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Conservation of Farmland in KwaZulu-Natal

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SEALING A LEAKING EARTH DAM

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INTRODUCTION

Storage dams which leak result in three major problems to the farmer :

- he does not derive full benefit from his investment
- the seepage water could cause waterlogging and/or salinisation problems downstream
- if the seepage takes place through the dam wall, it could cause the dam wall to collapse, with resultant damage downstream.

Leakages can take place either through the wall itself, through the foundation, or through the storage basin. In this leaflet the various methods of sealing these leaks are discussed.

A LEAK THROUGH THE EARTH DAM WALL

This can either be as a result of unsuitable permeable material having been used in the construction

of the embankment, or because the side slopes of the embankment are too steep. No earth embankment is entirely impermeable, and when water builds up against it, seepage takes place laterally into the embankment. It has a downward tendency under gravitational attraction as well. All the material below the so-called line of saturation is unstable, and the idea in designing an earth dam wall is to make sure that this line of saturation does not intercept the downstream sideslope. If it does, the soil surface below it (see Figure 1) will be unstable, seepage is accelerated and a slip circle could cause the collapse of the embankment. There are three methods of reducing this type of seepage:

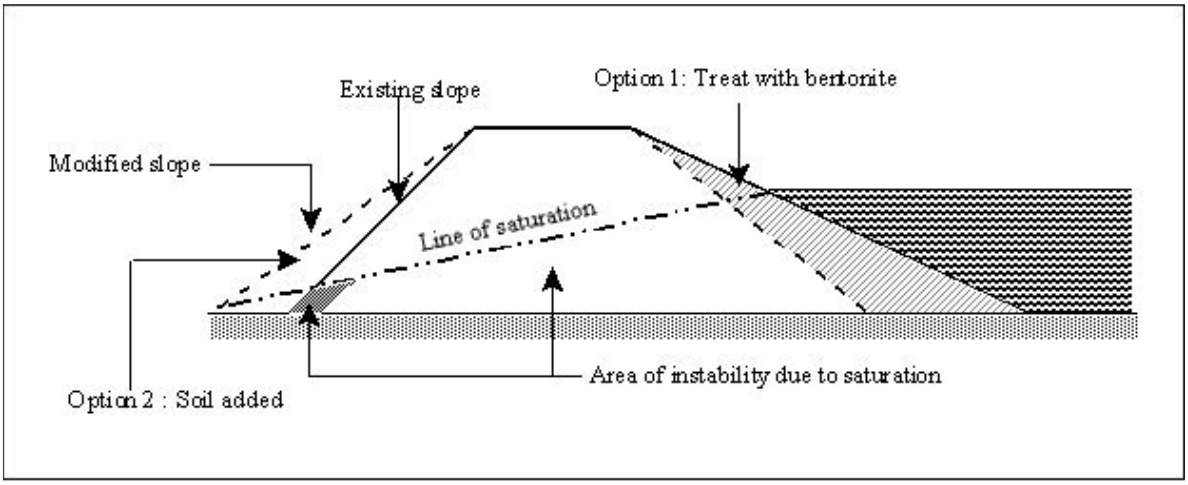

Figure 1. Cross section through dam wall showing how too steep a side slope can cause instability

- drain the dam and treat the waterside face with one of the preparations discussed later in treating seepage through the basin (Figure 1)
- cover the waterside face with an impervious membrane of butyl rubber or plastic (Figure 2)
- broaden the downstream width of the wall in order to cover the line of saturation (Figure 1).

The additional earthwork must be carried out in the recommended fashion, removing all vegetative material prior to construction, using soil at optimum moisture content, and working in a horizontal, stepwise manner, keying the new earthfill to the old one.

