
Draft
Jamaican Standard Specification
for
Road Construction – Base Course, Sub-base Course, Fills and
Wearing Course



BUREAU OF STANDARDS JAMAICA

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Draft Jamaican Standard

Jamaican Standard

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The attention of those using this specification is called to the necessity of complying with any relevant legislation.

Amendments

No.	Date of Issue	Remarks	Entered by and date

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Draft Jamaican Standard

Foreword

The Road Construction – Base Course, Sub-base Course, Fills and Wearing Course Standard was prepared by the Road Construction Technical Committee.

The works covered under these specifications include all labour, materials, equipment, and operations necessary for the construction of roadways, associated earthworks, structural backfill, granular layers, bituminous treatments, and asphalt concrete surfacing.

This standard is voluntary.

Committee representation

Related documents

This standard makes reference to the use of the material taken from the following sources:

- a) *JS133:2021 Jamaican Standard Specification for Ready-mixed concrete*
- b) *NWA Technical Specification, Effective December 17, 2015.*
- c) *American Concrete Institute*

Jamaican Standard Specification for Road Construction – Base Course, Sub-base Course, fills, and Wearing Course

1 Scope

This document specifies all labour, materials, equipment, and operations necessary for the construction of roadways, associated earthworks, structural backfill, granular layers, bituminous treatments, and asphalt concrete surfacing.

2 Terms and definitions

For the purposes of this standard the following terms and definitions apply.

2.1

fill material

material used for filling around foundations, footings, behind abutments and wing walls

2.2

formation level

final level of ground after completion of earthworks, representing the underside of the sub-base, or if no sub-base is provided, the underside of the base course

2.3

sub-grade

upper portion of the natural ground or compacted fill on which the sub-base is placed

2.4

excavation filling

all processes required to shape the works to the lines, grades, and levels shown on drawings. Excavated material deemed suitable by the Engineer may be reused as fill; unsuitable materials shall be removed from the site

2.5

structure backfill

selected material used to backfill around structural elements such as retaining walls and abutments

2.6

sub-base material

approved crushed aggregate graded according to the specified limits and compacted to $\geq 95\%$ MDD

2.7

base course material

high-quality crushed aggregate conforming to the “Base Type 1” gradation and mechanical properties, compacted to $\geq 98\%$ MDD

2.8

prime coat

bituminous application applied to granular base to ensure proper bonding with the subsequent

surface layer, including MC-70, MC-30, or approved asphalt emulsions at specified application rates

2.9

surface dressing

bituminous surface treatment consisting of one or two applications of binder and cover aggregate

2.10

asphalt concrete (AC)

hot-mix asphalt prepared in an approved plant with controlled bitumen content, aggregate gradation, and mechanical properties

2.11

maximum dry density (MDD)

dry density corresponding to peak compaction effort as determined by the appropriate Proctor test (ASTM D 698 or D 1557 as specified)

2.12

california bearing ratio (CBR)

measure of sub-grade strength, tested at specified compaction levels

2.13

employer's representative engineer

designated technical authority responsible for approving materials, construction methods, testing procedures, and ensuring compliance with specifications.

3 General requirements

3.1 Fill

Filling in around foundations, footings and behind abutments and wing walls shall be carried out using selected imported free draining granular material, compacted in layers not exceeding 150mm to 95% MDD.

Table 1 - Limits for filling

Sieve Size mm	Limits
150mm	100
25mm	50 - 100
4.75	20 - 80
1.18	10 - 50
0.3mm	5 - 25
0.15mm	0 - 15
0.075mm	0 - 10

3.2 Formation Level

Formation level shall be the surface level of the ground obtained after completion of the earthworks, that is the underside of the sub-base or where no sub-base is specified, the underside of the base. Any excess depth excavated below formation level, tolerance see below, shall be backfilled with material acceptable for road construction and compacted to 95% MDD.

3.3 Excavating & Filling

3.3.1 The Contractor shall carry out such scarifying, excavating or filling as may be necessary to form the new sub-grade in accordance with the Drawings and shall adhere to the slopes, levels, depths and heights shown thereon. Unless otherwise directed by the Engineer, all suitable excavated materials shall be used where filling material is required. The Contractor shall remove any excavated material that in the opinion of the Engineer is unsuitable for filling, from the site. Material used as fill shall be deposited and compacted to 95% MDD in layers not exceeding 150mm in depth after final compaction. Each layer shall extend over the full width of the formation. Where materials of widely different characteristics are drawn from different sources such material shall be deposited in alternate layers over the full width of the formation. No muds, organic material, silt, soft or otherwise unsuitable material shall be used as fill.

