

DIVISION 5 – SUBBASE, BASE AND LEVELLING COURSES

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SPECIFICATION SECTION 05100 – SUBBASE, BASE AND LEVELLING COURSES

1. DESCRIPTION

This Specification Section prescribes the supplying, processing, hauling, spreading, watering and compacting graded aggregates on prepared and accepted surfaces, constructed in accordance with details shown on the Drawings and subject to approval of the Engineer.

2. MATERIAL REQUIREMENTS

2.1 Reference Standards

The most recent editions of the following standards shall apply to the materials covered in this Specification Section:

Vietnamese Standard:

TCVN 8859-2011	Graded Aggregate Base and Subbase Pavement – Specification for Construction and Acceptance
22TCN346-06	Testing Procedure on Definition of Compaction of Road Foundation and Embankment by Sand Cone Method
22TCN333-06	Procedures of Soil and Macadam Compaction in Laboratory
22TCN332-06	Testing Procedures on Definition of CBR Value for Soil and Macadam in Laboratory
22TCVN8859-2011	Graded Aggregate Base and Subbase Pavement – Specification for Construction and Acceptance
TCVN7572-2006	Aggregates Used for Concrete and Mortar
TCVN 8821-2011	Standard Test method of CBR for Soil and Unbound Road Base in Place

International Standard:

AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T104	Soundness of Aggregate by Use of Sodium or Magnesium Sulfate

2.2 Material Sources

Materials from all sources proposed by the Contractor shall be tested and submitted to the Engineer for source approval in compliance with the requirements of this Specification Section. The Engineer's approval of a materials source does not confer approval on all materials delivered from that

source.

2.3 Storage, Mixing and Handling of Materials

Aggregates for Base, Subbase and Leveling Courses shall be stored in stockpiles that ensure the materials remain free draining and are adequately separated to prevent cross contamination. Stockpiles shall be placed on a properly prepared surfaces to ensure no contamination occurs when materials are re-handled. Materials shall be placed in stockpiles and subsequently re-handled in a manner which avoids segregation of the various sizes.

Materials of different sizes which are to be blended to meet the required gradation for Base, Subbase and Leveling Courses shall be kept in separate stockpiles. Blending shall be carried out on a properly prepared surface such that no contamination occurs. Blended materials shall be stored in a separate stockpile. Blending shall not be permitted insitu on the roadway.

All stockpiles are to be labeled with markers indicating the material type in the stockpile.

Materials previously approved but rendered unacceptable due to inadequate storage or handling will be rejected.

2.4 Material Requirements

The aggregate for Subbase and Base and Leveling Courses shall consist of hard durable particles and shall be; crushed stone, crushed slag, crushed or suitable natural material and filler of natural or crushed sand or other finely divided mineral matter. The aggregate shall be free from vegetable matter and lumps or balls of clay and shall be of such nature that it can be readily compacted to form a firm and stable subbase. The materials shall comply with the requirements given in Tables 1 and 2 of the Vietnamese Standard 22TCN334-06.

Table 1. Grading Requirement for Aggregate

Standard (mm)	Mass Percent Passing		
	D _{max} = 37.5mm	D _{max} = 25mm	D _{max} = 19mm
50	100	-	-
37,5	95 - 100	100	-
25	-	79 - 90	100
19	58 - 78	67 - 83	90 - 100
9,5	39 - 59	49 - 64	58 - 73
4,75	24 - 39	34 - 54	39 - 59
2,36	15 - 30	25 - 40	30 - 45
0,425	7 - 19	12 - 24	13 - 27
0,075	2 - 12	2 - 12	2 - 12

