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NAVFAC **IGS-03300 (JANUARY 2003)**

Supercedes IGS-03300(07/02)

Preparing Activity: LANTNAVFACENGCOM **Based on UFGS-03300N**

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

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SECTION 03300

CAST-IN-PLACE CONCRETE

01/03

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NOTE: This guide specification is issued by the Atlantic Division, Naval Facilities Engineering Command for regional use in Italy.

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NOTE: This guide specification covers requirements for cast-in-place concrete.

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NOTE: The following information shall be shown on the project drawings:

1. Loading assumptions.

2. Assumed temperature range when temperature stresses are a factor in design.

3. Material strengths used in design, fckcyl and fckcube.

4. Details of concrete sections, showing dimensions, reinforcement cover, and required camber.

5. Locations where structural lightweight concrete or lightweight insulation or fill concrete will be used.

6. Details which require a depressed structural slab for static-disseminating and spark-resistant tile, terrazzo, or other floor finishes in order to provide finished surfaces at the same elevations.

7. When exposed concrete surfaces are specified, the locations in the finished structure shall be indicated. If other than cast finish is required,

the type and location shall be indicated.
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SPECIFIERS NOTE: Rck is the 28 day compressive strength determined by testing a 150 mm cube of concrete. The 28 day compressive strength (fckcyl) determined by testing a 150 mm by 300 mm cylinder of concrete is 80 percent of the cube strength (fck=0.8 Rck). Common classes of concrete in Italy are as follows:

Class	**fck**	**Rck**
C12/15	**12**	**15**
C16/20	**16**	**20**
C10/25	**20**	**25**
C25/30	**25**	**30**
C30/37	**30**	**37**
C35/45	**35**	**45**
C40/50	**40**	**50**
C45/55	**45**	**55**
C50/60	**50**	**60**

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Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the technical proponents**, including their organization designation and telephone number, is on the Internet.**

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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PART 1   GENERAL

1.1   REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1854	(1996) Jet-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type

CORPS OF ENGINEERS (COE)

COE CRD-C-572	(1974) Polyvinylchloride Waterstop

EUROPEAN PRESTANDARD (ENV) (PR)

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NOTE: An ENV or PR is a European Prestandard which is an EN (European Standard) which is in transition. The transition period is usually 5 years and the availability of the document at national levels is left to the European community members. It should be made available in an appropriate form and its existence announced in the same way as that for an EN. The specifier shall review each norm listed and verify if it has been deleted.

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ENV 1170-8	(1998) Test method for glass-fibre reinforced cement - Cyclic weathering type test
UNI EN 1170-5	(2001) Precast concrete products - Test method for glass-fibre reinforced cement - Measuring bending strength, "Complete bending test" method

ITALIAN LAWS AND NORMS (D.M.)(LAW)(CIRC.)

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NOTE: Italian laws and normatives are the legislative regulations and decrees issued by the Italian government in the form of laws, norms, decrees, circulars, and letters. These Laws and Decrees concur together with Norms and Standards in forming the governing directives for construction.

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Law 595	(26 May 1965) Technical characteristics for hydraulic binders
Law 1086	(5 November 1971; Rev. 1983) Technical norms for the calculations, executions and testing of norms and prestressed

	reinforced concrete structures and metal structures
D.M. 9/1/96	(9 January 1996) Technical norms for the design, execution and testing of cast-in-place reinforced concrete, pre-cast prestressed reinforced concrete and steel structures
D.M. 16/1/96	Technical norms relative to general criteria for building safety verification and for loads and superimposed loads
C.M. 252	(15 October 1996) Technical Norms for the acception and modality of cement testing
D.M. 314	(12 July 1999) Regulation describing norms for the release of certification of compliance of cements to be used in structural and geotechnical engineering works for which it is mandatory the conformity of requirements n. 1 as per attached and stability of DMPR 246, 21 April 1993
A.I.T.E.C.	(20 September 2000) Italian Cement Association

ITALIAN NATIONAL ASSOCIATION FOR UNIFICATION OF STANDARDS (UNI)

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NOTE: A UNI Norm is a technical normative recognized as Italian Law, submitted by a private organization "Ente Nazionale Italiano di Unificazione" for Italy and is available only in the Italian language. It is the National Standard.

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UNI 5294	(1978) Mechanical tests of ferrous material - Reverse bend test for steel wires
UNI 5575	(1965) Plasticized PVC sheets - Requirements
UNI 6127	(1998) Concrete specimens for strength tests - Making and curing
UNI 6130-1	(1980) Concrete specimens for mechanical resistance tests - Form and sizes
UNI 6130-2	(1980) Concrete specimens for mechanical resistance tests - Moulds

UNI 6132	(1972) Destructive tests of concretes - Compression test
UNI 6394-1	(1983) Density of concrete - Determination on fresh concrete
UNI 6394-2	(1983) Density of concrete - Determination on hardened concrete
UNI 6395	(1972) Volumetric determination by pressure of air content in freshly mixed concrete
UNI 7548-1	(1992) Lightweight concrete by expanded clay or shale - Definition and classification
UNI 7549-1	(1976) Lightweight aggregates - Definition, classification and grading
UNI 7549-2	(1976) Lightweight aggregates - Visual identification of expanded shales and clays
UNI 7549-3	(1976) Lightweight aggregates - Sieve or screen analysis
UNI 7549-4	(1976) Lightweight aggregates - Determination of the bulk unit weight
UNI 7549-5	(1976) Lightweight aggregates - Determination of the unit weight of particle
UNI 7549-6	(1976) Lightweight aggregates - Determination of the water absorption coefficient
UNI 7549-7	(1976) Lightweight aggregates - Determination of strength of particles
UNI 7549-8	(1976) Lightweight aggregates - Determination of the potential degree of staining
UNI 7549-9	(1976) Lightweight aggregates - Determination of the loss on ignition
UNI 7549-10	(1976) Lightweight aggregates - Determination of the freezing resistance
UNI 7549-11	(1976) Lightweight aggregates - Determination of the soundness by autoclave test

UNI 7549-12	(1976) Lightweight aggregates - Evaluation of the properties by standard lab concrete tests
UNI 8520-1	(1999) Aggregates for use in concretes - Definition, classification and properties
UNI 8520-2	(1997) Aggregates for use in concretes - Requirements
UNI 8520-7	(1984) Aggregates for use in concretes - Determination of the sieved at 0,075 UNI 2332
UNI 8520-8	(1999) Aggregates for use in concretes - Determination of clay lumps and friable particles
UNI 8520-13	(1984) Aggregates for use in concretes - Determination of density and water absorption of fine aggregates
UNI 8520-15	Aggregates for use in concretes - Determination of the equivalent in sand
UNI 8520-16	Aggregates for use in concretes - Determination of density and water absorption of coarse aggregates. (hydrostatic balance and cylinder methods)
UNI 8520-17	(1984) Aggregates for use in concretes - Compression test of coarse aggregates
UNI 8520-21	(1999) Aggregates for use in concretes - Comparison in concrete with aggregates of known characteristics
UNI 8520-22	(1999) Aggregates for use in concrete - Determination of potential reactivity of alcali in aggregates
UNI 8656/FA-219	(1984/87) Liquid membrane-forming compounds for the protection of the concrete during the maturation - Classification and requirements
UNI 8926	(1986) Steel wires to be used in manufacturing of electrically welded fabrics and lattice girders for the reinforcment of concrete
UNI 8927	(1986) Electrically welded steel fabrics and lattice girders for the reinforcement of concrete

UNI 9418	(1998) Fresh concrete - Determination of consistency - Slump test
UNI 9858	(1991) Concrete - Performance, production, placing and compliance criteria
UNI 10622	(1997) Zinc-coated (galvanized) steel bars and wire rods for concrete reinforcement
UNI 10765	(1999) Admixtures for concrete - Multifunctional admixtures for concrete - Definitions, requirements and conformity criteria

ITALIAN/EUROPEAN HARMONIZATION STANDARDS (UNI EN)(UNI ENV)(CEI EN) (UNI EN ISO)(UNI ISO)

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NOTE: A UNI EN, UNI ENV, CEI EN, UNI EN ISO or UNI ISO is a European Standard with a coincident Italian National Standard or International Standard. The two standards are identical, with most (but not all) EN's available in the English language and the UNI available only in the Italian language.

