
Part 1 General

1.1 RELATED REQUIREMENTS

- .1 The list of work sections in this division is indicative and non-exhaustive. It does not exclude the works described in the other specification sections, shown in the drawings or necessary for the execution of the works in keeping with overall intent of the plans.
- .2 Section 01 32 16.07 – Construction Progress Schedules – Bar (GANTT).
- .3 Section 01 33 00 – Submittal Procedures.
- .4 Section 01 45 00 – Quality Control.
- .5 Section 01 74 11 – Cleaning.
- .6 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.2 SCOPE OF WORK

- .1 Provide and cast concrete in place. Provide the equipment and labour required to complete the concreting work indicated on all plans.
- .2 Finish concrete surfaces.
- .3 Repair defective concrete surfaces.
- .4 Heat and cure concrete.

1.3 REFERENCE CODES AND STANDARDS

- .1 Unless otherwise indicated, the most recent editions of all reference standards must be used.
- .2 Cast in place concrete work in compliance with A23.1 and A23.3 standards.
- .3 Parking work in compliance with S413 standard.
- .4 Sealing products used must be compliant with Master Painters Institute.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance Section 01 32 16.07 - *Construction Progress Schedules - Bar (GANTT) Chart*, convene pre-installation meeting one week prior to beginning concrete works.

- .1 Ensure key personnel, site supervisor, Departmental Representative, speciality contractor – finishing/forming and concrete producer attend.
- .1 Verify project requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals and samples in accordance with Section 01 33 00 - *Submittal Procedures*.
- .2 Provide testing results reports for review by Departmental Representative and do not proceed without written approval when deviations from mix design or parameters are found.
- .3 Submit two (2) copies of the most recent technical data sheets for the specified products. These sheets must show the physical properties of the material and include details on the installation method, restrictions, constraints and other manufacturer recommendations.
- .4 Provide a document produced by the manufacturer certifying that the latter officially recognizes the company in charge of executing the work in present section as authorized Contractor.
- .5 Concrete pours : provide accurate records of poured concrete items indicating date and location of pour, concrete quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Concrete hauling time : provide for review by Departmental Representative any deviations exceeding maximum allowable time specified in section 2.5 of Part 2 for concrete to be delivered to site of Work and discharged after batching.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance : in accordance with Section 01 45 00 - *Quality Control*.
- .2 Provide Departmental Representative, minimum 2 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.
 - .1 Provide test data and certification by qualified independent inspection and testing laboratory confirming that materials and mix designs used in concrete mixture will meet specified requirements.
- .3 Minimum 2 weeks prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative on following items :
 - .1 Falsework erection.
 - .2 Hot weather concrete.
 - .3 Cold weather concrete.
 - .4 Curing.
 - .5 Finishing.

- .6 Formwork removal.
- .7 Joints, if required.
- .4 Quality Control Plan : provide written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements :
 - .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from Departmental Representative, laboratory representative and concrete producer as indicated in CSA A23.1/A23.2 standard.
 - .2 Deviations to be submitted for review by Departmental Representative.
 - .2 Concrete delivery : ensure continuous concrete delivery from plant in compliance with CSA A23.1/A23.2.
- .2 Packaging Waste Management : remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 21 - *Construction/Demolition Waste Management and Disposal*.

Part 2 Products

2.1 DESIGN CRITERIA

- .1 Alternative 1 - Performance : to CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

2.2 PERFORMANCE CRITERIA

- .1 Quality Control Plan : ensure concrete supplier meets performance criteria of concrete as established by Departmental Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

2.3 MATERIALS

- .1 Cement : for general use, to CSA A-A5/A8/A362.
- .2 Water : to CSA A23.1.
- .3 Aggregates : to CSA A23.1/A23.2.
- .4 Admixtures :
 - .1 Air entraining admixture : to ASTM C260.

- .2 Chemical admixture : to ASTM C494. Departmental Representative must approve accelerating or set retarding admixtures during cold and hot weather placing.
- .5 Concrete adhesive : anticorrosion coating and cement and modified water-based epoxy three (3) component bonding agent :
 - .1 Bonding strength/concrete (CAN/CSA A23.2-6B) : 2-3 MPa.
 - .2 Bonding strength/steel (CAN/CSA A23.2-6B) : 1-2 MPa.
 - .3 Bonding strength at 14 days (ASTM C882) fresh on fresh : 20.7 MPa.
 - .4 Bonding strength at 14 days (ASTM C882) curing time in the open 12 hours : 13.8 MPa.
- .6 Acceptable materials or products: When materials or products are specified by their brand names, refer to bidders instructions for procedure on how to submit equivalent/substitution product or material for approval.

