

SPECIFICATION SECTION 03400 - EMBANKMENT

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SPECIFICATION SECTION 03400 - EMBANKMENT

1. DESCRIPTION

1.1 Embankment

This Specification Section prescribes the requirements and procedures for the construction of the subgrade and roadway Embankment.

1.2 Setting Out the Work, Staking and Surveying

This Specification Section also prescribes the requirements and procedures for surveying, setting out and staking.

Surveying, setting out and staking shall be performed by technically qualified survey crews using survey instruments and supporting equipment fit for purpose, capable of achieving the specified survey tolerances and the construction tolerances included in this and other Specification Sections.

The Contractor shall furnish the necessary equipment and material to survey, calculate and record data for the control of work and acceptable tools, supplies, and stakes and other materials necessary to set out the works of the type and quality normally used in highway survey work and suitable for the intended use.

2. MATERIAL REQUIREMENTS

2.1 Reference Standards

The latest edition of the following Standards shall be applied to the Works covered by this Specification Section.

Vietnamese Standards:

TCVN 4447-87	Earthworks - Construction and Acceptance
TCVN 9436-2012	Highway Embankments and Cuttings - Construction and Quality Control
TCVN8861-11	Flexible Pavement Determination of Elastic Modulus of Soils and Pavement Components Using Static Plate Load method
22TCN 304-03	Natural Gravel Aggregate Layer in Pavement Structure – Code of Construction and Acceptance Procedure
22TCN 346-06	Testing Procedure on Definition of Compaction of Road Foundation and Embankment by Sand Cone Method
22TCN 333-06	Procedures of Soil and Macadam Compaction in Laboratory
22TCN 332-06	Testing Procedures on Definition of CBR Value for Soil and

	Macadam in Laboratory
22TCN211-2006	Flexible Pavement
TCVN4195-2012	Soil for Construction - Standard Test Method for Specific Gravity
TCVN4202-2012	Soil for Construction – Standard Test Method for Volumetric Gravity
TCVN4197-95	Soil Methods of Laboratory Determination of Plastic Limit and Liquid Limit
International Standards:	
AASHTO M145	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T11	Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T87	Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test
AASHTO T146	Wet Preparation of Disturbed Soil Samples for Test
AASHTO T180	Moisture-Density Relations of Soils Using a 4.5kg Rammer and a 475mm Drop
AASHTO T224	Correction for Coarse Particles in the Soil Compaction Test
ASTM D1140	Amount of Material in Soils Finer than the No. 200 (75- μ m) Sieve

2.2 Submittals

2.2.1 Shop and Working Drawings and Schedules

- a) The Contractor shall prepare and submit his method statement for the earthworks which shall include an earthworks balance schedule or plan. The earthworks balance schedule or plan shall include details of all elements of Embankment construction. The plan shall include the construction of trial sections to prove the adequacy of the Contractor's methods, equipment and materials. The plan shall be updated on a weekly basis, in accordance with the progress of the Works and submitted with the Contractor's weekly work

schedule until completion of the Embankment Works. The Contractor shall submit his method statement together with all shop drawings, schedules and other supporting information to the Engineer for his approval. The Contractor's plan and schedule shall include the temporary drainage system which maintains the Site as dry as possible; discharging by the natural gradient during construction.

- b) The earthwork balance schedule or plan for operation for Embankment construction shall include:
 - (i) The use of suitable material obtained from common excavation within the Site limits or from excavation for channel relocation.
 - (ii) The use of borrow material stipulated in Specification Section 03300 Borrow Material.

For each item the schedule or plan shall identify; the location of the material source, the location where material is to be placed, the approximate timing of the operations and the quantities involved. When approved by the Engineer the plan shall be used for monitoring of quantities

2.2.2 Schedule for Setting the Work, Staking and Surveying

The Contractor shall submit a method statement for survey work and the setting out of the Works. The statement shall comply with the requirements for setting out the Works included in the general items and shall include but not be limited to the items detailed below. No work shall commence on Site until the Contractor's method statement has been approved by the Engineer.

