INTERNAL EROSION Associated with Conduits through Embankments

by

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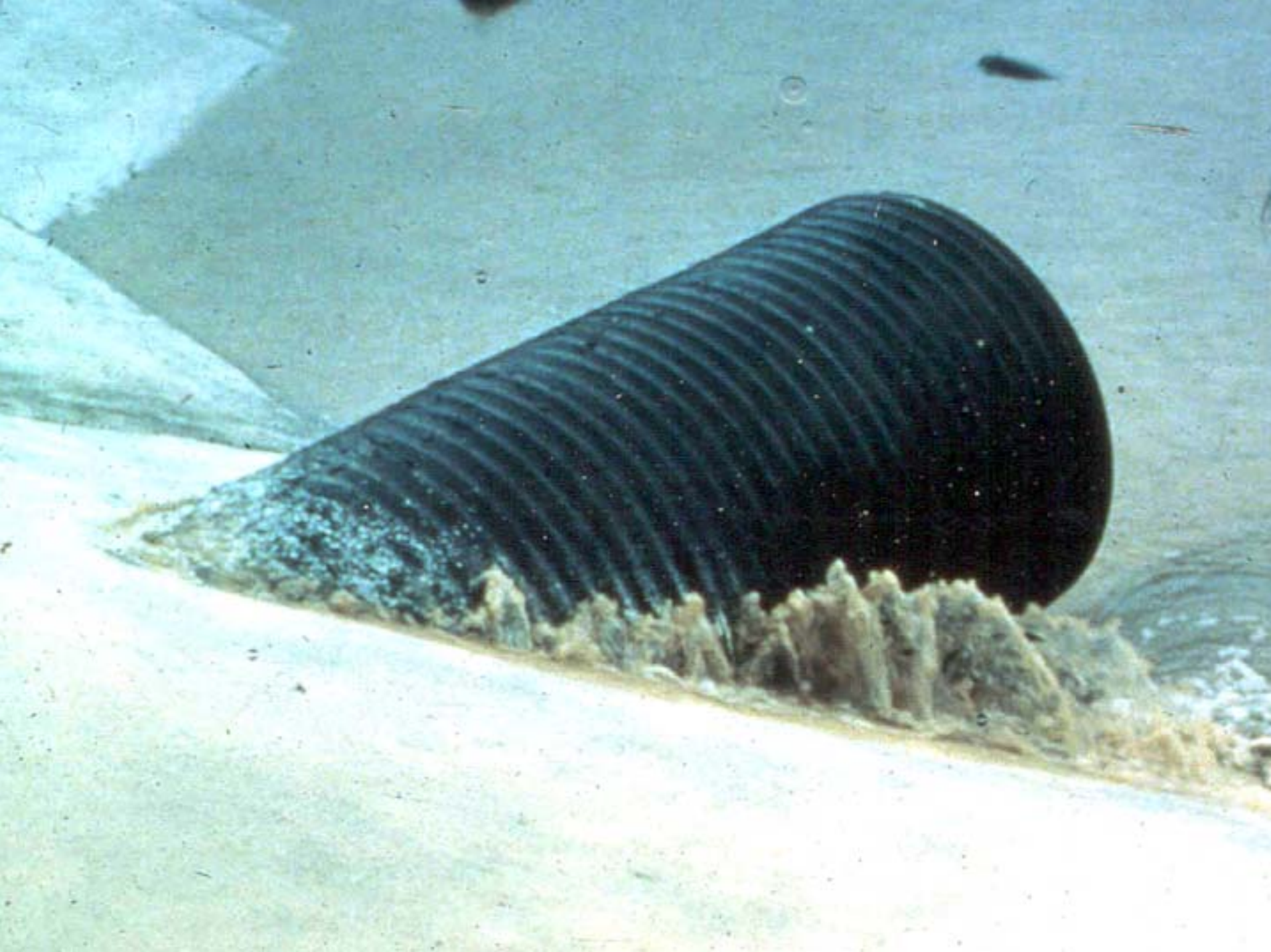
Maryland Dam Safety


Embankment Dam Schematic




DEC 11 2001


Anti-seep
collars do
not
prevent
seepage
failures!


