## SECTION IV—BEAMS

### TABLE 4.1.1—REINFORCED CONCRETE BEAMS DEPTH 10″ TO LESS THAN 12″

| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-11-RC-1 | 11″ | 24″ wide × 11″ deep reinforced concrete “T” beam (3290 psi); Details: see Note 5 figure. | 8.8 tons | 4 hrs. 2 min. | | | 7 | 1, 2, 14 | 4 |
| B-10-RC-2 | 10″ | 24″ wide × 10″ deep reinforced concrete “T” beam (4370 psi); Details: see Note 6 figure. | 8.8 tons | 1 hr. 53 min. | | | 7 | 1, 3 | $1^{3}/_{4}$ |
| B-10-RC-3 | $10^{1}/_{2}$″ | 24″ wide × $10^{1}/_{2}$″ deep reinforced concrete “T” beam (4450 psi); Details: see Note 7 figure. | 8.8 tons | 2 hrs. 40 min. | | | 7 | 1, 3 | $2^{2}/_{3}$ |
| B-11-RC-4 | 11″ | 24″ wide × 11″ deep reinforced concrete “T” beam (2400 psi); Details: see Note 8 figure. | 8.8 tons | 3 hrs. 32 min. | | | 7 | 1, 3, 14 | $3^{1}/_{2}$ |
| B-11-RC-5 | 11″ | 24″ wide × 11″ deep reinforced concrete “T” beam (4250 psi); Details: see Note 9 figure. | 8.8 tons | 3 hrs. 3 min. | | | 7 | 1, 3, 14 | 3 |
| B-11-RC-6 | 11″ | Concrete flange: 4″ deep × 2′ wide (4895 psi) concrete; Concrete beam: 7″ deep × $6^{1}/_{2}$″ wide beam; “I” beam reinforcement; 10″ × $4^{1}/_{2}$″ × 25 lbs. R.S.J.; 1″ cover on flanges; Flange reinforcement: $^{3}/_{8}$″ diameter bars at 6″ pitch parallel to “T”; $^{1}/_{4}$″ diameter bars perpendicular to “T”; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 11′ restrained; Details: see Note 10 figure. | 10 tons | 6 hrs. | | | 7 | 1, 4 | 6 |
| B-11-RC-7 | 11″ | Concrete flange: 6″ deep × 1′$6^{1}/_{2}$″ wide (3525 psi) concrete; Concrete beam: 5″ deep × 8″ wide precast concrete blocks $8^{3}/_{4}$″ long; “I” beam reinforcement; 7″ × 4″ × 16 lbs. R.S.J.; 2″ cover on bottom; $1^{1}/_{2}$″ cover on top; Flange reinforcement: two rows $^{1}/_{2}$″ diameter rods parallel to “T”; Beam reinforcement: $^{1}/_{8}$″ wire mesh perpendicular to 1″; Span: 1′3″ simply supported; Details: see Note 11 figure. | 3.9 tons | 4 hrs. | | | 7 | 1, 2 | 4 |
| B-11-RC-8 | 11″ | Concrete flange: 4″ deep × 2′ wide (3525 psi) concrete; Concrete beam 7″ deep × $4^{1}/_{2}$″ wide; (scaled from drawing); “I” beam reinforcement; 10″ × $4^{1}/_{2}$″ × 25 lbs. R.S.J.; no concrete cover on bottom; Flange reinforcement: $^{3}/_{8}$″ diameter bars at 6 pitch parallel to “T”; $^{1}/_{4}$″ diameter bars perpendicular to “T”; Span: 11′ restricted. | 10 tons | 4 hrs. | | | 7 | 1, 2, 12 | 4 |

*(Continued)*

**TABLE 4.1.1—REINFORCED CONCRETE BEAMS DEPTH 10″ TO LESS THAN 12″—continued**

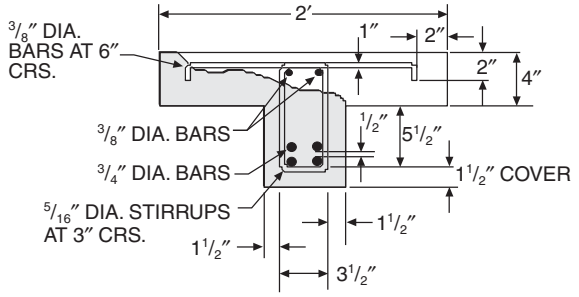
| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-11-RC-9 | $11^1/_2$″ | 24″ wide × $11^1/_2$″ deep reinforced concrete “T” beam (4390 psi); Details: see Note 12 figure. | 8.8 tons | 3 hrs. 24 min. | | | 7 | 1, 3 | $3^1/_3$ |

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound = 0.004448 kN, 1 pound per square inch = 0.00689 MPa, 1 ton = 8.896 kN.

