



Foreshore Protection Works

Bermuda Aquarium Museum and Zoo

Bermuda

Annex C

Specifications

Date: February 6, 2017

Project No. 60-04-75

PREAMBLE

These Particular Specifications supplement the Ministry of Works and Engineering Standard Specification 1993.

Where any clause, paragraph, or sub-paragraph in the Standard Specification is supplemented by one of the following paragraphs, the provisions of such clause, paragraph, or sub-paragraph shall remain in effect and the supplemental provisions shall be considered as added thereto.

Where any clause, paragraph, or sub-paragraph in the Standard Specification is amended, deleted or superseded by any of the following paragraphs, the provisions of such clause, paragraph, or sub-paragraph, not so amended, deleted or superseded shall remain in effect.

Clause numbers herein do not refer to the same clause numbers as in the Standard Specification.

Part 1. General

1.1 Work Covered By Contract Documents

Project Location: Bermuda Aquarium Museum and Zoo, 40 North Shore Road, Flatt's Inlet, Hamilton Parish, Bermuda.

Owner: Ministry of Public Works
Department of Works and Engineering
3rd Floor, Post Office Building
56 Church Street, Hamilton HM 12, Bermuda

Engineer: Ministry of Public Works
Department of Works and Engineering
3rd Floor, Post Office Building
56 Church Street, Hamilton HM 12, Bermuda

1.2 Brief Description of the Work

- A. The works have been divided into 3 sections labeled Works Area B and C. All work areas are along the Harrington Sound foreshore side of the Bermuda Aquarium Museum and Zoo. The foreshore was damaged as a result of several hurricanes.
- B. Access to work locations shall be scheduled to minimize the effect on the day to day operations of the Aquarium, Museum and Zoo.
- C. Work area 'B' requires undermining repairs by method of mass concrete fill and the construction of short retaining walls along the foreshore.
- D. Works area 'C' is a large cave that will be repaired using foamed concrete fill. Foaming agent, mixer and mix design to be supplied by MPW Engineer.
- E. Work area 'A' is not part of this contract it has been completed under a separate contract.
- F. All concrete to be poured from shore.
- G. All required formwork to have minimal impact on surrounding environment as these works are taking place in areas designated as marine reserve.
- H. Living vegetation will be undisturbed during the work.
- I. The contractor shall be responsible for all temporary works, access arrangements and transportation of materials to the site.
- J. The site shall be returned in good condition at the end of the project and all construction waste above and below water to be collected and disposed of in accordance with the latest editions of the Ministry of Public Works Waste Management Plan.

1.3 Form of Contract

- A. Project will be constructed under the FIDIC Short Form of Contract First Edition 1999 (Green Book Contract).
- B. The term “Architect” within the Ministry of Works and Engineering Standard Specification 1993 shall be replaced with “Engineer” as defined in the Contract.

1.4 Contract Method of Measurement

- A. Construct the Work under a lump sum contract. This is not a re-measure contract.
- B. All work detailed within these documents shall be covered completely within the lump sum price submitted.

1.5 Work Sequence

- A. Contractor shall schedule the works coordinating all tasks and elements.

1.6 Contractor Use Of Site

- A. The contractor shall confine his activity to the boundaries defined in drawing S1 – Site Plan, unless otherwise permitted by the Engineer.
- B. Use of Site is to be coordinated through the Ministry of Public Works.

Part 2. Drawings And Specifications Furnished

2.1 Owner Responsibilities:

- A. Provide 2 paper and 1 electronic copy of drawings and specifications to Contractor.
- B. Drawing List:
 - S0 – Cover
 - S1 – Site Plan
 - S2 – Works Area ‘A’ and Works Area ‘B’
 - S3 – Works Area ‘C’

2.2 Contractor Responsibilities:

- A. Pay for additional copies of drawings and specifications if required.
- B. Maintain at Site one complete set of up to date drawings and specifications. Make available to Engineer at any time.

2.3 Supplementary Drawings

- A. Engineer may furnish supplementary drawings to assist proper execution of work. Such drawings will be issued for clarification only and will have same meaning and intent as if included with plans referred to in Contract Documents.