78 inch CMP viewed
from downstream

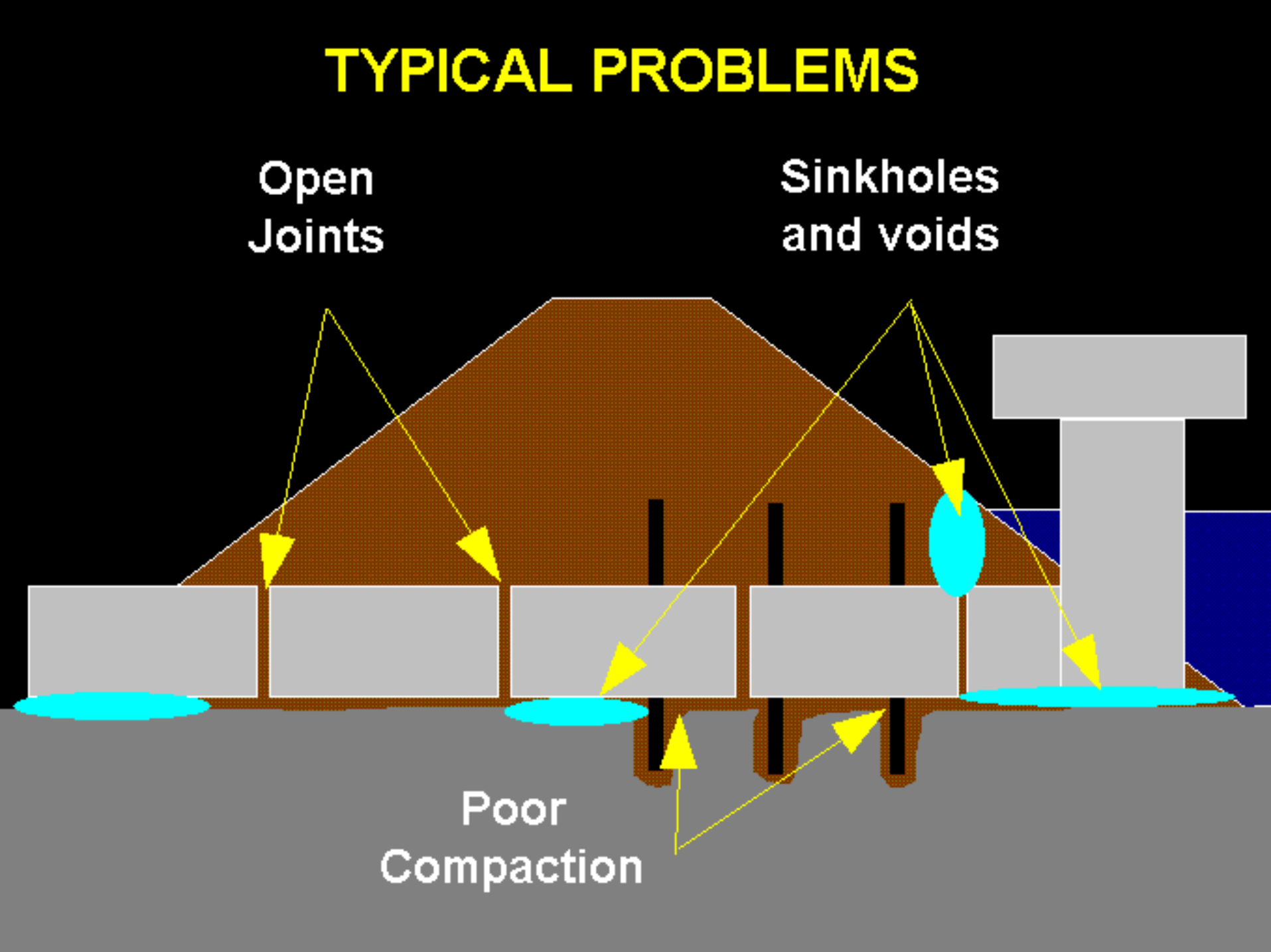

Failed PVC pipe with
anti-seep collar

What caused these failures?

- **Design**
- **Construction**
- **Inspection**
- **All of the above??**

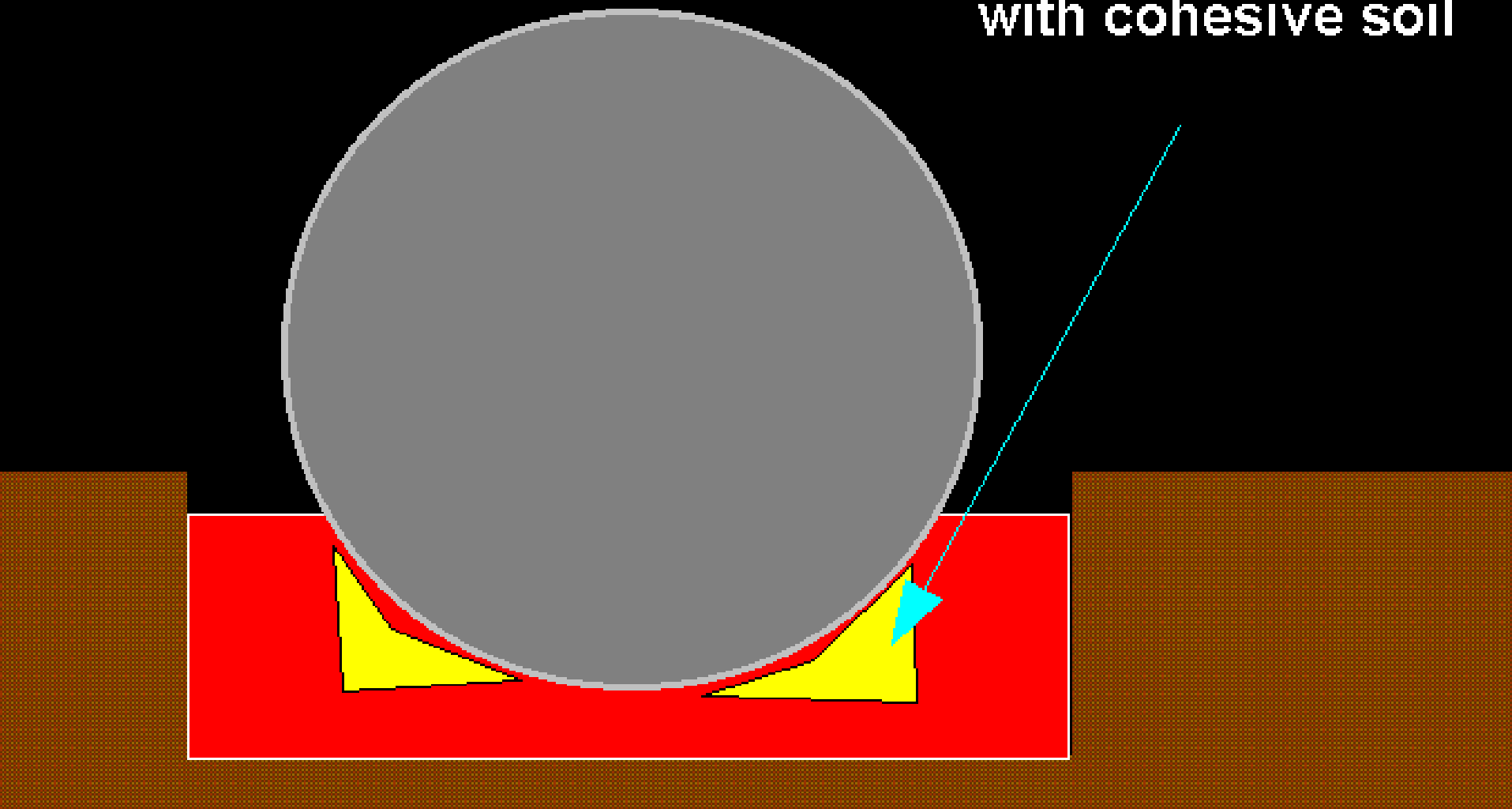

Spillways are “Confined Space”

