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RESEARCH ARTICLE OPEN ACCESS

A Review on Lining Material for Artificial Lake

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ABSTRACT
This article is a review on diffèrent types of lining material. Lining material is important where the infiltration rate of soil is more than 10mm. The paper presents easily adjustable various types of lining materials like clay, soil cement, concrete, chemicals like bentonite, Sodium bicarbonate, polymers like HDPE, LDPE, Silpoulin, LLDPE etc. Contrast to soil cement mixture with 10% cement content HDPE liner confirm to be uniformly effective and cheaper, when lined at the bottom and sides. Rate of percolation was 1.2cm/ 30days, whereas soil cement recorded 0.54 cm/hr. Sand and cement in 10:1 ratio with 5cm thick lining showed depletion in seepage to 93.81% compared to polyethylene, clay and chicken litter. 5% of mixing percentage of Sodium Bentonite with sand has showed 100% efficiency. Clay lining is the economical as compared to plastic membrane, biocrete and concrete lining. The literature review done on the topic in correlations with the farm lake site has used to select suitable material for lining. Various tests are conducted on material in view to study its compaction and permeability properties.

Keywords **-** Infiltration, Lining Material, membrane, Compaction, Permeability.

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I. INTRODUCTION

Global warming is evidencing the present rainfall scenarios like extreme dry Spell or heavy showers for short duration, means though the annual rainfall is normal water will not be sufficient for unirrigated provides subsistence to Indian farmer which is inadequate and uncertain. The rate of infiltration of rain water depends on the consistency and structure of the soil. Though the percolated water will be rejuvenate ground water storage it cannot be allowed as it takes more time where immediate irrigation requirements are to be met. Therefore, on farm water conservation and storage practices at low cost are to be adopted depending on the local climatic conditions. Arid and semi-arid regions are hardly secured to kharif crop production due to protract dry spells in kharif season

The Factual study can be used for designing the conservation practices. Runoff water can be conserved through institute and existing techniques. Heavy rains for short duration create runoff such water can be collected in a pond and used during the prolonged dry spells of kharif season and for rabbi cultivation. Various studied revealed that the water stored in a farm pond without lining evidence of seepage losses and also salinity, water logging, turbidity etc.which ultimately decreases the fertility of the adjacent agriculture, lands. Farm lake lining is a process of installing an impervious material in a pond to reduce the permeability of the soil from insignificant or to at least to tolerable limit. The size and depth of farm lake depends on various factors like as soil type, available land, farmer's requirement, possible use of excavated land and probable runoff of the region. Table 1 and 2 showing the infiltration rate and seepage loss through different types of soils respectively.

1.1 LINING MATERIAL

This article is a review on different types of lining material. Lining material is important where the infiltration rate of soil is more than 10mm. The paper presents easily adjustable various types of lining materials like clay, soil cement, concrete, chemicals like bentonite, Sodium bicarbonate, polymers like HDPE, LDPE, Silpoulin, LLDPE etc. and their major site-specific annotations. In a study made by CRIDA, on evaluation of Various lining materials at Bangalore, the total water loss per day was maximum with soil + cement (8:1) lining while the loss per unit volume was higher with stone powder + cement (8:1) lining (54.3 lit/m3) followed by stone slab (45.5 lit/m3) and the loss per unit volume is minimum in brick lining (20.1 lit/m)

1.2 EFFECT OF LINING MATERIALS

Clay lining: Excessive seepage in alfisols and luvisols or lixisols can be abridged through clay lining where as in vertisols soil compaction can

reduce seepage losses. Accumulate area should be compacted proportionately for two to three times and well graded material containing at least 20% clay can be applied evenly as liner studies conducted in various regions are shown in table 4. Clay lining is the economical as compared to plastic membrane, bioCrete and concrete lining. Thickness of the blanket varies from 10 to 30cm depending on the depth of water accumulate and type of soil.

