

Marshalling Yard Improvements**Saint John Ferry Terminal****Saint John, New Brunswick****Project No. R.090690.001**

Concrete Formwork and Falsework

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PART 1 - GENERAL

- 1.1 Related Work
- .1 Refer to other Specification Sections for related information.
 - .2 Refer to **Section 01 33 00** for Shop Drawing/Submissions requirements.
- 1.2 Reference Standards
- .1 Do concrete formwork and falsework in accordance with CSA standard A23.1, Concrete Materials and Methods of Concrete Construction, except where stricter standards specify otherwise.
 - .2 CSA S269.1, Falsework for Construction Purposes
 - .3 CSA-S269.3, Concrete Formwork.
- 1.3 Submissions
- .1 Shop Drawings:
 - .1 **Upon request**, submit to *Departmental Representative* for review four (4) sets of formwork and falsework shop drawings, in accordance with **Section 01 33 00**, at least four (4) weeks prior to erection. All such drawings to be stamped and signed by a Professional Engineer registered in the Province of New Brunswick.
 - .2 Clearly indicate method and schedule of construction, materials, arrangement of joints, ties, shores, liners, and locations of temporary embedded parts. Comply with CSA S269.1 for falsework drawings.
 - .3 Indicate formwork design data, such as permissible rate of concrete placement, and temperature of concrete, in forms.
 - .2 Product Data/Samples:
 - .1 Provide product data and samples for form ties.

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1.4 Measurement for
Payment

- .1 This item will not be measured separately.

PART 2 - PRODUCTS2.1 Materials

- .1 Formwork materials: plywood and wood formwork materials to CSA A23.1
- .2 Falsework materials: to CSA S269.1
- .3 Form release agent: chemically active release agents containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing concrete from sticking to forms.
- .4 Form ties: removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface. When forms are removed, no metal will be less than 50 mm from the surface of the concrete.

PART 3 - EXECUTION3.1 Fabrication and
Erection

- .1 Verify lines and levels before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Construct forms to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1
- .3 Line forms with material only as approved by *Departmental Representative*.
- .4 Construct falsework in accordance with CSA S269.1
- .5 Align form joints and make watertight. Keep form joints to minimum.
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- .6 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners and joints, unless specified otherwise.
 - .7 Clean formwork in accordance with CSA A23.1, before placing concrete.
 - .8 Leave formwork in place for at least seven days, exclusive for days when temperature falls below 5°C, unless otherwise directed by *Departmental Representative*.
 - .9 Re-use of formwork and falsework subject to requirements of CSA A23.1
 - .10 All holes from form ties and rods to be plugged with mortar to requirements of CSA A23.1.
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Concrete Reinforcement

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PART 1 - GENERAL

- 1.1 Related Work
- .1 Refer to other Specification Sections for related information.
 - .2 Refer to **Section 01 33 00** for Shop Drawing/Submission requirements.
- 1.2 Reference Standards
- .1 Do concrete reinforcement work in accordance with CSA standard A23.1, Concrete Materials and Methods of Concrete Construction, except where stricter standards specify otherwise.
 - .2 Reinforcing Steel Manual of Standard Practice, 2018, 29th edition (or latest edition) by Reinforcing Steel Institute of Ontario.
 - .3 CSA G30.18-09 (or latest edition), Billet-Steel Bars for Concrete Reinforcement.
 - .4 CSA G30.3-M1983 (R1998) (or latest edition), Cold-Drawn Steel Wire for Concrete Reinforcement.
- 1.3 Source Sampling
- .1 **Upon request,** provide *Departmental Representative* with certified copy of mill test of steel supplied showing physical and chemical analysis not less than 4 weeks prior to commencement of work.
- 1.4 Submissions
- .1 Shop Drawings:
 - .1 Clearly indicate bar sizes, spacing, location and quantities of reinforcement, mesh, chairs, spacers and hangers with identifying code marks to permit correct placement without reference to structural drawings; to Reinforcing Steel Manual of Standard Practice.
 - .2 Detail placement of reinforcing where special conditions occur.
 - .3 Design and detail lap lengths and bar development lengths to CSA standard
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A23.1, unless otherwise specified on drawings.

.4 Each drawing shall bear the signature and stamp of registered professional engineer in the Province of New Brunswick.

.2 Product Data/Samples:

.1 Provide product data for supports and spacers.

.4 Provide submissions in accordance with **Section 01 33 00.**

1.5 Storage

.1 Store reinforcing steel on racks or sills that will permit easy access for identification and handling and prevent it from becoming coated with material which would adversely affect bond.