TYPICAL PROBLEMS

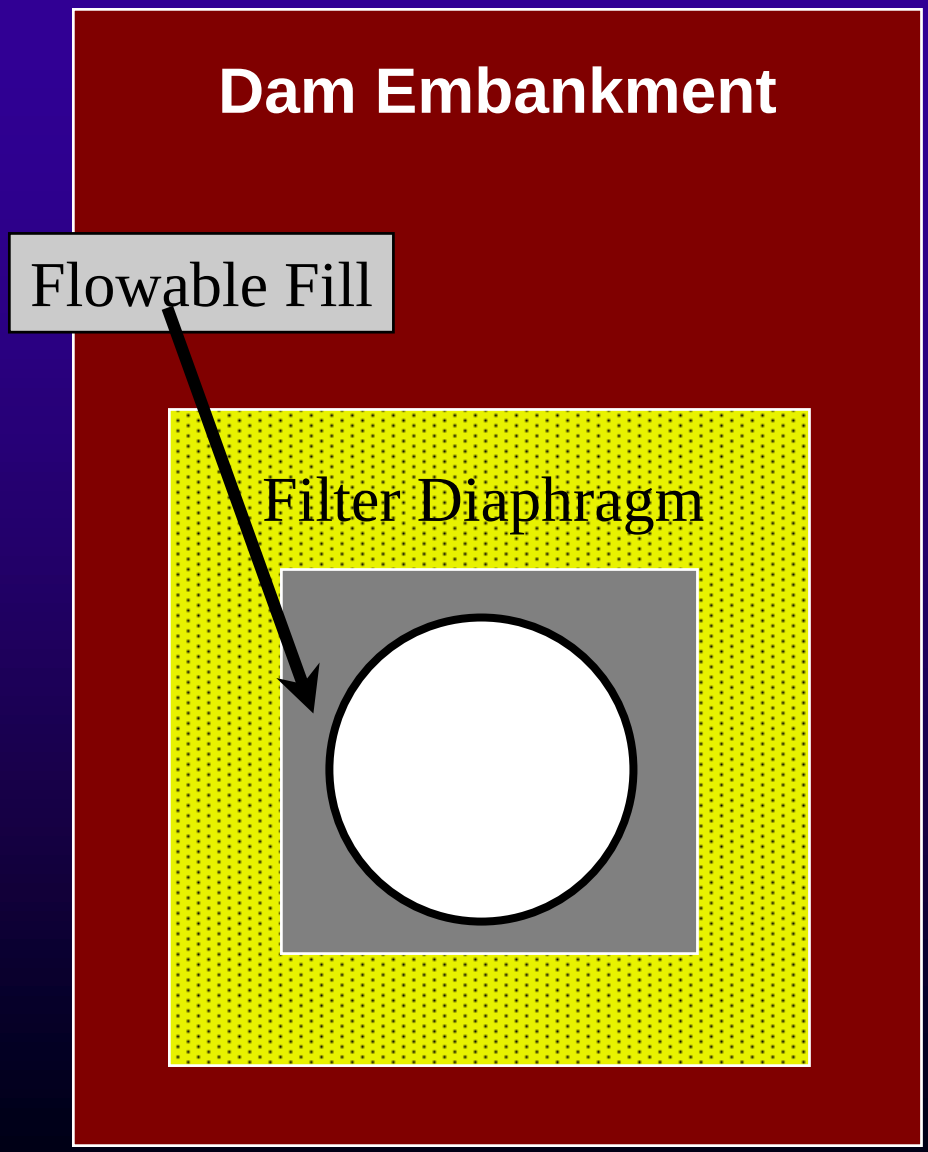


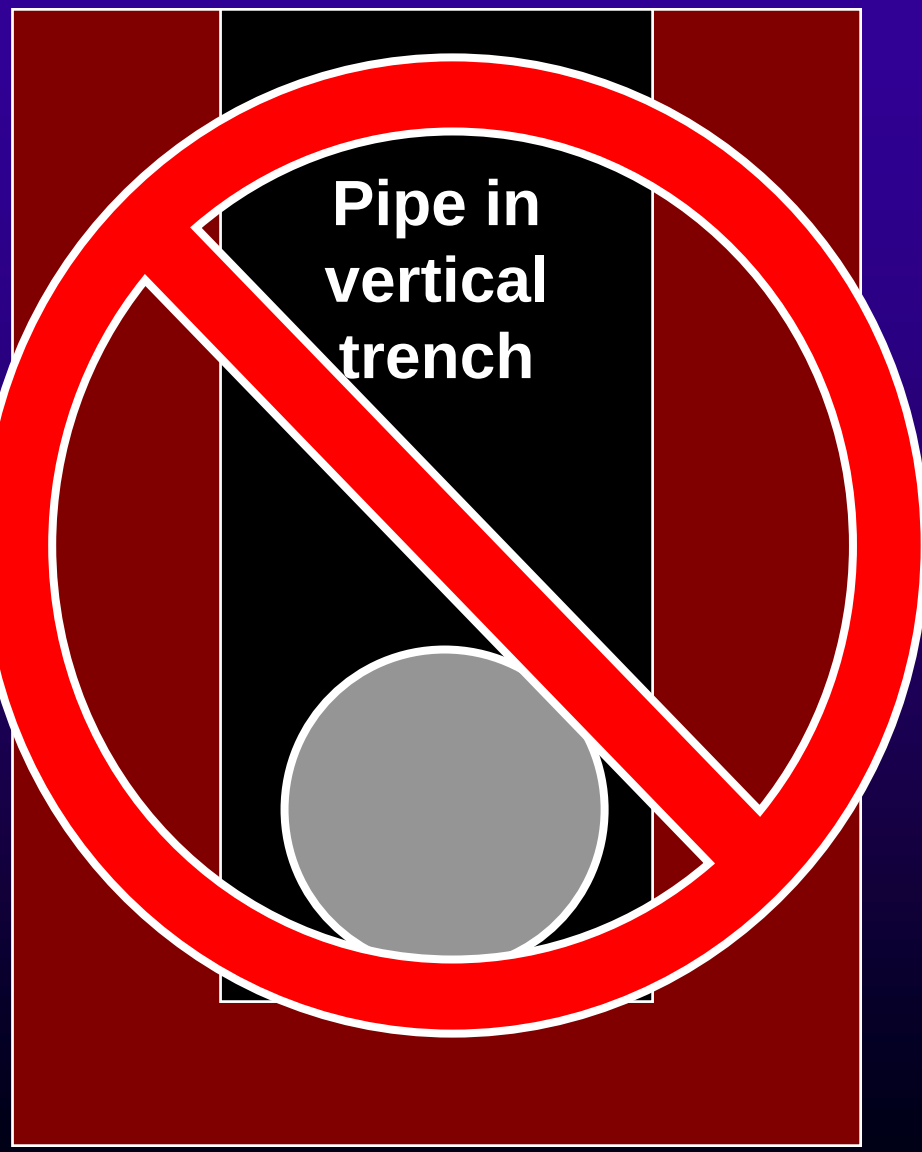

TÓP

Proper compaction in haunch area is critical, but difficult to do with cohesive soil