**Notes:**

1. Load concentrated at mid span.
2. Achieved 4 hour performance (Class “B,” British).
3. Failure mode – collapse.
4. Achieved 6 hour performance (Class “A,” British).

5.

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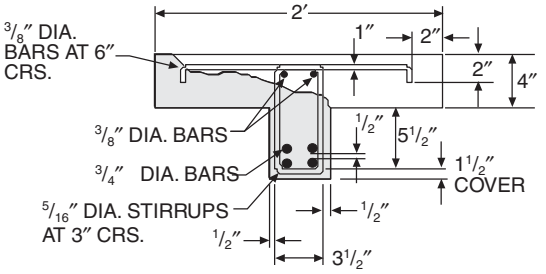


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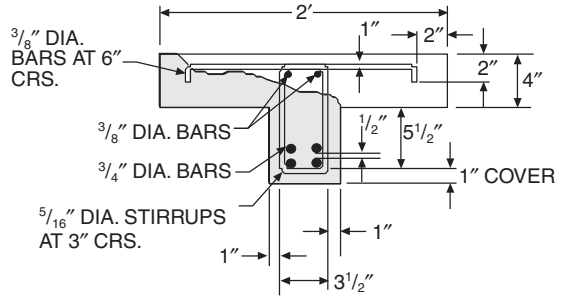


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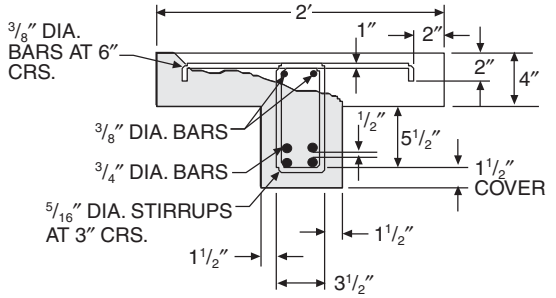


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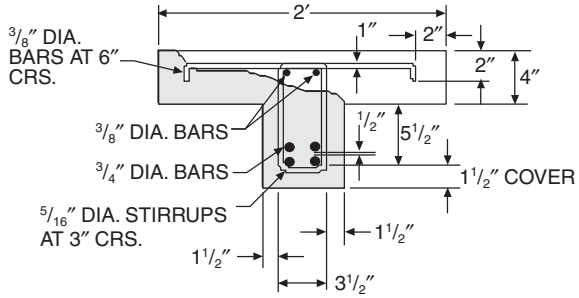


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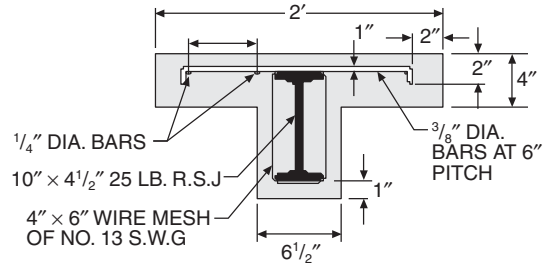


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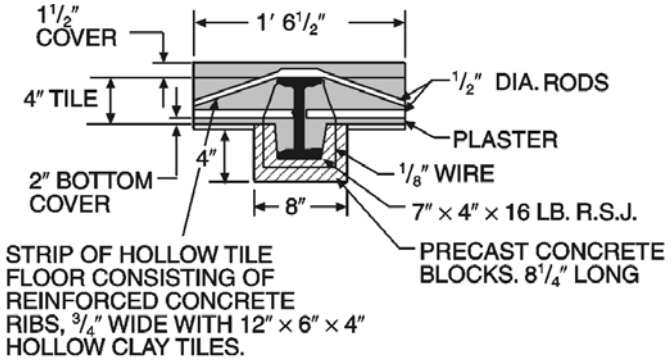
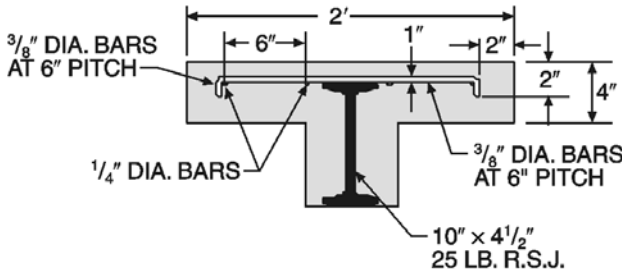
**TABLE 4.1.1—REINFORCED CONCRETE BEAMS
DEPTH 10″ TO LESS THAN 12″—continued**

11.