END OF SECTION

Part 1. General

1.1 Utilities and services

- A. The contractor shall identify any existing cables or pipes and manage and maintain these services/feeds during the contract through temporary diversion or insitu support.
- B. Interruption of supplies will not be permitted.

1.2 Setting out Stations

- A. The Ministry of Public Works will establish sufficient survey stations for the contractor to undertake the works.
- B. The coordinates and levels of these stations shall be provided to the contractor at least 7 days prior to commencement of site works.

1.3 Setting out and dimensions

- A. Upon taking possession of the site, the Contractor shall verify all levels, angles, grades, rises and dimensions.
- B. The Contractor shall be solely responsible for the accurate setting out of the works and shall employ a qualified surveyor whenever necessary. Any damages which may be incurred as a result of the incorrect setting out of the works shall be the responsibility of the Contractor.
- C. The Contractor shall be responsible for the maintenance of all bench marks on the site.

END OF SECTION

Part 1. General

1.1 Use of Site

- A. Use of site shall be limited to work in areas agreed with the Engineer. Do not disturb portions of site beyond the designated areas without the permission of the Engineer.
- B. Driveways and entrances serving all adjacent buildings shall be kept clear and available to the public, owners, owners' employees, guests, and both service and emergency vehicles at all times. These areas shall not be used for parking or storage of materials without prior agreement of the Engineer.

1.2 Working Hours

- A. Normal working hours shall be Monday to Saturday 7.30am through to 5.00pm and Sunday working may be permitted within the hours of 9.00am and 4.00pm with prior approval from the Engineer.

END OF SECTION

Part 1. General

1.1 Required Submittals

- A. The Contractor shall submit the following documents to the Engineers Representative:
- Schedule of Work
 - Construction Safety and Health Risk Assessments
 - Environmental Method Statements
 - Construction Method Statements

1.2 Administration

- A. The Contractor shall provide the Engineer with the submittals specified for review. Submittals shall be with reasonable promptness and in an orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an Extension of Time and no claim for Extension by reason of such default will be allowed.
- B. No Work shall proceed until relevant submittals are reviewed by the Engineer.
- C. The Contractor shall review submittals prior to submission to the Engineer. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project will be returned without being examined and will be considered rejected.
- D. The Contractor shall verify that field measurements and affected adjacent Work are coordinated.
- E. The Contractor's responsibility for errors and omission in submission are not relieved by the Engineer's review of submittals.
- F. The Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by the Engineer's review.
- G. The Contractor shall keep one review copy of each submission on Site.

1.3 Programme (Schedule of Work)

- A. The Programme shall be prepared in the form of a linked bar chart. All events, activities and constraints shall be numbered and shall be given a title. Details to be given for each event, activity or constraint should include:
- its title
 - its scheduled start and finish dates
 - its duration
 - any relevant "must" start or finish dates

- B. A separate bar shall be provided for each event, activity, operation or constraint, show proposed progress of all activities. Where applicable, labour, construction crews, plant and equipment to be employed shall be indicated.
- C. The “Critical Path” shall be clearly identified in the project Programme.
- D. The key milestones in the construction process shall be identified. Programme milestones shall include but not be limited to the following:
 - Start of construction
 - Placement of orders for critical equipment items
 - Completion of each construction stage
 - Delivery dates (to site) for critical equipment items
 - Final handover (final completion)
- E. The Contractor shall revise and resubmit the Programme every two weeks to reflect actual progress of the Works.
- F. With schedule updates, the Contractor shall provide written explanations to the Engineer as to why the previously reviewed Programme is not being met (if applicable).
- G. Submittals shall show changes in operations proposed (if required), to complete construction works within Contract Time.
- H. No progress payments will be approved until receipt of Programme updates deemed acceptable by the Engineer.

1.4 Method Statements

- A. The Contractor shall provide Method Statements for each key activity and additionally as requested by Engineer, to show construction methods, equipment and general methodology for carrying out the Work. Method Statements shall be related to activities shown on Construction Schedule.
- B. Method Statements shall identify, among other things:
 - Sequencing of works
 - Methods to ensure safe work at heights
 - Methods to ensure safe work in and around the water
 - Methods to ensure appropriate environmental protection
 - Other key tasks as specified in the Contract Documents, and/or as requested by the Engineer.