Table 2. Aggregate Subbase, Base and Leveling Course Properties

No.	Properties	Aggregate		Test Method
		Base / Leveling Course	Subbase	
1	Los-Angeles wear of aggregate (LA), %	≤ 35	≤ 40	TCVN7572-12:2006
2	Soaked CBR at maximum dry density	≥ 100	-	22TCN332-06
3	Liquid Limit (W_L), %	≤ 25	≤ 35	AASHTO T89-02 (*)
4	Plasticity Index (I_p), %	≤ 6	≤ 6	AASHTO T90-02 (*)
5	PP Index = Plasticity Index I_p x % material passing portion 0.075mm	≤ 45	≤ 60	
6	Percent by weight of aggregate with diamond or flattened shapes, %	≤ 18	≤ 20	TCVN 7572-2006 (**)
7	Compacted Density (K_{yc}), %	≥ 98	≥ 98	22TCN333-06 (Method II-D)

Note:
 (*) Liquid Limit, Plasticity Index are specified by test with material passing sieve 0.425 mm.
 (**). Aggregate with diamond or flattened shapes is sieve with thickness or width is less than 1/3 length or equivalent;
 - Test is conducted with various sieves of diameter of more than 4.75mm and account for more than 5% of sample quantity.
 - Aggregate with diamond or flattened shapes content of taken sample is average results certified for each sieve.

Aggregate with a $D_{max} = 37.5\text{mm}$ is appropriate for Subbase.

Aggregate with a $D_{max} = 25\text{mm}$ is appropriate Base Course.

The sand used for the compacted layer shall be free from clay, wood, bark or other extraneous matter. The material shall comply with the following requirements:

Organic content	:	<5%
Particles with a diameter > 0.25mm	:	>50%
Particles with a diameter <0.08mm	:	<5%

3. CONSTRUCTION REQUIREMENTS

The Contractor shall prepare and submit his method statement for Subbase, Base and Leveling Courses to the Engineer for approval. No work shall be covered up or put out of sight unless the work has been approved by the Engineer.

3.1 Submittals

The Contractor shall make all submittals for approval well in advance of his programmed start of the particular Works. The Contractor's submittals to the Engineer shall include the following:

- Two samples of 50 kg weight each of the proposed material, one of which shall be retained by the Engineer for reference;
- Certification of the origin and composition of proposed material for together with laboratory test data verifying that the materials comply with

the properties specified in subsection 2.4 of this Specification Section and the reference standards.

- c) The Contractor's method statement shall include details of trial sections to be carried out by the Contractor to demonstrate that the Contractor's proposed methods and materials.
- d) The Contractor shall submit the following in written form to the Engineer immediately following the completion of each section of the work and before any approval is granted for the placing of other materials on top of the Aggregate Subbase, Base and Leveling Courses :
 - i) The results of testing as specified in subsection 3.8 of this Specification Section.
 - ii) The results of surface measurement tests and survey data verifying that the surface and thickness tolerances shown on Table 3 are met.

3.2 Trial Sections

- a) Trial sections shall not commence until the Contractor has submitted his proposed materials and method statement for approval and both have been approved by the Engineer.
- b) The Contractor shall carry out trial sections for each of his proposed materials and for each of his proposed construction methods. The construction methods used for the trials shall be those methods detailed in the Contractor's method statement for use on the Permanent Works. In particular work on trial sections must use the same equipment and procedures intended for use on the Permanent Works.
- c) Trial sections shall be approximately 500 m². Trial sections may be carried out in the area of the Permanent Works. However should the trial section be unsatisfactory it shall be removed entirely and the layer beneath the trial section shall be made good all to the satisfaction of the Engineer.
- d) The trial section shall be tested to ensure that it complies with the requirements of Subsections 3.7 and 3.8 of this Specification Section.

3.3 Equipment and Labour used for Aggregate Subbase, Base, and Leveling Courses

- a) Equipment used for the laying of Subbase, Base and Leveling Courses shall be fit for purpose and in sound condition. All equipment shall be operated by trained and experienced operators.
- b) The laying of Subbase, Base and Leveling Courses shall be carried out by skilled and experienced labor.

