

FARM POND AND RESERVOIR LINING

Introduction

In India agriculture contributes 40% to our country's GNP and gives subsistence to 70% of our population. And yet 1/3 of our total geographical area is drought –prone because we are dependent upon the monsoons which can be erratic. Drought-prone areas have to be provided water not only for human and cattle consumption but also for irrigation. Whereas even after good monsoons water is not available only because of lack of proper management and storage.

Water Management is the cheapest and purest source of water is rain 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.

Vast amounts of water are lost through seepage, especially where the soil is gravelly and porous. 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. Introduction of plastics sheets in the form of LDPE film below the hard cover lining is effective in improving water tightness of lining.

Pond 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. Ponds can serve as storm water management detention facilities, add visual aesthetics, create an environment for wildlife, and serve as golf course hazards.

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 mean 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.

Pond liners or dam liners are generally required where:

- The natural ground is rock
- Fine clay is difficult to obtain
- Water is in short supply
- Underground faults exist
- Water or ground is toxic
- A small pond is to be installed

What are the benefits of a pondliner?

Covering bottom sediments with black plastic, landscape fabric or other light prevention materials can be useful in small scale situations for controlling submersed weeds. Several bottom-covering materials are commercially available. They are all called benthic barriers. The best benthic barrier is gas permeable and opaque and cannot be penetrated by plant roots or vegetation. Various types of pondliners are also used to keep water in the pond if a clay barrier is not available.

The Lining film

Lining film is a revolutionary concept in water management which dramatically reduces seepage loss at a reasonable cost. Lining film is tough, multilayer, wide width, black, low density polyethylene (LDPE) film by the latest Co-extrusion blown film technique it is available in various widths (4 to 10 metres) and thicknesses (100 to 250 microns).

Procedure to construct a Lined Pond

First of all the pond dimensions (L*B*D, Side Slope) are to be identified and than mark the top level as well as the bottom level length and breadth on the ground clearly. Put pegs at the corners of the pond and tie a rope to demarcate pond dimensions.

Next start digging the pond from the inside rectangle (l*b) and dig till desired depth is achieved. Excavated soil can be kept near the pond around the demarcated periphery and can be used later after screening as a soil cover. Screening is very important as it will remove big boulders and sharp edged gravel which could damage the plastic film.

Precautions

Digging along the slope is a tedious task but it must be done meticulously as the durability of the structure depends on it. If desired, a bamboo frame can be used to achieve uniform digging as per the desired slope.

Water losses in ponds and reservoirs

The need of water during the rainy season is minimal, and therefore, the water available from precipitation or from rivers/streams is stored in ponds and reservoirs for various domestic, agricultural and industrial purposes over a period of time. In the areas of acute shortage of water, ponds and reservoirs sometimes form the only source of water. However, a good portion of water stored in these reservoirs or pond is lost by evaporation, seepage and temperature. The seepage and temperature losses are shown in Table below. Evaporation being surface phenomenon is directly related to the surface area of a storage and temperature. The present estimate of evaporation losses are 6 M ha m. Taking into consideration the large and small storages of the country, the total water loss due to evaporation would be enough to meet the drinking water requirements of India in 2000 AD. Water loss in a storage is sum total of seepage losses through dam/bund and bed of reservoirs/ tank and evaporation from open surface.

Seepage and percolation losses in soil

Sl. No.	Type of soil	Water loss through seepage (Cumecs/million m² of wetted area)	Drop in depth per day (cm)
1.	Heavy clay loam	1.21	10.36
2.	Medium clay loam	1.96	16.84

3.	Salty clay loam	2.86	24.61
4.	Sandy loam	5.12	44.03
5.	Loose sandy soil	6.03	51.80
6.	Porous gravelly soil	10.54	90.65

In permeable soils, losses due to seepage are about 3% of storage capacity seepage, beside loss in storage, may result in water-logging in certain areas.

A tank having water about four metres in depth and located in a heavy clay loam soil area would totally get exhausted within 40 days whereas in case it is located in porous gravelly soil, the tank would get empty in five days. However, over a period of time, the silt deposit helps in partially clogging the pores in the sides and bed of tanks, which helps in reducing the seepage losses.