3.3.2 During preparation of the sub-grade the Contractor shall control and direct constructional traffic uniformly over its full width. Fill material shall not be stockpiled on the sub-grade unless permitted by the Engineer.

3.3.3 Should the quantity of excavation from the works be insufficient for the amount of filling required, the deficiency shall be made good by approved, imported suitable material and the Contractor shall be responsible for locating and obtaining and testing such material.

3.4 Preparation of sub-grade

3.4.1 All fill material used in earthworks shall be compacted to the requirements of these Specifications, by equipment approved by the Engineer for that purpose. At formation level the sub-grade material shall be compacted to give a minimum California Bearing Ratio (CBR) of 15% @ 95% compaction. Where there is no sub-base layer the CBR value shall be 30% or more at 95% compaction. The surface of the formation shall be finished smooth and true to the levels and cross-sections shown on the plans and shall not vary more than 12mm in 3.0m in profile and cross section or more than 12mm from design elevation.

3.4.2 Where existing levels are higher than formation levels it shall be excavated and removed in such a way that the formation undergoes the minimum amount of disturbance. When formation level is reached, the sub-grade material shall be compacted as specified to a minimum of 95% MDD and reshaped to meet the required levels and grades.

3.5 Structure Backfill

3.5.1 Structure backfill shall be selected from excavation or from a source selected by the Design-Builder. It shall not contain organics, stones larger than 75 millimetres, chunks of clay or other objectionable material. Backfill materials to be used around metal piles shall have a value of resistivity not less than 2000 ohm-cm or that of the existing in-place material, whichever is less. Backfill material shall have a pH value between six (6) and nine (9) inclusive.

3.5.2 The backfill material shall conform to the following gradation:

ASTM Sieve Size	Percent Passing
75 mm	100
19 mm	60-100
2.36 mm	35-80
75 µm	0-10

3.5.3 The fraction of the material passing the 425 µm shall have a plasticity index not greater than 12 percent when tested in accordance with the requirements of ASTM D4318 . Backfill compacted by pneumatic or mechanical tamping devices shall be placed in layers not to exceed 150 millimetres in depth before compaction. Each layer shall be compacted to 100 percent MDD as stipulated in AASHTO T99. As an alternate to the material requirements of pipe backfill, the Employer's Representative may allow material conforming to the following requirements to be used in a slurry mixture in situations where the slurry will be confined by free-draining soils:

ASTM Sieve Size	Percent Passing
37.5 mm	100
25 mm	90-100
2.36 mm	35-80
75 µm	0-8

3.5.4 The plasticity index shall not exceed eight (8) percent when tested in accordance with the requirements of AASHTO T90.

3.5.5 Backfill placed as a slurry shall be placed in uniform horizontal layers not exceeding one (1) metre in depth. The maximum water content of a slurry mixture shall be 145 litres per metric tonne of backfill material. Aggregate slurry shall be thoroughly mixed in a mixer approved by the Employer's Representative. Unless otherwise approved by the Employer's Representative, the slurry shall be compacted with internal vibrators.

3.5.6 Backfill material shall not be placed against the back of concrete abutments, concrete retaining walls, or cast-in-place concrete structures until the concrete has developed its full design strength. In addition, backfill material shall not be placed against concrete structures not designed to retain earth loads until the concrete has attained a minimum compressive strength of 14 MPa and in no case less than 72 hours.

3.6 Sub-Base & Base Course

3.6.1 The grading of the sub-base and base course shall conform to the following:

Table 2 – Grading of Sub-base and base course

	Sub-Base	Base Type 1	Base Type 2
Sieve Size			
75mm	100		
37.5mm	80 - 100	100	100
19mm	60 - 80	85 - 100	85 - 100
9.5mm	45 - 65		30 - 65

4.75mm	30 - 50	40 - 60	25 - 55
2.36mm	-	25 - 55	15 - 40
0.6mm	10 - 30	10 - 25	10 - 25
0.075mm	5 - 15	5 - 15	2 - 8
Mechanical Properties			
Los Angeles Abrasion (500 revs)	< 50%	< 50%	< 40%
CBR (4 days soaked)	>30%	>80%	>80%
Liquid Limit	< 30%	< 25%	< 25%
Plasticity Index	< 10%	< 6%	<6%
Crushed Faces		>75%	>75%
Compaction	>95%	>98%	>98%

3.6.2 The prepared foundation for the base shall be shaped carefully to the required cross-section and compacted thoroughly. Where pipes are specified on the Drawings, or ordered by the Engineer, they shall be in place and functioning before any base material is placed.

