

# ROAD PAVEMENTS – UNBOUND MATERIALS

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# Road Pavements – Unbound Materials

## 801 Unbound Materials for Sub-bases and Roadbases

- 1 Unbound sub-bases and roadbases shall be made and constructed using materials described in the following Clauses. The permitted alternatives for each part of the Works shall be as described in Appendix 7/1.
- 2 Materials when placed within 500 mm of cement-bound materials, concrete pavements, concrete structures or concrete products shall have a water soluble sulphate content not exceeding 1.9 g of sulphate (expressed as  $\text{SO}_4$ ) per litre when tested in accordance with BS 1377 : Part 3.
- 3 Except where otherwise stated in Appendix 7/1, unbound material up to 225 mm compacted thickness shall be spread in one layer so that after compaction the total thickness is as specified. Unbound material of compacted thickness greater than 225 mm shall be laid in two or more layers and the minimum compacted thickness of any such layer shall be 110 mm. Where the layers of unbound material are of unequal thickness the lowest layer shall be the thickest layer.

## 802 Compaction

- 1 Compaction shall be completed as soon as possible after the material has been spread and in accordance with the requirements for the individual materials.
- 2 Special care shall be taken to obtain full compaction in the vicinity of both longitudinal and transverse joints.
- 3 Compaction of unbound materials shall be carried out by a method specified in Table 8/1, unless the Contractor demonstrates at site trials that a state of compaction achieved by an alternative method is equivalent to or better than that using the specified method. The procedure for these trials shall be subject to approval by the Engineer.
- 4 Compaction of any layer of material shall continue until the material is free from movement under compaction plant. The surface of any layer of material shall on completion of

compaction and immediately before overlaying, be well closed, free from movement under compaction plant and from ridges, cracks, loose material, pot holes, ruts or other defects. All loose, segregated or otherwise defective areas shall be removed to the full thickness of the layer, and new material laid and compacted.

- 5 For the purposes of Table 8/1 the following shall apply:
  - (i) The number of passes is the number of times that each point on the surface of the layer being compacted shall be traversed by the item of compaction plant in its operating mode (or struck, in the case of power rammers).
  - (ii) The compaction plant in Table 8/1 is categorised in terms of static mass. The mass per metre width of roll is the total mass on the roll divided by the total roll width. Where a smooth-wheeled roller has more than one axle, the category of the machine shall be determined on the basis of the axle giving the highest value of mass per metre width.
  - (iii) For pneumatic-tyred rollers the mass per wheel is the total mass of the roller divided by the number of wheels. In assessing the number of passes of pneumatic-tyred rollers the effective width shall be the sum of the widths of the individual wheel tracks together with the sum of the spacings between the wheel tracks provided that each spacing does not exceed 230 mm. Where the spacings exceed 230 mm the effective width shall be the sum of the widths of the individual wheel tracks only.
  - (iv) Vibratory rollers are self-propelled or towed smooth-wheeled rollers having means of applying mechanical vibration to one or more rolls:
    - (a) The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine with mechanical transmission and a speed of 1.5-2.5 km/h for a towed machine or a self-propelled machine with hydrostatic transmission. If higher gears or speeds are used an increased number of passes shall be provided in proportion to the increase in speed of travel.
    - (b) Where the mechanical vibration is applied to two rolls in tandem, the

minimum number of passes shall be half the number given in Table 8/1 for the appropriate mass per metre width of one vibrating roll but if one roll differs in mass per metre width from the other, the number of passes shall be calculated as for the roll with the smaller value. Alternatively the minimum number of passes may be determined by treating the machine as having a single vibrating roll with a mass per metre width equal to that of the roll with the higher value.

- (c) Vibratory rollers operating without vibration shall be classified as smooth-wheeled rollers.
- (d) Vibratory rollers shall be operated with their vibratory mechanism operating at the frequency of vibration recommended by the manufacturer. All such rollers shall be equipped, or provided with devices indicating the frequency at which the mechanism is operating and the speed of travel. Both devices shall be capable of being read by an inspector alongside the machine.
- (v) Vibrating-plate compactors are machines having a base-plate to which is attached a source of vibration consisting of one or two eccentrically-weighted shafts:
  - (a) The mass per square metre of base-plate of a vibrating-plate compactor is calculated by dividing the total mass of the machine in its working condition by its area in contact with compacted material.
  - (b) Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer. They shall normally be operated at travelling speeds of less than 1 km/h but if higher speeds are necessary, the number of passes shall be increased in proportion to the increase in speed of travel.
- (vi) Vibro-tampers are machines in which an engine driven reciprocating mechanism acts on a spring system, through which oscillations are set up in a base-plate.
- (vii) Power rammers are machines which are actuated by explosions in an internal combustion cylinder; each explosion being controlled manually by the operator. One pass of a power rammer shall be considered to have been made when the compacting shoe has made one strike on the area in question.