2.4 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete : to meet Departmental Representative performance criteria and to CSA A23.1/A23.2.
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as in Quality Control Plan.
- .2 Prepare normal density concrete as specified in standard A23.1 in order to obtain the required mix for all of the types of concrete specified in the plans and specifications and in accordance with the exposure types.
- .3 Concrete type : Unless otherwise indicated in the drawings, provide the following types of concrete :

.1	Outdoor constructions, sidewalks, curbs	E-0
.2	Unexposed building structures (walls, columns)	N-1
.3	Unexposed building structures (structural slabs, slabs on deck)	N-2
.4	Basins and reservoirs (raft foundations, slabs columns and walls)	E-2
.5	Parking structures (walls, structural slabs with traffic, columns)	E-1
.6	Building foundations (Footings, projections and raft foundations) U.N.O.	N-1
.7	Retaining wall, trenches	E-1
.8	Slabs on ground - occupied building area	D-1
.9	Slabs on ground – parking area	D-2
.10	Indoor equipment base	N-1
.11	Outdoor equipment base	E-1
.12	Misc. metals stairs (steps and landings)	N-2

Concrete Type	Usual Application and Degree of Exposure Considered ⁽¹⁾	Strength at 28 Days (MPa) ⁽⁷⁾	Chloride Ion Permeability ⁽⁶⁾	Entrained Air ⁽⁸⁾	Aggregates Maximum ⁽²⁾ (mm)	Maximum Water/Cement Ratio
N-1	General use Unexposed	30 (26 max at 7 days)	---	4 to 7 %	20	(3)
N-2	Slabs and aprons Unexposed	30 (26 max at 7 days)	---	Max 3 %	20	(3)
E-0	General use Exposed	35 (30 max at 7 days)	---	5 to 8 %	20 ⁽⁵⁾	0,45
E-1	Parking Exposed	35 (30 max at 7 days)	< 1 500 coulombs at 56 days	5 to 8 %	20	0,40
E-2	Hydraulic works Exposed	30 (26 max at 7 days)	---	5 to 8 %	20	0,50
D-1	Slab on ground Unexposed	25 (21 max at 7 days)	---	Max 3 %	20	(3)
D-2	Slab on ground Exposed	25 (21 max at 7 days)	---	4 to 7 %	20	0,55
M-1	Lean concrete ⁽⁴⁾ Unexposed	10	---	4 at 7 %	20	(3)

Notes :

- ⁽¹⁾ Concrete exposure : To freeze-thaw cycles and/or de-icing salts (chlorides). For exposure classes, see A23.1, Table 1.
- ⁽²⁾ Aggregates : Provide a certificate compliant with A23.2 confirming that the aggregates are not subject to alkali-aggregate reactions. Anticipate the use of aggregates 10 mm maximum for concreting in thin spaces. Adjust the parameters of the mix, if necessary, to preserve the characteristics of the hardened concrete.
- ⁽³⁾ Maximum water/cement ratio : Must be determined based on the dosage based on required strength and the specifications.
- ⁽⁴⁾ Lean concrete : If pumpability is desired, enrich the water/cement ratio as required.
- ⁽⁵⁾ For sidewalks and curbs : Provide granite aggregates.
- ⁽⁶⁾ Chloride ion permeability : Conduct pre-qualification tests compliant with A23.2.
- ⁽⁷⁾ Strength at 7 days : See Article 2.2.4 for prior tests.
- ⁽⁸⁾ Entrained air : Air content required at the pouring locations in the forms (i.e. at the concrete pump outlet).