- a) Checking and any necessary correction of primary survey points detailed in the Contract documents.
- b) Details of the Contractor's own survey network established from the primary points provided. Such details shall include the structure of the network and the referencing of the various types of survey points in the network.
- c) Details of the network shall particularly refer to fixed points to be maintained at the site of bridges, other structures along the road alignment and temporary points to be established and re-established to suit the construction of Embankments, excavation work (staking) or paving work.
- d) The marking, protection and maintenance of all survey points, including

the primary survey points.

- e) The registering, routine checking and correction if necessary of all survey points.
- f) Any other procedures and controls necessary for the work

2.3 Materials

The material for Embankment, whether from common excavation or from borrow, shall be mostly composed of granular material, sand or gravel or classified soil, complying with the requirements described in this Specification Section. All materials shall be subject to the approval of the Engineer. Materials shall be tested according to the requirements of current Vietnamese Standards and be subject to the approval of the Engineer.

2.4 Subgrade

Subgrade layer is defined as the top 80cm of Embankment.

2.4.1 Top 30cm of Subgrade Layer

The material used for the top 30 cm of subgrade layer shall be laterite or equivalent suitable material with a minimum CBR of 9% according to Vietnamese Standard 22TCN 332-06; $K \geq 0.98$ and provided in accordance with Vietnamese Standard 22TCN211-2006.

2.4.2 50 cm below top 30cm of Subgrade

The material used for Embankment construction in the 50 cm layer below top 30cm of subgrade shall be hill soil or equivalent suitable material with a minimum K of 0.95; CBR value (saturated sampling for 96 hour) of more than 5% or equivalent, Liquid Limit (LL) $\leq 40\%$ according to Vietnamese Standard TCVN4197 -95, Plasticity Index (PI) $\leq 17\%$ according to Vietnamese Standard TCVN4197-95.

2.5 Embankment Layer below Subgrade

The minimum density below sub-grade shall be 95% according to Vietnamese Standard 22TCN332-06. Embankment layer shall comply with requirements for each soil classification as appropriate given in Table 1 below. The Embankment fill shall not use (1) fill material with a sodium chloride or a gypsum content of over 5% (2) mud, peat, alluvium and humus (with an organic content of over 10%) according to Vietnamese Standard TCVN4054-05. Where the selected material is hill soil, Liquid Limit (LL) $\leq 55\%$ according to Vietnamese Standard TCVN4197-95, Plasticity

Index $\leq 27\%$ according to Vietnamese Standard TCVN4197-95.

Table 1: Classification of Material Suitable for Embankment Including top 30cm of Subgrade Layer

General Classification:	Granular Materials (35% or less passing sieve 0.075mm)			
Group Classification:	A-1		A-3	A-2 ^(*)
	A-1-a	A-1-b		A-2-4
Sieve analysis, percent passing:				
2.00 mm (sieve No.10)	50 max	---	---	---
0.425 mm (sieve No.40)	30 max	50 max	51 max	---
0.075 mm (sieve No.200)	15 max	25 max	10 max	35 max
Characteristics of fraction passing 0.425 (sieve No.40):				
Liquid Limit:	---	---	---	40 max
Plasticity Index:	6 max	6 max	N.P.	10 max
Types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand
General rating	Excellent to Good			

3. CONSTRUCTION REQUIREMENTS

3.1 General

- a) Prior to the construction of roadway Embankments, all necessary clearing and grubbing, removal of topsoil and surface drainage in the area shall have been performed in compliance with the relevant specifications and to the satisfaction of the Engineer.
- b) Embankment construction shall consist of:
 - (i) Constructing roadway Embankments, including preparation of the area upon which they are to be placed;
 - (ii) Placing and compaction of approved material within roadway areas where unsuitable material has been removed;
 - (iii) Placing and compaction of Embankment material in holes, pits and other depressions within the roadway area and
 - (iv) Constructing the temporary drainage system which maintains the Site as dry as possible discharging by the natural gradient during construction.
- c) Materials for Embankments shall contain no muck, peat, sod, roots or other

deleterious matter. Rocks, broken concrete or other solid, bulky materials shall not be placed in Embankment areas where piling is to be placed or driven.

