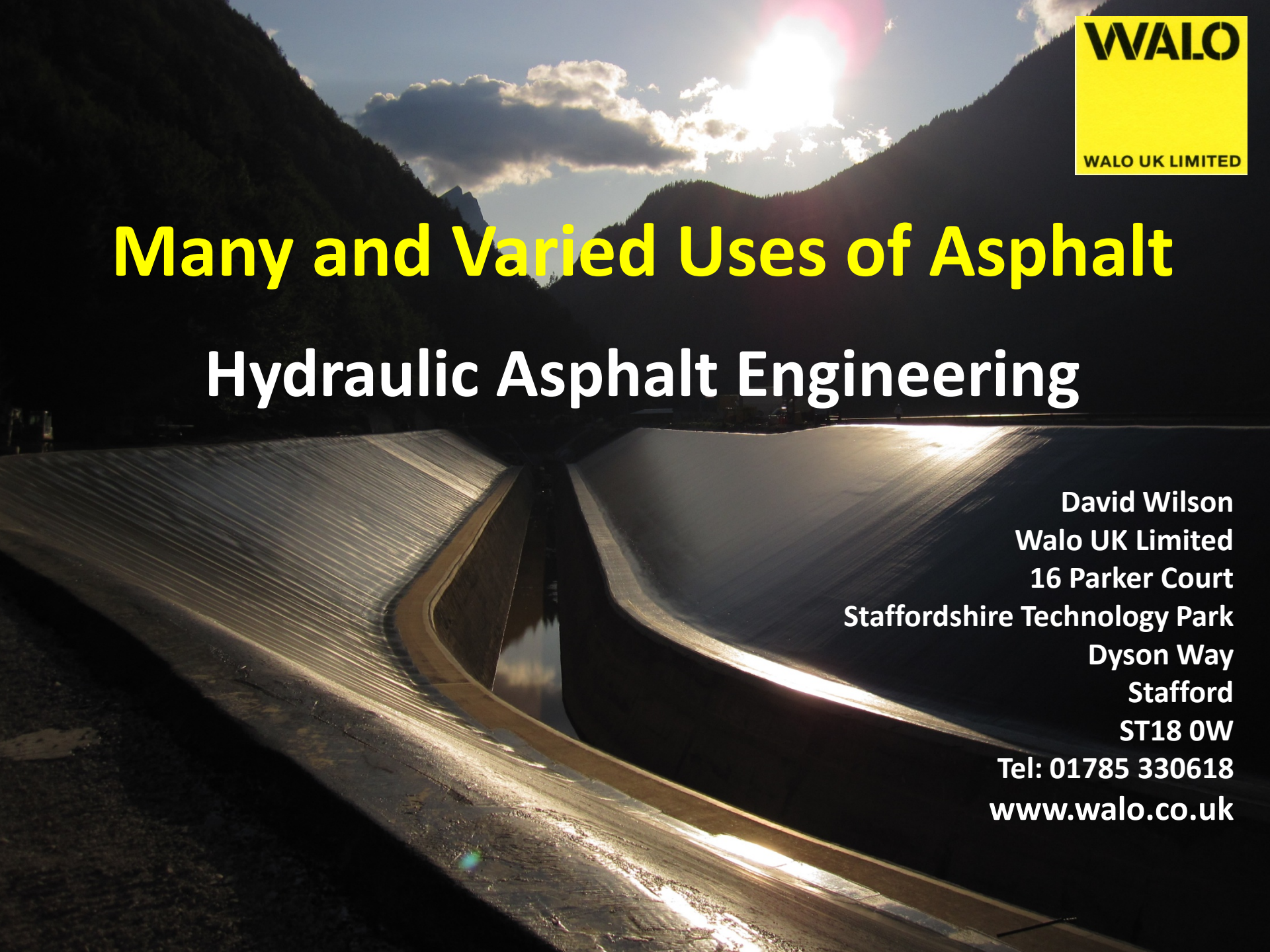

Many and Varied Uses of Asphalt

Hydraulic Asphalt Engineering

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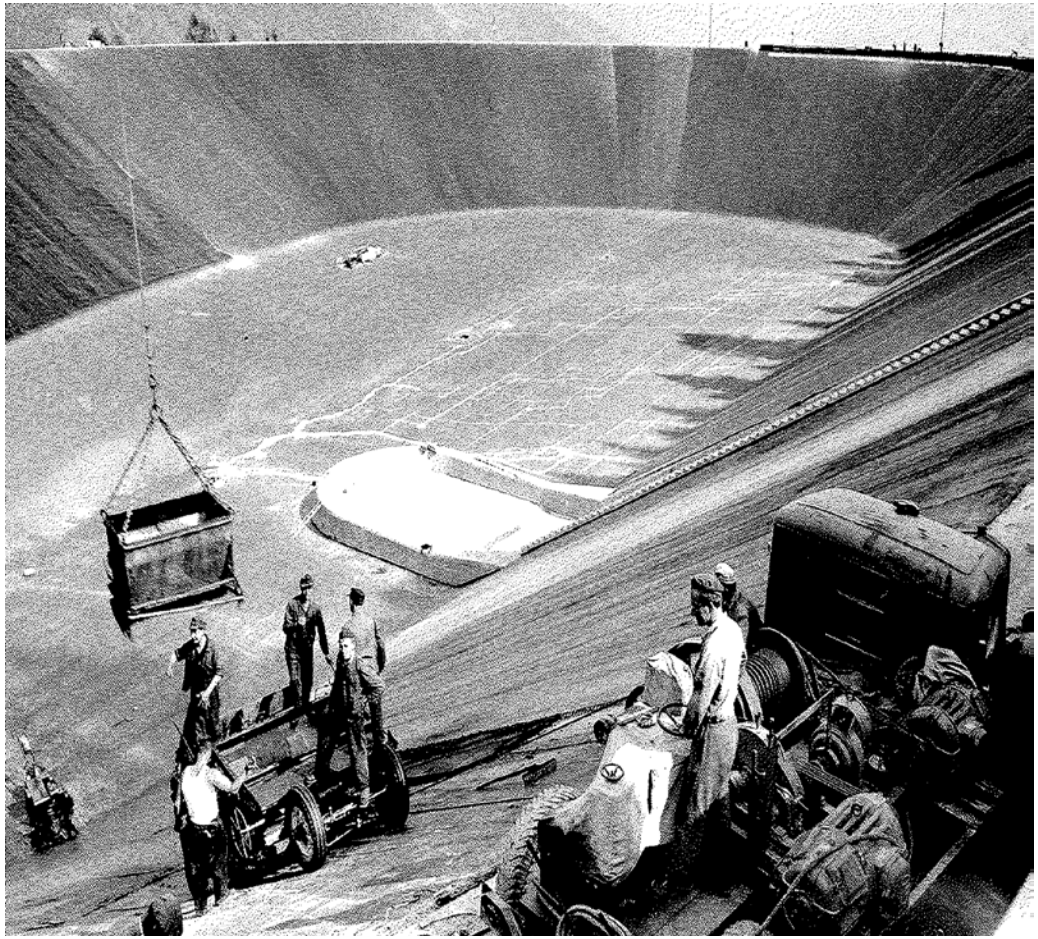
Walo Bertschinger AG