SPAN AND END CONDITIONS:-10′-3″ (CLEAR).
SIMPLY SUPPORTED.

12.

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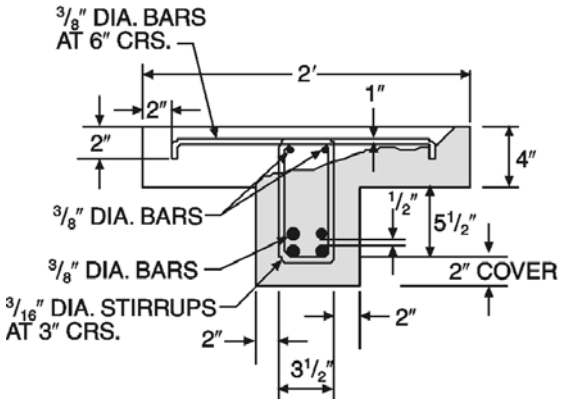



14. The different performances achieved by B-11-RC-1, B-11-RC-4 and B-11-RC-5 are attributable to differences in concrete aggregate compositions reported in the source document but unreported in this table. This demonstrates the significance of material composition in addition to other details.

**TABLE 4.1.2—REINFORCED CONCRETE BEAMS**
**DEPTH 12″ TO LESS THAN 14″**

| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-12-RC-1 | 12″ | 12″ × 8″ section; 4160 psi aggregate concrete; Reinforcement: 4-$^{7}/_{8}$″ rebars at corners; 1″ below each surface; $^{1}/_{4}$″ stirrups 10″ o.c. | 5.5 tons | 2 hrs. | | | 7 | 1 | 2 |
| B-12-RC-2 | 12″ | Concrete flange: 4″ deep × 2′ wide (3045 psi) concrete at 35 days; Concrete beam: 8″ deep; "I" beam reinforcement: 10″ × 4$^{1}/_{2}$″ × 25 lbs. R.S.J.; 1″ cover on flanges; Flange reinforcement: $^{3}/_{8}$″ diameter bars at 6″ pitch parallel to "T"; $^{1}/_{4}$″ diameter bars perpendicular to "T"; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 10′ 3″ simply supported. | 10 tons | 4 hrs. | | | 7 | 2, 3, 5 | 4 |
| B-13-RC-3 | 13″ | Concrete flange: 4″ deep × 2′ wide (3825 psi) concrete at 46 days; Concrete beam: 9″ deep × 8$^{1}/_{2}$″ wide; (scaled from drawing); "I" beam reinforcement: 10″ × 4$^{1}/_{2}$″ × 25 lbs. R.S.J.; 3″ cover on bottom flange; 1″ cover on top flange; Flange reinforcement: $^{3}/_{8}$″ diameter bars at 6″ pitch parallel to "T"; $^{1}/_{4}$″ diameter bars perpendicular to "T"; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 11′ restrained. | 10 tons | 6 hrs. | | | 7 | 2, 3, 6, 8, 9 | 4 |
| B-12-RC-4 | 12″ | Concrete flange: 4″ deep × 2′ wide (3720 psi) concrete at 42 days; Concrete beam: 8″ deep × 8$^{1}/_{2}$″ wide; (scaled from drawing); "I" beam reinforcement: 10″ × 4$^{1}/_{2}$″ × 25 lbs. R.S.J.; 2″ cover bottom flange; 1″ cover top flange; Flange reinforcement: $^{3}/_{8}$″ diameter bars at 6″ pitch parallel to "T"; $^{1}/_{4}$″ diameter bars perpendicular to "T"; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 11′ restrained. | 10 tons | 6 hrs. | | | 7 | 1, 3, 4, 7, 8, 9 | 4 |

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound = 0.004448 kN, 1 pound per square inch = 0.00689 MPa, 1 ton = 8.896 kN.