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UNI EN 196-1	(1996) Methods of testing cement - Determination of strength
UNI EN 196-2	(1996) Methods of testing cement - Chemical analysis of cement
UNI EN 196-3	(1996) Methods of testing cement - Determination of setting time and soundness
UNI EN 196-4	Methods of testing cement - Quantitative determination of constituents
UNI EN 196-5	(1996) Methods of testing cement - Pozzolanicity test for pozzolanic cements
UNI EN 196-6	(1991) Methods of testing cement - Determination of fineness
UNI EN 196-7	(1991) Methods of testing cement - Methods of taking and preparing samples of cement
UNI EN 196-21	(1991) Methods of testing cement - Determination of the chloride, carbon dioxide and alkali content of cement
UNI EN 197-1	(2001) Cement - Part 1: Composition,

	specifications and conformity criteria for common cements
UNI EN 197-2	(2001) Cement - Part 2: Conformity evaluation
UNI EN 206-1	(2001) Concrete - Part 1: Specification, performance, production and conformity
UNI EN 450	(1995) Fly ash for concrete - Definitions, requirements and quality control
UNI EN 451-1	(1996) Method of testing fly ash - Determination of free calcium oxide content
UNI EN 451-2	(1994) Method of testing fly ash - Part 2: Determination of fineness by wet sieving
UNI EN 480-4	(1996) Admixtures for concrete, mortar and grout - Test methods - Part 4: Determination of bleeding of concrete.
UNI EN 932-3	(1998) Tests for general properties of aggregates - Part 3: Procedure and terminology for simplified petrographic description
UNI EN 934-2	(2002) Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions and requirements
UNI EN 1367-1	(2001) Test for thermal and weathering properties of aggregates - Determination of resistance to freezing and thawing
UNI EN 1367-2	(2001) Test for thermal and weathering properties of aggregates - Magnesium sulfate test
UNI EN 1521	(1996) Determination of flexural strength of lightweight aggregate concrete with open structure
UNI EN 1744-1	(1999) Tests for chemical properties of aggregates - Part 1: Chemical analysis.
UNI CNR 10020	(1971) Beam test on steel bars
UNI ENV 10080	(1997) Steel for the reinforcement of concrete - Weldable ribbed reinforcing steel B 500 - Technical delivery conditions for bars, coils and welded fabric

UNI ISO 10287	(1995) Steel for reinforcment of concrete - Determination of strength of joints in welded fabric
UNI EN 12350-1	(2001) Testing fresh concrete - Part 1: Sampling
UNI EN 12350-7	(2002) Testing fresh concrete - Air content - Pressure methods
UNI EN 13055-1	(1997) Lightweight aggregates - Part 1: Lightweight aggregates for concrete and mortar
SS UNI U50.00.206.0	Formworks - General requirements for design, construction and use

1.2 DEFINITIONS

a. "Cementitious material" as used herein shall include all Portland cement, pozzolan, fly ash, ground iron blast-furnace slag, and [silica fume].

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item is required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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. Recommended codes for Army projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval.

Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Reinforcing steel; G

[Formwork]

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Materials for curing concrete

Joint sealants

Joint filler

Vapor retarder

Liquid chemical sealer-hardener compound

Polypropylene forms

Pour stops

Admixtures

Reinforcing Bars

[Epoxy bonding compound]

[Synthetic reinforcing fibers]

[Waterstops]

SD-04 Samples

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NOTE: Where flat surface finishing is important and the crew inexperienced in this type of concrete, ask for a sample installation to train the crew.

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[Slab finish sample]

SD-05 Design Data

Formwork calculations

Concrete mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, [silica fume], ground slag [synthetic reinforcing fibers], and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. No material shall be provided unless proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. The submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes.

SD-06 Test Reports

Concrete mix design; G

Fly ash

Pozzolan

Ground iron blast-furnace slag

Compressive strength tests

Reinforcing Bars

[Aggregates]

[Fiber-reinforced concrete]

[Tolerance report]

[Unit weight of structural lightweight concrete]

[Ion concentration]

[SD-07 Certificates

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NOTE: Include following paragraphs when job complexity justifies the additional cost associated

with these requirements.
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[Pumping concrete]

[Silica fume manufacturer's representative]

[Finishing plan]

[Form removal schedule]

]1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with UNI 9858, D.M. 314 and A.I.T.E.C. except as modified herein.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor retarder, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. D.M. 9/1/96 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground [to avoid excessive rusting]. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 Quality Assurance

1.6.1 Design Data

1.6.1.1 Formwork and Shoring Calculations

Include design calculations indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components. Furnish drawings and calculations of shoring and reshoring methods proposed for floor and roof slabs, spandrel beams, and other horizontal concrete members.Calculations shall comply with Law 1086, D.M. 9/1/96 and D.M. 16/1/96, or the latest updated revision. Calculations shall be signed by a registered professional engineer.

1.6.2 Drawings

[1.6.2.1 Formwork

Drawings showing details of formwork including; joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

]1.6.2.2 Reinforcing Steel

Provide drawings that indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

[1.6.3 Control Submittals

[1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal shall include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete will be pumped.

][1.6.3.3 Silica Fume Manufacturer's Representative

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NOTE: A pre-construction meeting with the concrete supplier, contractor, finisher, admixture supplier, and ROICC should be required for projects which require silica fume, corrosion inhibitors, or high-range water reducers (superplasticizers). An initial sample pour with the proposed concrete mix and methods of placing, finishing and curing may be beneficial to ensure concrete quality.

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Provide statement that the manufacturer's representative will be present at mix plant to ensure proper mix, including high range water reducer, and batching methods during the first 3 [_____]days of concrete mix preparation and placement. After which the manufacturer's representative shall designate a representative at the concrete producer's plant to ensure the concrete mix procedures meet the silica fume manufacturer's recommendations. [Representative to attend and advise at finishing of sample slab.]

][1.6.3.4 Finishing Plan

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NOTE: Include when finishing or special flatness are critical.

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The Contractor shall submit proposed materials and procedures to be used in obtaining the finish for the [_____] floors. Include qualification of person to be used for obtaining floor tolerance measurement, description measuring equipment to be used, and sketch showing lines and locations the measuring equipment will follow.

]1.6.3.5 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of

time for form removal.

]1.6.4 Test Reports

1.6.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other tests for cement, [silica fume,] aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Obtain approval before concrete placement.

1.6.4.2 Fly Ash and Pozzolan

UNI EN 196-5. Submit test results in accordance with UNI EN 450 for fly ash and D.M. 9/1/96 for pozzolan. Submit test results performed within 6 months of submittal date.

1.6.4.3 Ground Iron Blast-Furnace Slag

Submit test results in accordance with UNI EN 450 for ground iron blast-furnace slag. Submit test results performed within 6 months of submittal date.

[1.6.4.4 Aggregates

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NOTE: Require aggregate quality testing on large concrete projects, where concrete is exposed to seawater, alkali soils, moist conditions, or the quality of the aggregates is questionable.
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UNI 8520-22 for potential alkali-silica reactions and UNI EN 932-3 for petrographic analysis.

][1.6.4.5 Fiber-Reinforced Concrete

Test to determine durability of glass-fiber reinforced cement in accordance with ENV 1170-8. Test flexural strength in accordance with UNI EN 1170-5.

]1.6.4.6 Reinforcing Bars

Submit steel strength test reports showing that steel meets the minimum tensile strength requirements indicated on construction documents. Test shall be conducted in accordance with UNI 5294, D.M. 9/1/96 and UNI CNR 10020.

[1.6.5 Field Samples

1.6.5.1 Slab Finish Sample

Install minimum of 3000 mm by 3000 mm slab. Finish as required by specification. [Silica fume manufacturer's representative shall attend and advise.]

