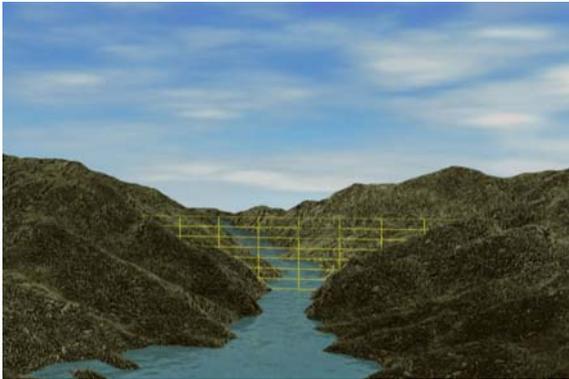


The Bakun Hydroelectric Project



Original Physiognomy of the Bakun HEP

The Bakun Hydroelectric Project is situated on the Balui River, Sarawak, Malaysia. The project comprises the construction of a 2,400MW hydroelectric dam, the transmission of its electricity, and the building of related infrastructure including access roads. It is the largest project in Malaysia, and known as “Three Gorges Project in Southeast Asia”. The project is planned to be completed in 2006.



Aerial view of the Bakun HEP

The powerhouse of Bakun HEP will accommodate eight turbine generator units, giving a total generating capacity of 240MW, which can meet the increasing demand for electricity. This project was first implemented the beginning of 1990 and was shelved in 1997 due to the Asian Economic Crisis. It was resurrected in the year 2000.



Bakun Dam

The Bakun Dam project includes: a 205-high-meter Concrete Face Rockfill Dam (CFRD) with a crest length of 740 m; width of crest and base of 12 m and 573 m, a concrete open chute spillway of 15000m³/second capacity, power intakes, eight power tunnels with a length of 700 meters and a diameter of 8.5 meters, power house and bottom outlets.

What are Penetron Waterstops?

- Penetron waterstops can effectively stop water and moisture penetration into concrete joints, and provide the best protection for concrete
 - Penebar PVC or Penebar SW 55 Expanding Waterstop
- Penebar PVC
 - Extruded from high grade thermoplastic PVC which has been formulated to give excellent flexibility and longevity characteristics.
 - Typical Detailing Profile 150mm, 200mm, 250mm
 - 0 profile Used in conjunction with split formwork, for both centrally and externally placed applications
 - V profile Fitted into split formwork or shuttering or casting centrally into the stop end; used for construction joints and movement joints, such as basement or retaining walls.
 - 0V profile Installation into the face of the concrete structures; used for construction joints on the waterside of the concrete wall or floor.
- Penebar SW55 Expanding Waterstop
 - A unique hydrophilic water-sealing product consisting of non-expansive co-extruded hydrophilic rubber that is capable of swelling and non-swelling physical properties.
 - Has a built-in delay system to avoid any pre expansion and must not show any signs of deterioration or disintegration during and after expansion.
 - features self-adhesive backing which makes installation easier and lowers construction time and costs.
 - Capable of water sealing up to 5 bar water-head and is used extensively throughout the construction industry to seal horizontal and vertical construction joints or poured in-situ concrete.
- ICS Penetron International Ltd is a ISO 9001 registered company.



Features & Advantages

- Penebar PVC

Sealing starts as soon as the concrete has hardened
Multi-Rib profile- barrier to water migration
Can be easily welded on site using welding blades and jig
Factory-made intersections to simplify and minimize on-site manipulation
Reinforced edge flanges for positive fixing and reducing the risk of damage
A range of types, profiles and sizes to suit different requirements are available

- Penebar SW 55

Built-in delay system to stop premature expansion

- Allows concrete to gain full strength before expansion
- No loss of waterstop integrity

Outstanding physical properties

- Does not turn to mush/lose integrity over time in water
- Bonds with both concrete surfaces
- Excellent adhesion to Penebar SW Primer
- Unaffected by repeated wet/dry cycles
- No compaction or displacement problems

Efficient application method

- Excellent for applications to rough concrete surfaces
- Can be embedded into wet concrete
- For use in horizontal / vertical joints
- Very easy to handle and install
- No need for special intersections, just simple butt joins
- No need for split forming required
- Can be joined with traditional PVC waterstop
- No site welding as is required with PVC materials

