

1.0 GENERAL

1.1 Scope

1.1.1 These specifications cover the requirements for the supply of Portland Cement Concrete to be used for all concrete work unless otherwise specified. The constituent materials - cement, aggregates, water and admixtures shall conform to the requirements of this specification. Where a Standard is referenced in this Specification, the current version of that Standard shall apply.

1.2 Submittals

1.2.1 Submit mix design(s) to the Engineer for review at least 10 working days prior start of the work.

2.0 PRODUCTS

2.1 Portland Cement

2.1.1 All cement shall be either Type GU Normal Portland Cement or Type HE High Early Strength Portland Cement or Type HS Sulphate Resistant Portland Cement conforming to the requirements of CSA Standard A3000.

2.1.2 The Engineer shall be notified within 5 working days of any changes to cement supply.

2.1.3 All chemical and physical test results of cement to be used in the production of the ready-mixed concrete shall be supplied to the Engineer.

.1 Certified copies of the test results supplied by the manufacturer of the cement will be sufficient.

2.2 Supplementary Cementing Materials

2.2.1 Use of Type F or CI fly ash, conforming to the requirements of CSA Standard A23.1, is permitted as follows:

.1 Not more than 20% of the mass of the total cement material content may be replaced with fly ash.

.2 Document the percentage of fly ash in the mix design.

.3 No fly ash shall be used when air temperature is below 5 °C, unless approved by the Engineer.

2.2.2 Use of Type N pozzolan, conforming to the requirements of CSA Standard A23.1, is permitted as follows:

.1 Not more than 10% of the mass of the total cement material content may be replaced with pozzolan.

- .2 Document the percentage of pozzolan in the mix design.
 - .3 No pozzolan shall be used when air temperature is below 5 °C, unless approved by the Engineer.
- 2.2.3 All chemical and physical test results of supplementary cementing material to be used in the production of the ready-mixed concrete shall be supplied to the Engineer.
- .1 Certified copies of the test results supplied by the manufacturer of the supplementary cementing material will be sufficient.
 - .2 One copy of the report shall be submitted within 5 working days to the Engineer.
 - .3 Test data shall be provided to the Engineer within 5 working days when using supplementary cementing materials for alkali silicate reactivity (ASR) or sulphate resistance.
- 2.3 Aggregates
- 2.3.1 Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1, Section 4.2.3.
 - 2.3.2 The nominal size of coarse aggregates shall be 20 mm as per Section 4.2.3.4, Table 11, Group I
 - 2.3.3 The maximum aggregate size for Low Shrink Material shall be 6 mm.
 - 2.3.4 The maximum allowable shale content in the aggregate shall not exceed one half of one percent.
 - 2.3.5 Representative samples of all aggregates proposed for use shall be submitted, when requested, to the Engineer sufficiently in advance of the commencement of operations to permit carrying out the required tests.
 - 2.3.6 Upon request of the Engineer, the Contractor shall provide the legal land description of the source pits for the aggregates used in this contract.
 - 2.3.7 Upon request of the Engineer, the Contractor at his expense shall provide a Petrographic analysis as per ASTM C295.
- 2.4 Water
- 2.4.1 Water used for mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, soluble chlorides, organic matter, sediments or other deleterious substances. It shall be equal to potable water in physical and chemical properties.
 - 2.4.2 Water shall conform to the requirements of CSA Standard A23.1, Section 4.2.2.

2.5 Admixtures

- 2.5.1 The admixtures shall conform to the latest requirements of CSA Standard A23.1, Section 4.2.4.
- 2.5.2 The manufacturer shall ensure that any additives used are compatible with the cement and with each other.
- .1 Air-entraining: Shall conform to the requirement of ASTM C260.
- .2 Chemical: Shall conform to the requirement of ASTM C494.
- 2.5.3 Other admixtures shall not be used, unless specified herein, without the written approval of the Engineer.
- 2.6 Storage of Material
- 2.6.1 All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Engineer. Storage of materials shall be in accordance with the requirements of CAN/CSA-A23.1.
- 2.7 Strengths and Proportions
- 2.7.1 The proportions of materials shall be such as to produce a concrete mix which will work readily into the corners and angles of the forms and around the reinforcement.
- 2.7.2 The manufacturer is to assume responsibility for the design and production of the concrete mixture in accordance with Alternative Number 1, of Table 5 of Properties of Concrete Design Mixes, and CSA Standard A23.1. Section 4.4.6.7 Compressive Strength Requirements and Section 4.4.6.8 Failure of Standard-cured Cylinder Test Results to Meet Requirements of CSA Standard A23.1 are superseded by the Strength Tests and Understrength Concrete requirements of Section 2500 for the Supply of Portland Cement Concrete.
- 2.7.3 Mix design shall also include test results from abrasion loss pursuant to test method A23.2-16A and A23.2-17A. The test shall be conducted on both coarse and fine aggregate, not just the fine aggregate pursuant to Table 1.
- 2.7.4 No concrete shall be placed until the Engineer has received copies of the mix design and has given written approval of its use.
- 2.7.5 The concrete mixes shall, in addition to any other provisions of these specifications, conform to the following table:

| PROPERTIES OF CONCRETE DESIGN MIXES | | | | | |
|---|--------------------------|--|-------------|--|-----------------|
| Mix No. | Name and Type of Cement | Minimum Specified 28-Day Compressive Strength | Air Content | Maximum Water / Cementing Materials by Weight | Specified Slump |
| Handformed Concrete | | | | | |
| 1 | Normal - GU | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 1FH | Fly ash - GU | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 1NP | Natural Pozzolan - GU | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 1HE | High Early Strength - HE | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 1RS | Rapid Set - RS | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 1EA | Exposed Aggregate | 32 MPa | 6.5% ± 1% | 0.45 | 70 mm ± 20 mm |
| 2 | Sulphate-Resistant - HS | 30 MPa | 6.5% ± 1% | 0.50 | 70 mm ± 20 mm |
| Extruded Concrete | | | | | |
| 3 | Normal - GU | 32 MPa | 6.5% ± 1% | 0.45 | 30 mm ± 10 mm |
| 3FE | Fly ash - GU | 32 MPa | 6.5% ± 1% | 0.45 | 30 mm ± 10 mm |
| 3NP | Natural Pozzolan - GU | 32 MPa | 6.5% ± 1% | 0.45 | 30 mm ± 10 mm |
| 3RS | Rapid Set - RS | 32 MPa | 6.5% ± 1% | 0.45 | 30 mm ± 10 mm |
| Concrete Base and Concrete Extension | | | | | |
| 4 | Normal - GU | Refer to Section 2240 and Section 2245 | 6.5% ± 1% | - | 100 mm ± 30 mm |
| 4FH | Fly ash - GU | | 6.5% ± 1% | - | 100 mm ± 30 mm |
| 4NP | Natural Pozzolan - GU | | 6.5% ± 1% | - | 100 mm ± 30 mm |
| 4HE | High Early Strength | | 6.5% ± 1% | - | 100 mm ± 30 mm |
| 4RS | Rapid Set - RS | | 6.5% ± 1% | - | 100 mm ± 30 mm |
| Low Shrink Material | | | | | |
| 5 | Normal - GU | 0.25-0.75 MPa | - | - | 175 mm ± 30 mm |

Note: Rapid Set (RS) uses admixtures to accelerate set time; High Early (HE) uses Type HE cement.

3. EXECUTION

3.1 Batch Plants

3.1.1 Concrete is to be produced in accordance with CSA Standard A23.1 (Section 5). Batch plants are subject to certification by the Saskatchewan Ready Mix Concrete Association.

3.2 Delivery and Mixing

3.2.1 Concrete shall be delivered in truck mixers.

3.2.2 The concrete shall be delivered to the site of the work and discharge shall be completed within one and one-half hours after the introduction of mixing water to the cement and aggregates, or the introduction of the cement to aggregates.

3.2.3 The allowable concrete temperature at delivery shall be in accordance with CSA A23.1-09 Table 14. The concrete temperature shall be tested in accordance with CSA A23.2-17C.

4.0 ACCEPTANCE

4.1 Inspection

4.1.1 The Engineer shall be afforded proper access to inspect ingredients and processes used in the manufacture and delivery of the concrete and for securing samples to determine whether the concrete is being furnished in accordance with these specifications. All tests and inspections shall be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

4.1.2 Sampling of concrete shall be obtained in accordance with Methods of Test and Standard Practices for Concrete CSA A23.2.

4.2 Strength Tests

4.2.1 For standard and accelerated strength tests either 100 mm X 200 mm or 150 mm X 300 mm cylinders shall be used. The size of the cylinder used shall, however, meet the aggregate size limitations as specified in clause 6.2 of CSA Test Method A23.2-3C.

4.2.2 Test cylinders will be used as the basis of acceptance of the concrete compressive strength. Cylinders for strength tests shall be made in accordance to CSA Test Method A23.2-3C. No field cured cylinders will be used as a basis of acceptance. A strength test for any class of concrete shall consist of two standard cylinders made from a sample secured from a single load of concrete in accordance with CSA Test Method A23.2-1C. A total of three test cylinders are to be cast with one cylinder tested at seven days and two tested at twenty-eight (28) days. The test result shall be the average of two (2) specimens at twenty-eight (28) days except that if one specimen in a test shows a manifest evidence of improper sampling, molding or testing, it shall be disregarded. Contrary to Section 4.4.6.3 of

CSA Standard A23.1, frequent testing will be conducted as directed by the Engineer. For concrete base course, additional cylinders should be formed and tested for determination of 20 MPa strength for street opening.

- 4.2.3 The Contractor shall apprise himself of the testing procedures used by the Engineer. In the case of discrepancy between the test results of the Contractor and the Engineer, a third party testing firm may be engaged to complete further testing. If the third party tests confirm the Contractors' QC tests, the cost for the third party testing will be paid for by the Engineer. If the third party tests confirm the Engineer's test, the cost for the tests shall be paid for by the Contractor.
- 4.2.4 Coring and testing of defective concrete shall be considered to be representative of twenty-eight day lab cured cylinder results, only if the following criteria are met:
- .1 Coring and testing shall be at the expense of the Contractor.
 - .2 Concrete was placed when the air temperature was above 5°C and protection was provided in accordance with CSA A23.1.
 - .3 Concrete is cored, tested and reported within 35 days of concrete placement.
 - .4 Drilled cores shall be sampled and tested in accordance with CSA A23.2-14C.
 - .5 Core results shall be reported as per CSA Clause 4.4.6.7.2.

