SPECIFICATIONS FOR
CONCRETE SLOPE PROTECTION

1.0 DESCRIPTION

The Work shall consist of:

.1 Excavating and grading to the required grades and limits as shown on the Drawings and as described in this Specification;

.2 Supply and placement of geotextile;

.3 Supply and placement of granular backfill to the required grades and limits as shown on the Drawings and as described in this Specification;

.4 Supply and placement of concrete on the structure headslopes for slope protection to the required grades and limits as shown on the Drawings and as described in this Specification; and

.5 Quality control (QC) testing of all materials.

2.0 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the date of tender advertisement.

2.1 Related Specifications

- Specifications for Supplying and Placing Granular Backfill
- Specifications for Supply and Installation of Geotextile Fabric
- Specifications for Reinforced Cast-in-Place Concrete

3.0 SUBMITTALS

The Contractor shall submit the following to the Engineer, in accordance with the Special Provisions:

.1 Concrete mix design (including proportions of all constituent materials) that meets the minimum compressive strength of 35 MPa at 28 days. Any changes to the concrete mix design shall be reviewed by the Engineer prior to implementing the change.

4.0 MATERIALS

4.1 Concrete

Concrete shall have a minimum compressive strength of 35 MPa at 28 days and meet requirements of CSA-A23.1, Exposure Class C-1, Air Content Category 1 for hardened concrete.

The temperature of the concrete shall be between 15°C and 25°C at discharge.

.1 Aggregates

General

All aggregates shall be handled to prevent segregation and inclusion of any foreign substances, and to obtain uniformity of materials. The coarse and fine aggregates, and aggregates secured from different sources, shall be piled in separate stockpiles. The site of the stockpiles shall be cleaned of all foreign materials and shall be reasonably level and firm or on a built up platform. If the aggregates are placed directly on the ground, material shall not be removed from the stockpile within 150 mm of the ground level. This material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

If either the coarse or the fine aggregate consists of a blend from more than one source, the aggregate sieve analysis shall show the gradation of the blended aggregates.

Coarse Aggregate

The maximum nominal size of coarse aggregate shall be 20 mm and meet the grading requirements of CSA A23.1, Table 11, Group I. Coarse aggregate shall be uniformly graded and not more than 1% shall pass a 75 um sieve. Coarse aggregate shall consist of crushed stone or gravel or a combination thereof, having hard, strong, durable particles free from elongation, dust, shale, earth, vegetable matter or other injurious substances. Coarse aggregate shall be clean and free from alkali, organic or other deleterious matter; shall have a minimum of two fractured faces; and shall have an absorption not exceeding 3 percent.

The aggregate retained on the 5 mm sieve shall consist of clean, hard, tough, durable, angular particles with a rough surface texture, and shall be free from organic material, adherent coatings of clay, clay balls, an excess of thin particles or any other extraneous material.

Coarse aggregate when tested for abrasion in accordance with CSA A23.2-16A or A23.2-17A shall not have a loss greater than 28%.

Tests of the coarse aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, Table 12, “Concrete exposed to freezing and thawing.

The shale content shall not exceed 0.5% measured by mass of dry coarse aggregate. The combined amount of ironstone, shale, chert, and/or mica shall not exceed 1% by mass of dry coarse aggregate.

Fine Aggregate

Fine aggregate shall meet the grading requirements of CSA A23.1, Table 10, FA1, be graded uniformly and not more than 3% shall pass a 75 um sieve. Fine aggregate shall consist of sand, stone, screenings, other inert materials with similar characteristics or a combination thereof, having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, lumps, shale, alkali, organic matter, loam or other deleterious substances.

Tests of the fine aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, Table 12.

.2 Admixtures

Air-entraining admixtures shall conform to the requirements of ASTM C260.

Chemical admixtures shall conform to the requirements of ASTM C494 for conventional mixes and ASTM C1017 for flowing concrete.

All admixtures shall be compatible with all other constituent materials. The addition of calcium chloride, accelerators and air-reducing agents, will not be permitted, unless otherwise approved by the Engineer.

.3 Cementitious Materials

Cementitious materials shall conform to the requirements of CAN/CSA-A3001 and shall be free from lumps. Normal portland cement, Type GU or GUb shall be supplied unless otherwise specified on the Drawings or in the Special Provisions.