History

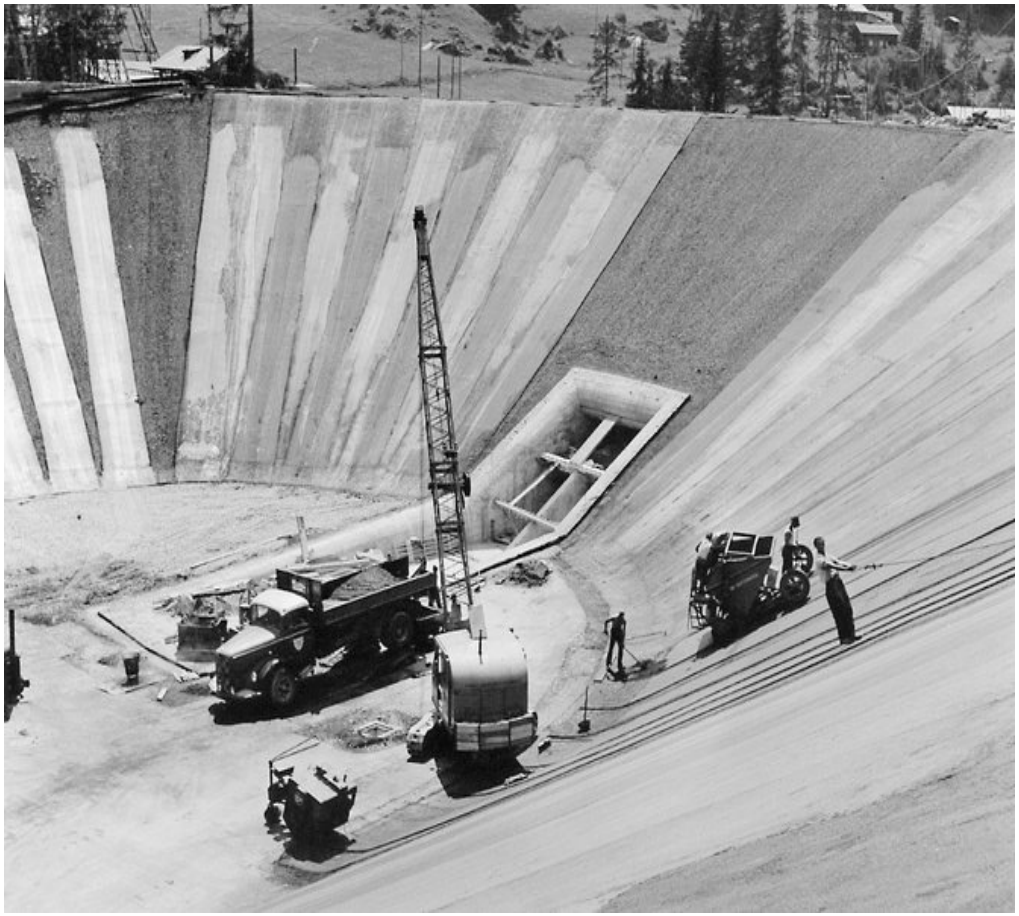
- Walo UK is a wholly owned subsidiary of Walo Bertschinger AG
- Walo Bertschinger AG Established in 1917 - 96 years
- Wholly owned by Bertschinger family
- Walo is “Walter” in Swiss-German

Walo Bertschinger AG

WALO UK LIMITED

Walo Bertschinger AG

WALO UK LIMITED



- Walo Bertschinger is a multi-disciplinary Civil Engineering employing over 3500 employees
- Hydraulic Asphalt Engineering key to early activities
- Walo is now recognised as one of the worlds leading specialists in hydraulic asphalt lining systems

Asphalt used to line……

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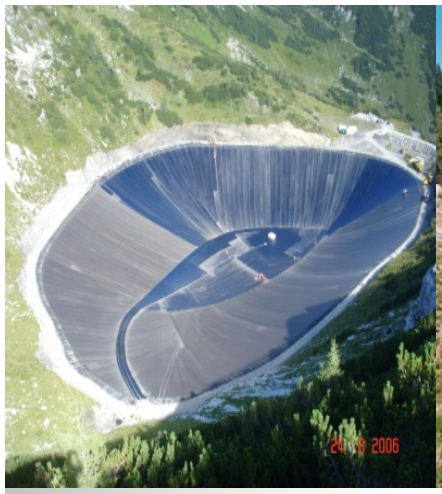