- c) Unsatisfactory work shall be rejected. Work will not be allowed to proceed until such time as the Contractor provides suitable equipment and experienced labor and operators able to produce satisfactory work in accordance with this Specification Section. In such case the Engineer may at his discretion instruct the Contractor to carry out further trial sections to demonstrate the capabilities of the replacement equipment and labor.

3.4 Placing, Spreading and Compacting Aggregate Subbase, Base, and Leveling Courses

Aggregate Subbase, Base and Leveling Courses shall not commence until; the layer to be covered has been approved by the Engineer, the Contractor's proposed materials and method statement have been approved by the Engineer and satisfactory trial sections have been completed.

Materials shall not be placed, spread or compacted in the rain.

During spreading, compacting and leveling of Subbase, Base and Leveling Courses material the Contractor shall ensure that no damage is caused to completed work. In particular care must be taken where equipment makes turns or runs on and off completed work. Any such damage to completed work resulting from the Contractor's operations shall be made good by the Contractor and at his expense and to the satisfaction of the Engineer.

- a) Placing
 - i) The aggregate Subbase, Base and Leveling Courses material shall be placed as a uniform mixture in a quantity which will provide the required compacted thickness. The material shall be delivered to the roadbed and spread at moisture content within the range specified in this Specification Section. The moisture content shall be uniform throughout the material.
 - ii) When more than one layer is required each layer shall be placed, spread and compacted as detailed in this Specification Section.
 - iii) The Contractor shall ensure that there is sufficient area prepared and approved for a full day's work on each layer of the Subbase, Base, and Leveling course.
 - iv) In case that no earthen shoulder constructed or no formwork installed prior to place base or subbase, the Contractor shall place base and subbase in the manner that the below layers shall be placed more than 15cm wider upper layers to ensure the compaction to the required density.
 - v) Hauling equipment may be routed over completed portions of the Subbase, Base and Leveling Courses provided that no damage results. Such routing shall be over the full width of the course to avoid rutting

or uneven compaction. Hauling equipment over completed portions shall cease when it is seen to be causing such damage.

b) Spreading

- i) Where the required thickness of Subbase, Base and Leveling Courses is 180mm and 150mm or less respectively the material may be spread and compacted in one layer. Where the required thickness is greater the aggregate Subbase, Base and Leveling Courses shall be spread and compacted into two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed the dimensions above. All subsequent layers shall be spread and compacted in a similar manner.
- ii) The Subbase, Base and Leveling courses material shall be spread and shaped by the methods in the Contractor's approved method statement and confirmed by the completion of satisfactory trials. Segregation of the fine and coarse aggregate particles shall not be permitted. Any segregated material shall be corrected or removed and replaced with a graded material.
- iii) Compaction shall begin immediately following the final spreading of each layer.
- iv) Subbase, Base and Leveling Courses shall be spread by the spreader but not by grader in order to keep the quality of the work.
- v) The top layer of the infilling layer in Leveling Course shall be spread by the spreader but not by grader in order to safeguard the quality of the work.
- vi) The infilling layer in the Leveling Course shall be spread by the grader in order to infill the material on ungraded roadbed.

c) Compaction

- i) Compaction shall be carried out only when the moisture content of the material is in the range -2% to +2% of the optimum moisture content, where the optimum moisture content is as defined by the maximum modified dry density determined by Vietnamese Standard 22TCN333-06.
- ii) Each layer shall be compacted to the full width by the methods in the Contractor's approved method statement confirmed by satisfactory trials. Rolling operations shall begin along the edges and progress gradually towards the center in a longitudinal direction. On super elevated sections rolling shall begin at the low side and progress towards the high side. The rolling operation shall continue until all roller marks are eliminated and the layer is uniformly compacted and the aggregates firmly keyed. Any irregularities or depressions that

develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, headers and walls and at all places not accessible to the roller the Subbase, Base and Leveling Courses material may be compacted with tampers or compactors. At the end at each shift the surface of the Base, Subbase and Leveling Courses shall be shaped and sloped to prevent ponding of rain water.

