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# ESTIMATION OF BEST COMBINATION OF LOW COST LINING MATERIALS TO REDUCE SEEPAGE LOSSES FROM RESERVOIR

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***Abstract:*** Makhamalabad farm, one of the farm of K. K. Wagh College of Agricultural Engineering and Technology, Nashik, was facing a problem of seepage loss from reservoirs having high infiltration rate of 317 mm·day$^{-1}$ and thus the reservoir was unable to store the water for long period. Therefore, the present research work was undertaken with the objective to make the soil strata impervious to avoid seepage losses from the reservoir. A laboratory model was made, for measuring infiltration rate of low cost lining materials. Infiltration rate of individual lining materials like black soil, river soil, cow dung and gypsum were first determined and then the infiltration rate of combination of lining materials in various sequence of lining materials was determined. Among the individual lining materials, gypsum had lowest infiltration rate of 5.12 mm·day$^{-1}$ than other lining materials. Therefore gypsum has proved to be the best material for lining, in case of individual material with a cost of *Rs* 7.50 per m$^2$. It was also observed that, the infiltration rate from combination of lining materials with the sequence of gypsum placed at bottom layer, then followed by river soil, black soil and cow dung gave the lowest infiltration rate of 1.14 mm·day$^{-1}$ as compared to other sequence of combination of lining materials. The cost of this combination of lining materials was *Rs* 27 per m$^2$ area which is lower as compared to per m$^2$ cost of *PE* film i.e. *Rs* 30.00 used for lining pond or reservoir.

***Key words:*** *seepage loss, reservoir, infiltration rate, gypsum, lining materials, PE film*

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## INTRODUCTION

Rain water is the cheapest and purest source of water. Harvesting of the water in pond, lakes, wells, tanks and reservoirs helps to preserve this water so that it can be put to varied uses later on. One of the most effective ways of water management is through Pond/Canal lining.

Pond sealing or lining is the process of installing a fixed lining of impervious material or mechanically treating the soil in a pond to impede or prevent water loss. Vast amounts of water are lost through seepage, especially where the soil is gravelly and porous [1].

It is estimated that 70% of water is lost between the storage and usage point. Many states have been experiencing drought resulting in shortage of water, particularly during the summer months. Lining of canals reduces seepage losses. The conventional methods for farm pond and canal lining are use of cast-in-situ concrete, bricks, stone-slabs, precast tiles, precast concrete slabs etc.

Ponds can serve as storm water management detention facilities, add visual aesthetics and create an environment for wildlife. These reservoirs and ponds are located in a variety of soil types which exhibit a wide range of seepage characteristics. Because of seepage, the water level of the reservoirs and tanks depletes rapidly, seepage losses not only means loss of useful water but also lead to other problems such as breach in the embankment, water logging and increased salinity in adjacent areas. With appropriate lining of reservoirs, ponds, canals the seepage loss can be minimized.

By lining the canal, the velocity of the flow can be increased because of the smooth canal surface. For example, with the same canal bed slope and with the same canal size, the flow velocity in a lined canal can be 1.5 to 2 times that in an unlined canal, which means that the canal cross section in the lined canal can be smaller to deliver the same discharge. Before the decision is made to line a canal, the costs and benefits of lining have to be compared. By lining the canal, the velocity of the flow can increased because of the smooth canal surface.

Makhamalabad Farm of K. K. Wagh College of Agricultural Engineering and Technology, Nashik was facing a problem of seepage loss through existing reservoirs, therefore it was unable to store water in those reservoirs even during rainy season and it was waste of money in constructing those reservoirs. Therefore, the research work was conducted, to solve the seepage loss problem by testing the infiltration rate of different materials (river soil, black soil, gypsum and cow dung etc.), selecting the best combination of different materials to reduce the seepage loss & then compare the cost of selected lining materials with *PE* film.

## MATERIAL AND METHODS

The present investigation was carried out in October 2013 in Irrigation and Drainage Engineering Laboratory, K. K. Wagh College of Agricultural Engineering and Technology, Nashik. A laboratory model for measuring infiltration rate was made to estimate the best combination of low cost lining materials, used to reduce seepage of water from reservoir/pond. Initially, soil sample from one of reservoir of Makhamalabad

farm was collected and then the chemical properties such as pH, *EC*, sodium content and texture of the soil were determined. Then by using laboratory model, infiltration rate of individual and combination of different lining material was determined. Following materials were used for making a model:

1. Hollow cylindrical bisleri tank (17.48 litre capacity)
2. Stand
3. Sieve
4. Polythene bag
5. Measuring cylinder

**Construction of Laboratory model**

Initially, the stand (cast iron) for supporting bisleri tank was made. Then Bisleri tank was cut from the top and bottom, to make the hollow cylindrical tank. The circular ring made of cast iron was covered with sieve of mesh size (2 mm) and was kept on stand to give support to hollow cylindrical tank. At the bottom of the stand, plastic bag was attached to collect the outflow of water from hollow cylindrical tank. The Laboratory model consisted of three sections viz top section, middle section and bottom section, in which top section contains water, middle section consists of lining materials and bottom section will collect the outflow of water [4].

