9.1	0.10	65	0.340	0.506
W9.5		0.348	8.8	0.095	61	0.323	0.481
W9	D9	0.338	8.6	0.09	58	0.306	0.455
W8.5		0.329	8.4	0.085	55	0.289	0.430
W8	D8	0.319	8.1	0.08	52	0.272	0.405
W7.5		0.309	7.8	0.075	48	0.255	0.379
W7	D7	0.299	7.6	0.07	45	0.238	0.354
W6.5		0.288	7.3	0.065	42	0.221	0.329
W6	D6	0.276	7.0	0.06	39	0.204	0.304
W5.5		0.265	6.7	0.055	35	0.187	0.278
W5	D5	0.252	6.4	0.05	32	0.170	0.253
W4.5		0.239	6.1	0.045	29	0.153	0.228
W4	D4	0.226	5.7	0.04	26	0.136	0.202
W3.5		0.211	5.4	0.035	23	0.119	0.177
W2.9		0.192	4.9	0.029	19	0.099	0.147
W2.5		0.178	4.5	0.025	16	0.085	0.126
W2		0.160	4.1	0.02	13	0.068	0.101
W1.4		0.134	3.4	0.014	9	0.048	0.071

Placement of Reinforcing

- reinforcing steel is used primarily to resist tension and thus prevent cracking or failure of the concrete member under tension.
  - Since concrete is weak in resistance to tensile forces,
- Tension may be induced by:
  - shrinkage of concrete as it hardens,
  - temperature changes
  - bending and shear forces.
- Typical placement of reinforcing steel in concrete structural members is illustrated in Figure 12-29.

FIGURE 12-29: Placement of reinforcing steel.

(Courtesy of Concrete Reinforcing Steel Institute)

