Embankment Dam Schematic
Sinkhole in crest of new MD dam
Loveton Dam Failure (1989)
Anti-seep collars do not prevent seepage failures!
78 inch CMP viewed from downstream
Failed PVC pipe with anti-seep collar
Annap Mall collapsed CMP
s. Riser
What caused these failures?

- Design
- Construction
- Inspection
- All of the above??
Spillways are “Confined Space”
Proper compaction in haunch area is critical, but difficult to do with cohesive soil.
Pipe Installation in Dam

Dam Embankment

Flowable Fill

Filter Diaphragm

Pipe in vertical trench
Excavation through dam

- Side slopes must be 2(H):1(V) or flatter

15 ft
FILTER DIAPHRAGM
CONSTRUCTION

Experienced contractor desired

- must realize that ponds are different from roads and utilities
- must work with design engineer
- compaction along spillway is critical--don’t construct embankment and then cut trench
- spillway joints must be watertight
Alternative Designs

- Avoid large diameter CMP
- User weir or drop box structure
- If pipes unavoidable, use:
  - Concrete pressure pipe (min. ASTM C-361)
  - Complete concrete cradle or flowable fill
  - Watertight joints
  - Filter diaphragm
- Avoid combining pond with road embankment
CHUTE SPILLWAYS SCHEMATIC
Concrete flumes on embankment have problems too.
CMP spillway on steep slope through dam embankment
Do's and Don’ts for Pond Design and Construction

- Don’t use anti-seep collars to “stop” leakage
- Do use filter diaphragms
- Don’t allow spillway installation in trench
- Do require watertight joints
- Do inspect each pipe joint as it is put together so it can be redone if necessary
- Do consider alternative spillway design that eliminates pipe through dam or foundation
Inspection

More than just testing Compaction!

- Inspector should:
  - work for the design engineer, not the contractor
  - understand design assumptions and effects of unanticipated conditions
  - not allow deviation from design without design engineer’s approval
  - observe and document: pipe mfg marks, joint type, gasket material and size, and installation procedure
Foundation

- Proof rolling
- Inspection by Geotechnical Engineer
Compaction

- Use STANDARD Proctor (ASTM D-698 or AASHTO T-99)
- Do Not use MODIFIED Proctor (ASTM D-1557 or AASHTO T-180)
- Nuclear gage readings need to be corrected to match lab moisture & density
Utility Conduits
(water, sewer, gas)

- Pipes through the dam must meet spillway requirements
- No granular backfill for pipes parallel to the dam axis
Pre-cast riser structures
Anchor Plates

Movement
Leaky Joints
Concrete Pipe Installation

- Pipe supports
- Clean and Lubricate joints
- Lubricate Gasket
- Tension Gasket
- Full concrete cradle, not just bedding
- If not o-ring gaskets then owner and engineer must approve
Prepare foundation and supports
Mudmat is a good idea
Clean joints
Lubricate joints
Lubricate o-ring
Tension o-ring with round-shaft screwdriver
Mis-aligned o-ring ...
...causes broken bell
Gaskets for Concrete Pipe

Traditional O-ring joint

- Deep joint allows for substantial extensibility
- Symmetric design accommodates internal or external pressure
Newer “Profile Gaskets”

Press-Seal Gasket Company states these “advantages” over o-rings:

• Stepped joint is cheaper to manufacture than groove for confined o-ring gasket
• Easier to install, less force needed to “home” joint
• Less bell breakage
Gaskets for Concrete Pipe

New style “Profile Joint”

- Smaller joint separation allowance
- Designed for internal pressure
Gaskets for Concrete Pipe
New style “Profile Joint”
Formed concrete cradle
Cradle poured against soil
Poor installation
Take Pictures!
Dam on Soft Foundation
Spillway pipe at end of construction
Same pipe after excessive foundation settlement