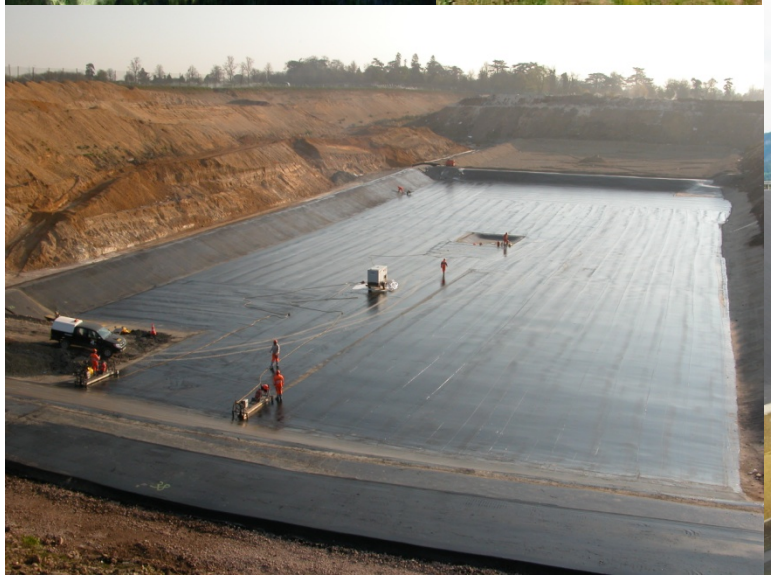

Hydro - Electricity Upper Reservoir

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Dam and Landfill Construction & Walo UK Limited

- First asphalt lined reservoir 1939
- First landfill cell lined in 1979
- First dam face lining in UK – Sulby Dam on Isle of Man - 1982
- Walo UK Limited established in 1999 – cover the UK and Ireland

Dam and Landfill Construction & Walo UK Limited

December 2012	No of Projects	% of Area
• Reservoirs	130	40 %
• Dams	47	15 %
• Channels / Canals	18	6 %
• Rehabilitations	75	15 %
• Lakes and ponds	60	4 %
• Landfills	93	20 %

Total: Over 10,000,000 m2

Dam and Landfill Construction & Walo UK Limited

- 5 Engineers from 4 countries and 9 languages
- 5 Supervisors from 3 countries and 8 languages
- 38 Labour force from 1 country resp. 2 villages (Portuguese)
- 2 – 3 Laboratory technicians
- 2 – 3 Mechanics
- 1 Secretary
- Full support of Walo Bertschinger AG

The use of Asphalt for Hydraulic Lining Systems

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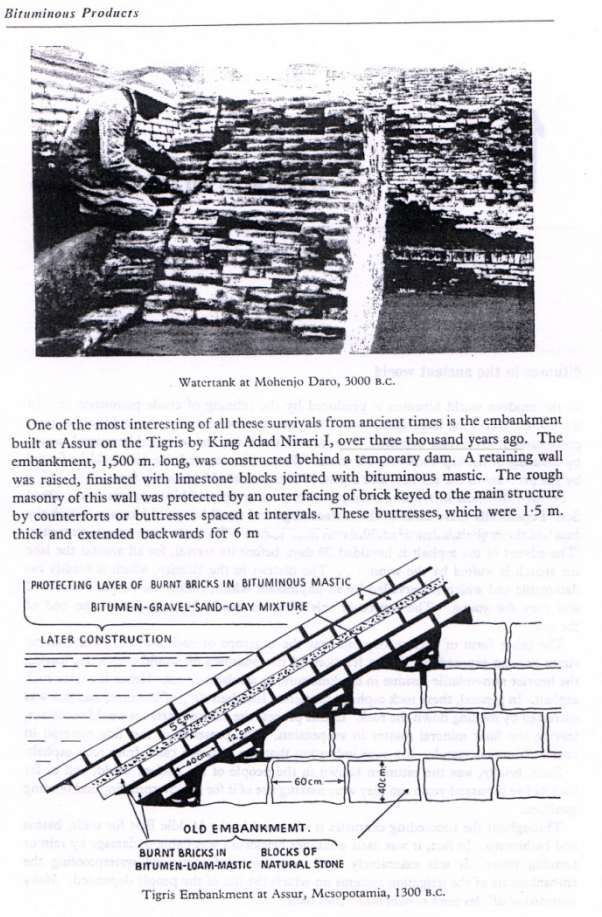

Bituminous Products

Watertank at Mohenjo Daro, 3000 B.C.

One of the most interesting of all these survivals from ancient times is the embankment built at Assur on the Tigris by King Adad Nirari I, over three thousand years ago. The embankment, 1,500 m. long, was constructed behind a temporary dam. A retaining wall was raised, finished with limestone blocks jointed with bituminous mastic. The rough masonry of this wall was protected by an outer facing of brick keyed to the main structure by counterforts or buttresses spaced at intervals. These buttresses, which were 1·5 m. thick and extended backwards for 6 m

Tigris Embankment at Assur, Mesopotamia, 1300 B.C.

There are many examples of engineered asphalt construction in the Middle East that have survived the millennia.

The secret to this longevity is durability and being dense enough to resist oxidisation.

This is an example of asphalt being used to impound water dating back some 3000 years

Dense Asphaltic Concrete (DAC) Lining System Properties

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- Satisfactory hydraulic conductivity (impermeable).
- Stability on slopes.
- Sufficient flexibility.
- Robustness.
- Resistance to chemical attack (landfill).
- Proven longevity
- Acceptance by regulatory authorities.
- Acceptable installation techniques.
- Realistic cost.

Dense Asphaltic Concrete (DAC) Lining System Properties

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A DAC lining system is designed and constructed to fulfil the following requirements;

a) It is watertight against the required maximum hydraulic pressure; a specified value of hydraulic head of water of up to 200 m and a hydraulic conductivity under such a head not exceeding 1 x 10^{-9} m/s.

b) It does not contain mobile toxic compounds.

c) It is sufficiently stable when placed hot and uncompacted to enable reliable compaction on slopes up to 1:1.6.

d) It has a total air voids content not exceeding 3% upon completion of compaction

Dense Asphaltic Concrete (DAC) Lining System Properties

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e) It is unaffected by sunlight, ambient temperatures up to 65^0 Celsius, frost action and all natural weather conditions.

f) It is resistant to mechanical forces resulting from impact of construction materials, drainage materials or constructional and operational plant and equipment.

g) It is sufficiently flexible to accommodate a differential settlement of the underlying formation to up to 40mm (measured normal to the plane of membrane) in a distance of 400mm without showing signs of stress or cracking.