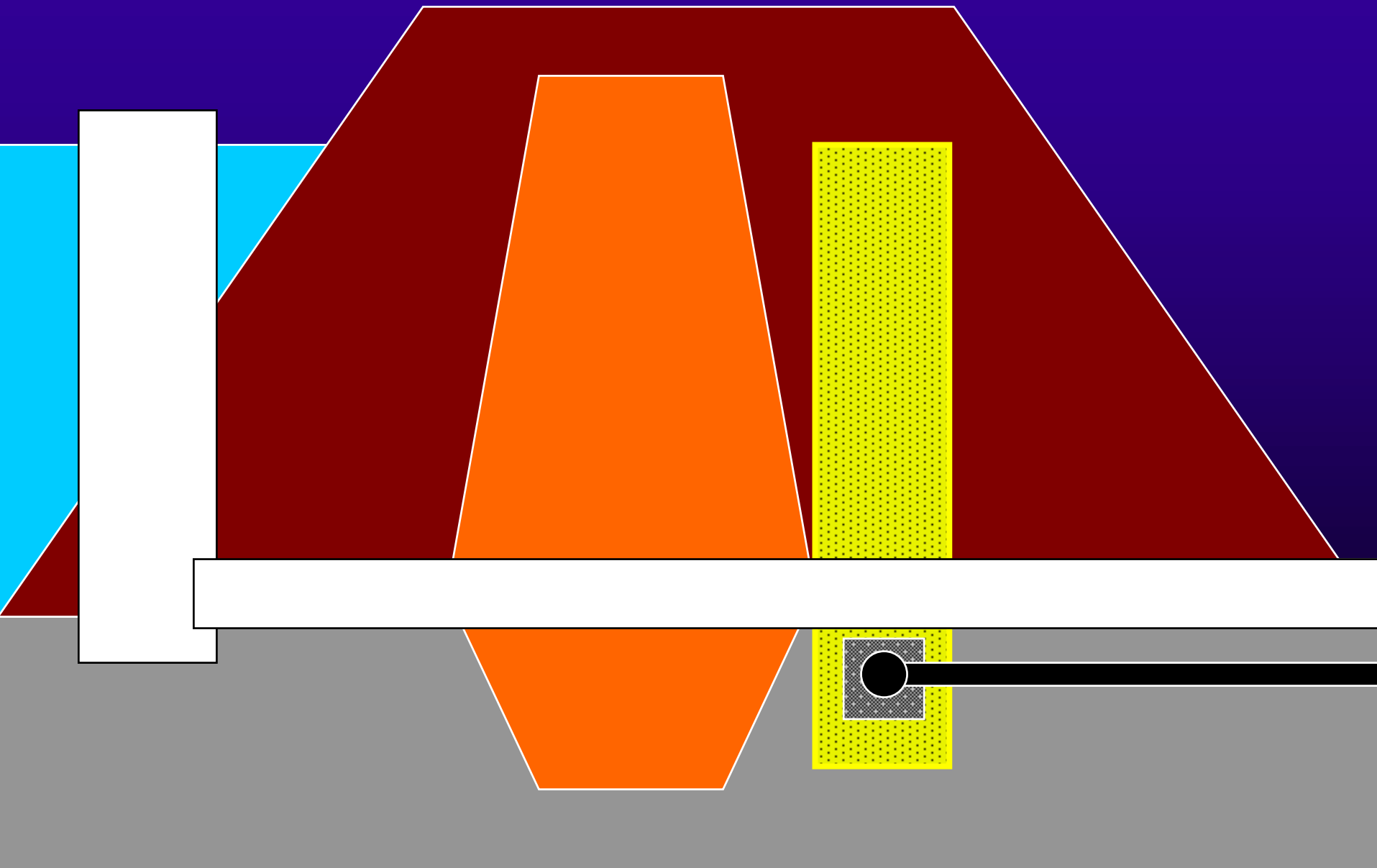
Pipe Installation in Dam





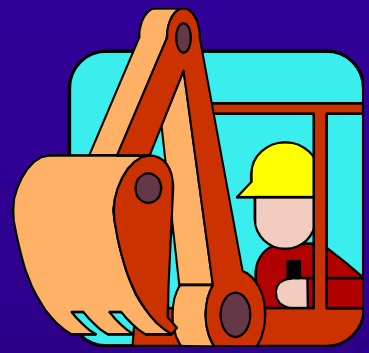

15 ft

FILTER DIAPHRAGM



CONSTRUCTION

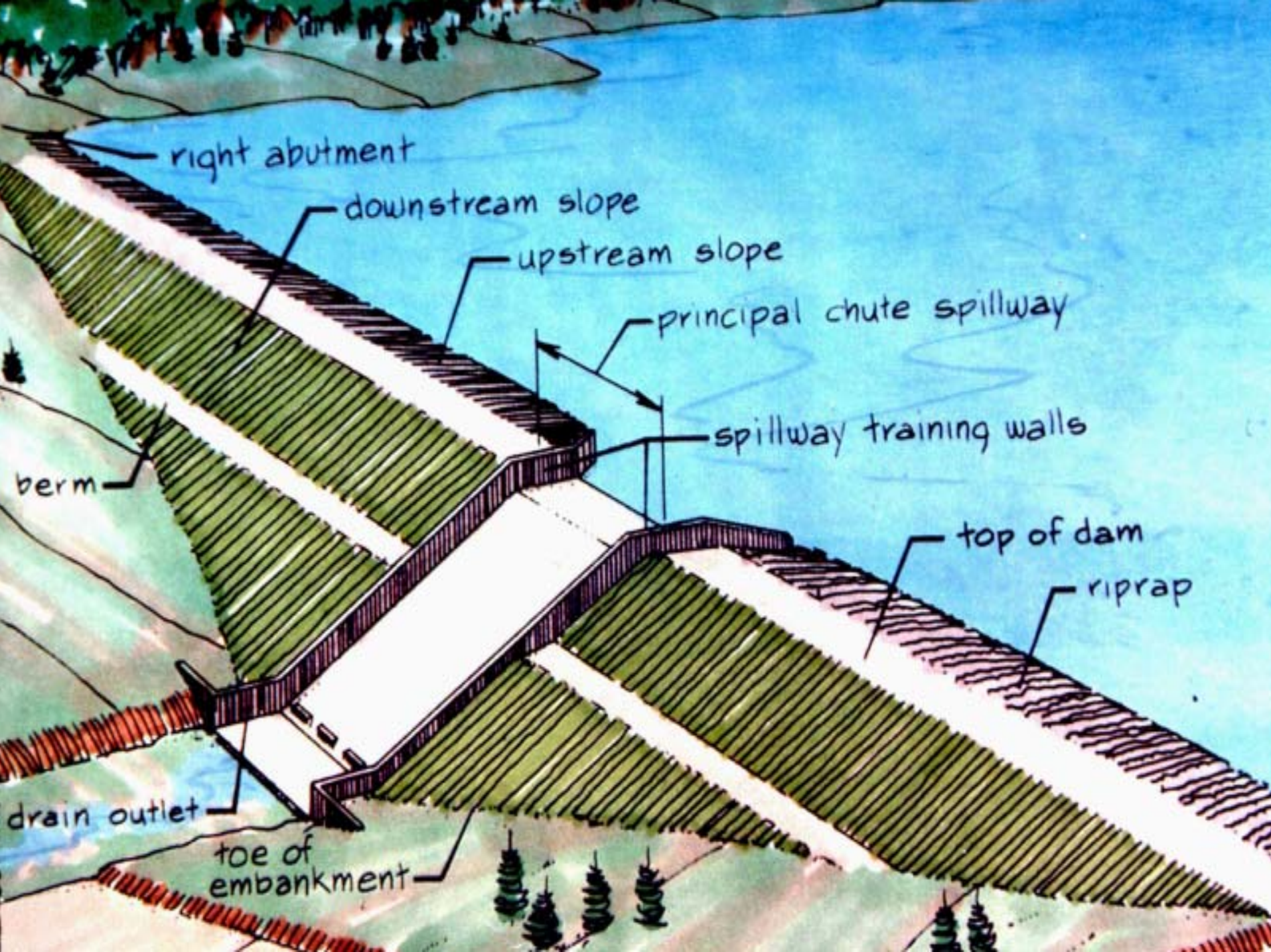
Experienced contractor desired



- 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 *with o-ring gaskets*
  - Filter diaphragm
- Avoid combining pond with road embankment