- (viii) Combinations of different types of plant or different categories of the same plant will be permitted; in which case the number of passes for each shall be such proportion of the appropriate number in Table 8/1 as will together produce the same total compactive effort as any one operated singly, in accordance with Table 8/1.

### 803 Granular Material Type A

- 1 Type A granular material shall be gravel or crushed rock. The material shall be well-graded and lie within the grading envelope of Table 8/2.
- 2 The material passing the 425µm BS sieve, when tested in accordance with BS 1377: Part 2, shall have a plasticity index of less than 6.
- 3 The material passing the 20 mm BS sieve shall have a CBR of 50 per cent or more when tested in accordance with BS 1377: Part 4 at the maximum dry density and optimum moisture content for the material as determined by the vibrating hammer method test in accordance with BS 1377: Part 4.
- 4 The material shall be laid and compacted at a moisture content within the range 1 per cent above to 2 per cent below the optimum percentage determined in accordance with the vibrating hammer method test in BS 1377: Part 4, and without drying out or segregation.
- 5 The material shall have a ten per cent fines value of 130 kN or more when tested in compliance with BS 812 : Part 111. The test sample shall be in a soaked condition at the time of test.
- 6 The aggregate source, when tested in accordance with BS 812 : Part 121, shall have a soundness value greater than 75, or such lower value as may be required in Appendix 7/1. Thereafter for routine testing of such aggregates, the water absorption value of the coarse aggregate shall be determined as in BS 812 : Part 2. If the absorption value of the coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered to site.

**Table 8/1: Compaction Requirements for Unbound Materials in Road Pavements**

Type of compaction plant	Category	Minimum number of passes for layers not exceeding the following compacted thickness		
		110 mm	150 mm	225 mm
Smooth-wheeled roller (or vibratory roller operating without vibration)	Mass per metre width of roll: over 2700 kg up to 5400 kg over 5400 kg	16	unsuitable 16	unsuitable unsuitable
		8		
Pneumatic-tyred roller	Mass per wheel: over 4000 kg up to 6000 kg over 6000 kg up to 8000 kg over 8000 kg up to 12000 kg over 12000 kg	12	unsuitable unsuitable	unsuitable unsuitable
		12		
		10	16	unsuitable
		8	12	unsuitable
Vibratory roller	Mass per metre width of vibrating roll: over 700 kg up to 1300 kg over 1300 kg up to 1800 kg over 1800 kg up to 2300 kg over 2300 kg up to 2900 kg over 2900 kg up to 3600 kg over 3600 kg up to 4300 kg over 4300 kg up to 5000 kg over 5000 kg	16	unsuitable 16	unsuitable unsuitable
		6		
		4	6	10
		3	5	9
		3	5	8
		2	4	7
		2	4	6
2	3	5		
Vibrating-plate compactor	Mass per square metre of base plate: over 1400 kg/m <sup>2</sup> up to 1800 kg/m <sup>2</sup> over 1800 kg/m <sup>2</sup> up to 2100 kg/m <sup>2</sup> over 2100 kg/m <sup>2</sup>	8	unsuitable 8	unsuitable unsuitable
		5		
		3	6	10
Vibro-tamper	Mass: over 50 kg up to 65 kg over 65 kg up to 75 kg over 75 kg	4	8	unsuitable 10
		3	6	
		2	4	8
Power rammer	Mass: 100 kg – 500 kg over 500 kg	5	8	unsuitable 12
		5	8	

**Table 8/2: Granular Material Type A**

Range of Grading	
BS Sieve Size	Percentage by mass passing
75 mm	100
37.5 mm	85-100
10 mm	40-70
5 mm	25-65
600 µm	8-30
75 µm	0-10

The particle size shall be determined by the washing and sieving method of BS 812 : Part 103

### 804 Granular Material Type B

- 1 Type B granular material shall be crushed rock. The material shall be well-graded, and lie within the grading limits of Table 8/3.
- 2 The material passing the 425 µm BS sieve shall have a liquid limit, determined in accordance with the cone penetrometer method (definitive method) in BS 1377: Part 2, not greater than 20 for limestone and 21 for all other rock types.
- 3 The material shall be laid and compacted at a moisture content within the range of the optimum to 2 per cent below the optimum percentage determined in accordance with the vibrating hammer method test in BS 1377: Part 4, and without drying out or segregation.