- .4 Upon request, provide a document confirming that the mixing facility and the materials used to manufacture the concrete are compliant with the requirements of the CSA-A23.1 standard.
- .5 In order to validate the proposed mix, two weeks at the latest before the beginning of the work, provide the Departmental Representative with a document produced by an independent laboratory recognized by the Departmental Representative, confirming that the mixes proposed by the Contractor will produce concrete that will meet the requirements of the specifications and of the A23.1 standard. These mixes must have been tested at 7 days in the last six months. The average strength of six (6) samples per mix must fall within the following percentages of strength at 28 days :
 - .1 Cements GU et GUb – SF = 75 % \pm 10 %.
 - .2 Cements GUb – S/SF, GUb – F/SF and ternary = 70 % \pm 10 %.
- .6 If required and following the tests and control results for the concrete at the site, the mixes must be corrected at the satisfaction of the Departmental Representative and meet the specifications.
- .7 Obtain the approval of the Departmental Representative before using chemicals other than those specified.
- .8 The use of calcium chloride is prohibited at all times.
- .9 Base slump for all of the mixes is 80 mm \pm 30 (except for M-1 concrete : 100 mm \pm 30). The slump may be modified by the Contractor based on the required workability of the concrete and its placement. When superplasticizer is added to facilitate placement, the maximum slump is limited to 175 mm.
- .10 Adjust the mixes if variations occur at the cement producer's level.

2.5 CONCRETE PROCUREMENT

- .1 The truck number and the characteristics of the concrete mix must appear on all bills of lading accompanying the delivery of premixed or truck-mixed concrete.
- .2 Unless instructed in writing by the Departmental Representative, adding water to the water already in the concrete mix, whether during transportation or after its delivery on site, is prohibited.
- .3 The concrete must be unloaded less than 2 hours after water and cement come into contact. After that period of time, the concrete will be refused. If the ambient temperature is 27 °C or more, the unloading delay is shortened to 90 minutes.

2.6 SURFACE FINISH

- .1 Sidewalk : Finish with wood trowel and brush.

- .2 Slabs on ground and structural slabs (unless otherwise indicated) :
 - .1 Concrete without entrained air : Monolithic finish smoothed with a steel trowel.
 - .2 Concrete with entrained air : Monolithic finish with a magnesium trowel.
- .3 Stairs and landings : Monolithic finish smoothed with a steel trowel and brush finished.
- .4 When a wet dash is required on the concrete's surface, coordinate the desired finish with the Architect and the wet dash supplier.
- .5 When a leak tight membrane is required on the concrete's surface, provide an appropriate finish taking adherence into consideration (coordinate with the Architect and the membrane supplier).
- .6 Based on the options provided by the concrete supplier, cement could be added to the concrete mix. Specific finishing methods will have to be anticipated to take the added cement into consideration.
- .7 Wet curing : See Article 3.3.

2.7 FINISHING PRODUCTS FOR CONCRETE SLABS

- .1 Various finishing products for concrete slabs, from various manufacturers, are listed in the table below.

FINISHING PRODUCTS FOR CONCRETE SLABS

Hardening agents :

Supplier	SIKA	EUCLID	MASTER BUILDERS
Non-metallic concrete hardener Application rate (kg/m ²)	EMERICRETE SH 6.0	SURFLEX TR 5.0	MASTERCRON F _F 6.0

Sealers or sealing agents :

Supplier	SIKA	EUCLID	MASTER BUILDERS
Sealer or sealing agents ⁽¹⁾ Type 1 (normal use) Application rate (m ² /litre)	FLORSEAL WB 25 7.0	SUPER DIAMOND CLEAR AC 9.0	ACRYSEAL 5.0

Sealer for saw kerf :

Supplier	SIKA	EUCLID	MASTER BUILDERS
Sealer for saw kerfs ⁽²⁾ Type 1 : (normal use)	LOADFLEX	EUCO QUICK JOINT 200	EPOGRIP

Notes :

