# TECHNICAL SPECIFICATIONS

## ITEM 2

## CONCRETE

1. Description: The requirements of this item shall govern for all concrete for structures, curb and gutter, and incidentals or miscellaneous construction.

   Concrete shall be composed of Normal Portland Cement or High Early Strength Cement, coarse aggregate, fine aggregate and water proportioned and mixed as hereinafter provided in these specifications.

2. Materials:

   A. Cement: Only one brand of cement shall be used in any one (1) structure, except by written permission of the City Engineer. When such permission is granted and more than one (1) brand is used in one (1) structure, the resulting concrete shall be uniform in color.

   Portland Cement shall meet the requirements of the current Standard Specifications for Portland Cement of the ASTM Designation C-150, Type I, for Normal Portland Cement, Type III for High Early Strength Portland Cement and Type II will have a maximum of five (5) percent tricalcium aluminate for exposure to sewage.

   All cement shall be sampled and tested in accordance with the current Standard Methods of Sampling and Testing Portland Cement of the ASTM Designation C-183, C-184, C-188, C-190 and C-191.

   B. Mixing Water: Water for use with cement shall be clean and free from injurious amounts of oil, acid, alkali, salt, organic matter or other deleterious substances. Water from doubtful sources shall not be used until tested and approved.

   Water which is suitable for drinking or for ordinary household use may be accepted for use without being tested.

   C. Coarse Aggregate: Coarse aggregate shall consist of gravel or crushed stone meeting the requirements of the current ASTM Specifications C-33.

   When tested by the Standard Method for Testing for Abrasion of Coarse Aggregate by use of the Los Angeles Testing Machine, ASTM Designation C-131, coarse aggregate shall have a percentage of wear of not more than forty (40).

   Coarse aggregate for Class F concrete shall have a minimum of fifty (50) percent calcium carbonate equivalent.

   When tested by approved methods, the coarse aggregate shall conform to the following grading requirements:

Maximum Size Aggregate

1-1/2"

| | |
|---|---|
| Retained on 1 1/2" screen | 0 to 5% |
| Retained on 3/4" screen | 25 to 60% |
| Retained on 1/4" screen | 95 to 100% |

1"

| | |
|---|---|
| Retained on 1" screen | 0 to 5% |
| Retained on 1/2" screen | 25 to 60% |
| Retained on 1/4" screen | 95 to 100% |

D. Fine Aggregate: Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof, conforming to the current ASTM Specification C-33.

When tested in accordance with the Standard Method of Test of Organic Impurities in Sands for Concrete, ASTM Designation C-40, the fine aggregate shall not show a color darker than the standard color.

When tested by approved methods, the fine aggregate shall conform to the following grading requirements:

| | |
|---|---|
| Retained on 3/8" screen | 0% |
| Retained on 1/4" screen | 0 to 5% |
| Retained on 20 mesh sieve | 15 to 50% |
| Retained on 100 mesh sieve | 85 to 100% |

E. Concrete Admixtures:

(1) Water Reducing Agent shall conform to ASTM C-494 Type A, and shall have a dosage as recommended by the manufacturer. Admix shall be Pozzolith by Master Builders Co.; WRDA by W.R. Grace; PSI by Gifford Hill & Company or approved equal.

(2) Set Retarding Agent: When, in the opinion of the Engineer, the ambient or concrete temperature requires the use of a set retarding admixture, such admix shall conform to ASTM C-494, Type D. Admixtures shall be PSI-R by Gifford Hill; Daratard by W.R. Grace, or approved equal.

(3) Air Entaining Admixture shall be used where specified or directed to improve workability and increase resistance to freeze and thawing, and scaling. The admix shall comply with ASTM C 260 and shall be used in accordance with manufacturer's recommendations. Products shall be Air-Tite by Gifford Hill; Daravair by W.R. Grace; MB-VR by Master Builders, or approved equal.

The total air content of the concrete shall be three (3) percent to six (6) percent.

F. Curing and Sealing Compound: All concrete shall be cured and sealed with a continuous acrylic membrane forming compound meeting the requirements of ASTM C-309. Curing compound shall be applied as soon as practical after placement of concrete and shall be used in accordance with the manufacturer's recommendations. Products shall be Sealco 309 by Gifford-Hill; Horn Clear Seal by W.R. Grace and Company, or an approved equal.

