GEOPAVE
MATERIALS TECHNOLOGY

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Technical Note

VERTICAL MOISTURE BARRIERS

1. INTRODUCTION

Over half of the Classified roads in Victoria are built on expansive soils of different degrees of expansivity. Road pavements built on subgrades of expansive soils, especially with a high to very high expansion potential, are affected by volume changes through seasonal wetting and drying cycles, resulting in two main types of damage:

(i) pavement roughness or loss of shape, and
(ii) severe longitudinal cracking.

These effects usually result in premature rehabilitation.

Vertical moisture barriers have been used to control these seasonal movements. Field trials evaluating the effect of these barriers have been conducted in Texas (Steinberg, 1992) and Victoria (Holden, 1992; Evans & Holden, 1994).

2. ROLE OF VERTICAL MOISTURE BARRIERS

The role of a vertical moisture barrier (Picornell & Lytton, 1986) is to stop the seasonal lateral migration of moisture to and from the subgrade beneath the pavement. To effectively stop this moisture migration, the moisture barrier must extend below the depth of cracking. The barrier must also prevent the invasion of plant roots. Thus it preserves a stable soil suction profile once this has been reached beneath the pavement. This stable suction will be the equilibrium suction that exists in the deeper foundation soils.

The most economical depth for a vertical moisture barrier is that which limits seasonal moisture changes so that pavement edge flapping (Holden, 1992) and pavement roughness is kept within acceptable limits, and associated cracking is also prevented.

The need for moisture barriers at a particular site depends on the magnitude of seasonal movements of the pavement. These movements depend on the soil properties, the climate, the road design, the drainage conditions, the water table depth, and the roots of neighbouring vegetation. These seasonal movements can be estimated using various methods (e.g. Lytton, 1994). The need for barriers should be confirmed by the results from PMS surveys.

3. METHOD OF INSTALLATION

At VicRoads, vertical moisture barrier construction has been under development since the success of the Morton Plains field trials (Holden, 1992), resulting in a new construction method, which produces the form of barrier shown in **Fig.1.** This method does not apply to sites with rock floaters occurring within the barrier depth.

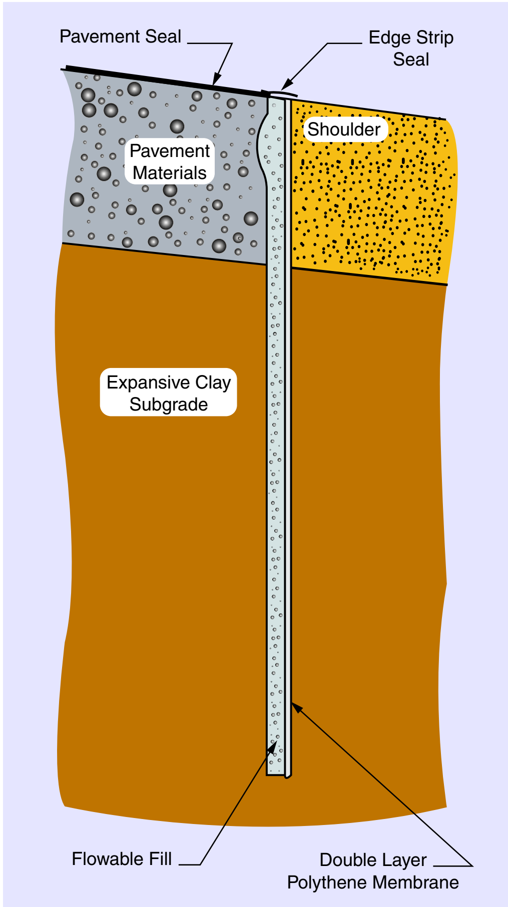

Figure 1. Cross-section of Barrier

Trench Excavation
A narrow slit trench is excavated to the design depth using a large (65 h.p.) trenching machine fitted with a specially designed slim-line trenching boom, having a slim-line crumber bar (Evans et al., 1995). Using a certain type of short chisel tooth with tungsten carbide inserts, attached to a two inch pitch chain, the machine produces a trench width of only 80 mm. The reason for reducing the trench width to the practical minimum was that the backfill material is the most expensive component of the barrier.

