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Study of Soil Properties of Canal

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ABSTRACT - Water has been transported from lakes, rivers, etc., through canals in urban areas for human use like irrigation and drinking water, etc. Seepage loss accounts for nearly 23% to 47% through its bed and sides of the canal. To improve the efficiency water carrying capacity of the canal, different types of lining are provided over the bed and sides of canals to make the bed and sides impervious which will improve the life and discharge of the canal. Canal lining obstructs water flow through the bed and sides. Canal linings are constructed with materials such as compacted earth, cement, concrete, plastics, boulders, bricks, etc.

Seepage loss mainly depends on soil characteristics of which sides and beds of canals have been constructed. To minimize seepage loss, lining are provided types of canal lining are used based on the characteristics of the soil, Permeability of the soil, and funds available. The average permeability of soil was found 6.5× 10^{-3}cm/sec which is silt soil. The best-suited lining of the Indira Canal is brick lining if the fund is less or CC lining if sufficient funds are available.

Keywords: Permeability, Lining, Seepage, Soil characteristics, brick ling

1. INTRODUCTION:

Canal Lining is an impermeable layer provided on the bed and sides of the canal embankment to minimize seepage loss. Different types of types of canal lining are used based on the characteristics of the soil, permeability of the soil, and funds available. Canal Lining is an impermeable layer provided in the bed and sides of the canal to improve the life and discharge capacity of the canal. Construction canal lining can save 60 to 80% of water lost through seepage in an unlined canal.

2. CANAL LINING

Canal Linings are provided in canals to resist the flow of water through their beds and sides of the canal. These can be constructed using materials such as compacted earth, cement, concrete, plastics, boulders, bricks, etc

Canal lining refers to an impermeable layer that provides the effectiveness and durability of irrigation canals. Canal lining is the process of providing a protective layer to the sides and bed of a canal to prevent water seepage and erosion. It employs the application of impermeable materials like concrete, asphalt, plastic, or clay to the canal's sides and bed. This addition effectively minimizes water loss through seepage. Consequently, canal lining contributes to substantial water conservation that would otherwise be wasted in unlined canals, leading to increased water availability for irrigation and other essential purpose.

Water flowing through the canal system may be lost to seepage before reaching an irrigable region, resulting in insufficient water for the crops. Therefore, it is important to establish an impermeable layer on the canal's bed and sides to reduce

3. ADVANTAGES OF CANAL LINING

3.1. SEEPAGE REDUCTION: The main purpose behind the lining of the canal is to reduce seepage losses. In some soils, the seepage loss of water in unlined canals is about 25 to 50% of the total water supplied. The cost of canal lining is high but it is justifiable for its efforts in saving most of the water from seepage losses. Canal lining is not necessary if seepage losses are very small.

3.2. PREVENTION OF WATERLOGGING

Water logging is caused due to phenomenal rise in the water table due to uncontrolled seepage in an unlined canal. This seepage affects the surrounding groundwater table and makes the land unsuitable for irrigation. So, this problem of water logging can be surely prevented by providing proper lining to the canal sides.

4.3. INCREASE IN COMMANDED AREA

The commanded area is the area that is suitable for irrigation purposes. The water carrying capacity of lined canal is much higher than the unlined canal and hence more area can be irrigated using lined canals.

3.4. INCREASE IN CHANNEL CAPACITY

Canal lining can also increase the channel capacity. The lined canal surface is generally smooth and allows water to flow with high velocity compared to an unlined channel. The higher the velocity of flow greater the capacity of the channel and hence

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channel capacity will increase by providing lining. On the other side with this increase in capacity, channel dimensions can also be reduced to maintain the previous capacity of the unlined canal which saves the cost of the project.

3.5. LESS MAINTENANCE

Maintenance of lined canals is easier than unlined canals. Generally, there is a problem of silting in unlined canals which removal requires huge expenditure but in the case of lined canals, because of the high velocity of flow, the silt is easily carried away by the water. In the case of unlined canals, there is a chance of growth of vegetation on the canal surface but not in the case of lined canals. The vegetation affects the velocity of flow and water-carrying capacity of the channel. A lined canal also prevents damage to the canal surface due to rats or insects.

3.6. SAFETY AGAINST FLOODS

A line canal always withstands floods while an unlined canal may not resist and also there is a chance of a breach that damages the whole canal as well as surrounding areas or fields. But among all concrete canal linings are good against floods or high-velocity flows.