- d) Where indicated on the Drawings the slopes of the Embankment shall be constructed using cohesive material.

3.2 Setting Out the Work, Staking and Surveying

- a) Approvals: No survey work shall start until the Contractor's method statement has been approved by the Engineer in accordance with subsection 2.2.2 of this Specification Section. No work shall start on Site until the setting out of the work has been approved by the Engineer.
- b) Notice: The Contractor shall give the Engineer 48 hours notice of intention to start any survey or setting out work on Site.
- c) Survey points: The Contractor shall check and correct as necessary to the satisfaction of the Engineer all primary survey points provided in the Contract Documents. The Contractor shall establish his own network of secondary survey points sufficient to control the lines, grades, levels and position of the Works.
- d) Cross section markers and control points. The Contractor shall establish cross section markers at 20 m. intervals or other intervals as may be required by the Engineer, set out perpendicular to the centre line of the road. The Contractor shall establish control points at the site of each structure, foundation or culvert. Control points shall be positioned or of a sufficient number that there is a clear sight line to all significant parts of the structure, foundation or culvert. Cross section markers and control points shall be within the site boundary but outside areas directly affected by the Works. Additional reference markers shall be established so that cross section markers and control points can be re-established should they be damaged or destroyed during construction work. All cross section markers, control points and reference markers shall be subject to the approval of the Engineer.
- e) Cross sections. The Contractor shall take cross sections at 20 m. intervals or such intervals as may be required by the Engineer. The Contractor shall prepare and submit cross section drawings to the Engineer for his approval. Drawings shall be provided in both hard and soft copies.
- f) Other markers, stakes or control points. The Contractor shall establish all other markers, stakes or control points necessary for the correct setting out of the

Works. Such items may be permanent for the duration of the Works or temporary for the particular work item. Such items shall include centre line markers, stakes, profile boards and other markers required to set out and control each stage of the construction of the road and drainage works and such markers or control points that may be necessary to set out and control each stage of the construction of a particular structure, foundation or culvert.

- g) Construction tolerances. The Contractor shall ensure that there are sufficient survey points, control points, cross section markers, stakes and other markers to ensure that all Works are constructed within the construction tolerances given in this and other sections of the specification.
- h) Register. The Contractor shall maintain a register of all survey points, control points, cross section markers, stakes and other markers. The register shall record all checks carried out and all events that may affect the items registered.
- i) Surveying tolerances. Survey tolerances shall be as detailed below.

Table 2: Survey Tolerances for Staking

Staking Phase	Horizontal	Vertical
Control points	± 5 mm	± 3 mm
Centreline points ^(a) - (PoC), (PoT), (PoT), and (PoC) including references thereto	± 5 mm	± 3 mm
Other center line points	± 10 mm	± 10 mm
Cross-section points, slope stakes, and slope stake references ^(b)	± 20 mm	± 10 mm
Culverts, ditches, and minor drainage structures	± 10 mm	± 10 mm
Retaining walls	± 10 mm	± 10 mm
Railroad crossing structures	± 3 mm	± 3 mm
Bridge substructure	± 5 mm	± 5 mm
Bridge superstructure	± 3 mm	± 3 mm
Clearing and grubbing limits	± 200 mm	-
Roadway subgrade finish stakes	± 10 mm	± 10 mm
Roadway finish grade stakes	± 3 mm	± 3 mm

Note: (a) Center line points are point of curve (PoC), point of tangent (PoT) and point on curve (PoC).

(b) Take the cross sections normal to the centerline within ±1 degree (0.02 rad).

- j) Permanent monuments and markers. The Contractor shall protect all existing land survey monuments and property markers within or on the Site boundary.

3.3 Method of Construction

- a) Where practical Embankment material generally shall be transferred directly from the excavation or borrow areas to the prepared surface and spread during

dry weather. Stockpiling of Embankment material shall generally not be permitted, especially during the wet season.

