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Alternative Local Canal Lining Materials for sustainable Irrigation Practices

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ABSTRACT

Studies were conducted on Agricultural Engineering Department demonstration farm to ascertain the applicability of low-cost materials for irrigation canal lining. Five treatments of the materials were employed as follows: (Laterite, clay, sandy loam, cow dung and sawdust), (Laterite, clay, sandy loam cowdung and maize chaff),(clay, sandy loam, cow dung, sand and cowpea chaff),(clay, sandyloam, cow dung and sand),concrete-(sand, gravel and cement) as control. These treatments were prepared and allowed to cure. As a guide in selecting suitable mixed ratio, the strength properties of the various materials were first tested in the laboratory using Universal Testing Machine (UTM). Subsequently, seepage through different lining materials was measured on the field using the ponding method. The average seepage losses per day for the treatments, 1,2, 3,4,5, were 0.092, 0.098, 0.110, 0.102 and 0.016 m^3/m^2/day respectively. Results show that the appropriate local composite of laterite, clay, sandy, loam, cow dung and sawdust at the mixing ratio of 1:1:3:2:2: was found to have average seepage rate of 0.092m^3/m^2/day. These materials are not expensive and it can easily be afforded by the local farmers.

Keywords: Local materials, Canal lining, Sustainable irrigation practices.

INTRODUCTION

The major objective of canal lining is the reduction of seepage losses which has been the greatest avenue for water loss during conveyance, lining of canals can be done with various materials depending on cost, type of soil formation, availability of material and cost of maintenance after the lining. The materials currently used globally are concrete, asphaltic materials, polyvinyl chloride (PVC), and polyethylene compounds, and stone and Brick masonries. The use of concrete is common due to its satisfactory water conveyance, but initial cost of lining is very high (Kasali *et al.,* 2002).

Excess canal seepage contributes to water logging of farm lands. Salt and alkali concentration in the soil costly road maintenance and drainage activities, groundwater seeps into basement of building and other conditions that concern the public. Although it is difficult and sometimes quite impractical to measure accurately the degree of contribution to these adverse conditions by anyone. The public should encourage reduction of canal seepage to protect public interest.

Irrigated lands are often located in a reasonable distance from the sources of their water supplies. Water obtained from natural streams and from surface reservoirs, as a rule must be conveyed father than water obtained from underground reservoirs. Main conveyance canals of irrigated projects vary from a few kilometers to 150 or more kilometers from storage reservoirs in the mountains by combining stored water with water from natural rivers and then again diverting it into large canal systems in the valleys. Days are required on some projects to convey the water from point of diversion to the point of use (Israelsen *et al,* 1980).

However, investigation has shown that seepage losses in unlined channel may cause much loss of valuable irrigation water. According to Khair *et al.,* (1984), as much as 47% of total amount of water diverted were lost as seepage in India.

Experiment conducted by Dutta (1981) on three minor irrigation projects in Bangladesh also showed that as much as 60% of the total water diverted was lost during conveyance. This therefore, necessitates the need to line channel with good materials to curtail this magnitude of losses.

Young (1974), Khair and Daulat (1978) reported that the initial high cost of standard types of lining is at present prohibitive for many projects. Therefore, there is need for other lining materials that are relatively cheap without affecting the satisfactory performance.

Biswas and Islam (1975) show that cow dung, clay lining, 3 inches (75 mm) thick, when laid carefully reduces seepage losses noticeably. In a similar effort, Kinori (1970) reported that sand with clay as binding material can reduce seepage losses but could not resist scour caused by water satisfactorily. Khair and Daulat (1978) concluded that lining made of indigenous materials may reduce seepage losses considerably but is less permanent and less effective than concrete lining. Therefore, the objective of this study is to test and evaluate the performance of different local materials for use in irrigation canal lining.

MATERIALS AND METHODS

The experiment consists of five treatments as follows:

- Laterite, clay, sandy loam, cow dung and sawdust
- Laterite, clay, sandy loam cow dung and maize chaff
- Clay, sandy loam, sand, cow dung ,sand and cowpea chaff
- Clay, sandy loam, cow dung and sand
- Concrete – (sand, gravel and cement) as control

The above treatments were prepared and mixed in different ratios to select the best mixture. The mixtures were made into 15 x 15 x 15 cm^3 moulds and were allow curing for a period of 14 days. Treatment one, two, three and four consists of 128, 128, 128, and 30 samples respectively.

After curing, the samples were observed for cracks thereby eliminating those with cracks. The rest were subjected to compression test using the Universal Testing Machine (UTM) to ascertain their strength as a guide to selecting the best mix ratio of each samples. After the laboratory test, the best mix ratio in each treatment was chosen according to their strength properties as shown in Table 1.