4. TYPES OF CANAL LININGS

4.1.1. Compacted Earth Lining - Compacted earth linings are preferred for the canals when the earth is available near the site of construction or in situ. If the earth is not available near the site then it becomes costlier to construct compacted earth lining. Compaction reduces soil pore sizes by displacing air and water. Reduction in void size increases the density, compressive strength, and shear strength of the soil and reduces permeability. This is accompanied by a reduction in volume and settlement of the surface. Proper compaction is essential to increase stability and frost resistance (where required) and to decrease erosion and seepage losses.

4.1.2. Soil Cement Lining- Soil-cement linings are constructed with mixtures of sandy soil, cement, and water, which harden to a concrete-like material. The cement content should be a minimum of 2-8% of the soil by volume. However, larger cement contents are also used. In general, for the construction of soil-cement linings following two methods are used.

(I) **Dry-mix method**

(ii) **Plastic mix method**

For erosion protection and additional strength in large channels, the layer of soil cement is sometimes covered with coarse soil. It is recommended the soil-cement lining should be protected from the weather for seven days by spreading approximately 50 mm of soil, straw, or hessian bags over it and keeping the cover moistened to allow proper curing. Water sprinkling should continue for 28 days following installation.

4.2. HARD SURFACE CANAL LININGS

It is subdivided into 4 types and they are

4.2.1 Cement Concrete Lining- Cement Concrete linings are widely used, with benefits justifying their relatively high cost. They are tough, durable, relatively impermeable, and hydraulically efficient. Concrete linings are suitable for both small and large channels and both high and low flow velocities. They fulfill every purpose of the lining. There are several procedures for lining using cement concrete

- Cast in situ lining
- Shotcrete lining
- Precast concrete lining
- Cement mortar lining

4.2.2 Brick Lining - In the case of brick lining, bricks are laid using cement mortar on the sides and bed of the canal. After laying bricks, a smooth finish is provided on the surface using cement mortar.

4.2.3 Plastic Lining - Plastic lining of the canal is a newly developed technique and holds good promise. There are three types of plastic membranes which are used for canal lining, namely:

- Low-density polyethylene
- High molecular high-density polythene
- Polyvinyl chloride

The advantages of providing plastic lining to the canal are many as plastic is negligible in weight, easy to handle, spread, and transport, immune to chemical action, and speedy construction. The plastic film is spread on the prepared subgrade of the canal. To anchor the membrane on the banks ‘V trenches are provided. The film is then covered with protective soil cover.

4.2.4 Boulder Lining- As the name says, in this type of canal lining several boulders or stone blocks are used for canal lining. Dressed stone blocks are not present in nature. So, irregular blocks are dressed according to the requirements. Dressed stone blocks are preferred to rough stone blocks or boulders because rough stone blocks provide greater resistance to the flowing water in the canal. Thus, this type of canal lining is preferred where head loss is not an important consideration and where the stones and blocks are available in abundance and at a moderate cost.

4.2.5 Prefabricated Cement Concrete Lining- This type of canal lining is preferred where cheap labor, easy availability, and

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transportation of aggregates are present. This type of canal lining is preferred over in situ concrete lining because better control over molding, mixing, and curing can be achieved in this type of canal lining. It also has a lesser construction period.

4.2.6 Asphalt concrete lining- Asphalt is mixed with sand and gravel to make a lining material in this type of canal lining. The thickness of this type of canal lining varies from 2 to 4 inches, and the serviceability varies from 15 to 20 years. Asphalt concrete linings are comparable to Portland cement concrete linings in many respects when properly constructed. These types of linings can be placed even in freezing temperatures.

4.2.7 Shotcrete lining- The term shotcrete refers to the application of sand cement mortar under air pressure. A 11.5 inches thick coat is durable but more costly than a cement concrete layer of equal thickness.

5. EXPERIMENTAL DATA ANALYSIS

Soil samples had collected from the embankment at three places of Indira Canal in Lucknow District i.e.