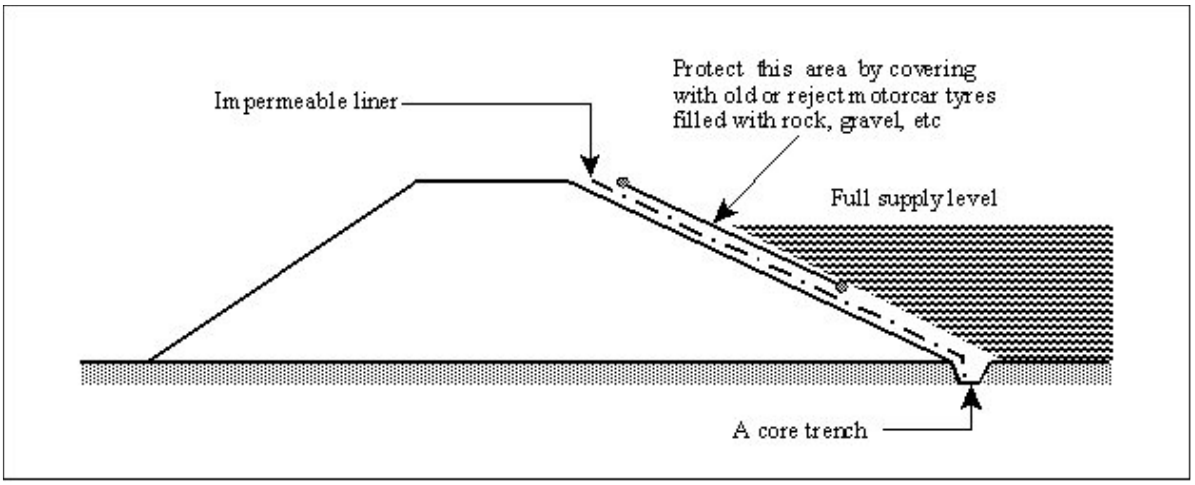

Figure 2. Fitting an impermeable liner to a dam wall to stop seepage through the embankment

A LEAK THROUGH THE FOUNDATIONS

This would generally be the result of stored water escaping underneath the dam wall along a porous ubstrate layer which was not sealed during construction. A core trench *is always* necessary along the centre of the base of an earth dam wall. The idea is to excavate it down through pervious substrata, also cutting off subterranean tunnels caused by insects, animals and tree roots, and backfilling with a strong clay at optimum moisture capacity. If this was not done during construction, or not done sufficiently well, a new core trench will have to be excavated and backfilled along the *upstream* toe of the embankment. Figure 3 explains what must be done.

SEEPAGE THROUGH THE BASIN

There are a number of methods and preparations available for sealing the basin of a pond, and these are discussed separately. Bear in mind that the basin is not necessarily porous over its entire area. It may be that only a part of the area causes the stored water to leak out, and the sealing of dams is expensive. A proper site inspection is needed to ascertain the true state of affairs before sealing is contemplated.

- A clay blanket of at least 250 mm depth is brought in from an outside source, and this is well compacted at optimum moisture content over the entire basin (or affected area of the basin). The clay must have a sufficient moisture so that a 3 mm N spindle can be rolled without it breaking. Depending upon the distance that the material has to be transported, this method can be fairly expensive. One cubic metre of compacted clay (about 1,5 tonne) will only cover 3,5 square metres to a depth of 250 mm.

- The product Calgon (sodium hexametaphosphate), obtainable through most chemists, is used as a deflocculant in soil laboratories. When mixed with water and shaken up, it causes the clay particles in a soil to separate from each other, instead of assisting the coarser particles to adhere to each other in the formation of a crumb-like structure. These separated clay particles can then move with seepage water into a soil profile, blocking the interstices and sealing the surface. In an experiment at Cedara using a rainfall simulator, rainfall

infiltration into the land surface of an Inanda clay soil was reduced from 42 mm/hr to 24 mm/hr through the application of Calgon sprayed onto the ground surface at the rate of 200 kg per hectare.