h) All joints are completely watertight

Typical Asphaltic Lining System

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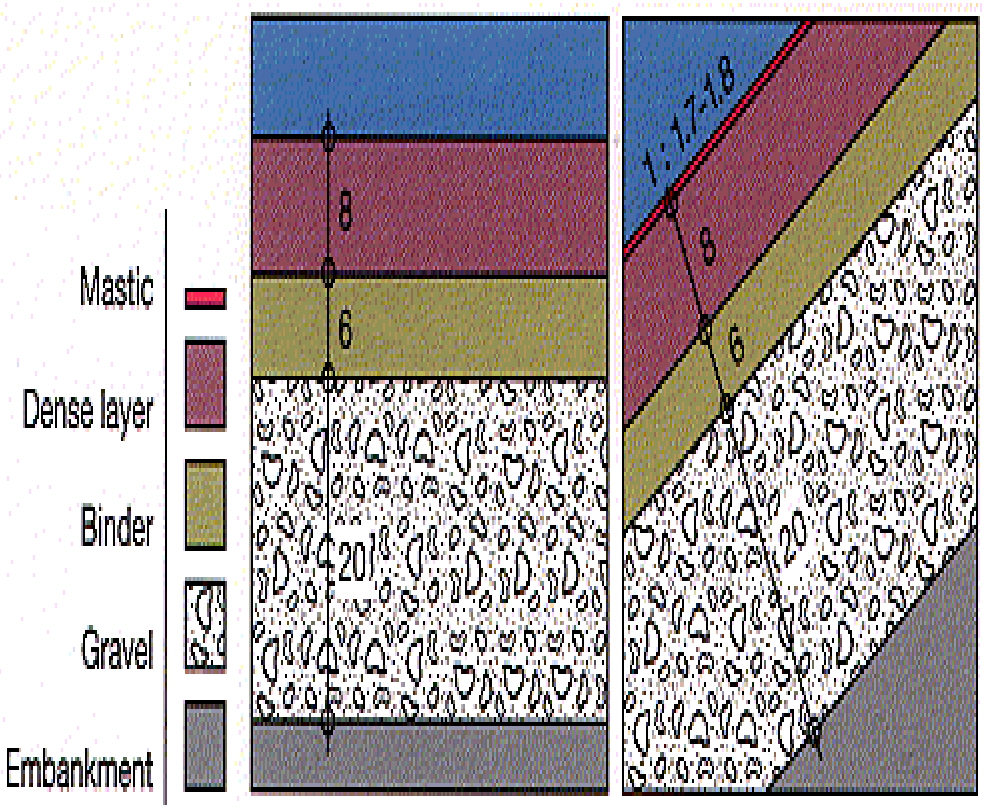
A dense asphaltic lining system generally comprises four layers each of which fulfils specific functions to ensure the integrity of the barrier system;

- The stabilising/drainage layer
- The asphaltic binder layer (ABL)
- The dense asphaltic concrete layer (DAC)
- Mastic seal coat

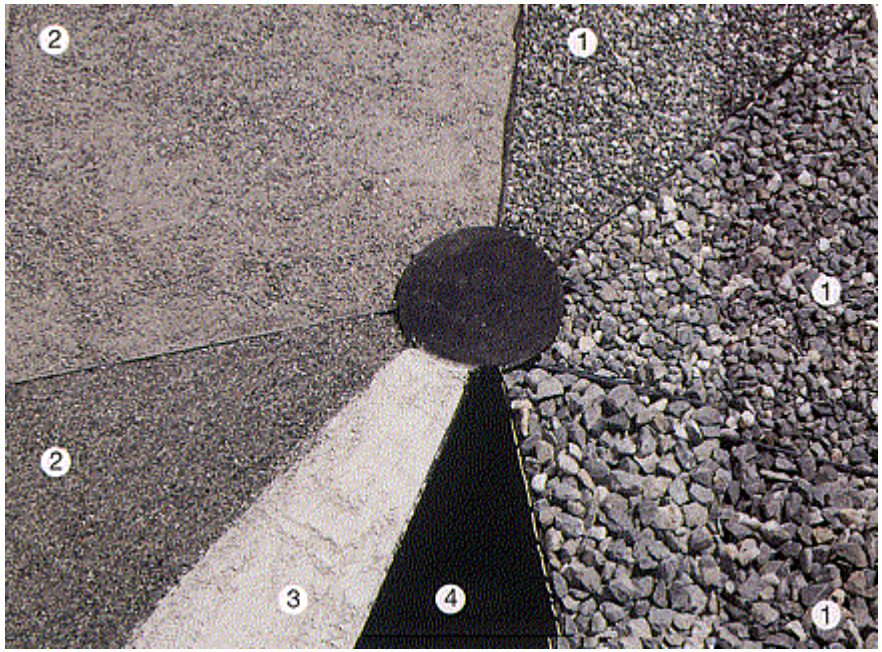
Typical Asphaltic Lining System



An asphaltic lining system would typically consist of;

- 200-300mm stabilising/drainage layer (min stiffness modulus of 50 MN/m2 – Min CBR 30%)
- 60mm of asphaltic binder layer (ABL) (10% - 15% air voids)
- 80mm of dense asphaltic concrete (DAC) (max 3% air voids)
- Mastic seal coat.

Hydraulic Asphalt Materials



- 1. Aggregates.
- 2. Sands.
- 3. Filler.
- 4. Bitumen.
- Mix designed in our Accredited Laboratory for optimum density and minimum impermeability.

Cores Through an Asphaltic Lining System

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Cores showing the difference in grading between the dense asphaltic concrete (DAC) layer and the open graded asphaltic binder (ABL) layer. The right hand core shows particles of the drainage material still attached.