Should the Contractor choose to include a silica fume admixture in the concrete mix design, the substitution of silica fume shall not exceed 8% by mass of normal portland cement. Condensed silica fume shall conform to CAN/CSA-A3000 – Cementitious Material Compendium, Type SF, with a SiO_2 content of at least 85%, a maximum of 10% ignition loss and no more than 1% SO_3 content.

Should the Contractor choose to include fly ash in the concrete mix design, the fly ash shall be Class CI and the substitution shall not exceed 25% by mass of cement. Fly ash shall conform to CAN/CSA-A3000 – Cementitious Material Compendium, Class CI.

Cementitious materials shall be stored in a suitable weather-tight building that shall protect these materials from dampness and other destructive agents. Cementitious materials that have been stored for a length of time resulting in the hardening or the formation of lumps shall not be used in the Work.

.4 Water

Water to be used for mixing and curing concrete shall be potable, shall conform to the requirements of CSA A23.1 and shall be free of oil, alkali, acidic, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

Water of unknown quality shall satisfy the additional requirements listed in Table 9 of CSA A23.1.

4.2 Reinforcing Steel

The reinforcing steel shall conform to the requirements of CSA G30.18 Grade 400W.

4.3 Granular Backfill

The granular backfill shall meet the requirements of the Specifications for Supplying and Placing Granular Backfill, Clauses 4.1 and 4.2, Type 1 – Granular Backfill.

The granular backfill shall consist of crushed stone or gravel or a combination thereof, having hard, strong, durable particles free from elongation, dust, shale, earth, vegetable matter or other injurious substances.

4.4 Geotextile Fabric

The geotextile shall meet the requirements of the Specifications for Supply and Installation of Geotextile Fabric.

5.0 CONSTRUCTION METHODS

5.1 General

All thickness measurements indicated herein and shown on the Drawings shall be perpendicular to the inclined slope protection surface.

5.2 Excavation & Grading

The Contractor shall excavate and/or fill the slopes to receive the granular backfill and concrete slope protection to the lines and grades as shown on the Drawings and to the satisfaction of the Engineer.

5.3 Geotextile

The Contractor shall supply and place the geotextile fabric to the limits as shown on the Drawings and in accordance with Specification 1295: Supply and Installation of Geotextile Fabric.

Unless otherwise shown on the Drawings, the geotextile fabric shall be non-woven Class II (heavy duty) of a type approved by the Engineer.

5.4 Granular Backfill

The granular backfill shall be placed in accordance with the Specifications for Supplying and Placing Granular Backfill, Clauses 5.1 and 5.2. Notwithstanding the Specifications for Supplying and Placing Granular Backfill, the Contractor shall backfill the trimmed slopes with a minimum 200 mm thick layer of granular backfill.

5.5 Reinforcing Steel

Reinforcing steel shall be placed accurately in the positions shown on the Drawings, and shall be retained in such positions by means of bar accessories and wires so that the bars shall not be moved out of alignment during or after the depositing of concrete.

The concrete cover shall be taken as the minimum distance from the concrete surface to the nearest deformation of the reinforcement including tie wires and stir-ups. Unless specified otherwise, reinforcing steel is to be placed within the allowable tolerances specified in CSA A23.1.

Reinforcing steel shall be kept free of all foreign materials in order to ensure a positive bond between the concrete and steel. The Contractor shall remove any material that has been deposited on the reinforcing steel before concrete is placed.

Intersecting bars shall be tied positively at each intersection with 16 gauge black annealed wire or equivalent approved by the Engineer.

5.6 Concrete

The temperature of the mixed concrete shall not be less than 15°C and not more than 25°C at the time of placing. Aggregates shall be heated to a temperature of not more than 65°C. The heating apparatus and housing for the aggregates shall be sufficient to heat the aggregates uniformly without the possibility of the occurrence of hot spots which may burn the materials. The water shall be heated to a temperature of not more than 65°C.

The Contractor shall provide sufficient personnel to properly deposit and vibrate the concrete and shall ensure that each batch of concrete is vibrated properly into place as it is deposited.

The concrete shall be placed in 3.0 meter wide vertical or horizontal strips unless otherwise shown on the Drawings. Formwork shall be provided above and below the reinforcing steel at the construction joint locations to ensure proper slab thickness, correct positioning of the reinforcement, and proper formation of construction joints.

The concrete surface shall be floated and trowelled as necessary to produce a smooth surface. The surface shall not vary more than 6 mm under a 3 m long straightedge. After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse

broom to produce regular corrugations to a maximum depth of 3 mm. An edging tool shall be used at all edges.

