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203. ROAD WORKS

203.1 ROADS AND PAVED AREAS

203.1.1 General

Road construction under this division shall include construction of new roads and paved areas and repairs to existing roads and paved areas where such repairs are necessitated by the performance of the Works, and the term "road" as used in this division shall also include other areas on which a road surfacing is required.

All roads shall be constructed to the lines, levels and cross-sections shown on the Drawings and as detailed in the Particular specification. Road surfacing may consist of compacted local soil, gravel, laterite or similar suitable material, with or without a stabilizing spray of bitumen, or of asphalt concrete placed on a bearing course of compacted gravel, laterite or other suitable base course material.

203.1.2 Earthworks for Road Construction (Subgrade)

All excavation and fill required for road construction shall be carried out in accordance with the applicable requirements of Division 201. The materials to be used and the degree of compaction to be obtained in each layer of the road structure shall be as shown on the Drawings or as required in the Specification.

203.1.3 Sub-Base and Base Courses

Sub-base preparation shall consist of the following:

- Scraping of the natural ground
- Earthworks and levelling of the surface
- Compaction with a pneumatic roller.

Unless otherwise specified, sub-base material shall consist of hard, durable particles or fragments of stone or gravel, screened and crushed to the required size and grading or an equivalent material, subject to the Engineer's approval. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base shall be levelled, watered, rolled and compacted to 96% of the Modified AASHTO Density. In case it consists of non-rock ground, the California Bearing Ratio CBR shall be greater than 30. The Material shall have a specific weight greater than 2.45 kg/dm³.

If the bearing of the foundation soil be inadequate, the top soil shall be stripped to a 20cm depth. The stripped area shall be backfilled with material that meets the requirements and have a minimum CBR of 15 when compacted to 96% of Modified AASHTO Density. The frequency of tests shall be determined by the Engineer.

The sub-base course material layer shall conform to the following grading:

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A.S.T.M.Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 1/2"	100%
1"	60-100
3/4"	55-85
No. 4	35-60
No. 10	25-50
No. 40	15-30
No. 200	0-15

The material shall have the following properties:

- Plasticity Index (AASHTO T90) 4-8
- Plastic Limit (AASHTO T89) 25 maximum
- Sand Equivalent (AASHTO T176) 50 minimum

Unless otherwise specified, base course material shall be crushed aggregate which shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size, and a filler of sand or other finely divided mineral mater. When produced from gravel, not less than 50 percent by weight of the coarse aggregate shall be particles having at least one fractured face and, if necessary to meet his requirement or to eliminate an excess of filler, the gravel shall be screened before crushing. All suitable oversize material less than 10 inches in diameter shall be crushed. The material shall be free from vegetable matter, lumps or balls of clay and other objectionable matter.

The sub-base and base courses shall consist of a minimum of 20 cm thick each course of compacted layers of screened and crushed material.

The sub-base shall be watered prior to the placing of the base course. The material shall then be laid, watered and compacted with a pneumatic roller to 98% of Modified AASHTO Density.

The last base course shall be levelled to ± 1 cm according to the levels shown on the drawings or specified by the Employer. Newly placed base courses shall not be opened to traffic.

The base course material shall have a specific weight greater than 2.45 kg/dm³ and shall conform to one of the following gradings:

A.S.T.M.Sieve designation	Percentage by Weight Passing Square Mesh Sieves								
	A	B	B-1	C	C-1	D	D-1	E	E-1
3 inch	100	-	-	-	-	-	-	-	-
2 inch	-	100	100	-	-	-	-	-	-
1 1/2 inch	-	-	70-100	100	100	-	-	-	-
1 inch	-	-	55-85	-	70-100	100	100	-	-
3/4 inch	-	-	50-80	-	60-90	-	70-100	100	100
3/8 inch	-	-	40-70	-	45-75	-	50-80	-	-
No. 4	15-45	20-50	30-60	25-55	30-60	30-60	35-65	35-65	45-80
No. 10	-	-	20-50	-	20-50	0	25-50	-	30-60
No. 40	-	-	10-30	-	10-30	0	15-30	-	20-35
No. 200	0-10	0-10	5-15(*)	0-10	5-15(*)	0-10	5-15(*)	0-10	5-15(*)

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(*) For gradings B-1, C-1, D-1 and E-1, the fraction passing the No. 200 sieve shall not be greater than two-thirds of the fraction passing the No. 40 sieve.

