2.0 EMBANKMENT (Specification 2.6)

Key Points

• All fill materials must be free from vegetable matter and the material must be approved as suitable.

• The material should be of an appropriate nature and at a moisture content that it can be compacted to form a stable layer.

• Generally embankments should be constructed in 150 mm compacted layers parallel to the finished grade of the road.

• For each completed layer the density should be checked (One test for each 1,000 square metres) by laboratory personnel. If test results show the required density is not achieved further compaction is necessary.

• Any soft areas must be rectified before further material is placed. Each earthworks layer requires to be approved before the next layer can be started.

2.1 Embankment Construction Methods

Before placing any material, clearing and grubbing and the removal of any unsuitable materials needs to have been completed. Also any necessary information to determine earthwork quantities should have been collected (normally cross sections of the original ground).

Where an existing embankment is widened, the new fill material must be fully keyed into the old embankment by means of benching. Steps not less than 300 mm high and 600 mm wide should be cut into the old embankment prior to any filling, see Figure 3. Material cut from these benches may be used as fill, if it is suitable.
a) Widening of existing embankment

- Cut back old embankment in steps
- Maximum slope
- Old Embankment
- Proposed widening and raising of embankment
- Peg to mark extent of new embankment
- Existing Embankment
- Remove vegetable matter below widened embankment

b) Widening procedure

- Embankment compacted to 95% standard compaction
- Compacted in steps. Minimum two layers of 0.15 m

Figure 3. Embankment widening procedure
Normally embankments should be constructed in layers approximately parallel to the finished grade of the road. The grade and crossfall should be maintained during construction, as this will enable water to run off the embankment allowing construction work to start as soon as possible after rainfall and avoid soft spots forming.

All fill material used must be free from roots, or any vegetable matter. Each layer of fill should be less than 150 mm on completion of the compaction. Compaction must be undertaken using appropriate equipment. If large rollers (very heavy vibrating compaction) are used it may be possible to increase the depth of the layers but this should only occur after checking that adequate compaction is being achieved. Generally the compaction should begin at the outer embankment edges and gradually progress toward the centre rolling in a longitudinal direction so that the full width is uniformly compacted. In order to ensure proper compaction of the embankment slope it is good practice to overfill by 150 – 300 mm and then trim the embankment to the specified shape. The arisings can be re-used as fill material.

The fill material needs to be of a type and moisture content so that it can be compacted to form stable layers. The water content of each layer, before being compacted, must be assessed. The material may require water to be added or be allowed to dry to bring the moisture content close to the optimum in order to make it possible to achieve the required dry density and hence degree of compaction.

Normally one density test for each 1,000 square metres of every layer should be carried out by laboratory personnel. These tests should be carried out at random and be across the full width of the embankment. If the test results show that the density is less than that required, then further compaction to obtain at least the required density is necessary. Results of all the compaction tests undertaken should be kept on file.
If it is not possible to arrange for compaction testing at the appropriate time (e.g. where this would delay the contractor) a visual check of the earthworks should be made. If the layer appears to be satisfactorily compacted, approval maybe given. In this case tests must be carried out on the subsequent layer. This procedure is not acceptable for any layer within 300 mm of the subgrade level.

As an alternative the Dynamic Cone Penetrometer (DCP) can be used to test earthworks. The DCP is a rapid in-situ method which after correlation can be utilised to obtain CBR's and density results.

If the embankment contains any -

- soft areas this generally means insufficient compaction has been used. Further rolling required.
- spongy areas, (which move under the wheel of the roller) this generally means the materials have been placed too wet. In this case the material needs to dry out, and to enable this to occur scarification of the surface is often necessary.

Each compacted layer requires to be approved before the Contractor can commence on a new layer. If the Contractor does not obtain approval before starting a new layer, or does not follow acceptable procedures, the contractor must be advised of the non-compliance and the Engineer informed immediately.

Adequate compaction for embankments (refer to Appendix ‘B’) is to ensure that only limited settlement will occur with time. If the embankment settles unevenly this will give an uneven surface to the road. Figure 4 provides a comparison between placing material in a single thick layer and placing thinner layers in an approved manner. It is particularly important to adequately compact fill material adjacent to bridges and culverts to prevent noticeable transverse level differences occurring.
Figure 4. Compaction of Materials

Comparison of Alternative Methods

<table>
<thead>
<tr>
<th>THICK LAYER PLACED THEN COMPACTED</th>
<th>THINNER LAYERS EACH COMPACTED</th>
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<tbody>
<tr>
<td>Top of layer compacted, but overall poorly compacted.</td>
<td>All layers well compacted.</td>
</tr>
<tr>
<td>Gaps between materials (high voids).</td>
<td>Few gaps between materials (low voids).</td>
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<tr>
<td>Poor compaction. Allows water to enter layer. Weakens the material.</td>
<td>Good compaction. Prevents water entering layer. (material retains its strength).</td>
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<tr>
<td>Settling in time, may cause uneven pavement surface.</td>
<td>Little Settlement.</td>
</tr>
<tr>
<td><strong>UNACCEPTABLE</strong></td>
<td><strong>APPROVED MANNER</strong></td>
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<td><strong>SPECIFIED</strong></td>
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