
Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 04 03 07 – Historic works – masonry repointing and repair.
- .2 Section 04 03 41 – Historic works – Repair of Stone.
- .3 Section 04 03 42 – Historic works – Replacement of Stone.
- .4 Section 04 05 00 – Common Work Results for Masonry.
- .5 Section 04 03 31 – Brick masonry.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C207-06, Specification for Hydrated Lime for Masonry Purposes.
 - .2 ASTM C348-08, Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - .3 ASTM C940-98a (2003), Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced Aggregate-Concrete in the Laboratory.
 - .4 ASTM C144-04 Standard specification for Aggregate for Masonry Mortar
- .2 Canadian Standards Association (CSA International).
 - .1 CSA-A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .2 CSA A179-04, Mortar and Grout for Unit Masonry.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .4 European standards
 - .1 EN 459-1:2001, Building lime. Part 1: Definitions, specifications and conformity criteria.
 - .2 EN 459-2:2001, Building lime. Part 2: Test Methods.

1.3 SUBMITTALS

- .1 Submit documents and samples in accordance with Section 04 05 00 - Common Work Results for Masonry.
- .2 Submit two copies of WHMIS MSDS Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements for materials used for the work of this Section. Indicate VOC content.
- .3 Samples (coloration)
 - .1 Colour matched samples for mortar types 1, 2, 3, 4 and in quantity and size prescribed by CSA A179M.
 - .2 Prepare color mortar samples to represent same exposure conditions of building with direct natural light. Fully cure samples for 7 days.

- .3 Submit two 100 mm diameter size samples each type of mortar specified in the specifications.
 - .1 In addition to samples of works mentioned in section 04 05 00, do three repointing samples on the building (locations to be determined by Departmental Representative) for each mortar color. The mortar color will be definitely determined with these samples of repointing. The repointing of the samples will be done in conformance to specifications and drawings.
- .4 Additional cubes for testing. Provide additional series of cubes for long term testing by Departmental Representative as follows:
 - .1 For all mortar types: up to 5 sets of cubes from selected mortar batches as directed by Departmental Representative.
 - .2 Prior to the mixing or preparation of mortars submit for approval to the Departmental Representative technical data sheets and samples of the following elements:
 - .1 Aggregate
 - .2 Cements
 - .3 Lime

1.4 MORTAR TESTING

- .1 Submit test reports in accordance with Section 01 45 00 - Quality Control.
- .2 Test results must show that properties are appropriate to particular mortar mix.
- .3 Test reports required 40 days prior to beginning of masonry works:
 - .1 Grading sieve analysis of proposed sand.
 - .2 Expansion analysis of proposed sand in condition as delivered to site and after any change in environmental conditions.
 - .3 Air content of mortar mix in plastic state.
 - .4 Vicat cone penetration of mortar mix data.
 - .5 Compressive Strength of mortar at 7 and 28 days, a minimum of 40 days prior to starting work, or as directed by Departmental Representative. No delay to work schedule will be justifiable and accepted relating to lateness occasioned by the Contractor who does not meet this requirement.
 - .6 Laboratory results of tests at 7 and 28 days must necessarily be transmitted to Departmental Representative in a maximum delay of 2 workable days..
- .4 Test reports required after commencement of work:
 - .1 Expansion analysis of sand (water content) upon delivery and following any change in environmental conditions, or upon request by Departmental Representative.
 - .2 Air content of mortar mix on a daily basis.

- .3 Vicat cone penetration measurements on each mortar batch. Contractor must give Vicat tests results on all mortar batches on a weekly base to Departmental Representative. Transmit results in Excel format and highlight results under or over what is prescribed in millimeters.
- .4 Compressive strength of mortar at 7 and 28 days, once a week on all types of specified mortars.
- .5 Mock-up: provide colour matched samples on building for final acceptance of materials.
- .6 Refer to Section 04 05 00 - Common Work Results for Masonry for other quality assurance requirements.

1.5 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with the requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous material; and regarding labelling and the provision of Material Safety Data Sheets.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal and Section 04 05 00 - Common Work Results for Masonry.

