# STUDY OF CANAL LINING AND CANAL SEEPAGE USING HDPE SHEET FOR NIRA DEOGHAR CANAL, BHOR

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## ABSTRACT

*Effective management of water in an irrigation system requires knowledge of the quantity of water flowing in the canal in order to send the appropriate quantity of water to every consumer at the right time, avoid unnecessary losses, and avoid physical and environmental damages. Seepage outflow from canals affects the efficient operation of the canal system as this water leaves the canal, moving downhill and through the soil strata, and may no longer be directly available to the water consumers. Also, seepage affects the effective water management basis because it sometimes produces erosion and piping damage at control structures. Canals continue to be major navigation systems for delivering water for irrigation. The seepage loss from irrigation canals constitutes a considerable percentage of the usable water. The loss of water by seepage from unlined canals in India varies from 0.3 to 7.0 m3/s per 106 m2 of wetted surface. The seepage loss from canals is ruled by hydraulic conductivity of the subsoils, canal geometry, location of the water table relative to the canal, and several other factors.*

*We will be doing estimation of seepage losses in the Nira Deoghar canal. The canal seepage section that I will measure is of 7 km length. For this project Nira Deoghar projects right bank canal is selected for measuring discharge and find out the seepage losses. We will measure the water depth and calculated the difference between the levels and find out seepage loss in lined and unlined canal. The inflow-outflow method used to measure seepage, in which area and velocities will be measured under steady flow conditions will be considered. We will calculate discharge and seepage loss by using Direct method. As a result, reaches the highest seepage losses will be identified and how major seepage loss can be prevented by using HDPE sheet will be computed. Hence, the study of canal lining and the seepage taking place must be computed. A comparative study will be done on the lined, unlined and the lined canal with HDPE sheet to conclude the project. And further from the wasted seepage water how can crop(rice and wheat) yield be harvested will be hence computed.*

**Keyword:** - *Canal lining, Canal Seepage, Seepage Losses, HDPE Sheet, Seepage evaluation, Concrete, Shotcrete, Exposed HDPE, IITD sheet, Nira Deoghar canal, Nira river, Bhor, Erosion, Piping damage.*

## 1. INTRODUCTION

Seepage and evaporation are the most serious forms of water loss in an irrigation canal network. Seepage losses are dependent on the channel geometry, while evaporation loss is proportional to the area of free surface. In

this paper, a methodology to determine the distinguished canal dimensions for a particular discharge is developed. The nonlinear water loss function for the canal which include seepage and evaporation loss, was derived. Excessive seepage losses can cause water logging and soil salinity demanding the installation of elaborate and costly drainage systems. Besides the cultivable area is reduced, resulting in a loss of potential crop production. Implementation of irrigation scheme which comprises of extensive distribution system is an expensive proposition. Thus, it is very necessary to ensure that large losses do not occur in transit due to seepage. In practice, considerable loss of water occurs due to seepage in earthen canals. This loss is inescapable unless the canal is lined. An irrigation canal where the bed and the sides of the canal cross- section are protected with impervious or fairly impervious material of sufficient durability for preventing seepage losses.

Thus, main objective of lining the irrigation canals with impermeable material is to stop seepage, thereby saving valuable irrigation water. When canal is lined considerable extra area can be commanded with the help of the saving resulted from lining the canals. When a canal is to be lined the canal may be built to much smaller cross-section than an unlined one as there is practically no loss in the lined canals due to seepage. Condition of canal is also enhanced a lot and as a result it requires less maintenance and efficiency. The preservation of irrigation water is considered as the fundamental factor for agricultural development of the country. The elimination of seepage losses in irrigation canals by means of linings assures better utilization of the conveyed water and an improved economic situation, losses from earthen irrigation channels depend on a number of factors and vary from (30 to 50) percent of the discharge available at the head of an irrigation system.