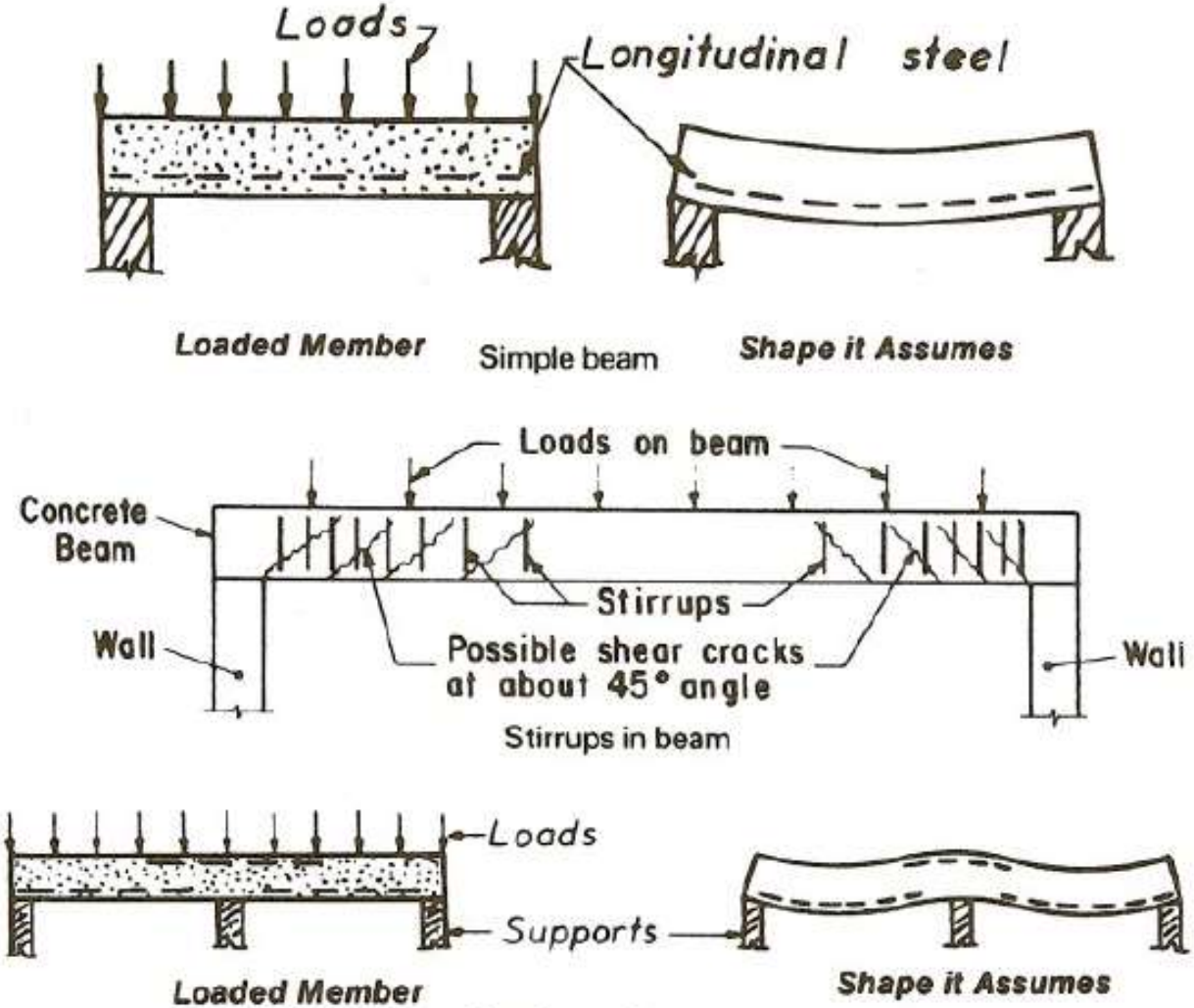
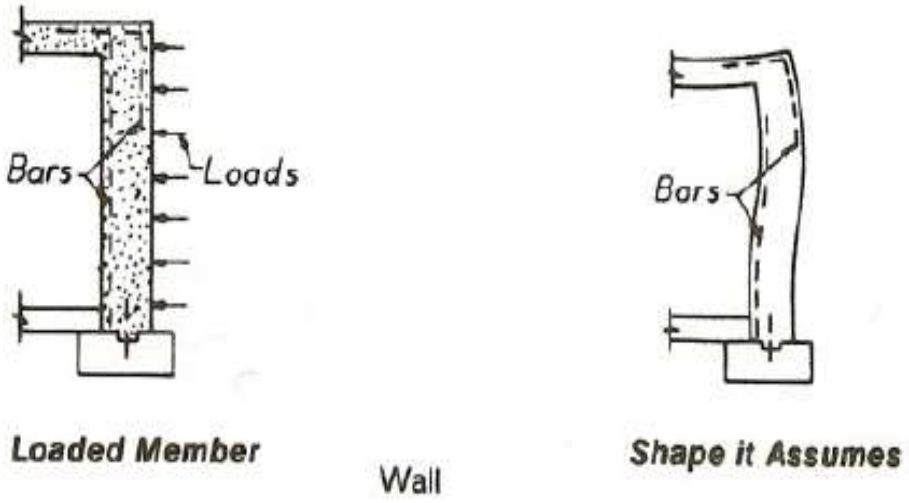
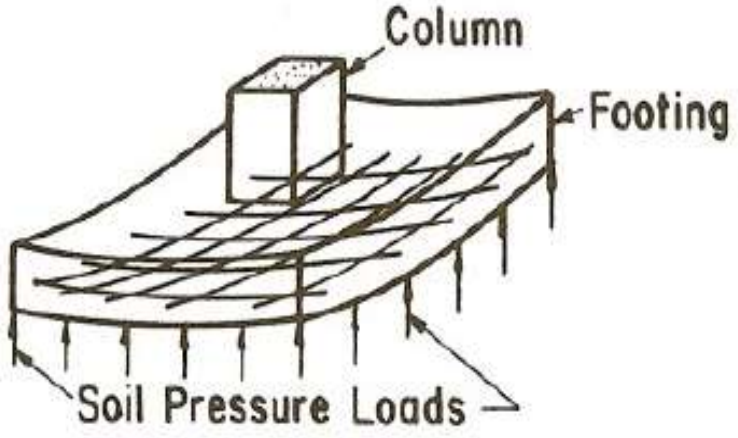


FIGURE 12-29: Placement of reinforcing steel.