]PART 2 PRODUCTS

2.1 SOURCE MANUFACTURERS

At the contractor's option, manufacturers other than those listed will be permitted, provided that their products are in compliance with all the requirements specified herein.

2.1.1 Concrete

The following manufacturers provide concrete that generally comply with these specifications:

BUZZI UNICEM S.p.a.
Via Luigi Buzzi, 6
15033 Casale Monferrato
Tel. 01 42433.411
Fax. 01 42433.464
WEB: www.buzziunicem.it

ITALCEMENTI
Via A. Guerini, 5
48100 Ravenna
Tel. 0544 514511
Fax 0544 514634
WEB: www.calcestruzzi.it

UNI Calcestruzzi S.p.A.
Via C. Massaia, 71
10147 Torino
Tel. 011 2971111
Fax 011 3958814
E-mail: mbergamini@unicalcestruzzi.it

2.1.2 Materials for Curing Concrete

The following manufacturers make concrete curing materials that generally comply with these specifications:

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. 02 376731
Fax 02 37673214

MPM S.p.A.
Via S. Cristoforo, 84

00100 Roma
Tel. 06 51958288
Fax 06 51958330
E-mail: antoniodemastri@tiscalinet.it
WEB: www.mpmspa.com

2.1.3 Joint Sealants

The following manufacturers make joint sealant materials that generally comply with these specifications:

JOINT
Via del Vivaio, 15
40132 Bologna
Tel. 051 400086
Fax 051 400398

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. 02 376731
Fax 02 37673214

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. 02 721261
Fax 02 870571
E-mail: info@sika.it

2.1.4 Liquid Chemical Sealer-Hardener Compound

The following manufacturers make sealer-hardener materials that generally comply with these specifications:

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. 02 721261
Fax 02 870571
E-mail: info@sika.it

MPM S.p.A.
Via S. Cristoforo, 84
00100 Roma
Tel. 06 51958288
Fax 06 51958330
E-mail: antoniodemastri@tiscalinet.it
WEB Site: www.mpmspa.com

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. 02 376731

Fax 02 37673214

PROIND S.r.l.
Via Fornace Cavallino, 13/15
20090 Opera (MI)
Tel. 02 57602651
Fax. 02 57606357

2.1.5 Wood/Metal Forms

The following manufacturers make wood/metal form materials that generally comply with these specifications:

ATLAS
Via Artigianato, 28
50100 Firenze
Tel. (055) 820406

DIDOR ITALIA S.r.l.
Via Canale, 37
66010 Torrevecchia Teatina
Chieti - Italy
Tel. 0871 362528
Fax. 0871 362529

EDILSABRI
Via Bocca di Cave, 7
00131 Roma
Tel. (06) 4131504
Fax (06) 4131731

TECNOTRANC S.r.l.
Via Padova, 46
21040 Oggiona S. Stefano (VA)
Tel. (0331) 734560
Fax (0331) 734575

2.1.6 Epoxy Bonding Compound

The following manufacturers make epoxy bonding materials that generally comply with these specifications:

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. (02) 376731
Fax (02) 37673214

MPM S.p.A.
Via S. Cristoforo, 84
00100 Roma
Tel. (06) 51958288
Fax (06) 51958330
E-mail: antoniodemastri@tiscalinet.it

WEB Site: www.mpmspa.com

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. (02) 721261
Fax (02) 870571
E-mail: info@sika.it

2.1.7 Waterstops

The following manufacturers make waterstop materials that generally comply with these specifications:

JOINT
Via del Vivaio, 15
40132 Bologna
Tel. (051) 400086
Fax (051) 400398

PROIND S.r.l.
Via Fornace Cavallino, 13/15
20090 Opera (MI)
Tel. 02 57602651
Fax. 02 57606357

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. (02) 721261
Fax (02) 870571
E-mail: info@sika.it

W.R. GRACE ITALIANA S.p.a.
Via Trento, 7
20017 Passirano di Rho- Milano
Tel. 3902 93537 531
Fax. 3902 93537 516

2.1.8 Grout and Leveling Compound

The following manufacturers make grout and leveling compound materials that generally comply with these specifications:

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. (02) 376731
Fax (02) 37673214

MPM S.p.A.
Via S. Cristoforo, 84
00100 Roma
Tel. (06) 51958288

Fax (06) 51958330
E-mail: antoniodemastri@tiscalinet.it
WEB Site: www.mpmspa.com

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. 02 721261
Fax 02 870571
E-mail: info@sika.it

2.1.9 Admixtures

The following manufacturers make concrete admixtures that generally comply with these specifications:

MAPEI S.p.A.
Via Cafiero, 22
20158 Milano
Tel. (02) 376731
Fax (02) 37673214

SIKA ITALIA S.p.A.
Via E. De Amicis, 44
20123 Milano
Tel. 02 721261
Fax 02 870571
E-mail: info@sika.it

2.1.10 Vapor Retarder

The following manufacturer makes vapor retarder material that generally complies with these specifications:

ITALDRENI S.r.l.
Via Papa Giovanni XXIII, 14
42020 S. Polo d'Enza (RE)
Tel. 39 0522 244211
Fax. 39 0522 244244
WEB: www. italddreni.it

2.1.11 Welded Wire Fabric

The following manufacturers make welded wire fabric reinforcing that generally comply with these specifications:

ACTIS FURIO S.r.l.
Via Valbrona 3, C.P.
20125 Milano
Tel. 6435751/2-6432648
Fax. 66100186

PITTINI
IMPIANTI INDUSTRIALI S.p.a.

Osoppo/Ud
Tel. 0432/981811
Fax. 0432/981810
WEB: www.pittini.it

2.1.12 Polypropylene Forms

The following manufacturer makes polypropylene form products that generally comply with these specifications:

DALIFORM S.r.l
Via Montereale, 75
33170 Pordenone
Tel. 0434.554310
Fax. 0434.365633

2.1 MATERIALS FOR FORMS

Provide wood, plywood, polypropylene, or steel. Use plywood or steel forms where a smooth form finish is required. Lumber shall be square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Steel and polypropylene form surfaces shall not contain irregularities, dents, or sags. Formwork shall comply with SS UNI U50.00.206.0 .

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Form ties and accessories shall not reduce the effective cover of the reinforcement.

[2.2.1 Polyvinylchloride Waterstops

COE CRD-C-572.

][2.2.2 Dovetail Anchor Slot

Preformed metal slot approximately 25 by 25 mm of not less than 0.864 mm galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

]2.3 CONCRETE

2.3.2 Contractor-Furnished Mix Design

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NOTE: For concrete exposed to weather or special exposure conditions, leave in optional column(s) for air entrainment and water-cement ratio. When specifying air entrainment give one number and allow variation of 1.5 percent on either side.

Maximum aggregate size should not exceed:

1. 1/5 the dimension of nonreinforced members.

2. 3/4 the clear spacing between reinforcing bars or between reinforcing bars and forms.

3. 1/3 the depth of nonreinforced slabs on the ground.

