Application of EPDM Geomembrane Liners for Water and Environmental Containment

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INTRODUCTION

Increasingly conserving water in Malaysia is becoming the engineer's top priority and water loss through inappropriate choice of containment lining material requires an engineered lining solution that is cost effective and durable. There are many types of geomembrane liners manufactured from polymers with Ethylene Propylene Diene Monomer (EPDM) most effectively used for potable water containment by prevention of contamination from groundwater (algae resistance) and its suitability for all types of soil conditions and concrete structures. EPDM provides an engineered lining solution for most water containment applications with a design life of 30 years and can adapt to any containment shape.

EPDM lining is a highly flexible synthetic rubber waterproofing membrane developed by Firestone Building Products that offers a practical and cost effective engineering solution for water containment applications such as landscape ponds and lakes, irrigation pond and canals, aquaculture lining and water reservoirs. Since its introduction in Malaysia in 2005, EPDM lining has been implemented in landscape lakes, storm detention ponds and as secondary containment for leaking concrete structures. EPDM is a tough and durable material with defined engineering characteristics and if designed properly, can reduce construction cost significantly through its ease of installation and provides a long term engineering solution for water containment.

CHARACTERISTICS AND TEST METHODS

Physical properties such as elongation that is critical in lining because of poor substrate stability and puncture resistance (EPDM has high puncture values both for dynamic and static tests) are the basic requirements for geomembrane lining. EPDM geomembrane remains highly flexible even after continuous ultraviolet exposure during its service life. Compared with other geomembranes such as HDPE, PVC and PP; EPDM geomembrane has the highest resistance to UV and ozone radiation (no migration of plasticisers). The flexibility of EPDM lining is measured through its elongation ability of 300%. This property of EPDM enables irregular containment subgrades to be bridged. EPDM provides hydrostatic puncture strength during permanent elongation making it a material with unmatched leak bridging capabilities. For example, precast drainage culverts/canals with leaking joints may be lined with EPDM to bridge over settled joint locations and over cracked concrete containment structures due to differential settlement. EPDM lining is inert and elastic (low toxicity and no volatile organic compound) with low environmental impact and is compatible with aquatic life. Refer to Table 1 for main EPDM properties. Reference from the supplier must be made for EPDM exposure to oil based chemicals as this may cause swelling, softening (30 % loss in tensile strength) and surface deterioration of the EPDM.

EPDM Physical Properties	ASTM Test Results
Tensile Strength	8.0 N / mm^2
Elongation (heat aged)	300 %
UV and Ozone Resistance	Crack Free (ASTM)
Seam Peel Strength	1.8 N / mm^2
Tear / Shear Resistance	11.7 N / mm
Weight	1,150 kg / m^3

Table 1 : EPDM Engineering Characteristics. The Firestone EPDM membrane is produced in accordance with ASTM D 4637. This standard outlines the minimum requirements for the membrane and those values are therefore guaranteed

ENGINEERING APPLICATIONS

The most common problem encountered by design engineers for water containment is the varied subgrades when making the choice of lining material and ground water infiltration causing contamination of the valuable water resource. EPDM lining is particularly suitable for pervious subgrades and can be applied over any subgrade terrain encountered. Figures 1 and 2, shows FIRESTONE geomembrane used for landscape and storm detention lakes for local housing developers in Kuala Lumpur. Other applications for EPDM lining include waterproofing layer laid over concrete containment structures, irrigation / water transport canals, and aquaculture purposes.

Figure 1: Landscape lake application

Figure 2: Storm detention lake

DESIGN OF GEOMEMBRANE LINING

Design of the EPDM liners comprises the detailing and anchoring of the liners at the terminations (Refer to Figure 4 for typical liner termination details) and the provision of sub-soil venting for the build-up of gases at the layer between the liner and the subgrade. In most situations, the minimum tie-into the side