.2 Do not store reinforcing steel in direct contact with the ground.

1.6 Measurement for Payment

.1 This item will not be measured separately.

.2 Wire ties and spacers to be considered incidental to supply and placing of reinforcement.

PART 2 - PRODUCTS

2.1 Materials

.1 Reinforcing steel: to CSA G30.18; billet steel grade 400 deformed bars.

.2 Wire ties: to CSA G30.3 plain, cold drawn annealed steel wire.

.3 Chairs, bolsters, bar supports, spacers: to CAN/CSA-A23.1. Chairs shall be plastic or stainless steel.

.4 Welded steel wire fabric: to CSA G30.5. Provide in flat sheets only.

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| | .5 | Mechanical splices: subject to approval of Department Representative. |
| | .6 | Plain round bars: to CAN/CSA-G40.21. |
| 2.2 | | Reinforcing Steel |
| | | <u>Fabrication</u> |
| | .1 | Fabricate reinforcing to CSA standard A23.1 |
| | .2 | Fabrication tolerances for reinforcing steel to Reinforcing Steel Manual of Standard Practice. |
| | .3 | Obtain <i>Departmental Representative's</i> acceptance for locations of reinforcement splices other than shown on steel placing drawings. |
| | .4 | Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists. |
| | .5 | Upon approval of the Departmental Representative, weld reinforcement in accordance with CSA W186. |

PART 3 - EXECUTION

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| 3.1 | <u>Placing</u> | .1 | Accurately place reinforcing in positions indicated on reviewed placing drawings and in accordance with CSA A.23.1. Hold firmly during placing, compacting and setting of concrete. |
| | | .2 | Ensure reinforcement cover is maintained during concrete pour. |
| | | .3 | Tie reinforcement where spacing in each direction is: |
| | | .1 | Less than 300 mm: - tie at alternate intersections. |
| | | .2 | 300 mm or more: - tie at each intersection. |
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| 3.2 | <u>Field Bending</u> | .1 | Do not field bend reinforcement except where indicated or authorized by <i>Departmental Representative</i> . |
| | | .2 | When authorized, bend reinforcement without heat, by applying slow and steady pressure. |
| | | .3 | Replace bars which develop cracks or splits. |
| 3.3 | <u>Cleaning</u> | .1 | Clean reinforcing before placing concrete. |
| 3.4 | <u>Inspection</u> | .1 | Do not place concrete until <i>Departmental Representative</i> has inspected and accepted reinforcement work in place. |
| 3.5 | <u>Surface Conditions</u> | .1 | Reinforcement, at time concrete is placed, to be free from mud, oil or other nonmetallic coatings that adversely affect bonding capacity. |
| | | .2 | Reinforcement, with rust, mill scale, or combination of both to be considered as satisfactory, provided minimum dimensions, including height of deformations, and mass of hand wire brushed test specimen are not less than specified requirements in applicable CSA Standards. |
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PART 1 - GENERAL1.1 Related Work

- .1 Refer to other Specification Sections for related information on aggregates, form work and false work, concrete reinforcement, paint, miscellaneous items.
- .2 Refer to **Section 01 33 00** for Shop Drawing/Submissions requirements.

1.2 Reference Standards

- .1 Conform to the latest issues of the following standards, amendments and supplements except where otherwise stated in the project documents:
 - .1 Canadian Standards Association (CSA)
 - .1 CSA-A23.1, Concrete Materials and Methods of Concrete Construction.
 - .2 CSA-A23.2, Methods of Test for Concrete.
 - .3 CSA-A23.3, Design of Concrete Structures.
 - .4 CSA A3000, Cementitious Materials Compendium.
 - .2 American Society for Testing and Materials (ASTM).
 - .1 ASTM C 156, Test Method for Water Retention by Concrete Curing Materials.
 - .2 ASTM C 260, Specification for Air-Entraining Admixtures.
 - .3 ASTM C 309, Standard Specification for Liquid Membrane-Forming Compounds for Concrete.
 - .4 ASTM C 494, Specification for Chemical Admixtures for Concrete.
 - .3 American Concrete Institute
 - .1 ACI 117, Standard Tolerances for Concrete Construction and Materials.

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.2 ACI 202R, Guide to Durable Concrete.

.3 ACI 305, Hot Weather Concreting.

.2 Conflicts between the specifications, codes and standards shall be resolved by the Department Representative in the best interest of the project.

.3 Concrete quality will be assessed by the Department Representative in accordance with CSA A23.2, Methods of Test for Concrete.