To conserve water stored in ponds and reservoirs, means must be found to minimum seepage and evaporations losses. Even in the areas receiving very low rainfall, about 200 to 300 cu. M. of water is reported to be possible for collection from each Ha of land which otherwise goes waste by run off. Harvesting and storing of this water if done in dug-out farm ponds will not only help in reducing the run off but will also help in providing protective irrigation to a portion of the catchment area. If protected against seepage, it would have a potential to support a short duration crop. The seepage and other losses in normal unlined ponds in sandy loamy soils are reported to be to an extent of 5 to 15 cm. per day. If this can be minimized by way of lining the walls and floor of the ponds with LDPE films or any other such material, the water could be well utilized.

Conventional lining method like brick and tile lining are either too expensive or not sufficiently effective. Since the water in the reservoir/pond is stagnant, LDPE film lining with 30-60 cms soil cover is adequate for bed-lining. Depending on the circumstances and soil conditions, single tile lining with the LDPE film or double tile lining or LDPE film lining with soil cover can be used on the sides. Polyethylene film lining alone or in combination with conventional lining has proved to be a seepage proof barrier between the soil and the water.

Benefits of Pond and Reservoir lining with plastics film

- ❖ Reduction in seepage losses to the maximum extent (95%).
- ❖ Harvesting and storing of rain water from early monsoons.
- ❖ Utilisation of harvested rain-water for short during crops as well as during off season.
- ❖ Lining of ponds and reservoirs improve water availability over a longer period of time.
- ❖ It is highly useful in porous soils where water retention in ponds and water harvesting tanks is minimal.
- ❖ Economical and effective method of storing water.
- ❖ Eliminates water logging and prevents upward intrusion of salts into stored water.
- ❖ Useful for the purpose of storage of drinking water, for pisciculture and for providing supplementary irrigation. A large number of ponds have been lined with plastics for providing drinking water in the coastal and hilly areas of Gujarat, West Bengal, Karnataka and Himachal Pradesh, and uttaranchal.
- ❖ Prevents soil erosion.
- ❖ Technique is also suitable for effluent ponds and channels to reduce soil and ground water contamination.

This technique can also be used in the lining of salt-pans for improving productivity as well as quality of salt.

Materials

Film

The properties of LDPE film shall conform to Indian Standards

The LDPE film, shall conform to the following average mechanical properties when tested as per Indian Standards.

Table 1 Typical Mechanical Properties of LDPE

Property	Test Method	Unit	Expected Value
1.	2.	3.	4.
Melt flow	IS: 2530	gm/10 min	0.20
Density	IS: 2508	gm /cm ³ at 23°c	0.930
Carbon black content	IS: 2530	%	2.5-3.0
Carbon black dispersion	-do-	-	Satisfactory
Nominal thickness	IS: 2508	microns	100,125,150 175,200,250
Tolerance on thickness	-do-	%	±20
Tensile Strength at Break*	-do-	Kg/cm ²	M/D 140 T/D 110
Elongation at break*	-do-	%	M/D 200 T/D 400
Dart impact strength:			
For 100 microns	IS: 2508	F 50 gms	120
125 microns	IS: 2508	F 50 gms	155
150 microns	IS: 2508	F 50 gms	190
175 microns	IS: 2508	F 50 gms	215
200 microns	IS: 2508	F 50 gms	250
250 microns	IS: 2508	F 50 gms	320
Kinetic coefficient of friction	IS: 2508		Not less than 0.40

* Measured on 100 micron Thick LDPE Film

Note: The dispersion of Carbon black in film matrix shall be uniform.

The shall have nominal thickness of not less than 100 microns (0.10 mm). The thickness shall suit physical properties of subgrade soil and designed water depth in the canal.

