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NAVFAC **IGS-02751 (JANUARY 2003)**

Supercedes IGS-02751(12/02)

Preparing Activity: LANTNAVFACENGCOM **Based on UFGS-02751N**

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

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SECTION 02751

CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS

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 Portland cement concrete pavement for large road and airfield projects using slipform pavers or paving "trains" on fixed forms. If the concrete is to be laid on a surface other than a prepared subgrade or base, some paragraphs may need to be supplemented or modified. Joints, reinforcement, and mooring eyes are covered in Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements." For repair jobs or small jobs such as parking lots or small sections of residential streets see Section 02752, "Reinforced Cement Concrete Pavement for Roads and Site Facilities."

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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NOTE: The following information should be shown on the drawings:

1. Plan of paving, showing horizontal dimensions; location with respect to existing structures, and existing ground contours.

2. Section of paving showing thickness and detailed dimensions.

3. Finished lines and grades of paving and shoulders.

4. See NAVFAC MIL HDBK 1021/4 for guidance on the location and types of joints. Details of contraction, expansion and construction joints should be shown on the drawings.

5. Reinforcement as required. Specify reinforcement in Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements.

6. Mooring eyes, as required. Refer to Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements."

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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.

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	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

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 6127	(1998) Concrete specimens for strength tests - Making and curing
UNI 6133	(1983) Destructive tests of concretes - Flexure test
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 8520-10	Aggregates for use in concretes - Determination of degradation by sulfates
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 8520-20	Aggregates for use in concretes - Determination of freeze-thaw resistance
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 8981-7	(1989) Durability of concrete works - Criteria for mix design, mixing and placing of concrete
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
SS UNI U50.00.206.0	Formworks - General requirements for design, construction and use

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 CNR 10020	(1971) Beam test on steel bars
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 932-1	(1998) Tests for general properties of aggregates - Part 1: Methods for sampling

UNI EN 932-3	(1998) Tests for general properties of aggregates - Part 3: Procedure and terminology for simplified petrographic description
UNI EN 933-1	(1999) Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method
UNI EN 933-2	(1997) Tests for geometrical properties of aggregates - Part 2: Determination of particle size distribution - Test sieves, nominal size of apertures
UNI EN 933-3	(1998)Tests for geometrical properties of aggregates - Part 3: Determination of particle shape - Flakiness index
UNI EN 933-8	(2000) Tests for geometrical properties of aggregates - Part 8: Assessment of fines - Sand equivalent test
UNI EN 933-9	(2000) Tests for geometrical properties of aggregates - Part 9: Assessment of fines - Methylene blue test
UNI EN 934-2	(2002) Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions and requirements
UNI EN 1097-1	(2000) Tests for mechanical and physical properties of aggregates - Determination of resistance to ware (micro-Deval)
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 1744-1	(1999) Tests for chemical properties of aggregates - Part 1: Chemical analysis
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 EN 12350-1	(2001) Testing fresh concrete - Part 1: Sampling

UNI EN 12350-2	(2001) Testing fresh concrete - Part 2: Slump test
UNI EN 12350-7	(2002) Testing fresh concrete - Air content - Pressure methods
UNI EN 12504-1	(2002) Testing concrete in structures - Cored specimens - Taking, examining and testing in compression

1.2 SUBMITTALS

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NOTE: Where a "G" in submittal tags follows a submittal item, it indicates Government approval for that item. Add "G" in submittal tags following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significantly to merit approval by the Government. Submittal items not designated with a "G" will be approved by the QC organization.

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

SD-03 Product Data

Curing materials

Admixtures

SD-05 Design Data

Mix design; G

At least 30 days prior to the mixing and placing of concrete, submit mix design for approval. Furnish a complete list of materials including type, brand, source and amount of cement, fly ash, pozzolan, ground granulated blast-furnace slag, admixtures, aggregates, and applicable reference specifications. The laboratory test reports shall include mill test and other tests for cement, aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage versus sieve size. Test reports shall be submitted along with concrete mix design. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

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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 aggregates is questionable.

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Aggregate tests

Concrete slump tests

Air content tests

Pavement thickness tests

Flexural strength tests

Alkali reactivity test

Submit testing results as required in paragraph entitled "Field Quality Control in Part 3 of this section."

SD-07 Certificates

Ready-mixed concrete plant identification

Batch ticket information

Cementitious Material

Aggregates

Admixtures

Curing materials

SD-11 Closeout Submittals

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NOTE: Use this paragraph for contracts which require concrete quantities of 1500 cubic meters and more.

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Control charts

Submit copies weekly.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Cement, Fly Ash, Pozzolan and Ground Granulated Blast-Furnace Slag

Store immediately upon receipt. Store bagged material in a dry weathertight ventilated structure. Stack bags close together to reduce circulation of air but do not stack against outside walls. Transfer bulk material to weatherproof bins. Test cement stored longer than 6 months by

standard mortar tests or loss on ignition tests to determine whether suitable for use. Do not use such cement without approval of the Contracting Officer.

1.3.2 Aggregates

Sufficient aggregate shall be stored at the site at all times to permit continuous, uninterrupted operation of the mixing plant while concrete is being placed. Store aggregates in a manner to minimize segregation and prevent contamination. Store different sizes in separate piles. Stockpile coarse aggregates in thin, horizontal layers with no cone stockpiling permitted. Should coarse aggregates become segregated, remix stockpile to conform to the specified grading requirements.