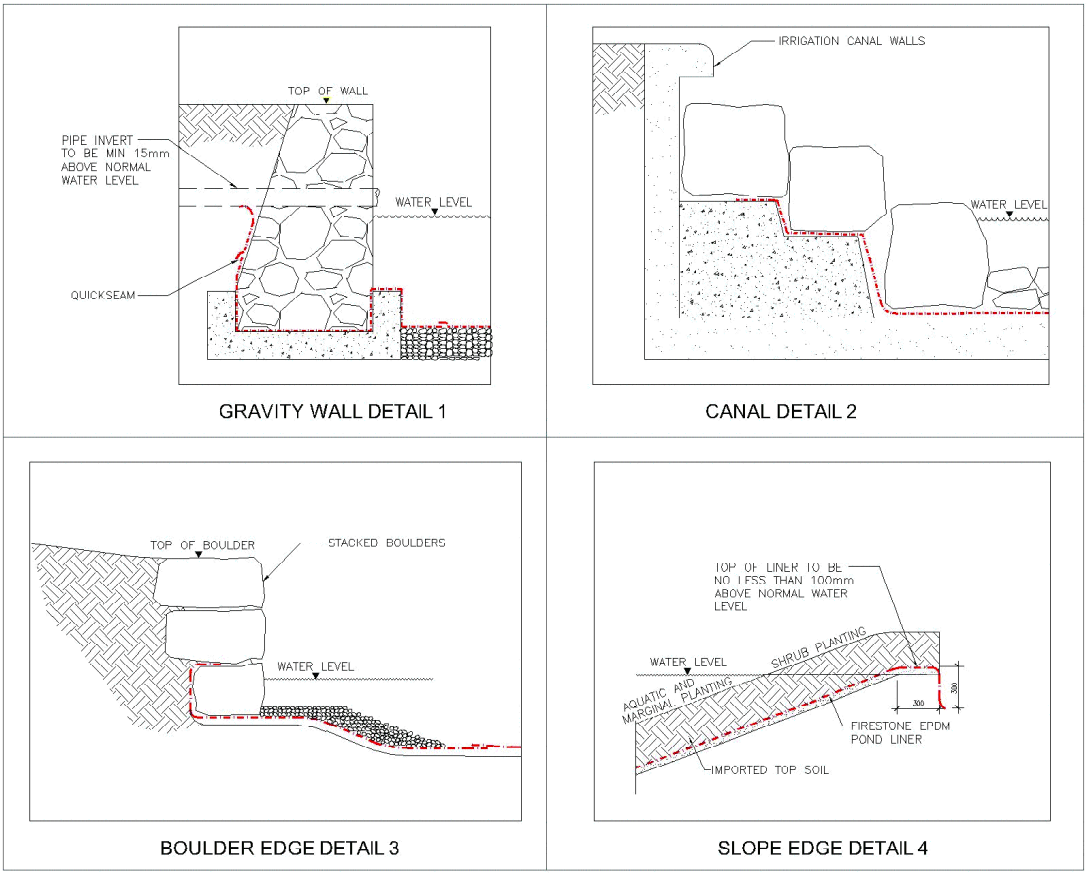

Figure 4: Typical liner clamping / termination details

soil slopes required is 1.0 m using an anchoring trench and at structural terminations, mechanical fasteners are designed. The provision of sub-soil gas piping is to eliminate the formation of liner base bulges/blisters due to trapped air inside the liner during installation and from subgrade natural gases. Alternatively, a layer of non-woven geotextile may be placed as an underlayer gas and drainage layer and to act as a cushion barrier for the geomembrane over hard surfaces.

Equally important in the design of liners is the determination of the soil stability at the base such as presence of cavities in sandy gravel soil layers causing geomembrane perforation. The variation of groundwater levels may affect the liner installation during construction causing internal erosion under the geomembrane.

Table 2: Lining slope guide

Soil Type	Side Slope
Clay soil	2.5 H / 1 V
Clay & sandy soil	2.3 H / 1 V
Sandy gravel	2.0 H / 1 V
Soft rock	1.5 H / 1 V

The base of the containment should ideally be sloped at 2 % for desilting/drainage and the slopes shall be inclined at the recommended values as shown in Table 2.

CONSTRUCTION METHODS AND SITE QUALITY ASSURANCE

Engaging an experienced EPDM geomembrane installer is important to ensure that unforeseen site conditions encountered are taken into account in the overall lining design and installation details of the liner adjusted to suit site conditions.

In most cases, compaction of the subgrade up to 85% MDD is sufficient with hard surface irregularities cushioned using non-woven geotextile before laying of the liners. The site laying of the geomembrane liners is fast; using large panel sizes of 12m (width) x 30m (long) to minimise site seams. Typically, EPDM geomembrane installations in Malaysia are at the rate of 600 sq.m., per day on prepared subgrade surfaces.

The proprietary EPDM geomembrane site cold seaming process is easily made by application of a splice tape over primer applied joints up to the width of 75mm. This method of seaming ensures no premature heat aging and the EPDM properties remains uniform after installation. Site EPDM geomembrane seams can be verified by taking site seam samples at the rate of one per 1,000 sq.m., and the integrity tested at RRI, Malaysia; for seam shear and peel strength. Unfinished liners during construction shall be protected at the ends for wind uplift during storm and to control internal erosion. Spot repair of the EPDM liners is made at areas with tears from sharp/falling objects such as rock and by abrasion. At pipe penetrations and structural termination areas, the liners are required to be secured using mechanical fasteners as shown in Figure 5.

CONCLUSIONS

Geomembrane EPDM liners are versatile by its ability to mould into the soil shape and can be applied for a wide variety of soil engineering problems and cost effective due to its fast installation, suitability for localised spot repairs at leakages and tears, without loss of flexibility, and robust cold seaming method. EPDM geomembrane lining is well suited as a long term engineering water containment solution in Malaysia to conserve our valuable water resources through experienced design and installation by trained contractors. ■

Figure 5: Liner termination at pipe penetrations