3.6.3 The base shall be of approved material spread uniformly upon the prepared sub-base in layers not exceeding 150mm in depth after final compaction.

3.6.4 After each layer has been placed as specified above, it shall be uniformly compacted by a roller. The type of compaction equipment, the wheel loads, etc. including minimum number of passes, shall be approved by the Engineer to ensure thorough compaction for the full depth of the layer.

3.6.5 The percentage of moisture in the mixture shall not be more than 2% above the specified optimum moisture content as determined in the laboratory.

3.6.6 The finished surface shall be, at all points not less than the specified depth below the finished pavement surface or vary more than 12mm in 3m using a straight edge.

3.6.7 Should the foundation material beneath the base become churned up and mixed with the base material at any time, the Contractor shall proceed as follows. He shall remove the mixture and replace it with a new base material to the required depth of base as shown on the Drawings or as previously required by the Engineer; such replaced base material shall be compacted to 95% MDD.

(h) Any portion of the base that is not accessible to the roller, or other compacting unit, shall be compacted thoroughly with hand tampers, or with approved mechanical vibrators. All soft and yielding material, and other portions of the base which will not compact readily when rolled, vibrated or tamped, shall be removed as directed.

(i) The rolling, vibrating or tamping shall be continued until the entire grade is uniformly and thoroughly compacted, true to the lines and grades given.

3.7 Prime coat

3.7.1 Before placing of bituminous surface dressing, asphalt concrete surfacing or regulating course, the existing surface shall be dry and must be thoroughly cleaned of all loose material to the satisfaction of the Engineer. Where the surface is to be a surface dressing a prime coat of MC-70 cutback bitumen shall be applied to the base to ensure a good bond. Where asphalt concrete is to be placed, the prime coat shall be MC-30 cutback bitumen. The prime coat shall be uniformly applied by means of a pressure distributor at a rate between 0.9 and 1.2 litres per square metre.

3.7.2 After application of the prime coat, it shall be cured for a minimum of 48 hours. Traffic shall not be allowed on the primed surface during the curing period. The curing period shall be until the bituminous material has penetrated and dried, and in the opinion of the Engineer, shall not be picked up by traffic. Where traffic cannot be withheld from the primed surface before setting, the prime coat shall be blinded with a light uniform sprinkling of sand. The primed surface shall not be left exposed for longer than 7 days.

3.7.3 In lieu of using a petroleum based Prime Coat an Application of emulsified asphalt material can be used, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material. The asphalt emulsion material shall be uniformly applied with an asphalt distributor at the rate of 0.15 to 0.30 gallons per square yard (0.68 to 1.36 liters per square meter) depending on the base course surface texture. The type of asphalt material and application rate shall be approved by the RPR prior to application. Following application of the emulsified asphalt material and prior to application of the succeeding layer of pavement, allow the asphalt coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread sand to effectively blot up and cure excess asphalt material. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner. Keep traffic off surfaces freshly treated with asphalt material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces. Where traffic cannot be withheld from the primed surface before setting, the prime coat shall be blinded with a light uniform sprinkling of sand. The primed surface shall not be left exposed for longer than 7 days.

3.8 Single & Double Surface Dressing

3.8.1 Single surface dressings shall consist of a single application of either 85/100 bitumen or CRS-2 bitumen emulsion sprayed on a prepared surface followed with a single application of stone chippings. The nominal size and spread rate of the stone chippings and the type and nominal spray rate of the bituminous binder are stated in the Bills of Quantities. The actual rates to be applied shall be determined from field trials conducted on test sections as approved by the Engineer.