1.3.3 Admixtures

Store admixture in undamaged containers which will prevent evaporation. Retest air-entraining admixture stored longer than 6 months or which has been subject to freezing. Do not use admixtures stored longer than 15 months.

1.4 EQUIPMENT

Maintain all equipment in satisfactory working condition throughout the length of the contract.

1.4.1 Vibrators

1.4.1.1 Internal Vibrators

Pneumatic gas driven, or electric mounted on the slipform paver or fixed form paver or on a seperate frame. Operating frequency shall be between 8,000 and 12,000 vibrations per minute. Space vibrators 450 mm to 600 mm apart. Use on pavements of 200 mm or greater thickness.

1.4.1.2 Surface Vibrators

Pan or vibrating screed with operating frequency between 3,000 and 6,000 vibrations per minute. Use on pavements less than 200 mm thick.

1.4.2 Slipform and Fixed Form Pavers

Use equipment designed to spread, consolidate, screed, and float finish the freshly placed concrete in one pass requiring a minimum of hand finishing.

1.4.3 Curing Compound Spray Equipment

Self-propelled, straddling newly paved lane, with spraying nozzles and pressure that can be controlled and operated to completely and uniformly cover pavement surface with required amount of curing compound. Continuously mechanically agitate curing compound throughout full depth of drum during application. Use air agitation only to supplement mechanical agitation. Spraying pressure shall be sufficient to produce a fine spray as necessary to cover the surface thoroughly and completely with a uniform

film. Small or irregular areas may be sprayed by hand methods.

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NOTE: Include the bracketed paragraph on projects where the Contractor is required to provide an on-site batch plant. Edit paragraphs as appropriate.
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[1.4.4 Batch Plant

The Contractor shall provide a batch processing plant. All areas used for production shall be kept clean at all times and debris shall be moved to the approved spoil area. The spoil area shall be contained within the batch plant laydown area. Access roads from work locations to the location of the batch plant shall be kept clean at all times. The Contractor shall bear all costs arising from these operations and shall remove all plant and materials within 14 days of completion of production. The Contractor shall return the area to a condition acceptable to the Contracting Officer at the completion of work. Locate plant as indicated and approved by the Contracting Officer. Electric power is available at the batch plant site[, but is not included as part of this contract].

Assemble the plant on a firm and stable foundation as to facilitate inspection of all operations at all times and make necessary adjustments to compensate for varying moisture content of aggregate and for changing proportions of materials. Provide test weights or other equipment for calibrating and checking the measuring devices. Make all necessary corrections to secure satisfactory performance. Arrange the batch plant so that the weighing beam or dial and the aggregate discharge gates are in full view of the operator. Install glass windows to provide a view of mixer charging and discharging, truck loading positions, and water and additive gages. Scales shall be accurate to within 1/2 of one percent. Batching shall be such that the ingredients are consistantly measured within the following tolerances: 1 percent for water, 2 percent for aggregate, and 3 percent for addmixtures. Furnish mandatory batch ticket information for each load of concrete materials. Provide a canvas tremie or curtains attached to the discharge hopper to prevent loss of materials when discharging into batch trucks or mixers.

The Contractor shall provide water [and electric power]for plant operations.

]1.5 QUALITY ASSURANCE

1.5.1 Required Data

Submit name and location of the ready-mixed concrete plant. Submit batch ticket information as specified in UNI 8981-7.

PART 2 PRODUCTS

2.1 SOURCE MANUFACTURERS

2.1.1 Concrete for Pavement

The following manufacturers generally comply with these specifications:

ITALCEMENT
Via San Bernardino, 149/A
24126 Bergamo
Tel: 035/4167111
Fax: 035/4167046
Web Site: www.calcestruzzi.it

MAC S.p.A.
Via Vicinale delle Corti, 21
31100 Treviso
Tel: 0422/304251
Fax: 0422/421802
Web Site: www.mac-mbt.com

2.2 MATERIALS

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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-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-D	**Portland-silica fume cement**
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

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2.2.1 Cementitious Material

"Cementitious Material" as used herin shall include all portland cement, fly ash, pozzolan 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 197-1 and UNI EN 196-5.

2.2.1.4 Ground Granulated Blast-Furnace Slag

Law 595 and UNI EN 197-1.

2.2.1.5 Silica Fume

Silica fume shall not be used.

2.2.1.6 Burnt Shale

Burnt shale shall not be used.

2.2.1.7 Limestone

Limestone shall not be used.

2.2.2 Water

Law 1086, D.M. 9-1-96, and D.M. 16-1-96. Water shall be fresh, clean and potable.

2.2.3 Aggregates

Aggregates for concrete shall comply with UNI 8520-1 definitions and UNI 8520-2 requirements. Acceptance criteria testing shall be carried out in accordance with UNI 8520-7, UNI 8520-8, UNI 8520-10, UNI 8520-16, UNI 8520-17, UNI 8520-20, UNI 8520-21, and UNI 8520-22. Aggregate testing shall also be in compliance with UNI EN 1367-1 and UNI EN 1367-2.