Non toxic and non hazardous

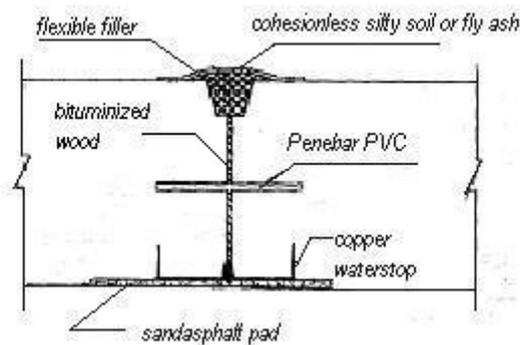
Proposal for Concrete Joints Sealing of the Bakun HEP

- Proposal for joints of the Bakun CFRD

- Perimetric joints

The concrete face-plinth joint is also called the perimetric joint.

The joint detail includes three separate waterproof barriers: a zone of cohesionless silty soil or fly ash above, Penebar PVC waterstops and a joint filler within the joint, copper waterstop and a sandasphalt pad underneath the joint.



- Horizontal joints

Horizontal joints include horizontal construction joints of concrete face slab and horizontal joints between concrete face slab and wave wall.

Horizontal construction joints of concrete face slab: no installation of joint sealing materials.

Horizontal joints between concrete face slab and wave wall: two separate waterproof barriers-copper waterstop + a joint filler.

- Vertical joints

A separate waterproof barrier: copper waterstop.

Two separate waterproof barriers-copper waterstop + a joint filler.

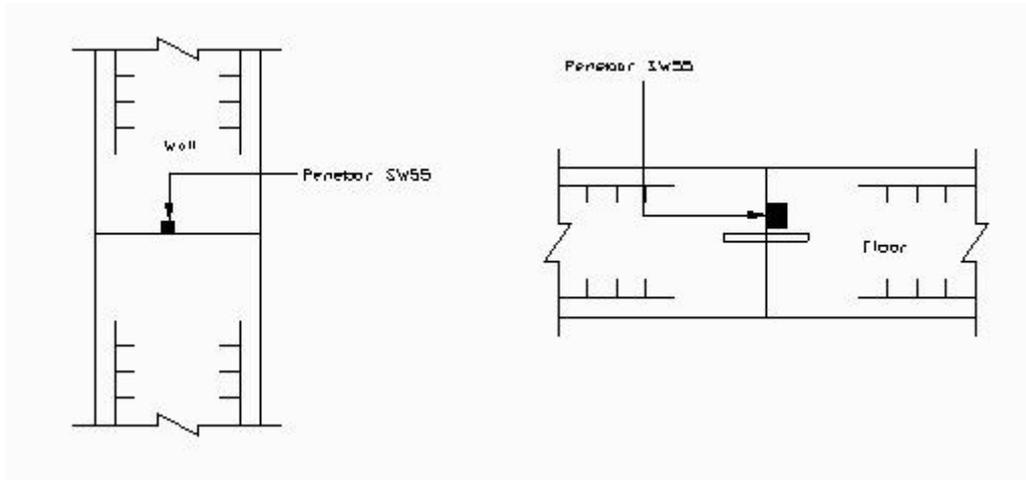
- Expansion and contraction joints of toe slab

A separate waterproof barrier: Penebar PVC.

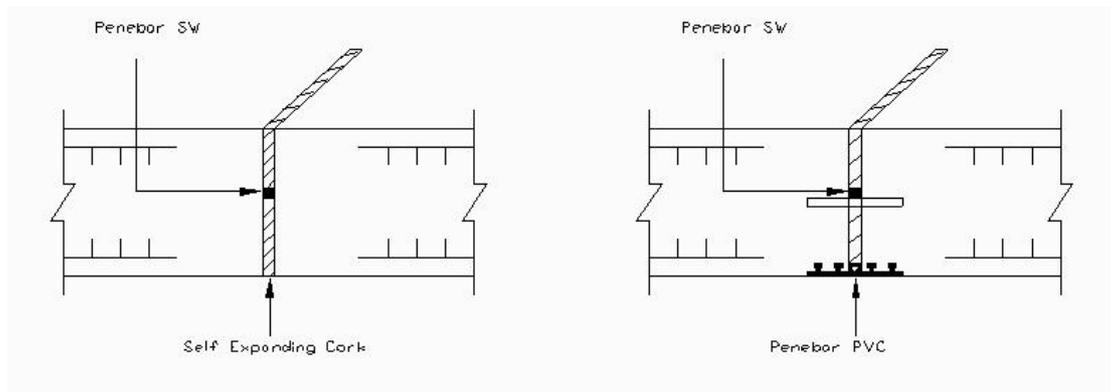
Penebar PVC together with the sealing materials of perimetric joints should form a closed system.