If no specific grading is specified, the grading shall comply with C above.

If fine aggregate or filler in addition to that naturally present in the base-course material is necessary in order to meet the grading requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base-course material at the screening and crushing plant or on the road. The material for such purpose shall be obtained from sources approved by the engineer and shall be free from hard lumps.

That portion of the base course material passing No. 40 sieve shall be nonplastic.

The base course material shall be tested for abrasion in accordance with B.S. 812 and the following maximum values shall be acceptable.

<u>Aggregate fraction</u>	<u>Maximum abrasion (%)</u>
3/4" - 1"	40
1/2" - 3/4"	35
3/8" - 1/2"	30
1/8" - 3/16"	28

Sub-base and base courses shall be placed in layers not exceeding 15 cm in thickness, after compaction. Unless otherwise specified, base course materials shall be placed only by means of spreader boxes or equivalent equipment. Placing base course materials directly by means of trucks, shovel dozers and other loading or hauling equipment will not be permitted. Blending material, where required, shall be added by means of spreader boxes or other approved equipment and the whole base course layer shall be thoroughly mixed to its full depth by means of graders, mixers or other approved equipment.

During placing and mixing, water shall be added in the amount necessary to provide the optimum moisture content for compacting.

Unless otherwise specified, the following densities shall be required:

- For sub-bases: 96% of the Modified A.A.S.H.T.O. Density
- For base-courses: 98% of the Modified A.A.S.H.T.O. Density

203.2 GRANULAR SUB-BASE COURSE

203.2.1 Subgrade Surface Preparation

- A. The minimum thickness of sub-base shall be as shown on the Drawings. At transition points, such as specified changes of sub-base thickness, areas adjacent to structures and at tie-ins to existing pavements the subgrade shall be adjusted to a depth sufficient to permit construction of the sub-base course to the specified finished levels and thicknesses. Transitions shall be of sufficient lengths to avoid abrupt changes of grade that compromise drainage paths in the sub-base and shall be within plus or minus 3 % of the final design grade unless otherwise directed by the Engineer. Surplus material shall be removed and disposed of.

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- B. The subgrade shall be inspected and approved immediately prior to commencement of sub-base construction. Any soft, yielding material shall be removed and replaced by topping material approved by the Engineer. Holes, depressions and other irregularities shall be made good as directed by the Engineer and the subgrade recompacted and finished to receive the sub-base course.

203.2.2 Construction

A. Mixing And Spreading

- All components of sub-base course material shall be mixed thoroughly and uniformly with water in situ. The amount of water added shall be sufficient to maintain the material within the specified moisture content range at the time of compaction. Water shall only be added as necessary during placing and compaction of sub-base material. Watering of granular material in stockpiles or in trucks before or during delivery to the Site shall not take place.
- The sub-base material shall be placed on the subgrade in a uniform layer or layers not exceeding 200 mm thickness (after compaction).
- The Engineer shall permit compaction of sub-base in layers of up to 300mm if heavy duty vibratory compaction equipment is used and compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness of the layer.
- Sub-base material shall be placed to the required width using a self-propelled spreader or a motor grader equipped with blade extensions. Water shall be applied by approved spraying equipment and thoroughly mixed with the sub-base material.
- The material shall not be handled in such a way as to cause segregation. If the spreading equipment causes segregation in the material or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the equipment, the use of such equipment shall forthwith be discontinued and replaced by a spreader or grader capable of spreading the material in a satisfactory manner.
- All segregated material shall be removed and replaced with well-graded material. Skin patching shall not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances shall be permitted during the compaction process.
- Neither hauling nor placement of material shall be permitted when, in the judgment of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting or rutting of the subgrade or cause contamination of the sub-base material.

B. Compaction

- The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent ravelling or excessive drying the application of such water shall be carried out as directed by the Engineer and at the Contractor's expense.
- The sub-base material shall be compacted by progressing gradually from the outside towards the centre, with each succeeding pass uniformly overlapping the previous pass.