1.3 Submissions

.1 Shop Drawings:

.1 **Upon request**, submit shop drawings and erection drawings for formwork and falsework. All such drawings to be stamped and signed by a Professional Engineer registered in the Province of New Brunswick.

.2 **Upon request**, submit placement drawings for reinforcing steel.

.3 **Upon request**, submit placement drawings for miscellaneous items.

.2 Product Data/Samples:

.1 Provide technical data and/or samples for curing compounds (winter/ summer /green /white /red), evaporation retardant and finishing aids, expansion joint materials/sealants, grouts.

.3 Certificates:

.1 Minimum four weeks prior to starting concrete work submit to *Departmental Representative* manufacturer's test data and certification by qualified independent inspection and testing laboratory that the following materials will meet specified requirements:

.1 Portland cement.

.2 Admixtures.

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- .2 Provide certification that plant, equipment, and materials to be used in concrete work comply with requirements of CSA A23.1
 - .3 Provide certification that mix proportions selected will produce concrete of specified quality and yield and that strength will comply with CSA A23.1
 - .4 **Provide certification that concrete will not include alkali reactivity aggregates.**
- .4 Methodology:
- .1 Submit methodology for cold weather concreting.
 - .2 Submit methodology for hot weather concreting.
 - .3 Submit methodology for concrete placement operations.
 - .4 Submit methodology for supporting reinforcing steel.
 - .5 Submit methodology for curing and crack control. To be stamped and signed by a Professional Engineer registered to practice in the Province of New Brunswick.
- .5 Test Results:
- .1 Provide design mix tests results.
 - .2 Provide mill test certificates for reinforcing steel.
- 1.4 Storage of Materials
- .1 Store all materials to prevent contamination or deterioration, whether at the plant or at the job site.
 - .2 Store cement in watertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment whether at the plant or at the job site.
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| | .3 | Prevent stored liquid admixtures and compounds from freezing and powdered admixtures and compounds from absorbing moisture. |
| 1.5 | <u>Source Sampling</u> | .1 At least 4 weeks prior to commencing work, inform <i>Departmental Representative</i> of proposed source of aggregates and provide access for sampling. |
| 1.6 | Ready-Mix Concrete
<u>Supply</u> | .1 Provide, with each load of concrete delivered to site, duplicate delivery slips containing following:
1. Name of ready-mix batch plant.
2. Serial number of ticket.
3. Date and truck number.
4. Project identification.
5. Class of concrete or mix.
6. Amount of concrete in cubic metres.
7. Time of loading or first mixing of aggregate, cement and water.
8. Time of discharge of concrete.
9. Admixtures added at plant.
10. Amount of water added at plant. |
| 1.7 | Measurement for
<u>Payment</u> | .1 Heating of water and aggregates and providing cold weather protection will not be measured but considered incidental to work.

.2 Cooling of concrete and providing hot weather protection will not be measured but considered incidental to work.

.3 Supply of anchor bolts, washers and nuts will not be measured but considered incidental to work. Bolt grouting will be considered incidental to the work.

.4 Supply and installation of rigid PVC sleeves, expansion joints/sealants and curing compounds, or other compounds will be considered incidental to the work. |
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- .5 Concrete work will be measured in accordance with **Section 01 29 00.**

PART 2 - PRODUCTS2.1 Materials

- .1 Aggregates: to CSA A23.1, for Class "C-1" exposure. Only concrete aggregate that have a historical record of usage in a similar environment shall be used in the work. The contractor at his own expense shall provide the necessary certification that the aggregate meets the requirements of this specification. No change in aggregate source shall be made without the prior approval of the Department Representative.
- .2 Portland Cement: Normal Portland Type 10 meeting the requirements of CSA Standard A5. Silica fume shall be added to the mixture at a rate of 7.5% by mass of the Portland cement.
- .3 Water: to CSA A23.1. Water used in mixing and curing concrete shall be fresh, clean, potable and free of injurious amounts of contaminants and chemicals. Recycled wash water from concrete plants shall not be used.
- .4 Chemical Admixtures:
- .1 Admixtures for concrete shall conform to ASTM C494 and C260.
- .2 All concrete supplied by the contractor shall be air-entrained and contain such other admixtures as required by these specifications.
- .3 A water-reducing admixture shall be used in all concrete mixtures containing Normal Type 10 cement.
- .4 Chloride base admixtures shall not be used.
- .5 The contractor shall provide certification that all admixtures proposed for use are compatible with

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the Portland cement when used in the proposed combinations.