- iii) The aggregate Subbase, Base and Leveling Courses surfaces, which are to receive a prime coat, shall be compacted to produce a stable, tightly locked surface with no open pores and suitable for priming. All coarse aggregates shall be tightly locked in place. The locking process shall be achieved by compaction only. Under no circumstances shall any form of fine aggregate be added to the surface to assist the locking process. Vibration shall not be used in the final stages of the compaction of the surface. Pneumatic rollers or static steel wheeled rollers shall be used for the final surface compaction unless excessive breakdown or degradation of the aggregate Subbase, Base and Leveling Courses occurs, in which only pneumatic rollers shall be used.
- iv) When the underlying material is soft or yielding compaction of the Subbase, Base and Leveling courses shall be stopped and the underlying materials rectified in a manner approved by the Engineer.
- v) Compaction of each layer shall continue until a satisfactory field density has been achieved. Insitu densities shall be determined in accordance with Vietnamese Standard 22TCN346-06.
- vi) Proof rolling shall be conducted after finishing by a roller of at least 25 tons weight. If the deflection is more than 3mm the layer shall be replaced at the Contractor's expense.

3.5 Rectification of Unsatisfactory Aggregate Base or Subbase or Leveling Courses

- a) Areas that do not meet the tolerances given in subsection 3.10 of this Specification Section or which develop irregularities in the surface after construction shall be rectified by loosening the surface and removing or adding material as required, followed by reshaping and recompacting.
- b) Material which is below the minimum moisture content shall be corrected by scarifying the material, sprinkling with an adequate quantity of water, thoroughly mixing and recompacting by methods subject to the approval of the Engineer.
- c) Material which is above the maximum moisture content shall be rectified by scarifying the material followed by intermittent working by motor

grader or other suitable equipment to air dry the material under dry weather conditions. If sufficient drying cannot be achieved by reworking the loose material it shall be removed from the work and replaced with a material at a suitably moisture content. This work shall be subject to the approval of the Engineer.

- d) The aggregate Subbase or aggregate Base or aggregate Leveling Courses, which becomes saturated due to rain or flooding after it has been satisfactorily compacted according to this Specification Section, will generally require no rectification work provided its material properties and surface uniformity meet the requirements of this Specification Section.
- e) Aggregate Subbase or aggregate Base or aggregate Leveling Courses layers which do not meet the density or material property requirements of this Specification Section shall be rectified by means approved by the Engineer. Such means may include; additional compaction, loosening followed by moisture content adjustment and recompact, removal and replacement of the material or the application of an additional thickness of material.
- f) No additional measurement or payment shall be made for the rectification measures detailed above.

3.6 Control of Traffic on Subbase, Base, and Leveling Course Surfaces

- a) Subject to the approval of the Engineer construction traffic or other traffic may be routed over completed portions of the Subbase, Base and Leveling courses when shaping and compaction are substantially completed and provided that no damage results. Such routing shall be over the full width of the course to avoid rutting or uneven compaction. Hauling equipment over completed portions shall cease when it is seen to be causing such damage.
- b) The Contractor may, at his discretion, provide running course gravel for temporary protection of the surface of aggregate Subbase, Base and aggregate Leveling Courses exposed to traffic. Any such provision shall be entirely at the Contractor's expense and shall include the removal of all gravel and any necessary remedial work to the aggregate Subbase, aggregate Base and the aggregate Leveling courses.
- c) Pending the construction of the final surfacing, completed portions of the Subbase, Base, and Leveling Courses under Site traffic shall be maintained as follows:
 - (i) The completed portions shall be maintained at all times by drag brooming. The traffic shall be controlled by temporary speed restrictions and during working hours it shall be channeled by

suitably defined traffic lanes, with frequent transverse shift of the defined lanes, to obtain an even spread of traffic over the entire surface.