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NOTE: Serious problems have been experienced in some areas with reactive aggregates, and with porous particles absorbing moisture to the point of saturation followed by freezing. In the case of individual reactive particles, and in the case of frozen porous material, should the depth of embedment be insufficient to restrain the forces built up by expansion, the concrete above the particle is expelled from the slab. This phenomenon is often referred to as "pop outs." This expansion can also become destructive in nature and cause swelling, cracking and eventual concrete slab failure. See note in paragraph entitled "Alkali Reactivity Test" for additional applicable information.

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2.2.3.1 Alkali Reactivity Test

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1. While not wholly conclusive, petrographic examination (UNI EN 932-2) and chemical test method (UNI EN 1744-1) provide valuable indicators. However, chemical test results may not be correct for aggregates containing carbonates of calcium, magnesium or ferrous iron, such as calcite, dolomite, magnesite or siderite; or silicates of magnesium such as serpentine. The ASTM C 227 mortar bar method while preferable and more reliable, requires at least 6 months and preferably one year to yield results.

2. UNI 8520-22 identifies most important rocks and mineral known to be deleteriously reactive with the alkalies in Portland cement. However, this list is not inclusive, and particles having a glassy or micro-crystalline structure should be considered suspect. Contract documents for important concrete projects should include provisions for preventing reactive aggregate being used, if possible, or requiring their use exclusively with low-alkali cements, suitable blended cements, or pozzolanic admixtures as available and as required to avoid deleterious effects on the concrete.

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Fine and Coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with UNI 8520-22. The coarse and fine aggregates shall be evaluated separately, in accordance with UNI 8520-22, and in combination, which match the contractors's proposed mix design proportioning, utilizing the modified version of UNI 8520-22 described below.. Test results of the combination shall have a measured expansion of less than 0.08 percent at 16 days. Should the test data indicate an expansion of greater than 0.08 percent, the aggregate(s) shall be rejected and the Contractor shall submit new aggregate sources for retesting or may submit additional test results incorporating Lithium Nitrate for consideration at no additional cost to the Government.

UNI 8520-22 shall be modified as follows to include one of the following options:

a. Utilize the Contractor's proposed low alkali Portland cement and fly ash or pozzolan in combination for the test proportioning. The laboratory shall use the Contractor's proposed percentage of cement and fly ash or pozzolan.

b. Utilize the Contractor's proposed low alkali Portland cement and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory shall use the Contractor's proposed percentage of cement and GGBF.

c. Utilize the Contractor's proposed low alkali Portland cement, fly

ash or pozzolan, and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory shall use the Contractor's proposed percentage of cement, fly ash or pozzolan, and GGBF.

2.2.3.2 Fine Aggregates

UNI EN 933-1, UNI EN 933-2, UNI EN 933-8, UNI EN 933-9, UNI 8520-13, and UNI 8520-15.

2.2.3.3 Coarse Aggregates

UNI 8520-7, UNI 8520-8, UNI 8520-10, UNI 8520-16, UNI 8520-17, UNI 8520-20, UNI 8520-21, maximum size [38 mm][25 mm][19 mm] except as otherwise modified herein.

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NOTE: In the text below, use 40 percent for airfield projects. For road projects, consult CNR 139/92, "Norms concerning aggregates - Criteria and acceptance requirements of aggregates used in road superstructures".

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a. Abrasion loss shall not exceed [40] [_____] percent for aggregates tested in accordance with UNI EN 1097-1.

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NOTE: At the text below, for airfield projects in regions and localities where the possibility exists that local aggregate sources may be low quality, uncrushed or poorly graded, consider specifying crushed coarse aggregates and a minimum specific gravity of 2.55. Available sources should be evaluated.

Concrete characteristics.

1. Strength: Military Handbook MIL-HDBK-1021/4 requires a flexural strength of 4.5 MPa as a basis for pavement design.

2. Aggregate Size:

a. Specify the maximum aggregate size as 38 mm, except as specified herein. For slipform pavement, specify 25 mm maximum aggregate size.

b. The American Concrete Paving Association in Technical Bulletin No. 15, entitled "Optimum Size Coarse Aggregates for Portland Cement Concrete Paving," has concluded that for a given water-cement ratio and percentage of fine aggregates, the flexural strength of concrete becomes progressively

higher as the maximum aggregate size (coarse aggregate) decreases. For the same cement content and range of sand content generally used in pavement construction, the report states that the 19 to 38 mm range in coarse aggregates size developed higher strength concrete than when the coarse aggregate is 38 mm and larger. Four different gradings were studied with maximum aggregate size 9.5, 19, 25, 38 mm (cement content for all mixes was approximately 6 sacks for cubic yard). For this reason it is suggested that the maximum aggregate size be limited to 38 mm, and preferably, the maximum size shall be 25 mm which is also desirable for slipform paving. Gradations for such sizes are available in UNI 2334, Size 40 for 38 mmmaximum size aggregate or size 25 for 25 mm maximum size aggregate. Exceptions to the selection of aggregate size may be as follows:

(1) In Italy, the source is predominantly crushed stone, 38 mm maximum aggregate size may be specified (or 25 mm maximum size for slipform pavers). Experience has shown that the flexural strength, 4.5 MPa, is obtained with approximately 307 kg 7.2 sacks per cubic meter.

