



SECTION 03 11 00
CONCRETE FORMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. CONTRACTOR shall supply all labor, tools, equipment and materials to set forms for the proper placement of concrete for structures. It is CONTRACTOR's responsibility to design and build adequate forms and to leave them in place until the forms can be safely removed. CONTRACTOR is responsible for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength. Means and methods of repair shall be reviewed by ENGINEER prior to performing the WORK.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
 - 1. Section 03 15 00, Construction Joints.
 - 2. Section 03 31 00, Structural Concrete.
 - 3. Section 03 35 00, Concrete Finishing.
 - 4. Section 03 60 00, Grouting.

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Concrete Institute (ACI):
 - a. Manual of Concrete Practice.
 - b. 117, Specifications for Tolerances for Concrete Construction and Materials.
 - c. 318, Building Code Requirements for Structural Concrete.
 - d. SP-4, Formwork for Concrete.
 - 2. American Plywood Association (APA):
 - a. J20, Grades and Specifications.
 - b. PS-1-07, US Product Standard for Structural Plywood.
 - c. V345, Concrete Forming.

1.04 SUBMITTALS

- A. General:



1. Design, placement and maintenance of formwork and form systems is the responsibility of CONTRACTOR. Submittals other than those listed are not required nor will they be reviewed.
 2. Alternate form system configurations require preparation by a licensed Professional Engineer and submittal to ENGINEER for review and approval.
- B. Product Technical Data:
1. Manufacturer and type of form materials.
 2. Manufacturer and type of form ties.
 3. Manufacturer and type of void form including compressive strength.
 4. Manufacturer of form release agent.
- C. CONTRACTOR shall submit information about the type of wedge anchor or nail, and the means of patching the surface for review and acceptance by ENGINEER.

1.05 QUALITY ASSURANCE

- A. Formwork, and if required shoring and reshoring, shall be designed by a Professional Engineer licensed to practice in the state where the PROJECT is located.

PART 2 PRODUCTS

2.01 GENERAL

- A. For the purposes of this SPECIFICATION, exposure shall be defined as a surface, interior or exterior, of a structure that will be exposed to view during its use. For example, the interior wall of a buried culvert is a surface exposed to view.

2.02 FORMS FOR SURFACES EXPOSED TO VIEW

- A. Walls:
1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.
 2. Symons hand set steel-ply forms, or equal.
- B. Beams:
1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.
 2. Symons hand set steel-ply forms, or equal.
- C. Sides of Column Footings:
1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.



2. Steel of sufficient thickness that the form remains true to shape after numerous repetitive uses.
 3. Symons hand set steel-ply forms, or equal.
- D. Sides of Curved or Straight Continuous Wall Footings:
1. APA high-density overlay Plyform Class I exterior.
 2. APA PS 1-07, B-B Plyform Class I, exterior.
 3. For curved surfaces, plywood of sufficient thickness, free from knots and other imperfections, which can be cut and bent and held in place accurately to the required curvature without splintering or splitting, shall be used.
- E. Floor and Roof Slabs: APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.
- F. Columns: Regardless of materials of construction, the forms shall be such to permit bracing in two directions at half height and full height at a minimum. Two braces at ninety degrees (90°) are required at half and full height.
1. Steel of sufficient thickness that the form remains true to shape after numerous repetitive uses.
 2. Fiberglass of sufficient thickness that the form remains true to shape.
- G. Column Capitals: Steel, sixteen (16) gage or thicker, so that the form remains true to shape after numerous repetitive uses.

2.03 FORMS FOR SURFACES NOT EXPOSED TO VIEW

- A. Wood or steel sufficiently tight to prevent mortar leakage.

2.04 ANCHORAGE IN SLABS FOR BRACES FOR WALL AND COLUMN FORMS

- A. Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column alignment under all load conditions including wind.
- B. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of wall or column braces in water retaining structures. Wedge anchors or nails may be used in other structures when in the opinion of ENGINEER the resulting concrete finish patch will be acceptable.

