Use of Geogrid as Seepage Barrier in Earthen Dam

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Abstract **-** Dam is a solid barrier constructed to store flowing water at a suitable location across a river valley. Clay, sand and gravel are used to built the earth dam and hence also called as earth fill dam or rock fill dam. To avoid loss of water by percolation Geotextile are used as a membrane in a raw water reservoir. In a 1970,using Geosynthetic material the first large earthen dam was built in a France. There are various failures in a earthen dam like hydraulic, seepage and structural failure. In this paper we mainly focused on seepage failure of earthen dam. Geotextile help to improve the long term performance of dam.

Index Terms *– Earthen Dam, , Geosynthetic, Geotextile , Permeability of soil , seepage failure.*

I. INTRODUCTION

A. General:-

Earthen dam serves community in many ways, such as flood control use as recreation site, water supply, and irrigation. earth dam are cost effective, straight forward construction. Because the necessary body material may be found directly on the site. Due to this reason earth dam become popular and widely constructed throughout the global. Earthen dams are also called as earth fill dam, rolled earth dam or simply earth dams are constructed as a simple embankment of compacted earth a rolled earth dam is constructed of a one type of material but contain a drain layer to collect seepage water. Most of earthen dam exhibit some seepage. This seepage occurs through earthen embankment and through its foundation. Increasing seepage can erode fine material from the downstream slope and foundation. Due to increase seepage, weakening the adhesive properties of the soil and stability, which weak the structure and serve pathway for seepage. Seepage failures account for 40% of a all embankments or dyke failures. Seepage can also cause slope failure by saturating the slope material, there by weakening the adhesive properties.

Geosynthetic consist of variety of products grouped under Geotextile, geogrid, geomembrane, geocomposites, that use for various industrial and infrastructure project. Geosynthetic use as filter material for drainage purpose. The use of Geotextile in embankment dams is a common practice worldwide. The vast majority of these uses are in shallow-burial applications such as a separator/filter Underneath erosion control materials such as riprap, as filters in toe drains, and as protective cushions/drainage layers placed against waterproofing geomembrane.

A Geosynthetic having low permeability use as effective barrier for water migration. Migration from one area to other that is from upstream face of dam. One of the beneficial use of Geosynthetic is erosion control . it provide stabilization to surface of soil particle migration and mass moment due to water flow.

B. Function of Geosynthetic

- Filtration of soil particle structure.
- Embankment soil.
- Separation of dissimilar materials.
- Upstream face drainage.
- As an reinforcement.
- As an protection cover.
- Surface stabilization.

C. Objectives:

- Promote the low failure of dam.
- Reduce the cause of failure.
- To increase the life of earthen dam.
- To decrease the permeability of upstream side of dam.
- To reduce the capillary action of upstream side of dam.
- To control flow of pore water.

D. Scope of study:

- Geosynthetic used as protective covering for up-stream side of dam.
- Erosion control at sloping side.
- Reduce permeability
- Increase life span of the dam.
- Improving stability of structure.

II. METHODOLOGY

Different data was required to establish the cause of failure of seepage. The information needed included:

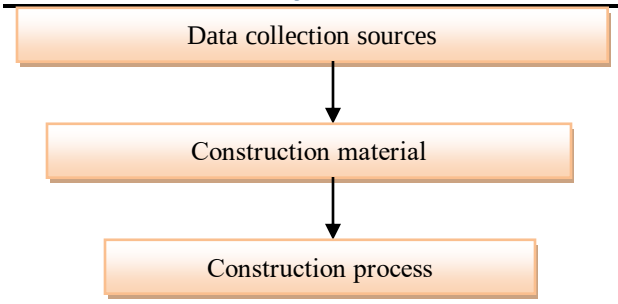

Fig. 1 - Methodology

A. Data collection sources

The methods used include:

1. Interviews:-
   Face to face interviews were conducted. The interviews were done to collect data on the Dam construction information and the how the condition of the dam has been since it was constructed. The dam site officer was interviewed to get detailed information concerning how construction was done. To ensure a balanced view point, interviews were carried out with their side living in the vicinity of the dam to obtain further information concerning construction. The resident also provided the condition of the dam since it was constructed.
2. Literature review
3. Direct observation