CONCRETE FOR FLOORS (UNI 9858): The following criteria applies only when structural or durability requirements do not necessitate higher strengths:

Class	Usual Traffic	Typical Uses	[28 day Max. Str. MPa	Slump mm
1	Light foot	Residential or tile covered	20	100
2	Foot	Offices, churches, schools, hospitals, residences	24	100
3	Light foot & pneumatic wheels	Drives, garage floors, and sidewalks for residence	25	100
4	Foot and pneumatic wheels	Light industrial, commercial	30	75
5	Foot & wheels abrasive wear	Single-course industrial, integral topping	35	75
6	Foot & steel-tire vehicles - severe abrasion]	Two-course heavy industrial topping	D.M. 9/1/96	

GUIDELINES FOR CONCRETE NOT EXPOSED TO SEVERE CONDITIONS FOR MAXIMUM WATER-CEMENT RATIO:

Compressive Strength	Without AE	With AE
20 MPa	0.58	0.50
25 MPa	0.54	0.48
30 MPa	0.50	0.45

AE= air-entrainment

REQUIREMENTS FOR SPECIAL EXPOSURE CONDITIONS (UNI 9858 and D.M. 9/1/96):

Exposure Condition	Max. Water-Cement Ratio (Normal Weight Aggregate)
Concrete intended to be watertight:	
(a) Concrete exposed to fresh water	**0.50**
(b) Concrete exposed to brackish water or seawater	**0.45**
Concrete exposed to freezing and thawing in moist conditions:	
(a) Curbs, gutters, guardrails, or thin sections	**0.45**
(b) Other elements	**0.50**
(c) In presence of deicing chemicals	**0.45**
For corrosion protection for reinforced concrete exposed to deicing salts, brackish water, seawater, or spray from these sources:	
(a) Min. concrete cover per	**0.40**
(b) UNI 9858 cover exceeded by 13 mm	**0.45**

****

Law 1086, D.M. 9/1/96, C.M. 252, and Law 595 [including UNI 7548-1]except as otherwise specified. The compressive strength (Rck) of the concrete for each portion of the structure(s) shall be as indicated [and as specified below].

Location	UNI EN 206-1 Rck (Min. 28-Day Comp. Strength) (MPa)	UNI 8520-1 UNI 9418 Maximum Nominal Aggregate (mm)	Range of Slump (mm)	[Maximum Water-Cement Ratio] (by weight)	[Air Entr.] (percent)
[All areas]	C20/25	[_____]	[_____]	[_____]	[_____]
Concrete exposed to weather	C20/25	25	50-100	0.50	[6]
All other areas	[_____]	[_____]	[_____]	[_____]	[_____]
Plain footings, caissons, and substructure walls	C20/25	20	50-100	0.50	[_____]

Location	UNI EN 206-1 Rck (Min. 28-Day Comp. Strength) (MPa)	UNI 8520-1 UNI 9418 Maximum Nominal Aggregate (mm)	Range of Slump (mm)	[Maximum Water-Cement Ratio] (by weight)	[Air Entr.] (percent)
Beams and reinforced walls	C30/37	20	50-100	0.50	[_____]
Building columns	C35/45	20	50-100	0.45	[_____]
Pavement and exterior slabs	C20/25	25	50-100	0.50	[_____]
Floor slabs	C20/25	20	50-100	0.50	[_____]
Floor toppings	C20/25	25	50-100	0.50	[_____]
Walks, curbs, and gutters	C20/25	25	50-100	0.50	[_____]
Utility structures	C20/25	25	50-100	0.50	[_____]
Drainage structures	C20/25	25	50-100	0.50	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

****

NOTE: Chlorides can cause corrosion of reinforcement. Use 0.15 for reinforced concrete exposed to chlorides in service, 1.00 for reinforced concrete that is dry or protected from moisture in service, and 0.30 for other reinforced concrete.

****

Maximum slump shown above may be increased 25 mm for methods of consolidation other than vibration. Slump may be increased to 200 mm when superplasticizers are used. [Provide air entrainment using air-entraining admixture. Air entrainment shall be within plus or minus 1.5 percent of the value specified.] [The water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days shall not exceed [0.15] [1.00] [0.30]]. For composite cements, use 25 to 35 percent (by weight) fly ash or pozzolan, 40 to 50 percent GGBF slag or a combination that is approved by the Contracting Officer.

2.3.2.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with UNI 6130-1, UNI 6130-2 and UNI 6127 and tested in accordance with UNI 6132. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and [air content] suitable for the work shall be made based on methodology described in UNI EN 206-1. The trial mixture shall use at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required will be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus fly ash, pozzolan,[silica fume,] and ground granulated blast-furnace slag by weight equivalency method. Laboratory trial mixture shall be designed for maximum permitted slump and air content. Each combination of material proposed for use shall have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with UNI 6130-1, UNI 6130-2 and UNI 6127 and tested in accordance with UNI 6132 for 7 and 28 days. From these results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition a curve shall be plotted showing the relationship between 7 and 28 day strengths.

[2.3.2.2 Lightweight Concrete Proportion

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NOTE: Check with structural designer for unit weight of concrete. UNI EN 1521 provides recommendations for lightweight concrete.

****

UNI 7548-1, using weight method. Provide UNI 7549-1 aggregates for concrete; 2000 [____] kg/cu. m (dry) for floors with a [_____] MPa minimum compressive strength at 28 days. Provide aggregate size of [_____] mm. Range of slump shall be between [_____] and [_____] mm. [Provide [_____] percent air entrainment using an air-entraining admixture.] [Maximum water-cement ratio shall be [_____].]

]2.3.2.3 Required Average Strength of Mix Design

The selected mixture shall produce an average compressive strength exceeding the specified strength by the amount indicated in UNI 9858 and UNI EN 206-1. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation shall be calculated and the required average compressive strength shall be determined in accordance with D.M. 9/1/96 and UNI EN 206-1, using x >/= fck + 1.48 Sn and x min >/= fck-4. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength

shall be as follows:

a. x_3.

a. x_{min}.

2.4 MATERIALS

****

NOTE: UNI EN 197-1 and UNI EN 197-2 cover 27 products in the family of common cements. They are grouped into five main cement types (refer to Table 1 of UNI EN 197-1).

The following are acceptable for use:

1. CEM I - Portland cement.

2. CEM II - Portland composite cement that includes the types:

CEM II/A-S, CEM II/B-S	**Portland-slag cement**
CEM II/A-D	**Portland-silica fume cement**
CEM II/A-P, CEM II/B-P, CEM II/A-Q, CEM II/B-Q	**Portland-pozzolan cement**
CEM II/A-V, CEM II/B-V	**Portland-fly ash cement**

The following are acceptable for use with restrictions on constitutant materials or material percentages:

1. CEM II - Portland composite cement that includes the types:

CEM II/A-M, CEM II/B-M	**Portland-composite cement**

2. CEM III - Blast furnace cement, type CEM III/A

3. CEM IV - Pozzolanic cement, type CEM IV/A

4. CEM V - Composite cement, type CEM V/A

The following <u>are not acceptable</u> for use:

1. CEM II - Portland composite cement that includes the types:

CEM II/A-W, CEM II/B-W	**Portland-fly ash cement**

CEM II/A-T, CEM II/B-T Portland-burnt shale cement

CEM II/A-L, CEM II/B-L,
CEM II/A-LL, CEM II/B-LL Portland-limestone cement

2. CEM III - Blast furnace cement, that includes the types:

CEM III/B, and CEM III/C

3. CEM IV - Pozzolanic cement, type CEM IV/B

4. CEM V - Composite cement, type CEM V/B

****

2.2.1 Cementitious Material

"Cementitious Material" as used herin shall include all portland cement, fly ash, pozzolan[, silica fume] and ground granulated blast-furnace slag.

2.2.1.1 Cement

UNI EN 197-1 and UNI EN 197-2, with maximum alkali content of 0.60 percent. Cement certificates shall include test results in accordance with UNI EN 197-1 and UNI EN 197-2, including Equivalent Alkalies. Blended and composite cements shall contain a minimum of 50 percent portland cement by weight of total cementitious materials.[Cement shall be high early strength cement, (Class R).] Cement sampling and testing to verify the compliance of the product with the codes cited above shall be carried out as specified in UNI EN 196-1, UNI EN 196-2, UNI EN 196-3, UNI EN 196-4, UNI EN 196-5, UNI EN 196-6, UNI EN 196-7 and UNI EN 196-21.

2.2.1.2 Fly Ash

UNI EN 206-1 and UNI EN 450, Type (V) Siliceous fly ash, except that the maximum allowable loss on ignition shall be 6 percent and maximum available alkalies shall be 1.5 percent. The maximum allowable calcium oxide (CaO) content shall be 8 percent, as tested in accordance with UNI EN 451-1 and UNI EN 451-2. Fly ash certificates shall include test results in accordance with UNI EN 206-1 and UNI EN 450 including Available Alkalies. Type (W) Calcareous fly ash shall not be used.