- (1) Unless otherwise indicated by the Departmental Representative, the sealer must be applied after the slab has cured for a minimum of 28 days. The General Contractor is responsible for the cleaning of all surfaces prior to application.
- (2) Where a floor covering is expected, saw kerfs must be filled with a non-shrink grout such as "Plani-Patch" or equivalent, after 28 days of slab curing. Where no floor coverings are expected, use either of the sealing products listed in table.
 - .2 The sealer for saw kerfs must be applied after the slab has cured for 90 days, unless otherwise instructed in writing by the Departmental Representative. The saw kerf must be filled with sealer to its maximum depth. The use of an Ethafoam bead or silica sand may only be used if authorized in writing by the Departmental Representative.
 - .3 When one or several of the products mentioned in the table above is specified in the plans, the Contractor must provide the Departmental Representative with a copy of the technical data sheet(s) for the product(s) used.
 - .4 The Contractor must follow the recommendations of the manufacturers of the products listed in the table above and specified in the plans.
 - .5 Upon request of the Departmental Representative, the Contractor must provide, at least two (2) weeks prior to the first concrete placement for the slabs, a letter confirming that he and his sub-contractors have read the technical data sheets of the products used and that they have consulted, if necessary, one of the supplier's technical representatives from the supplier to make sure the application methods have been understood.
 - .6 At all times, the Contractor is solely responsible for the methods used to ensure the optimum performance of the products used.
 - .7 Upon request, the Departmental Representative may require the attendance on site of one of the supplier's technical advisors. The Contractor must allow and facilitate access for the Departmental Representative or the technical advisor for the purpose of verifying, observing and supervising the quality of the products, as well as the application methods used, and of taking samples for testing and analysis.
 - .8 Upon request and at all times, the Departmental Representative may require an extraordinary site meeting on the use of the specified products. The Contractor must call all of the following parties to the meeting: the concrete supplier, the floor finish sub-contractor, the supplier's technical advisor, and the Contractor's site supervisor.
 - .9 When a floor covering is specified, the Contractor is responsible for the verification of the compatibility between the products used and the floor covering.

Part 3 Execution

3.1 PREPARATION AND GENERAL

- .1 Obtain Departmental Representative's written approval before placing concrete.
 - .1 Provide minimum 24 hours' notice prior to placing of concrete and specify the area of work involved and the estimated time of concrete placement.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - *Concrete Reinforcing*.
- .3 During concreting operations :
 - .1 Development of cold joints is not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .5 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .6 Protect previous Work from staining.
- .7 Clean and remove stains prior to application for concrete finishes.
- .8 Maintain accurate records of poured concrete items to indicate date, location of pour, concrete properties, ambient air temperature and test samples taken.
- .9 Do not place load upon new concrete until authorized by Departmental Representative or in accordance with Section 03 10 00 - *Concrete Forming and Accessories*.
- .10 Transport the concrete from the truck to its destination using means that will keep the concrete components from separating or from significantly altering its consistency.
- .11 The concrete dropping height must never exceed 1.5 m. Sliders and chutes placed to avoid concrete segregation must be used.
- .12 Concrete is compacted using vibrators plunged into its mass. Vibrators must be inserted fairly close together to obtain complete compactness. Excessive vibration that could cause the separation of the concrete's components must be avoided. Do not force the concrete into place horizontally with the vibrators.
- .13 An adequate number of vibrators must be kept on site. Emergency vibrators must be available at all times, in case the regular vibrators fail.
- .14 Prior to concrete placing, formworks must be cleaned and the water drained from them.
- .15 Concrete must not be placed in water without special permission and then, only strictly as specified and instructed by the Departmental Representative.

- .16 Concrete curing and protection: As specified in the A23.1 standard and these specifications. The latter will prevail on the standard.
- .17 Prior to placing fresh concrete against hardened concrete, apply a concrete adhesive to the latter.

3.2 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Sleeves and inserts :
 - .1 Do not allow penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Departmental Representative.
 - .2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by Departmental Representative.
 - .4 Do not remove or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative, prior to concreting.
 - .5 Confirm locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .3 Anchor bolts :
 - .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.
- .4 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.

3.3 SURFACE TOLERANCE

- .1 Concrete tolerance to CSA A23.1.

3.4 FIELD QUALITY CONTROL

- .1 An independent laboratory retained and paid for by the Departmental Representative will take samples and conduct tests at regular intervals in order to determine if the concrete in place meets the specified quality requirements.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Ensure that the testing laboratory is certified according to standard CSA A283.