Table 2 Thickness of LDPE Film Rigid Cover/with Earth Cover corresponding to Water Depth

Sl. No.	Water Depth (Metres)	Film Thickness (microns)		
		With Rigid Cover	With Earth Cover	
		Film as Primary Barrier	Film as Secondary Barrier	
1.	up to 1m	150	100	200
2.	1 m to 3 m	200	100	250
3.	Exceeding 3 m	250	100	300

LDPE film shall be obtained in rolls having a continuous unspliced length, and in various widths without joints as per requirements. The length of rolls may be of about 40 metres for convenience in handling. Film rolls can be obtained in specific lengths and widths as per requirements of the designed section of a canal to avoid wastage and minimise the joints. The film supplied must conform to the Indian Standard specifications. However the film sample may be got tested before use at the nearest PDC or testing laboratory where facilities may be available.

Top cover: The top cover over the film may consist of any of the following:

- (a) Insitu cement concrete M10 of IS: 456
- (b) Precast cement concrete tiles confirming to IS: 3860
- (c) Stone slabs
- (d) Brick
- (e) Compacted soil
- (f) Burnt clay tiles conforms to IS: 3367

Sand : Sand required for cushion layer below the film shall be of fine quality, passing through 53 m IS Sieve.

Film Laying Technique

- The film shall be laid/ spread/ unrolled over subgrade prepared below the designed bed level to the extent of cover thickness, in strips. Depending on the width of bed/ perimeter of the section, the film can be laid parallel or perpendicular to the flow of the water. Longitudinal joints should be avoided.
- Where longitudinal joints can not be avoided, the loose ends of the film strip shall be anchored with an allowance of 50 cm for anchoring in the trenches, where ever necessary. Necessary space shall be kept vacant at the trenches for anchoring the film.
- The film shall be spread loosely over the subgrade so that it shall attain the contours of subgrade and compensate for thermal variations during the day. An extra length of one percent in both the directions on this account shall be provided.
- The adjacent layers of film shall be laid in such a manner that over- lap shall point towards down stream of canals.
- The film shall be jointed using any suitable method explained in para 12.0.
- Film shall be spread in the above manner and held in position at the two extremities of bed by placing excavated earth or sand bags on it, while the two ends of film are being loosely held over the embankment.

Jointing of Film

There are various methods of jointing adjacent length of the film to avoid leakage along the joints. The method depends on its suitability to a particular set of prevailing site conditions.

Simple Over Lapping

Figure 3 gives the method of over lapping of the film. The simple over lap shall not be less than 30 cm for earth cover and 15 cm for hard cover. It is the least preferred of all the methods sealing as overlap joint is prone to leakage.

Folded Over Lap

Figure 4 shows the details of a folded over-lap. The fold shall not be less than 7.5 cm.

Jointing by Hot Bitumen

The film can also be jointed by a coat of bitumen which is easily available from standard suppliers such as Indian Oil corporation. Bitumen grade 85/25 and 80/ 100 in the ration of 2:1 should be heated at a temperature around 100⁰C. Heated bitumen can be crudely tested on a small piece of film so that overheated bitumen may not damage the film. After ascertaining the appropriateness of the temperature, apply a thick coat of tested bitumen on 10 cm area along the width of both the sheets and fold them as shown in Fig. 5 and cover the same wide brick masonry profiles (Dhamalies) at a suitable interval depending upon the width of the film which should come directly over this joint at a regular interval in order to ensure a better joint of the film. Using damaged film is not recommended. However, this method has been found very convenient for repairing punctures in the film at site itself. In case of big holes, pieces of sheet should be pasted from both sides.

Sealing by Adhesive Tapes

Adjacent lengths of the film can also be jointed with suitable adhesive tapes as shown in Fig. 6. The hydrostatic pressure and the over-layer is sufficient to make the over-lap practically water-tight. However with passage time under submerged conditions, the joints may open up. Soil particles creeping into the joint while laying, may also lead to leakage.