3.8.2 Double surface dressing shall consist of a first coat of 85/100 bitumen conforming to AASHTO M-20 or CRS-2 bitumen emulsion conforming to ASTM D2397 sprayed at a rate of 1.1 – 1.3 litres/m² topped with a layer of 19mm nominal aggregate at 24 kg/m² followed by a second coat of 85/100 bitumen or CRS-2 emulsion at a rate of 0.9 – 1.1 litres/m² topped with a layer of 9mm nominal aggregate at 12 kg/m² including compaction with one or more pneumatic tyred rollers or by approved steel wheel roller until the aggregate is firmly embedded in the asphaltic material, all as specified. The actual rates to be applied shall be determined from field trials conducted on test sections but the Engineer may order subsequent test sections or alter the previously established rates of application where he deems it necessary.

3.8.3 Stone chips shall be crushed stone of 19mm (3/4") size and 9mm (3/8") size, Los Angeles Abrasion wear shall not exceed 30% after 500 revolutions, polish stone value is to be > 54%. Sodium Sulphate soundness is to be 12% max or Magnesium soundness is to be 18% max., 90% of the aggregate is to have at least one fractured face, and at least 75% of the aggregate shall have two fractured faces, and conform to the following gradation:

3.9 Gradation for Cover Aggregate

Table 3 - Gradation for cover aggregate

ASTM Sieve Size (mm)	% Passing by Weight 1st Layer 19mm Nominal	2nd Layer 9mm Nominal
25	100	
19	90 - 100	
12.5	20 - 55	100
9.5	0 - 15	85 - 100
4.75	0 - 5	10 - 30
2.36	0 - 2	0 - 10
1.18		0 - 5
0.075	0 - 1	0 - 1

3.10 Spread Rate for Cover Aggregate

Table 4 - Spread rate for cover aggregate

		Kg/m ²
1st Layer	19mm Nominal	20 - 24
2nd Layer	9mm Nominal	10 - 12

3.11 Asphalt Concrete

3.11.1 Bituminous mixes shall be prepared in an approved plant where heated aggregate and bitumen shall be measured separately and accurately by weight or volume.

3.11.2 The aggregates used in asphalt concrete sourced from the approved pre-mix plant shall be durable, clean, fractured face, free from deleterious matter, etc., and shall have the following properties:

3.11.2.1 For each mix type, the supplier shall establish the job mix formula and the grading curve of the aggregates. The bitumen content (by weight) shall be agreed with the Engineer following laboratory tests and site trials.

3.12 Grading

The aggregate grading including filler should be within the following gradation:

Table 5 -Grading of Aggregate

Specification	4a	4b	4c	4d
Sieve mm				
25			100	
19		100	80-100	100
12.5	100	80 - 100	50-80	75-90
9.5	80 - 100	70 - 90	46-72	60-84
4.75	55 - 75	50 - 70	36-56	33-70
2.36	35 - 50	35 - 50	28-44	19-56
0.6	18 - 29	18 - 29	15-27	10-44
0.3	12 - 23	12 - 23	10-20	7-34
0.15	7 - 16	7 - 16	5-13	4-16
0.075	4 - 10	4 - 10	2-8	3-8
Bitumen	5 - 7	5 - 7.5	4.0-6.5	4.0-6.0

3.13 Mechanical Properties

Table 6 – Mechanical Properties

	Specification	4a	4b	4c	4d^a
Stability N	ASTM D 6927	8'000	8'000	8'000	10'000
Flow mm	ASTM D 6927	2 - 4	2 - 4	2 - 4	2 - 4
Voids in Mix %	ASTM D3203	3 - 5	3 - 5	3 - 5	3 - 5
Voids filled with Asphalt %	ASTM D 6927	70 - 80	70 - 80	70 - 80	65 - 75
VMA	ASTM D 6995	>16	>15	>14	>15
Dust to binder Ratio		0.8 - 1.6	0.8 - 1.6	0.8 - 1.6	0.8 - 1.6
Tensile Strength %	ASTM D 4867	>75	>75	>75	>75
Coarse Agg					
Specific Gravity	ASTM C 127	>2.45	>2.45	>2.45	>2.45
Absorption %	ASTM C 127	< 4	< 4	< 4	<4
L.A.A %	ASTM C 131	< 40	< 40	< 40	<40
Flakiness %	BS 812 105.1	< 30	< 30	< 30	<30
Sodium Sulphate % Magnesium Sulphate	ASTM C 88	< 12 < 18	< 10 < 15	< 10 < 15	<10 <15
Crushed Face One % Crushed Face Two %	ASTM D 5821	< 75	< 75	< 75	<85 <75
Polished Stone Value %	BS EN 1097-8	>54	>54	>54*	>54
Fine Agg					
Plastic Index. %	ASTM D 4318	< 4	< 4	< 4	<4
Liquid Limit. %	ASTM D 4318	< 25	< 25	< 4	<4
Sodium Sulphate % Magnesium Sulphate	ASTM C 88	< 10 < 12	< 10 < 12	< 10 < 12	<10 <12
^a Only if used as a Wearing Course					