The Contractor shall sawcut the concrete slope protection to a depth of 40 mm every 3.0 meters in both the longitudinal and transverse directions no more than 24 hours after the concrete has been poured. All construction joints between adjacent strips shall lie in the same vertical plane as the sawcuts. The Contractor shall supply and place an approved joint sealant at the joints immediately after sawcutting.
The Contractor shall supply and place flexcell to any adjacent reinforced concrete structures as shown on the Drawings or as directed by the Engineer.

5.7 Curing

The Contractor shall supply and place an approved concrete curing compound with fugitive dye to the exposed surfaces of the concrete slope protection. The curing compound shall be water based and membrane forming and of a type approved by the Engineer.

The curing compound shall meet the requirements of ASTM Standard C309 and be applied as directed by the Manufacturer in accordance with the applicable ASTM specification.

5.8 Concrete Slope Pavement in Cold Weather

When the daily minimum air temperature or the temperature in the immediate area of concrete placement, falls below 5°C or there is a probability that the temperature will fall below 5°C within 24 hours of placing the concrete, the requirements for cold weather concreting as specified in the Specifications for Reinforced Cast-in-Place Concrete shall be met.

6.0 QUALITY MANAGEMENT

6.1 Quality Control

.1 General

Batches of concrete that do not meet the requirements of this Specification will be rejected by the Engineer and his/her decision shall be final. The Engineer reserves the right to require immediate removal of any concrete from the rejected batches that may have already been placed in the structure.

The Contractor shall be responsible for all concrete testing, including but not limited to making test cylinders, transporting cylinders to an independent certified testing laboratory of his choice, storage, curing, breaking, and providing written reports of the concrete test results to the Engineer. The quality control testing shall meet the minimum testing requirements for the specified frequency and test procedure as described in Tables 1 and 2. All testing shall be completed by qualified personnel who are certified at the time of testing as ACI CSA-Based Concrete Field Testing Technician – Grade 1, and shall be conducted at the point of discharge into the forms.

If Ready Mix Concrete is being used, and loads are frequently being rejected, the Engineer, on 24 hour notice, may refuse permission for further use of the Ready Mix Supplier.

.2 Aggregate

The sample of the aggregates shall be current and fully represent the material to be used in production. Sampling shall be done no more than 90 days prior to concrete production. Additional samples shall be provided periodically if so determined by the Engineer.

If the fine aggregate consists of a blend from more than one source, the "Fine Aggregate Sieve" analysis shall show the gradation of the blended fine aggregates. Similarly in the case of blended

coarse aggregates, the "Coarse Aggregate Sieve" analysis shall indicate the gradation of the blended coarse aggregates.

The Contractor shall make all the aggregates available for sampling by the Engineer at least 28 days prior to the first concrete pour.
The Contractor shall advise the Engineer of any changes in the aggregates subsequent to the Engineer obtaining the samples.

.3 Concrete

Compressive Strength Tests

A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standard Specifications as referenced with modifications as indicated. One cylinder shall be tested at seven days. One cylinder shall be tested at fourteen days. The 28 day test result shall be the average of the strengths of the remaining two specimens, except that if one specimen in a test in the opinion of the Engineer shows distinct evidence of improper sampling, molding, or testing, it shall be discarded and the 28-day strength will be based on the remaining cylinder. Additional cylinders may be cast, at the discretion of the Engineer or Contractor.

Sampling

Sampling of concrete shall be carried out in accordance with CSA A23.2-1C.

When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose.

Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA A23.2-3C, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved moulds. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in Section 7.3.2.1 of CSA A23.2-3C, for a period of at least 24 hours, and further protection from adverse weather and mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a site office trailer that is used by the Contractor's personnel or the Engineer during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and approved by the Engineer before any concrete is placed.

The Contractor shall deliver the test cylinders to an independent CSA certified testing laboratory. Handling and transporting of the cylinders shall be in accordance with CSA 23.2-3C. No extra laboratory curing time will be allowed for cylinders that are delivered late to the laboratory. A copy of the test results shall be forwarded to the Engineer within 2 days of the break date.

If the test cylinders were allowed to freeze, or were otherwise mishandled resulting in unreliable strength test results, the Engineer may reject the affected portions of the Work, unless core-testing, at the Contractor's expense, confirms the in-situ strength of the concrete.