(2) River run materials are rare in Italy but are generally used when available locally. When river run materials or porous aggregates are used, the maximum aggregate size should be limited to 25 mm. For these materials it requires 346 kg 8.1 sacks of cement per cubic meter to obtain the concrete strength of 4.5 MPa at 28 days. For airfield projects consideration should be given to specifying crushed coarse aggregates and specific gravity of 2.55.

3. Durability of Concrete:

a. Minimum Cement Content: The cement required to produce concrete strength of 4.5 MPa at 28 days is generally sufficient to provide durable concrete and resistance to surface abrasion. Air entraining admixtures should be required. If the selected cement factor is 290 kg 6.8 sacks per cubic meter to assure durable concrete, the specified strength may be obtained provided that the maximum coarse aggregate are sizes discussed above or crushed stone. Specifying a minimum cement content will not necessarily provide the specified flexural strength and additional cement may be required. The actual amount of cement required to obtain the required strength is decided by the Contractor based on mix designs for local aggregates and equipment and methods to be used in the field production of the

concrete. Select a minimum cement content to compensate for poor quality aggregates, seawater exposure, and for sites of difficult concrete placement conditions. Guidance for minimum cement contents for suitability, durability and workability of concrete is frequently given in the State Standard Specifications.

b. Corrosion Protection: In environments where concrete is exposed to sulfate-soil conditions, specify UNI EN 197-1, Type CEM II/A-S or Type CEM II/B-S cement and a minimum of 7.85 sack equivalent per cubic meter (6 sack equivalent per cubic yard). For marine environments use 9.2 sack equivalent per cubic meter (7 sack equivalent per cubic yard). Also consider using UNI EN 197-1, Type CEM III/A cement.

c. Slump: Specify low-slump concrete. Generally, the range is 25 to 75 mm for regular pavement, 13 or 38 mm for slip form paving.

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b. Aggregates shall be gravel, crushed gravel, or crushed stone.

c. Specific gravity not less than 2.55, saturated-surface-dry (SSD). Provide aggregate tests in conformance with UNI 8520-13.

d. Furnish coarse aggregate in at least two separate sizes with separation at the 19 mm sieve when combined material graded from 4.75 mm to 37.5 mm nominal maximum size is specified. When the nominal maximum size of aggregate is 25 mm or less, such separation is not necessary.

e. Deleterious Substances: Test in accordance with UNI EN 1744-1 and UNI EN 932-3.Requirements of UNI 8520-22 apply. Deleterious substances in coarse aggregate shall not exceed the following percentages by weight:

(1) Clay Lumps and Friable Particles: 1.0 percent when tested in accordance with UNI 8520-8.

(2) Lightweight Pieces: 1.0 percent as determined by UNI 8520-1. When blast furnace slag is used, unit weight shall control.

(3) Materials Finer than 75 micrometers Sieve: 1.0 percent when tested in accordance with UNI 8520-7.

(4) Flat and Elongated Particles: 5 to 1 ratio with a total of 15 percent when tested in accordance with UNI EN 933-3.

2.2.4 Admixtures

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NOTE: Admixtures are used in concrete to improve the concrete or to provide sound concrete under conditions where it would be burdensome to do so without use of an admixture. The following information is applicable:

1. Air Entraining Agents. Air entrainment should be specified for concrete exposed to freezing and thawing and sulfates and for seawater exposed concrete. Air entrainment improves the workability of plastic concrete, and where not specified, it should generally be permitted if the Contractor desires to use it, provided the requirements specified herein are met. If the Contractor is required to furnish a mix design, specify that concrete shall be air-entrained in accordance with requirements specified herein.

2. Retarders. Retarding admixtures act to slow the hardening of concrete in hot weather. Generally, retarders should be permitted, when not specified, if the Contractor desires to use it.

3. Water Reducers. Water reducing admixtures are used to improve the quality of concrete, obtain specified strength at lower water-cement ratios or to increase the slump of a given mixture without increase in water content. Generally, water reducing admixtures should be permitted, when not specified, if the Contractor desires to use them.

4. Accelerators. Calcium chloride and non-calcium chloride types are available. When added to the concrete acts to accelerate the hardening of concrete in cold weather. Calcium chloride accelerators should not be permitted for seawater exposed concrete, reinforced concrete and in concrete in contact with aluminum or other non-ferrous materials.

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Where not shown or specified, admixtures may be used subject to written approval of the Contracting Officer.

2.2.4.1 Air-Entraining Admixtures

UNI EN 934-2 and UNI 10765.

2.2.4.2 Retarding Admixtures

UNI EN 934-2 and UNI 10765.

2.2.4.3 Water-Reducing Admixtures

UNI EN 934-2 and UNI 10765.

2.2.4.4 Accelerating Admixtures

UNI EN 934-2 and UNI 10765.

2.2.5 Curing Materials

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NOTE: Curing materials are essential for proper curing of concrete however some precautions have been noted and the following information is applicable.

1. Polyethylene Sheeting is difficult to keep in place and if it is not placed uniformly and without any air pockets the surface will have mottling and increase the potential of surface "pop outs" from reactivity.

2. Liquid Membrane-Forming Compounds. The Navy has encountered problems with liquid membrane forming compounds due to adhering too well and too long to pavement surface. It is difficult to remove and if left on, the pavement becomes slippery resulting in skid resistance being below the acceptable minimum criteria thereby affecting aircraft safety and striping paint not adhering properly and pealing off in some areas.