### 1.1 Study Area

The objective function is based on minimum water loss from a canal cross section due to seepage and evaporation. There are two main sources of water loss. The seepage relies upon the wetted perimeter and depth of flow whereas evaporation is function of top width of the flow section.
The main objectives of the project are given below:-

The purpose of this Project is to present the main considerations regarding the issue of whether to line or not, the following irrigation canals -
To evaluate seepage losses canals followed by a description of the most commonly used lining methods.
To estimate the expected cost of implementing the recommended types of lining according to some alternative schemes,
To compute the benefits produced by the lining and calculate the corresponding benefit/cost ratio.
To study the prime reasons for considering the lining and the benefits it offers.

## 2. METHODOLOGY

Site selection: For this project Nira Deoghar projects right bank canal is selected for measuring discharge and find out the seepage losses; because some section of canal is Unlined and some section is Lined (with cement concrete).we can find out seepage in lined section and unlined section and find out remedies for reducing the seepage.


**Fig -1**: Location of Nira Deoghar dam and its dimensions

- Data collection: Data is collected by two methods

Direct measurement (Inflow-outflow method)
Empirical formulas

1. Direct measurement (Inflow-outflow method):

This method gives direct measurement of flow rate in to reach and out of reach of canal; so flow of rate which goes into the soil can be easily find out.

$$S = Qi + R - Qo - D + I - E$$

S = Seepage through canal
Qi = Upstream inflow
R = Rainfall
Qo = Downstream outflow
I = Inflow along the reach
D = Evaporation loss
E = Outflow along the reach