The depth of the trench is based on the depth of the zone of seasonal influence, which depends on the soil type and the climate. For most expansive soil areas in Victoria, a depth of 2 m is considered to be satisfactory. (The special boom can excavate to a maximum depth of 2.2 m).

A conveyor belt fitted to the trenching machine shifts the spoil to the verge, where it is later spread by a grader. In cases where the sub-base contains hard boulders in excess of 100 mm diameter, an initial pass is made with a standard trenching boom having a three inch pitch chain fitted with rock teeth. The initial trench has a minimum width of 150 mm and is only to the bottom of the sub-base layer.

Membrane Placement

The membrane used in the slit trench is a dual layer of thin (0.2 mm) low density polythene; this common builders' film is very cheap and readily available. To place the membrane in the slit trench without damaging it, a specially designed membrane dispenser is used (Evans et al., 1995). As the 2 m high membrane is placed, it is held up on the shoulder side of the trench by polystyrene wedges at 2-3 m spacing. Each 100 m length of membrane is joined to the next length either by butyl tape or by welding using a hot wire technique. The membrane is placed on the shoulder side of the trench (Fig. 1) so that the cementitious backfill is thus on the pavement side of the trench, filling any cavities under the pavement caused by overbreak during trenching. Another reason for this membrane position is to protect the somewhat "brittle" backfill from vertical shear stresses generated by seasonal movements; the dual layer of polythene introduces a local low-friction shearing plane.

Backfilling the Trench

A slurry type cementitious material, commonly known as flowable fill or Controlled Low Strength Material (CLSM), is used to backfill the trenches (refer to Technical Note No. 7). When a large length (50-100 m) of trench is completed, the flowable fill (about 2 MPa cured strength) is poured into it using a specially designed mobile hopper (Evans et al., 1995). If the job is carried out during the winter or spring, when the trench walls are likely to collapse, then the backfilling should follow closely, i.e. within a few metres, behind the trencher. This can be achieved by using a dry mix of the "flowable" fill that has a very steep angle of repose.

The trench is over-filled to form a ridge, in order to compensate for a minimal rapid shrinkage within the flowable fill. The next day a grader is used to trim off the ridge, level with the pavement seal. After at least a week, the surface is cleaned thoroughly using a water or air jet and an edge strip seal applied (i.e. cold bituminous emulsion and size 7 screenings).

4. TIMING OF BARRIER INSTALLATION

Vertical moisture barriers can be either incorporated into the design of a new pavement or used as a remedial treatment for existing pavements. However, the time of installation in relation to moisture conditions in the subgrade of the proposed or existing pavement can be critical.

For a new pavement or widening, to reduce the future loss of shape and prevent possible cracking, it is important to ensure that the soil suction in the subgrade is at, or near, the equilibrium soil suction. (Marmaras et al., 1994).

The ideal time to install barriers for existing pavements is also when the subgrade is at its equilibrium soil suction. If the subgrade is not at equilibrium, especially if tree roots are severed, a period of one to two years will be required before carrying out surface regulation and applying the final pavement seal. Therefore, moisture barriers should be programmed to be installed two years before a scheduled rehabilitation or reseal.

If the pavement is severely cracked at the time of barrier installation, then an interim effective water- proof pavement seal, such as a geotextile or glass-fibre reinforced seal, will be required.

5. FINAL PAVEMENT SEAL

It is imperative that the final pavement seal provides a long-term water proof seal against vertical moisture penetration into the pavement layers and especially into the expansive clay subgrade. For this reason, a SAM (Strain Alleviating Membrane) seal should be applied at the time of rehabilitation or resealing of the road.

6. REFERENCES

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Steinberg, M.L. (1992). Vertical Moisture Barrier Update. Transportation Research Record 1362, TRB, Washington DC, p. 111.

For information on the design of pavements on expansive clay subgrades, refer to Technical Bulletin No. 37 - VicRoads Guide to Pavement Design.

7. CONTACT OFFICER

Andrew Papacostas	Phone:	(03) 9881 8927
GeoPave Facsimile		(03) 9881 8900