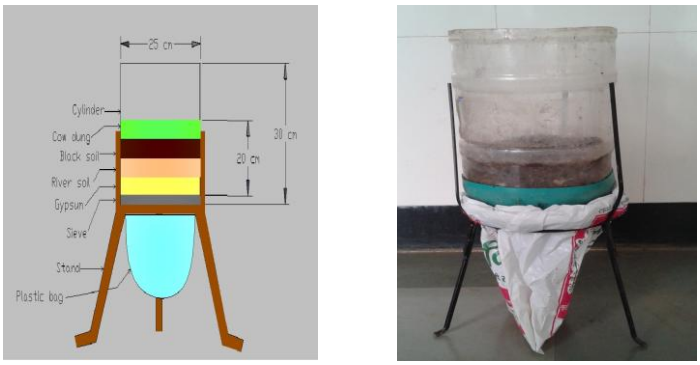


*Figure1. Laboratory model for measuring infiltration rate*

After making the laboratory model, the lining materials were filled in the cylinder in layers, each having thickness of 5 cm. Then water was spread on lining materials and compaction of lining material was done [5]. The measured quantity of water was added into top section of model and then the water was allowed to pass through different lining materials until water has stopped infiltrating into the bottom section. Plastic bag was attached to the base of the middle section to collect infiltrated water. The water collected in bottom section was measured with the help of measuring cylinder, which is nothing but outflow of water infiltrated from lining material.

The low cost easily available materials were used for lining such as river soil, black soil, gypsum and cow dung etc. River soil and black soil contains high amount of clay, so they have low permeability at optimum moisture content [2] and hence river and

black soil were selected as the lining materials. The addition of organic material such as livestock manure [5] can reduce seepage also the organic material cause anaerobic condition resulting in slime growth which plugs passages and its heavy application is required to effectively reduce seepage [3], therefore cow dung was used as one of the lining material.

*Table1. Specification of Laboratory Model*

| *Particulars* | *Specification* |
|---|---|
| *Inner diameter of cylinder* | *25 cm* |
| *Height of cylinder* | *30 cm* |
| *Thickness of cylinder* | *2.1 Mm* |

Initially, infiltration rate of individual material was measured and in similar manner lining materials in different sequences were combined and their infiltration rates were determined. Also then texture, *EC*, pH and sodium content of river & black soil were determined using standard procedures.

## RESULTS AND DISCUSSION

The texture of soil sample (field soil) from the reservoir of Makhamalabad farm was determined and it was found that the field soil content 62.8% gravel, 34.25% coarse sand, 2.07% fine sand and 0.87% clay, which meant that the field soil was very porous in nature resulting in heavy loss of water due infiltration & seepage from the sides & bed of reservoir.

Then the chemical properties of lining materials were determined as shown in Tab. 1 and it was found that the field soil was acidic in nature, river soil was normal to saline in nature and black soil was acidic in nature. The sodium content in black soil was more (374.5 ppm) than river soil (335.1) and field soil (129.59 ppm) *EC* of all three soils was normal, indicating that salinity affects are negligible.

*Table 2.Chemical properties of lining material*

| *Soil type* | *pH* | *EC (mhos·cm$^{-1}$)* | *Sodium (ppm)* |
|---|---|---|---|
| *Field soil* | *5* | *0.4* | *129.59* |
| *River soil* | *6.13* | *0.39* | *335.1* |
| *Black soil* | *5.74* | *0..50* | *374.5* |

The infiltration rate of individual lining material was determined as shown in Tab. 2. It was observed from Tab. 2. and Fig. 2. that field soil had very high infiltration rate (317.05 mm·day$^{-1}$) than river soil (22.10 mm·day$^{-1}$), cow dung (20.51 mm·day$^{-1}$), black soil (12.69 mm·day$^{-1}$) and gypsum (5.12 mm·day$^{-1}$). Also it was found that gypsum had very low infiltration rate of 5.12 mm·day$^{-1}$.

Then the infiltration rates of combination of lining materials in different sequences were determined and the best combination of lining material was found as shown in Tab. 3. in which the infiltration rate was minimum (1.14 mm·day$^{-1}$).

