

Different Ways of Lining Canals

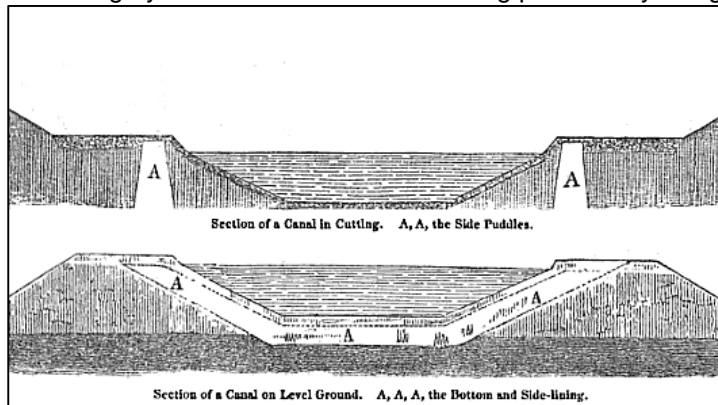
Summary Notes of a presentation given at the "Canal & River Restoration Workshop" held in Birmingham, 25 April 2015

Author: Les Clarke, Principal Engineer, Technical Solutions, Canal & River Trust

(Please note that products mentioned are what we have used and that this is not an endorsement).

- Traditional lining material was puddle clay
- Canals were not necessarily lined, even on embankments, finance as much as engineering would have dictated this
- Across areas of peat the canal would not be lined
- Canals would have leaked large quantities of water on first filling
- Siltation from erosion and rotting vegetation would have sealed them over the months/years following opening
- Effect of diesel engines & propellers from the 1930's has had significant effect on bank protection and siltation
- Change of use, commercial to leisure
- Gradual degradation of assets over time
- Slow renaissance of canals from 1950's onwards, accelerating from the 1980's

A drawing by S C Bees from 1852 showing puddle clay linings:

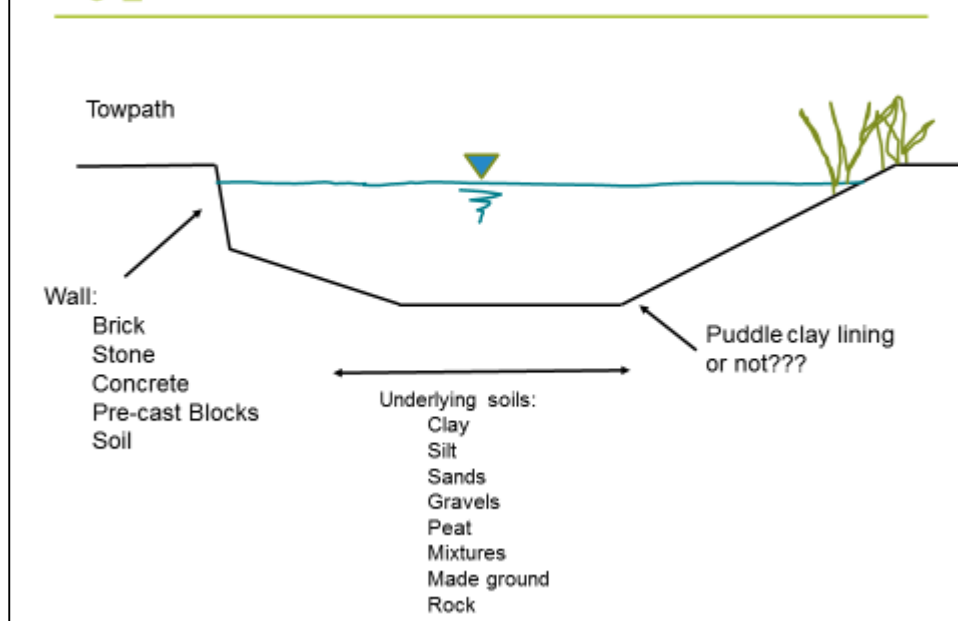


Why are canals lined?