Material Design

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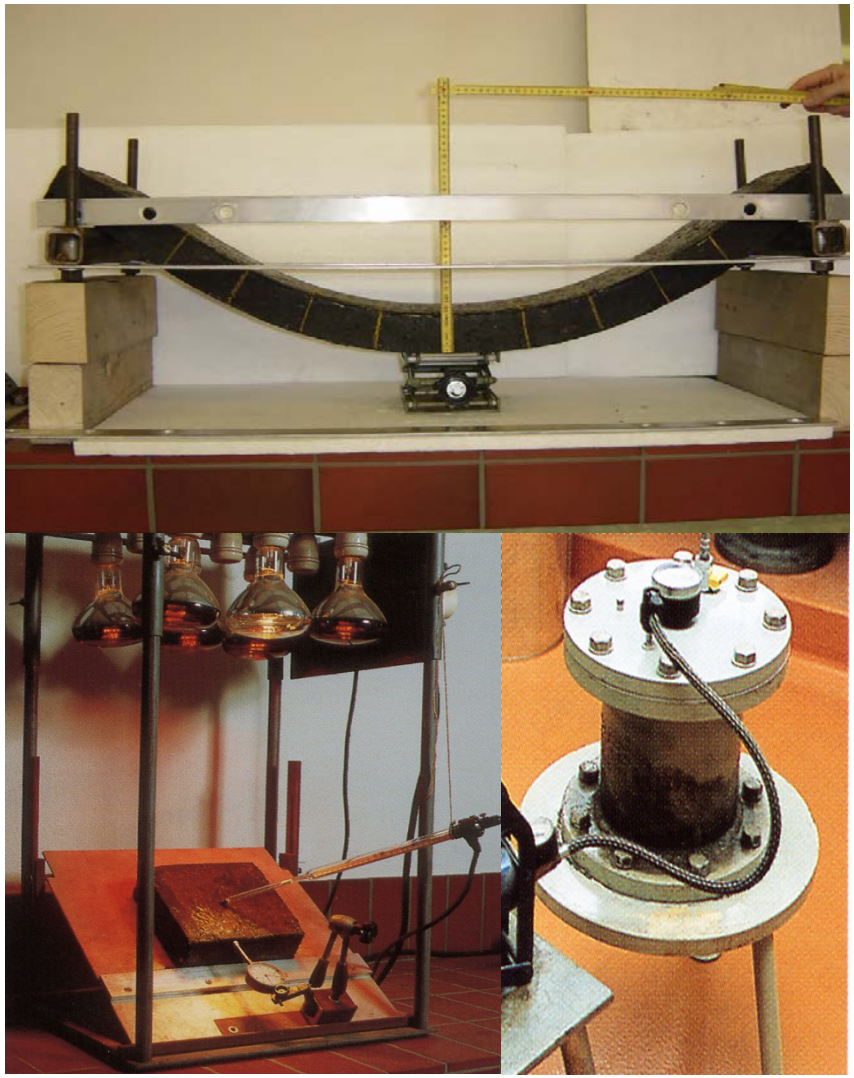
- Each and every different Hydraulic Engineering site has its own unique materials design
- Undertaken in the Walo Central Laboratories in Zurich
- Fully Accredited
- Designed to meet the individual site criteria using local source aggregates i.e. Altitude; Temperature Range; Slope Steepness; Permeability Requirements; Settlements etc

Material Design



- In total 34 different tests are undertaken to achieve the optimum design

- DAC Mix design; Before commencement of the works on site Walo select samples of possible aggregates, fillers, bitumen etc. to be tested to determine the suitability of the various materials to produce satisfactory mixes to enable the DAC to meet the requirements of the Specification.

DAC Design Testing Includes the Following -

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- Particle size distribution of the coarse and fine aggregates to BS EN 933-1 and fillers to BS EN 933-10;
- Flakiness index of coarse aggregates to BS EN 933-3
- Particle density of coarse and fine aggregates to BS EN 1097-6
- Water absorption of coarse and fine aggregates to BS EN 1097-6;
- Magnesium sulphate soundness of coarse and fine aggregates to BS EN 1367-2;
- Adhesion to bitumen to coarse aggregates to AASHTO – T182;
- Penetration of bitumen to BS EN 1426
- Softening point of bitumen to BS EN 1427
- Marshall test to BS EN 12697-34 on DAC layer mix and asphalt binder layer to determine air voids in compacted mix. Test to be carried out with 2 x 10, 2 x 20, 2 x 30 blows;
- Specific gravity (Maximum density) of mixes to BS EN 12697-5 on DAC layer mix and asphaltic binder layer mix.
- Bulk density of mixes to BS EN 12697-6 on DAC layer mix and asphaltic binder layer mix
- Swelling test on both DAC layer and asphalt binder layer in water at room temperature for 28 days;
- Hydraulic conductivity of the design mix for both DAC layer and asphalt binder layer.

DAC Design Testing Includes the Following -

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- All aggregates and fillers in the DAC layer and the asphaltic binder layer shall conform with the requirements of BS EN 13043 when tested in accordance with:-

- BS EN 932, General properties (including sampling)
- BS EN 933, Geometrical properties (size and shape)
- BS EN 1097, Physical properties (strength and surface characteristics)
- BS EN 1367, Thermal and weathering properties (often known as durability)

- The maximum size of coarse aggregate in the DAC layer shall not exceed 16 mm measured in any dimension. All aggregates and fillers used in the construction of the DAC layer in landfills shall not contain carbonate content in excess of 4%

Water Permeability Coefficient Determination

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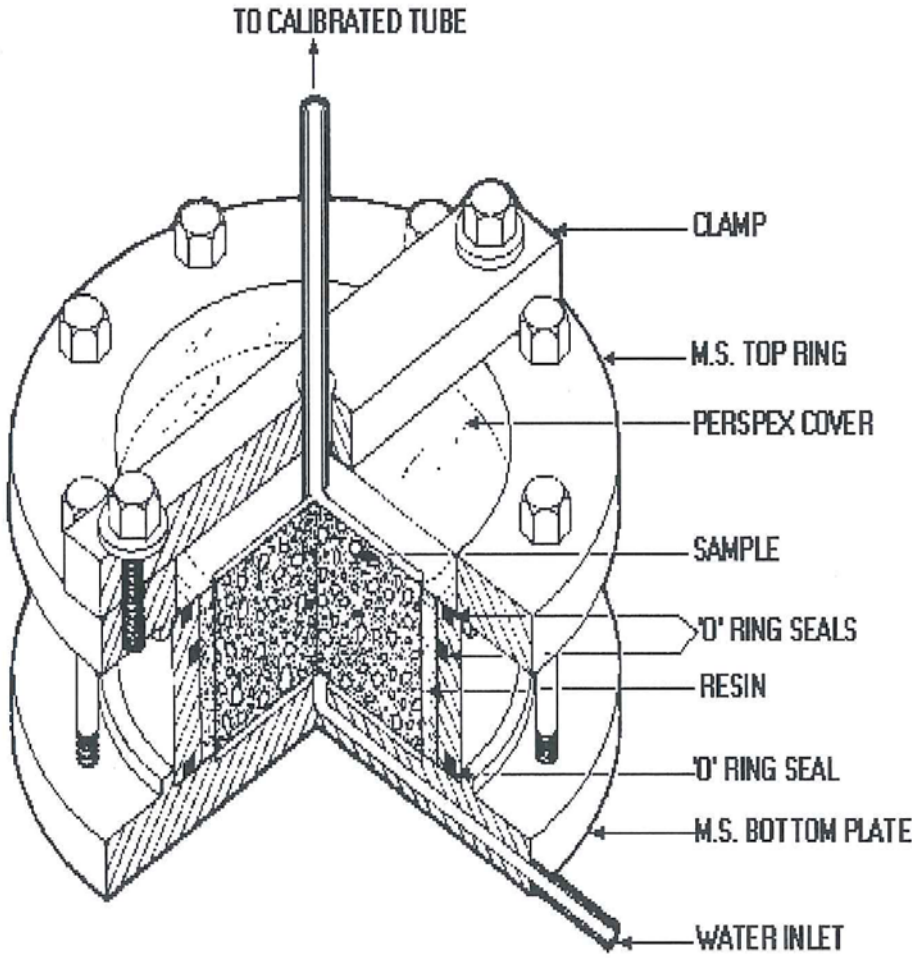