For field evaluation of the selected treatments or materials, five trapezoidal channels of size 2m x 0.5m x 0.4m were dug. The channels were lined carefully with the selected treatments using thickness of 10cm.

The channels were allowed to cure, thereafter, they were impounded with water to a certain level. The surface of the water was sealed up by pouring black engine oil on it to eliminate surface evaporation. The level of water in each channel was monitored for a period of 10 consecutive days in determination of the seepage losses in each channel when the seepage rates became relatively constant.

The seepage rates in the channels were calculated by pounding method, using the following relationship:

$$S = \frac{24W(d_{1-}d_2)L}{PLT} \quad \text{............1}$$

Where S = seepage rate in m^3/m^2/day.
W = average width of water surface, (m).
d_1 = depth of water (m), at the beginning of measurement
d_2 = depth of water (m), after time, t
P = average wetted perimeter, (m).
T = time interval between d_1 and d_2 (hr)
L = length of canal, (m).

RESULTS AND DISCUSSION

Table 3 shows the summary test data of treatment effects on soil strength properties. Results of the test shown in Table 3 indicate that treatment No.1 consisting of laterite, clay, sandy loam, cow dung and sawdust mix in the ratio of 1:1:3:2:2 gave the least values of percentage deflection at peak, percentage strain at peak and the highest Young Modulus with the exception of treatment No. 5 (concrete) among the other treatment

These values are indicative of the stiffness of the mix and its resistant to scour and cracks that may lead to high seepage. This is indicative of failure of this mix at high loads. The maximum load that the lining materials could be subjected to in practice is rainfall kinetic energy load. To attain such loads in practice is not feasible given that the canal will be conveying large quantities of water which upon raindrop impact will dissipate the rainfall energy: It could therefore be deduced that the low seepage loss recorded under treatment No. 1 was preferred due to the strength of the resulting composite materials after curing.

From Fig 1, it can be deduced that seepage loss through the linings decreased with time and attained a constant rate after a few days. The use of the composite materials of laterite, clay, sandy loam, cow dung and sawdust (treatment No 1) resulted in a drastic reduction in seepage losses when compare with other low-cost local materials with average seepage loss of 0.092 m^3/m^2/day. It compared favorably with concrete with 0.016 m^3/m^2/day seepage loss rate. In general the average seepage loss per day for the five treatments was 0.092, 0.098, 0.110, 0.102 and 0.016m^3/m^2/day respectively. Thus, lining made of indigenous materials could be conveniently used to reduce seepage losses when carefully selected and laid. However, they will not compare with concrete in terms of performance (effectiveness and durability).

Considering the facts that the load of the preferred treatment No.1was lowest among the treatments as recorded in the Universal Testing Machine test, the composite of laterite, clay, sandy loam, cow dung and sawdust is recommended for use in lateral and farm ditches where high flow velocities are not predominant.

CONCLUSION

From the experimental results obtained, it could be deduced that low cost materials could be very effective as lining materials for canal, provided the mixing ratio are appropriately chosen. Local composite of laterite, clay, sandy loam, cow dung and sawdust at the mixing ratio of 1:1:3:2:2 were found to be satisfactory as lining materials in term of strength and seepage reduction. However, because of their low load carrying capacity, they are recommended for use in laterals and shallow farm ditches where high flow velocities do not prevail.

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Appendix

Table 1: Shows Best Mixing Ratio for Different Treatment

Expt. Material	Best mix ratio
(i) Laterite, clay, sandy loam, cow-dung and saw dust	1:1:3:2:2:1
(ii) Laterite, clay, sandy loam, cow-dung, maize chaff	1:2:3:1:1
(iii)Clay, sandy loam, cow-dung, sand and cow-pea chaff	1:3:2:3:1
(iv)Clay, sandy loam, cow-dung and sand	2:3:1:2
(v) Cement, sand and granite (control)	1:2

Table 2: Average Seepage Losses in each channel

Treatment No	**Average Seepage Losses m^3/m^2/day**
Treatment 1	0.092
Treatment 2	0.098
Treatment 3	0.110
Treatment 4	0.102
Treatment 5	0.016

Table-3 Show Best Sample From Each Treatment

Treatment		WEIGHT (g)	LOAD @ PEAK (N)
i.	L, C, Sl, Cd, SD	4338	5,111
	L, C, Sl, Cd, MC	4204	4,398
ii.	C, Sl, Cd, S	3528	3,343
iii.	C, Sl, Cd, S	5414	3,152
Cement, Sand and Gravel (control)		8300	65,039