**2.1 Table for discharge and volumetric flow**

| Chainage | Breadth | Water Depth | Slope | Nd | B+Nd | (B+Nd) Xd | P=B+2d (√1+N^2) | R=A/P | V= | Discharge |
|---|---|---|---|---|---|---|---|---|---|---|
| 7000 | 7.06 | 0.86 | 0.67 | 0.5762 | 7.6362 | 6.567132 | 10.156 | 0.646626 | 0.422389 | 2.773884 |
| 6900 | 7.06 | 0.86 | 0.67 | 0.5762 | 7.6362 | 6.567132 | 10.156 | 0.646626 | 0.422389 | 2.773884 |
| 6800 | 7.06 | 0.86 | 0.67 | 0.5762 | 7.6362 | 6.567132 | 10.156 | 0.646626 | 0.422389 | 2.773884 |
| 6700 | 7.06 | 0.86 | 0.67 | 0.5762 | 7.6362 | 6.567132 | 10.156 | 0.646626 | 0.422389 | 2.773884 |
| 6600 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6500 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6400 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6300 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6200 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6100 | 7.06 | 0.865 | 0.67 | 0.57955 | 7.63955 | 6.608211 | 10.174 | 0.649519 | 0.423654 | 2.799598 |
| 6000 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5900 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5800 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5700 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5600 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5500 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5400 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5300 | 7.06 | 0.87 | 0.67 | 0.5829 | 7.6429 | 6.649323 | 10.192 | 0.652406 | 0.424915 | 2.825397 |
| 5200 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 5100 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 5000 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 4900 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 4800 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 4700 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 4600 | 7.06 | 0.875 | 0.67 | 0.58625 | 7.64625 | 6.690469 | 10.21 | 0.655286 | 0.426171 | 2.851282 |
| 4500 | 7.06 | 0.88 | 0.67 | 0.5896 | 7.6496 | 6.731648 | 10.228 | 0.658159 | 0.427422 | 2.877252 |
| 4400 | 7.06 | 0.88 | 0.67 | 0.5896 | 7.6496 | 6.731648 | 10.228 | 0.658159 | 0.427422 | 2.877252 |
| 4300 | 7.06 | 0.885 | 0.67 | 0.59295 | 7.65295 | 6.772861 | 10.246 | 0.661025 | 0.428668 | 2.903308 |
| 4200 | 7.06 | 0.885 | 0.67 | 0.59295 | 7.65295 | 6.772861 | 10.246 | 0.661025 | 0.428668 | 2.903308 |
| 4100 | 7.06 | 0.885 | 0.67 | 0.59295 | 7.65295 | 6.772861 | 10.246 | 0.661025 | 0.428668 | 2.903308 |
| 4000 | 7.06 | 0.885 | 0.67 | 0.59295 | 7.65295 | 6.772861 | 10.246 | 0.661025 | 0.428668 | 2.903308 |
| 3900 | 7.06 | 0.89 | 0.67 | 0.5963 | 7.6563 | 6.814107 | 10.264 | 0.663884 | 0.429909 | 2.929448 |
| 3800 | 7.06 | 0.89 | 0.67 | 0.5963 | 7.6563 | 6.814107 | 10.264 | 0.663884 | 0.429909 | 2.929448 |
| 3700 | 7.06 | 0.895 | 0.67 | 0.59965 | 7.65965 | 6.855387 | 10.282 | 0.666737 | 0.431146 | 2.955673 |
| 3600 | 7.06 | 0.895 | 0.67 | 0.59965 | 7.65965 | 6.855387 | 10.282 | 0.666737 | 0.431146 | 2.955673 |
| 3500 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.434134 | 3.006303 |
| 3400 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 3300 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 3200 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 3100 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 3000 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 2900 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 2800 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2700 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2600 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2500 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2400 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2300 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2200 | 7 | 0.915 | 0.67 | 0.61305 | 7.61305 | 6.965941 | 10.29766 | 0.676459 | 0.508417 | 3.541604 |
| 2100 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 2000 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1900 | 7 | 0.905 | 0.67 | 0.60635 | 7.60635 | 6.883747 | 10.26162 | 0.670825 | 0.502418 | 3.45852 |
| 1800 | 7 | 0.91 | 0.67 | 0.6097 | 7.6097 | 6.924827 | 10.27964 | 0.673645 | 0.505416 | 3.499922 |
| 1700 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1600 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1500 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1400 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1300 | 7 | 0.92 | 0.67 | 0.6164 | 7.6164 | 7.007088 | 10.31568 | 0.679266 | 0.51142 | 3.583568 |
| 1200 | 7 | 0.925 | 0.67 | 0.61975 | 7.61975 | 7.048269 | 10.3337 | 0.682066 | 0.514426 | 3.625813 |
| 1100 | 7 | 0.93 | 0.67 | 0.6231 | 7.6231 | 7.089483 | 10.35172 | 0.68486 | 0.517434 | 3.66834 |
| 1000 | 7 | 0.93 | 0.67 | 0.6231 | 7.6231 | 7.089483 | 10.35172 | 0.68486 | 0.517434 | 3.66834 |
| 900 | 7 | 0.935 | 0.67 | 0.62645 | 7.62645 | 7.130731 | 10.36974 | 0.687648 | 0.520445 | 3.71115 |
| 800 | 7 | 0.94 | 0.67 | 0.6298 | 7.6298 | 7.172012 | 10.38776 | 0.690429 | 0.523458 | 3.754244 |
| 700 | 7 | 0.95 | 0.67 | 0.6365 | 7.6365 | 7.254675 | 10.4238 | 0.695972 | 0.529491 | 3.841284 |
| 600 | 7 | 0.96 | 0.67 | 0.6432 | 7.6432 | 7.337472 | 10.45984 | 0.70149 | 0.535534 | 3.929465 |
| 500 | 7 | 0.96 | 0.67 | 0.6432 | 7.6432 | 7.337472 | 10.45984 | 0.70149 | 0.535534 | 3.929465 |
| 400 | 7 | 0.98 | 0.67 | 0.6566 | 7.6566 | 7.503468 | 10.53192 | 0.71245 | 0.547649 | 4.109269 |
| 300 | 7 | 0.985 | 0.67 | 0.65995 | 7.65995 | 7.545051 | 10.54994 | 0.715175 | 0.550684 | 4.154941 |
| 200 | 7 | 0.99 | 0.67 | 0.6633 | 7.6633 | 7.586667 | 10.56796 | 0.717893 | 0.553722 | 4.200902 |
| 100 | 7 | 0.99 | 0.67 | 0.6633 | 7.6633 | 7.586667 | 10.56796 | 0.717893 | 0.553722 | 4.200902 |
| 0 | 7 | 1 | 0.67 | 0.67 | 7.67 | 7.67 | 10.604 | 0.723312 | 0.559804 | 4.293695 |