4.3 Air Content

- 4.3.1 Air content tests shall be determined in accordance with the most recent edition of CSA Standard A23.1 (Test Method A23.2-7C or A23.2-4C).
- 4.3.2 The following criteria apply to all mixes numbered 1, 2 and 3. The concrete load shall be rejected if the air content measured is less than 4.4%. If air content is measured between 4.4% and 5.4% the supplier will be allowed to add air to bring it within specification. Retesting is required with any addition of admixtures to concrete made on-site. In this latter event, however, if the initial air content measured in three consecutive loads of concrete delivered falls below 5.4%, the third load shall be rejected and all subsequent loads shall be rejected until initial air content measured is again over 5.4%.
- 4.3.3 If measured air content exceeds the limit of the specification the supplier may elect to turn the drum. If this action brings the load within the specification before the time limit for age of concrete expires, the concrete may be accepted at the discretion of the Engineer.
- 4.3.4 Any additional costs due to extra testing will be at the Contractor's expense.

4.3.5 If concrete placed is not within specification, the Engineer may request linear traverse testing as per ASTM standard C457 at the Contractor's expense.

4.3.6 Air Content Payment Adjustment Factors

| <u>.1</u> | <u>Air Content</u> | <u>Payment Factor</u> |
|-----------|--------------------|--|
| | 3.5% - 4.4% | 25% |
| | 4.5% - 5.4% | 75% |
| | 5.5% - 7.5% | 100% |
| | 7.6% - 9.0% | 100% pending approval of the 28 day compressive strength results |
| | <3.5% or >9.0% | Concrete must be removed and replaced at the expense of the Contractor |

.2 Penalties will be assessed when the specified air content is not met. Payment reduction will be assessed on the total quantity of the day (cubic metres).

4.4 Slump Test

4.4.1 Concrete delivered to the site which exceeds the maximum specified slump shall be rejected. When concrete delivered to the site is less than the specified range of slump additional water, or chemical admixture may only be injected into the mixture at the discretion of the Engineer. The drum shall be turned until the uniformity of the concrete is within the allowable limits. Retesting is required with any addition of admixtures to concrete made on-site.

4.5 Understrength Concrete

4.5.1 For low-slump concrete used in slip formed paving only, water may be added to the transit mixer only under the supervision of the supplier's testing laboratory, provided the requirements for concrete quality are maintained. Once water is added the mixer drum shall be rotated 30 times at mixing speed and the slump and air tested before discharge.

4.5.2 The strength level of each class of concrete shall be considered satisfactory, if it is equal to or exceeds the specified 28 day strength.

4.5.3 The following remedies shall be applied only when the above criteria are not met. Notwithstanding the options of the Owner set forth in Section 4.4.6.8, Failure of Tests to Meet Requirements of CSA Standard A23.1, the Owner reserves the right, in the Owner's sole discretion, to accept such concrete installed at the place of Work, with or without conditions, and to reduce payment on individual strength tests for that day's production not meeting the minimum strength tests for that class at one age, in accordance with the following:

- .1 For Mixes No. 1, No. 1FH, No. 1HE, No. 1RS, No. 1EA, No. 3, and No. 3FE, concrete represented by concrete cylinder tests between 24 MPa and 32 MPa will be subject to payment reduction per unit rate and concrete represented by concrete cylinder tests below 24 MPa shall be rejected and replaced at the expense of the contractor.
- .2 For Mix No. 2, concrete represented by concrete cylinder tests between 22.5 MPa and 30 MPa will be subject to payment reduction per unit rate, and concrete represented by concrete cylinder tests below 22.5 MPa shall be removed and replaced at the expense of the contractor.
- .3 For Mixes No. 4 and 4HE, concrete represented by concrete cylinder tests between 12 MPa and 15 MPa will be subject to payment reduction per cubic metre, and concrete represented by concrete cylinder tests below 12 MPa shall be rejected and replaced at the expense of the contractor.
- .4 Reduction in payment described in (.1), (.2) and (.3) above shall be calculated as follows:

- .1 Reduction in Payment

$$= \frac{\text{Specified Strength} - \text{Actual Strength}}{\text{Specified Strength}} \times 4.0$$

multiplied by the price per unit rate and the total quantity placed before the next set of tests. If no subsequent test is taken, the quantity will be for the remainder of the concrete supplied for that day.

- .2 Costs of replacement of rejected concrete shall include removal of the rejected concrete and replacement thereof and all labour, equipment and material costs, including all incidental work.
- .3 No bonus shall be paid for supply of concrete that exceeds the minimum specified strength.
- .4 Penalties will be assessed when the minimum specified strength is not met. Payment reduction will be assessed on the total quantity of the day (cubic metres).