2.05 ANCHORAGE IN SLABS FOR UPTURNED COLUMN FOOTING FORMS

- A. Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column configuration and diameter. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of column footing forms.



2.06 FORM TIES

- A. Water Retaining Structures and Below Grade Structures: Symons, S-Panel Ties, or equal, with water seal and one (1) inch break back cones on both tie ends, shall be used on all wall forms.
- B. Other Structures: Symons, S-Panel Ties, or equal, with one (1) inch break back cones on both tie ends, unless otherwise called out or shown in the DRAWINGS or approved by ENGINEER, shall be used on all wall forms.
- C. Twisted Wire Ties: Twisted wire ties with loops to hold forms in position are not permitted.

2.07 CHAMFER STRIP

- A. Chamfer strips, three-quarters (3/4) inch or as shown on the DRAWINGS, shall be placed in the corners of forms and at the tops of walls or up-turned footings, to produce beveled edges on permanently exposed concrete surfaces. Interior angles of intersecting concrete surfaces and edges of construction joints shall not be beveled unless otherwise indicated in the DRAWINGS. The chamfer strip may be made of wood or polyvinyl chloride (PVC).

2.08 STIFF-BACKS

- A. Stiff-backs for wall forms shall be constructed of lumber or Glulams, uniform in width and thickness, free from knots and other surface defects. Only one (1) joint is permitted in the board of a stiff-back and joints shall be offset so as to not occur at the same point. Stiff-backs shall extend to a point not less than six (6) inches above the top of forms.

2.09 GANG WALER PLATES FOR THE TOP OF CURVED WALLS

- A. Gang waler plates shall be constructed of plywood as described below cut to the radius of the wall curve. The gang waler plate shall be of sufficient depth to permit notching for stiff-backs.
 - 1. APA high-density overlay Plyform Class I, exterior.
 - 2. APA PS1, B-B Plyform Class I, exterior.

2.10 WEDGE INSERTS

- A. When permitted by ENGINEER at the tops of walls or columns, wedge inserts may be used to support future formwork or catwalks. The inserts shall be Richmond Screw Anchor, or equal.

2.11 FORM RELEASE AGENT

- A. Magic Kote by Symons Corp. or equal.



PART 3 EXECUTION

3.01 GENERAL

- A. Forms shall be used, wherever necessary, to confine the concrete and shape it to the specified lines and grades as shown on the DRAWINGS. CONTRACTOR shall set and maintain concrete forms so as to ensure completed WORK is within all applicable tolerance limits. If a type of form does not, in the opinion of ENGINEER, consistently perform in an acceptable manner, the type of form shall be changed and the method of erection shall be modified by CONTRACTOR, subject to the review of ENGINEER.
- B. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete, and shall be maintained rigidly in position. The design of formwork and placing rate of concrete with medium and high-range water reducing agents shall be adjusted to compensate for the greater hydraulic pressures exerted on the forms by concrete of high fluidity.
- C. Forms shall be clean and free from mortar and other foreign material from previous use prior to being placed.
- D. CONTRACTOR shall demonstrate that forms are vertical, with proper alignment, grade or radius when requested by ENGINEER.

3.02 FORM SURFACE TREATMENT

- A. Prior to placing reinforcing steel, coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Contact with hardened concrete against which fresh concrete is to be placed is prohibited. All bond breaking materials or processes shall be used only after acceptance by ENGINEER. Care shall be taken in applying form oil to avoid contact with reinforcement steel. Embedded material which becomes coated with form oil shall be thoroughly cleaned or replaced at the expense of CONTRACTOR.

3.03 TOLERANCES

- A. Tolerances are defined as allowable variations from specified alignments, grades, and dimensions. Allowable variations from specified alignments, grades, and dimensions are prescribed in the following sub-section. Descriptions of these criteria can be found in Part 2 of the ACI Manual of Concrete Practice, and ACI 117.
- B. Footings and Foundations:
 - 1. Drilled Piers:
 - a. Vertical Alignment: Less than or equal to two percent ($\leq 2\%$) of the shaft length.
 - b. Lateral Alignment: Less than or equal to one-twenty-fourth ($\leq 1/24$) of shaft diameter, three (3) inches maximum.