**Table 8/3: Granular Material Type B**

Range of Grading	
BS Sieve Size	Percentage by mass passing
75 mm	100
37.5 mm	85-100
10 mm	40-70
5 mm	25-45
600 µm	10-22
75 µm	0-8

The particle size shall be determined by the washing and sieving method of BS 812 : Part 103

**Table 8/4: Granular Material Type C**

Range of Grading	
BS Sieve Size	Percentage by mass passing
75 mm	100
37.5 mm	80-100
20 mm	60-80
10 mm	40-65
5 mm	25-50
600 µm	8-20
75 µm	0-8

The particle size shall be determined by the washing and sieving method of BS 812 : Part 103

- 4 The material shall have a ten per cent fines value of 130 kN or more when tested in compliance with BS 812 : Part 111. The test sample shall be in a soaked condition at the time of test.
- 5 The flakiness index shall be less than 45 when determined in accordance with BS 812: Section 105.1.
- 6 The aggregate source, when tested in accordance with BS 812 : Part 121, shall have a soundness value greater than 75, or such lower value as may be required in Appendix 7/1. Thereafter for routine testing of such aggregates, the water absorption value of the coarse aggregate shall be determined as in BS 812 : Part 2. If the absorption value of the coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered to site.

- 3 The material passing the 20 mm BS sieve shall have a CBR of 150 or more when tested in accordance with BS 1377: Part 4 at the maximum dry density and optimum moisture content for the material as determined by the vibrating hammer method test in accordance with BS 1377: Part 4.
- 4 The material shall be laid and compacted at a moisture content within the range of the optimum to 2 per cent below the optimum percentage determined in accordance with the vibrating hammer method test in BS 1377: Part 4, and without drying out or segregation.
- 5 The material shall have a ten per cent fines value of 130 kN or more when tested in compliance with BS 812: Part 111. The test sample shall be in a soaked condition at the time of test.
- 6 The aggregate source, when tested in accordance with BS 812: Part 121, shall have a soundness value greater than 75, or such lower value as may be required in Appendix 7/1. hereafter for routine testing of such aggregates, the water absorption value of the coarse aggregate shall be determined as in BS 812: Part 2. If the absorption value of the coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered to site.

### 805 Granular Material Type C

- 1 Type C granular material shall be screened or crushed gravel. The material shall be well-graded and lie within the grading envelope of Table 8/4.
- 2 The material passing the 425 µm sieve shall have a liquid limit, determined in accordance with the cone penetrometer method (definitive method) in BS 1377: Part 2, not greater than 20 for limestone and 21 for all other rock types.

**Table 8/5: Wet-Mix Macadam**

Range of Grading	
BS Sieve Size	Percentage by mass passing
50 mm	100
37.5 mm	95-100
20 mm	60-80
10 mm	40-60
5 mm	25-40
2.36 mm	15-30
600 µm	10-22
75 µm	0-8

The particle size shall be determined by the washing and sieving method of BS 812 : Part 103

### 806 Wet-Mix Macadam

- 1 Wet-mix macadam shall be made and constructed in the following manner.

#### Aggregate

- 2 The coarse and fine aggregate shall consist of crushed rock and the aggregate shall have the grading shown in Table 8/5.
- 3 The material shall have a 10% fines value of 130 kN or more when tested in compliance with BS 812: Part 111 except that the samples shall be tested in a saturated and surface dried condition. Prior to testing the selected test portions shall be soaked in water at room temperature for 24 hours without previously having been oven dried.
- 4 The flakiness index shall be less than 40 when determined in accordance with BS 812: Section 105.1.
- 5 The material passing the 425 µm BS sieve shall have a liquid limit, determined in accordance with the cone penetrometer method (definitive method) in BS 1377: Part 2, not greater than 20 for limestone and 21 for all other rock types.
- 6 The aggregate source, when tested in accordance with BS 812: Part 121, shall have a soundness value greater than 75, or such lower value as may be required in Appendix 7/1.

Thereafter for routine testing of such aggregates, the water absorption value of the coarse aggregate shall be determined as in BS 812: Part 2. If the absorption value of the coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered to site.

#### Moisture Content

- 7 The material shall be transported, laid and compacted at a moisture content within the range 0.5 to 1.5 percent below the optimum percentage determined in accordance with the vibrating hammer method test in BS 1377: Part 4 and without drying out or segregation.

#### Laying and Compaction

- 8 The compacted thickness of each layer shall not be more than 150 mm.
- 9 Compaction of wet-mix macadam shall be carried out in accordance with the requirements of Clause 802, using vibrating rollers having a mass per metre width of vibrating roll of at least 1800 kg.
- 10 The material shall be protected from weather during transit to the site, whilst awaiting tipping and during laying.
- 11 On completion of compaction the surface of the material shall be sealed with cationic bitumen emulsion (70 per cent bitumen) sprayed at a rate between 1.1 and 1.4 litre/m<sup>2</sup>, covered with 6 mm chippings at a rate of spread of 6 to 8 kg/m<sup>2</sup>, and lightly rolled.