3.13.1 Marshall properties shall be taken from Marshall pills compacted at 75 blows

3.13.2 The bitumen shall be PG70 -22 or 60/70 penetration grade and conform to ASTM D 946,

3.14 Temperature

3.14.1 The temperature of the Asphaltic concrete shall not exceed 175 deg centigrade at any point and bitumen shall not exceed 165 deg centigrade before being added to the virgin aggregate.

3.14.2 Laying temperature should be greater than 135 deg centigrade and rolling of the asphaltic concrete should be completed by no less than 85 deg centigrade.

3.14.3 Density of the rolled mat shall be greater than 98% of the Marshal Molds compacted in the laboratory or the density from the design mix.

3.15 Mineral Filler

3.15.1 If needed mineral filler shall consist of finely ground particles of limestone, hydrated lime, Portland Cement or other non-plastic mineral matter approved by the Employer's Representative. It shall be thoroughly dry and free from lumps. When tested by ASTM D546-88, it shall meet the following graduation requirements:

Table 7 - Mineral filler requirements

ASTM Sieve Sizes Min.	Percent Passing By Weight
600 μm	100
150 μm	90 - 100
75 μm	65 - 100

3.15.2 Mineral dust shall comprise all mineral matter which will pass the 75 μm ASTM sieve and hence includes such fine particles as may be in the coarse and fine aggregate as well as the mineral dust portion of the mineral filler.

3.15.3 The temperature of the mixture shall be controlled such that the temperature of the asphalt cement does not exceed 175 degrees Celsius, and that of the aggregate at the drier outlet is between 138 degrees Celsius and 177 degrees Celsius, depending upon the amount of moisture in the aggregate. The temperature of the mixture as it is dumped from the mixer shall be between 129 degrees Celsius and 175 degrees Celsius.

3.16 Samples for Approval

Prior to starting work on the road construction, the contractor is to submit for approval a sample of each type of material to be used for construction of the road along with appropriate test results. Tests required are as shown in the table below:

Table 8 - Test required for construction material

	Sub-base	Base	DSD Aggregates
Grading	X	X	X
Atterberg Limits	X	X	
CBR	X	X	

MDD	X	X	
LA Abrasion	X	X	X

Where asphalt concrete is to be used, the Contractor shall submit to the Engineer for his approval a mix design of the proposed mix along with all supporting documentation.

3.17 During Construction

As materials are delivered and processed, tests are to be carried out to show the material meets specification and the required densities and rates of application have been achieved. The frequency of testing shall be as shown in the table below.

Table 9 – Test to be carried out on material during construction

	Formation	Sub-base	Base	DSD	AC	Concrete
Grading		4000 t	2000 t	300 t	200 t	weekly
Atterberg Limits		4000 t	2000 t			
CBR		8000 t	4000 t			
MDD		4000 t	2000 t			
LA Abrasion		8000 t	4000 t	300 t		
Field Densities	100 m	40 m	20 m		20m	
Aggregate Spread Rate				daily		
Bitumen Spray rate				daily		
Bitumen extraction stability and flow					200 t	
Slump						Per batch
Compressive Strength						25 m3

3.18 Concrete

3.18.1 Scope

The work shall include the mixing (in an approved offsite batching plant or on site) and placing of concrete at the location and to the dimensions shown on the plans. Concrete shall comprise of Portland cement, water, fine aggregate, coarse aggregate, additives and admixtures and shall be proportioned, mixed and placed in accordance with these specifications.

3.18.1.2 Use of Ready Mix Concrete

Where the Contractor proposes using ready mixed concrete, he shall submit full details of proposed arrangements to the Engineer in writing before any concrete will be accepted on site. This specifically includes the proposed mix design and the 28-day crushing test results of the lab / plant mix. Ready mixed concrete delivered to the site shall comply with Jamaican Standard Specification for Ready-mixed concrete JS 133. The mixing speed of the drum shall be not less than 4 or more than 16 revolutions per minute of the mixing blades.