- (ii) Where the completed portions are too dry, so that surface stability does not or is unlikely to improve under the effect of traffic and/or rolling and where rain is not imminent or has been insufficient, a uniform application of water shall be applied to the entire surface. Up to 4 liters/square meter shall be applied in gradual increments so as to avoid flooding or scouring the surface.

3.7 Testing

- a) The supporting test data required for initial source approval of the material shall include all the tests specified in this Specification Section on at least three representative samples from the proposed material source, selected to represent the range of material quality likely to be obtained from the source. Where observed changes in the material or in its source or in its method of production occur the material shall be resubmitted for source approval.
- b) All holes in the finished work made by density testing or otherwise during testing shall be backfilled by the Contractor without delay. Holes shall be filled with the specified material and compacted to the density and surface tolerance requirements of this Specification Section.
- c) During construction routine material quality control testing shall be carried out to monitor the material being brought on Site. The extent of the testing shall be subject to the approval of the Engineer, but shall be at least as detailed below.
 - (i) For every 3,000 cubic meters.
 - 5 plasticity index tests
 - 5 particle grading tests
 - 1 maximum dry density determination
 - CBR Tests
 - (ii) The density and moisture content of the compacted material shall be routinely determined using Vietnamese Standard 22TCN346-06. The test shall be made to the full depth of the layer at locations as directed by the Engineer but not more than 200 m apart.
 - (iii) For the acceptance of aggregate delivered to the Site for construction: samples shall be taken from material at the Site and tests shall be conducted for every 1,000 cubic meters from each material supply source or when material quality is extraordinary. Material shall meet all physical properties specified in Tables No. 1 and 2 and

compacting test conducted inside the Laboratory.

- (iv) Moisture, aggregate material separation (observed by eyes and checking sieve particle). Test on moisture and sieve particles shall be conducted for every 200 m³ aggregate or every shift;
- (v) Compacted density tests shall be conducted on every finished aggregate layer by sand cone according to Vietnamese Standard 22TCN346-06 or equivalent process as required by the Engineer. At the final stages of compaction density tests shall be frequently performed. Compaction tests shall be conducted every 800m² in random locations;
- (vi) Flatness and geometric factors shall be checked according to the requirements specified in Table 4. The data will be the basis for acceptance of the Works.

3.8 Final Checking and Accepting of Construction Works

- a) Density tests shall be conducted for every 7000 m² in two random locations;
- b) Geometric factors checks shall be made on 20% of completed Works in accordance with the requirements of Table 4.

3.9 Testing Frequencies

Testing frequencies shall be in accordance with Vietnamese Standard TCVN 8859-2011 or other international standard as proposed by the Contractor and subsequently approved by the Engineer.

In principle representative samples shall be taken from proposed material source for every 3,000 m³ of supply or as necessary, whenever:

- a) Material is produced from a new source;
- b) Material is produce from a new bench in a quarry;
- c) Appearance of material delivered to the Site is, in the opinion of the Engineer, obviously different from the approved samples;
- d) There is a change in crushing or crushing jaw or size of mesh or
- e) The Engineer considers necessary.

The material shall meet all mechanical and physical property requirements specified in Table 1 and Table 2 of this Specification Section.

Table 3: Frequency of Tests

Item	Test Description	Test Frequency	Remark
a	Material testing: (for material quarries approval)	Article 8.1 (Table 3) Article 8.2	
b	During construction period:	Article 8.3 (Table 4)	
c	After construction period: (For acceptance of construction works)	Article 8.4	

Source: Vietnamese Standard TCVN 8859-2011: Graded Aggregate Base and Subbase Pavement.

3.10 Tolerances for Acceptance

- The allowable tolerances after compaction are as shown in Table 4.
- The surface of all aggregate Subbase, Base and Leveling Courses shall be free of irregularities which can hold moisture and the camber of all such surfaces shall comply with that shown on the Drawings.
- When testing the regularity of aggregate Subbase, Base and Leveling Courses surfaces to be treated with bituminous surfacing, all loose material shall be removed by hard brooming.