1.3 SOIL CEMENT

Is a highly compacted concoction of natural soil/ aggregate and Portland cement, the soil material can be in any combination of sand, silt, clay and gravel which is readily available. Soil cement is a concoction of Portland cement and natural soil. For best results the soil should be graded with a maximum size of 3/4th inch and contains 10 to 35% fines passing the No. 200 sieve (Bureau of reclamation). Rate of application and ratio of soil cement should determine based on laboratory test and field situations. Depending on the depth of water stored, thickness of the lining material is firm as 4" for water depth up to 8 feet and 6" for water depth up to 12 feet (NRCSCPS, 740-1).On an average 93.5% seepage is reduced with 4.9 l/m^2/day. Though the seepage losses from the lined pond are increasing perennially it can be adapted where the budget is a constraint.

1.4 POLYMER LINING

Water-resistant lining material for lake are polyethylene, butyl rubber and asphalt sealed liners are widely accepted in a thin film form but if not broken or punctured. Thickness of plastic films are between 3-20 mils. Before lying a plastic film, pond area should be cleared with gravel more than 6 inch to protect it against puncture.

Table.1 Seepage losses and percolation losses in different soils

Type of soil	Water loss through seepage (cumec/million m 2 of wetted area)	Drop in depth per day (cm)
Heavy clay loam	1.21	10.36
Medium clay loam	1.96	16.84
Sandy clay loam	2.86	24.61
Sandy loam	5.12	44.03
Loose sandy soil	6.03	51.80
Porous gravelly soil	10.54	90.65

Table.2 Infiltration rates of different types of soil

Soil Type	Infiltration rate (cm/hr)
Clay	0.5
Clay loam	0.8
Silty loam	1.0
Fine sandy loam	1.2
Fine sand	1.2-2.0
Coarse sand	2.0-2.5

II. LITERATURE REVIEW

Sr. no	Source	Observation	location	Material
1	Shehzad et al., (2017)	5% of mixing percentage of Sodium Bentonite with sand has showed 100% efficiency under laboratory condition and 92% to 96% efficiency under site condition.	CEWRE, Lahore, Pakistan	Sodium Bentonite
2	Kadu et al., (2017)	Amalgamation of concrete over HDPE sheet shown 100% seepage control compared to 70 % of seepage control by concrete lining.	Neera devdhar project, India	HDPE+ Concrete
3	Wallace and Bailey (2015)	Seepage losses deceases by 93.81% through Biocrete whereas clay and polyethylene lining showed depletion of 56.73% and 76.37% respectively.	Bangladesh (delta plain)	Biocrete

4	Samuel et al., (2013)	Contrast with annual seepage of 255.15m3 /annum, lined canal showed 100% sealing.	North east hilly region of India	Silpaulin
5	Mohan et al., (2013)	compared to unlined pond. Which resulted in widening in crop production as irrigation Seepage losses are decreases considerably frequency is increased through plastic lined lake than unlined lake.	Erumapatti block Namakkal district, Tamil Nadu	HDPE (GSM UV sheet Irradiated Plastic)
6	Jat et al., (2011)	Seepage rate to 62% decreases with 1.08 cm/m2/day with 100% CaCO3 lining and seepage rate expand with the decrease in the CaCO3 lining percentage with 60cm and 30cm as 1.35 and 1.75 cm/m2 /day respectively.	Bilwara, Rajasthan	Clcarious soil lining
7	Deopur and Chahar (2010)	0.6mm novel sheet developed by IIT, Delhi is UV resistant, thin, made to control the limitations of HDPE and PVC lining presently being used.	E IIT, Delhi.	Geomembran e
8	Dhanapal et al., (2010)	8:1 proportion of soil and sand with 5cm thickness take down minimum seepage of 4.9 l/m2 /day, contrast to the seepage from brick and cement lining (Kadapa slab) of 137 l/m2 /day).	Alfisols in dry lands of Karnataka	Soil Cement (Small Pond) Kadapa Slab (Big Pond)
9	Mishra et al., (2009)	Evaluated that only brick lined lake with cement plaster could control seepage and resist well for years whereas plastic, asphalt, soil cement etc. proved to be ineffective in the fourth year of lining.	Hyderabad	Concrete
10	Samuel and Mathew et al., (2008)	Cost sustain for the lining material is less compared to concrete masonry, brick masonry, Ferro cement and fibre glass.	Kasaragod (Dist.) Kerala	Silpaulin
11	Mathew et al., (2008)	Contrast to soil cement mixture with 10% cement content HDPE liner confirm to be uniformly effective and cheaper, when lined at the bottom and sides. Rate of percolation was 1.2cm/ 30days, whereas soil cement recorded 0.54 cm/hr.	Kerala and coastal Karnataka	HDPE (250µ)
12	Jayanthi et al., (2004)	Sand and cement in 10:1 ratio with 5cm thick lining showed depletion in seepage to 93.81% compared to polyethylene, clay and chicken litter	AICRPDA, Phulbani, Orissa, India.	Soil Cement (Biocrete)