Slump

Slump tests shall be completed in accordance with CSA A23.2-5C.

Air Content

Air content tests shall be completed in accordance with CSA A23.2-4C.

Testing Cylinders

Test cylinders will be tested in compression in accordance with CSA A23.2-9C.

Failure to Meet Slump or Air Content Specifications

In the event that slump and/or air content are outside the specified tolerance range, as determined by the Contractor's or the Engineer's testing, the Engineer may accept adjustments of the deficient condition as an alternate to rejection provided adjustments are made within the maximum time allowed as specified in 5.1.4. of the Specifications for Reinforced Cast-in-Place Concrete that does not meet the specifications will be rejected after the maximum time is exceeded.

Coring for Compressive Strength Testing

Coring to confirm or contest low concrete strength test results shall be approved by the Engineer prior to any coring being done. When coring is approved, arrangements shall be made by the Contractor, through the Engineer, to employ an independent, certified testing service, all at the expense of the Contractor. The cores shall be taken and tested within seven days of the testing of the twenty-eight day cylinders representing the concrete in question. Where practical, three 100 mm cores shall be taken for each strength test previously taken, and there shall be no doubt that the cores taken, and the cylinders under consideration represent the same batch of concrete. Cores may not be taken unless the Engineer is present. Cores shall be tested by an independent CSA certified laboratory and in accordance with the requirements of CSA A23.2-14C. The average strength of the cores as reported by the independent testing service shall constitute a test.

The foregoing procedure may be modified if the concrete in question was placed during weather conditions not suitable, in the opinion of the Engineer, to permit satisfactory curing. In the event the Contractor chooses to take cores after 7 days, they shall be taken as prescribed in the foregoing paragraph, transported to an approved laboratory, and cured for a period of time such that the total of curing time in place in the structure plus the curing time in the laboratory is equal to 28 days. The cores shall then be tested and reported as specified above.

In cases where the concrete strength, as indicated by the cores, is higher than the strength based on the concrete cylinder results, the core results shall be used as the basis for acceptance of and payment for the concrete. If the core strengths are lower than the strength from the concrete cylinder tests, the cylinder tests shall govern.

6.2 Quality Assurance

Quality assurance testing will be carried out by the Engineer and the costs for breaking and provision of concrete test cylinder reports will be paid for by the Department.

The Engineer shall be afforded full facilities for the random quality assurance inspection and testing that may be carried on to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete. The facilities shall be adequate in the opinion of the Engineer to permit proper sampling of but not limited to, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant specifications is the responsibility of the Contractor and shall be provided prior to any concrete pour.

The results of the quality assurance testing carried out by the Engineer will serve to monitor and review the quality control program of the Contractor.

Additional tests will be required if the results are borderline or widely variable. In case of an unacceptable result, one check test will be permitted.

All materials supplied by the Contractor to be permanently incorporated in the structure are subject to testing by the Engineer and subject to the Engineer's approval prior to their use in construction. Concrete cylinders, slump tests and all other field tests considered necessary shall be made by the Engineer. The Contractor shall assist the Engineer in the performance of these tests as often during the processes of mixing and depositing concrete as the Engineer shall direct. The Contractor shall be responsible for removing and replacing all defective concrete at his own expense.

There shall be no charge to the Department for materials taken by the Engineer for testing purposes.

7.0 METHOD OF MEASUREMENT

7.1 Concrete Slope Pavement

Concrete slope pavement, including excavation and grading, will be measured on a volume basis. The volume to be paid for will be the total volume computed from the Drawing dimensions.

7.2 Geotextile

Supply and placement of geotextile is considered incidental to the supply and placing of concrete slope pavement and no separate measurement will be made for this Work.

7.3 Granular Backfill

Supplying and placing of granular backfill is considered incidental to the supply and placing of concrete slope pavement and no separate measurement will be made for this Work.

7.4 Heating Concrete

Heating of concrete is considered incidental to the supply and placing of concrete slope pavement and no separate measurement will be made for this Work.

8.0 BASIS OF PAYMENT

8.1 Concrete Slope Pavement

The supplying and placing of concrete slope pavement will be paid for at the Contract Unit Price per cubic metre for "Concrete Slope Pavement", measured as specified herein, which price will be payment in full for performing all operations herein described and other items incidental to the Work.