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2.2.5.1 Polyethylene Sheeting

UNI 8656/FA-219, white color, with a minimum sheet thickness of 0.25 mm.

2.2.5.2 White-Burlap-Polyethylene Sheet

UNI 8656/FA-219 , 0.10 mm thick white opaque polyethylene bonded to 0.31 kg per meter (1.0 m) wide burlap.

2.2.5.3 Liquid Membrane-Forming Compound

UNI 8656/FA-219, white-pigmented, clear or translucent with white fugitive dye.

2.2.6 Joints, [Reinforcement][and][Mooring Eyes]

Provide as specified in Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements."

2.2.7 Reinforcment

Reinforcing steel shall conform with UNI 8926, UNI 8927, UNI 10622, and UNI ENV 10080.

2.3 CONCRETE MIX DESIGN

2.3.1 Contractor-Furnished Concrete Mix Design

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NOTE: 14 Days is the default value for flexural testing due to short turnaround time associated with airfield pavements. Testing at 28 days is acceptable if the project schedule permits a 28 day curing period of the in place work. For accelerated project schedules, testing at 7 days is an option.

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Contractor-furnished mix design concrete shall be designed in accordance with UNI 8981-7 and UNI EN 206-1, except as modified herein, and the mix design shall be as specified herein under paragraph entitled "Submittals." The concrete shall have a minimum flexural strength of 4481 kPa at [7][14][28] days. The air content shall be 5.5 plus or minus 1.5 percent. The design shall include a graph of flexural strength verses time (in days) for the selected mixture proportions. Concrete specimines shall be tested at the ages of 3, 7 and 14 days, minimum. The minimum cement factor and slump shall be as follows:

Method of Finishing to be Used	Minimum Cement Factor, kg Per Cubic Meter Aggregate Size		Range in Slump (mm)
	19 & 25 mm	38 mm	
Machine finish without vibration	368	351	50 to 75 mm
Machine finish, with vibration (except slip form)	340	323	25 to 50 mm
Hand tools	396	379	75 to 100 mm
Slip form	340	323	0 to 25 mm

The cement factors given in the foregoing table are minimum; if they are not sufficient to produce concrete of the flexural strength required, they shall be increased as necessary, without additional compensation under the contract. The cement factor shall be calculated using cementitious material, including fly ash, pozzolan and or GGBF slag. 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. The slump will be determined by UNI EN 12350-2 and shall be within the ranges given herein;

the specific slump shall be as approved by the Contracting Officer. Obtain acknowledgement of receipt prior to beginning any concrete work. Approved admixtures shall be used in proportions recommended by the manufacturer to obtain the optimum effect, with seasonal atmospheric and job conditions considered. If modifications to the mix are required, a new mix design shall be submitted for approval.

[2.3.2 Concrete Made With High-Early-Strength Portland Cement

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NOTE: When high early strength concrete is required in the project, identify location of concrete and select Class R, high early strength cement.

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Provide high-early-strength Portland cement concrete for [_____].

]2.4 FIXED FORMS

Use metal forms free from irregularities, bulges, warps, dents, and sags. Top face of form shall not vary by more than 3 mm in 3 m, and lateral variation shall be less than 6 mm in 3 m. Use forms sufficiently strong to resist pressure of concrete and loads resulting from finishing operations without springing, settling, or losing their shape. Clean forms before reuse. Before placing concrete, coat contact surfaces of forms with a non-staining release agent.

PART 3 EXECUTION

3.1 PREPARATION

Before placing concrete, bring [subgrade] [base] surface to finish grade and elevations as shown. [Fine grading of cement treated bases shall be complete prior to initial hardening of base material.] Moisten underlying material in advance of placing concrete to ensure a firm, moist condition at time concrete is placed. Do not permit equipment other than concrete delivery or paving equipment on prepared underlying material. In cold weather protect underlying material from frost. Do not use chemicals to eliminate frost. Maintain drainage ditches, gutters and side drains to drain the [subgrade] [base] during construction.

3.1.1 Base for Fixed Form Construction

Finish to the design profile. Test prepared surfaces with a template. Do not vary [subgrade surface] [surface of base material] more than 12 mm from indicated elevations.

3.1.2 Base for Slipform Construction

Finish to the design profile. Do not vary surface of base material more than 12 mm from indicated elevations. Minimum width of sub-base shall be 600 mm greater on each side than the width of the paving to accommodate the slipform equipment tracks. Grade and elevation control of the slip form paver shall be by string line.

3.2 FIXED FORMS

Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, compaction, and finishing so that forms will not deviate vertically more than 3 mm from required grade and elevations indicated. Maximum vertical deviation of top of any side form, including joints, shall not exceed 3 mm from a 3 m straightedge, nor shall inside face vary more than 6 mm from a 3 m straightedge. Provide stake sockets and interlocking devices that will prevent movement of the form. Forms shall comply with SS UNI U50.00.206.0 .

Base bids on fixed forms being used, however, slipform equipment may be used to place concrete in forms.

3.3 JOINTS, [REINFORCEMENT] [AND MOORING EYES]

Place joints, [welded wire fabric] [reinforcement steel] [and mooring eyes] in accordance with Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements."