A Water pressure is applied to a test surface as follows:-
1 bar for 12 hours; 2 bar for 12 hours; 3 bar12 hours; 4 bar for 24 hours and finally 5 bar for 120 hours.

If water appears on the exposed face the flow rate is measured

If no water observed sample is weighed and split to measure depth of water penetration

Water permeability coefficient based on the measured flow rate or depth of penetration and then calculated using Darcy's or Valenta's modified formula respectively

How Steep is Steep?

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How do you place asphalt on very steep slopes?

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Vertical Placement on Small Slopes

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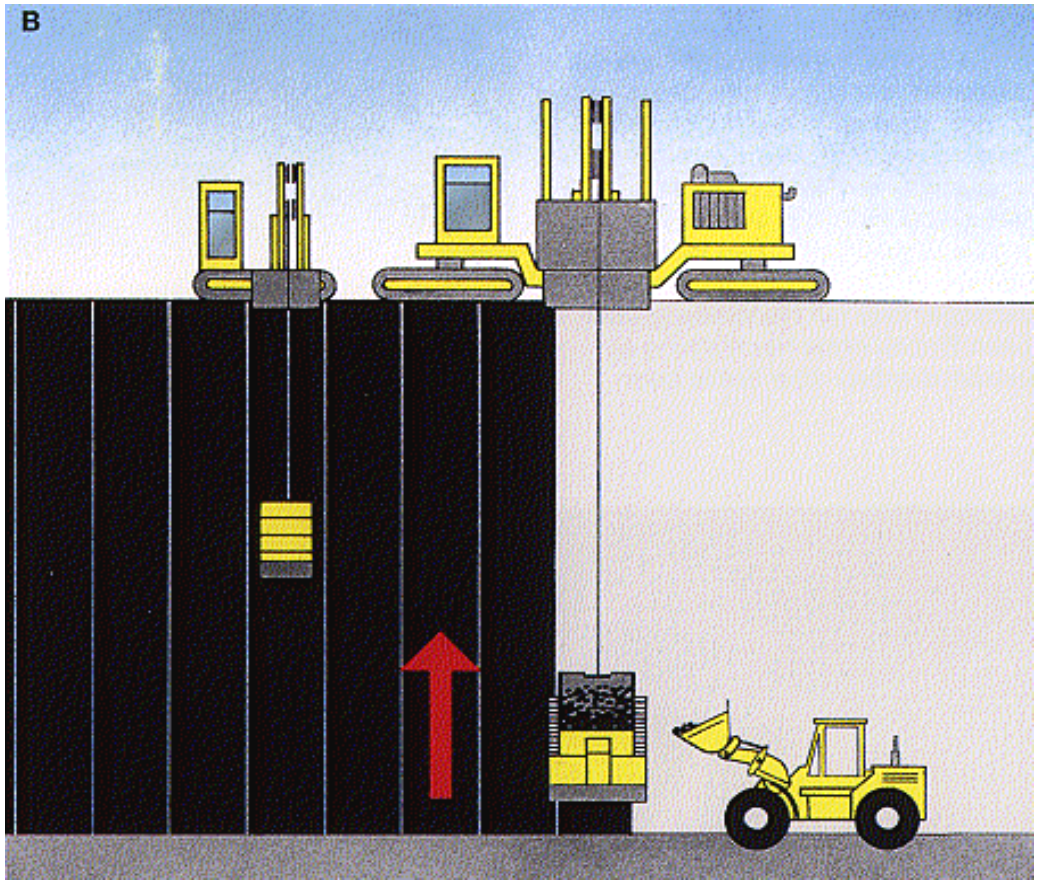

On smaller slopes the paver can be fed from the base.