**Table -1**: Table showing discharge and volumetric flow of 7 km section of Nira Deoghar Canal

**Fig -2**: Canal condition of Nira Deoghar (Lined and Unlined)

**2.2 Direct measurement**

As the discharge on 0 chainage m is 4.23 (m^3/s) and at 7000 m chainage is 2.77 ($m^3$/s), so the discharge difference is 1.46($m^3$/s)

(1)

There were 9 distributaries located in 7 km sector of channel
50 liter/sec is discharge of each distributaries

Total discharge of distributaries = 9*50 = 450liter/sec(0.45m^3/sec)
Total reduction discharge = 1.46-0.45 = 1.01 $m^3$/s

(2)

It's found that in canal losses main loss is "seepage loss"(98 to 99%) and evaporation loss is minor loss (0.5 to 1%).so by considering this
Seepage loss = loss in discharge - evaporation loss
= 1.01 ($m^3$/s) - 0.0101($m^3$/s)

(3)

= 0.9999 ($m^3$/s) in 7000 meters

999 liter/sec water can be saved in 7000 meter run by applying HDPE sheets(High Density Polyethylene sheets) and providing cement concrete cover to protect HDPE sheets from any action or attack.
Cement Concrete lining cost for "NIRA DEOGHAR" canal project is 1.5 crore/kilometer
For example: we considered 7 km channel section
Approximate cost of cement concrete lining is= 1.5crore/km * 7 KM=10.50 crore (4)
HDPE sheets lining cost is 185 RS/square meter

For canal bed width 7 meter and top width 18 meter and channel length 7000 meter (7 km)
Total cost of lining HDPE sheets =
For HDPE =185 * 189840 = 35,120,400/- (5)
Total cost of lining = 10,50,00,000 + 35,120,400 = 140,120,400/-

Total cost of lining HDPE sheets (with geotextile cover)
For Geotextile = 185*189840 *2 = 70,240,800/-

Total cost of lining (HDPE + cement concrete) = 10,50,00,000 + 3,51,20,400 + 70,240,800/-= 210361200/- (6)

By using HDPE sheets we can save 999 liter/sec water

By assuming 0.999 m^3/s as a discharge which can save in seepage losses
For bottom width side area is = (7+2)*7000 = 63000 sq meter
For side channel area is = (7.06 + 2)*7000 = 63420 sq meter
For side channel area is = (7.06 + 2)*7000=63420 sq meter
Total area is = 63000 + 63420 +63420 =189840 sq meter (7)

Volume of water saved per kilometer =999/7 = 142.71 litre/sec/km
= 0.142 m^3/sec/km
For 7 km we saved 0.999 m^3/sec

Consider this as a discharge and Rice as a crop
Base period = 100 days
Delta = 120 cm
Duty = (864*100)/(120) = 720 ha/cumec
Discharge = area/duty
0.999 = area /720 = 719.28 hectare

4 ton rice can be produced in 1 hectare base period 100 days
Extra rice can be produce = 719.28*4000 = 2877120 kg Rice
Approx. wholesale rate or price at farmers stage = 25 Rs/ kg
Total earning = 25 * 2877120 = 71928000 RS

Now for wheat base period is 100 days
Duty = (864*100/50) = 1728 ha/cumec
Discharge = area/duty
0.999 =area/ 1728= 1726.272 hectare 3 tons /hectare Wheat
3000*1726.272 = 5178816kg wheat
Approx. wheat cost will be 20 Rs at farmers end= 20*5178816=103576320 Rs
Benefits due to lining= 71928000+ 103576320 = 175504320 Rs

## 3. MATERIALS

1.Concrete: Excellent durability, but only 70 percent long-term effectiveness. Irrigation districts are familiar with concrete and can easily perform required maintenance

| Lining material | Maintenance | Effectiveness in seepage reduction | BCR |
|---|---|---|---|
| Concrete alone | 10% of cost | 70 % | 2.5 to 3 benefit to cost ratio |

2.Shotcrete : As a shotcrete can be advantageously used as a lining material for canal lining