G. Bonding Agent: Bonding agent shall be a liquid polymer latex compound such as Daraweld-C manufactured by W.R. Grace and Company or an approved equal.

H. Reinforcing Steel:

(1) Bar Steel: All bar reinforcement shall be open hearth new billet steel of structural, intermediate, or hard grade. New billet steel shall conform to the requirements of the latest Standard Specification for Billet-Steel Concrete Reinforcement Bars, ASTM Designation A-15.

Unless otherwise shown on the plans, all reinforcing bars shall be deformed bars. Twisted bars are not considered as deformed bars and will not be used. The form of deformed bars shall be such as to provide a net sectional area at all points equivalent to that of the plain round bars of equal nominal size.

(2) Wire Fabric: Wire for fabric reinforcement shall be cold-drawn from rods hot rolled from open hearth billets. Wire shall conform to the requirements of the latest Standard Specification for Drawn Wire for Concrete Reinforcement, ASTM Designation A-82.

I. Premolded Expansion Joint Filler shall conform to the requirements of ASTM Designation D-994 or other as approved by City Engineer.

3. Equipment: The Contractor shall obtain the Inspector's approval of all concrete mixing, handling and transporting equipment before any pour of concrete is commenced. Such approval will not relieve the Contractor of his responsibility for providing adequate equipment to carry on satisfactorily the project operations.

4. Batching and Mixing: All batching and mixing of concrete materials shall conform to ACI 304-73 "Recommended Practice for Measuring, Mixing and Placing Concrete". All materials shall be measured separately and accurately and batches shall be uniform. The coarse and fine aggregate shall be measured or weighed, loose and separately.

When transit mix concrete is used, the delivery of concrete shall be continuous at regular and uniform intervals, without stoppages or interruptions. Transit mix concrete shall not be placed in the job after a period of forty-five (45) minutes after the cement has been placed in the mixer.

5. Consistency: In general, the consistency of concrete mixtures shall be such that:

A. The mortar will cling to the coarse aggregate.

B. The aggregate will not segregate in the concrete when it is transported to the place of deposit.

C. The concrete and mortar will show no free water when removed from the mixer.

D. The surface of the finished concrete will be free from a surface film of "laitance".

Any concrete mix failing to meet the above outlined consistency requirements, although meeting the slump requirements, will be considered unsatisfactory, and the mix shall be changed to correct such unsatisfactory conditions.

6. Classification and Proportions: Concrete shall be proportioned as determined by the Inspector. The total volume of materials in the concrete mixture shall be so regulated that the cement content per cubic yard of concrete shall not be less than the minimum specified for that class of concrete.

A. The concrete shall be uniform and workable and the minimum cement content, maximum water content, and the maximum slump for the various classes of mixes shall conform to the following:

| Class | Min. Cement Bags/C.Y. | Max. Size Coarse Ag. (Inches) | Max.Water Gals./Bag (Net) | Max. Slump (Inches) |
|---|---|---|---|---|
| A | 5.5 | 1.5 | 6.75 | 5 |
| B | 5.0 | 1.5 | 7.00 | 4 |
| C | 6.0 | 1.0 | 6.25 | 5 |
| D | 6.5 | 1.5 | 6.25 | 5 |
| E | 3.0 | 1.5 | 6.25 | 4 |
| F | 6.0 | 1.5 | 5.50 | 4 |

The maximum amount of coarse aggregate (dry loose volume) per cubic foot of finished concrete shall not exceed zero-point-eighty-two (0.82) cubic feet.

The maximum amount of water, as set forth in the table above, is based upon the assumption that the aggregates are in a saturated, surface dry condition.

