

1.01 SUMMARY:

- A8 (deleted text) A8

1.02 ^{A16}REFERENCES:^{A16}

- October 2008
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- Amendment No. 17

EN 1994	Eurocode 4. Design of Composite Concrete and Steel Structures.
EN 206-1	Concrete – Part 1: Specification performance, production and conformity
EN 197-1	Cement – Part 1: Composition, specifications and conformity criteria for common cements

1.03 REQUIREMENTS:

A. General:

1. Cement shall be in accordance with the recommendations of ASTM C 150, or ASTM C 595.
2. Aggregates shall meet the requirements of ASTM C 33 and shall ^{A5}be classified as not being potentially reactive with alkalis in the concrete mix, in accordance with Appendix XI in ASTM C 33. ^{A5}
3. Supplementary cementing materials shall be in accordance with the recommendations of ACI 232.1R for natural pozzolan, ACI 232.2R for fly ash, and ACI 233R for ground granulated blast-furnace slag (GGBFS) ^{A5}, and ACI 234R for silica fume. ^{A5}
4. Chemical admixtures shall be in accordance with the recommendations of ACI 212.3R.
5. Concrete shall be in accordance with the recommendations of ACI 117, ACI 201.2R, ACI 304R, ACI 305R, and ACI 308R. ^{A5}Maximum water soluble chloride ion content of hardened concrete, at ages between 28 and 42 days, shall not exceed 0.15 percent for marine concrete and shall not exceed 0.30 percent for other concrete, measured as percent by weight of cement. Waters soluble chloride ion content shall be tested in accordance with ASTM C 1218. ^{A5}
6. Formwork shall be in accordance with the recommendations of ACI 347.
7. Reinforcing bars shall meet the requirements of ASTM A 615 or ^{A5}ASTM A 706^{A5} for deformed and plain bars, ASTM A 767 for zinc-coated bars, and ASTM A 775 for epoxy-coated bars. ^{A10}Reinforcing bar diameters may be in SI units or American Standard sizes. ^{A10}
8. Measuring, mixing, transporting, and placing of concrete shall be in accordance with the recommendations of ACI 304R.
- ^{A5}9. Protect materials from contamination or deterioration during shipping and handling. ^{A5}
- ^{A5}10. On-site batching of concrete shall conform to specified industry standards and shall be of sufficient capacity for the anticipated work. Aggregates stockpiles shall be adequately protected against excessive heat, excessive moisture variations, and salt contamination. ^{A5}

B. Placing Concrete:

1. **Pumping:** The process shall conform recommendations of to ACI 304R and ACI 304.2R as a minimum.
2. **Hot Weather:** The precautions shall conform to recommendations of ACI 305R as a minimum. ^{A5}The temperature of the concrete at the time of placing shall not exceed 35-degrees Celsius (95-degrees Fahrenheit). ^{A5}
3. **Depositing Concrete under Water:** Methods and equipment shall conform to the recommendations of ACI 304R as a minimum.
- ^{A5}4. **Silica Fume Concrete Mixes:** Concrete finishers shall be specifically trained in finishing concrete containing silica fume, due to reduced bleed water and increased stickiness. ^{A5}

C. Curing and Protection:

1. All concrete shall be cured using the moist (wet) curing method(s), unless specified otherwise and approved by Employer's Representative for a specific condition. ^{A5}Early moisture loss shall be controlled to prevent plastic shrinkage cracking. ^{A5}
2. Procedures shall conform to ACI 301 and the recommendations of ACI 308, unless otherwise specified.
3. **Curing Periods:** The materials and methods of curing shall be subject to approval by the Employer's Representative. ^{A5}The minimum curing duration shall be 7 days unless approved by the Employer's Representative. Additional curing may be necessary for slower curing concrete mixes. ^{A5}

D. ^{A16}Repair of Defects: Defects shall be repaired to the satisfaction of the Employer's Representative. ^{A16} Defects shall be defined by the ACI 301 requirements for structural concrete or by the following, whichever is more stringent.