(Courtesy of Concrete Reinforcing Steel Institute)





Placement of Reinforcing

- Standard types and sizes of wire bar supports are illustrated in Figure 12-30.

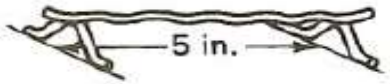
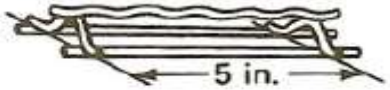
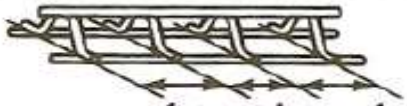
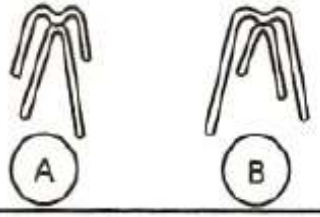
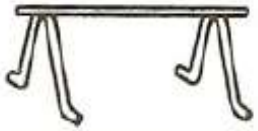
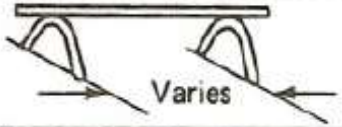
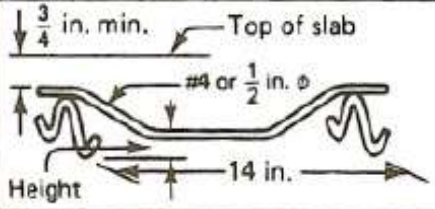
Symbol	Bar support illustration	Type of support	Standard sizes
SB		Slab bolster	$\frac{3}{4}$, 1, $1\frac{1}{2}$, and 2 in. heights in 5 ft and 10 ft lengths
SBU*		Slab bolster upper	Same as SB
BB		Beam bolster	1, $1\frac{1}{2}$, 2; over 2 in. to 5 in. height in increments of $\frac{1}{4}$ in. in lengths of 5 ft
BBU*		Beam bolster upper	Same as BB
BC		Individual bar chair	$\frac{3}{4}$, 1, $1\frac{1}{2}$, and $1\frac{3}{4}$ in. heights
JC		Joist chair	4, 5, and 6 in. widths and $\frac{3}{4}$, 1, and $1\frac{1}{2}$ in. heights