2.2.1.3 Pozzolan

UNI EN 196-5 and UNI EN 197-1.

2.2.1.4 Ground Granulated Blast-Furnace Slag

Law 595 and UNI EN 197-1.

[2.2.1.5 Silica Fume

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NOTE: Use silica fume concrete for marine structures where low permeability and enhanced durability are necessary. The silica fume and high range water reducer additive should be from the same manufacturer. Select weight percentage based-on performance required.
****

****
NOTE: Use for high durability and low permeability. The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume, the slump can be increased 50 to 125 mm without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.
****

****
NOTE: Undispersed lumps (40 micrometers to 800 micrometers) of silica fume can react with cement alkalis just like reactive aggregates. Care should be taken when specifying silica fume. Avoid specifying silica fume in favor of other pozzolanic materials when contractor quality control is questionable.
****

Law 595 and UNI EN 197-1, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide [5] [7.5] [10] percent by weight of the total cementitious material.

]2.2.1.6 Burnt Shale

Burnt shale shall not be used.

2.2.1.7 Limestone

Limestone shall not be used.

2.4.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

****
NOTE: Include the first bracketed item on large concrete projects, where concrete is exposed to

seawater, alkali soils, moist conditions, or the quality of the aggregates is questionable.

When the use of alkali-reactive aggregates is permitted, delete everything after the first two sentences, add the following, and add paragraph entitled "Additional Curing When Using Alkali-Reactive Aggregates" as follows:

"Alkali-reactive aggregates may be used where not exposed to either seawater or alkali soil conditions, and when used with one of the following cements and tested in accordance with UNI 8520 to ensure that a 75 percent minimum reduction of expansion due to alkali-aggregate reaction is provided.

1. C.M. 252 low alkali cement (maximum of 0.60 percent equivalent Na2O).

2. Law 595 blended cement.

3. C.M. 252, low alkali, Class 32.5 MPa Class IV or 42.5 MPa cement with fly ash, pozzolan, or ground slag.

Furnish a mix design utilizing alkali-reactive aggregates with a maximum water-cement ratio of 0.45."

"Additional Curing When Using Alkali-Reactive Aggregates.

Furnish UNI 9858 test results to verify the anticipated rate of strength development for the proposed concrete mix design. Submit an increased curing period and minimum time to strip formwork based upon the reduced rate of strength development."

****

UNI 8520-1 and UNI EN 1744-1, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalies in the cement. [Aggregates shall show expansions less than 0.10 percent at 6 months when tested in accordance with UNI 8520-22 using a cement with an alkali content above 0.8 percent (expressed as sodium oxide), and shall not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with UNI EN 932-3.]

2.5.3.1 Aggregates for Normal Weight Concrete

All aggregates for normal weight concrete shall be as defined in UNI 8520-1. Minimum aggregate property requirements are specified in UNI 8520-2 shall

be verified by testing in accordance with UNI 8520-7, UNI 8520-8, UNI 8520-13, UNI 8520-15, UNI 8520-16, UNI 8520-17, UNI 8520-21, UNI 8520-22, UNI EN 1367-1, and UNI EN 1367-2.

[2.4.3.1 Aggregates for Lightweight Concrete

All aggregates for lightweight concrete as defined in UNI 7548-1 shall comply with UNI 7549-1, UNI EN 1521 and UNI EN 13055-1. Aggregate properties consistent with the requirements specified in UNI 7549-1 shall be verified in accordance with UNI 7549-2, UNI 7549-3, UNI 7549-4, UNI 7549-5, UNI 7549-6, UNI 7549-7, UNI 7549-8, UNI 7549-9, UNI 7549-10, UNI 7549-11 and UNI 7549-12..

]2.4.4 Nonshrink Grout

Law 595.

2.4.5 Admixtures

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NOTE: Do not allow calcium chloride in concrete exposed to saltwater, severe sulfate solutions, or both moisture and chlorides.
****

Addmixtures shall comply with UNI 10765 and UNI EN 934-2. Do not use calcium chloride admixtures.

[2.4.5.1 Air-Entraining

****
NOTE: Use for concrete exposed to freeze-thaw conditions.
****

Provide air entraining admixture for all concrete exposed to the weather. Air entrainment shall be accomplished by the addition of an air entraining admixture to the concrete mix. The air content shall be as follows:

Maximum Aggregate Size	Amount of Air (percent volume of concrete)
25 mm	6 (plus or minus 1.5)
20 mm	7 (plus or minus 1.5)

]2.4.5.2 High Range Water Reducer (HRWR) (Superplasticizers)

UNI 10765 and UNI EN 934-2. Test in accordance with UNI EN 480-4.

2.5.5.3 Accelerating / Retarding

UNI 10765 and UNI EN 934-2.

2.4.6 Vapor Retarder

Polyethylene sheeting, minimum 0.25 mm thickness.

2.4.7 Materials for Curing Concrete

2.4.7.1 Impervious Sheeting

UNI 5575; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Pervious Sheeting

Pervious sheeting shall be burlap cloth.

2.4.7.3 Liquid Membrane-Forming Compound

UNI 8656/FA-219, Liquid membrane-forming compound, white-pigmented, as recommended by the concrete manufacturer.

2.4.8 Liquid Chemical Sealer-Hardener Compound

Compound shall be magnesium fluosilicate which, when mixed with water, seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.4.9 Expansion/Contraction Joint Filler

ASTM D 1751 or ASTM D 1752, 13 mm thick, unless otherwise indicated, or 100 percent recycled material meeting ASTM D 1752, subparagraphs 5.1 and 5.4.

2.4.10 Joint Sealants

2.4.10.1 Horizontal Surfaces, 3 Percent Slope, Maximum

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NOTE: For horizontal surfaces subject to jet fuel, specify two component cold-applied sealant (fast-curing type).
****

ASTM C 920, Type M, Class 25, Use T. ASTM D 1854 for surfaces subjected to jet fuel.

2.4.10.2 Vertical Surfaces Greater Than 3 Percent Slope

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NOTE: Specify ASTM C 920 for vertical surfaces greater than 3 percent slope and not subject to jet fuel, gasoline, fuel oil, etc.
****

ASTM C 920, Type M, Grade NS, Class 25, Use T (elastomeric joint sealants, multi-component, non-sag, traffic use).

2.4.11 Epoxy Bonding Compound

Law 1086 and Law 595 for bonding hardened concrete or freshly mixed concrete to hardened concrete.

[2.4.12 Wood/Metal Forms

Dimensions and thicknesses to be sufficient and fit in order to be suitably stiffened and braced to produce the best result on the concrete surface finishes and structures and precise conformity with the design.

][2.5.13 Polypropylene Forms

Elements shall be polypropylene, modular type, spherical top and with four connected arch jambs. Each element shall conform to the following:

a. Dimension: 500 by 500 mm.

b. Height: [270] [_____] mm.

c. Weight: 1.8 kg.

][2.4.14 Pour Stops

Profile shall consist of "L" shaped plastic foil.

]2.5 REINFORCEMENT

UNI ENV 10080. Reinforcement to be used for construction that will be subject to corrosion due to an aggressive environment or in concrete elements with reduced thickness where it is not possible to guarantee an adequate concrete cover for the reinforcement shall be galvanized in accordance with UNI 10622.

2.5.1 Reinforcing Bars

****
NOTE: UNI ENV 10080 bars are mainly used in seismic design or for welding.
****

UNI ENV 10080, unless otherwise specified. UNI ENV 10080 with the bars marked R, Grade [B500A][B500B].

2.5.2 Mechanical Reinforcing Bar Connectors

Provide 125 percent minimum yield strength of the reinforcement bar.

2.5.3 Welded Wire Fabric

UNI 8926 and UNI 8927. Provide flat sheets of welded wire fabric for slabs

and toppings. Standard fabric shall be manufactured from wire of the same steel in both directions.

