

Base courses
Crushed-limestone base course
Crushed gravel base course
Vibratory -compacted macadam stone base course

SECTION R7

Base courses
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R7 01 Scope

The work covered by this Section of the Specification consists in the furnishing of all plant, labor, equipment and material and in performing all operations in connection with the construction of various types of base courses on a previously constructed subgrade or sub-base, complete, in place and accepted, subject to the terms and conditions of the Contract, in strict accordance with this Section of the Specification and conforming in all respects to the line, grade, thickness and typical cross-section as shown on the Drawings.

The various types of base courses covered by this Section of the Specification are as follows: -

1. Crushed-Limestone Base Course.
2. Crushed-Gravel Base Course.
3. Vibratory-Compacted Macadam Stone Base Course.

R7 02 Materials

The material requirements for various types of base courses shall be as follows:

1. Crushed-Limestone and Crushed-Gravel Base Course: The material for the crushed-limestone or crushed-gravel base course shall be composed of hard sound, durable crushed limestone, particles free from thin elongated, soft and disintegrated material or other objectionable matter. The crushed limestone or gravel shall be produced from the sources -shown on the Drawings or from sources selected by the Contractor and approved by the Engineer's Representative. Preliminary approval of sources shall not mean that all material in such sources is acceptable. When the grading and fracture requirements cannot be produced by utilizing all of the pit-run material, portions of the raw material, as may be required, shall be removed by mechanical screening prior to the crushing operations. Boulders encountered in the pit up to 25cm in the largest dimension, shall be processed by mechanical crushing. The crushed limestone or gravel as finally processed shall comply with the following requirements:

- (a) **Grading :** The grading as determined by AASHTO Standard Method T27-74 shall be as shown in Table R7/1 below :

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TABLE R7/1
CRUSHED LIMESTONE OR CRUSHED GRAVEL GRADING

US Sieve Size		Percentage Passing by Weight
mm	Imperial	
37.5	1½in	100
25.0	1 in	80-100
12.5	½in	50-80
4.75	No. 4	30-60
0.425	No. 40	10-30
0.075	No. 200	5-15*

*The fraction of the material passing the 0.075mm (No. 200) sieve shall not be more than 60% of the fraction passing the 0.425mm (No. 40) sieve. When using crushed gravel the percentage passing the 0.075 (No. 200) sieve shall be 5-12%.

- (b) **Fracture:** The fraction of the aggregate retained on the sieve shall contain at least 75% by weight of crushed particles having more than one fractured face.
- (c) **Abrasion Loss:** The abrasion loss of the crushed limestone as determined by AASHTO Standard Method T96-74 shall not exceed 45%.
- (d) **Fines:** The fraction of the aggregate passing the 2mm (No.10) sieve shall consist of limestone or gravel screenings and shall be free of loam, organic or other foreign matter. The material passing the 0.425mm (No. 40) sieve, when prepared in accordance with AASHTO Standard Method T146-49 and tested by the appropriate methods, shall conform with the following requirements:

AASHTO Standard Method	Maximum
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Liquid Limit T89-68	25%
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Plasticity Index T90-70	4%
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- (e) **Gypsum content :** The Gypsum content of crushed grave in terms of SO₃ shall not be more than 5% by weight when tested in accordance with BS 1377 Test No. 9.
- (f) The California Bearing Ratio of the base course when tested in accordance with ASTM D 1883 at 95% Modified compaction shall not be less than 80%.
- (g) The soundness test according to AASHTO T104 shall have a weighted loss of not more than 12% when subjected to 5 cycles of the test with sodium sulphate solution, and not more than 18% when subjected to 5 cycles with magnesium sulphate solution.