1.7 ACCEPTABLE PRODUCTS AND MATERIALS

- .1 Where a particular brand name is stipulated, see Instructions to Bidders for procedure for requesting approval of substitute materials and products

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Use **same** brands of materials, suppliers and source of aggregate for entire project.
- .2 **Mortar and grout:** in compliance with CSA A179.
- .3 **Aggregate:** to CSA A179. Use well graded aggregate passing 4.75 mm down to 300 microns sieve where joints are greater than 6 mm. Use aggregate passing 1.18 mm down to 300 micron sieve where 6 mm thick joints or less are indicated. Colour of sand to match existing. Contractor shall custom prepare the aggregate to suit any adjustment requests of the Departmental Representative.
 - .1 Grading of sand: sieve analysis for mortar joints greater than 6 mm in width:

SIEVE SIZE WEIGHT	PERCENTAGE BY WEIGHT PASSING EACH SIEVE	PERCENTAGE BY RETAINED ON EACH SIEVE
4.75 mm	100	0
2.36 mm	90	10
1.18 mm	70	20
600 microns	50	20
300 microns	30	20

- .2 Grading of sand: sieve analysis for mortar joints less than 6 mm in width:

SIEVE SIZE WEIGHT	PERCENTAGE BY WEIGHT PASSING EACH SIEVE	PERCENTAGE BY RETAINED ON EACH SIEVE
1.18 mm	90	10
600 microns	70	20
300 microns	40	30

- .4 **Colour:** dry powdered in inorganic pigments, maximum quantity permitted in dry form will not exceed 8% of the total binder volume.
- .1 Acceptable material:
- .1 Mortar pigment as manufactured by Rockwood Pigments.
- .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .5 **Sand:** to CSA A179 and ASTM C144
- .1 Sand from gravel pit, composed of angular particles, sieved and washed, free of any organic material, graded as specified.
- .2 Acceptable materials
- .1 Sand type Bomix by Daubois
- .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .3 Sand is to be dried 100% and kept dry throughout period of work.
- .6 **Water:** potable or from approved non-potable supply.
- .7 **Lime:**
- .1 Lime Type 1: Hydrated lime: conforming to ASTM C 207, type SA, containing air entrainment agent.
- .2 Lime Type 2: fresh hydraulic lime, finely ground, to standard EN 459-1, type NHL 3.5, containing air entraining agent, to Departmental Representative's approval.
- .3 Lime Type 3: Dispersed hydraulic lime. (DHL)
- .8 **Portland Cement:** conforming to CSA-A3000, white, non staining, normal, type GU (hydraulic) for walls above soil, and type HS (high resistance to sulfate) for foundation walls.
- .9 **Grout for stonework:** Hydraulic lime based injection and reinforcement grout, conforming to CSA A179, ASTM C348 and ASTM C940, control water content to conform to CSA A179, Clause 4.2.1.2 or Clause 4.3.1.5,

- .10 **Dispersed hydrated limes (DHL) for crack repairs of stone:**
- .1 For mortar repairs including wide cracks mixed on site with aggregate and pigments.
 - .1 Acceptable material:
 - .1 Restoration mortar type Neostone by Daubois
 - .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
 - .2 For thin cracks and fissures (Colouring using dry pigment to be established before starting masonry works): Dispersed Hydrated Lime (DHL) for Injection and Shelter Coat. Note that injection lime must be pigmented as well as finishing Shelter Coat.
 - .11 **Restoration mortar for patching stone surfaces:**
 - .1 Proprietary premixed stone patching material that is formulated to closely match the colour, texture and physical properties of the stone to be patched.
 - .2 The mortar shall be formulated to need only to be mixed with potable water at the site.
 - .3 The mortar shall be vapour-permeable, frost resistant of at least 25 cycles, salt resistant and shrink resistant.
 - .4 Be physically compatible with the substrate, including, but not limited to porosity, tensile strength and compressive strength.
 - .5 Contractor must work with five different restoration mortar colors according to the colors of stone to repair. Submit three samples of each color.
 - .6 Acceptable materials:
 - .1 Daubois Neostone C35 restoration mortar.
 - .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.
 - .12 **Acrylic latex mortar additive:** General purpose reactive acrylic modifier specially formulated for use as an additive to cement-based mortars to improve mechanical performance, workability, adhesion and resistance to harsh environmental exposure.
 - .1 For latex modified mortar at 10% - use the specified repointing mortar and dilute the necessary water with latex by the following mix: 50% of acrylic latex type RL-1 by Edison and 50% water to do the mortar mix.
 - .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers
 - .13 **Vicat test equipment:** Use the following Vicat cone model: Modified Vicat Cone Penetrometer and as per standard ASTM C780. The Vicat control station must be in the mortar station described at item 3.3. The Vicat device must be anchored to a perfectly level table with a uniform flat surface.