1.5 Certificates

- A. The Contractor shall submit certificates of insurances within 10 working days after award of Contract.

END OF SECTION

Part 1. General

1.1 Environmental Measures

- A. The Contractor shall meet or exceed the requirements of all Bermuda environmental legislation and regulations, including all amendments up to project date provided that in any case of conflict or discrepancy, the more stringent requirements shall apply.
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Part 2. Execution

2.1 Fires

- A. Fires and burning of rubbish on site will not be permitted.

2.2 Disposal of Arisings

- A. All rubbish and waste material shall be collected and disposed of in accordance with the latest editions of the Ministry of Public Works Waste Management Plan.

2.3 Work In Or Adjacent To Water

- A. Works performed in and around water will be carried out in accordance with regulations of Bermuda authorities having jurisdiction.
- B. The Contractor shall install temporary enclosures, screens, traps or other devices to prevent any excess concrete or other construction materials, waste materials or debris falling into the water.
- C. Any solid object inadvertently dropped into the water shall be removed immediately. On conclusion of construction all debris shall be disposed of to prevent its entry into the water.
- D. Re-fuelling of machinery must take place at a safe distance from the water under methods approved by the Engineer.

2.4 Drainage

- A. The Contractor shall provide temporary drainage and pumping as necessary to keep site free from water. Water containing suspended materials shall not be pumped into waterways, sewer or drainage systems. Disposal or runoff of water containing suspended materials or other harmful substances shall be controlled in accordance with Bermuda authority requirements.

2.5 Environmental Protection

- A. When, in the opinion of the Engineer, negligence of Contractor results in damage or destruction of local flora and or fauna, or other environmental or aesthetic features beyond work areas as shown on contract drawings, the Contractor shall be responsible, at his expense,

for complete restoration including replacement to satisfaction of the Engineer.

2.6 Pollution Control

- A. The Contractor shall control emissions from equipment and plant to Bermuda authorities' emission requirements.
- B. The Contractor shall prevent extraneous materials from contaminating air, land or water, by vacuum, temporary enclosures, screens, traps or other devices.
- C. Spills of deleterious substances shall be immediately contained and cleaned up in accordance with provincial regulatory requirements. Spills shall be reported forthwith to the Engineer.

2.7 Storage And Handling Of Fuels And Dangerous Fluids

- A. Fuel storage facilities shall be located a minimum of 100 m from any water body in an area approved by the Engineer and impermeable dykes constructed so that any spillage is contained.
- B. The Contractor shall prevent spillage of gasoline, diesel fuel and other oil products into the water and on land. Clean up spills promptly at own cost in accordance with Bermuda regulatory requirements. Any fuel spills shall be reported to the Engineer immediately.
- C. Proper use of primers, grouts, bonding adhesives and other hazardous substances will be undertaken to prevent their entry into the water. Substances are to be stored and mixed on protected surfaces away from site to prevent their entry into waterways and contamination of soils.
- D. Used oil filter cartridges and other products of equipment maintenance shall be collected and disposed of at industrial waste facility to the satisfaction of the Engineer.

END OF SECTION

Part 1. General

1.1 Protection

- A. The Contractor shall provide the protection necessary to prevent damage to existing properties, and shall protect existing trees and vegetation which are to remain.

1.2 Disposal

- A. All materials arising from site clearance which are surplus to or unsuitable for use in the works shall be disposed of by the Contractor to approved tipping areas or as directed by the Engineer's Representative.

END OF SECTION

Part 1. General

1.1 Scope

- A. Work includes, but is not limited, to the following:
- Preparation of the sub-grade for structural foundations and backfilling with structural fill material
 - Shoring and bracing excavations as required.
 - Finish grading
-

Part 2. Products

Not Used.

Part 3. Execution

3.1. Method of work

- A. All excavation shall be carried out in approved and orderly manner.

3.2. Excavating foundations

- A. The foundation shall be excavated to the depth and sizes shown on the drawings and shall be thoroughly cleaned before being submitted to the Engineer's Representative for inspection approval.
- B. Any localised pockets of poorly cemented rock or soil shall be removed. Any such areas or voids otherwise occurring shall be filled with concrete to the level of the structural foundation.
- C. The Contractor shall take all necessary precautions to protect approved foundations from sediment run-off, erosion or contamination by other unsuitable material until the works can proceed further.