2. **Vibratory-Compacted Macadam Stone Base Course:** The requirements for the material to be used for the macadam stone base course shall be as specified under Clause R7 02 1 Crushed-Limestone Base Course with the following exceptions:

The material for the macadam stone base course shall be composed of coarse and fine aggregate. The coarse aggregate shall consist of either crushed limestone, crushed gravel or any other suitable crushed material, composed of clean, tough and durable particles and shall be free from thin elongated particles, soft and disintegrated material or other objec-

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tionable matter. If crushed gravel is used, it shall contain 75% of fractured particles. The fine aggregate shall consist of clean, tough, durable particles of crushed stone screenings, and shall be free from dirt and other objectionable material. The material shall be secured from sources shown on the Drawings or from sources selected by the Contractor and approved by the Engineer's Representative. Preliminary approval of sources of material shall not mean that all material in such sources is acceptable. The coarse and fine aggregate shall meet the following requirements:

- (a) **Grading:** The grading of the material for the vibratory-compacted macadam stone base course, as determined by AASHTO Standard Method T27-74, shall be as shown in Table R7/2 below:

TABLE R7/2
VIBRATORY-COMPACTED MACADAM STONE BASE METERIAL

U.S. sieve Size		Per Cent Passing by Weight	
mm	Imperial	Coarse Aggregate	Fine Aggregate
630	21/2in	100	-
500	2in	90-100	-
37.5	1 1/2in	35-70	-
25.0	1in	0-15	-
125	1/2in	0-5	-
95	3/8in	-	100
475	No.4	-	85-100
015	No.100	-	10-30

The material shall be screened to produce separate stock-piles of material above 10mm.

- (b) **Abrasion Loss:** The abrasion loss for the material for the vibratory-compacted macadam stone base course, as determined on representative samples of slaked material in accordance with AASHTO Standard Method T96-74, shall not exceed 45%.
- (c) The soundness test according to AASHTO T104 shall have a weighted loss of not more than 12% when subjected to 5 cycles of the test with sodium sulphate solution and not more than 18% when subjected to 5 cycles with magnesium sulphate solution.

R7 03 Sampling and testing

The following requirements for the sampling and testing of the material shall apply to the various base courses:

The sources of material shall be selected in advance of the time when the material will be

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required in the work, and adequate representative samples submitted to the Engineer for testing and preliminary approval not less than 20 days before such material is required for use in the work. The Employer will sample and test the material of the particular base course or courses, as called for in the Special Specification of Particular Application, and/or the Bill of Quantities, and/or as shown on the Drawings, on the site as frequently as deemed necessary to assure conformance with the requirements of Clause R7 01. Any material found not to conform with the requirements of Clause R7 01 will be subject to rejection. All rejected material shall be removed and replaced with material meeting the requirements of the Clause R7 01 by the Contractor, at no cost to the Employer.

R7 04 Equipment

All equipment, tools and machines used in the performance of the work shall be subject to the approval of the Engineer's Representative, and shall be maintained in a satisfactory condition at all times. Any machine, combination of machines or equipment, which will handle the material and produce the type of base course as called in the Special Specification of Particular Application, and/or the Bill of Quantities, and/or as shown on the Drawings, such as (a) Crushed-Limestone Base Course, (b) Crushed-Gravel Base Course, or (c) Vibratory-Compacted Macadam Base Course, in accordance with this Specification, may be used on approval. The only exception is the vibratory compactor, which is an essential requirement for the construction of the Vibratory-Compacted Macadam Stone

Base Course, but may be used by the Contractor in conjunction with the construction of other types of base course with the approval of the Engineer's Representative.

1. The Blade Graders, Sprinkling Equipment and all compacting equipment shall be as described and specified in Clause R6 04.

2. Mechanical Spreaders: Mechanical spreaders shall be the spreader box type capable of receiving material to be spread by a hopper to an even depth. The spreader shall be adjustable so that the width and thickness of the spread can be set to any dimension required by the Drawings and Specification and for uniform and complete coverage. The mechanical spreader may be self-propelled or receive propulsion from an outside source. If self-propelled, the speed of the spreader shall be controllable.