- .14 **Lead joint cover** : lead joint cover installed at locations indicated on drawings.
- .1 Acceptable material :
- .1 Weathercap by Weathercap Inc
- .2 Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers

2.2 MORTAR TYPES - PROPERTIES AND ADMISSIBLE TOLERANCES

- .1 Mortar and joint type chart

TYPE	USE OF MORTAR	MORTAR MIX	COMPRESSIVE STRENGTH
<u>Type 1</u> Non-pigmented mortar	<ul style="list-style-type: none"> - Repointing of foundations interior and exterior sides - Installation of stone frames of passing windows of Central Building. - Installation of stones on East Wing including Quarter Master (1913-1914) - Backpointing of mortar joints on East Wing including Quarter Master (1913-1914) - Consolidation of stone substrate on East Wing including Quarter Master (1913-1914) 	Type N - 1 : 2 : 6 Portland cement: hydrated lime: aggregate mix	Required compressive strength of 6 MPa to 8.5 MPa at 28 days
<u>Type 2</u> Non-pigmented mortar	<ul style="list-style-type: none"> - Backpointing of all masonry of Central Building. Including the two square towers (1885) - Brick installation - Stone installation Central Building. Including the two square towers (1885) 	Type O - 1 : 2,5 : 8 Portland cement: hydrated lime: aggregate mix	Required compressive strength of 2 MPa to 3, 5 MPa at 28 days.
<u>Type 3</u> Pigmented mortar	<ul style="list-style-type: none"> - Frontpointing of all masonry surfaces above ground (interior and exterior) of Armoury, including all interior brick walls and interior side of walls of the Multifunctional Room. 	Type O - 1 : 2,5 : 8 Portland cement: hydrated lime: aggregate mix and pigment addition	Required compressive strength of 2 MPa to 3,5 MPa at 28 days.
<u>Type 4</u> Pigmented and latex modified mortar	<ul style="list-style-type: none"> Repointing of abutments of Central Building and the first meter of masonry above ground level of all façades of the Armoury (East Wing, QM, Central Building, etc.) 	Type O - 1 : 2,5 : 8 Portland cement: hydrated lime: aggregate mix latex acrylic addition	Required compressive strength of 2 MPa to 3,5 MPa at 28 days.
<u>Type 5</u> Lead joint cover	<ul style="list-style-type: none"> Protective lead joint cover on mortar joints of strips of square towers 	lead joint covers installed according to typical details on drawings	N/A

- .2 If the cement- hydrated lime-sand mortar does not meet the requirements of compressive strength at 7 days, but meets the requirements of compressive strength at 28 days, it will be accepted. If mortar does not meet the requirements of compressive strength at 7 days, but it's resistance at 7 days exceeds two thirds of the required value at 7 days, the general contractor can choose to pursue his works at his own risk while awaiting the results at à 28 days or dismantle these works. The contractor must conform to the specifications requirements for compressive strength of mortars which are more binding than the standards concerning compressive strength of mortars of type O or type N.
- .3 Vicat Cone Penetration of mortar mix in plastic state:
 - .1 Pointing Mortar stone: 18 to 25 mm.
 - .2 Pointing Mortar brick: 22 to 30 mm.
 - .3 Backpointing mortar : 20 to 35 mm
- .4 Allowable air content for all lime/cement mortars: 8 to 12 %. Air content of plastic mix, using meter designed to record air content of mortar to EN 459-2. 2.
- .5 Dispersed Hydraulic Lime and shelter coat: Properties established by mixing in accordance with the manufacturer's instructions and to the same consistencies as the approved mock-up.
- .6 Repair mortar: Properties established by mixing in accordance with the manufacturer's instructions and to the same consistency as the approved mock-up.