B. The concrete mix will be designed with the intention of producing concrete which will have compressive or flexural strength equal to or greater than the following when using current ASTM Designation C-39 and C-293.

| Class of Concrete | Compressive Strength (Pounds Per Square Inch) | | Flexural Strength (Pounds Per Square Inch) | |
|---|---|---|---|---|
| | 7-Day | 28-Day | 4-Day | 7-Day |
| A | 2,000 | 3,000 | 400 | 500 |
| B | 1,700 | 2,500 | 350 | 425 |
| C | 2,000 | 3,000 | 400 | 500 |
| D | 2,000 | 3,000 | 400 | 500 |
| E | 1,000 | 1,500 | 150 | 250 |
| F | 2,700 | 4,000 | - | - |

C. The following class of concrete will be used as shown, unless otherwise specified:

| Class | Use |
|---|---|
| A | Formed Structures, such as: Walls, Decks, Structural Foundations, Floor Slabs, Paving, Culverts, Storm Sewer Manholes and Inlets, except Water Retaining Walls and Structures exposed to sewage. |
| B | Unformed Structures, such as: Riprap, Sidewalks, Curb and Gutter, Gutter, Valleys, Exposed Encasement or as noted on Plans. |
| C | Drilled Shafts and Thin Wall Sections, Formed Septum Walls. |
| D | Railings, Stairs and Unformed Foundation Seals. |
| E | Confined Cradling, Blocking, Backfill, unexposed Encasement below grade, or Backfill. |
| F | Structures exposed to Sewage and Water Retaining Walls. |

In order to obtain a more workable mix and denser concrete, there shall be added as a part of the concrete for Class "A" and Class "F" concrete a cement dispersing or water reducing agent conforming to ASTM Specification C-494, Type A. The agent shall be added in accordance with the manufacturer's recommendations.

The quantity of water to be used shall be determined by the Engineer and shall be such as to give a mixture containing the minimum amount of water consistent with the required workability. The quantity of water shall be varied only by the Engineer.

7. Quality of Concrete: During the progress of the work the Inspector may cast test cylinders or beams for testing to maintain a check on the compressive or flexural strength of the concrete actually placed.

Test beams or cylinders shall be required for each fifty (50) cubic yards or portion thereof, placed each day. On small structures, such as manholes, inlets, culverts, wing-walls, etc., the Inspector may vary the number for small placements to tests for each twenty-five (25) cubic yards, placed over a several-day period.

8. General Construction Requirement for Concrete Structures:

A. Prior to starting work the Contractor shall inform the Inspector as to the methods of construction and the amount and character of equipment he proposes to use, the adequacy of which shall be subject to the approval of the Inspector.

B. Forms and falsework to be used in the construction of the various units of a structure shall be in accordance with all governing safety requirements and shall be the responsibility of the Contractor.

C. Approval by the Inspector of construction methods, equipment, or form and falsework plans will not relieve the Contractor of responsibility for the safety or correctness of methods used, adequacy of equipment, or from carrying out the work in full accordance with the contract.

9. Concrete Delivery: The rate of delivery of transit mixed concrete shall be so arranged that a cold joint is not allowed to form between loads. Concrete shall be hauled in vehicles so constructed and operated to provide constant agitation during transportation. Concrete improperly mixed shall not be placed in the structure.

   The transit mixer shall be of an approved revolving drum or revolving blade type so constructed as to produce a thoroughly mixed concrete with a uniform distribution of the materials throughout the mass and shall be equipped with a discharge mechanism which will insure the discharging of the mixed concrete without segregation.

   The mixer drum shall be water-tight when closed and shall be equipped with a locking device which will automatically prevent the discharging of the mixer prior to receiving the required number of revolutions.

   The entire quantity of mixing water shall be accurately measured and controlled. Each batch shall be mixed to the consistency as described in paragraph 5 above. Any additional mixing shall be done at a slower speed specified by the manufacturer for agitation and shall be continuous until the batch is discharged.

10. Construction Joints: Construction joints shall be placed as shown on the plans unless otherwise specifically authorized by the Engineer, in which case the joints shall be so placed and formed as to least impair the strength and appearance of the structure. All construction joints shall be made on horizontal and vertical planes and formed with mortises or keys made in the concrete unless shown otherwise on the plans.

11. Forms: Nominal one (1) inch lumber surfaced to a uniform width and thickness will be permitted for general use on the various portions of structures, if backed by a sufficient number of studs and wales.