Vertical Placement on Larger Slopes

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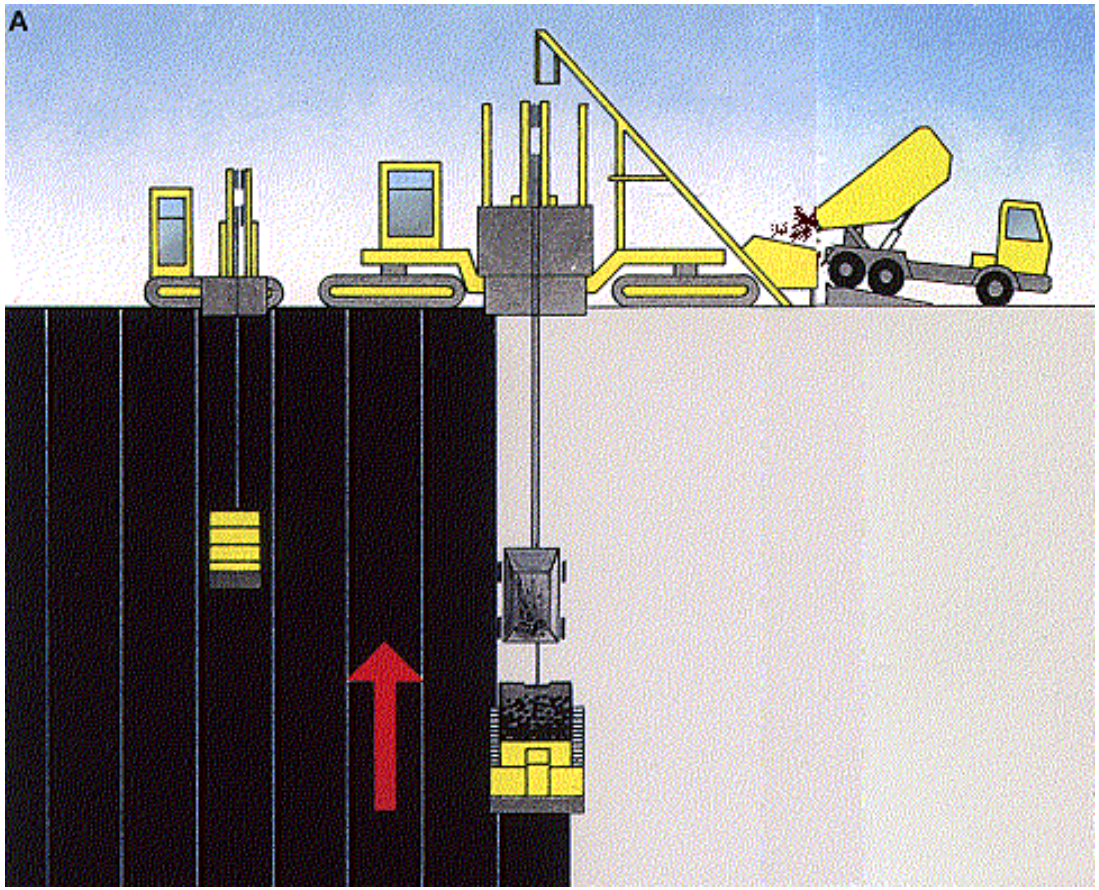

Longer slopes require re-loading part way up the slope.

Vertical Placement on Slopes

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Vertical Placement on Slopes

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Vertical Placement on Slopes

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Horizontal Placement on Slopes

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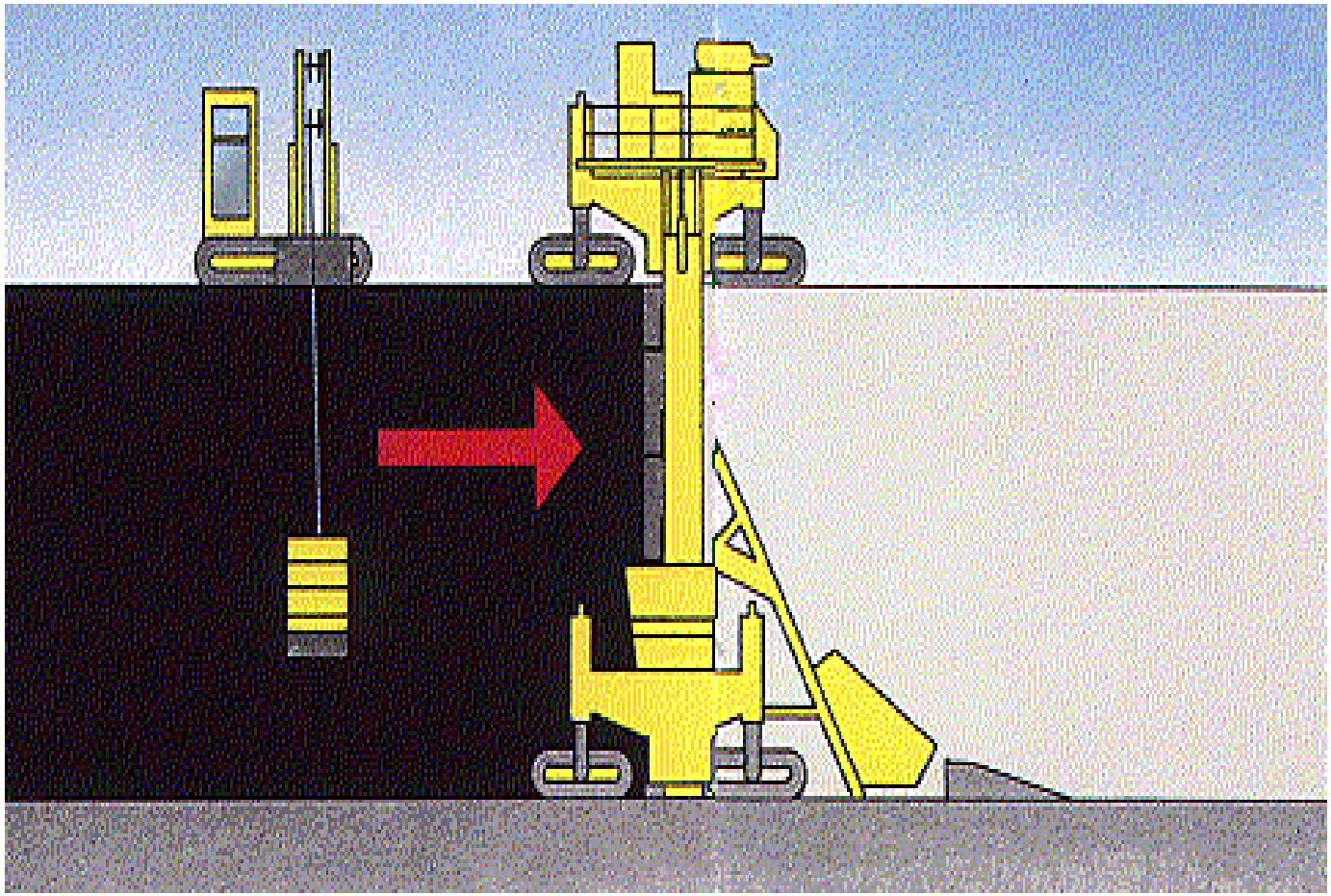

Horizontal paving fed from the top and top.