B. Construction material:

1. Selection of material:

- Soil: It is main component for construction of dam. We will use the soil sample passing from 2.36mm sieve.
- Gravel: We will use the Course aggregate which passing through 12.5mm IS Sieve and retained on 10mm IS sieve.
- Clay: We will use clay for preparation of core part of the dam.
- Geosynthetic:
  Geotextile are porous fabrics made of a synthetic fiber. They are typically manufactured and delivered in rolls. Adjacent grid are commonly overlapped, though they are occasionally sewn together. Geotextile are predominantly manufactured from polyester and polypropylene; other materials that are used include nylon, polyethylene, polyvinyl chloride and fiberglass. Two major types of geo textiles are commonly manufacturing depending on the method used to bond the individual filaments to form fabric:

i. Woven fabrics with heat-bonded or mechanically bonded fibers; and

ii. Non-woven fabrics with staple or continuous filaments that are needle punched, heat bonded, resin-bonded, or bonded with a combination of these methods.

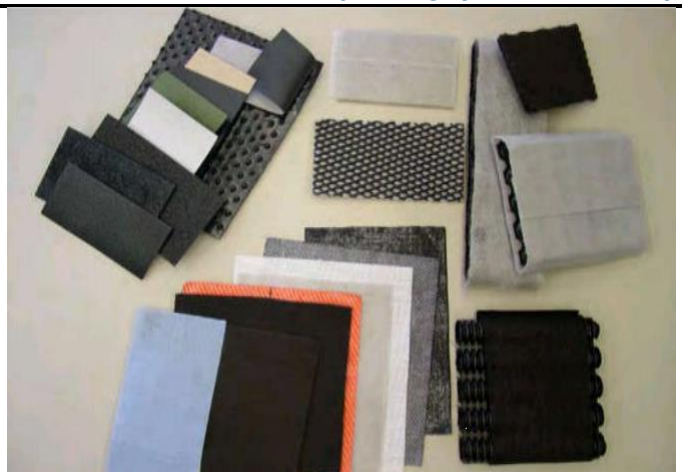

Fig. 2 – Types of Geosynthetic

C. Construction process

1. General Layout:

Model of Earthen Dam: These dams are constructed with uniform and homogeneous materials. Earthen dams are normally constructed with soil and grit mixed in proper ratios. The seepage actions of these dams are not favorable, therefore, for safety purpose in case of rapid drawdown, the upstream slope is usually kept relatively flat (3:1). Homogeneous section is modified if we construct rock toe at the downstream lower end and providing horizontal filter drain. Geomembrane are low-permeability water barriers.

They are commonly manufactured and delivered in rolls and seamed on site.

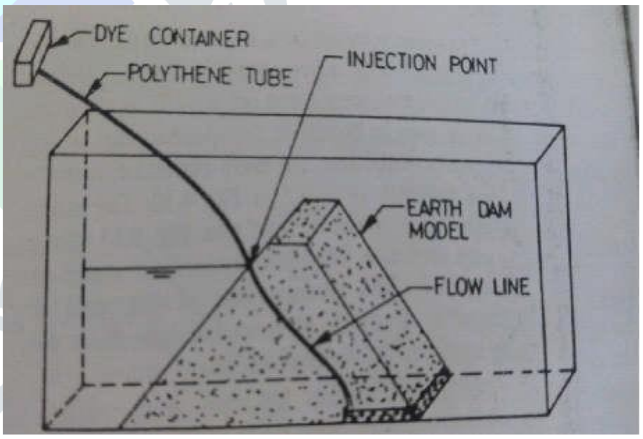

Fig. 3 – General layout of model.

III. CASE STUDY

Dam selected for case study: Wadaj dam

Location : Wadaj , Tal-Junnar, Dist-Pune

Case histories in geotechnical engineering provide a number of useful purposes, one of which is to provide real data against which designers can test their predictions of behavior. There is so many evidence to indicate that, despite the many advances made in geotechnical engineering and engineering science in the past the designer's ability to predict the behavior of designed structures accurately has not increased.