- .3 The Contractor must cooperate fully with this testing by granting access to the site and equipment, by supplying the labour and material necessary for the preparation of the tubes, and by storing the samples to avoid issues or losses. The Contractor will provide a closed space available exclusively for the storage of the samples.
- .4 Three (3) tubes will be filled with concrete from the day's placement. If the day's placement exceeds 100 m³, three (3) additional tubes per 50 m³ will be filled with concrete.
- .5 The samples and tests must be processed as close as possible from the point of placement in the forms (e.g. at the outlet of the concrete pump, conveyor or bucket) in order to obtain accurate concrete properties.
- .6 The tubes will be stored and cured as laboratory specimens. One will be broken after 7 days and the other two after 28 days. Occasionally, the laboratory will fill a fourth tube, which will serve as a control specimen on site and will be broken at its request.
- .7 All of the testing methods (destructive or not) and storage and curing facilities must meet the requirements of the CSA-A23.1/A23.2 standard.
- .8 If the concrete is mixed at the plant, the air content and slump will be tested from each truck mixer. If the concrete is mixed at the construction site, control will take place every four (4) cubic meter of concrete or more frequently if required by the Departmental Representative.
- .9 For testing purposes, submit small and large aggregates samples to the Departmental Representative, as well as the mix formula, as specified in standard A23.2.

3.5 CURING

- .1 General
 - .1 Curing must begin immediately after placing and finishing and the temperature and humidity during the curing period must be suitable to ensure that the concrete will achieve proper strength, durability and other properties.
 - .2 All of the concrete surfaces must be cured (e.g. sides and top of walls).
 - .3 The material required to ensure the protection of the concrete and its curing must be available and ready to be used prior to the beginning of concrete placement.
- .2 Curing types and duration
 - .1 Concrete must cure for a minimum duration of 7 consecutive days following placement. During that period, the temperature of the concrete must be higher than 10 °C. The duration of curing must be extended until the concrete achieves a strength higher than 70 % of the specified strength.
- .3 Curing methods
 - .1 Concrete curing must be achieved through one or several of the following methods :

- .1 Ponding or continuous watering.
 - .2 Water retaining material (canvas or other absorptive material kept wet).
 - .3 Forms in contact with the concrete's surface.
 - .4 Other water retaining materials approved by the Departmental Representative.
 - .5 Curing products are not acceptable for parking slabs as indicated in S413-07 standard.
- .4 Curing materials
 - .1 Materials used to cure concrete must meet the requirements of one of the following standards :
 - .1 ASTM C171 Sheet Materials for Curing Concrete.
 - .2 ASTM C309 Liquid Membrane – Forming Compounds for Curing Concrete.
 - .2 The water used for curing must not have damaging effects on concrete.
 - .3 Notes on curing products :
 - .1 Most liquid curing products are not suitable for concrete surfaces that will be bonded with a subsequent layer of concrete or with another surface covering. However, they are suitable if the products are to be removed completely after curing through sandblasting or a known solvent, or if tests clearly show that traces of the product will not reduce bond below specified values.
 - .2 The curing products must be applied to form a film sufficiently thick and continuous on the concrete's surface. The mix and application method must comply with the manufacturer's recommendations. This film must be protected to ensure it remains intact for the entire curing period.
- .5 Reduction of the curing period
 - .1 Reducing the curing period through means to obtain the specified concrete strength over a shorter period of time must be authorized by the Departmental Representative.
- .6 Curing during extreme temperatures
 - .1 Curing in hot weather :
 - .1 When the ambient temperature reaches 27°C or higher, curing during the first three (3) days must be achieved through uninterrupted watering or the use of a water retaining material maintained constantly wet, in order to use cooling as a result of evaporation.
 - .2 Curing in cold weather :
 - .1 During freezing weather, curing with water must cease 12 hours before the end of the protection period.

3.6 CONCRETE PROTECTION

.1 General

- .1 Freshly placed and finished concrete must be adequately protected against unfavorable conditions, such as high winds, precipitation, frost, abnormally high temperatures, temperature variations, premature drying and loss of moisture during the period of time required for the concrete to achieve the desired characteristics. In addition, work or other disturbances near the concrete that may affect new concrete negatively, such as soil compaction, pile driving, vibrations, etc., must be taken into consideration when selecting the protection measures.
- .2 The Contractor is responsible for determining the various criteria required to establish adequate protection methods based on site conditions. The data must be submitted to the Department Representative for verification and approval. In addition the measuring instruments will have to be made available, upon request from the Department Representative, for periodic validation.