2.3 Mixes

- .1 Coloured mortars: incorporate colour into mixes, using dry pigments not exceeding 8% of binder volume.
 - .1 Use clean mixer for coloured mortar.
 - .2 The Contractor to allow for at least 3 different mortar colours for each type of coloured mortar to match the colour of the existing mortar joints in the project. The final and precise mixes and colours to be determined with the mock-up.
- .2 Pointing and bedding mortar:
 - .1 Correct water content and proper consistency for pointing will be established using a Vicat Penetrometer.
 - .2 Mixes throughout project will be regularly monitored with the Vicat Penetrometer during the duration of project to insure the consistency remains constant.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTONS

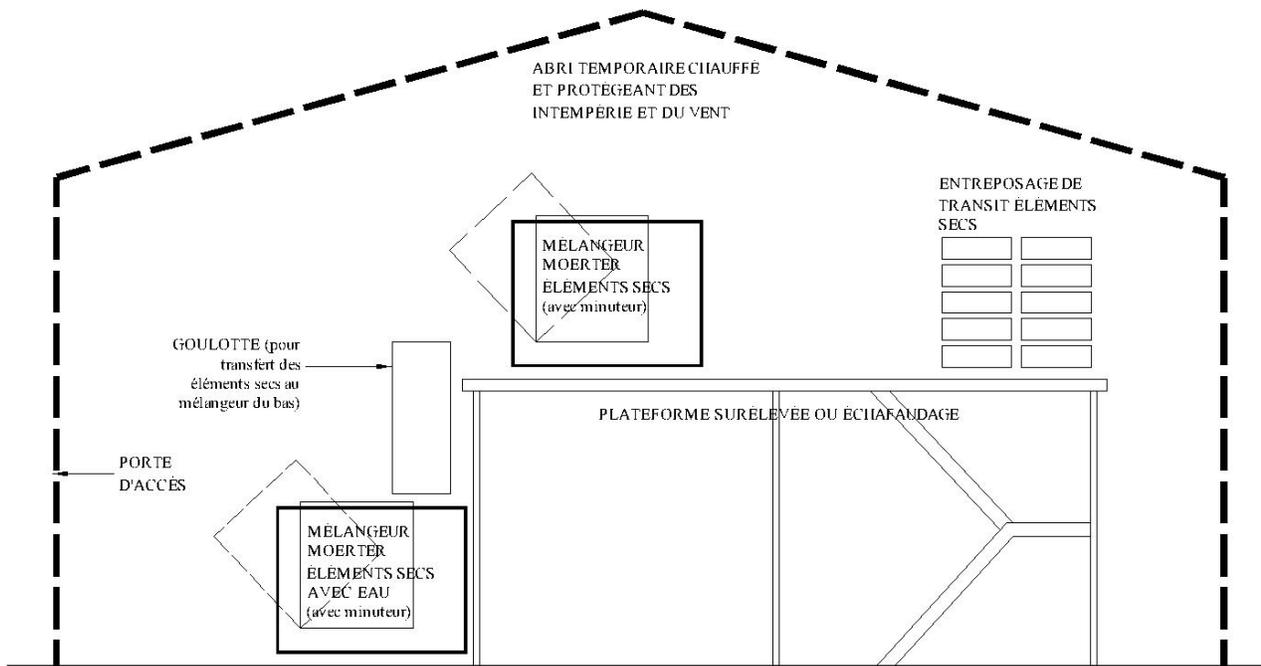
- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 CONSTRUCTION

- .1 Do masonry mortar and grout work in accordance with CSA A179 except where specified otherwise.

3.3 INSTALLATION MORTAR STATION ON SITE – GENERAL

- .1 The contractor must provide a mortar station according to below sketch for the whole duration of masonry works.



3.4 DOSING AND MIXING – INSTALLATION AND REPOINTING MORTAR

- .1 Prepare measuring boxes to ensure accurate proportioning of MORTAR.
 - .1 Each measuring box must contain the exact proportion of volume for each ingredient of a specific mix.
- .2 Sequence of mixing the mortar:

STEP no.1: Mix the sand (100% dry) with the white Portland cement during 1.0 min.