TABLE I

Salient Features of Dam

Sr no	Attributes	Value
1	Name of dam	Wadaj dam
2	River	Meena
3	Nearest city	Junnar
4	district	Pune
5	state	Maharashtra
6	Purpose of dam	Irrigation
7	Year of completion	1983
8	Type of dam	Earthen dam
9	Length of dam(m)	1935
10	Maximum height above foundation(m)	28
11	Total volume content of dam(TMC)	1009
12	Design flood(cumecs)	1426
13	Type of spillway	Ogee

Fig 4. Information board on dam site.

Fig 5.Water Level

IV.TEST CONDUCTED

Soil sample for test = soil collected from Wadaj dam.

A. Determination of water content (oven dry method)–

TABLE II

TYPICAL VALUE OF WATER CONTENT

Sr.No	Soil Type	Max. quantity used
1.	Sandy soil	5 to 10 %
2.	Loam soil	10 to 15 %
3.	Clay soil	15 to 20 %

- Definition –
  Moisture content is the amount of water contained in a material, such as soil.
- Aim – To determine the water content in the soil sample.
- Formula:-
  W = Ww/Ws
  Where,
  W= Water content.
  Ww = Weight of water.
  Ws = Weight of soil sample.

TABLE III

OBSERVATION TABLE

Con.No	Empty weight of container(w_1)	Empty weight of container +wt. of soil(w_2)	Empty weight of container +Dry soil(w_3)
1.	0.046	0.454	0.384
2.	0.050	0.610	0.528
3.	0.042	0.550	0.466

- Calculation :
  $W = Ww/Ws = (W_2 – W_3) / (W_3 – W_1)$
- Result:- Water content (W) of soil is = 19.22%

B. Permeability test-

TABLE IV

TYPICAL VALUE OF PERMEABILITY

Sr.No	Soil type	Permeability Coefficient	Relative permeability
1.	Coarse gravel	Exceeds 10^{-1}	High
2.	Sand .clean	10^{-1} to 10^{-3}	Medium
3.	Sand , dirty	10^{-3} to 10^{-4}	Low
4.	Silt	10^{-4} to 10^{-7}	Very low
5.	Clay	Less than 10^{-7}	Impervious

- Definition -
  It is the property of porous material which permits the passage or seepage of water through its interconnecting voids.
- Laboratory methods of permeability determination –
- There are two methods : -
  1. Constant head method.
  2. Falling/variable head method.

1. By using falling head method -

Falling head method (without using geogrid) :-

- Aim – To determine coefficient of permeability (K).
- Formula :
  $K = (2.3aL/At) \log10 (h_1/h_2)$

Where,

a = Area of stand pipe =0.942cm^2

A = c/s area of soil sample in cm^2=75.58.

h_1 = Initial head=70cm

h_2= Final head=57cm

L = Length of sample=24.24cm

t = time interval =300sec.

Hence, Coefficient of permeability of falling head test is $1.72x10^{-4}$cm/sec.

- Falling head method (with using geogrid) :-
  h_1 = 75cm
  h2 = 60cm

Hence, Coefficient of permeability of falling head test is $2.25x10^{-4}$cm/sec.

Result:

TABLE V

Sr. No.	Type of soil	Coefficient of Permeability
1.	Without using geogrid.	1.72×10^{-4} cm/sec
2.	With using geogrid.	2.25×10^{-4}cm/sec

Hence coefficient of permeability reduces with using geogrid.

V. Conclusion

In India due to increase in urbanization, water demand also increase. As our nation is agro based water demand for irrigation also increase. To fulfill all requirements related to water it is necessary to conserve it. For conservation of water in a dam structure, it must be reduce quantity of seep water. Geo-grid has less permeability; therefore it is use at upstream side of dam. In this we can conclude that in future it will increase storage capacity as well as stability of dam structure.

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