Use of Geosynthetics in Canal Lining

Annapoorni Iyer[1], **Shabana Khan**[2]

[1]Division Manager, Maccaferri Environmental Solutions Pvt Ltd.
Email: iyerwdc@maccaferri-india.com
[2]Senior Manager, Maccaferri Environmental Solutions Pvt Ltd.
Email: shabanawdc@maccaferri-india.com

ABSTRACT:

Canal irrigation in India is one of the principal methods used for improving the growth of crops. After, wells and tube wells, canal irrigation is the second largest source of irrigation especially in the plain areas of northern India, valleys of Indian peninsular plateaus, coastal lowlands etc. Understanding the importance of canal structures, its lining is equally important to achieve high efficiency in functioning aspects. Unlined canals always stand at the risk of loss of water due to seepage, side erosions and failures and further the canal getting obstructed type of issues and here comes the importance of lining of canals. With growth of technology various geosynthetic products in the form of drainage composite, Geomembrane etc are now being used due to its robust nature, durability, chemical resistance, light in weight and cost effectiveness. An interesting case study of Canal lining is being described in the paper to demonstrate the use of geosynthetic in lining applications.

Keywords:
Geosynthetic, Canal Lining, Landfill, Geomembrane, Drainage Composite.

Canal irrigation in India is one of the principal methods used for improving the growth of crops. After, wells and tube wells, canal irrigation is the second largest source of irrigation especially in the plain areas of northern India, valleys of Indian peninsular plateaus, coastal lowlands etc. Understanding the importance of canal structures its lining is equally important to achieve high efficiency of canal functioning. Unlined canals always stand at the risk of loss of water due to seepage, side erosions and failures and canal getting obstructed etc kind of issues and there comes the importance of lining of canals. Form the ages different conventional construction materials like tile, brick, concrete, soil layer are used for lining of canals. The major aspects considered for lining are durability, cost, effectiveness, ease of construction and water tightness. Earth/soil lining are more prone to vegetation growth and erosion. As rightly claimed**,** Cement Concrete Lining has been a time-tested solution for such problems While the Concrete lining has its own advantages it has a range of disadvantages as well considering the rigidity of solution, cost, time of construction and durability.

Over the years in it is found that conventional methods like earth lined or concrete lined canal face the problems of Seepage loss in subsurface soil and water logging in surrounding subsurface due to seepage loss, which increase the ground water table and leads to flooding in surrounding areas in rainy season.

With the advent of technology came the terminology Geosynthetics which became a simple replaceable solution to various problems faced in the field of Civil Engineering and canal lining is one amongst them. Geosynthetics is the collective term applied to thin, flexible, sheets of polymeric material incorporated in or within soil to enhance its engineering performance. To define a few Geosynthetics products that are being adopted as conventional solution to various problem related to hydraulics and geotechnical engineering to be precise are as follows::

A. **Geomembrane:** Geomembrane are relatively impermeable sheets of plastic, used as an impermeable layer to check the liquid movement in different civil engineering structures such as landfills, canal lining, pond lining, cut-off trenches etc.
B. **Geotextile:** Geotextile is a permeable planner material made from synthetic fibers/yarns. They generally provide the protection to geomembrane against puncture from subgrade aggregates.
C. **Geonet (Drainage Net):** Geonet are High density polyethylene products consisting of a regular dense network, whose constituents' elements are linked by knots of extrusions and whose openings are much larger than the constituent.
D. **Drainage Composites:** Drainage Composite (also known as Geo-composite) is a composite material made from different Geosynthetics products to serve their functions simultaneously. Geocomposite which is being used in canal lining is comprises of impermeable membrane, drainage net and filter Geotextile which together form a drainage layer with added waterproofing function.

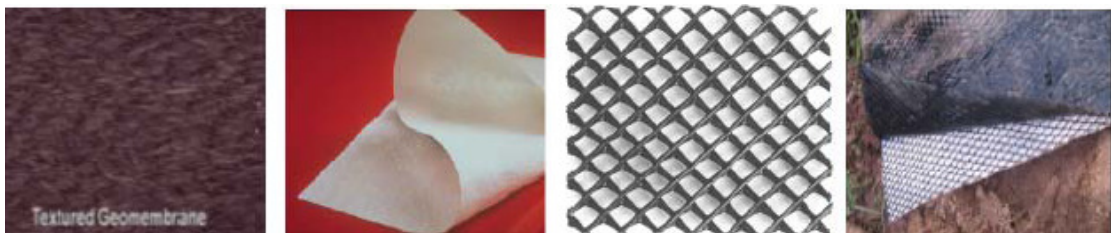

Fig 1: **Geosynthetic Products(From left)** A. Geomembrane B. Geotextile C. Geonet D. Drainage Composite

Combination of various Geosynthetics materials in the form of geotextile, geogrids, geomembrane, and geonets are used in lining of canals to perform the function of drainage, impermeability, filtration etc. They help in minimizing the seepage losses, mitigate pore water pressure being built up beneath lining and reduce water logging related problems.