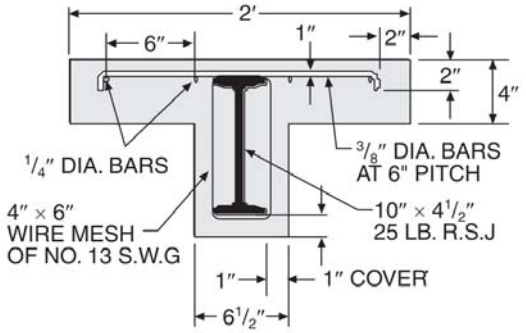
**Notes:**

1. Qualified for 2 hour use. (Grade "C," British) Test included hose stream and reload at 48 hours.
2. Load concentrated at mid span.
3. British test.
4. British test - qualified for 6 hour use (Grade "A").

*(Continued)*

**TABLE 4.1.2—REINFORCED CONCRETE BEAMS
DEPTH 12″ TO LESS THAN 14″—continued**

5.

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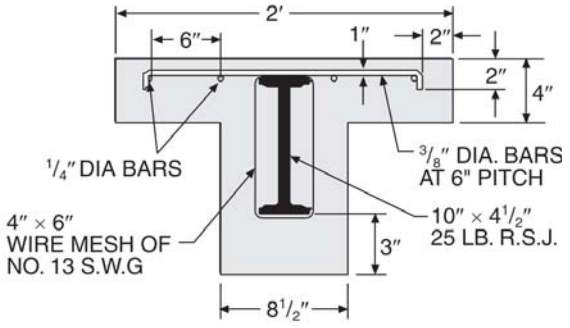
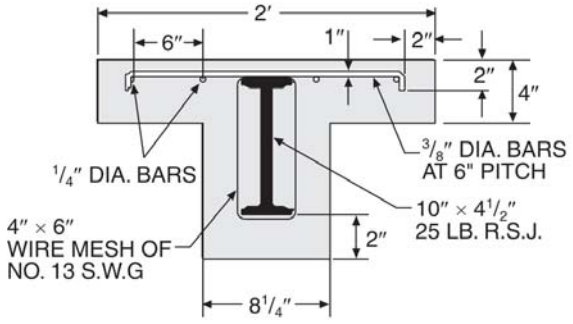



7.




8. See Table 4.1.3, Note 5.

9. Hourly rating based upon B-12-RC-2 above.

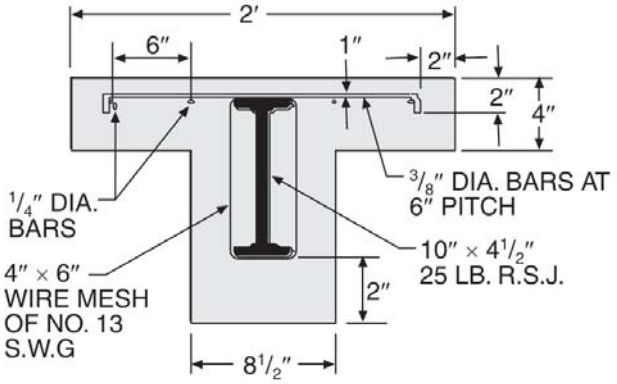
**TABLE 4.1.3—REINFORCED CONCRETE BEAMS**
**DEPTH 14″ TO LESS THAN 16″**

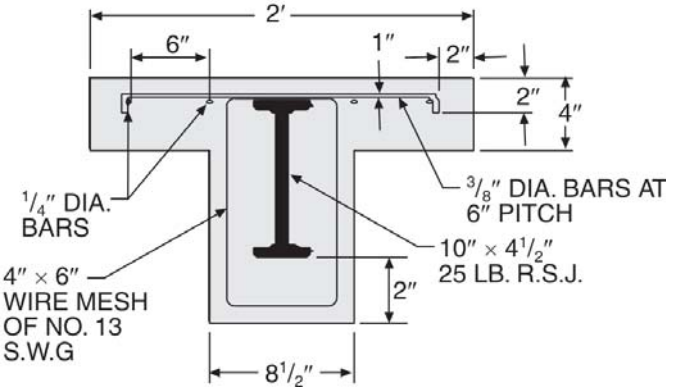
| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-15-RC-1 | 15″ | Concrete flange: 4″ deep × 2′ wide (3290 psi) concrete; Concrete beam: 10″ deep × $8^1/_2$″ wide; "I" beam reinforcement: 10″ × $4^1/_2$″ × 25 lbs. R.S.J.; 4″ cover on bottom flange; 1″ cover on top flange; Flange reinforcement: $^3/_8$″ diameter bars at 6″ pitch parallel to "T"; $^1/_4$″ diameter bars perpendicular to "T"; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 11′ restrained. | 10 tons | 6 hrs. | | | 7 | 1, 2, 3 5, 6 | 4 |
| B-15-RC-2 | 15″ | Concrete flange: 4″ deep × 2′ wide (4820 psi) concrete; Concrete beam: 10″ deep × $8^1/_2$″ wide; "I" beam reinforcement: 10″ × $4^1/_2$″ × 25 lbs. R.S.J.; 1″ cover over wire mesh on bottom flange; 1″ cover on top flange; Flange reinforcement: $^3/_8$″ diameter bars at 6″ pitch parallel to "T"; $^1/_4$″ diameter bars perpendicular to "T"; Beam reinforcement: 4″ × 6″ wire mesh No. 13 SWG; Span: 11′ restrained. | 10 tons | 6 hrs. | | | 7 | 1, 2, 4, 5, 6 | 4 |

