

## Appendix C Concrete Materials Design Memorandum

### C-1. Concrete Materials Investigation

The scope of the investigation will vary depending on the quantity, criticality of the exposure condition, and the type of structure. Critical exposure condition is defined as an exposure condition which is deleterious to concrete such as freezing and thawing, sulfate exposure, or acid attack. For a small (less than 5,000 yd<sup>3</sup> of concrete), nonhydraulic structure exposed to a noncritical environment, investigation will generally be limited to determining that a commercial ready-mix plant is within acceptable haul distance. Examples of such structures include sidewalks, fireplaces, boat ramps, and picnic table bases in a recreation area or culvert headwalls on an access road. For a small nonhydraulic structure which will be subjected to critical exposure conditions, additional investigations addressing the measures to be specified to mitigate the potential concrete deterioration should be included in the DM. Regardless of the criticality of the exposure condition, if the structure contains 5,000 yd<sup>3</sup> or more of concrete, a more detailed investigation will normally be required. A more rigorous and detailed investigation will also be required for hydraulic structures such as locks, dams, intake structures, powerhouses, major pumping stations, urban floodwalls, concrete-lined channels, tunnel linings, and appurtenant structures of earth-fill dams. A separate DM is required for lock or dam.

### C-2. Concrete Materials Design Memorandum

The following typical information should be covered in concrete materials design memoranda for various types of structures and exposure conditions.

*a. Small nonhydraulic structure (less than 5,000 yd<sup>3</sup> of concrete) subjected to noncritical exposure condition.*

- (1) Concrete quantity.
- (2) Environmental and functional conditions to which concrete will be subjected.
- (3) Source of concrete (available commercial ready-mix plants).
- (4) Availability of aggregate of the quality and grading which is to be specified.
- (5) Determination of strength or w/c requirements.

*b. Small nonhydraulic structure (less than 5,000 yd<sup>3</sup> of concrete) subjected to critical exposure condition.*

- (1) Concrete quantity.
- (2) Description of critical environmental and/or functional conditions to which concrete will be subjected.
- (3) Specifications requirements to be used to obtain satisfactory durability, including thermal considerations of placing temperature and insulation.
- (4) Availability of concrete meeting the specifications from commercial ready-mix plants in the project area.
- (5) Availability of aggregate of the quality and grading which is to be specified.
- (6) Determination of strength or w/c requirements.

*c. Hydraulic structures other than lock or dam or large nonhydraulic structure (5,000 yd<sup>3</sup> or more of concrete) regardless of the criticality of the exposure condition.*

- (1) Structures in this category include:
  - (a) Powerhouse superstructures.
  - (b) Bridges.
  - (c) Fish hatchery complexes.
  - (d) Visitor centers.
  - (e) Water or vehicular tunnel linings.
  - (f) Major pumping stations.
  - (g) Intake structures.
  - (h) Urban floodwalls.
- (2) Brief description and location of project.
- (3) Concrete investigation.
  - (a) Concrete quantity.
  - (b) Climatic and functional conditions to which concrete will be subject (frost action, sulfate attack, acid water, etc.).

(c) Concrete qualities to be required.

(d) Typical sectional views of various portions of the structures showing classes of concrete.

(4) Portland cement investigation.

(a) Special requirements to be specified for cementitious materials (low alkali, heat of hydration, false set, C<sub>3</sub>A limitations, etc.).

(b) Availability of these cementitious materials.

(c) Types of cementitious material to be specified with justification.

(d) Testing requirements.

(e) Cost data.

(5) Pozzolan and other cementitious materials investigation.

(a) Types investigated for use.

(b) Availability.

(c) Cost data.

(6) Aggregate investigation.

(a) Description of aggregate sources investigated including photographs of working faces of operating quarries.

(b) Cost estimates.

- Cost at source.

- Distance to project.

- Available mode of transportation.

- Transportation cost.

- How a source's use affects the cost of cementitious material due to aggregate reactivity, water requirement, strength characteristics, etc.

(c) Documentation of aggregate quality.

- Reference

- Reference to TM 6-370 (USAEWES 1953)\*, including volume numbers, area, latitude, longitude, and index number.