**Fig -3**: Lining using Shotcrete

Canal lining by Shotcrete concrete (gives excellent condition as compare with other material after 7 years)
Shotcrete - The specified shotcrete thickness was 3 inches minimum. Because the actual shotcrete thickness is averages about 5 inches.
Condition: The shotcrete is in excellent condition. No obvious visible differences exist in the performance of the four shotcrete test sections. No freeze-thaw damage is evident after 7 years of service. A large pond just upstream from the drop structure (station 27+80) indicates a low seepage rate. Small ponds are present on all four test sections.
Contraction cracks on the sidewalls have developed every 100 to 200 feet. Crack width varies from hairline to 1/8 inch. Cracks do not extend completely across the canal prism but, instead, usually disappear somewhere in the sidewall or invert. Cracks are more evident during cold weather. Cracks grow in length and numbers with time but do not seem to widen significantly

| Lining material | Maintenance | Effectiveness in seepage reduction | BCR |
|---|---|---|---|
| Shotcrete | 10% of cost | 85% | 3 to 3.5 benefit to cost ratio |

3.Exposed HDPE - Excellent effectiveness (90 percent), but susceptible to mechanical damage from animal traffic, construction equipment and vandalism. Also often difficult to maintain because of irrigation districts unfamiliarity with geomembrane materials, and need for special equipment to perform repairs.

| Lining material | Maintenance | Effectiveness in seepage reduction | BCR |
|---|---|---|---|
| Exposed HDPE | 10 % of cost | 90 % | 3.5 to 4 benefit to cost ratio |

Canal overview - Very good condition after 6½ years of service.
Tears in the liner at station 16+00.

**Fig -4**: Lining using Exposed HDPE sheet

Canal lining with exposed HDPE liner sheet Construction Cost: $1.38 per square foot
Location: Station 15+00 to 20+00 (500 linear feet; 15,000 square feet) Condition: Very Good - After 6½ years of service, the exposed HDPE liner is in very good condition, with only minor mechanical damage. About half of this test section has standing water (typically 6 to 12 inches deep). A small (3-inch-long) tear or cut was found in the invert (station 16+00). A semicircular tear (perhaps from an animal hoof) is present on the left bank above the waterline (station 18+50). The anchor trench on the left bank is holding up well. The degree of HDPE texturing ranges from quite rough to almost smooth.
Maintenance: Minimal maintenance required to date Performed: In 1994, the district placed a concrete anchor pad

**Table -2**: Comparison between normal concrete and shotcrete

| Sr. no | Point | Normal concrete | Shotcrete |
|---|---|---|---|
| 1 | Seepage | Reduced upto 70 % | Reduced upto 90% |
| 2 | Cracks | More | Less |
| 3 | Special equipment | Not required | Required |
| 4 | maintenance | More | Less |
| 5 | Rate | 600 to 700 Rs/sq meter | 1000 to 1500 Rs/sq meter |

4.IITD SHEET - IIT Delhi also compare there IITD sheets with High Density Polyethylene sheet and found some positive points as compare with (HDPE)

| Material | Thickness (mm) | Puncture Strength (Index), (kN) | Tensile Strength at Break (kN/m) |
|---|---|---|---|
| HDPE 1.5mm | 2.0 | 0.5 | 50 |
| IITD | 0.6 | 0.5 | 55 |

COST OF HDPE SHEETS = 185/ sq meter
COST OF IITD SHEETS = 250/ sq meter

**3.1 Comparison**

With knowing cost of lining material, normal concrete, shotcrete, HDPE, IITD we can compare the following combination of lining
As we have taken 7 km section of canal as study total cost is computed below

HDPE+CONCRETE

| Sr no | HDPE | CONCRETE | Cost | Total cost(for 7 km) |
|---|---|---|---|---|
| 1 | 35120400 | 15000000*7 | 35120400+105000000 | 140120400 |

HDPE+SHORTCRETE

| Sr no | HDPE | SHOTCRETE | Cost | Total cost(for 7 km) |
|---|---|---|---|---|
| 1 | 35120400 | 1100*150000 | 165000000+35120400 | 200120400 |