Table 4. Tolerances for Aggregate Subbase, Base and Leveling Courses

Position	Subbase	Base / Leveling Course	Remarks
Layer Thickness	± 10 mm	± 5 mm	Measurement of cross-section shall be conducted for every 40-50 m for straight section and 20 – 25 m for horizontal or vertical curves
Surface Level	-10 mm	-5 mm	
Width on Top	-50mm	-50mm	
Cross Fall or Camber	$\pm 0.5\%$	$\pm 0.3\%$	
Surface Irregularity by 3-m straight edge	≤ 10 mm	≤ 5 mm	One position for every 100m

4. MEASUREMENT AND PAYMENT

4.1 Method of Measurement

- The aggregate Subbase and aggregate Base Courses shall be measured in cubic meters of compacted material; placed in position and approved by the Engineer. No measurement or payment will be made for additional material placed in compliance with subsection 3.4a)iv) of this Specification Section.
- The volumes shall be measured from the cross sections shown on the Drawings where the required thickness is uniform and from the cross

sections approved by the Engineer where the required thickness is not uniform. Volumes shall be based on lengths measured horizontally along the road centerline.

- c) The aggregate Leveling Course shall be measured and paid under pay item 05100-02 according to the cubic meters of compacted material placed in position and approved by the Engineer. The Contractor shall survey and agree the profiles of the formation, with the Engineer, prior to the placing of the Leveling Course. The volume of compacted fill shall be taken from cross sections agreed/approved by the Engineer. No allowance shall be made for materials placed outside the design limits shown on the cross sections. Where trial sections are carried out outside the limit of the Permanent Works no additional payment shall be made.
- d) The compacted sand course shall be measured from the cross sections shown on the Drawings where the required thickness is uniform and from the cross sections approved by the Engineer where the required thickness is not uniform. Volumes shall be based on lengths measured horizontally along the road centerline.
- e) The Subbase, Base and Levelling Courses provisions, material requirements and construction requirements identified in this Specification Section shall be measured for payment in pay items 05100-01, 05100-02 and 05100-03.
- f) Any Subbase, Base and Levelling Courses Works not specifically identified in this Specification Section but which are necessary for the performance of the Works shall be deemed to be included in pay items 05100-01, 05100-02 and 05100-03.
- g) The preparation and maintenance of the subgrade on which the aggregate Subbase, Base, or Leveling Courses or compacted sand courses are to be placed shall be deemed to be Indirectly Paid Work.
- h) No measurement shall be made for repairs to layers caused by traffic or natural conditions.
- i) No measurement shall be made for extra material provided in any of the overlaying courses arising from any deficiency in the Subbase or Base or Leveling Courses or compacted sand course.
- j) When rectification of unsatisfactory Subbase, Base or Leveling Courses or compacted sand course is directed by the Engineer no additional measurement or payment shall be made for the extra work or quantities necessitated by the rectification.
- k) Where adjustment of moisture content has been directed by the Engineer prior to compaction, no additional payments shall be made for adding water or drying out the material or for any other work required to obtain

satisfactory moisture content.

4.2 Basis of Payment

The work under this Specification Section shall be paid for in accordance with the applicable unit prices as indicated in the Bill of Quantities and given below. Payment shall be full compensation for the Works prescribed in this Specification Section including hauling, supplying, placing, compacting, finishing and testing the materials, backfilling of holes made during testing, the supply and placing of any running course and maintenance of the surface under traffic and for furnishing all labor, materials, tools, equipment and any incidentals to complete the work as shown on the Drawings.

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
05100	Subbase , Base and Levelling Courses	
05100-01	Aggregate Subbase Course	m ³
05100-02	Aggregate Base Course	m ³
05100-03	Compacted Sand	m ³