3.19 Cement

3.19.1 All cement used in the works shall be ordinary Portland cement complying with JS 32 or ASTM C 150

3.19.2 Each consignment of cement delivered to the site shall be kept separate and distinct. All accepted cement stored on site shall be kept in a suitable shed, which shall be weather tight and well ventilated. The cement shall be effectively protected from the weather during transport and until used in the works.

3.19.3 If the Engineer approves the handling of cement in bulk it shall be stored in approved silos which shall be water-tight free from condensation and other defects likely to cause air-setting or other deterioration of the material. Cement more than three months old shall not be used.

3.19.4 The Engineer will reject any cement which does not comply with the appropriate standard. He will also reject cement, which has deteriorated due to inadequate protection or other sources. The Contractor shall remove all rejected cement from the site without delay at his own expense.

3.20 Fine Aggregates

Fine Aggregate shall consist of clean, coarse and hard sand, free from dust and organic impurities, obtained from an approved source and shall comply with the requirements for fine aggregate of JS 124 or ASTM C 33. The sand shall be well graded and must pass a 18mm sieve and not more than 10% must pass a No. 100 BS sieve. It shall be washed without extra cost if so, directed by the Engineer.

3.21 Coarse Aggregate

3.21.1 Coarse aggregate shall be clean uncrushed gravel, crushed gravel, screened pit ballast or crushed stone free from clay, earth or other impurities and is to be obtained from a source approved by the Engineer.

3.21.2 The coarse aggregates shall comprise naturally occurring material complying with the requirements of and shall comply with the requirements for coarse aggregate of JS 124 or ASTM C33.

3.22 Testing of Aggregates

3.22.1 The flakiness index for all coarse aggregates to be used for concreting, when determined by the sieve method described in BS 812 shall not exceed 40% for 62.5mm into 37.5mm aggregate nor shall it exceed 35% for 18mm and 10mm aggregate. The grading specification for aggregates for concrete shall comply with BS 882 (See Appendix A).

3.22.2 Prior to any aggregate being used in concrete on or for the works, approval for their use shall be sought from the Engineer. Such requests shall be accompanied by test results. During

the course of the project, each load delivered to the site shall be accompanied by a delivery note, to be retained if so, required by the Engineer stating the quantity and description of the aggregates delivered.

3.23 Samples of Aggregate

3.23.1 No deliveries in bulk shall commence until samples are approved by the Engineer as complying with this specification.

3.23.2 The samples are to be drawn and tested in accordance with the relevant Clauses in JS 112 or ASTM. Aggregates shall also be tested for drying shrinkage. The costs of all unsatisfactory tests on samples submitted or drawn from site will be the responsibility of the Contractor.

3.24 Admixtures

Admixtures shall not be used without the specific approval, in writing from the Engineer.

3.25 Water

3.25.1 The Contractor shall provide at his own expense water for all purposes and shall notify the Engineer of the proposed source or sources of supply. Only fresh clean drinking water shall be used. Water shall be obtained from the public supply, and no water taken from a spring, river, lake or similar source shall be used for any purpose on the works unless approved by the Engineer. The Engineer may arrange for sampling and testing in accordance with BS 3148 should he consider this necessary.

3.25.2 The minimum cube strengths of any concrete mix at 7 days shall be not less than two-thirds of that specified in the above table for the concrete at twenty-eight days.

The mix shall contain no more than 533kg of cement per cubic metre of finished concrete.

3.26 Concrete Mix Design

3.26.1 At least two weeks prior to the production of any concrete, the Contractor shall submit a proposed mix design to the Engineer. The Contractor shall submit a separate mix design for each class of concrete to be used on the project. The Contractor shall substantiate each mix design by furnishing test data and providing all details of the mixture proposed for use.

3.26.2 The complete solid volume mix designs submitted for approval shall include all weights and volumes of all ingredients. The brand, type, and source of hydraulic cement and admixtures, the aggregates' gradation, source of aggregates, the specific gravity of all ingredients, the proposed slump, a code number to identify the mix design and the intended use for each mix design shall be an integral part of each mix design.

3.26.3 No changes in the approved mix designs or code numbers shall be made by the contractor except by approval of the Engineer. A new mix design shall be submitted for approval any time the Contractor requests a change in materials or proportioning of the materials from that given in each approved mix design. In no case shall the approval of a mix design relieve the Contractor of the responsibility for the results obtained by the use of such approved mix design.