1. Near Mati
2. Near Ayodhya Road Crossing
3. After Aquaduct

5.1. SIEVE ANALYSIS

SN	SIEVE SIZE	SAMPLE-1(%FINER)	SAMPLE-2(%FINER)	SAMPLE-3(%FINER)	Selected Grading
1.	4.75	100	100	100	100
2.	2.00	98	97	98	97
3.	0.425	84	87	88	87
4.	0.075	33	38	41	38
5.	0.002	3	4	3	4

5.2. LIQUID LIMIT, PLASTIC LIMIT, OMC, DRY DENSITY

SN	LL	PL	OMC	DRY DENSITY	Selected Parameter
SAMPLE-1	23	19	14.50	1.60	Sample 1
SAMPLE-2	24	20	15.00	1.55	
SAMPLE-3	24	20	16.00	1.57	

5.3. PERMEABILITY: SELECTED SAMPLE

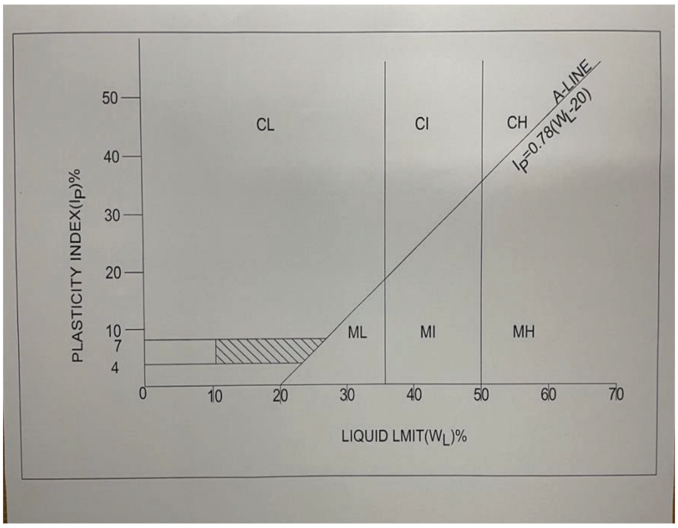
SN	Admixture	Test-1	Test-2	Test-3	Dry sample condition
1	Natural Soil	6.9×10^{-3}	6.4×10^{-3}	6.2×10^{-3}	crackles
2	0.50	0.5×10^{-3}	0.4×10^{-3}	0.7×10^{-3}	crackles
3	1.00	9.9×10^{-4}	9.3×10^{-4}	9.5×10^{-4}	crackles
4	2.00	1.7×10^{-4}	1.2×10^{-4}	1.3×10^{-4}	crackles
5	3.00	4.6×10^{-5}	4.4×10^{-5}	4.2×10^{-5}	crackles
6	3.20	5.2×10^{-6}	4.9×10^{-6}	4.7×10^{-6}	crackles
7	3.40	1.3×10^{-6}	1.4×10^{-6}	1.3×10^{-6}	crackles
8	**3.60**	$\mathbf{0.8\times 10^{-6}}$	$\mathbf{0.4\times 10^{-6}}$	$\mathbf{0.9\times 10^{-6}}$	**crackles**
9	3.80	0.9×10^{-7}	0.6×10^{-7}	0.5×10^{-7}	Fine crack
10	4.00	0.9×10^{-7}	0.6×10^{-7}	0.5×10^{-7}	Fine crack

5.4. ANALYSIS :

Soil of embankment has higher fine sand and silt content.

1.Indian Standard Classification System(ISC) had prepared to classify the soil by plasticity chart:

WL =2, PL=19



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7.CONCLUSION:

Many types of canal lining are used based on the characteristics of the soil, permeability of the soil, and fund available. The average permeability of soil was found 6.5 $\times 10^{-3}$ cm/sec which is silt soil. The best suited lining of the Indira canal is brick lining if the fund available is less or CC lining if sufficient fund is available. The coefficient of permeability of natural soil was 6.5 $\times 10^{-3}$cm/sec.

PI = 23-19=4

6. SUMMARY OF PRESENT EXPERIMENTAL RESEARCH WORK:

The Coefficient of permeability 1$\times$ 10^{-6} cm/sec is optimum above which lining of the canal is required. Canal lining is a very costly activity. Admixture in embankment soil will decrease the Coefficient of permeability, and as per the code, requirement lining of the lining is not required. Lime is a very cheap and readily and widely available admixture. Lime also works as a binding material. Experimentally, based on the primary parameter, the quantity of lime may be obtained, which will use to avoid lining in the canal. Received the sample from three places in the Indira Canal, a 3.60% optimum quantity of lime was obtained, and a 0.7$\times$ 10^{-6}cm/sec coefficient of permeability was found below which lining is not required; the lining of the canal is necessary.

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