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- Rolling shall continue until the entire thickness of each sub-base layer is thoroughly and uniformly compacted to 100 % AASHTO T 180 maximum density. Final rolling of the completed course shall be completed by a self-propelled roller. Rolling shall be accompanied by sufficient blading, to ensure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied by a method approved by the Engineer.
- Any areas inaccessible to normal compaction equipment shall be compacted by portable mechanical tampers until the required standard of compaction is achieved.
- Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.
- Prior to placing a subsequent layer, the existing surface shall be made sufficiently moist as directed, to ensure a proper bond between layers.
- Material which has dried out prior to final compaction or which has dried and de-compacted subsequent to final compaction shall be watered and recompactd using equipment and procedures approved by the Engineer. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall remove the material and reconstruct the sub-base course on a re-approved subgrade.

C. Tolerances

- The fully compacted and completed sub-base course shall conform to the lines, grades and cross sections as shown on the Drawings.
- The levels of the finished sub-course shall be checked by the Contractor in the presence of the Engineer at maximum intervals of 10 m and at intermediate points as directed.
- The tolerances on levels of the finished surface shall be plus 10 mm to minus 20 mm. A minus tolerance shall be compensated by the addition of material in the proceeding layer.
- When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centreline, the maximum deviation of the surface from the testing edge between any two contact points shall not exceed 10 mm.
- All areas which exceed the specified tolerances shall be corrected by removing the defective sections of sub-base and reconstructing them or, if approved by the Engineer, by the addition of new material, mixing, re-compacting and finishing to the specified standard.

203.3 AGGREGATE BASE COURSE

203.3.1 Surface Preparation

- A. Where a sub-base course is present, it shall have previously been constructed in accordance with the requirements Granular Sub-Base Course and properly maintained and kept well drained thereafter.
- B. The sub-base surface shall be inspected and approved prior to commencement of base construction. Holes, depressions and other irregularities shall be made good as directed by the Engineer and the sub-base recompactd as necessary and finished ready to receive the base course.
- C. Where a sub-base course has been omitted in the Drawings and the aggregate base course is placed directly on completed sub-grade,

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preparation of the sub-grade surface shall be as specified in Section 3.02 - Granular Sub-Base Course

203.3.2 Construction

A. Mixing And Spreading

- All components of base course material may be premixed with water, in a pugmill mixing plant or on site. The amount of water added, as determined, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. The Engineer shall consider other methods of mixing provided such method(s) do not reduce the standard of work. The Contractor shall demonstrate, in the presence of the Engineer, his ability to attain the requirement given in this Specification.
- The premixed material shall be placed on the sub-base in a uniform layer or layers not exceeding 250 mm in thickness before compaction. Where the required uncompacted thickness is greater than 250 mm but less than 500 mm, the material shall be placed in layers of equal thickness.
- Compaction of sub-base in layers of up to 350 mm after compaction shall be permitted if heavy duty vibratory compaction equipment is used and compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness of the layer.
- The base course material shall be placed to the required width using a self-propelled spreader or motor grader and shall be delivered such that it is ready for compaction without further shaping.
- The material shall not be handled in such a way as to cause segregation. If the spreader causes segregation in the material or leaves ridges or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the spreader operation, the use of such a spreader shall forthwith be discontinued and it shall be replaced by a spreader capable of carrying out this work in a satisfactory manner.
- All segregated material shall be removed and replaced with well-graded material. Skin patching shall not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances shall be permitted during the compaction process.
- Hauling or placement of material shall not be permitted when, in the judgment of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting or rutting of the sub-base or sub-grade or cause contamination of the base material.

B. Compaction

- The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent ravelling or excessive drying, the application of such water shall be carried out using a method approved by the Engineer and at the Contractor's expense.
- The base course material shall be compacted by means of suitable compaction equipment, progressing gradually from the outside towards the centre, with each succeeding pass uniformly overlapping the previous pass.
- Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 maximum density. Final rolling of the completed course shall be by means of an

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approved self-propelled roller. Rolling shall be accompanied by sufficient blading to ensure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied by a method approved by the Engineer.