.2 Protection against evaporation

- .1 If the evaporation rate of superficial moisture is higher than $0.50 \text{ kg/m}^2 \text{ hr}$, additional action must be taken to prevent the quick drying of the concrete's surface. The General Contractor must implement at least two of the most appropriate measures listed below :
 - .1 Water the support prior to concrete placement.
 - .2 Build sun screens above the concrete during finishing.
 - .3 Lower the temperature of the concrete to bring the evaporation rate under $0.50 \text{ kg/m}^2 \text{ hr}$, while respecting the temperature restrictions applicable to the concrete at placement time.
 - .4 Cover the concrete surface with a white polyethylene sheet in between the various finishing operations.
 - .5 Spray water (fogging) on the concrete immediately after placement and before the finishing, taking care to avoid water accumulation that would alter the quality of the cement paste.
 - .6 Place and finish the concrete at night.

Note :

The Contractor must estimate the evaporation rate using Figure D1 in Appendix D of the A23.1 standard, based on relative humidity measurements, the temperature of the concrete and of the ambient air and on wind speed, to be submitted to the Departmental Representative for verification.

3.7 CONCRETING IN HOT WEATHER

- .1 Then ambient temperature is 27°C or higher or when it is likely that temperature will reach 27°C during concrete placement (based on the weather forecasts for the area), the Contractor must take special care to protect the concrete from the effects of hot and dry weather.

- .2 Under the intense dry conditions defined in Item 3.6.2 (protection against evaporation), the forms, framework, fresh concrete and concreting materials must be protected against direct sunlight or cooled through fogging.
- .3 The temperature of the concrete during placement must be as low as possible and must not in any way exceed the temperatures listed in the table entitled "Temperature Range for Concrete Placement". When the temperature of the concrete remains higher than 25 °C during placement, the Contractor must consider using an additive to delay setting, at his own expense.

3.8 CONCRETING IN COLD WEATHER

- .1 General
 - .1 If temperature is 5 °C or lower, or if there is a possibility that it will drop under 5 °C in the 24 hours following concrete placement (based on the weather forecasts in the area), all of the material required to protect the concrete and curing must be available on site and ready to use prior to concrete placement.
 - .2 In addition, the concrete must be adequately protected during the entire curing period. During curing, the temperature of the concrete must be continually maintained above 10 °C and the maximum temperature variation allowed between the concrete surface and the ambient temperature must not be exceeded.
 - .3 Protection must be ensured through heated shelters, blankets, insulation or a combination of the above.
- .2 Temperature range of concrete at the time of placement
 - .1 At placement time, the temperature of the concrete mix must comply with the following table :

TEMPERATURE RANGE FOR CONCRETE PLACEMENT

ELEMENT THICKNESS	TEMPERATURE (°C)	
	Minimum	Maximum
Less than 0.3 m	10	35
Between 0.3 m to less than 1 m	10	30
Between 1 m and 2 m	5	25
In excess of 2 m	5	20

- .3 Preparations for concrete placement in cold weather
 - .1 Prior to the placement of the concrete on the entire surface, snow and ice must be removed. Calcium chloride must not be used as a de-icing agent in the forms. Concrete must not be placed on or against a surface whose temperature is lower than 5 °C or on a surface that could make the temperature of the concrete drop below the minimum range allowed in the table entitled "Temperature Range for Concrete Placement".

.4 Protection methods

.1 Heated shelters

- .1 The shelters must be built in such a way as to resist driving wind and snow and be reasonably air tight. There must be sufficient space between the concrete and the shelter to allow the circulation of heated air. The shelter must be heated with live steam, forced heated air or using fixed heating devices or others. At concrete placement time and during the curing period, the concrete surfaces must be protected against direct exposure to combustion gas or drying caused by heating devices, using forms or an impervious membrane.
- .2 Avoid combustion gases inside the heated shelters by using indirect-fired heaters and provide fresh air circulation as this could cause severe health problems and the concrete surface could be damaged by carbonation and others.

.2 Protection blankets and insulation

- .1 The type of protection blanket and the quantity of insulation required to ensure proper curing in cold weather must be determined by the Contractor based on the ACI306R standard ("Guide to cold weather concreting"), and on the ambient temperature and wind speed (chill factor), the size and shape of the concrete structure and on the cement content of the concrete. Submit the calculations to the Departmental Representative for verification.

.3 Minimum protection during curing

- .1 When the exterior temperature is 5 °C or lower, appropriate blankets and sufficient insulation must be properly placed on the concrete elements.