2.5.4 Wire

UNI ENV 10080. All welded wires assembled in the field shall be made with wires complying with UNI 8926 and tested for "bend and re-bend" in accordance with UNI 5294. A random sample shall be tested to confirm that welded joint resistance is in accordance with UNI ISO 10287.

2.5.5 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.6 Fiber-Reinforced Concrete

****

NOTE: Only use fiber reinforcement when approved by the designer. Drawings should indicate where fiber reinforced concrete is located. Fiber reinforcing is used to help: control cracking due to plastic shrinkage; reduce permeability; and increase impact capacity; shatter resistance, abrasion resistance, and toughness. Fiber reinforcing will not: control cracking due to structural stresses; significantly increase strength; control curling or creeping; justify reducing structural members; eliminate control joints; or replace any moment or structural steel reinforcement. Include flexural toughness tests when synthetic reinforcement fibers are used to increase toughness and when justified by size and importance of job, but not when fibers are used only to control plastic shrinkage cracking. Include technical representative when warranted by size and importance of job.

****

In addition to the requirements specified above, fiber reinforced concrete shall be provided in accordance with ENV 1170-8, synthetic fiber reinforced concrete, and as follows. Synthetic reinforcing fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 480 MPa, graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. A minimum of 2.6 kg of fibers per cubic meter of concrete shall be used. Fibers shall be added at the batch plant. [Provide the services of a qualified technical representative to instruct the concrete supplier in proper batching and mixing of materials to be provided.]

PART 3 EXECUTION

3.1 FORMS

Provide forms, shoring, and scaffolding for concrete placement. Set forms

mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 20 mm unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water shall be watertight. In order to provide interspace or hollow space between floor slabs and ground level below, polypropylene forms are supported by 110 mm diameter polypropylene pipes of variable height complete with bell end forms to be filled with dry cast-in-place concrete.

3.1.1 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.1.2 Removal of Forms and Supports

After placing concrete, forms shall remain in place for the time periods specified in UNI 9858 and UNI EN 206-1. Prevent concrete damage during form removal. Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for columns and walls, sides of beams and other parts not supporting the weight of the concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation, but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors, and walls until the structural components are strong enough to carry their own weight and any other construction or natural loads. In no case shall supporting forms or shores be removed before the concrete strength has reached at least 70 percent of design strengths as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and strength of the forming and shoring system. The job-cured test specimens for form removal proposed shall be provided in numbers as directed by the Contracting Officer and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent. If the analysis of concrete strength-time relationship is not performed, the forms and shoring supporting the weight of concrete members shall be left in place for a minimum of 14 days after concrete placement, as approved by the Contracting Officer. At his option, the Contracting Officer may increase this period to 21 [28]days.

3.1.2.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if UNI 6132 test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.1.3 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, slabs and beams over 3000 mm in span and cantilevers over 1200 mm shall be reshored for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Reshoring elements shall have the same load-carrying capabilities as original shoring and shall be spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.2 Waterstop Splices

Fusion weld in the field.

3.3 Formed Surfaces

3.3.1 Tolerances

UNI 6130-2 [and as indicated]. The minimum concrete cover for reinforcement specified in the Contract documents takes precedence over all permissible reinforcement-placement variations; nothing in the variations listed below shall be construed as permitting violation or compromise thereof:

a. Height of bottom bars above form: Plus or minus 6 mm.

b. Lengthwise positioning of bars: Plus or minus 50 mm.

c. Spacing bars in walls and solid slabs: Plus or minus 25 mm.

d. Spacing bars in joints, beams, and footings: Minus zero mm or plus 6 mm.

e. Height of top bars: Minus zero mm or plus 6 mm.

f. Stirrup spacing:

1.) For any one stirrup: plus or minus 25 mm

2.) For overall group of stirrups: plus or minus 25 mm.

3.3.2 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used.

3.3.3 Concrete Protection for Reinforcement

Concrete protection for reinforcement shall be as indicated. For areas not specifically indicated, use the following:

a. Concrete deposited against the earth: 80 mm.

b. Concrete deposited against forms and exposed to weather: 40 mm.

c. Concrete deposited against forms and not exposed to weather:

1.) Slabs and walls: 20 mm.

2.) Beams and columns: 40 mm.

d. All other areas: 25 mm.

3.4 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

Law 1086 and D.M. 9/1/96. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement shall not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.4.1 Vapor Retarder

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 300 mm [and tape or cement joints]. Remove torn, punctured, or damaged vapor retarder material and provide with new vapor retarder prior to placing concrete. Concrete placement shall not damage vapor retarder material.

3.4.2 Reinforcement Supports

Law 1086 and D.M. 9/1/96. Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.4.4 Splicing

As indicated. For splices not indicated, comply with D.M. 9/1/96. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 50 mm. Welded splices shall be approvedby the Contracting Officer prior to use.

3.4.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Bolt threads shall match the connector. Countersink the

connector in the concrete. Caulk the depression after the bolt is installed.

3.4.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.4.8 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.4.9 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 13 mm wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints shall be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.5 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

D.M. 9/1/96 and UNI EN 206-1, except as modified herein. Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.5.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.5.2 Mixing

UNI 9858. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. [Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 29 degrees C.] Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 29 degrees C except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions

of the mixer at mixing speed is required. [If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits.] Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.5.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed. Do not add water into the mixer while transporting concrete to the placement site.

3.5.4 Ready Mixed Concrete

Where ready mixed concrete (i.e. prepared in a batch plant off of the job site) is used, it shall be supplied in compliance with the "Typical Clauses for Ready Mix Concrete Supply Operations" by ANCE, unless otherwise required in the contract documents and specifications. Each load of concrete shall be accompanied by the delivery ticket reporting all the information specified in UNI EN 206-1.

3.6 PLACING CONCRETE

****

NOTE: When necessary to deposit concrete under water, add the following paragraph:

"Depositing Concrete Under Water.

Methods and equipment used shall prevent the washing of the cement from the mixture, minimize the formation of laitance, prevent the flow of water through the concrete before it has hardened, and minimize disturbance to the previously placed concrete. Do not deposit concrete in running water [, seawater,] or in water temperatures below 2 degrees C. Tremies, if used, shall be watertight and sufficiently large to permit a free flow of concrete. Keep the discharge end continuously submerged in fresh concrete. Keep the shaft full of concrete to a level well above the water surface. Discharge and spread the concrete by raising the tremie to maintain a uniform flow. Place concrete without interruption until the top of the fresh concrete is at the required height."

Add the following to paragraph entitled "Curing Periods": "A structure permanently submerged in fresh water shall be cured for 12 hours minimum prior to being submerged in fresh water. A structure permanently submerged in seawater shall be

cured for 5 days minimum prior to being submerged in seawater."

****

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 1 m from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 3 m centers maximum in each direction when pouring interior slabs and on 6 m centers maximum for exterior slabs.

[3.6.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width shall be a minimum of 100 mm greater than indicated.

]3.6.2 Vibration

****

NOTE: Epoxy coating not used.

****

UNI EN 206-1, D.M. 9/1/96 and Law 1086. Furnish a spare working vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 100 mm in depth with high frequency, mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 100 mm or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 500 mm apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 1000 mm maximum vertical lifts. External vibrators shall be used on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

[3.6.3 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

][3.6.4 Pumping

****

NOTE: Pumping, especially lightweight concrete, requires careful attention to mix designs and pumping procedures. Allow pumping when other means of placement will be impractical or expensive.

****

D.M. 314. Pumping shall not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment shall not exceed 50 mm. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy. Rapid changes in pipe sizes shall be avoided. Maximum size of course aggregate shall be limited to 33 percent of the diameter of the pipe. Maximum size of well rounded aggregate shall be limited to 40 percent of the pipe diameter. Pump concrete directly into forms. Deposition of fresh concrete onto grade or existing slab, then placed into forms by other means is not permitted.

][3.6.4.1 Pumping Lightweight Concrete

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NOTE: Specify minimum of 330 kg per cubic meter unless structural considerations require higher cement content. Require field trial run only when justified by job complexities or size.