III. PROBLEM STATEMENT

The farm artificial lake constructed at Solapur. The lake has a problem of percolation. The water stored in the lake has more percolation loss than the evaporations and other losses. The soil bed for existing lake has granular soil with compacted layer of same soil. The bed material is covered with Jute clothes to prevent erosion. The present bedding material is unable to control the percolation and further loss of water. The losses of water due to percolation is such that the full capacity of lake turns in to no water in 40 to 45 days. The client approached for technological solution to prevent the loss of water from the artificial lake. The industry problem mentioned above lead to extend our study to design the liner system along with composition with reference to The Geotechnical parameters of composition material.

Study site when lake is full.

Study site when lake is empty.

IV. MATERIAL AVAILABLE ON SITE

4.1 Black Cotton Soil-

Black cotton soils are also called as regur soils, they found in north-western region of India known as Deccan plateau region of India.

Fig 1. black cotton soil.

4.2 Red Bole Soil-

Red soil is a type of soil that typically develops in warm, temperate, and humid climates and comprise approximately 13% of Earth's soils. It contains thin organic and organic-mineral layers of highly leached soil resting on a red layer of alluvium.

Fig 2. red bole soil

4.3 Bentonite Soil-

The addition of bentonite, used as soil conditioner, can promote sandy soil macro-aggregate formation, moisture content retention and increase soil concentrations.

Fig 3. bentonite soil

V. TEST IS TO BE DONE

5.1 Natural Moisture Content of Black Cotton Soil & Red Bole Soil-

The natural moisture content will be given an idea of the state of soil in the field. The natural water content also known as the ratio of the weight of water to the weight of the solids in a given mass of soil. This ratio is usually expressed as percentage. The Information of the natural moisture content is essential in all studies of soil mechanics. It is used for determining the bearing capacity and settlement of the soil. The natural moisture content will be given an idea of the state of soil in the field.

5.2 Modified Proctor Test-

The Modified proctor test is used for the determination of the compaction of the various types of soils and their properties with a change in the water content. It is also determining the relationship between dry density and the water content of the soil.

Fig.1 modified proctor test

5.3 Falling Head Permeability Test-

The falling head permeability test is used for low permeability soils, such as silts and clays. A relatively small soil sample is used, cause of water flow will be slow. After ramp down the sample and saturating it with water, a standpipe is connected to the container holding the soil.


Fig.1 falling head permeability test

VI. CONCLUSION

There is a need to use advanced techniques to improve serviceability of water harvesting structures. The techniques like Bentonite, polymer spray and geo-membrane in combination with protector cover can be undertaken for studies. Locally available material on site can be used as a lining material in combination based on experimental investigation. Government is encouraging the water harvesting structures in few parts of the country by providing subsidies for the cost of construction.

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