    Forms shall be mortar tight, and of sufficient strength to prevent bulging between supports. Forms shall be maintained to the lines designated until the concrete is sufficiently hardened to permit form removal and until the minimum time for forms to remain in place has elapsed in accordance with ACI Standard 318-71 "Building Code Requirements for Reinforced Concrete (ASI318-71)".

    Where corners occur, suitable chamfer strips shall be placed at the angle of the forms to round off or level them. All forms shall be constructed so as to permit removal without injuring the concrete. At the time of placing concrete, the forms shall be clean and entirely free of all chips, dirt, sawdust, and other extraneous matter.

    For thin wall sections and other locations where access to the bottom of the forms by other methods would be cumbersome and inadequate, clean-out opening shall be provided.

    Only spreaders approved by the Inspector shall be used.

    Metal form ties of an approved type shall be used to hold forms in place. Such ties shall be of a type especially designed for use in connection with concrete work, and they shall have provision to permit ease of removal of the metal as hereinafter specified. The use of metal form ties of a type that are encased in paper or other materials to allow the removal of the complete tie, leaving a hole through the concrete structure, will not be permitted. Metal ties shall be held in place by devices attached to walls. Each device

shall be capable of developing the strength of the tie.

All cavities produced by the removal of metal ties shall be carefully cleaned and completely filled with retempered sand cement mortar mixed in proportion of one to three, and the concrete shall be left smooth and even.

12. Placing Concrete:

A. General: The Contractor shall give the Inspector at least twenty-four (24) hours advance notice that he intends to pour concrete in any unit of the structure. The mixing of concrete and placing of same in the forms shall not be commenced until the Engineer has given his approval. No concrete shall be placed in any unit prior to completion of the form work and the placement of the reinforcing and other steel.

Where the Contractor's operations involve the placing of concrete from above directly into an excavated area or through the completion of forms, all concrete so placed shall be deposited through a vertical sheet metal or other approved pipe or tremie not less than six (6) inches nor more than ten (10) inches in diameter. The pipe shall be made in sections so that the outlet may be adjusted to proper heights during placing operations.

Concrete shall be placed in continuous horizontal layers approximately twelve (12) inches in thickness. The rate of delivery shall be so arranged that a cold joint is not allowed to form between loads. The Contractor shall avoid unauthorized construction joints by placing required portions of abutments, piers, walls, floors, slabs columns or superstructures in one continuous operation. As a safety precaution, openings in the forms shall be provided for the removal of laitance and other foreign material.

All concrete shall be well compacted and the mortar flushed to the surface of the forms of continuous working with concrete spading implements and mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted. The vibrators shall be applied to the concrete immediately after deposit and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms until it has been reduced to a plastic mass. The mechanical vibrator shall not be operated so that it will penetrate or disturb layers placed previously which have become partially set or hardened. The vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be done to an extent that will cause segregation. Vibration shall be supplemented by hand spading to insure the flushing of mortar to the surface of all forms.

B. Foundation and Footings: Concrete shall not be placed in footings until the depth and character of the foundation has been inspected and permission has been given to proceed.

Concrete in deep foundations shall be placed in a manner that will avoid separation of the aggregates or displacement of the reinforcement. Suitable chutes or vertical pipes shall be provided.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted, if desired by the Contractor and approved by the Engineer, and the entire excavation filled with concrete to the elevation of the top of the footing.

C. Weather Conditions for Placement: No concrete shall be placed when the atmospheric temperature is

at or below forty (40) degrees F (taken in the shade away from artificial heat) unless permission is given or in cases where the temperature drops below forty (40) degrees F after the concreting operations have been started.

The Contractor shall furnish sufficient canvas and frame work or other type of housing to enclose and protect the structure in such a way that the air around the forms and fresh concrete can be kept at a temperature not less than fifty (50) degrees F for a period of five (5) days after the concrete is placed.

Sufficient heating apparatus such as stoves, salamanders, or steam equipment and fuel to furnish all required heat shall be supplied.

D. Installation of Premolded Expansion Joint Filler shall be made where indicated, and the filler shall extend through the entire section of the structure.

13. Finishing:

A. Slabs, Valve Vault, Tops, Etc.: As soon as concrete placing operations have been completed for a slab section of sufficient width to permit finishing operations, the concrete shall be approximately leveled and then struck, off, tamped, and screeded using a longitudinal screed. The screed shall be of a design adaptable to the use intended, shall have provisions for vertical adjustment, and shall be sufficiently rigid to hold true to shape during use.