- c. Level Alignment to Cut-off Elevation: More than one (1) inch, less than three (3) inches.
2. Continuous Wall Footings (Circular and Non-circular):
 - a. Lateral Alignment: Less than or equal to two percent ($\leq 2\%$) of the footing width, two (2) inches maximum.
 - b. Relative Alignment: Variation less than or equal to one (≤ 1) inch in ten (10) feet (variation between specified plane and as built surface).
 - c. Cross-sectional Dimension:
 - 1) Horizontal Dimension: Variation more than two (2) inches, less than one-half ($1/2$) inch.
 - 2) Vertical Dimension (thickness): Variation plus or minus one-half ($\pm 1/2$) inch.
 - d. Circular Wall Footing Only:
 - 1) Variation in Radius in Any Twenty (20) Feet of Wall Length: Less than or equal to one-half ($\leq 1/2$) inch.
 - 2) Variation in Radius in Entire Wall Length: Less than or equal to one (≤ 1) inch.
3. Column Footings:
 - a. Lateral Alignment: Variation less than or equal to two (≤ 2) inches.
 - b. Level Alignment: Variation from specified elevation more than one-half ($1/2$) inch, less than two (2) inches.
 - c. Relative Alignment: Variation less than or equal to one (≤ 1) inch in ten (10) feet (variation between specified plane and as built surface).
 - d. Cross-sectional Dimension:
 - 1) Horizontal Dimension: Variation more than two (2) inches, less than one-half ($1/2$) inch.
 - 2) Vertical Dimension (Thickness): Variation plus or minus one-half ($\pm 1/2$) inch.
- C. Cast-in-Place Concrete for Buildings and other Structures:
 1. Member (such as a beam, column, wall, slab, or pier):
 - a. Vertical Alignment: Variation from specified plump less than or equal to three-eighths ($\leq 3/8$) inch (full height) one-quarter ($1/4$) inch (one form section).



b. Lateral Alignment:

- 1) Maximum in Any Bay: Variation less than or equal to one-half ($\leq 1/2$) inch.
- 2) Maximum in Any Twenty (20) Feet of Length: Variation less than or equal to one-half ($\leq 1/2$) inch.
- 3) Maximum for Entire Wall Length: Variation less than or equal to one (≤ 1) inch.
- 4) Floor and Wall Opening Locations: Variation less than or equal to one-half ($\leq 1/2$) inch.
- 5) Saw cuts and Joints: Variation less than or equal to three-quarters ($\leq 3/4$) inch.

c. Level Alignment:

- 1) Top Elevation of Slabs: Variation less than or equal to three-quarters ($\leq 3/4$) inch.
- 2) Lintels, Other Lines Exposed to View: Variation less than or equal to three-quarters ($\leq 3/4$) inch.

d. Cross-sectional Dimensions:

- 1) Walls and Slabs (Thickness): Variation plus or minus one-quarter ($\pm 1/4$) inch.
- 2) Columns and Beams: Variation more than one-half ($1/2$) inch, less than one-quarter ($1/4$) inch.
- 3) Size of Wall and Floor Openings: Variation plus or minus one-quarter ($\pm 1/4$) inch.

e. Relative Alignment (Offset between Adjacent Formwork): Variation plus or minus one-quarter inch ($\pm 1/4$) inch.

f. Variation in Specified Grade:

- 1) For Any Distance Less than Ten (< 10) Feet: Variation less than or equal to one-quarter ($\leq 1/4$) inch.
- 2) For Entire Structure: Variation plus or minus one-half ($\pm 1/2$) inch.
- 3) For Manholes and Outlet Structures: Variation less than or equal to one (≤ 1) inch.

