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USACE / NAVFAC / AFCEC / NASA **UFGS-03 11 13.00 10 (August 2010)**

Preparing Activity: USACE **Superseding UFGS-03 11 13.00 10 (May 2009))**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2013
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DIVISION 03 - CONCRETE

SECTION 03 11 13.00 10

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

08/10

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SECTION 03 11 13.00 10

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING
08/10

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NOTE: This guide specification covers the requirements for formwork for cast-in-place concrete and will be used with Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE or Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS. Formwork for architectural cast-in-place concrete is specified in Section 03 33 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM C1074	(2011) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2013b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C578	(2012b) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

1.2 SYSTEM DESCRIPTION

The design, engineering, and construction of the formwork is the responsibility of the Contractor. Design formwork in accordance with methodology of ACI 347 for anticipated loads, lateral pressures, and stresses, and capable of withstanding the pressures resulting from placement and vibration of concrete. Comply with the tolerances specified in Section [03 31 01.00 10 CAST-IN-PLACE CONCRETE] [03 70 00 MASS CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE], paragraph CONSTRUCTION

TOLERANCES. However, for surfaces with an ACI Class A surface designation, limit the allowable deflection for facing material between studs, for studs between walers and walers between bracing to 0.0025 times the span. Design the formwork as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. Monitor the adequacy of formwork design and construction prior to and during concrete placement as part of the Contractor's approved Quality Control Plan. Submit design analysis and calculations for form design and methodology used in the design. [At least [_____] days either before fabrication on site or before delivery of prefabricated forms.]

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Formwork[; G][; G, [_____]]

SD-03 Product Data

Design
Form Materials
Form Releasing Agents

SD-04 Samples

Sample Panels[; G][; G, [_____]]
Fiber Voids[; G][; G, [_____]]

SD-06 Test Reports

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NOTE: If form removal is not allowed before 24 hours, the submittal, "Formwork Not Supporting Weight of Concrete; G", and the corresponding bracketed sentences in paragraph FORMWORK NOT SUPPORTING WEIGHT OF CONCRETE should be deleted.
****

Inspection
Formwork Not Supporting Weight of Concrete[; G][; G, [_____]].

SD-07 Certificates

Fiber Voids

1.4 QUALITY ASSURANCE

Provide Sample Panels of sufficient size to contain joints and not less than 2 meters long and 1.5 meters wide 6 feet long and 4 feet wide. The panels shall be of typical wall thickness and constructed containing the full allocation of reinforcing steel that will be used in the structure, with the forming system that duplicates in every detail the one that will be used in construction of the structure. Use the same concrete mixture proportion and materials, the same placement techniques and equipment, and the same finishing techniques and timing that are planned for the structure. Construction of Class A finish will not be permitted until sample panels have been approved. Protect sample panels from construction operations in a manner to protect approved finish, and are not to be removed until all Class A finish concrete has been accepted. After shop drawings have been reviewed, submit sample panels for Class A finish with applied architectural treatment; panels shall be built on the project site where directed.

1.5 DELIVERY, STORAGE, AND HANDLING

Store fiber voids above ground level in a dry location. Keep fiber voids dry until installed and overlaid with concrete.

PART 2 PRODUCTS

2.1 FORM MATERIALS

****
NOTE: This paragraph should be edited to reflect project requirements. Description of classes of finish are contained in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE.

For Civil Works Projects see the appropriate Concrete Materials Design Memorandum and EM 1110-2-2000 for description of class finishes. See paragraph 5.4.e in EM 1110-2-2000 for guidance in selecting appropriate finishes.

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Submit manufacturer's data, including literature describing form materials, accessories, and form releasing agents.

2.1.1 Forms For Class A Finish

Forms for Class A finished surfaces shall be plywood panels conforming to APA L870, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.1.2 Forms For Class B Finish

This class of finish shall apply to all surfaces except those specified to receive[Class A] [,] [Class C] [,] [Class D]. Forms for Class B finished surfaces shall be plywood panels conforming to APA L870, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type. Steel lining on wood sheathing will not be permitted.

2.1.3 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to APA L870, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

2.1.4 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.5 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05 30 00 STEEL DECKS.

2.1.6 Pan-Form Units

Pan-form units for one-way or two-way concrete joist and slab construction shall be factory-fabricated units of the approximate section indicated. Units shall consist of steel or molded fiberglass concrete form pans. Closure units shall be furnished as required.