.5 Maximum temperature variation allowed

- .1 During the protection and curing period, the maximum variations between the temperature of the concrete surface and the ambient temperature must be respected in order to reduce cracking.
- .2 In addition, to avoid cracking at the end of the curing period due to abrupt changes in temperature, some protection must be maintained until the temperature variation between the concrete and the ambient air is equal or lower than the variations indicated in the following table.

**MAXIMUM TEMPERATURE VARIATION ALLOWED BETWEEN
THE CONCRETE SURFACE AND AMBIENT AIR
(WIND 25 KM/H AT MOST)**

Concrete Thickness (m)	Maximum Temperature Variation Allowed (°C) Length/Height Ratio of the Structure *				
	0 **	3	5	7	20 or more
< 0.3	29	22	19	17	12
0.6	22	18	16	15	12
0.9	18	16	15	14	12
1.2	17	15	14	13	12
> 1.5	16	14	13	13	12

* “Length” is the greatest restricted size and “Height” is the unrestricted dimension.

** Very high and thin elements, such as columns.

3.9 TEMPERATURE RECORDS

- .1 It is the Contractor’s responsibility to determine and record the ambient temperature and that of the concrete during the protection and curing period. The records must include the date, time and location of each temperature measurement. In cold weather, the temperature of the shelters and concrete surfaces must be monitored, among other activities. In hot weather, the ambient temperatures and those of the concrete surface must be recorded, as well as wind speeds and relative humidity. Without limitation, the temperatures records must be in line with temperature form attached to this section. Upon request, the temperature records must be sent to the Departmental Representative for verification.

3.10 NON-CONFORM CONCRETE

- .1 The Departmental Representative may require the demolition, replacement or repairs with regard to any concrete deemed non-conforming to the specifications.
- .2 If the strength of placed concrete measured through sampling proves to be inadequate versus the specifications, the Departmental Representative may require financial compensation based on the provisions of the CCDG. The control laboratory will be responsible for the calculation of the penalty.

3.11 OPENINGS IN CONCRETE

- .1 Make openings in existing concrete as instructed by the Departmental Representative and only after having received his approval. Use a carborundum saw blade or diamond drill.

3.12 CONSTRUCTION JOINTS

- .1 Clean the surface of the construction joint before starting the second concreting phase to remove the laitance produced as a result of over-vibrating the concrete and any foreign substance.

- .2 The surface of the concrete previously placed must have a roughness amplitude of at least 5 mm.
- .3 Follow the specific instructions of the Departmental Representative if required by the nature of the work.

3.13 SEALANT AND HARDENER

- .1 When requested, apply a hardener or sealant as recommended by the manufacturer.

3.14 SAW KERFS IN SLABS

- .1 Make saw kerfs in the slabs as soon as possible, i.e. as soon as the concrete is sufficiently set so that the saw does not break the edges of the kerf. Make the kerfs within 18 hours from the delivery of the concrete at the site. Regarding the application of a sealer on the saw kerf, refer to the item "Finishing Products for Concrete Slabs".
- .2 For slabs on ground, provide saw kerfs as shown on plans or according to a pattern pre-approved by Departmental Representative.
- .3 For slabs on deck, make 50mm saw kerfs along main beams and along joist when on column line. If high rebar is present, adjust depth to 20 mm to avoid damaging reinforcing steel.

3.15 LEAK TESTING

- .1 General
 - .1 All concrete reservoirs (buffer tank (retention of rain water), sewer, water, wash basin, chemical retention pond, drinking water reservoirs including pumping wells, etc.) must be watertight. Perform, in the presence of Departmental Representative, leak tests before backfilling infrastructure.
- .2 Leak Testing
 - .1 Unless otherwise authorized by the Departmental Representative, perform leak test before exterior backfilling of infrastructure. In addition, wait a minimum of 28 days after the concreting walls and 7 days after the concreting slab before the leak tests.
 - .2 Leak test should be performed independently on each of the compartments where there will be liquid present.
 - .3 Adjacent compartments must be tested sequentially, one after the other.
 - .4 Isolate the compartment where test is to be conducted.
 - .5 Seal all openings (close all valves, interconnecting pipes, etc.) that could generate a leak. Temporary blind flanges may be required.
 - .6 Fill the compartment with water up to the maximum normal operating level.
 - .7 Wait 72 hours before testing to allow saturation of the concrete.