2. Stairways:

a. Relative Alignment:

- 1) Difference in Height between Adjacent Risers: One-eighth ($1/8$) inch.
- 2) Difference in Width between Adjacent Treads: One-quarter ($1/4$) inch.

3.04 PLUMB AND STRING LINES

- A. Plumb and string lines shall be installed on wall and column forms before, and maintained during, concrete placement. There shall be sufficient number of plumb or string lines in walls, for example at every other stiff-back, properly installed to permit



continuous monitoring. During concrete placement, CONTRACTOR shall continually monitor plumb and string line positions and immediately correct deficiencies. The plumb and string lines shall extend to a point at least six (6) inches above the top of wall or column.

3.05 FORMWORK CAMBER

- A. In order to maintain specified tolerances of joists, beams or slabs subject to dead load deflection, CONTRACTOR shall camber formwork to compensate for dead load deflection prior to hardening of the concrete.

3.06 GANG WALER PLATES FOR CIRCULAR WALLS

- A. CONTRACTOR shall place a gang waler plate cut to the curvature of the wall, such as a circular wall, at the top of the wall forms. The gang waler plate shall be attached to the forms with a gang waler rod at appropriately designed intervals. The gang waler plate may be notched to permit the stiff-back to extend above the top of the wall forms. The gang waler plate shall be sufficiently stiff to maintain the required curvature.

3.07 HAND SET MODULAR FORMS

- A. Hand set modular forms, such as Symons hand set steel-ply forms, shall be placed with no more than two intersecting joints occurring at one level in the formwork above the bottom modular form level. Figure 1 illustrates the required form pattern.

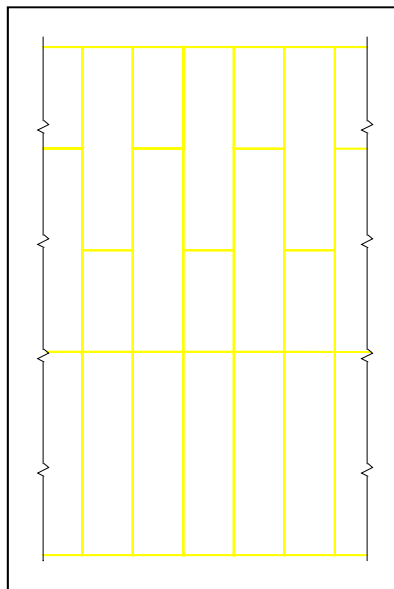


Figure 1

- B. The above form configuration is one way recommended by Simons Corp. to eliminate vertical, in plane, bending of the forming system. CONTRACTOR may develop alternate means of maintaining vertical alignment.



3.08 FORMWORK CLOSURE

- A. Forms that prohibit visual review of items such as reinforcing steel, waterstops and bearing pads by ENGINEER, shall not be placed until ENGINEER has performed a final review of the reinforcing steel.
- B. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of sections or members to be placed such as walls, slabs, beams and columns, prior to placing forms or concrete.
- C. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as loose concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

3.09 HOT OR COLD WEATHER PLACEMENT AND STEEL FORMS

- A. Prior to placing concrete when steel forms are used, the forms shall be heated when the surface temperature of the form is below forty degrees Fahrenheit (40°F) or cooled when the surface temperature of the form is above ninety degrees Fahrenheit (90°F). If water is used to cool forms where ponding of water may occur (for example, at the bottom of a column), the water shall be permitted to drain prior to placing concrete.

3.10 REMOVAL OF FORMS

- A. The forms for any portion of a structure shall not be removed until the concrete has reach sufficient strength with a factor of safety of 2.0, to withstand applied loads such as self weight and wind loads or withstand damage when the forms are removed.
- B. For post-tensioned concrete slabs and beams, formwork shall not be removed until the entire slab or member has been stressed and stressing records accepted.

3.11 RESHORES

- A. When a reshore plan is to be performed, it shall comply with Article Quality Assurance.

END OF SECTION



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