3.27 Water Content

3.27.1 The water/cement ratio shall not exceed figures in Table 9 for all concrete specifications incorporated into the works. The quantity of water used shall not exceed that required to

produce a dense concrete with sufficient workability, to enable it to be placed and compacted where required.

Table 10 - Water/cement ratio for material

Class	Maximum Aggregate Size (mm)	Minimum Cement Content per m ³ of Concrete (kg)	Maximum Water Cement Ratio (kg/kg)*	Standard Cylinder / Cube Compressive Strength (MPa)
AA	19	480	0.35	35/40
A	19	420	0.40	30/35
B	19	375	0.45	25/30
C	19	335	0.50	20/25
D	19	305	0.55	16/20
E	19	280	0.60	13/15
F	37.5	235	0.65	10/12

3.27.2 Maximum slump for standard concrete to be placed should comply with the following table and a +_ of 25mm

Table 11 - Maximum slump for standard concrete

Concrete construction	Slump, mm (in.)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75 (3)	25 (1)
Plain footings, caissons, and substructure walls	75 (3)	25 (1)
Beams and reinforced walls	100 (4)	25 (1)
Building columns	100 (4)	25 (1)
Pavements and slabs	75 (3)	25 (1)
Mass concrete	75 (3)	25 (1)

3.27.3 Test cubes or cylinders shall be made in sets of six and shall be stored and tested strictly in accordance with BS 1881/cylinder. Three cubes of each set shall be tested at seven days, and the remaining three cubes retained and tested 28 days if required by the Engineer.

3.27.4 The cubes shall be cast in the presence of the Engineer, if he should so desire, and shall be marked with a reference number for identification and to define the mixing plant, the class of mix, the location in the structure from which the sample was taken, the slump and the date cast.

3.28 Mixing Concrete

3.28.1 Concrete shall attain the 28-day compressive cube strength in accordance with JS 133:2021, ASTM C39/C39M or BS 1881.

3.28.2 Unless otherwise specified in the contract or so directed by the Engineer, the average of 3 cylinders / cubes shall attain a compressive cube strength at 28 days of the required strength in accordance with JS 133:2021, ASTM 39. or BS 1881?

3.28.3 Concrete shall be mixed in a power-driven batch mixer, which has been approved by the Engineer.

3.28.4 The quantity of material in each batch shall not exceed the rated capacity of the mixer and the speed of rotation shall be within the range recommended by the manufacturers.

3.28.5 For drum type mixers, mixing shall continue for not less than 1.5 minutes after all materials are in the drum. When concrete is produced in a ready mix plant and delivered to site the supplier shall comply with JS 133 mixing shall be carried out for a period of at least five minutes. Each batch shall be homogeneous and completely discharged without segregation.

3.28.6 Where a truck mixer or agitator is used for transporting concrete, the discharge of the concrete shall be completed within 2 hours after either the introduction of the mixing water to the cement and aggregates, or the introduction of cement to the aggregates, whichever period is the longer, unless retarders are used to extend the setting time of the concrete, and approved by the Engineer.

3.28.7 No hand-mixing of concrete is permitted on the job site.

3.29 Temperature of Concrete

Limit the maximum concrete temperature to 95 °F (35 °C)/38 at the time of discharge where an approved retarder is used. This limit is for general types of hot weather construction such as pavements, bridges, and buildings, not mass concrete.

3.30 Concreting in hot weather

To minimise damage to concrete due to heat, the below should be carried out :

- a) Dampen the subgrade and formwork by sprinkling them with water just before placing the concrete.
- b) Store aggregates and cement in shaded areas and insulate water tanks to prevent heat gain.
- c) Direct sunlight and wind increase the rate of moisture loss, so shade the pour area and block wind if possible.
- d) Employ retarding admixtures to slow the concrete's setting time.
- e) Discharge concrete from the truck as soon as possible to prevent it from heating up from agitation and hydration.
- f) Start Curing Immediately: Begin curing the concrete as soon as final finishing is complete.
- g) Use Curing Methods: Protect the concrete surface from rapid drying by:
 1. Applying curing blankets to keep the concrete wet.
 2. Using a curing compound to form a moisture-retaining barrier.
 3. Continuing to keep the wet coverings moist.
 4. Schedule for Cooler Times: Consider scheduling the pour for the late afternoon or evening to take advantage of lower temperatures.