- Proposal for joints of auxiliary structure

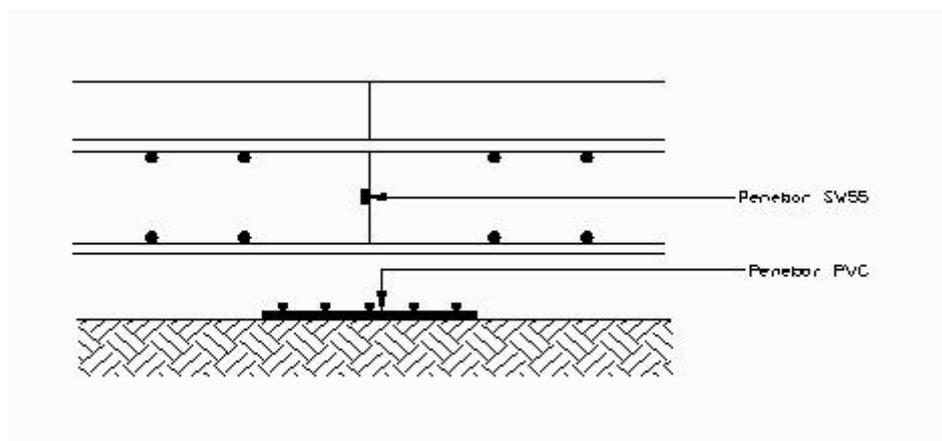
-- Construction joints

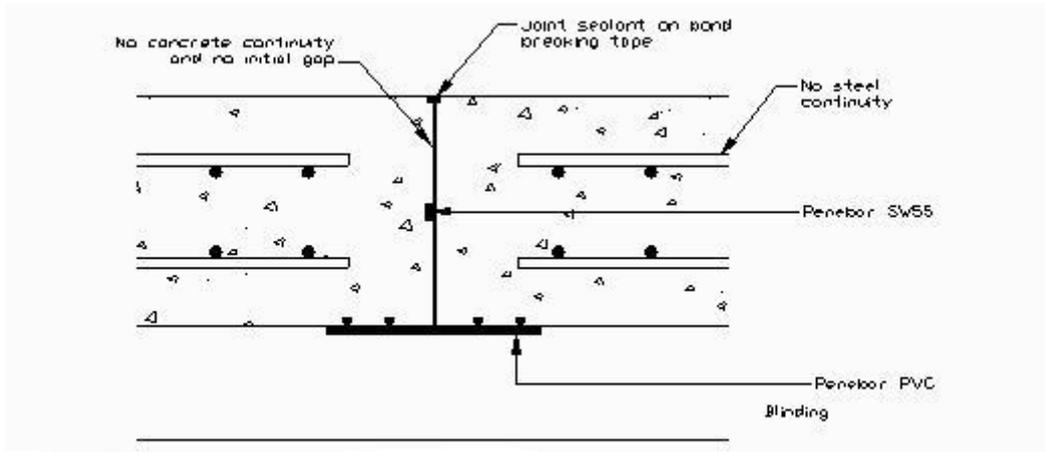


-- Expansion joints



-- Contraction joints





Installation of Penebar

- Installation of Penebar PVC

- Selecting the correct Penebar PVC

The width of watersealing depends on the thickness of the concrete and positioning of the reinforcement. The thickness of the concrete should be greater than or equal the width of the watersealing profile. For concrete thickness over 250mm, Penebar PVC 250mm wide profile should be used. If the concrete has a 400mm – 1000mm thickness, double protection is required. Consult our nearest technical department for further assistance.