3.4 MEASURING AND MIXING

3.4.1 Site Mixing / Batch Plant

Law 1086.

3.4.1.1 Mixer Performance

Before the start of concrete production, the uniformity of the mixed concrete shall be determined and the mix time adjusted. Adjustments in the mixer shall be made until the variation in the control parameters are within the allowable limits. Mixer performance shall be validated after repair of a mechanical breakdown which affects the mixing characteristics of the plant; or when there is extreme variability in the fresh concrete.

3.4.1.2 Scales

The accuracy of the scales shall be determined and scales certified proir to the start of production of concrete. Scales shall also be checked when the mixture is variable in consistency and the indicated proportions do not appear to have varied from the selected proportions. Scales shall be certified after each 20,000 cubic meters of concrete mixing.

3.4.1.3 Batch Plant Control

The measurement of all constituent materials of the concrete mixture shall be continuously controlled and monitored. Daily reports shall be prepared by the Contractor which identifies the mixture proportions, the variance from the design mixture, annotations where mix proportions are modified to account for variations in moisture content of the aggregate, aggregate grading, and/or environmental conditions.

3.4.2 Ready-Mixed Concrete

UNI 8981-7, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. Additional water may be added to bring slump within required limits, provided that specified water-cement ratio is not exceeded.

3.5 CONVEYING AND PLACING CONCRETE

3.5.1 Placing

Law 1086, except as modified herein. Place concrete continuously at a uniform rate, with a minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If an emergency stop does occur within 3 m of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of emergency stop has been corrected.

3.5.1.1 Cold Weather

Law 1086. High-early-strength-concrete shall be maintained above freezing for a period greater than one-quarter of the period specified for portland cement concrete or a minimum of 48 hours.

3.5.1.2 Hot Weather

Law 1086.

3.5.2 Consolidation

Law 1086.

3.5.3 Protection Against Rain

Law 1086.

3.6 FINISHING

Start finishing operations immediately after consolidation. Use finishing machine, except that hand finishing may be used in emergencies and for concrete slabs that are of shapes or locations that are not accessible with a finishing machine. Finishing operations shall not displace coarse aggregate from surface and shall produce a surface of uniform texture true to grade and design profile. Excessive operation over an area, which results in an excess of mortar and water being brought to the surface, will not be permitted. Finish pavement surface on both sides of a joint to the same grade. Finish transverse joints from a securely supported transverse bridge.

3.6.1 Fixed Form Finishing

Maintain travel of machine on forms without vertical movement which will affect precision of concrete finish. Keep form tops clean by a device

attached to the machine. Finish concrete flush with top of forms.

3.6.2 Slip-Form Finishing

Remove concrete slurry from vertical edges of slip-formed concrete using stiff brushes or other approved scrapers. Do not use concrete slurry to build up edges of concrete to compensate for edge slump. In locations where sloughing occurs, attach temporary forms to underlying material in the proper location and correct defective edges. Such procedures are to be used sparingly. Should excessive sloughing occur, halt operations until proper corrective adjustments have been made.

3.6.2.1 Edge Slump

Determine slump of edges with a 4 meter straightedge. Before the concrete hardens, correct edge slump of pave exceeding 6 mm at edge of pavement. The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 450 mm from the edge.

3.6.3 Hand Finishing and Floating

As soon as placed and consolidated, strike off and screed concrete to required cross section. If necessary, place and screed additional concrete and float until a satisfactory surface has been produced. Advance floating operation not more than half the length of the float and then continue over new and previously floated surfaces. Hand finishing shall be limited to small irregular areas not accessible with finishing machine.

3.6.4 Surface Correction and Testing

After finishing is completed but while concrete is still plastic, use straightedges to eliminate minor irregularities and score marks. Use straightedges 3 m in length and operated from sides of pavement and from bridges. Equip a straightedge operated from side of pavement with a handle one meter longer than one-half the width of pavement. Check surface for trueness with straightedge held in successive positions parallel and at right angles to center line of pavement, with whole area covered to detect variations. Advance straightedge along pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed concrete, strike off, consolidate, and refinish. Strike off and refinish projections above required elevation. Continue straightedge testing and finishing until entire surface of concrete is free from observable departure from straightedge.

3.6.5 Texturing

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NOTE: Select the type of texturing for the particular use of the concrete surface: roads, and airfields. Climatic conditions must be considered for exposed concrete. Generally, specify artificial turf texture or burlap drag finish. When required specify surfaces to receive brooming.

1. Specify wire brooming for non-skid concrete surface textures. Permit steel or new fiber brooms.

2. Specify broomed finish if required in lieu of artificial turf finish. Broomed finish may cause excessive tire wear and is not recommended except for special conditions in which light mechanical brooming may be desirable.

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Law 1086. Before surface sheen has disappeared and before concrete becomes nonplastic, give the pavement surface a texture [as shown.] [as specified in paragraph entitled "Surface Finish."]

3.6.6 Surface Finish

[3.6.6.1 Artificial Turf or Burlap Drag Finish

Before concrete becomes non-plastic, finish surface by dragging a strip of clean, artificial turf or wet burlap 600 mm wider than pavement. Select dimensions so that at least 600 mm of material in the direction of travel is in contact with pavement. Drag surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks.