"Drainage composites" is a subset within the family of geosynthetic materials. They are used as composite component in hydraulics and to containment applications, as well as in environmental, geotechnical, and transportation applications. The main object of drainage composites materials, is to combine the best features of different materials in such a way that specific problems are solved in optimal manner providing optimum performance and minimum cost. Drainage composites consist of various combinations of Geotextile, Geogrids, Geonets, Geomembrane and/or other materials. The properties of each system are dependent on the components chosen and their interactions. Such high performing drainage composites may be used for any of the basic functions of Geosynthetic, i.e. separation, reinforcement, filtration, drainage, and liquid/vapor containment.

Drainage composites (Figure 1) are prefabricated subsurface drainage products which directly replace the granular drainage layer. They normally consist of a polymer plastic sheet core covered by a Geotextile acting as a filter and separator on one or both sides. This allows water to pass through into the polymer core but prevent the soil to washing through. The rigid polymer core may be nubbed, columned or dimpled. These Drainage composites make an excellent drain on the backfilled side of retaining walls, road drains, basement walls, and plaza decks. The different types are Edge drain, Wick drain, sheet drains.

MAIN FUNCTION OF DRAINAGE COMPOSITE IN DIFFERENT APPLICATIONS:

The main function of drainage composite is drainage, filtration, separation and protection.

Drainage: Water passes into the 3-D core structure, and flows along its plane. By draining excess pore water from the adjacent soil mass, stability of the structure and the soil is improved and maintained. Lateral ground pressure on the structure is also reduced.

Filtration: The Geotextile allows water to pass into the core, while preventing the passage of fine soil particles through it. The Geotextile has a specific pore size range designed to cater for a broad spectrum of soil types.

Separation: Drainage composites also serve to separate the structure from the backfill material, offering protection and keeping dampness at bay.

Protection for Waterproofing: Drainage composites shall protect the waterproofing system from mechanical damage and at the same time shall drain off the water away from the structure.

MAIN COMPONENT OF DRAINAGE COMPOSITE:

1. One or two non-woven Geotextile layers OR Geomembrane on one side and Geotextile on another side
2. High discharge capacity core thickness of 5-25mm
3. Discharge capacity in-plane 0.0002 to 0.01 m3/m width/sec

DRAINAGE COMPOSITE MATERIAL SELECTION CRITERIA:

Drainage Composite material shall pass water while retaining soil without clogging. One side of this composite material shall be impermeable and the material shall be resistant to chemical attack and rot. The properties of Drainage Composite drains as given in Table 1 shall be determined as per ASTM test procedure/ or any other international standard methods.
Long term compressive stress and eccentric loadings on the core of a Drainage Composite should be considered during design and selection. Though not yet addressed in standardized test methods or standards of practice, the following criteria (Berg, 1993) are suggested for addressing core compression. The design pressure on a Drainage Composite core should be limited to either:

a. The maximum pressure sustained by the core in a test of 10,000 hour duration or

b. The crushing pressure of a core, as defined with a quick loading test, divided by a safety factor of 5.

   Intrusion of Geotextile into the core and long term outflow capacity shall be measured with a sustain transmissivity test. The ASTM D 4716 test procedure, shall be followed.

Table 1. Drainage Composite properties

Properties	Test procedure
Fabric properties	
Tensile Strength, either direction,	**ASTM D 4632**
Elongation, either direction (%)	**ASTM D 4632**
Puncture Resistance	**ASTM D 4833**
[1] Apparent Opening Size	**ASTM D 4751**
Core Properties:	
Compressive Strength	**ASTM D 1621**
Flow Rate	**ASTM D 4716**

[1] *Apparent Opening Size (AOS) requirement may be adjusted by the Engineer when less than 50 % of the soil particles by weight passes US No. 200 Sieve or when permeability (ASTM D 4491) of the Geotextile is equal to or less than permeability of the soil.*

CASE REFERNCE –CANAL LINING AT HARYANA

Herewith a case study is presented that was executed in Haryana. There was a high level of pore water pressure being expected to act on the existing concrete canal lining for a length of 30 Km out of the total 65 Km length of the canal. The client, Haryana Irrigation Department was looking for alternative which was technically better and cost effective to overcome the anticipated problem.

Due to striking technical features of drainage composite it was decided to place it beneath the concrete lining. By ensuring consistent quality and proper drainage function the proposed Geocomposites takes out lot of uncertainties of conventional solution and hence the concrete lining thickness could be reduced to minimum stipulated in codes i.e 3 to 4 inches.

Fig 2: Typical Sectional details of Geosynthetics in Canal Lining

CONCLUSION:

Better filtration capability, dissipation of pore water pressure and thereby increasing the life and functional efficiency of canal are some of the striking features of adopting Drainage composite for canal lining. This may or may not be accompanied with cement concrete lining that varies as per the site conditions and requirement. With the growing importance of canal irrigation, the drainage composite is definite to find a strong place in a country like India which is agriculturally developed and stand second in farm output.

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