TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE CASPER, WYOMING SOIL CONSERVATION SERVICE

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IRRIGATION DITCH AND CANAL LINING

Bentonite & Exposed Pre-Molded Polyester
Plastic Membrane Reinforced with Fiberglass

Introduction

There are five (5) acceptable methods for lining irrigation ditches and canals. Three methods, nonreinforced concrete, flexible membrane and galvanized steel are covered in the Technical Guides. The purpose of this Technical Note is to outline the requirements and procedures for lining a ditch or canal with bentonite or pre-molded polyester plastic membrane reinforced with fiberglass. If lining by either of these two methods is proposed, the following material shall be used as a basis for design and construction specifications.

Conditions Where Practice Applies

Ditches and canals to be lined shall serve as integral parts of an irrigation water distribution or conveyance system which has been designed to faciltate the conservation use of soil and water resources on a farm or group of farms.

The lands served by the lined ditches or canals shall be suitable for use as irrigated land.

Water supplies and irrigation deliveries for the area served shall be enough to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall be located where they will not be subject to damage from side drainage flooding or they shall be protected from such damage.

Capacity

A lined ditch or canal shall have enough capacity to meet its requirement as a part of the planned irrigation water distribution or conveyance system without danger of overtopping. Design capacity shall be based upon the following, whichever is greater:

A. The capacity shall be sufficient to deliver the volume of water required to meet the peak consumptive use of the crops in the area served.

B. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

BENTONITE LINING

Scope

Bentonite lining is restricted to design capacities of less than 100 cubic feet per second. Maximum allowable velocities for different soils is shown in Table I. Bentonite lining should not be installed where irrigation water is high in calcium.

Velocities

Velocities in canals or ditches lined with bentonite shall not exceed the non-erosive velocities for the soil material which is used for the protective cover or the material through which the canal or ditch passes, whichever is least. The maximum design velocities shall not exceed those shown in Table I.

TABLE I

Materials Excavated for Canal	Maximum Allowable Velocity in feet per second
Fine sand	1.5
Sandy loam	1.75
Silt loam	2.00
Loam and fine gravel	2.50
Clay	3.75
Gravel	4.00

Design

A. Values of "n" in Manning's Formula
Canals and laterals lined with bentonite must be designed with enough capacity to carry the required flows at the velocities that will be developed under the maximum probable retardance conditions. For checking designs to see that velocities will not exceed permissible values in erodible soils, a Manning's "n" of no greater than 0.025 shall be used.

B. Freeboard
Freeboard is the height of canal or lateral banks above the maximum water surface elevation which can be expected under the most severe design operating conditions. The required freeboard shall be at least one-third of the design flow depth (0.33d) and in no case shall it be less than 0.5 foot.

In selecting the flow depth and freeboard, consideration must be given to providing enough hydraulic head for successful operation of all ditches or other conveyance structures diverting from the canal or lateral. Water surface elevations at all turnout locations shall be high enough to provide the required flow into the field laterals.

C. Side Slopes
Canals and ditches must be constructed with side slopes that will be statically stable. Slope requirements will vary with different types of cover material but in no case shall the side slopes be steeper than 1½:1.

Construction

There are three methods of using bentonite for sealing ditches or canals. Method 1 is the preferred method and if properly placed, will controll seepage for many years. Method 3 is a season control at best.

A. Method 1
Over excavate the canal section approximately 6 to 12 inches,

salvaging the excavated material. Spread bentonite as a membrane, 1 to 2 inches or more thick over the overexcavated area. Backfill and compact the membrane to the design lines and grades.

B. Method 2
Shape the canal or ditch section to the designed lines and grades. Spread bentonite evenly over the area at a rate of 2 to 2.5 pounds per square foot, (approximately ½" thick). Mix the bentonite blanket with the upper 3 to 6 inches of soil. This can be done with a disk, spiked-tooth harrow or rake. The treated area should then be rolled or tamped until a good soil density is obtained.

C. Method 3
Bentonite is applied in one of three ways. It can be scattered over the surface of the water, dumped into the ditch at intervals before the water is turned on, or put into the ditch water as slurry. The bentonite swells, and the resultant gel fills the voids along the sides and bottom of the ditch. Since it does not penetrate the soil to any depth, it forms a thin coating on the wetted perimeter of the ditch, which reduces seepage. But since bentonite shrinks on drying and is eroded by flowing water, the coating does not last.

The application rates stated above are based on refined bentonite, which has a density of 60 lbs. per cubic foot. Pit run bentonite may be used, providing an adjustment in the application rate is made.

EXPOSED PRE-MOLDED POLYESTER PLASTIC MEMBRANE REINFORCED WITH FIBERGLASS

Scope

Exposed pre-molded polyester plastic membrane reinforced with fiberglass lining is restricted to installation in ditches and canals which have a bottom width of thirty (30) inches or less.

Design

A. Velocity
For design purposes, the carrying capacity of the lined canals or ditches shall be computed by the Manning's equation, using a coefficient of roughness "n" of not less than 0.013.

Design velocities in excess of 1.7 times the critical velocity (1.7Vc) shall be restricted to straight reaches that discharge into a section or structure design to reduce the velocity to less than the critical velocity. The maximum velocity in these straight reaches shall be 15 feet per second.

B. Freeboard
The required freeboard varies with the size of the ditch or canal, the velocity of the water, the horizontal and vertical alignment, the amount of storm or waste water that may be intercepted, and the change in the water surface elevation that may occur when any control structure is operating. The minimum freeboard for any lined ditch or canal shall be 3 inches.

When velocities are within ± 30 percent of critical, the freeboard shall be at least 6 inches. The minimum freeboard requirement is based on the assumption that the finished channel bottom elevations will vary no more than 0.1 foot from the design elevations. Construction deviations greater than 0.2 foot shall not be permitted. If a construction deviation greater than 0.1 foot is to be permitted, the minimum freeboard shall be increased an additional 3 inches.

Additional freeboard shall be provided as required by slope, velocity, depth of flow, alignment, obstructions, curves, and other site conditions.

In selecting the flow depth and freeboard, consideration must be given to providing enough hydraulic head for successful operation of all ditches or other conveyance systems from the canal or lateral. Water surface elevations at all turnouts shall be high enough to provide the required flow into the field laterals.

C. Lining Thickness
A reinforced membrane lining of fiberglass and resin shall be at least 0.05 inches thick, providing this thickness will provide needed strength, and water tightness.

D. Related Structures
Plans for ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation. The design shall insure that the capacity or freeboard of the ditch is not reduced. All structures shall meet Soil Conservation Service standards.

Construction

The pad or foundation shall be constructed of compacted earth. The height shall be at least two (2) inches above the top of the lining.

Berms and ditch banks shall be wide enough to prevent excessive deposition in cut sections and to insure support of the lining in fill sections. The minimum width shall be one foot. Where the bank or berm is to be used as a roadway, the minimum top width shall be eight (8) feet.

Outside bank slopes and slopes above the berm elevation in cut sections must be flat enough to insure stability. They shall not be steeper than 1 and ½ to 1.

Bulkheads formed to fit the lining, and with sufficient size to extend at least 12 inches into the earthen ditch pad for the entire width of the ditch lining, shall be installed at the beginning and end of the lining section and at intervening points as needed to provide adequate anchorage.

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