][3.6.6.2 Brooming

Before concrete becomes non-plastic, finish by brooming surface with a wire broom at least 450 mm wide. Gently pull the broom over surface from edge to edge just before concrete becomes non-plastic. Slightly overlap adjacent strokes of broom. Broom perpendicular to centerline of the pavement so that corrugations produced will be uniform in character and width, and not more than 2 mm in depth. Broomed surface shall be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

]3.6.7 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish edges, including the edges at formed joints, with an edge having a maximum radius of 6 mm. [If brooming is specified for the final surface finish, edge transverse joints before starting the brooming, then operate the broom to obliterate as much as possible mark left by edging tool without disturbing the rounded corner left by the edger.] Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. After removal of forms, repair damaged and honeycombed areas with mortar composed of one part Portland cement to two parts sand.

3.7 CURING AND PROTECTION

Immediately after the finishing operations have been completed and the water film has evaporated from the surface or as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with Law 1086 using one of the following methods:

[3.7.1 Liquid Membrane Curing

Uniformly coat the concrete surface with liquid membrane-forming compound with approved mechanical spray equipment at the rate of 2.7 liters per 10 square meters of surface or as recommended by the manufacturer. Irregular areas or sections of paving where the use of mechanical spraying equipment is not practicable may be sprayed with approved hand spraying equipment. Coat edges of paving within 60 minutes after the removal of forms. Protect concrete surfaces from foot and vehicular traffic and other sources of abrasion for a minimum of 72 hours. Maintain continuity of applied liquid membrane-forming compound for the entire curing period. Prior to application of curing compound, fill open joints by inserting moistened paper or fiber rope, or cover joints with strips of waterproof material to prevent curing compound from entering the joint. Seven days after application of curing compound, joints may be exposed and prepared to receive joint sealant materials.

][3.7.2 White-Burlap-Polyethylene Sheet

Thoroughly wet the burlap and cover surface and edges of paving with the burlap face in contact with the concrete. Lap sheets to provide full coverage. Maintain the sheets fully wetted and in position for the entire curing period.

][3.7.3 Polyethylene Sheeting

Apply white polyethylene to surface and edges of paving while concrete is still moist. If concrete surface appears dry, wet with a fine spray of clean water. Lap adjacent sheets 450 mm and weight to keep sheeting in contact with paving. Keep sheeting continuously in place for the entire curing period.

]3.8 FIELD QUALITY CONTROL

Sampling and testing shall be conducted on site at the expense of the Contractor, by a laboratory officially authorized by the Italian Public Work Ministry and approved by the Contracting Officer. Samples shall be supplied by the Contractor as specified at the expense of the Contractor.

3.8.1 Sampling

3.8.1.1 Aggregates

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NOTE: Specify frequency of sampling aggregates during concrete placement; e.g., 1360 metric tons for coarse aggregates; 907 metric tons for fine aggregate.

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Sample fine and coarse aggregates at the batch plant. During concrete placement sample coarse aggregates for each [_____] metric tons and fine aggregates for each [_____] metric tons. Sample in accordance with UNI EN 932-1. When test results indicate that fine aggregates consistently meet specified gradation requirements, the rate of sampling may be reduced if approved by the Contracting Officer.

3.8.1.2 Concrete

Obtain samples of plastic concrete in accordance with UNI EN 12350-1. Quality control samples may be taken at the concrete batch plant; however, samples for verification of concrete strength and slump for submittal to the Government shall be taken in accordance with UNI EN 12350-1 at the job-site as concrete is delivered. From each sample mold the required number of beams and cylinders for each group of test specimens.

3.8.1.3 Sample Identification

Tag each for identification. Tag shall contain the following information:

Contract No. [_____]

Sample No. [_____]

Date of Sample [_____]

Sample [_____]

Source [_____]

Intended Use [_____]

For Testing [_____]

3.8.2 Testing

3.8.2.1 Aggregate Tests

Perform gradation tests on each sample;UNI EN 933-1, UNI EN 933-2, UNI EN 933-8, UNI EN 933-9. Make other aggregate tests on initial source samples, and repeat tests whenever there is a change of source. During progress of concrete placement perform gradation tests for fine and coarse aggregates. Include sieve analysis for each fractional size and gradation analysis of the combined material representing the aggregate part of the concrete mix.

3.8.2.2 Concrete Testing

a. Concrete Slump: Test consistency of concrete slump in accordance with UNI EN 12350-2. Determine consistency of concrete at the start of each day's concrete placement and for each group of test specimens.

b. Air Content: Determine air content at the start of concrete placement and for each group of test specimens. Record results with test specimens. Determine air content in accordance with UNI EN 12350-7.

c. Surface Tests: After curing, test pavement surface with a straightedge or device which will reveal irregularities in the concrete surface. Irregularities in the concrete surface shall not exceed 3 mm in 3 m in both the longitudinal and transverse directions for primary roads, runways and taxiways and shall not exceed 6 mm in 3 m in both the longitudinal and transverse direction for secondary roads. Where defective areas of pavement are removed or replaced, the portion of the slab which remains in the pavement abutting the replacement slab shall have length and width not less than 3 m from the nearest edge or joint.