R7 05 Operation of quarries and pits

R7 06 Stockpiling

R7 07 Weather limitations

R7 08 Preparation of sub-grade

R7 09 Grade and alignment control

The requirements for these clauses shall conform to the requirements as specified in Clauses R6 05 to R6 09.

R7 10 Construction methods, including placing, spreading and compaction

1. Crushed-Limestone Base Course and Crushed-Gravel Base Course: Where the base course thickness exceeds 12·5cm it shall be constructed in layers of equal thickness, the thickness of no layer shall exceed 12·5cm, except that if a vibratory compactor is used for compaction the thickness of the layers may be increased to a maximum of 25cm providing that satisfactory compaction is obtained.

Each layer shall be compacted until the entire depth of the course is at least 98 per cent of density at optimum moisture as determined by AASHTO T180-74, or 98 per cent of the maximum dry density achieved in the BS Compaction Test 4· 5kg rammer (Test 12) in BS I 377 (1975).

Compaction shall be completed as soon as possible after the material has been spread.

Water shall be applied to the materials during the rolling operations in such amount as may be required to obtain the specified density. Where an appreciable amount of loose materials remains on the surface after rolling as specified above, the layer shall be thoroughly rolled with a pneumatic-tired roller, with the addition of water where required. Prior to beginning rolling operations on either layer, embankment materials shall be shaped against the edge of the layer in such depth as will permit uniform, simultaneous compaction of the base course layer and the shoulders. In all places not accessible to the rolling equipment, the materials shall be compacted thoroughly with approved mechanical or hand tampers to a density comparable to that obtained by rolling. Each hand tamper shall weigh not less than 23kg. The surface of the final layer shall be finished by blading and by rolling

with pneumatic-tired rollers, with the addition of water as required by the Engineer's Representative, until the surface is smooth and free from waves and irregularities and is true to grade and cross-section. All use of water shall be at the Contractor's expense.

2. Vibratory-Compacted Macadam Stone Base Course: Where the vibratory-compacted macadam stone base course thickness exceeds 25cm, it shall be constructed in two layers of equal thickness.

Each layer shall be compacted until the entire depth of the course is at least 98% of the density at optimum moisture content as determined by AASHTO T180 (modified Compaction) or 98% of the maximum dry density achieved in the BS 1377 Test No. 12 using a 4· 5kg rammer.

In advance of placing the coarse aggregate for the base course, a layer of screenings, meeting the requirements for fine aggregate as specified under Clause R702-2 (a), shall be uniformly spread to a thickness as prescribed by the Engineer, which will be one half the amount set by the laboratory on the basis of void age determined.

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The spreading and leveling of all the aggregate for the base course shall be performed by the use of approved self-propelled spreading and leveling machines or spreader boxes, equipped with shoes or runners of sufficient length to preclude damage or displacement to the subgrade or sub-base.

Coarse aggregate shall then be spread on the previously spread fine aggregate, to a loose thickness necessary to obtain the required compacted thickness of the layer. The coarse aggregate must be laid and spread by a method whereby the coarse aggregate, as it is laid, precedes the laying device. Running of equipment over or compaction of the previously laid layer of the fine aggregate will not be permitted. The layer of fine aggregate must be kept loose, dry and of even thickness immediately ahead of the laying of the coarse aggregate. In case of moisture in the fine aggregate layer, this layer must be raked and loosened and permitted to dry before application of the coarse aggregate layer.

The coarse aggregate layer, after being laid to a depth to give, when rolled, the proper thickness, shall be given two passes by a smooth wheel having a weight per 3cm width of at least 64kg, on at least one roll; the rolling being only sufficient to establish the required profile and level of the stone. Rolling shall start with the rollers at the outer edge of the stone without overlapping the shoulder. Care must be exercised that clay or other undesirable material is not transferred to the stone base by the rollers or by other means. Before a roller is placed on the stone the rollers must be cleaned of any undesirable material. Progression of the rollers shall be longitudinal from side to centre, except on superelevated curves where rolling shall begin on the low side and progress towards the higher side.