****

D.M. 9/1/96. Aggregates shall be presoaked or presaturated. Cement content shall be minimum of [330 kg per cubic meter] [_____] and shall be sufficient to accommodate a 100 to 150 mm slump. [Field trial run shall be made in accordance with UNI 9418.]

][3.6.5 Cold Weather

Law 1086 and D.M. 9/1/96. Do not allow concrete temperature to decrease below 10 degrees C. Obtain approval prior to placing concrete when the ambient temperature is below 4 degrees C or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 10 degrees C minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 3 degrees C in any 1 hour and 10 degrees C per 24 hours after heat application. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature.

]3.6.6 Hot Weather

Law 1086 and D.M. 9/1/96. Maintain required concrete temperature to prevent the evaporation rate from exceeding 1 kg per square meter of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the

curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.7.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 600 square mm surface area or 6 mm maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action from the Contracting Officerprior to repair. Repair extensive defects with high strength, nonshrink grout. Do not load structural elements until repairs or replacment has been completed. The surface of the concrete shall not vary more than the allowable tolerances specified. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.7.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified shall be finished with wood floats to even surfaces. Finish shall match adjacent finishes.

3.7.3 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch this holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 6 mm in height.

3.7.4 [_____] Finish

****

NOTE: Add information where special type of finish is desired. See D.M. 9/1/96 for information on smooth rubbed finish, grout cleaned finish, cork floated finish, and exposed aggregate. Areas requiring special finish should be clearly indicated on the drawings and coordinated with the specifications.

****

Provide concrete indicated with a [_____] finish as follows: [_____].

[3.7.5 Surface Finish Samples

****

NOTE: Include when either job complexity or

aesthetics justify the additional cost associated with these requirements.

****

Provide a minimum of three sample concrete panels for each finish for each mix design, one by one m, 75 mm thick. Use the approved concrete mix design(s). Provide sample panels on-site at locations directed. Once approved, each set of panels shall be representative of each of the finishes specified and shall be representative of the workmanship and finish(es) required. Do not remove or destroy samples until directed by the Contracting Officer.

]3.8 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

****

NOTE: Include these paragraphs where floor flatness is not critical. Coordinate concrete finish with applicable architectural finish material to be installed over concrete floor. For thin-set tile, coordinate with Section 09310, "Ceramic Tile."

****

D.M. 9/1/96, unless otherwise specified. Slope floors uniformly to drains where drains are provided. [Depress the concrete base slab where quarry tile, ceramic tile, [or] [_____] are indicated.] [Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile [_____].] Where straightedge measurements are specified, Contractor shall provide straightedge.

3.8.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.8.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled to a tolerance as defined below, the surface shall be roughened with stiff brushes of rakes before final set.

3.8.1.2 Floated

Use for [surfaces to receive [roofing,] [waterproofing membranes,] [sand bed terrazzo,]][_____] [and] [exterior slabs where not otherwise specified.] After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, float shall begin when the surface has stiffened sufficiently to permit the

operation. During or after the first floating, surface shall be checked with a 3 meter straightedge applied at no less than two different angles, one of which is perpendicular to the direction of strike off. High spots shall be cut down and low spots filled during this procedure to produce a surface level within [6] [_____] mm in 3 m.

[3.8.1.3 Concrete Containing Silica Fume

Finish using magnesium floats or darbies. [Finish using techniques demonstrated in the sample installation.]

]3.8.1.4 Steel Troweled

****

NOTE: C.M. 252 and Law 595 suggests power troweling three times for Class 5 floors and where increased wear resistance is needed.

****

Use for floors intended as walking surfaces[,] [and] for reception of floor coverings[, and] [_____]. First, provide a floated finish. The finish shall next be power troweled [two] [three] [_____] times, and finally hand troweled. The first troweling after floating shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Additional trowelings shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be essentially free of trowel marks and uniform in texture and appearance. The finished surface shall produce a surface level to within [6] [_____] mm in 3 m. On surfaces intended to support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

[3.8.1.5 Nonslip Finish

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NOTE: Include when nonslip finish using dry shake aggregate is desired.

****

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Apply dry shake aggregate of [ceramically bonded aluminum oxide] [_____] to the surface at a minimum rate of 1.2 kg per square m. Blend approximately two-thirds of the aggregate with Portland cement as recommended by the manufacturer and apply to the surface evenly and without segregation. After blended material has been embedded by floating, apply the remainder of the blended material to the surface at right angles to the previous application. Apply blended material heavier in any areas not sufficiently covered by the first application. Perform a second floating immediately following the first. After the selected material has been embedded by the two floatings, complete the operation with a [broomed] [floated] [troweled] finish.

]3.8.1.6 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.8.1.7 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by [belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained.] [a burlap drag. Drag a strip of clean, wet burlap from 900 to 3000 mm wide and 600 mm longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks.] Round edges and joints with an edger having a radius of 3 mm.

3.8.1.8 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish [indicated on the drawings] [specified herein].

b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 5 degrees C at the time of placing. Place the topping and finish as [indicated] [specified herein].

[3.8.2 Flat Floor Finishes

****

NOTE: Use these paragraphs where floor flatness is

critical. Indicate areas where these requirements apply. Flatness will affect the appearance and function of finishes applied to the concrete and in situations such as large or long expanses of glossy floor materials. Low tolerance for product (thin set tile and wood gymnasium floors, etc.) and equipment will dictate to the designer to specify higher than normal flatness requirements. The numbers provided in brackets are typical numbers, but A/E should research and select numbers high enough to get desired results but not so high as to cause undue cost increases and construction problems. Ff/FL 20/15 is equivalent to 8 mm in 5.05 mm. This test method is not suitable for unshored deck. Fitted partitions need FL greater than or equal to 25.

****

D.M. 314. Construct in accordance with one of the methods UNI EN 197-1 for tolerance tested with UNI 9858.

a. Specified Conventional Value:

Floor Flatness (Ff) [20] [_____] [13] [_____] minimum
Floor Levelness (FL) [15] [_____] [10] [_____] minimum

b. Specified Industrial:

Floor Flatness (Ff) [30] [_____] [15] [_____] minimum
Floor Levelness (FL) [20] [_____] [10] [_____] minimum

3.8.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide test reports to Contracting Officer within 12 hours after collecting the data. Floor flatness tolerance report shall include:

a. Key plan showing location of data collected.

b. Results required by UNI 9858.

3.8.2.2 Remedies for Out of Tolerance Work

Contractor shall repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor shall submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs shall not result in damage to structural integrity of the floor. For floors exposed to public view, repairs shall not result in any uneven or unusual coloring of the surface.

]3.8.3 Concrete Walks

Provide 100 mm thick minimum. Provide contraction joints spaced every 1500 lineal mm unless otherwise indicated. Cut contraction joints 25 mm deep with a jointing tool after the surface has been finished. Provide 13 mm

thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 15 m maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 6 mm in 1500 mm.

3.8.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.8.5 Curbs [and Gutters]

Provide contraction joints spaced every 3 m maximum unless otherwise indicated. Cut contraction joints 20 mm deep with a jointing tool after the surface has been finished. Provide expansion joints 13 mm thick and spaced every 30 mm maximum unless otherwise indicated. Perform pavement finish.

[3.8.6 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks shall be precast concrete, 600 mm long, 300 mm wide, and 100 mm thick, unless otherwise indicated, with smooth finished countersunk dishes sloped to drain away from the building.

]3.9 CURING AND PROTECTION

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NOTE: When the use of alkali-reactive aggregates is permitted, delete everything after the first two sentences, add the following, and add paragraph entitled "Additional Curing When Using Alkali-Reactive Aggregates" as follows:

"Alkali-reactive aggregates may be used where not exposed to either seawater or alkali soil conditions, and when used with one of the following cements and tested in accordance with UNI 7116 to ensure that a 75 percent minimum reduction of expansion due to alkali-aggregate reaction is provided.