- If satisfactory TM 6-370 data are not available, local aggregate sources should be evaluated as outlined in paragraph 2-3.

(d) Service records.

(e) Map showing location of project and deposits.

(f) Volume of concrete of each maximum size aggregate (MSA).

(g) Recommendations as to which sources should be listed in the specifications.

(h) Recommendations for required aggregate quality tests and test limits and discussion of how test limits were set.

(7) Construction plant investigation.

(a) Onsite batch plant requirements, type and capacity.

(b) Mixer requirements, type.

(c) Commercial ready-mix plant availability, capacity and plant type.

(d) Special requirements (time of delivery, temperature control, maximum lift thickness, insulation, curing methods, including requirements for shielding concrete from the direct rays of the sun on areas cured with clear curing compound).

(e) Conveying requirements.

*d. Lock or dam or both (separate DM).*

(1) Description and location of project.

(2) Concrete investigations.

(a) Approximate quantities of concrete in various structures or parts of structures by types or classes.

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\* References cited in this appendix are given in Appendix A of this EM.

(b) Anticipated number of separate contracts with concrete quantities included in each contract.

(c) Climatic and functional conditions to which concrete will be subjected.

(d) Concrete qualities to be required, include anticipated instructions to be furnished the government resident engineer (see paragraph 6-2).

(e) Sectional views of various portions of the structures showing classes of concrete.

(3) Portland cement investigations.

(a) Types of portland cement to be specified, including special requirements with justification.

(b) Availability of these cementitious materials.

(c) Testing requirements.

(d) Results of laboratory studies to determine necessary cementitious contents to obtain desired concrete qualities.

(e) Map showing location of project and sources.

(4) Pozzolan and other cementitious materials investigation.

(a) Types of pozzolan and other cementitious materials investigated.

(b) Availability of pozzolans and other cementitious materials.

(c) Map showing location of sources and location of project.

(d) Cost data.

(e) Anticipated quantity of pozzolan and other cementitious materials to be used per cubic yard of concrete for various classes of concrete (include test data).

(f) Type(s) of pozzolan and other cementitious materials to be specified or allowed.

(5) Aggregate investigation.

(a) Summary of aggregate investigation conducted.

(b) Description of each source investigated including unsatisfactory sources.

(c) Aggregate processing requirements.

(d) Map showing location of project and sources.

(e) Drawing showing locations and logs of cores or test pits.

(f) Photographs of cores or typical material from sand and gravel deposits.

(g) Photographs of working faces in existing quarries.

(h) Cost estimates.

- Cost at source.

- Distance to project.

- Available transportation.

- Transportation cost.

- Cost of special processing.

(i) Documentation of aggregate quality.

- Reference to TM 6-370, including volume numbers, area, latitude, longitude, and index number.

- If satisfactory TM 6-370 data are not available, local aggregate sources should be evaluated as outlined in paragraph 2-3 of the text.

(j) Discussion of test results.

(k) Service records including photographs where available.

(l) Test quarry-test pit investigations. This may require a separate DM.

(m) Recommendations as to which sources should be listed in the specifications.

(n) Recommendations for required aggregate gradings, aggregate quality tests and test limits, and discussion of how test limits were set.

(6) Construction plant investigation.

- (a) Plant requirement, type, and capacity.
- (b) Mixer requirements, type, and expected capacity and quantity.
- (c) Anticipated area at project site to be reserved for concrete production.
- (7) Conveying equipment.
  - (a) Bucket size.
  - (b) Time of delivery.
  - (c) Conveyor belts, pumps, etc.
- (8) Thermal studies. The discussion of the considerations related to the steps necessary to minimize the effects of the heat of hydration in a massive structure may be of such length as to justify a separate DM or a

separate chapter or appendix in the concrete materials DM. The following items should be discussed:

- (a) Concrete properties used as input to the nonlinear, incremental structural analysis (NISA).
- (b) Results of the NISA.
- (c) Insulation requirements including R-value and duration.
- (d) Special curing requirements.
- (e) Lift thickness.
- (f) Minimum time between lifts.
- (g) Form stripping time.
- (h) Maximum placing temperature.