The initial strike off shall leave the concrete surface at an elevation slightly above grade so that, when consolidation and finishing operations are completed, the surface of the slab will be at the grade elevation shown on the plans with proper allowance for finished camber when required.

Tamping and screeding operations shall be continued until the concrete is properly consolidated and the surface voids are eliminated. The surface shall then be brought to a smooth true alignment by means of longitudinal screeding, floating, belting, and/or other methods approved by the Engineer. When templates are used, they shall be of such design as to permit early removal in order to avoid construction joints and to permit satisfactory finishing at and adjacent to the site of the template.

While the concrete is still plastic, the surface shall be straightedged by the use of a standard ten (10) foot metal straightedge. Deviations in excess of permissible variations shall be corrected. The final surface finish of the slab shall be done after the initial straightedging, and corrective adjusting, if required, is completed, as specified hereinafter.

B. Formed Surfaces: Immediately after forms are removed, the formed surfaces shall be finished as follows:

(1) Any honeycomb areas shall be chipped out to firm concrete and thoroughly cleaned of chips and particles of broken concrete. A bonding agent shall then be applied to the entire surface of the cavity, and the cavity packed with a relatively dry mortar of the same sand-cement ratio as the concrete mix used in the structure. The mortar shall be thoroughly compacted to insure complete filling of the cavity and the surface struck off to match the surrounding concrete.

(2) Exterior surfaces that will be more than one (1) foot below grade will require no further finish.

(3) Exterior surfaces to be exposed to view and to a point one (1) foot below finish grade, and interior

exposed surfaces, shall be finished as follows.

All fins, form marks or offsets, and other protrusions shall be removed and surface voids shall be filled or pointed with grout. After the pointing has dried sufficiently to permit rubbing, all surfaces shall be wetted and given a surface rubbing with a No. 16 Carborundum stone or an abrasive of equal quality. The rubbing shall be continued sufficiently to bring the surface to a paste, to remove all form marks and projections, and to produce a smooth dense surface without pits or irregularities. The material that has been ground to a paste shall be carefully spread or brushed uniformly over the surface and allowed to take a reset. The use of cement to form a surface will not be permitted.

C. Floor and Slab Finishes: Finish treatment of floors and slabs to be provided after the initial treatment specified under "A" above shall be as follows:

(1) Sidewalks: The sidewalk shall be floated with a steel trowel to provide a smooth, burnished surface. After floating and before the finish has set, the surfaces shall be lightly brushed with a fine brush to remove the surface cement film, leaving a fine grained, smooth but sand texture.

(2) Concrete Valleys, Driveways, Vault Tops and Floors, Etc.: After the initial treatment specified in "A" above, and after the surface has become firm, the surface shall be given a single floating with a wood float to provide a uniform surface.

(3) Other slab surfaces shall be finished with one of the above finishes, or not finished, as otherwise specified or as approved by the City Inspector.

14. Curing Concrete: Immediately after finishing, all upper non-formed surfaces shall be covered with a continuous, uniform, water impermeable coating. Immediately after removal of the side and end forms of non-exposed surfaces, and after required finishing of exposed surfaces, the formed surfaces of all concrete shall receive a like coating. The solution shall be applied under pressure with a spray nozzle in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film.

The rate of application shall be such as to insure complete coverage, but the area covered shall not exceed two hundred (200) square feet per gallon of curing compound.

The coating shall be sufficiently transparent and free from permanent color to result in no pronounced change in color from that of the natural concrete at the conclusion of the curing period. It shall, however, contain a fugitive dye of color strength to render the film distinctly visible on the concrete for a period of at least four (4) hours after application.

Under normal conditions, the curing compound, after application, shall dry to touch within one (1) hour and shall dry thoroughly and completely within four (4) hours. When thoroughly dry, it shall provide a continuous flexible membrane free from cracks or pinholes and will not disintegrate, check, peel, or crack during the required curing period. If for any reason the seal is broken during the curing period, it shall be immediately repaired with additional sealing solution.