Table 1
AGGREGATE TESTING REQUIREMENTS

TEST	STANDARD REFERENCE	MANITOBA STANDARD	MINIMUM FREQUENCY
Sampling	CSA A23.2-1A ASTM D 75		One test per hour of production or as directed by the Engineer.
Gradation Analysis	CSA A23.2-2A ASTM C 136, C 117	MRB-A202	
Clay Lumps	CSA A23.2-3A ASTM C 142		
Low-Density Granular Material (Shale Content)	CSA A23.2-4A	MRB-A208	
Material Finer than 80 μm	CSA A23.2-5A ASTM C 117	MRB-A204	
Soundness	CSA A23.2-9A ASTM C 88		
Bulk Density	CSA A23.2-10A ASTM C 29		
Potential Expansivity	CSA A23.2-14A		One test per material or as directed by the Engineer.
Petrographic Analysis	CSA A23.2-15A ASTM C 295		
Potential Alkali-Silica Reactivity	CSA A23.2-25A CSA A23.2-27A ASTM C 289 ASTM C 1567		
Potential Alkali-Carbonate Reactivity	CSA A23.2-26A CSA A23.2-27A ASTM C 586		
Coarse Aggregate Only:			
Relative Density and Absorption	CSA A23.2-12A ASTM C 127	MRB-A210	One test per material or as directed by the Engineer.
Flat and Elongated Particles	CSA A23.2-13A ASTM D 4791		
Los Angeles Abrasion: Small Size	CSA A23.2-16A ASTM C 131	MRB-A206	
Los Angeles Abrasion: Large Size	CSA A23.2-17A ASTM C 535	MRB-A205	
Micro-Deval	CSA A23.2-29A ASTM D 6928	MRB-A214	As directed by the Engineer.
Crush Count	ASTM D 5821	MRB-A203	One test per hour of production or as directed by the Engineer.
Flakiness Index		MRB-A216	
Dry-Rodded Unit Weight	ASTM C 29	MRB-A207	
Fine Aggregate Only:			
Relative Density and Absorption	CSA A23.2-6A ASTM C 128	MRB-A211	One test per material or as directed by the Engineer.
Organic Impurities	CSA A23.2-7A ASTM C 40		
Surface Moisture	CSA A23.2-11A ASTM C 70		
Micro-Deval	CSA A23.2-23A ASTM D 7428		As directed by the Engineer.

Table 2
CONCRETE TESTING REQUIREMENTS

TEST	STANDARD REFERENCE	MANITOBA STANDARD	MINIMUM FREQUENCY
Water			
Water	ASTM C 1602		As directed by the Engineer.
Cement			
Mill Certificate	CSA A5 CSA A362 Type 10E-SF/F (Silica Fume or Fly Ash)		As directed by the Engineer.
Admixtures			
Air Entraining	ASTM C 260		As directed by the Engineer.
Chemical	ASTM C 494		
Mix Design			
Proportioning	CSA A23.1 Alternative 1 or 2	MRB-C401	At the beginning of the project, repeated as many times necessary to develop a suitable concrete mix design.
Density of Plastic Concrete	CSA A23.2-6C ASTM C 138	MRB-C404	
Batch Plant			
Calibrated by Weights and Measures	CSA A23.1		MRMCA certification and calibrated within the last calendar year.
Ready-Mix Concrete			
Sampling	CSA A23.2-1c		One complete test and set of cylinders for compressive strength testing for one out of every three loads of concrete placed including temperature, air content and slump (one out of every two loads when silica fume used).
Temperature	ASTM C 1064		
Compressive Strength	CSA A23.2-3C CSA A23.2-9c	MRB-C405	
Air Content by Pressure Method	CSA A23.2-4C	MRB-C403	
Slump and Slump Flow	CSA A23.2-5C	MRB-C402	
Flexural Strength	CSA A23.2-3C CSA A23.2-8c		As directed by the Engineer.
Air Content by Volumetric Method	CSA A23.2-7C		
Other Related Testing			
Core Compressive Strength	ASTM A23.2-14C ASTM C 42		As directed by the Engineer.
Petrographic Analysis of Aggregates in Concrete	ASTM C 295		
Sulphate Ion Content in Water	CSA A23.2-3B ASTM D 516	MRB-C406	
Bond Tests	CSA A23.2-6B ASTM C 1583		
Cement Content	ASTM C 1084		
Rapid Chloride Permeability	ASTM C 1202		
Air Void Parameters	ASTM C 457		