3.31 Handling and Placing Concrete

3.31.1 The Contractor shall allow a reasonable period of time between the finalisation of all details in preparation for the concrete pour and the actual commencement of the pour, to allow

the Engineer to inspect all details for their conformance with the Specifications. No concrete may be placed until permission is given by the Engineer after he has inspected and approved the reinforcement and formwork.

3.31.2 In preparation for the placing of concrete all saw-dust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces serving temporarily to hold the form correctly in their locations shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete. (c) Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement.

3.31.3 The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be subject to written approval of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

3.31.4 Open troughs and chutes shall be metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

3.31.5 All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

3.31.6 When placing operations would involve dropping the concrete more than 1.5m, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars, which project.

3.31.7 Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- a) The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.
- b) Vibrators shall be of a type and design approved by the Engineer They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.
- c) The intensity of vibration shall be such as to visibly affect a mass of concrete of 25mm slump over a radius of at least 450mm.
- d) The contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. There shall at all times be available on the job a standby gasoline driven vibrator in case of breakdown.
- e) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms. Vibrations shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrator shall be inserted and withdrawn out of the concrete slowly. The vibrator shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued at any one point to the extent that localized areas of grout are formed.
- f) Application of vibrator shall be at points uniformly spaced and not farther apart than twice the radius over which the vibrator is visibly effective.

- g) Vibration shall not be applied directly or through the reinforcement to sections of layers of concrete, which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation and vibrators shall not be used to transport concrete in the forms.
- h) Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

3.31.8 Concrete shall be placed in horizontal layers not more than 300mm thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separate between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer, which has not taken initial set.

3.31.9 When the placing of concrete is temporarily discontinued, the concrete after becoming firm enough to retain its form shall be cleaned of latency and other objectional material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feathered edge" might be produced at a construction joint, as in the sloping top surface of a wing wall, an inset form shall be used to produce a blocked out portion in the preceding layer, which shall produce an edge thickness of not less than 150mm in the succeeding layer. Work shall not be discontinued within 450mm of the top of any face unless provision has been made for a coping less than 450mm thick, in which case, if permitted by the Engineer the construction joint may be made at the underside of the coping.

3.31.10 Immediately following the discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel-bond at and near the surface of the concrete, while cleaning and reinforcement steel.

END OF DOCUMENT

Standards Council

The Standards Council is the controlling body of the Bureau of Standards Jamaica and is responsible for the policy and general administration of the Bureau.

The Council is appointed by the Minister in the manner provided for in the Standards Act, 1969. Using its powers in the Standards Act, the Council appoints committees for specified purposes.

The Standards Act, 1969 sets out the duties of the Council and the steps to be followed for the formulation of a standard.

Preparation of standards documents

The following is an outline of the procedure which must be followed in the preparation of documents:

1. The preparation of standards documents is undertaken upon the Standard Council's authorisation. This may arise out of representation from national organisations or existing Bureau of Standards' Committees of Bureau staff. If the project is approved it is referred to the appropriate sectional committee or if none exists a new committee is formed, or the project is allotted to the Bureau's staff.
2. If necessary, when the final draft of a standard is ready, the Council authorises an approach to the Minister in order to obtain the formal concurrence of any other Minister who may be responsible for any area which the standard may affect.
3. The draft document is made available to the general public for comments. All interested parties, by means of a notice in the Press, are invited to comment. In addition, copies are forwarded to those known, interested in the subject.
4. The Committee considers all the comments received and recommends a final document to the Standards Council
5. The Standards Council recommends the document to the Minister for publication.
6. The Minister approves the recommendation of the Standards Council.
7. The declaration of the standard is gazetted and copies placed on sale.
8. On the recommendation of the Standards Council the Minister may declare a standard compulsory.
9. Amendments to and revisions of standards normally require the same procedure as is applied to the preparation of the original standard.

Overseas standards documents

The Bureau of Standards Jamaica maintains a reference library which includes the standards of many overseas standards organisations. These standards can be inspected upon request.

The Bureau can supply on demand copies of standards produced by some national standards bodies and is the agency for the sale of standards produced by the International Organization for Standardization (ISO) members.

Application to use the reference library and to purchase Jamaican and other standards documents should be addressed to:

Bureau of Standards Jamaica
6 Winchester Road
P.O. Box 113,
Kingston 10
JAMAICA, W. I.