- .5 Non-shrink grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents, of pouring consistency, capable of developing compressive strength of 50 MPa at 28 days.
- .6 Curing compound: Curing Compound shall be carried out as outlined in CSA A23.1 for Class of Exposure Class C-1.
- .7 Premoulded joint fillers:
 - .1 Bituminous impregnated fibre board: to ASTM D1751 (latest edition), non-extruding resilient type.
- .8 Joint sealer: self-levelling, two component sealant capable of remaining resilient over temperatures ranging from - 25° C to 35° C. Material will be capable of an elongation of 300%, have tensile recovery of 90% ASTM D412-75 (or latest edition), hardness of 25-35 Shore A and have a high bond strength to the concrete faces.

2.2 Concrete Mixes

- .1 Prior to starting concrete work, submit to the *Departmental Representative* the proposed mix design(s) for approval. Mix design(s) to be in accordance with Alternative 1 of Table 11 in CSA A23.1 (latest edition). Comply with additional requirements of CSA A23.1 (latest edition) for concrete placed near sea water.
- .2 Use concrete mix designed to produce air entrained concrete meeting the following requirements:
 - .1 Cement to be normal Portland cement, Type 10.
 - .2 Minimum compressive strength at 28 days: 35 MPA.
 - .3 Exposure: Class C-1 and S-3.

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- .4 Maximum aggregate size to CSA A23.1 (latest edition) table 2, Group 1, 20 mm sieve size.
 - .5 Minimum cement content 385 kg/m³.
 - .6 Air content: 6 to 8%.
 - .7 Maximum water/cement ratio to be 0.40.
 - .8 Slump at time and point of discharge 80 mm +/- 20 mm. Where the nature of the work requires larger slumps, they are to be obtained by the use of admixtures rather than increasing the water content. The use of such admixtures and the increase in slump to be approved by the *Departmental Representative* prior to implementation in the work.
 - .9 Modify concrete mix to the approval of the *Departmental Representative* to accommodate pumping.
 - .10 Admixtures to the approval of the *Departmental Representative* and the recommendation of the manufacturer. Admixtures must be dispersed separately into mixing water.
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- .3 Do not use calcium chloride or compounds containing calcium chloride.
 - .4 Weigh aggregates, cement, water and admixtures separately when batching. Inspect and test scales for accuracy as directed. Accuracy to be such that successive quantities can be measured to within one percent of desired amounts. Test certificates to be submitted to *Departmental Representative* upon request.
 - .5 Where seven day strength is less than 70% of specified 28 day strength, provide additional protection curing and make changes to mix proportions to the satisfaction of the *Departmental Representative*.
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- .6 Provide certification that plant, equipment and all materials to be used in concrete comply with the requirements of CSA A23.1 (latest edition).
 - .7 Provide certification from independent testing and Inspection Company that mix proportions selected will produce concrete of specified quality and can be effectively placed and finished for all work under this contract.

PART 3 - EXECUTION3.1 General

- .1 Obtain *Departmental Representative's* approval before placing concrete. Provide 24 hours' notice of intended placement.
 - .2 Place, consolidate, finish, cure and protect concrete to CSA A23.1, except where specified otherwise.
 - .3 Prior to placing of concrete, obtain *Departmental Representative's* approval of proposed method for protection of concrete during placing and curing in adverse weather.
 - .4 Do not commence placing concrete until *Departmental Representative* has inspected/reviewed forms, inserts, dowels, reinforcing steel, joints; conveying, spreading, consolidation, finishing, curing and protective methods.
 - .5 Ensure that reinforcement and anchorage are not disturbed during placing.
 - .7 The contractor shall maintain daily and accurate records of all concrete placed in the work, indicating date, time of batching, time and location of placement, concrete quantity and proportions, concrete temperature and records of samples taken.
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These records shall be available to the Department Representative on a daily basis.

- .8 Do not place load(s) upon new concrete until *Departmental Representative* is satisfied that the Contractor has carried out all calculations and tests necessary to confirm that the load(s) will not cause damage or create a safety hazard. Calculations and tests to be stamped by a Professional Engineer registered in the Province of New Brunswick.