right abutment
downstream slope
upstream slope
principal chute spillway
spillway training walls
berm
top of dam
riprap
drain outlet
toe of embankment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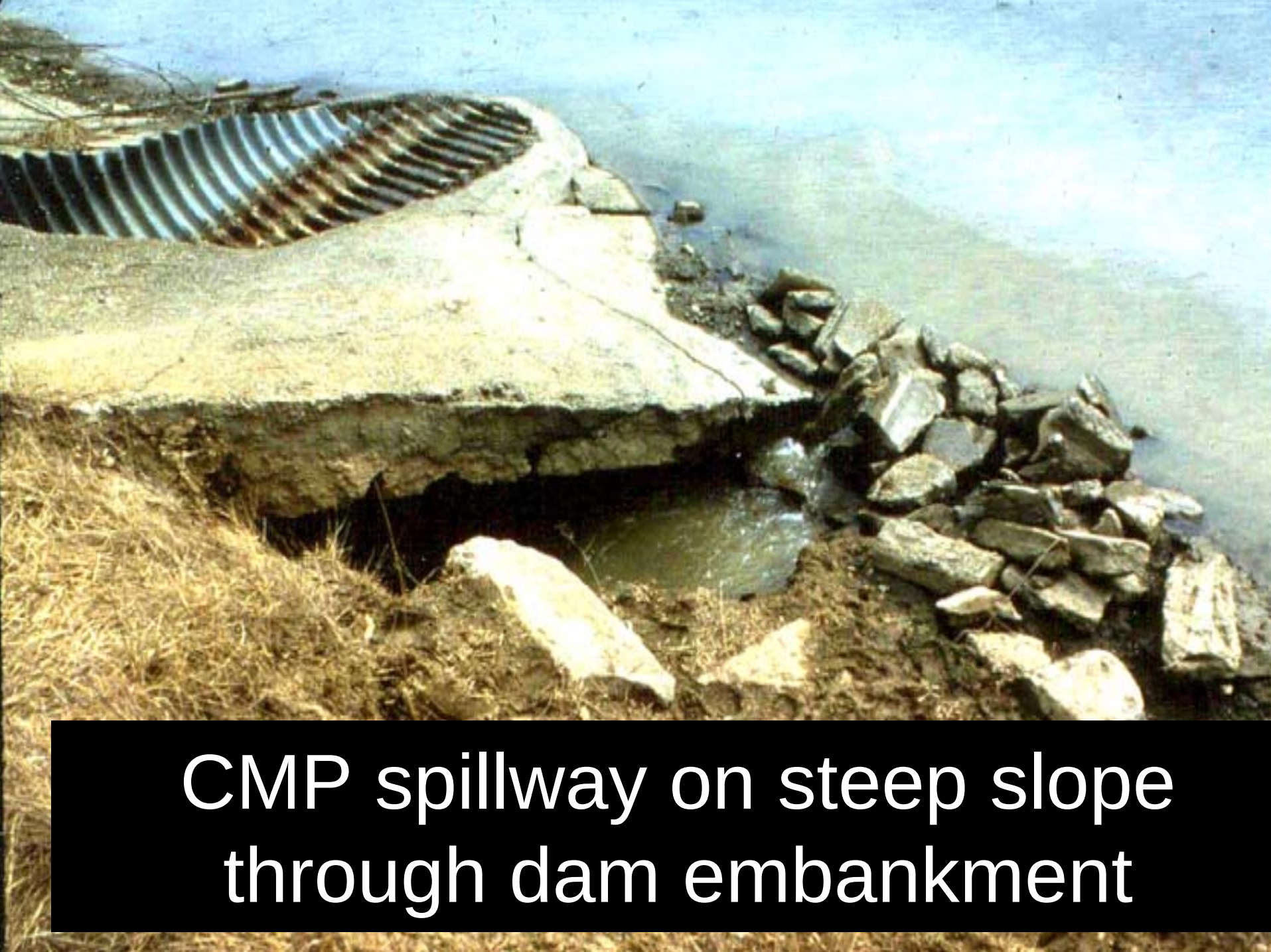
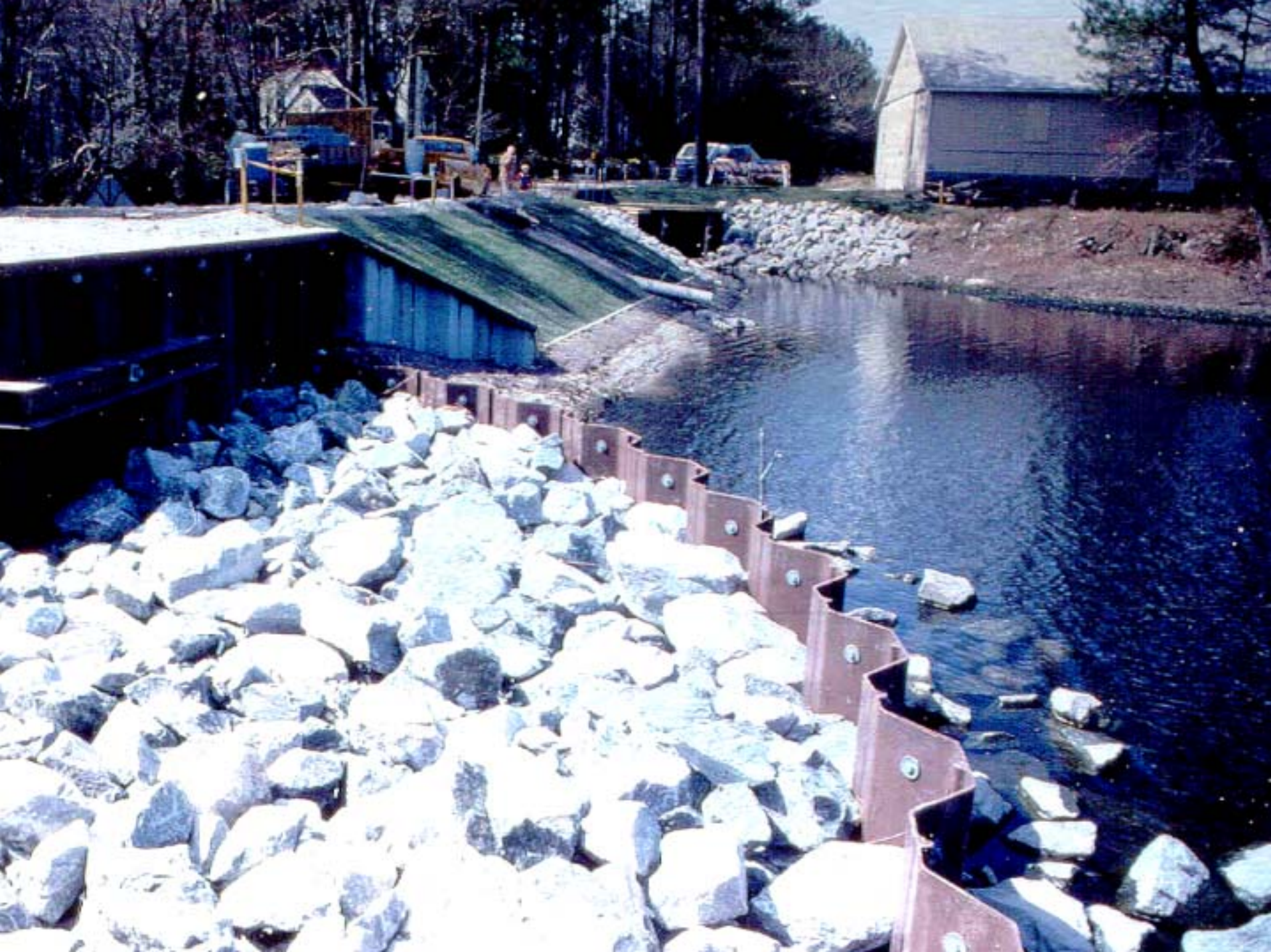