- .8 Inspect walls (including inside walls) and sealing strips of the compartment for detecting the presence of leaks.
- .9 Make a visual inspection of the entire structure and seal any cracks and / or defects. Inject cracks so as to seal the entire thickness of the concrete. No water leak will be tolerated.
- .3 Calculation of the maximum allowable water loss
 - .1 The Contractor shall demonstrate by means of leak testing that reservoir meets the water retention characteristics. The leak tests are to be borne by the Contractor and shall be performed under the supervision of Departmental Representative.
 - .2 The maximum allowable water loss consists of measuring the lowering of the water level in each reservoir compartment every day, over a period of three (3) consecutive days. The lowering of the water must be measured independently for each compartment in the presence of the Departmental Representative.
 - .3 The maximum allowable daily water loss should be less than a head of water corresponding to 0.15 % of the volume of the compartment. The volume of the compartment is calculated at the maximum normal operating level.
 - .4 Calculations daily maximum allowable water loss (mm / day) :
$$\text{Padm.} = \frac{(V * 0.15 \%) \times 1000}{S}$$

Where :

Padm.= Maximum allowable daily water loss (mm)

V = Compartment volume at normal operating level (m³)

S = Interior surface of compartment (m²)
 - .5 The test is considered negative if the decrease in the measured water level is greater than the requirement of maximum allowable water loss for each of the three (3) days of testing.
 - .6 If a lower level than the daily requirement is found, the Contractor shall make the necessary corrections. These corrections must be followed by a full second leak test, until the requirements are met. Remedial work shall be performed according to a method and with materials approved by the Departmental Representative.
 - .7 Leak test is to check the overall behavior of the structure. This test is therefore not a guarantee of proper operation of the mechanical and related works (drainage, valves, interconnected pipes, etc.). In addition, a positive leak test does not release the Contractor of any defects on this work or related infrastructure in the future.
 - .8 The Contractor may not request the provisional acceptance of the work until all defect have been corrected and the tests described in this section have performed and successfully met the requirements to the satisfaction of the Departmental Representative.

3.16 CLEANING

- .1 Clean in accordance with Section 01 74 11 - *Cleaning*.
- .2 Waste Management: separate waste materials for reuse/recycling in accordance with Section 01 74 21 - *Construction/Demolition Waste Management and Disposal*.
 - .1 Provide appropriate area on job site where concrete trucks can be safely washed.
 - .2 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site as approved by Departmental Representative.
 - .3 It is prohibited to dispose of unused admixtures or additive materials into sewer systems, into lakes, streams, onto ground or in other location where it could pose a health or environmental hazard.
 - .4 Prevent admixtures and additive materials from entering drinking water supplies or streams.
 - .5 Using appropriate safety precautions, collect liquid or solidify liquid with inert, non-combustible material and remove for disposal.
 - .6 Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

3.17 ANNEXE

- .1 Records
 - .1 Temperature records.

Project : _____
BPR project number : _____
Reading by : _____



temperature records

Checked item, date and time	During the concrete pouring						During the concrete curing								
	A.T.. (°C)	R.H.. (%)	C.T.. (°C)	W.Speed (km/h)	evap. rate	Time	A.T.. (°C)			C.T.. (°C)			R.H.. (%)		
							7h00	12h00	16h00	7h00	12h00	16h00	7h00	12h00	16h00
	Day 1					Day 1									
						Day 2									
						Day 3									
						Day 4									
						Day 5									
						Day 6									
						Day 7									
							Day 1					Time	7h00	12h00	16h00
Day 1															
Day 2															
Day 3															
Day 4															
Day 5															
Day 6															
Day 7															
	Day 1					Time	7h00	12h00	16h00	7h00	12h00	16h00	7h00	12h00	16h00
						Day 1									
						Day 2									
						Day 3									
						Day 4									
						Day 5									
						Day 6									
						Day 7									
	Day 1					Time	7h00	12h00	16h00	7h00	12h00	16h00	7h00	12h00	16h00
						Day 1									
						Day 2									
						Day 3									
						Day 4									
						Day 5									
						Day 6									
						Day 7									

* the verified item must be clearly described and located

R.H. : Relative humidity
C.T. : Concrete temperature
W. Speed : Wind speed
Evap. rate : Evaporation rate
A.T. : Ambient temperature

END OF SECTION