1. Pockets of honeycomb (uncemented coarse aggregate) are found covering an area that is at least 650 square cm and more than ^{A5}10 mm ^{A5} deep.
2. Sand streaks (pockets or streaks of uncemented fine aggregate) are found covering an area that is at least 650 square cm and more than ^{A5}10 mm ^{A5} deep.
3. Corners of forms are not filled.
4. The bottom of concrete is not down to indicated levels, or uncemented material appears at the bottom.
5. Members do not meet required tolerances.
6. The concrete fails to set-up.
- ^{A5}7. Visible cracks exceeding 0.25 mm (0.010 inches) in width and actively leaking cracks at liquid-holding basins. ^{A5}

1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:

A. **Structural Marine Concrete:** This Subparagraph covers the requirements for structural marine concrete. Included in this Subparagraph are lock walls, approach structures, lock heads, lock floors, Water-Saving Basins and conduits, and Crossunders.

1. The concrete shall have a design life of 100 years.
2. The concrete shall conform to recommendations of ACI 201.2R and ACI 222.R. Mass concrete shall conform to recommendations of ACI 207.1R. Use low heat and sulphate resisting concrete mixtures where required.

^{A16}3. (Reserved) ^{A16}

4. ^{A5}The ^{A5} use of fly ash or ground granulated blast-furnace slag in the mixture is encouraged. Consideration shall be given to heat dissipation, permeability, setting time, strength gain, curing time, ^{A5}especially ^{A5} for mass concrete placements.
5. Where concrete elements retain water, such as at water conduits, Water-Saving Basins, etc, the concrete elements shall conform to applicable requirements for water-retaining concrete structures.
6. ^{A5}Minimum concrete cover at reinforcing bars shall be 75 mm at marine concrete structures unless approved by the Employer’s Representative. ^{A5}

7. Required characteristics of concrete mixtures:

Minimum compressive strength ^{A5} based on cylinder tests ^{A5}	^{A5} as required by design ^{A5}
Maximum water-cementitious materials ratio	^{A5} 0.40 ^{A5}
^{A5} Permeability: maximum total charge passed per ASTM C 1202 ^{A5}	^{A5} 1,000 Coulombs ^{A5}

- a. The mixture proportions shall be developed by the Contractor to produce the design strength ^{A5}and durability ^{A5} required, and to provide durability, workability, and mixture consistency to facilitate placement and consolidation into the forms and around reinforcement, without segregation or bleeding.
- b. ^{A5}Permeability testing shall be in accordance with ASTM C 1202. Perform tests on five samples and report the average passed charge. Discard any tests that vary from the average by more than 30 percent and recalculate the average of the remaining tests. ^{A5}
- c. ^{A5}Concrete shrinkage shall be tested in accordance with ASTM C 157, except that air storage shall commence at the age of 7 days and test specimens shall be stored in the drying room for 28 days. The average shrinkage of three test specimens after 28 days of air storage shall not exceed 0.042 percent relative to the initial comparator reading. ^{A5}

- d. ^{A5}For mass concrete placements, the internal and external concrete temperatures shall be monitored and the maximum difference between them at any point in time shall not exceed 20-degrees Celsius (36-degrees Fahrenheit) and the maximum internal temperature of the concrete shall not exceed 70-degrees Celsius (160-degrees Fahrenheit). Also the temperature difference between the outside of the concrete and the adjacent air temperature shall not exceed 20-degrees Celsius (36-degrees Fahrenheit). Concrete constituents shall be cooled and ice shall be used in accordance with industry standards as needed to control heat at mass concrete placements. A request for consideration of alternate temperature limits may be made based upon submittal of detailed thermal analyses in accordance with ACI 207.1R. ^{A5}
- ^{A5}e. Maximize aggregate size for mass concrete placements. Coordinate reinforcement spacing with aggregate sizing. ^{A5}

B. **Structural Concrete:** This Subparagraph covers the concrete required for structural concrete for buildings and miscellaneous structures. Included in this Subparagraph are buildings and structures located at or above the level of the lock walls.