3.3. Disposal

- A. All unsuitable material arising from excavation which is surplus to or unsuitable for use in the works shall be disposed of by the Contractor to an approved spoil area or as directed by the Engineer's Representative.

END OF SECTION

Part 1. General

1.1 Surface Finishes

A. The surface finishes for formed surfaces shall be as specified below:

Location	Type
Works area 'C'	Surface finish to match surrounding rock and shall be demonstrated on trial panels at the Bermuda Aquarium Museum and Zoo for approval by the Dept. of Planning and the Dept. of Conservation Services prior to commencing work.

END OF SECTION

Part 1. General

1.1 Galvanizing

- A. All bar reinforcement and steel fabric unless indicated otherwise on the drawings shall be prepared and hot-dip galvanized in accordance with the requirements of BS 729.
- B. Steel bars to be used for reinforcement supports and spacers shall be hot-dip galvanized and treated in accordance with BS 729 as above.
- C. With the prior approval of the Engineer's Representative the Contractor may cut and bend this steel on site provided 2 coats of an approved metallic zinc-rich paint is applied to the cut end of the steel and to those areas where damage occurs to the galvanizing coating.

1.2 Cover to reinforcement

- A. Where concrete cover to reinforcement is not described on the drawings it shall be in accordance with the following:

Location	Cover
All Faces	75mm (3")

1.3 Laps and joints

- A. Bars laps shall be as specified in the table below:

Bar Diameter (mm)	Lap Length (mm)
12	400 (16")

END OF SECTION

Part 1. General

1.1 Codes and standards

- A. All concrete work shall be in accordance with the British Standard Code of Practice BS 5400-4.

1.2 Workability

Location	Slump	Tolerance
Foundations	75mm (3")	+/- 35mm (1½")
Walls	75mm (3")	+/- 35mm (1½")
Fill	75mm (3")	+/- 35mm (1½")

1.3 Concrete Grades

- A. The concrete grades are given in the table below:

Grade	Characteristic Strength		Lowest Grade for compliance with use
	N/mm ²	PSI	
15	15.0	2200	Sub-base and backfill concrete
40	40.0	5800	Reinforced concrete

- B. The concrete shall have a minimum cement content of 350kg/m³ and a water cement ratio of 0.45. The lightweight foamed concrete (used in Works area 'C') shall have a minimum cement content of 1200kg/m³ and a water cement ratio of 0.6.

1.4 Compaction

- A. All concrete shall be compacted to produce a dense homogenous mass. Unless otherwise agreed by the Engineer's Representative, it shall be compacted with the assistance of immersion (poker) vibrators. Vibration shall continue until all the air bubbles have dispersed and the tone of the vibrator becomes constant and in a manner that does not promote segregation. Sufficient vibrators in serviceable condition shall be on site so that spare equipment is always available in the event of breakdowns.

1.5 Additives

- A. No additives shall be added to the concrete mix without the approval of the Engineer.

END OF SECTION

Mix Designs

Below is a discussion about calculating mix designs for EABASSOC Lightweight Foamed Concrete. There are some general comments and then the discussion has been divided into three sections which deal with different ranges of dry densities, they are:

- (a) below 700 kg/m^3 ,
- (b) above 1200 kg/m^3 and
- (c) between 700 and 1200 kg/m^3 .

General

EABASSOC Lightweight Foamed Concrete can be made with a range of dry densities, typically from 400 to 1600 kg/m^3 (25 to 98 psi), and a range of compressive strengths, 1 to 15 N/mm^2 (145 - 2175 psi).

In every case when making foamed concrete one has to choose a ratio of sand:cement:water for making the slurry and then calculate the amount of foam that has to be added to that slurry in order to give the correct density of foamed concrete. Table 1 shows some typical mix designs over a range of densities and compressive strengths.

In general terms, the lower the ratio of sand:cement, the stronger the foamed concrete will be. Also foamed concrete of a higher density will also have a higher strength. When placing foamed concrete as a thin section over a large exposed area it needs to be cured in the same way as normal concrete so that it will gain the appropriate strength.