STEP no.2: Mix the dry hydrated lime with dry ingredients and pigments during 1.5 min

STEP no.3: put the established water quantity in the humid mixer (put 50% of latex acrylic and 50% water for type 4 mortar)

STEP no.4: Pour gradually the dry ingredients (top mixer) in the bottom mixer which contains water and whip-mix during 3 minutes up until materials are completely mixed, without apparent white lime particles in the mix.

STEP no.5: Let the mix rest during 3 minutes.

STEP no.6: Whip-mix during 2 minutes, the mortar should easily form when spun by hand in into a ball. Whip-mix until everything is well mixed and mortar has reached the consistence determined by the Vicat cone penetration test.

- .3 The duration of all mixing sequences must be controlled automatically par by timers on the mixers and not manually.
- .4 The mortar must be used within 90 minutes after the end of mixing. After this delay it must be thrown away. It is formally forbidden to add water after the mixing and to install mortar which has been mixed since more than 90 minutes.
- .5 Add sufficient water to obtain workable consistency for setting units to comply with specified allowable tolerances.
- .6 Blend colouring additives with sand. Maintain specified grading.
- .7 Mortar water content must be determined with Vicat penetration test.
- .8 Write down water quantities and use the same quantities for subsequent mixes to help ensure uniformity of all subsequent mixes.
- .9 All mortar used to rebuild areas of the building walls can be mixed with a horizontal axis mortar mixer. Only mixers with electric motors and with timer are permissible. Mixers running on fossil fuels are not permitted because of fumes.
 - .1 Mixing by hand for repointing mortars is forbidden.
 - .2 Submit mixing tools and container for approval prior to starting pointing work.
- .10 Thoroughly clean all mixing boards and mechanical mixing parts between batches. No residual water must remain at the bottom of the mixer. Residual water must be removed at the end of each batch.
- .11 Mortar must be weaker than the units it is binding.
- .12 Mortar must not contain elements detrimental to the original masonry or surrounding materials.
- .13 Contractor to appoint two individuals to mix mortar, for duration of project. In the event that these individuals must be changed, mortar mixing must cease until the new individuals are trained to satisfaction of Departmental Representative and mortar mix is tested.

3.5 DOSAGE –INJECTION GROUT FOR CRACKS WITH DHI

- .1 Mix DHL with water and pigments in conformance to manufacturer's instructions and by using the same methods and same mixers as those used for the approved sample works. Refer to section 04 03 41 – Historic works – Stone repairs, and to section 04 05 00 – Common Work Results for Masonry Mix DHL injection grout and the Shelter Coat with appropriate pigments to match the color of the mix with the different existing colors of the stones. Plan working with 5 **different colors** for the DHL injection grout and the Shelter Coat.
- .2 Mix in small quantities as needed. Mix manually using a high speed, 2500 rpm, drill with paddle mixer attachment.

3.6 DOSAGE –RESTORATION MORTAR FOR STONE SURFACE REPAIRS

- .1 Follow manufacturer's written instructions. Start by mixing dry ingredients in a bucket during approximately 2 minutes.
- .2 Add the mix to a predetermined water quantity in a tub/bucket.
- .3 Mix during about 3,5 minutes.
- .4 The mix gives a mortar rather dry. It forms easily a ball with a small pressure in the hand.

3.7 CLEANING

- .1 Upon completion of mortar work, remove surplus materials, rubbish, tools and equipment from the site
- .2 Remove mortar droppings and splashing using clean cotton cloth or clean sponge and water. Do not smear onto adjacent surface and causing lime streaking on stone.
- .3 Clean masonry with low pressure clean water and soft nylon bristle brush. See Section 04 03 07 – Historic works - Masonry Repointing and Repair.

3.8 PROTECTION OF COMPLETED WORK

- .1 Cover completed and partially completed work not enclosed or sheltered with a waterproof covering at end of each work day. Anchor securely in position.

3.9 QUALITY CONTROL ON SITE

- .1 See section 04 05 00 for requirements in terms of quality control of the mortar.

END OF SECTION