1. The concrete shall have a design life of 50 years.
2. ^{A5}Minimum concrete cover at reinforcing bars shall be 50 mm (2-in) at exterior exposed concrete surfaces of concrete structures unless approved by the Employer's Representative. ^{A5}
3. **Required characteristics of concrete mixtures shall be as follows:**

Minimum compressive strength ^{A5} based on cylinder tests ^{A5}	21 MPa
Maximum water-cementitious materials ratio	^{A5} 0.50 ^{A5}

- a. The mixture proportions shall be developed by the Contractor to produce the design strength required and to provide durability, workability, and mixture consistency to facilitate placement and consolidation into the forms and around reinforcement, without segregation or bleeding.
- b. ^{A5}The concrete to be used on exposed faces of structures within the lock complexes shall include requirements for special exposure conditions due to the spray from salt or brackish water. ^{A5}
- c. ^{A5} (Reserved) ^{A5}
- d. ^{A5} (Reserved) ^{A5}

C. **Roller-Compacted Concrete:**

1. The design life of roller-compacted concrete (RCC) shall correspond to the type of structure where it is being utilized.
2. The concrete shall be in accordance with the recommendations of ACI 201.2R and ACI 207.5R.

3. **Main characteristics of concrete mixtures shall be as follows:**

Minimum compressive strength	15 MPa
Maximum water-cementitious materials ratio	0.55

- a. The mixture proportions shall be developed by the Contractor to produce the design strength required and to provide durability, workability, and mixture consistency to facilitate placement, and consolidation, as well as to ensure watertightness at the lift joints.
- b. Fly ash ^{A5} and ^{A5} or ground granulated blast-furnace slag may be used in the concrete mixture. Tests shall be made using actual job materials to ascertain the early and later age strengths and durability performance required.

1.05 SUBMITTALS: All drawings and other submittals shall be submitted in accordance with the requirements of Section 01 33 00 (*Submittal Procedures*) and the requirements of this Section.

- A. **Intermediate Design:** ^{A16}When the design has advanced sufficiently to allow the Employer to review it, the Contractor shall submit the following information to the Employer's Representative. ^{A16}

1. **For the Lock Walls, Approach Walls, Lock Heads, Lock Floors, Water-Saving Basins and Conduits, Crossunders, and Valve Chambers:**

a. **Drawings Showing:**

- 1) Proposed structure dimensions and joint locations, and details.
- 2) Reinforcing layout.

b. **Documentation:**

- 1) ^{A5}Report identifying the proposed ^{A5} concrete types and mixes, including ^{A5} complete ^{A5} test reports that substantiate the design strength, ^{A5} durability ^{A5} and permeability. ^{A5}Sources and material properties for all constituents in the concrete mix shall be identified. ^{A5}

c. **Draft Specifications.**

2. **For Buildings and Miscellaneous Structures:**

a. **Drawings Showing:**

- 1) Complete structure dimensions and joint locations, and details.
- 2) Reinforcing layout.

- b. ^{A16}**Documentation:** Proposed concrete types and mixes, including test reports that substantiate the design requirements and identify sources and material properties for all constituents in the concrete mix. ^{A16}

c. **Draft Specifications.**

B. ^{A16}**Final Design:** The Contractor shall submit the following information for review. ^{A16}

1. **For Lock Walls, Approach Walls, Lock Heads, Lock Floors, Water-Saving Basins and Conduits, Crossunders, and Valve Chambers:**

a. ^{A5}**Final** ^{A5}**Drawings Showing:**

- 1) Complete structure dimensions and joint locations and details.
- 2) Reinforcing details.