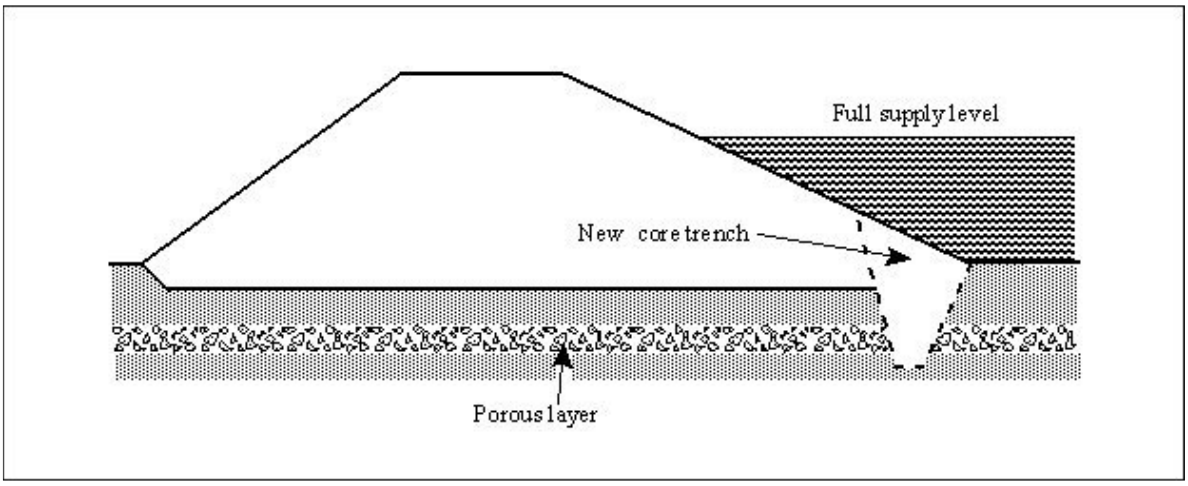

Figure 3. Cutting a core trench into an existing dam

- Organic matter can work in the same way as that mentioned above. Karroo farmers have for many years sealed storage ponds by fencing off the dam at full supply level and feeding stock in the enclosure with hay throughout the winter. Dung and vegetative material is thereby trampled into the basin surface, effectively sealing it. Another similar method is to just pack hay bales throughout the basin, and as the hay rots and the water seeps away the organic material moves into the soil surface, swells, and seals the interstices. There is, of course, a pollution problem to this solution.

- Sodium bentonite is a chemical with the appearance of very fine clay which swells to fifteen times its own size when coming into contact with water. When mixed with well-drained soil in the correct proportions it radically reduces the capacity for water to move through that soil. There are two ways in which bentonite can be used: the mixed blanket technique and the pure blanket method. Irrespective of the method used, however, there are a few rules that are basic to both:

    - the treatment does not appear to work very well on gradients in excess of 1 in 3 (vertical to horizontal),

    - the area to be treated must be free of vegetation and rocks,

    - never start an area larger than can be completed in one day,

    - carefully seal off all installations that will penetrate through the treated layer, such as concrete works, pipes, *etc*. This can be done by carefully hand-applying and hand compacting a mixture of 1 part bentonite to 4 parts of damp (but not wet) soil, along all the edges of such installations, and to a depth of at least 100 mm. (Figures 4 and 5),

- be very careful to join the new day's work to that of the previous day, otherwise leakages will continue,
- leave the treated area undisturbed for at least four days for the chemical hydration to take place, and
- divide the area to be treated into suitably sized squares, each one large enough to require one standard 40 kg bag of bentonite at the recommended rate. Ensure an even spread of the chemical over the given panel.

The two different methods are as follows, and all the steps enumerated must be completed in one day on any given area. It is preferable that no work with bentonite take place on a windy day.