- Any areas inaccessible to normal compaction equipment shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.
- Each layer shall be completely compacted and approved prior to delivery of materials for the following layer.
- Prior to placing a following layer, the surface shall be made sufficiently moist, to the satisfaction of the Engineer, to ensure an effective bond between the layers.
- Material which has dried out prior to final compaction or which has dried and de-compacted subsequent to final compaction shall be watered and recompactd using approved equipment and procedures. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall scarify the material in the upper layer and reconstruct the base course on a re-approved sub-base surface to the satisfaction of the Engineer.

C. Tolerances

- The fully compacted and completed base course shall conform to the lines, grades and cross sections as shown on the Drawings.
- The elevations of the finished base course shall be checked by the Contractor in the presence of the Engineer at intervals of 20 metres on straight lines and of 10 metres on curves and at intermediate points as directed.
- The tolerances on elevations of the finished surface shall not exceed + 10 mm or -15 mm.
- When the finished surface is tested with a 4 metre long straightedge, placed parallel to or at right angles to the centreline, the maximum deviation of the surface from the testing edge between any two contact points shall not exceed 12 mm.
- All areas which exceed the specified tolerances shall be corrected by removing defective sections of base course and reconstructing them or by scarifying and adding new material and re-compacting and finishing to the specified standard

203.4 TESTING

203.4.1 Testing on fill materials

All natural fine fills shall conform to the below listed requirements:

- C. Complete Identification Tests
 - Sieve analysis and sedimentometry
 - Atterberg limits (liquid limit, plasticity index, shrinkage)
- D. Test on organic soils
- E. Standard Proctor tests with complete determination of compaction diagram
- F. Modified Proctor tests with complete determination of compaction diagram
- G. CBR tests at 95% of the maximum dry density.

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The number of the aforesaid tests shall be as determined by the Engineer.

203.4.2 Tests on Backfill

Placing natural fine fill shall be controlled by the Engineer in the following manner:

Three series of the following tests shall be conducted on each backfilled layer or on every 250 m³ of placed backfills:

Measurement of moisture content

Measurement of compactness (dry density)

203.4.3 CBR tests on natural ground

CBR tests shall be conducted according to relevant standards.

The frequency of tests shall be as determined by the Engineer.

203.4.4 Tests on crushed aggregates

The required tests on crushed aggregates to be used for roads are the following:

- Measurement of the specific gravity
- Measurement of the compressive strength on 7 cm side cube
- Los Angeles test
- Sieve analysis
- tests on organic soils according to French Standards
- Measurement of the sand equivalent.

A series of tests shall be carried out on each 500 m³ of aggregates or as directed by the Engineer.

Following are the two density control tests to be carried out on site on each placed crushed aggregate layer:

- Either on each finished layer,
- Or on each 250 m³ of placed aggregates,
- Or as directed by the Engineer.

203.5 ROADS - METHODS OF MEASUREMENT AND PAYMENTGranular Sub-Base Course

- A.** Granular Sub-base Course shall be measured by the cubic meter of granular materials furnished, screened, crushed if necessary, mixed with water, placed, spread, compacted and finished, completed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and of the field measurements of the area and compacted depth for each Trial Section.
- B.** Rates for Granular Sub-base Course in Temporary Diversions shall also include for removal and disposal of the sub-base material and reinstatement of the

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area of the temporary diversion, to the satisfaction of the Engineer, on completion of use.

- C. No measurement shall be made for direct payment of over-depth or over-wide construction, regardless of the Engineer's permission for it to remain in place.

Aggregate Base Course

- D. Aggregate Base Course shall be measured by the cubic meter of aggregate materials furnished, crushed, screened, mixed with water, placed, spread, compacted and finished, completed, and accepted. Measurements shall be of volumes computed from the cross sections shown on the Drawings and of the field measurements of the area and compacted depth for each Trial Section.
- E. Rates for Granular Base Course in Temporary Diversions shall also include for removal and disposal of the sub-base material and reinstatement of the area of the temporary diversion, to the satisfaction of the Engineer, on completion of use.
- F. Rates for Aggregate Base Course in Temporary Diversions shall also include for removal and disposal of the sub-base material and reinstatement of the area of the temporary diversion, to the satisfaction of the Engineer, on completion of use.

PAY ITEM**UNIT OF MEASUREMENT**

Granular Sub-Base Course

Cubic metre (m³)

Aggregate Base Course

Cubic metre (m³)