Horizontal Placement on Slopes

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Horizontal Placement on Slopes

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With the horizontal paving machine the number of joints needing treatment is significantly reduced.

Asphaltic Dam Cores

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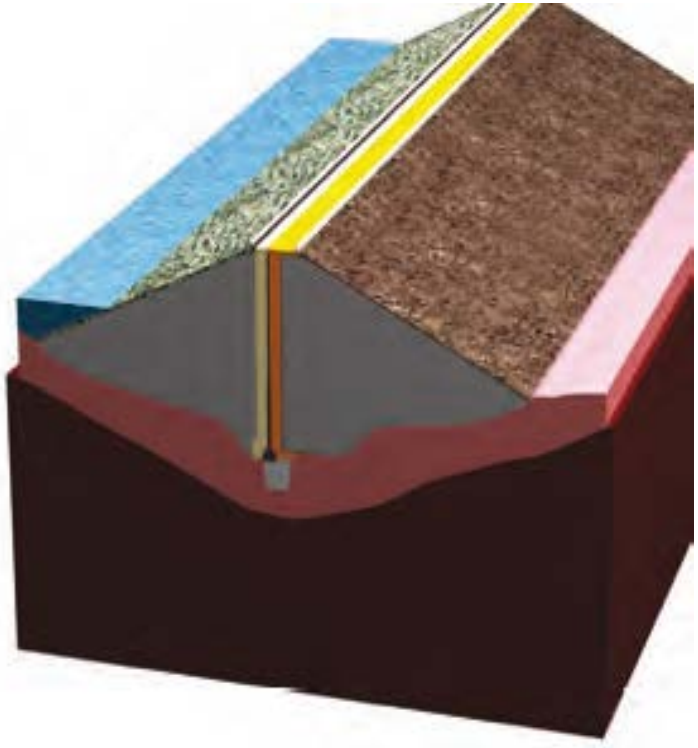

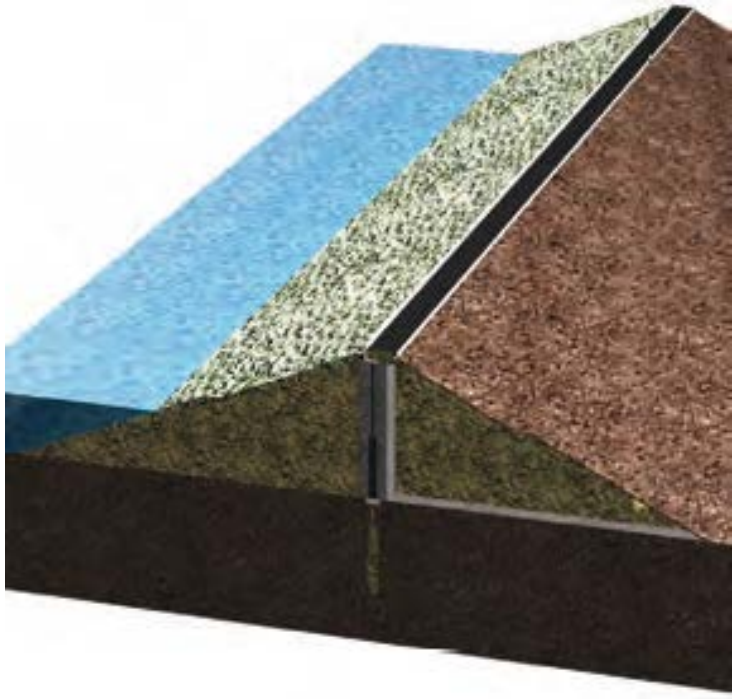

Asphaltic Dam Cores

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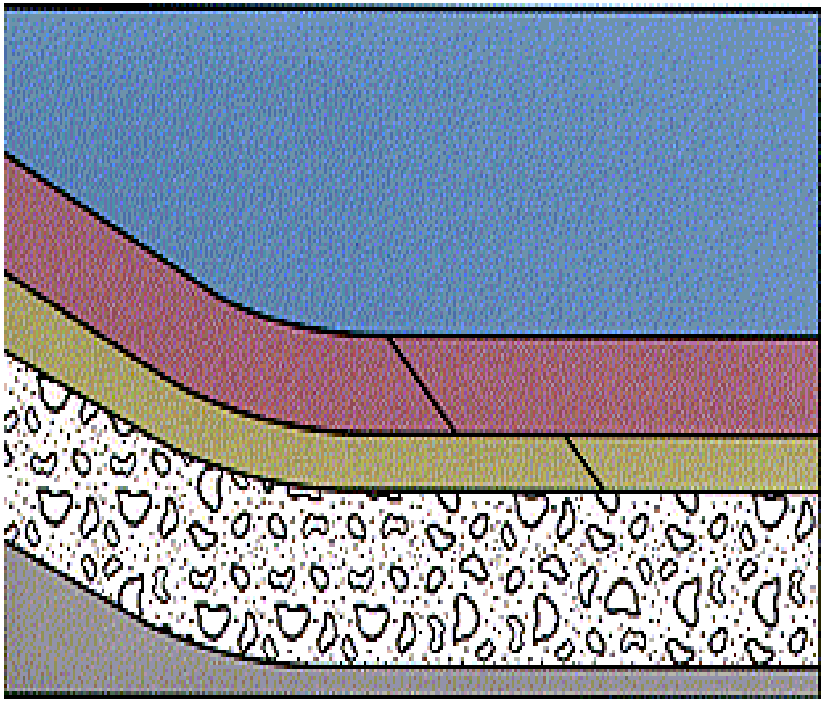
Joints



- All joints are chamfered at 45°.
- Cold or end of day joints are re-heated before laying new asphalt against them.
- Finally all joints are re-heated and re-compacted, then vacuum tested to ensure complete impermeability.
- Once completed the asphaltic membrane forms one complete homogeneous liner without any joints

Joints

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Joints Adjacent to Structures

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Rehabilitation Works to Asphaltic Lining Systems

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Rehabilitation Works to Asphaltic Lining Systems

WALO UK LIMITED

When you think things are difficult – think again……

WALO UK LIMITED

Danke – Merci – Grazie – Grazia – Thank you !

Many and Varied Uses of Asphalt

Any Questions Please?

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