- **The Pure Blanket Method**
  - wet the surface to be treated to optimum moisture content and compact firmly with either a vibratory or steel wheel roller,
  - having marked out a grid system of 2 metre x 2 metre squares, spread the contents of a 40 kg bag evenly over each one, giving a uniform thickness of 10 t o 15 mm, and
  - cover the bentonite film with a layer of soil 250 mm thick, moisten and compact.
- **The Mixed Blanket Method**

  This method should be more cost effective than the previous one, but requires an estimation of the quantity of bentonite required for the specific soil type. One supplier recommends an application rate of 40 kg per 3 square metres for 'average soil with no gravel in it'. On the other hand a 5 kg sample sent to them for analysis will give the more accurate rate of application. The method is as follows:
  - wet the soil (to 150 mm depth) to optimum moisture content,
  - loosen the top 150 mm with a plough or harrow,
  - mark out the grid and spread the chemical evenly,
  - mix the soil and chemical thoroughly using a disc harrow or rotary tiller, and
  - compact and cover with 100 mm of imported soil.

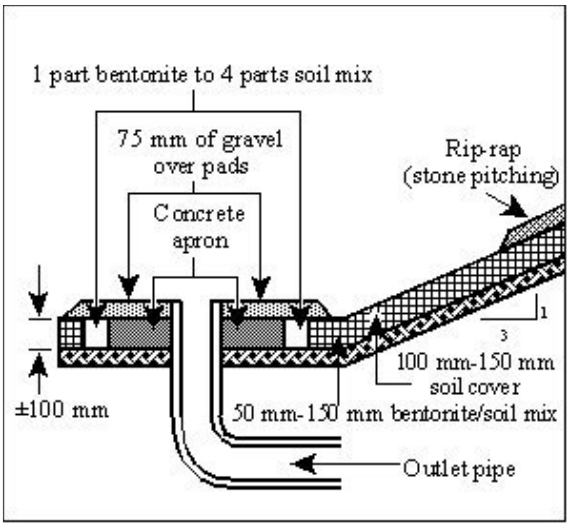

Figure 5. Sealing pipes and embankment with bentonite

Bentonite can be applied in granular form for emergency repairs as a water surface application when the dam contains water, although success is not certain. For further information and assistance the reader is referred to the following suppliers of bentonite:

Cullinan Minerals Ltd, Olifantsfontein, Gauteng.
Boland Base Minerals, Milnerton, Cape.
Aquasave Sealants Natal, Durban, KwaZulu-Natal.
James Panton Associates, Hillcrest, KwaZulu-Natal.

- **Rubberised geofabric liner:** A non-woven polyester liner impregnated with a water-based bitumen emulsion containing rubber latex (called Viaseal) is reported to have a high puncture resistance. It is also reported to be resistant to attack by a wide range of chemicals. The base of the pond is cleared of rocks and vegetation, smoothed and compacted, and the geofabric rolled out with 150 mm overlaps for sealing adjacent widths. As a first coat a 1 : 1 mixture of Viaseal and water is squeegeed on and into the fabric and allowed to dry. Two subsequent coats of the undiluted product are then applied, with an allowance for drying time in between. One litre per square metre of Viaseal is the average application rate.

  The product is obtainable from Jeffco Marketing, Jacobs, Durban, KwaZulu-Natal.

- **Bitumen emulsion:** This is a bituminous product (called Agrimuls) which is soluble in water. It is used to treat a dam already containing water. Agrimuls is diluted 1 : 9 with water, and poured into the pond at the rate of up to a half litre of Agrimuls (or 4,5 R of the diluted mixture) per square metre of dam surface. This figure applies to sandy soils. Soils with greater clay content will require less. If the water in a dam is not urgently needed, one could try a low rate, giving it a long enough period for the Agrimuls to work into the soil. The rate of seepage is then checked, and if it is still too high, more Agrimuls can be added. Care must be taken to get as even a spread of the solute as possible. As the water in the dam seeps away, so the individual particles of bitumen adhere to the soil granules it comes into contact with, and builds up an impervious asphalt lining. Agrimuls can be obtained from African Bitumen Emulsions (Pty) Ltd, Jacobs, Durban.

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