d. Test for Pavement Thickness: Obtain 100 mm diameter core samples to determine in-place thickness of concrete pavement. Obtain cores in accordance with UNI EN 12504-1. Remove cores at varying intervals but in no case less than one core for each [1700] [_____] square meters. Repair core holes with non-shrink grout. Measure cores in accordance with UNI EN 12504-1. A tolerance in pavement thickness of plus or minus 13 mm will be permitted for individual core; however, the average thickness of cores must be at least [_____] mm. When determining the average, cores with a thickness of more than 13 mm greater than specified thickness shall be assigned a thickness of the specified thickness plus 13 mm. If measured pavement thickness is less than that shown by more than 13 mm, remove deficient areas and replace with pavement of the specified strength, quality and thickness. When a core indicates unsatisfactory thickness, limits of the pavement to be removed and replaced shall be determined as follows: Take one core for each slab of lane in question in both directions from unsatisfactory core until satisfactory thickness is indicated; remove and replace pavement in each panel, for the full width of the lane, in which a core indicated unsatisfactory thickness. Include the following information in each of the reports of corings:

(1) Date concrete represented by core was placed

(2) Date core was taken

(3) Location of Core: Lane number, station number

(4) Thickness of core

(5) Condition of Core: Appearance, concrete texture, condition of bottom of core

(6) Disposition of Cores: In ROICC or Contractor possession.

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NOTE: The default value of age for design strength

is 14 days, for which field cured test specimines would be tested at ages of 7 and 14 days. Test data is compared to the strength/age curve of the mix design. Ages of test specimines may be modified to match project schedule.

For accelerated project schedules (short turnaround times) use the ages of 3 and 7 days; when the project permits extended curing time use the ages of 14 and 28 days; otherwise use the default values of 7 and 14 days.

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e. Flexural Strength: During progress of work verify flexural strength by testing beams made from concrete taken from the delivery vehicle at intervals specified herein. Mold and cure beams in accordance with UNI 6127. Perform tests in accordance with UNI 6133. Mold at least ten beams each day from concrete placed that day. Select one group of five beams near the beginning of the work and a second group of five beams from the final third of concrete to be placed that day. An approved laboratory shall furnish necessary labor, concrete and facilities for molding, handling, and storing the beams at the site of the work and testing beams. Perform tests at [3][7][14] days and [7][14][28] days.[Earlier tests may be performed at the Contractor's request, with no additional cost to the Government.] Concrete shall meet the following requirements:

(1) From each group of five beams, three beams tested at [7][14][28] days shall have an average flexural strength equal to or greater than the specified strength. Specimens obviously defective shall not be considered in the determination of the strengths.

(2) No individual beam of the three beams tested shall have a flexural strength less than 4.1 MPa. Discard defective beams.

(3) Test two beams of the group at [3][7][14] days. If the ratio of the [3/7][7/14][14/28]-day strength is less than expected (compared to the mix design strength/age curve), make necessary adjustments for conformance.

(4) When a satisfactory relationship between the [3/7][7/14][14/28]-day strengths has been established and approved by the Contracting Officer or his authorized representative, the [3][7][14]-day test results may be used as an indication of the [7][14][28]-day strengths. If test results of any concrete to be used in the project show that the concrete strength is below the specified limits and does not meet other requirements of this specification, the Contractor shall make necessary adjustments, as approved by the Contracting Officer or his authorized representative at the Contractor's expense. Concrete which at the end of 60 days does not meet the specified strength shall be removed or otherwise corrected at the Contractor's expense, with

corrective methods subject to the approval of the Contracting Officer or his authorized representative.

(5) If the [7][14][28] day strength test results do not meet the requirements specified herein, the Contractor shall take a minimum of three core samples from the in-place work represented by the low strength test results and test UNI EN 12504-1, at no cost to the Government. Concrete represented by core tests shall be considered structurally adequate if the average of the three cores is equal to at least 100 percent of the specified design strength. Remove concrete not meeting the strength criteria and provide new, acceptable concrete. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete.

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NOTE: Use the text below for contracts which require concrete quantities of 1500 cubic meters and more.

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[f. Control Charts: Maintain control charts for concrete flexural strength in accordance with UNI 6133, except as otherwise modified herein. Post copies of charts at the job site. Indicate specified mix design strength and average strength determined by specimine testing. Each control chart shall consist of the following plots:

(1) Test Results: At the same location, plot each individual test strength (the average results of two beams tested at [3][7][14] days and the average results of three beams tested at [7][14][28] days).

(2) Moving Average for Strength: Moving average of five consecutive tests UNI 6133.

]3.8.2.3 Reinforcment

Steel reinforcment shall be tested in accordance with Law 1086 and D.M. 9-1-96 or the latest updated revision, with UNI 5294 and UNI CNR 10020. Specimen preparation and testing shall be carried out in accordance with UNI ENV 10080.

3.9 PAVEMENT PROTECTION

Protect pavement against damage. Exclude traffic by erecting and maintaining barricades and signs until concrete is at least [7][14][28] days old. Subgrade planer, concrete finishing machines, slipform pavers and similar equipment may be permitted to ride upon surface of previously constructed slabs when concrete has attained a minimum flexural strength of 3.5 MPa. For fill-in lanes, use equipment that will not damage or spall edges of joints of previously constructed pavement.

-- End of Section --