Picture of Shebdon Embankment taken in October 2012. Holes in canal bed due to piping failure. No puddle clay lining.



Typical channel cross section



The underlying natural soils may be permeable, for instance sands and gravels, and so the canal will not hold water. Originally many canals were lined with puddle clay but not necessarily all of them. Some canals were not constructed with clay linings and they would have leaked water until the bed silted up naturally with debris and leaf fall.

Key Issues for Lining Designs:

- Side slope angles
- Connection details to hard structures
- Protection from mechanical damage during and after installation
- Erosion protection, propeller scour damage
- Protection from UV light - plastics
- Longevity – design life
- Ease of construction/installation
- Quality of construction
- Cost

Currently canals are lined in different ways, for example:

- Puddle clay
- Plastic membranes:
 - PVC (polyvinylchloride) ± polyester reinforcement
 - Polyethylene ± polyester reinforcement:
 - HDPE
 - MDPE
 - LDPE
 - Rubber: EPDM
- Bentonite geomembranes:
 - Natural sodium bentonite
 - Dry granules, hydrated bentonite paste
- Bituminous geomembranes
 - e.g. Colas Coletanche
- Reinforced concrete
- Acrylic polymer impregnated geotextile
 - Sahara system

PVC Lining System:



Above - Mon & Brec Canal



Above - Kennet & Avon Canal

Bentonite Geomembrane lining system:
Dutton Breach, Trent & Mersey Canal



Sahara acrylic lining system:
Montgomery Canal, Redwith Bridge to Pryces Bridge



Bituminous membrane lining system:
Millness Cutting, Lancaster Canal



Llangollen Canal, Irish Bridge (?)



Reinforced concrete channel lining system:
Llangollen Canal, near Llangollen



Lining Systems – some key points

PVC Lining System:

- Needs protection from UV light
- Needs protection from mechanical damage
- Flexible, easy to lay, relatively lightweight
- Seals to hard structure are via cast-in water-stops or mechanical fixing
- Joints need welding

Bentonite Geomembrane Lining Systems:

Natural sodium bentonite
Pre-hydrated form
Granular forms

Pre-hydrated sodium bentonite – Rawmat HDB

- Ready to hold water immediately
- Needs covering straight away with 300mm+ of soil or similar covering to prevent expansion
- Not to be laid in wet weather
- Heavy to lay
- Easy overlap joints
- Seals are via bentonite paste plus mechanical fixing if necessary
- Equivalent to 600mm thickness of puddle clay
- Not to be used in highly alkaline water – calcium rich
- Self-sealing if punctured

Granular sodium bentonite

- Needs to hydrate before holding water
- Granules need to be held in place via internal stitching system to prevent migration within the geotextiles
- Needs covering before hydration with 300mm+ of soil or similar covering to prevent expansion
- Not to be laid in wet weather
- Easy overlap joints
- Seals are via bentonite paste plus mechanical fixing if necessary
- Equivalent to 600mm thickness of puddle clay
- Not to be used in highly alkaline water – calcium rich
- Self-sealing if punctured

Acrylic Geotextile Lining System – Sahara:

- Easy to lay
- Overlap joints
- Lightweight
- Seals are via acrylic paste, Geoblock, and mechanical fixing if necessary
- Needs protection from mechanical damage
- Self-sealing if punctured

Bituminous geomembrane – Coletanche by Colas:

- Robust, hard wearing
- Doesn't necessarily require protection from UV light or mechanical plant or boats
- Heavy to lay
- Not very flexible
- Joints are heat welded
- Seals to hard structure via bitumen paste and mechanical fixing
- A "Rolls Royce" system but more expensive

Reinforced concrete channels:

- Robust
- Hard wearing

- Long life in use
- Seals and joints are all designed to standard proven methods
- Complicated cross section shapes are more expensive
- Ideal for narrow constricted channels
- More expensive relative to other systems