Immediately prior to the completion of the rolling of the coarse aggregate and before further fine material or aggregate is applied, the coarse aggregate shall be checked for humps, hollows or other irregularities. Any irregularity which exceeds 6mm in 3m shall be corrected. The defective areas shall be removed or new material added, as may be required, re-rolled and treated as may be necessary to eliminate completely the defects and produce a course of uniform strength throughout and with a surface uniformly smooth, true to crown and grade.

After the surface has been completely checked and corrections satisfactorily made, fine aggregate, meeting the requirements specified, shall be spread uniformly over the surface of the layer with approved spreading devices, in an amount specified by the Engineer's Representative after determination by the laboratory of the voids.

After the fine aggregate has been satisfactorily placed and is loose and dry, the entire basecourse shall be compacted with a vibratory plate compactor having a static pressure under the base plate of at least 0.16kgf per square centimeter or a vibratory roller having a static load per 3cm width of vibrating roll of at least 55kg.

The vibratory compactor shall not make more than two passes, unless otherwise directed by the Engineer's Representative. A pass means one complete non-overlapping coverage of the entire base. Areas which show deficiencies in fine aggregate, shall have fine aggregate added and re-tamped with the vibratory compactor until the entire surface is uniform. When the base course has been satisfactorily compacted by the vibratory compactor, the surface shall be watered with an approved sprinkling device. The amount of water to be applied shall be so regulated as not to produce puddles or standing water.

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Following sprinkling operations, the surface shall be broomed to the extent that all excess fine aggregate is removed, and that the coarse aggregate in the base course is permitted to protrude approximately 6mm above the surface.

After the brooming, the surface shall be rolled with a pneumatic-tired roller sufficiently to re-compact any looseness of the aggregate caused during brooming operations.

During dry weather the completed base shall be watered as directed by the Engineer's Representative.

When more than one layer is required to complete the base course to the thickness as shown on the Drawings, each layer shall be constructed as before prescribed.

R7 11 Thickness and finish

The following requirements for thickness and smoothness shall apply to the various base courses:

The tolerance for level shall conform to Table R9/6 as amended. Any areas of base course having waves and irregularities in excess of 1cm in 3m or 2cm in 15m shall be corrected by scarifying the surface, adding approved material, re-shaping, re-compacting and finishing as specified and as approved by the Engineer's Representative. Skin patching of an area without scarifying the surface to permit proper bonding of the added material will not be permitted.

R7 12 Maintenance

The following requirements for maintenance shall apply to the various base courses:

The completed base course shall be maintained in an acceptable condition at all times, as directed by the Engineer's Representative until the prime coat is applied. When the base course is to carry traffic for an indefinite length of time before receiving a surfacing or pavement, the Contractor shall maintain the surface until final acceptance and shall prevent raveling by wetting, blading, rolling and the addition of fines as may be required to keep the base tightly bound and leave a slight excess of material over the entire surface, which must be removed and the finish restored as specified under Clause R7]0 before the application of the prime coat.

R7 13 Measurement

The following requirements for measurement for payment shall apply to the various base courses:

The unit of measurement for payment shall be the square meters of completed and accepted base course. The area of completed base course shall be determined by the length along the centerline and upon the surface of the road, times the width as shown on the Drawings, plus any areas authorized as measured separately.

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R7 14 Payment

The following requirements for payment shall apply to the various base courses:

The area of base course, determined as specified in Clause R7 13, will be paid for at the unit price tendered per square meter in the Bill of Quantities which payment shall constitute full compensation for the construction and completion of the base course, including: preparation of the subgrade or sub-base, the furnishing of all materials, supplies, plant, equipment, tools and labor; the handling, mixing, manipulating, placing, shaping, compacting, including the necessary water for compaction, rolling and finishing; correcting un-satisfactory areas and mixtures; maintenance; and for furnishing all other labor and incidentals necessary to complete the work required by this Section of the Specification.