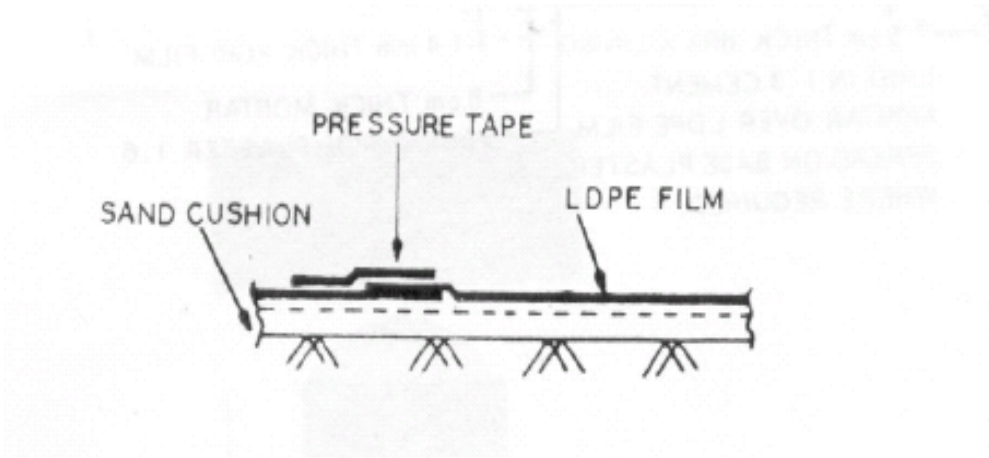


Fig 1 : Over-lap Joint with Pressure Tape

Heat sealing

As shown in Fig. 7 the over-lap joints shall be heat sealed with hot iron. The temperature of the iron shall be adjusted and maintained at 150°C and pressed on the film joint over-lap for 3 seconds, for 100 micron film. For every 50 micron increase in the film thickness the time be increased by one second. To avoid the risk of the film sticking to the iron a poly-tetra-fluor –ethylene (PTFE) impregnated glass cloth or Teflon sheet or cellophane sheet should be placed between the film and the iron.

Heat sealing is the most effective of all the methods.

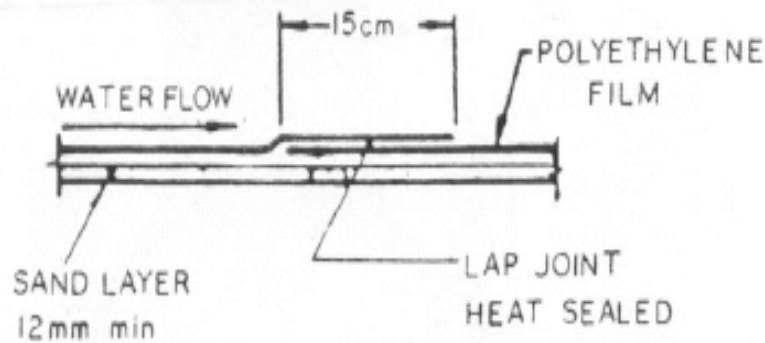


Fig. 2 : Heat Sealing of Joints

Earth Cover over Film

- ✓ The earth from excavation of adjacent section be used for covering the film in earlier section. Thus, by the time, earth cover is provided in one section, the adjacent section is ready to receive film lining.
- ✓ All the stones, roots etc., should be removed from the earth used for filling.
- ✓ The film on the bed should be covered first. To avoid any damage to the film a 7.5 cm layer of earth free from gravel or granular material should be laid and compacted over the film.
- ✓ Rest of the earth cover should be spread over it in 15 cm layers, watered, and compacted by using light roller or manual templates.
- ✓ Extra length of the film shall be placed in trench at embankment top and covered with earth. The embankment may be then raised to designed level.

Do's and Don'ts for Use of Film on Canal

- See at the time of purchase that the film rolls are packed properly. Keep the film rolls in original packing prior to actual use or laying the film.
- Don't leave unpacked film rolls exposed to sun over prolonged periods. Store them preferably indoors.
- See that uniform pressure is applied while heat sealing the film.
- Don't rough handle or drag the film rolls as the film may get damaged in the process.
- Don't let workers walk on the film while the lining operation is in progress to avoid any damage to the film. If unavoidable they should walk barefoot.
- Don't slide the cover material like bricks, tiles etc., on the film to avoid any damage and displacement.
- Don't use hooks for lifting the rolls.
- Don't use reprocessed LDPE film, as the quality of reprocessed LDPE film can not be guaranteed and may lead to premature failure of the film.