40

Technical Note

CONSTRUCTION OF EMBANKMENTS OVER WEAK GROUND USING LIGHTWEIGHT FILL (EXPANDED POLYSTYRENE)

1. INTRODUCTION

This Technical Notes provides guidance on the use of ultra lightweight expanded polystyrene (EPS) as fill for embankment construction over weak ground. It is intended for situations where the construction of a conventional embankment over weak and compressible ground will result in unacceptably high and or long term settlement or where a conventional embankment will be subject to instability. EPS can be used as a fill material for bridge approach embankments and for road embankments. Figure 1 shows a typical EPS filled embankment cross-section.

VicRoads has successfully used EPS in embankments to minimise embankment loading and to reduce settlement to an acceptable level. These embankments vary in height up to about 4 m. However, it is possible to build EPS embankment fills to greater heights.

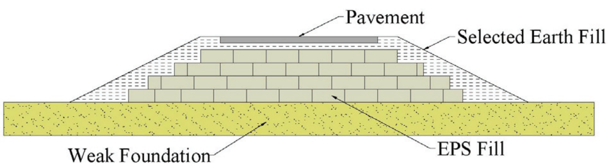

Figure 1. Typical EPS Fill Embankment Cross-section

2. WHAT IS EPS?

Moulded EPS foam blocks are available in Australia in a number of grades or classes with different strengths and densities (AS 1366, Part 3–1982). Table 1 shows the strengths and densities of the various classes of EPS. The block sizes available vary slightly between manufacturers, but are of the order of 1.2 m wide, 0.5 to 0.6 m thick and 3.6 to 5.0 m long. It can be seen that the nominal density of EPS varies from 11 to 28 kg/m^3, approximately 1% of the density of soil.

3. ADVANTAGES OF USING EPS FILL

EPS offers the following advantages:

- Can provide a cost effective method of embankment construction where ground improvement and/or ground support would be required for conventional fill.
- Significant reduction in construction time, where staged construction and/or surcharging may be required for conventional fill.
- Significant reduction in the risk of failure of the embankment during construction on very weak or highly compressible ground.
- Significant reduction in maintenance costs, where differential settlement and/or long-term secondary compression are anticipated for conventional fill.
- Can reduce differential settlement between approach embankments and rigid structures.
- Can reduce down-drag effects when widening embankments on weak ground.
- May avoid the need for relocation of services sensitive to settlements and/or lateral ground movement induced by embankment construction.
- Rapid embankment construction can be achieved, even at sites with difficult access, as the EPS blocks can be lifted and moved easily by hand.
- Once the embankment base has been prepared, the embankment may be completed in poor weather conditions.

Table 1: EPS Properties (AS 1366, Part 3-1982)

Property	Class					
	L	LS	S	M	H	VH
Compressive stress @ 10% deformation (kPa)	50	70	85	105	135	165
Nominal density (kg/m^3)	11	13.5	16	19	24	28

4. DESIGN CONSIDERATIONS

The following design aspects need to be considered:

- Information regarding the ground surface profiles, sub surface profiles, soil strength, immediate and long-term settlements and groundwater conditions should be obtained for reliable analysis of embankment stability and settlement.
- Traffic loading, and exceptional loading (heavy construction plant or surcharge) requirements assessed to determine the class of the EPS to be selected.
- Applied stress level from dead loads is below 30% of the EPS material strength.

- Design CBR of 2% shall be applied for pavement directly constructed on Class M EPS.
- Maximum flood level determined for the site.
- In case of high groundwater conditions, design should consider anchoring to avoid floatation.
- Possibility of flotation occurring during and after construction of the completed embankment.
- Effect of wind during construction (EPS blocks have blown off trucks during unloading)
- Presence of organic solvents and natural gas should be determined where land fill or contaminated land is expected (an impermeable and chemically resistant barrier must be provided to prevent such substances from coming into contact with the EPS fill).
- Use of a vapour barrier may be required in contaminated ground.
- The risk of damage to the EPS posed by fuel spills should be considered (an impermeable barrier may be provided to prevent fuel from coming into contact with the EPS fill).
- Protection of the EPS from the effects of bush fires. Note that there have also been instances of EPS embankments being burnt during construction, either accidentally, or on purpose by vandals.
- Shall be protected from rodent attack.

5. SELECTION OF EPS FOR BRIDGE APPROACH FILLS

Table 2: Laboratory Test Results for Class M EPS

Property	Result
Dry density (kg/m^3)	20
Water uptake on soaking (kg/m^3)	36-57
California Bearing Ration(%)	2.2
Compressive stress @ 10% deform'n (kPa)	103
Initial tangent modulus (MPa)	3.5
Resilient Modulus (MPa)	8.0

Based on VicRoads previous experience with EPS applications, Class M EPS is generally selected as the most suitable material for EPS embankments. Studies carried out by VicRoads (McDonald and Brown, 1993), indicated that for Class M EPS, long term compression due to creep would be minimal for static pressure less than about 30 kPa. Other laboratory studies carried out by VicRoads included water uptake upon inundation, the Californian Bearing Ratio (CBR) and the resilient modulus (E_r) under cyclic triaxial stress (ARRB, 1991). The CBR and resilient modulus are used to provide pavement design parameters. Laboratory test results on Class M EPS are included in Table 2.

6. CONSTRUCTION

A typical cross section showing an EPS embankment is presented as Figure 1. The following should be considered before construction of an EPS embankment is carried out:

- The ground surface should be smooth and flat. A bedding layer of sand may be placed and levelled by hand to provide a smooth and flat surface.
- EPS fill should be constructed in layers. In each layer, EPS blocks should be placed such as to overlap the joints in the layer below. Where practicable, the orientation of the long axes of the blocks should be at right angles to the layer below.
- EPS blocks should be cut to size to suit the required fill outline, top and bottom of each block should be trimmed prior to delivery to site.
- EPS blocks can be cut to size on site using a chainsaw, a hand saw or a hot wire.
- EPS stockpiles should be anchored against wind.
- No plant should be operated over EPS fill until at least 150 mm of fill or a 100 mm concrete slab cover has been placed.
- The maximum applied pressure from construction plant should be limited to 20 kPa.
- Where the operation of plant directly on polystyrene fill is unavoidable, temporary planks should be provided to distribute axle loads such that the design strength of the fill is not exceeded.

7. REFERENCES

McDonald, P. and Brown R.G (1992). Ultra Lightweight Polystyrene for Bridge Approach Fill.

Australian Standard AS 1366, Part 3-1992. Rigid cellular plastic sheets for thermal insulation, Part 3 – Rigid cellular polystyrene – Moulded (RC/PS – M).

VicRoads Technical Note 25 (1998). Embankment/Landslip Repair Using Expanded Polystyrene.

Sanders R.L. and Seedhouse R. L. (1994), TRL-Contractor Report 356. The use of polystyrene for embankment construction, Babtie Shaw & Morton Ltd.

8. CONTACT OFFICERS

Nelson Fok — Phone (03) 9881 8950
E-mail — nelson.fok@roads.vic.gov.au

Fashiur Rahman — Phone (03) 9881 8951
E-mail — fashiur.rahman@roads.vic.gov.au

GeoPave Facsimile: (03) 9881 8900

GeoPave believes this publication to be correct at the time of printing and does not accept responsibility for any consequences arising from the use of the information herein. Readers should rely on individual judgement and skill to apply information to particular issues.