Most mix designs use 0.6 as the water:cement ratio which is standard for 'normal' foamed concrete, however it is possible to increase the amount of water to increase flowability. It is also possible to increase flowability by adding extra water after the foamed concrete has been made. Slurry which is too runny is better than slurry which is not runny enough. Cement-only mix designs require slightly less water than those containing sand.

Differences in materials available locally will mean that the results which are obtained will always be slightly different so it is always important to carry out on-site trials

The real key to making good foamed concrete is to experiment with different mix designs. You will then learn what you can and cannot do!

a) Dry Densities below 700 kg/m^3

When making EABASSOC Lightweight Foamed Concrete with a dry density of less than 700 kg/m^3 it is not sensible to include sand in the mix design. The resulting foamed concrete would not have sufficient strength to be of any use. For such light foamed concrete using a 'cement-only' mix design is recommended. Hence, Table 1 contains mix designs with ratios of 0:1:0.55 for dry densities of 400 and 600 kg/m^3 .

Dry Density (kg/m ³)	409	500	586	799	732	968
Wet Density (kg/m ³)	520	637	750	940		1140
sand:cement:water	0:1:0.55	0:1:0.55	0:1:0.55	1:1:0.6	0:1:0.55	1:1:0.6
Cement (kg)	314	392	466	352	592	431
Dry Sand (kg)	0	0	0	352	0	431
Water (kg)	173	215	257	211	326	258
Slurry Density (kg/m ³)	1784	1785	1783	2005	1784	2005
Foaming Agent (ltr)	0.99	0.90	0.81	0.74	0.66	0.60
Water (ltr)	33	30	27	25	22	20
Foam (ltr)	727	660	595	543	486	441

Dry Density (kg/m ³)	1207		1398	1553	
Wet Density (kg/m ³)	1320		1530	1700	
sand:cement:water	3:1:0.6	2.5:1:0.6	3:1:0.6	3:1:0.6	2.5:1:0.6
Cement (kg)	283	317	329	367	412
Dry Sand (kg)	848	794	988	1101	1030
Water (kg)	170	190	198	220	247
Slurry Density (kg/m ³)	2238	2199	2238	2239	2198
Foaming Agent (ltr)	0.57	0.56	0.44	0.36	0.32
Water (ltr)	19	18.5	14.7	11	10.5
Foam (ltr)	419	408	323	246	231

Table 1. Mix designs for EABASSOC Lightweight Foamed Concrete for a range of dry densities. The amounts of cement, sand, water and foam shown for each mix design are required to make 1m³ of EABASSOC Lightweight Foamed Concrete.

When making foamed concrete we recommend that a density check of the slurry is carried out before the foam is added.

The amounts of foaming agent are for EABASSOC Foaming Agent, where the foam is made using the dry method using a dilution of 3% and expansion rate of 22 times.

b) Dry Densities above 1200 kg/m³

If the required dry density is greater than 1200 kg/m³ a good starting point mix design is 3:1:0.6 which provides a balance between strength and cost. The ratio of 3:1:0.6 is commonly used as a standard for many applications where a density greater than 1200 kg/m³ is required. If the strength for a given dry density is not high enough the amount of sand can be reduced. This will mean that more cement is being used so the final foamed concrete will be stronger but will also be more expensive.

Table 1 contains mix designs with ratios of both 3:1:0.6 and 2.5:1:0.6 for dry densities of 1200 and 1600 kg/m³.

c) Dry Densities between 700 and 1200 kg/m³

Calculating a mix design to make foamed concrete with a dry density between 700 and 1200 kg/m³ is more tricky. The reason for this is because there is an infinite amount of possible mix designs which will produce foamed concrete with a density in this range. The variety of possible mix designs is large because it is possible to make foamed concrete with or without sand in this range of dry densities. The optimum choice of mix design is the one which will give the required strength for the cheapest cost.

A mix design with a ratio of 3:1:0.6 will give a low strength for densities below 1200 kg/m³. In Table 1 there are mix designs with ratios of both 1:1:0.6 and 0:1:0.55 for dry densities of around 765 and ratios of 1:1:0.6 for dry densities of 1000 kg/m³.