- b) With the exception of surcharge Embankments and berms, roadway Embankment materials shall be placed in horizontal layers not exceeding 30cm thick prior to compaction or such other thickness as may be confirmed by the Contractor's trial sections. Each layer shall be compacted as specified, tested for density and accepted by the Engineer, before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compaction. Each layer shall be placed in a manner that ensures a uniform density. Water shall be added or removed as necessary in order to obtain the required density. Removal of water shall be accomplished through aeration by ploughing, blading, disking, or other methods subject to the approval of the Engineer.
- c) Where Embankment is to be constructed across soft ground that will not support the weight of trucks or other hauling equipment the lower part of the Embankment may be constructed, subject to the approval of the Engineer, by dumping successive loads of material in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment when placing subsequent layers.
- d) No placing and/or compaction of material under saturated or flooded conditions shall be carried without the express approval of the Engineer.
- e) Any rock fill shall be covered with one or more layers of well graded material 20 cm thick containing no stones larger than 5 cm and capable of filling all the interstices in the top of the rock fill. These layers shall be constructed to the density requirements for Embankment given in this specification.
- f) Dumping and spreading and compaction areas shall be kept separate and no work shall be permitted on completed layers until such time as compaction complies with the requirements of this Specification Section and the layer has been approved by the Engineer
- g) Hauling and spreading equipment shall be routed over each layer of the fill in such manner as to make use of the compact active effect provided and to minimize rutting and uneven compaction.
- h) Lower Embankment layers shall be compacted and shaped with a 4% cross fall from the centre of the Embankment to allow drainage of rainwater during construction. The cross fall shall be gradually reduced in the upper layers such

that the required design cross fall is achieved below the pavement structure.

3.4 Compaction of Embankment Material

a) Subgrade Layer and General Embankment Layer

All layers shall be compacted to a uniform moisture content of -3% to +1% of the optimum moisture content for the particular material being laid. All layers shall be placed to a maximum thickness of 25 cm and compacted to a uniform density. These requirements shall be subject to the completion of satisfactory trial sections as detailed in this specification and approved by the Engineer.

b) Embankment Layers Below the Subgrade Layer

The Contractor may of his own choice place material below the subgrade layer to a maximum thickness of 50 cm (measured before compaction) prior to compaction of the same. The Contractor shall prepare and submit to the Engineer a specific method statement for placing layers to such a thickness. The method statement shall in particular refer to the equipment used to place and compact the material. The Contractor shall carry out trial sections, as detailed in this Specification Section, to demonstrate that his proposed method will produce work that complies with this Specification Section. The method statement and the trial sections shall be subject to the approval of the Engineer. Where any such layers are of significantly different materials these materials shall be referred to in the method statement and separate trial sections shall be carried out for each material and subject to the approval of the Engineer.

c) Testing Method

During progress of the Works the Contractor shall carry out density tests on compacted material in accordance with Vietnamese Standard 22TCN346-06, or other approved field density tests, including the use of properly calibrated nuclear testing devices. Such calibration shall include comparison with direct measurement of insitu density in the field in accordance with Vietnamese Standard 22TCN346-06. Tests shall be carried out on the full depth of the layer at locations subject to approval by the Engineer. For backfill around structures or in culvert trenches, at least one test per complete layer of backfill placed shall be carried out. In Embankments, at least one test shall be performed.

d) Testing Frequency:

At least one group of three in-situ density tests shall be carried out for every 1,500 m² of material placed for each layer of compacted fill subject to the approval of the Engineer. For backfill around structures or in culvert trenches, at least one test per complete layer of backfill placed shall be carried out and according to Vietnamese Standard TCVN 4447-87 or other international standard as proposed by the Contractor with approval from the Engineer.