2.1.7 Form Ties

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NOTE: Removable tie rods are not allowed for structures intended to be a water barrier. Specify the locations where removable tie rods are not to be used.
****

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Provide solid backing for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 6 mm 1/4 inch nor more than 25 mm 1 inch deep and not more than 25 mm 1 inch in diameter. Terminate the embedded portion of metal ties not less that 50 mm 2 inches from any concrete surface exposed to water. Removable tie rods shall be not more than 38 mm 1-1/2 inches in diameter. Plastic snap ties may be used in locations where the surface will not be exposed to view.

2.1.8 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, follow the recommendation of the form coating manufacturer. Submit manufacturer's recommendation on method and rate of application of form releasing agents.

2.1.9 Fiber Voids

Fiber voids shall be the product of a reputable manufacturer regularly engaged in the commercial production of fiber voids. The voids shall be constructed of double faced, corrugated fiberboard. The corrugated fiberboard shall be fabricated of [wet strength] [standard kraft] paper liners, impregnated with paraffin, and laminated with moisture resistant adhesive, and shall have a board strength of 20 kg/square centimeter 275 psi. Voids which are impregnated with paraffin after construction, in lieu of being constructed with paraffin impregnated fiberboard, are acceptable. Voids shall be designed to support not less than 4900 kg/square meter 1000 psf. To prevent separation during concrete placement fiber voids shall be assembled with steel or plastic banding at 1.22 m 4 feet on center maximum, or by adequate stapling or gluing as recommended by the manufacturer. Fiber voids placed under concrete slabs and that are 200 mm 8 inches in depth may be heavy duty "waffle box" type, constructed of paraffin impregnated corrugated fiberboard. Submit one sample unit of fiber voids prior to installation of the voids and certificates attesting that fiber voids conform to the specified requirements.

2.2 FIBER VOID RETAINERS

2.2.1 Polystyrene Rigid Insulation

Polystyrene rigid insulation shall conform to ASTM C578, Type V, VI, or VII, square edged. Size shall be 38 mm 1-1/2 inches thick by 400 mm 16 inches in height by 1 m 3 feet in length, unless otherwise indicated.

2.2.2 Precast Concrete

Precast concrete units shall have a compressive strength of not less than 17 MPa 2500 psi, reinforced with 150 mm by 150 mm by W1.4 WWF 6 inch by 6 inch by W1.4 WWF wire mesh, and 300 mm (height) by 1 m (length) by 40 mm (thickness) 12 inches (height) by 3 feet (length) by 1-5/8 inches (thickness) in size unless indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Forms shall be constructed true to the structural design and required alignment. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in [Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE] [Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS] and conforming to construction tolerance given in TABLE 1. Continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface class [or classes] specified. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker. Submit drawings showing details of formwork, including dimensions of fiber voids, joints, supports, studding and shoring, and sequence of form and shoring removal. [At least [_____] days either before fabrication onsite or before delivery of prefabricated forms.] [If reshoring is permitted, submit the method, including location, order, and time of erection and removal.]

3.1.2 Fiber Voids

Voids shall be placed on a smooth firm dry bed of suitable material, to avoid being displaced vertically, and shall be set tight, with no buckled cartons, in order that horizontal displacement cannot take place. Each section of void shall have its ends sealed by dipping in paraffin, with any additional cutting of voids at the jobsite to be field dipped in the same type of sealer, unless liners and flutes are completely impregnated with paraffin. Prior to placing reinforcement, the entire formed area for slabs shall be covered with a 1.22 x 2.44 m 4 x 8 feet minimum flat sheets of fiber void corrugated fiberboard. Joints shall be sealed with a moisture resistant tape having a minimum width of 75 mm 3 inches. If voids are destroyed or damaged and are not capable of supporting the design load, they shall be replaced prior to placing of concrete.

3.1.3 Fiber Void Retainers

Fiber void retainers shall be installed, continuously, on both sides of

fiber voids placed under grade beams in order to retain the cavity after the fiber voids biodegrade.

3.2 CHAMFERING

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated 300 mm twelve inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 FORM REMOVAL

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NOTES: For unsupported concrete, form removal is based upon a minimum time requirement of 24 hours. As an option, form removal may be allowed between 18 hours and 24 hours after placement. In this case, form removal is based upon a minimum time (18 hours), minimum ambient temperature (10 degrees C (50 degrees F)), and minimum compressive strength requirement. For supported concrete, form removal is based solely upon a minimum compressive strength requirement.

An experienced concrete materials engineer or [_____] should be consulted before allowing the use of the maturity concept instead of compressive strength test on field cured cylinders.