- Installation Instructions

Placing is made in accordance with the engineer's drawing on which the Penebar PVC profile and the position required is marked. Level differences, bends, junctions, etc. should be carefully considered before placing. The use of factory produced junction pieces are encouraged so that on-site welding is reduced to butt joints only, thereby minimizing joint failure. Penebar PVC is placed continuously, thereby maintaining an integral sealing network.

Fixing to Reinforcement

Normally, approximately 3 fixing clips per meter are attached to the ends of the Penebar PVC. The fixing clips simplify the fixing of Penebar PVC to the reinforcing steel by means of tying wires and thus ensure Penebar is not displaced during concreting.

Fixing to Formwork

A 2-part (split) formwork may be used (preferred). In this case, allow half the Penebar to jut out while the other half is casted in. This Penebar is clamped between the formwork.

Fixing to Slab

Place Penebar flat on the lean concrete or base of the structure. The formwork for the stop ends will terminate in the middle of the Penebar, allowing one half of the Penebar PVC to be casted while the other half remains exposed to receive the next casting.

Notes:

When working with expansion joints where there is a central bulb (either centrally or externally placed), it is important that the bulb should not be casted into the concrete but remains exposed (free).

Penebar PVC performs its function only if both sides are well embedded in the concrete. The accumulation of coarse aggregate (honeycombs) should be avoided around Penebar PVC.

Placing fresh concrete near the Penebar PVC requires care, as it may be forced from its position by the pressure from the fresh concrete. This may cause the ends to fold up. To prevent this, the same concrete pressure must be present on both sides of Penebar PVC. The consistency of the concrete itself should be neither too plastic nor too stiff, and the aggregate must be well graded. Vibration should be executed with care.

Removal of formwork in the vicinity of Penebar PVC must be done with care.

The Penebar PVC end should be thoroughly checked for honeycombing on the stop end and repaired if necessary. It must also be cleaned of all hardened concrete remnants from the first concrete stage. The remaining procedure is similar to the first stage.

Penebar PVC is made from thermoplastic PVC and allows for easy on-site welding. However, it is recommended to use factory fabricated junctions such as T,L and Corner pieces. The ends are heated with a welding blade until the PVC ends are closely pressed together. The welded joint should be inspected once it has cooled.

Sources of Welding Errors:

- Irregularity of cut edges
- Insufficient or excessive heating of blade
- Dirt accumulation on blade including charred remains of PVC.

(Clean PVC from blade while it is still hot)

Junction pieces					
Material Requirement and Number and Type of Welding					
Type	Material	Welding Type	Type	Material	Welding
Cross-piece flat	1.2m + 2 w	2m- weldings	T-piece vertical	0.9m	1 butt-welding
Cross-piece Vertical	1.2m	2 butt-weldings	L-piece flat	0.6m + 2 w	1m-welding
T-piece lat	0.9m + 1.5 w	1m-welding	Corner-piece vertical	0.6m	1 butt-welding

Note: Free wing 30cm length all

- Installation of Penebar SW 55

- Surface Preparation

Carefully brush off any dust and debris and apply a coat of Penebar SW Primer to the dry concrete surface where the waterstop is to be placed.

- Installation

Apply Penebar SW-55 waterstop to prepared surface when primer is dry to the touch.

Using moderate hand pressure with the heel of the hand, press a continuous bead of Penebar SW-55 firmly into position. Check to be certain that the waterstop has bonded to the primer area properly.

Peel the protective backing from the exposed side of the Penebar SW-55. Butt join and knead the ends together to form a continuous uninterrupted gasket.

Place second pour of concrete around Penebar SW-55 waterstop making sure that the concrete is properly compacted and vibrated.

For vertical joints, apply a coat of primer to the concrete surface and to the Penebar SW-55 and allow to tack off before pressing into place.

Limitations

Not recommended for use in suspended slabs or expansion joints.

Minimum cover of 51mm of concrete over Penebar SW-55 and 102mm cover of concrete on un-reinforced concrete.

Expansion rate can vary in salt and contaminated water.

Increase cover when using lightweight, low strength concrete.

Not for use where excessive shrinkage may occur.