IITD+CONCRETE

| Sr no | IITD | CONCRETE | Cost | Total Cost(for 7 km) |
|---|---|---|---|---|
| 1 | 47460000 | 15000000*7 | 47460000+105000000 | 152460000 |

IITD+SHORTCRETE

| Sr no | IITD | SHORTCRETE | Cost | Total Cost(for 7 km) |
|---|---|---|---|---|
| 1 | 47460000 | 1100*150000 | 47460000+165000000 | 212460000 |

By considering 10 % maintenance cost of original cost and 50 years of project life We have 4 different combination of lining materials and comparison as well B/C ratio will be given as follows

1) HDPE + Concrete = 140120400 * (10/100) *(50) = 700,602,000/-
Total cost = 700,602,000+140120400 = 840,722,400/-
Benefits = 175504320 * 50 = 8775216000/-
B/C ratio = 8775216000/840722400 = 10.43

2) HDPE + Shotcrete = 200120400
200120400 *(10/100)*(50) = 1000602000
Total cost= 1000602000 + 200120400 = 1200722400
Total benefit = 175504320 * 50 = 8775216000/-
B/C ratio = 8775216000/1200722400 = 7.33

3) IITD + Concrete = 152460000 Rs
Maintenance cost for lifespan of project = 152460000 * (10/100) * (50) = B/C ratio = 762300000
Total cost = 152460000 + 762300000 = 914760000/-
Total benefits = 175504320 * 50 = 8775216000/-
B/c ratio = 8775216000/914760000 = 9.59

4) IITD + Shotcrete = 212460000 Rs
Total maintenance for lifespan of project = 212460000 * (10/100) * (50)= 1062300000
Total cost = 212460000 + 1062300000 = 1274760000
Total benefits = 175504320 * 50 = 8775216000/-
B/C ratio = 8775216000/1274760000 = 6.883

5) HDPE(with geotextile cover) + Concrete =210361200/-
Total maintenance for lifespan of project = 210361200 * (10/100) * (50) = 1051806000
Total cost = 1051806000 + 210361200 = 1262167200
Total benefits = 175504320 * 50 = 8775216000/-
B/C ratio = 8775216000/1262167200 = 6.95

6) HDPE (with geotextile cover) + Shotcrete =
35120400 + 70240800 + 165000000 = 270361200/-
Total maintenance for lifespan of project = 270361200 * (10/100) * (50) = 1351806000/-
Total cost = 1351806000 + 270361200 = 1622167200/-
Total benefits = 175504320 * 50 = 8775216000
B/C ratio = 8775216000/1622167200 = 5.409

## 4. DISCUSSION OF RESULTS

| MATERIALS | HDPE+CONCRETE | HDPE+SHOTCRETE | IITD+CONCRETE | IITD+SHOTCRETE |
|---|---|---|---|---|
| B/C RATIO | 10.43 | 7.33 | 9.59 | 6.833 |

| MATERIALS | HDPE(with geotextile cover) + concrete | HDPE (with geotextile cover) + shotcrete |
|---|---|---|
| B/C RATIO | 6.95 | 5.409 |

As per results shown in table B/C ratio of all the lining materials which are shown above
Are more than 1.so all the materials can be used for canal lining and gives benefits. HDPE sheet is a best s olution to minimize the losses of unlined canal as well as concrete lined canal

### 4.1 Measuring Discharge and Seepage Evaluation


**Fig -5**: Automated Reservoir Level

## 5. CONCLUSION

**Fig -6**: HDPE sheet after laying

As the benefit cost ratio is greater than 1 this method of HDPE sheets lining justifying its application, further we can line different irrigation channel using this HDPE sheet lining material and reduces the seepage loss .It will help in increasing production and overall benefit

HDPE sheets are advantageously used for canal lining and also useful for reducing the losses in unlined as well lined canal also. HDPE sheets reduces the losses upto 99% if fixed and maintained properly material quality of lining which affect less due to different actions. By using this HDPE sheet we can produce 4 ton rice and 3 ton wheat in 1 hectare base period 100 days.

## 6. REFERENCES

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