3.3 Placement of Concrete

- .1 Perform all cast-in-place concrete work in accordance with CSA A23.1 (latest edition), as specified in these specifications and in accordance with the manufacturer's literature for proprietary products.
- .2 If allowed by *Departmental Representative*, pump concrete to following requirements:
- .1 Arrange equipment so that no vibrations result which might damage freshly placed concrete.
 - .2 Where concrete is conveyed and placed by mechanically applied pressure, provide suitable equipment.
 - .3 Operate pump so that concrete, without air pockets, is produced.
 - .4 When pumping is discontinued and concrete remaining in pipe line is to be used, void pipe line in a manner that prevents contamination of concrete or separation of ingredients.
- .3 Concrete will be deposited in all cases as neatly as practicable, directly in its final position, and will not be caused to flow in a manner to permit or cause segregation.
- .4 Each layer of concrete will be vibrated and tamped with an appropriate vibrator as allowed by the *Departmental Representative*. The concrete must be compacted to the

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maximum practicable density, free of air pockets, and until it is in complete contact with the reinforcement and formwork.

3.4 Inserts

- .1 The contractor shall place embedded parts and assemblies in accordance with CSA A23.1. The embedded parts shall be carefully positioned and placed securely.
- .2 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of all modifications from *Departmental Representative* before placing of concrete.
- .3 All items to be embedded in the concrete shall be clean and free of oil films, rust, dirt or other deleterious substances which affect bond.

3.5 Protection and Curing

- .1 Provide protection and curing in accordance with CSA A23.1
 - .2 Freshly deposited concrete will be protected from premature drying and excessively hot and cold temperatures, will be maintained without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete. It will be protected from harmful effects of sunshine, drying winds, cold weather, running or surface water and mechanical shock.
 - .3 The exposed surfaces of freshly placed concrete shall be kept in a continuously moist condition for a period of 7-days by the use of absorbent mats or burlap which shall be wetted down as required to prevent any dry areas on the concrete surface.
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| | .4 | In areas where appropriate, the Department Representative may allow the use of water based curing compounds. |
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| 3.6 | <u>Finishing</u> | .1 | Finish concrete in accordance with CSA A23.1. |
| | | .2 | Grind off fins, nibs and other raised protuberances with an approved hand stone. |
| | | .3 | For unformed exposed surfaces, the finish shall be by hand or power float. The surface tolerance shall be as follows:
.1 Abrupt irregularities - 2 mm
.2 Gradual irregularities - 4 mm
.3 Bugholes and pits maximum 12 mm diameter
.4 Maximum surface pits 1 per 0.1 m2 |
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| 3.7 | <u>Construction Joints</u> | .1 | Construction joints shall comply with CSA A23.1 for the type of joint specified unless otherwise shown on the drawings and in this specification. |
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| 3.8 | <u>Field Quality Control</u> | .1 | Inspection and testing of concrete and concrete materials will be carried out by the Contractor and may be verified by a Testing Laboratory designated by the Departmental Representative in accordance with CSA A23.1(latest edition). |
| | | .2 | The Contractor will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent. |
| | | .3 | If tests do not meet requirements of the Departmental Representative, take such measures as indicated in CSA A23.1 and CSA A23.2 (latest editions). |
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- .4 Arrange and pay for inspection and testing when necessary for production control to meet requirements.
- .5 Inspection and testing by Departmental Representative will not augment Contractor's quality control or relieve him of contractual responsibility.
- 3.9 Defective Work
- .1 Concrete is defective when:
- .1 failing to meet any requirement of this specification
- .2 concrete contains honeycombing or embedded debris
- .3 28-day strength in any area is less than 95% of specified minimum.
- .2 Repair or remove and replace defective work as directed by the Departmental Representative.
- .3 Take corrective measures as directed by the Departmental Representative to prevent occurrence of further defective concrete.
- .4 Patching and repair of new concrete in defective areas or where embedded fixtures for construction purposes are present shall be repaired in accordance with CSA A23.1 except where otherwise stated.
- .5 The Contractor shall commence all permitted repairs within 48 hours of the examination by the Department Representative.
- .6 In general, all repairs shall be conducted using similar concrete to that of the parent concrete. Bonding agents acceptable to the Department Representative shall be used in all repairs.
- .7 Repair patches or replacement concrete shall be cured for the same length of curing period as the base concrete.
- .1 Immediately prior to application of the mortar or concrete, the surface shall
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- be blown with air jets to remove free water.
- .2 The mortar or concrete surface shall then be rubbed thoroughly with clean burlap or other approved methods so as to fill all the voids.
- .3 While the mortar in the voids is still plastic, the surface shall be sack rubbed with a mix of the same proportions and materials except that no water shall be used.
- .4 The final rubbing shall be performed in a manner which assures that the voids are filled and left flush with the surface of the surrounding concrete.
- .8 Cracks which develop in the new concrete and which are considered by the Department Representative to lessen the durability of the work shall be repaired by grout injection at no extra cost to the contract. The type of grout to be used shall be determined by the Department Representative based on durability and placing considerations.
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