1. Law 595, low alkali cement.

2. C.M. 252 blended cement.

3. C.M. 252, low alkali, Type 32.5 and 42.5 cement with fly ash, pozzolan, or ground slag.

Furnish a mix design utilizing alkali-reactive aggregates with a maximum water-cement ratio of 0.45."

"Additional Curing When Using Alkali-Reactive

Aggregates.

Furnish UNI 6132 test results to verify the anticipated rate of strength development for the proposed concrete mix design. Submit an increased curing period and minimum time to strip formwork based upon the reduced rate of strength development."

Add to "Curing and Protection" when using silica fume.

Prevent concrete with silica fume from drying by one or more of the following:

1. Misting surface of concrete with fog nozzle;

2. Liquid membrane-forming compound;

3. Pervious or impervious sheeting.

Increase curing time per manufacturer's recommendations.

****

UNI EN 206-1, UNI 6127 and D.M. 9/1/96, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating.

3.9.1 Moist Curing

Remove water without erosion or damage to the structure.

3.9.1.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water shall not be more than 10 degrees C less than the temperature of the concrete. For temperatures between 4 and 10 degrees C, increase the curing period by 50 percent.

3.9.1.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For

temperatures between 4 and 10 degrees C, increase the curing period by 50 percent.

3.9.1.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 150 mm over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.9.1.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 300 mm minimum. Provide sheeting not less than 450 mm wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.9.2 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where hot weather conditions will cause an evaporation rate exceeding one kg water per square meter per hour.

3.9.2.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats shall be 5 square meters maximum per Liter of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.9.2.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion for at least 72 hours after compound application. Maintain continuity of the

coating for the entire curing period and immediately repair any damage.

3.9.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener shall not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.9.4 Curing Periods

D.M. 9/1/96 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that will be in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval by the Contracting Officer.

3.9.5 Requirements for Portland Class 32.5, Class IV, UNI EN 206-1, High-Early-Strength Portland Cement

The curing periods shall be not less than one-fourth of those specified for Portland cement, but in no case less than 72 hours.

3.10 FIELD QUALITY CONTROL

3.10.1 Sampling

UNI EN 12350-1. Collect samples of fresh concrete to perform tests specified. UNI 6127 for making test specimens. Specimen dimensions and forms shall comply with UNI 6130-1 and UNI 6130-2 respectively. Sampling shall be performed under the direction of the Contracting Officer without proir notification to the contractor.

3.10.2 Testing

3.10.2.1 Slump Tests

UNI EN 12350-1 and UNI 9418. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 16 cubic meters (maximum) of concrete. [When pumping concrete, perform tests at point of delivery to the pump.]Test shall be performed under the direction of the Contracting Officer.

3.10.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 10 degrees C and above 27 degrees C) for each batch (minimum) or every 16 cubic meters (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.10.2.3 Compressive Strength Tests

****

NOTE: When the same mix design is used for multiple elements such as slabs, beams, and walls, the design element type may be specified in lieu of or in addition to the mix design in order to better identify deficient concrete.

****

UNI 6132and D.M. 9/1/96. Make five test specimens for each set of tests in accordance with UNI 6127. [When pumping concrete, collect sample for specimens at the point of discharge from the pump.] Precautions shall be taken to prevent evaporation and loss of water from the specimen. After sample collection, each specimen shall be labeled containing the date of sampling, project name, and indication that the sample was prepared under the direction of the Contracting Officer or his representative. Specimens shall be delivered to a testing firm officially authorized by the Italian Public Work Ministry. Test two specimens at 7 days, two specimens at 28 days, and hold one specimen in reserve.

Type A Criteria

This criteria is applicable to all construction requiring no more than 1500 cubic meters of cast-in-place concrete.

Samples for strength tests of [each mix design of] [and for] [_____] concrete placed each day shall be taken not less than once a day, nor less than once for each 120 cubic meters of concrete, nor less than once for each 500 square meters of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed.

Each test consists of 3 samples as a minimum, each sample consists of 2 specimens. The measured resistance of the sample is given by the average value of the measured resistance of the two specimens of that sample. For sample strength values of R1, R2 and R3 where R1 < R2 < R3; the test results will be acceptable if the following equasions are verified:

$Rm > Rck + 3.5 \quad (N/mm^2)$

$R1 > Rck - 3.5 \quad (N/mm^2)$

where Rm is the design cubic strength of concrete and Rck is the average value of the measured strengh of the samples.

Type B Criteria (Statistic criteria)

This criteria is applicable to all construction requiring more than 1500 cubic meters of cast-in-place concrete.

Prepare at least one sample for each day of concrete placement, but not less than 15 samples for the entire project.

Each sample consists of 2 specimens. The measured resistance of the generic sample (Ri) is given by the average value of the measured resistance of the two specimens of that sample. The test results will be acceptable if the following equasions are verified:

$Rm > Rck + 1.4 \times S \quad (N/mm^2)$

$R1 > Rck - 3.5 \times S \quad (N/mm^2)$

where Rm is the design cubic strength of concrete, Rck is the average value of the measured strengh of the samples, S is the standard deviation of the measured strength of the samples and R1 is the minimum sample value of the measured strengths.

Remove concrete not meeting strength criteria and provide new acceptable concrete for both Type A and Type B criteria.

[3.10.2.4 Air Content

UNI 6395 or UNI EN 12350-7 for normal weight [and lightweight]concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

][3.10.2.5 Unit Weight of Structural Lightweight Concrete

D.M. 9/1/96. Determine unit weight of lightweight concrete. Perform test for every 15 cubic meters maximum. Fresh concrete shall be tested in accordance with UNI 6394-1. Hardened concrete shall be tested in accordance with UNI 6394-2

][3.10.2.6 Ion Concentration

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NOTE: Include only when justified by size of job or when quality of concrete is questionable.

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D.M. 9/1/96. Determine water soluble ion concentration. Perform test once for each mix design.

]

3.10.2.7 Steel Reinforcment

Steel reinforcment shall be tested in accordance with Law 1086, UNI 5294, UNI CNR 10020, and D.M. 9/1/96 or the latest updated revision. Specimen preparation and testing shall be performed in accordance with UNI ENV 10080. Each steel batch delivered to the job site shall be marked for identification as required by D.M. 9/1/96. The mark shall clearly address manufacturer brand name, the factory location, steel type with indication

of weldable steel (if required).

a. Mechanical Test on Site or Shop Assembly

Collect a minimum of 3 specimens for each diameter used and for each delivery of steel bars and wires. Then calculate the characteristic values of fy or $f_{(0.2)}$ and f_t (yeild strength, strength developed at 0.2% of elongation, and tensile strength respectively) by the average value of the measured strengths of all specimens having the same diameter, minus 10 N/mm^2 for fy and $f_{(0.2)}$ and minus 20 N/mm^2 for f_t. Refer to D.M. 9/1/96.

If the results are not in compliance with the minimum properties certified by the steel manufacturer, the Contracting Officer will order a new test on six additional specimens having the same diameter as those specimens whose test failed. In this case the average value of fy or $f_{(0.2)}$ and f_t will be recalculated on the 9 values of the measured strengths. Then the characteristic values will be obtained by the average value minus 20 N/mm^2 for fy and $f_{(0.2)}$ and minus 30 N/mm^2 for f_t. If the test fails again, the Contracting Officer will order statistic testing over a minimum of 25 specimens, following the procedure of attachment 4 of D.M. 9/1/96, specified for factory production testing.

b. Mechanical and Chemical Composition Test on Factory

Steel manufacturer shall provide continuous control of the production on factory, with both in-house labratory testing and external official labratory testing for mechanical and chemical properties of all steel products. Interior quality control for mechanical properties as required by the D.M. 9/1/96 shall use a statistic procedure. Exterior labratory testing shall be performed a minimum of 2 times per year. The certification of the results of the most recent tests on the factory shall be submitted to the Contracting Officer coinciding with the steel delivery to the job site.

-- End of Section --