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Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the [minimum time] [,] [or] [minimum compressive strength] [,] [or] [minimum time, minimum ambient temperature, and minimum compressive strength] requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will

prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Form removal shall be scheduled so that all necessary repairs can be performed as specified in Section [[_____]] [_____], paragraph [_____]. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C31/C31M and ASTM C39/C39M at the expense of the Contractor by an independent laboratory that complies with ASTM C1077 and shall be tested within 4 hours after removal from the site.[After obtaining approval, the Contractor may use maturity instrumentation instead of control cylinders to determine the compressive strength of the concrete. ASTM C1074 procedures shall be used for estimating concrete strength by means of the maturity method. All expenses associated with instrumenting the concrete and evaluating the strength using maturity relationships shall be the responsibility of the Contractor.]

3.4.1 Formwork Not Supporting Weight of Concrete

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NOTES: If form removal is to be allowed before 24 hours, the concrete must have sufficient strength to resist damage from the removal operation. A minimum of 3.5 MPa (500 psi) is recommended.

If the bracketed sentences below are deleted from the project specification, the corresponding submittal requirements for the evaluation and results of control cylinder tests [or maturity instrumentation] should also be deleted from paragraph SUBMITTALS.

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Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed.[Form removal before 24 hours will be allowed for simple floor slab, sidewalks, and driveways provided the ambient temperature during this period has not fallen below 10 degrees C50 degrees F at any time since placement and evidence from compressive tests on field-cured concrete control cylinders [or maturity instrumentation] indicate[s] that the concrete has attained a compressive strength of at least [_____] MPa psi. Control cylinders shall be prepared for each set of forms to be removed before 24 hours. The stability of the concrete shall be evaluated by a structural engineer prior to removal of the forms.] If forms are to be removed in less than 24 hours on formwork not supporting the weight of concrete, submit the evaluation and results of the control cylinder tests[or maturity instrumentation] shall be submitted to and approved before the forms are removed.

3.4.2 Formwork Supporting Weight of Concrete

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NOTE: ACI 347 suggests that at least 70 percent of the design strength should be achieved before

removal of formwork support from horizontal members, unless otherwise approved by the Contracting Officer. (ACI 347, paragraph 3.7.2.1) When specifications are being prepared, a structural engineer should determine the actual minimum percentage of design strength that should be achieved for the specific conditions on each structure.

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Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, forms shall be left in place until control concrete test cylinders [or maturity instrumentation] indicate evidence the concrete has attained at least [_____] percent of the compressive strength required for the structure in accordance with the quality and location requirements.

3.4.3 Tunnel Forms

Tunnel lining bulkhead forms shall not be removed in less than 12 hours and tunnel lining forms in not less than 16 hours.

3.5 INSPECTION

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing. Submit field inspection reports for concrete forms and embedded items.

TABLE 1
TOLERANCES FOR FORMED SURFACES

1. Variations from the plumb:	
a. In the lines and surfaces of columns, piers, walls and in arises	6 mm in any 3 m1/4 inch in any 10 feet of length Maximum for entire length -- 25 mm1
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	6 mm in any 6 m1/4 inch in any 20 feet of length Maximum for entire length -- 13 mm 1/2 inch
2. Variation from the level or from the grades indicated on the drawings:	
a. In slab soffits, ceilings beam soffits, and in arises,measured before removal of supporting shores	6 mm in any 3 m1/4 inch in any 10 feet of length 10 mm3/8 inch in any bay or in any 6 m20 feet of length Maximum for entire length -- 20 mm 3/4 inch
b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	6 mm1/4 inch in any bay or in any 6 m20 feet of length Maximum for entire length -- 13 mm 1/2 inch

TABLE 1 TOLERANCES FOR FORMED SURFACES	
3. Variation of the linear building lines from established position in plan	13 mm in any 6 m1/2 inch in any 10 feet 25 mm1 inch maximum
4. Variation of distance between walls, columns, partitions	6 mm per 3 m1/4 inch per 10 feet of distance, but not more than 13 mm 1/2 inch in any one bay, and not more than 25 mm1 inch total variation
5. Variation in the sizes and locations of sleeves, floor openings, and wall opening	Minus 6 mm1/4 inch, Plus 13 mm1/2 inch
6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 6 mm1/4 inch, Plus 13 mm1/2 inch
7. Footings:	
a. Variation of dimensions in plan	Minus 13 mm1/2 inch, plus 50 mm2 inches when formed or plus 75 mm3 inches when placed against unformed excavation
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 50 mm2 inches
c. Reduction in thickness	Minus 5 percent of the specified thickness
8. Variation in steps:	
a. In a flight of stairs	Riser -- 3 mm1/8 inch Tread -- 6 mm1/4 inch
b. In consecutive steps	Riser -- 2 mm1/16 inch Tread -- 3 mm1/8 inch

-- End of Section --