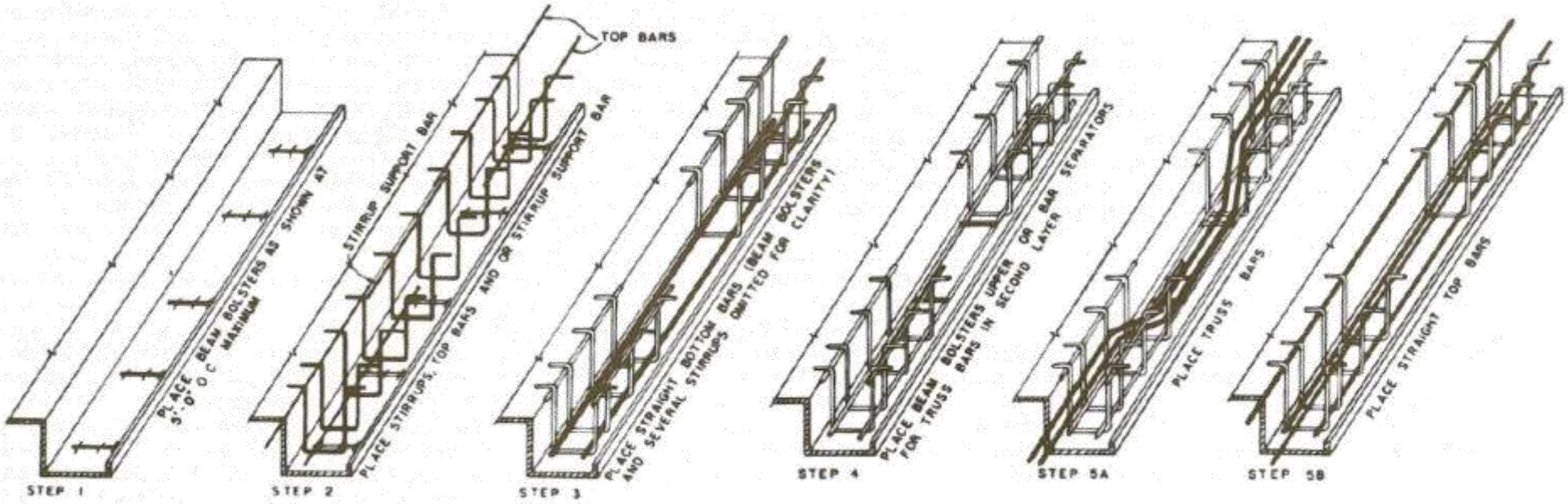
FIGURE 12-30: Wire bar supports.
(Courtesy of Concrete Reinforcing Steel Institute)

HC		Individual high chair	2 to 15 in. heights in increments of $\frac{1}{4}$ in.
HCM*		High chair for metal deck	2 to 15 in. heights in increments of $\frac{1}{4}$ in.
CHC		Continuous high chair	Same as HC in 5 foot and 10 foot lengths
CHCU*		Continuous high chair upper	Same as CHC
CHCM*		Continuous high chair for metal deck	Up to 5 in. heights in increments of $\frac{1}{4}$ in.
JCU**		Joist chair upper	14 in. Span. Heights −1 in. through +$3\frac{1}{2}$ in. vary in $\frac{1}{4}$ in. increments

* Available in Class A only, except on special order.
** Available in Class A only, with upturned or end bearing legs.

Placement of Reinforcing

- Figure 12-31 illustrates the CRSI-suggested sequence for placing reinforcing steel in a deep, heavily reinforced concrete beam



12-5 QUALITY CONTROL

- **Common Deficiencies in Concrete Construction**
- **Inspection and Testing**

Common Deficiencies in Concrete Construction

- Adequate Quality Control must be exercised over concrete operations.
  - to be obtained the required strength, durability, and appearance.
- Quality control measures specifically applicable to formwork are described in Section 12-3.
- Deficiencies in concrete construction practice may usually be traced to inadequate supervision of construction operations.
- A review by the U.S. Army Corps of Engineers has produced a list of repetitive deficiencies observed in concrete construction.

Inspection and Testing

- The inspection and testing associated with concrete Quality Control may be grouped into five phases.
  1. mix design;
  2. concrete materials quality;
  3. batching, mixing, and transporting concrete;
  4. concrete placing, vibrating, finishing, and curing; and
  5. testing of fresh and hardened concrete at the job site.

Inspection and Testing

- Mix design includes:
  - the quantity of each component in the mix,
  - the type and gradation of aggregates,
  - the type of cement,.
- Aggregate testing includes:
  - tests for organic impurities and excessive fines,
  - gradation,
  - resistance to scratch, and
  - aggregate moisture.

Inspection and Testing

- Recent developments in concrete testing technology have greatly reduced the time required to obtain results from on-site testing of plastic concrete.
  - For example, a nuclear water/cement gauge is now available which measures within 15 minutes:
    - the cement content,
    - water content, and
    - water/cement ratio of plastic concrete.