Table 3: Frequency of Test

Item	Test Description	Test Frequency	Remarks
a	Material testing & preparation work before construction: (for material & quarries approval)	Article 8.21 (Table 31) Article 10.2 ; 10.3	
b	During construction period:	Article 10.4 ; 10.5	
c	After construction period: (For acceptance of construction works)	Article 10.8 ; 10.9; 10.10; 10.11; 10.12; 10.14 (Table 33 & 34)	

Source: TCVN 4447-87: Earth Works - Code of Construction and Acceptance Procedure

(e) Corrections:

A correction for coarse particles may be made in accordance with Vietnamese Standard 22TCN333-06. If by such tests, the Engineer determines that the specified density and moisture conditions have not been attained, the Contractor shall perform additional works as may be necessary to attain the specified conditions.

3.5 Compaction Equipment

Equipment used for the compaction of Embankment shall be fit for purpose and in sound condition and may be of any type, provided that it is capable of compacting each lift of material as specified.

All equipment shall be operated by trained and experienced operators and the compaction of Embankments shall be carried out by skilled and experienced labor.

The Contractor shall carry out trial sections to demonstrate to the satisfaction of the Engineer that his proposed methods, equipment and labor are capable of constructing Embankments in accordance with this Specification. Suitable compaction equipment

is as follows:

- a) Sheep's foot, tamping or grid rollers shall be capable of exerting a force of 45 Newton per mm of length of roller drum.
- b) Steel wheel rollers other than vibratory rollers shall be capable of exerting a force of not less than 45 Newton per mm of width of the compression roller.
- c) Vibratory steel wheel rollers shall have a minimum mass of 6 tons. The compactor shall be equipped with amplitude and frequency controls and specifically designed to compact the material on which it is used.
- d) Pneumatic tire rollers shall have smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 550 kPa.

Unsatisfactory work produced as a consequence of inadequate equipment and labor 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. 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.

3.6 Compaction Trials

- a) No work can begin on the formation of Embankments until the Contractor has carried out trial sections in accordance with his method statement for the compaction of each type of fill material to be used in the Works. The trials shall be carried out using the equipment and labor the Contractor intends to use for the Permanent Works. The trials shall determine the relation between; the types of compaction equipment, the number of passes required and such methods as may be necessary for adjusting moisture content in order to construct Embankments in accordance with this Specification Section. Trials areas shall be not less than 10 m wide and 50 m long and subject to the approval of the Engineer. All trial sections shall be subject to the approval of the Engineer before Embankment works can begin.
- b) Materials used in trial sections shall be sampled and tested in accordance with this Specification Section to confirm compliance with the requirements of this Specification Section. The trials shall be used to determine the target densities for the materials used and the densities shall be determined in accordance with the requirements of this Specification Section. Work may be suspended and

new trial sections may be required, subject to confirmation by the Engineer, if the Contractor fails to achieve the target densities determined in the trial sections during construction of the Embankment.

- c) Compaction trials for each of the specified Embankment layers may be carried out on completed and approved sections of the underlying layer subject to the approval of the Engineer. However no work on the respective layer can begin until the trial has been approved.
- d) Trial sections may be included in the Permanent Works, subject to the approval of the Engineer. However should the trial section be unsatisfactory it shall be removed entirely and the layer beneath the trial section shall be made good at the Contractor's cost and to the satisfaction of the Engineer.
- e) The Contractor shall adhere to the compaction procedures, materials, labor, equipment and methods used on approved trial sections for the duration of the work. If, during construction of the Works, the character and properties of the fill material change or the Contractor changes his compaction equipment or methods new trial sections shall be carried out. Work shall be suspended until such time as the new trials have been successfully completed subject to the approval of the Engineer.

3.7 Protection of Roadbed and Slope during Construction

Embankment construction shall comply with subsection 3.3 of this Specification Section. Crossfalls shall be maintained in such condition that Embankments will be well drained at all times. Drainage for seepage water, if any, shall be taken into consideration and where necessary temporary ditches or gutters shall be so constructed as to prevent damage to Embankments by erosion. The Contractor is expected to take all necessary measures to ensure that Embankments under construction are protected from damage due to rain.

3.8 Protection of Structures

If Embankment can be placed on one side only of abutments, wing walls, piers or culvert headwalls care shall be taken to ensure that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning or excessive pressure against the structure. When noted on the Drawings the fill adjacent to the abutment shall not be placed higher than the bottom of the parapet of abutment until the superstructure is in place. When Embankment is to be placed on both sides of a concrete wall, box type structure or other structures, operations shall be so conducted that there is no significant difference in the elevation of the Embankment on either

side of the structure.