In this best combination of lining material cow dung was placed in first layer, followed by black, river soil and gypsum.

*Table 3. Infiltration rate of individual lining material*

| *Materials* | *Thickness (cm)* | *Inflow (ml)* | *Outflow (ml)* | *Time (h)* | *Infiltration rate (mm·day$^{-1}$)* |
|---|---|---|---|---|---|
| *Field soil* | *5* | *1000* | *980* | *2* | *317.05* |
| *Black soil* | *5* | *1000* | *990* | *48* | *12.69* |
| *River soil* | *5* | *1000* | *970* | *27* | *22.10* |
| *Cow dung* | *5* | *1000* | *800* | *24* | *20.51* |
| *Gypsum* | *5* | *1000* | *200* | *24* | *5.12* |

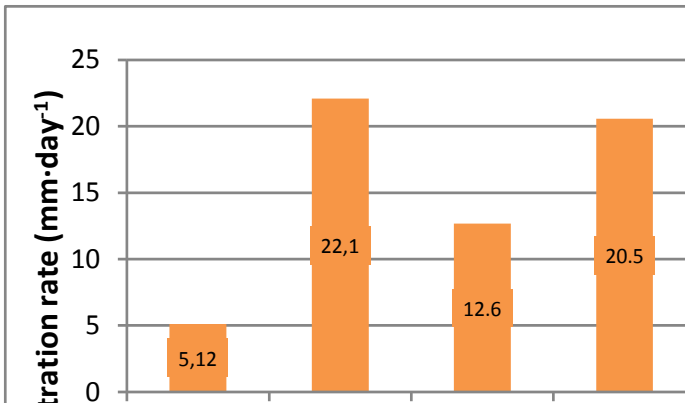


*Figure 2. Infiltration rates of individual lining*

*Table 4. Best combination of lining material*

| *Sr. No.* | *Combination* | *Thickness (cm)* | *Inflow (ml)* | *Outflow (ml)* | *Time (h)* | *Infiltration rate (mm·day$^{-1}$)* |
|---|---|---|---|---|---|---|
| *1.* | *Cow dung* | *20* | *1000* | *180* | *24* | *1.14* |
| *2.* | *Black soil* | | | | | |
| *3.* | *River soil* | | | | | |
| *4.* | *Gypsum* | | | | | |

## CONCLUSIONS

Sodium content in soil affects the infiltration rate, infiltration rate decreases with increase in sodium content of soil. Therefore, the infiltration rate of black soil (12.69 mm·day$^{-1}$) was low as compared to the river soil (22.10 mm·day$^{-1}$) and field soil (317 mm·day$^{-1}$).

From the present investigation, it was concluded that gypsum had lowest infiltration rate (5.12 mm·day$^{-1}$) as compared to other materials used for lining. Therefore gypsum has proved to be the best material for lining, in case of individual material with a cost of *Rs* 7.50 per m$^2$.

The best combination of lining material was cow dung used as in first layer, followed by black soil, river soil and gypsum. The cost of this combination was *Rs* 27.00 per m$^2$, which was lower than the cost of *PE* film i.e. *Rs* 30.00 per m$^2$.

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## OCENA NAJBOLJE KOMBINACIJE JEVTINIH MATERIJALA OBLOGA ZA SMANJENJE GUBITAKA CURENJEM IZ REZERVOARA

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***Sažetak:*** Farma Makhamalabad ima problem gubitaka zbog curenja rezervoara sa visokim stepenom infiltracije od 317 mm·dan$^{-1}$, tako da rezervoar nije u stanju da skladišti vodu na duži period. Zato je izvedeno istraživanje sa ciljem postizanja nepropusnosti zemljišta radi izbegavanja gubitaka curenjem iz rezervoara. Napravljen je laboratorijski model za merenje infiltracije jevtinih materijala za obloge: crnica, rečni supstrat, goveđa balega i gips. Među njima, gips je imao najmanji stepen infiltracije od 5.12 mm·dan$^{-1}$ i ocenjen je kao najbolji materijal za oblogu, sa cenom od *Rs* 7.50·m$^{-2}$. Takođe je utvrđeno da je infiltracija kombinovane obloge od gipsa u donjem sloju, na koji su dodati slojevi od ostalih materijala bila najmanja i iznosila 1.14 mm·dan$^{-1}$ u poređenju sa ostalim kombinacijama. Cena ove kombinovane obloge bila je *Rs* 27·m$^{-2}$, što je jevtinije od *PE* filma (*Rs* 30.00·m$^{-2}$) koji je korišćen za oblaganje lagune ili rezervoara.

***Ključne reči:*** *curenje, rezervoar, infiltracija, gips, materijali obloga, PE film*

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