b. **Documentation:**

- 1) Final concrete types and mixes, including ^{A5}complete ^{A5} test reports that substantiate the design requirements ^{A5}, including strength, durability, and permeability. Sources and material properties for all constituents in the concrete mix shall be identified. ^{A5}
- 2) Manufacturer's data for joint sealants.
- 3) Manufacturer's data for joint filler.
- 4) Substantiation for durability of concrete.
- 5) Substantiation for watertightness of concrete.

c. ^{A5}**Final** ^{A5}**Specifications.**

2. **For Buildings and Miscellaneous Structures:**

a. **Final Drawings Showing:**

- 1) Complete structure dimensions and joint locations, and details.
- 2) Reinforcing details.

b. **Documentation:** Final concrete types and mixes, including test reports that substantiate the design requirements. ^{A5}Sources and material properties for all constituents in the concrete mix shall be identified. ^{A5}

c. **Final Specifications.**

C. ^{A5}**Construction:**

1. **Concrete Placement and Compaction:** The Contractor shall submit the method statement for placing and curing concrete, including detailed procedures for placing concrete in hot weather or in mass concrete placements. ^{A5}

2. **Material Test Reports:** The Contractor shall submit reports for the following.

- a. Aggregates tested in accordance with ASTM C 33.

- b. Admixtures tested in accordance with ASTM C 494, ASTM C 1017, and testing specified herein, as well as air-entraining agents tested in accordance with ASTM C 260.
 - c. Cement tested in accordance with ASTM C 150 for Portland cement and ASTM C 595.
 - d. Fly ash and natural pozzolan tested in accordance with ASTM C 618.
 - e. Ground granulated blast-furnace slag tested in accordance with ASTM C 989.
 - f. Water tested in accordance with ASTM D 512 and ASTM D 516.
 - ^{A5}g. Silica Fume tested in accordance with ASTM C 1240. ^{A5}
3. **Concrete:** The Contractor shall submit the following.
- a. **Mix Designs:** Reports on strength tests conducted in the field for all concrete used, specifications and reports for materials used, and other ^{A5}required ^{A5} test results.
 - b. Time/strength curves for the various mix designs.
 - c. Permeability test results where required.
 - d. Test reports by independent test labs conforming to ASTM C 1077 and showing that the mixture has been successfully tested to produce concrete with the properties specified and that it will be suitable for the job conditions.
 - e. Describe the processes and methodology whereby the mixture proportions were developed and tested and how proportions will be adjusted as the work progresses to achieve, as closely as possible, the designated levels of relevant properties.
 - f. Shop drawings.
4. **Formwork:** The Contractor shall submit the following.
- a. Design calculations or manufacturer's data.
 - b. Specifications.
 - c. Placement and removal schedules.
 - d. Methods for forming joints ^{A5}in concrete. ^{A5}
 - e. Locations of inserts, pipe work, conduits, sleeves, and other embedded items.
5. **Reinforcement Steel:** The Contractor shall submit certificates of compliance with the ASTM standards stated in this Section.

1.06 QUALITY ASSURANCE:

- A. All requirements of Section 01 40 00 (*Quality Requirements*) shall apply to this Section.
- B. All concrete mixtures shall be fully tested to show conformance to required properties prior to use on the project.
- C. **Quality Control:** The Contractor shall submit ^{A5}the ^{A5} proposed quality-control plan for:
 - 1. Concrete production operations.
 - 2. Concrete testing, records, and procedures to verify that the concrete meets the design requirements.
 - 3. Procedures for ensuring that tolerances are met. Tolerances shall not be cumulative.
 - 4. Procedures for ensuring that reinforcement and embedded items are correctly placed.
- ^{A5}D. **Trial Concrete Placement:** At least 63 days prior to full production for construction, a trial placement of Structural Marine Concrete shall be performed to confirm placing, finishing, and curing practices. Additional trial placements may be required if results of the initial trial placement are unsatisfactory. ^{A5}

END OF SECTION

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