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound = 0.004448 kN, 1 pound per square inch = 0.00689 MPa, 1 ton = 8.896 kN.

**Notes:**

1. Load concentrated at mid span.
2. Achieved 6 hour fire rating (Grade "A," British).
3. 4.




5. Section 43.147 of the 1979 edition of the *Uniform Building Code Standards* provides:

   "A restrained condition in fire tests, as used in this standard, is one in which expansion at the supports of a load-carrying element resulting from the effects of the fire is resisted by forces external to the element. An unrestrained condition is one in which the load-carrying element is free to expand and rotate at its support.

   "(R)estraint in buildings is defined as follows: Floor and roof assemblies and individual beams in buildings shall be considered restrained when the surrounding or supporting structure is capable of resisting the thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying . . . is assumed to be free to rotate and expand and shall be considered as unrestrained.

   "Restraint may be provided by the lateral stiffness of supports for floor and roof assemblies and intermediate beams forming part of the assembly. In order to develop restraint, connections must adequately transfer thermal thrusts to such supports. The rigidity of adjoining panels or structures shall be considered in assessing the capability of a structure to resist therm expansion."

   Because it is difficult to determine whether an existing building's structural system is capable of providing the required restraint, the lower hourly ratings of a similar but unrestrained assembly have been recommended.
6. Hourly rating based upon Table 4.2.1, Item B-12-RC-2.

**TABLE 4.2.1—REINFORCED CONCRETE BEAMS—UNPROTECTED DEPTH 10″ TO LESS THAN 12″**

| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-SU-1 | 10″ | 10″ × 4 1/2″ × 25 lbs. “I” beam. | 10 tons | 39 min. | | | 7 | 1 | 1/3 |

For SI: 1 inch = 25.4 mm, 1 pound = 0.004448 kN, 1 ton = 8.896 kN.

**Notes:**

1. Concentrated at mid span.

**TABLE 4.2.2—STEEL BEAMS—CONCRETE PROTECTION DEPTH 10″ TO LESS THAN 12″**

| ITEM CODE | DEPTH | CONSTRUCTION DETAILS | PERFORMANCE | | REFERENCE NUMBER | | | NOTES | REC. HOURS |
|---|---|---|---|---|---|---|---|---|---|
| | | | LOAD | TIME | PRE-BMS-92 | BMS-92 | POST-BMS-92 | | |
| B-SC-1 | 10″ | 10″ × 8″ rectangle; aggregate concrete (4170 psi) with 1″ top cover and 2″ bottom cover; No. 13 SWG iron wire loosely wrapped at approximately 6″ pitch about 7″ × 4″ × 16 lbs. “I” beam. | 3.9 tons | 3 hrs. 46 min. | | | 7 | 1, 2, 3 | 3 3/4 |
| B-SC-1 | 10″ | 10″ × 8″ rectangle; aggregate concrete (3630 psi) with 1″ top cover and 2″ bottom cover; No. 13 SWG iron wire loosely wrapped at approximately 6″ pitch about 7″ × 4″ × 16 lbs. “I” beam. | 5.5 tons | 5 hrs. 26 min. | | | 7 | 1, 4, 5, 6, 7 | 3 3/4 |

For SI: 1 inch = 25.4 mm, 1 pound = 0.004448 kN, 1 pound per square inch = 0.00689 MPa, 1 ton = 8.896 kN.

**Notes:**

1. Load concentrated at mid span.
2. Specimen 10-foot 3-inch clear span simply supported.
3. Passed Grade “C” fire resistance (British) including hose stream and reload.
4. Specimen 11-foot clear span - restrained.
5. Passed Grade “B” fire resistance (British) including hose stream and reload.
6. See Table 4.1.3, Note 5.
7. Hourly rating based upon B-SC-1 above.