CMP spillway on steep slope through dam embankment


APR 23 2003



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

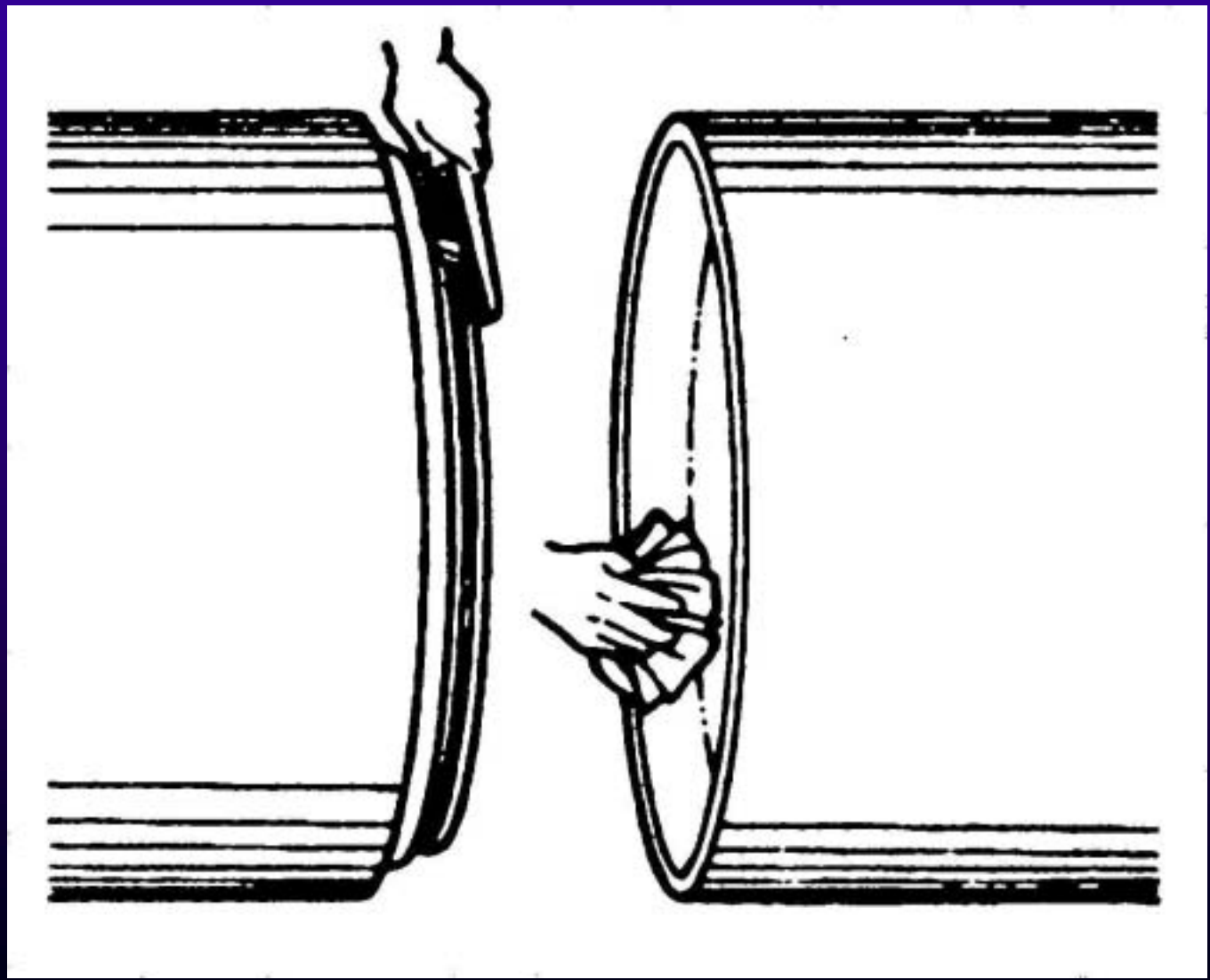
- Pipe supports
- Clean and Lubricate joints
- Lubricate Gasket
- Tension Gasket
- Full concrete cradle, not just bedding
- If not o-ring gaskets then owner and engineer must approve