3.9 Rounding and Warping Slopes

Except in solid rock the tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded to a 1m tangent length from shoulder edge. At intersections of cuts and fills, slopes shall be adjusted and wrapped to flow into each other or into the natural ground surfaces without noticeable break.

3.10 Finishing Roadbed and Slopes

- a) On completion of the Embankment the finished surface shall be free of any soft or other unsuitable material that has not compacted properly and free of low sections, holes or depressions. Any necessary corrections by; scarifying, blending, scraping, dragging, rolling, or other methods of work shall be performed to provide a thoroughly compacted roadbed shaped to the grades and cross sections shown on the drawings and subject to approval by the Engineer.
- b) All slopes shall be reasonably uniform, without any noticeable break and in reasonable conformance with the Drawings and with no variations readily discernible as viewed from the road subject to approval by the Engineer,

3.11 Complementary Requirements for Subgrade Construction

- a) After completion of Embankment construction and before the placement of any base material for pavement, all culverts, transversal drains, ducts and the like (including their fully compacted backfill), ditches, drains and drainage outlets shall be completed.
- b) The Contractor shall be responsible for protecting the surface of the completed Embankment and maintaining it in an acceptable condition until such time as he completes the aggregate base courses. Damage caused to the completed surface after its acceptance and prior to subsequent work shall be repaired at the Contractor's expense. All repair work shall be subject to the approval of the Engineer.
- c) Proof rolling shall be conducted after completion using 25 tons minimum weight roller at locations subject to approval by the Engineer. If the deflection is more than 5mm the Embankment shall be checked and replaced if necessary, subject to the approval of the Engineer.
- d) Static Plate Load Method tests shall be conducted to check the designed elastic

modulus of the subgrade in accordance with TCVN8861-2011.

3.12 Requirement for Compaction

The required compaction for each layer is given below. The values given may be revised, subject to the approval of the Engineer, based on the test results obtained during compaction of the trial sections and subject to ensuring the CBRs specified in subsection 2.4 of this Specification Section are achieved.

Table 4: Requirement for Compaction

Layer	Compaction*
Top 30cm Layer (Subgrade)	98% (22TCN333-06, Method 2D) or AASHTO T180
50 cm Layer below Top 30cm Layer (Subgrade)	95% (22TCN333-06, Method 2D) or ASSHTO T180
Layers below Subgrade	95% (22TCN333-06, Method 2D) or ASSHTO T180

3.13 Testing frequencies

Testing frequencies shall be accordance with Vietnamese Standard: 22TCN 304-06 or other international standard as proposed by the Contractor with approval from the Engineer.

Table 5: Frequency of Test

Item	Test Description	Test Frequency	Remarks
a	Material testing & preparation work before construction: (for material & quarries approval)	Article 4.2.1	
b	During construction period:	Article 4.2.2	
c	After construction period: (For acceptance of construction works)	Article 4.2.3	

Source: 22TCN 304-03: Natural gravel aggregate layer in pavement structure - Code of Construction and Acceptance Procedure.

3.14 Dimensional Tolerances after compaction

Irrespective of the tolerances given below, all exposed finished fill surfaces shall be sufficiently smooth and uniform, and shall have sufficient slope to ensure that they are free draining and that no ponding occurs.

Table 6: Tolerances after Compaction

	Items	Tolerance	Lot Size
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	Items	Tolerance	Lot Size
Embankment	Center line	±15 mm	Smaller value of either every 20m shown on the approved Contractor's Drawing or 1000m ³
	Thickness of one layer	±40 mm	
	Final grades levels	±30 mm	
	Width on Top	±40 mm	
Slope	Thickness by cohesive soil	±50 mm	Smaller value of either every 20m shown on the approved Contractor's Drawing or 500m ²
	Surface irregularity from the specified profile line	±20 mm	
Capping Layer and Subgrade	Center-side location	±10 mm	Smaller value of either Every 20m shown on the approved Contractor's Drawing or 1000m ²
	Width	±30 mm	
	Thickness	±15 mm	
	Level	±15 mm	
	Surface irregularity by 3m straight edge	±10 mm	
	Cross fall or camber	± 0.5%	
	Longitudinal grade over 25 m length	± 0.1%	

4. MEASUREMENT AND PAYMENT

4.1 Method of Measurement

- a) The quantities for Embankment construction shall be measured in cubic meters. Profiles shall be taken immediately before the Embankment work starts and immediately after the Embankment or sections of the Embankment have been compacted, completed and approved by the Engineer. For the purposes of measurement and payment the pay item descriptions make no differentiation between Embankment construction (1) with excavated material from the Works or (2) with borrow material from off Site. The Contractor shall include in his unit rates for constructing the Embankments with borrow material from off Site, excavated material from the Works or a combination of both. Separate pay items will not be measured for payment for Embankment construction (1) for borrow material from off Site and (2) excavated material from the Works on Site.
- b) The actual Embankment volume shall be computed from the average cross section areas using the profile of the ground after clearing and grubbing and removal of topsoil has been completed and the profile of the top of the

Embankment fill shown on the Drawings or approved shop drawings or within such limits as may be approved by the Engineer.

- c) For Embankments placed over excavated hillsides the measurement shall be the volume of fill between the original ground profile after excavation and the finished slopes and grades shown on the Drawings or approved shop drawings. The excavation and backfill for benches on hillsides shall be deemed as incidental to roadway excavation and embankment construction. No separate measurement and payment shall be made for benching.
- d) For Embankments placed over ground, which was not identified in the Drawings as requiring “soft soil treatment” but where settlement has occurred due to differential consolidation no separate payment shall be considered for adjusting the Embankment to compensate for the settlement and the cost of any such adjustment shall be deemed an incidental cost included in the prices and rates for Embankment construction.
- e) For Embankments placed over ground, which was identified in the Drawings as requiring “soft soil treatment”, separate payment shall be made for adjusting the Embankment to compensate for the settlement and shall be deemed to be included in pay item 03400-03. The means and methods of measuring this volume caused by embankment settlement will be based on settlement plate measurements and as approved by the Engineer.
- f) The Embankment provisions, material requirements and construction requirements identified in this Specification Section shall be measured for payment in pay items 03400-01, 03400-02 and 03400-03.
- g) Any Embankment Works not specifically indentified in this Specification Section but which are necessary for the performance of the Works shall be deemed to be included in pay items 03400-01, 03400-02 and 03400-03.
- f) g) Additional Embankment required due to work carried out by the Contractor at his convenience to facilitate his own construction methods or due to any over excavation by the Contractor shall not be measured and shall not be considered for payment.
- h) Deduction for Structures: The volume of pipe culverts, box culverts, underpasses and bridges and the volume of backfill around such structures and filling which has been paid for under other items of work, shall be deducted from the volume of Embankment placed.

4.2 Basis of Payment

- a) The accepted quantities, measured as provided above, shall be paid for in accordance with the applicable unit prices as indicated in the Bill of Quantities and given below.
- b) Payment shall be full compensation for the entire work prescribed in this Specification Section including preparation of foundations for Embankment (over unconsolidated ground or other ground approved by the Engineer), classified soil material (from borrow or excavation from the Site), layering, blending (if required), watering, temporary drainage, hauling, compacting, shaping, trimming, finishing and maintaining Embankments and for furnishing all labor, materials, tools, equipment, tests and any incidentals to complete the work as shown on the Drawings and as required in accordance with this Specification Section and subject to approval by the Engineer.
- c) No payment shall be made for survey or setting out work which shall be considered incidental to the works as a whole and deemed to be included in the Contractor's rates and prices.

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
03400	Embankment Construction	
03400-01	Embankment Construction (K95)	m ³
03400-02	Embankment Construction (K98)	m ³
03400-03	Settlement Compensation Construction by Borrow Material	m ³