11/20/06

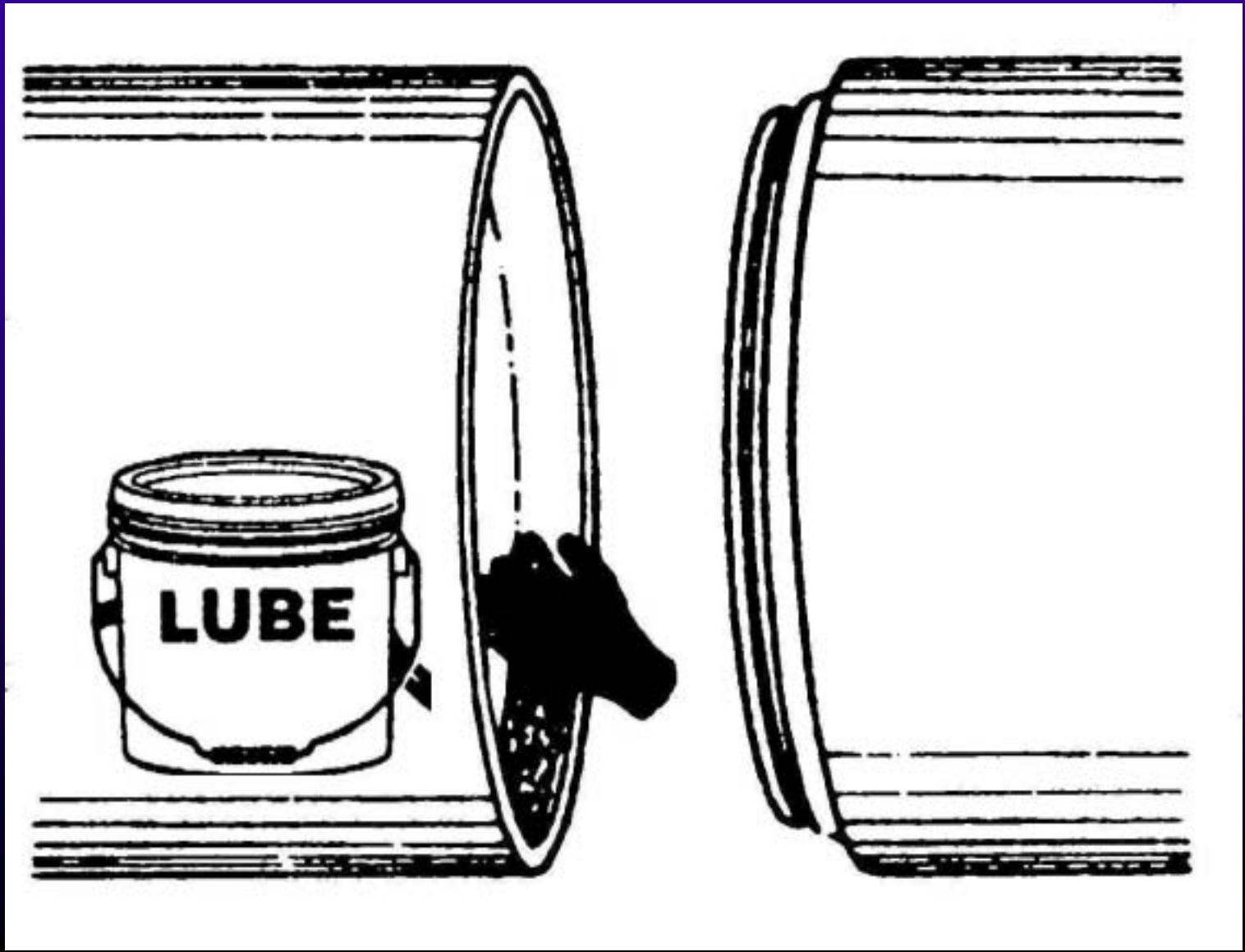
Prepare foundation and supports

Mudmat is a good idea

Clean joints

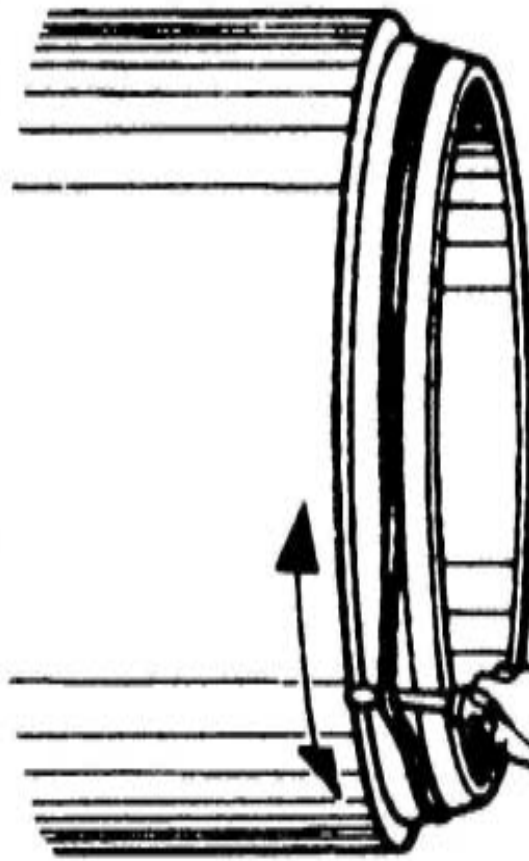


Lubricate joints

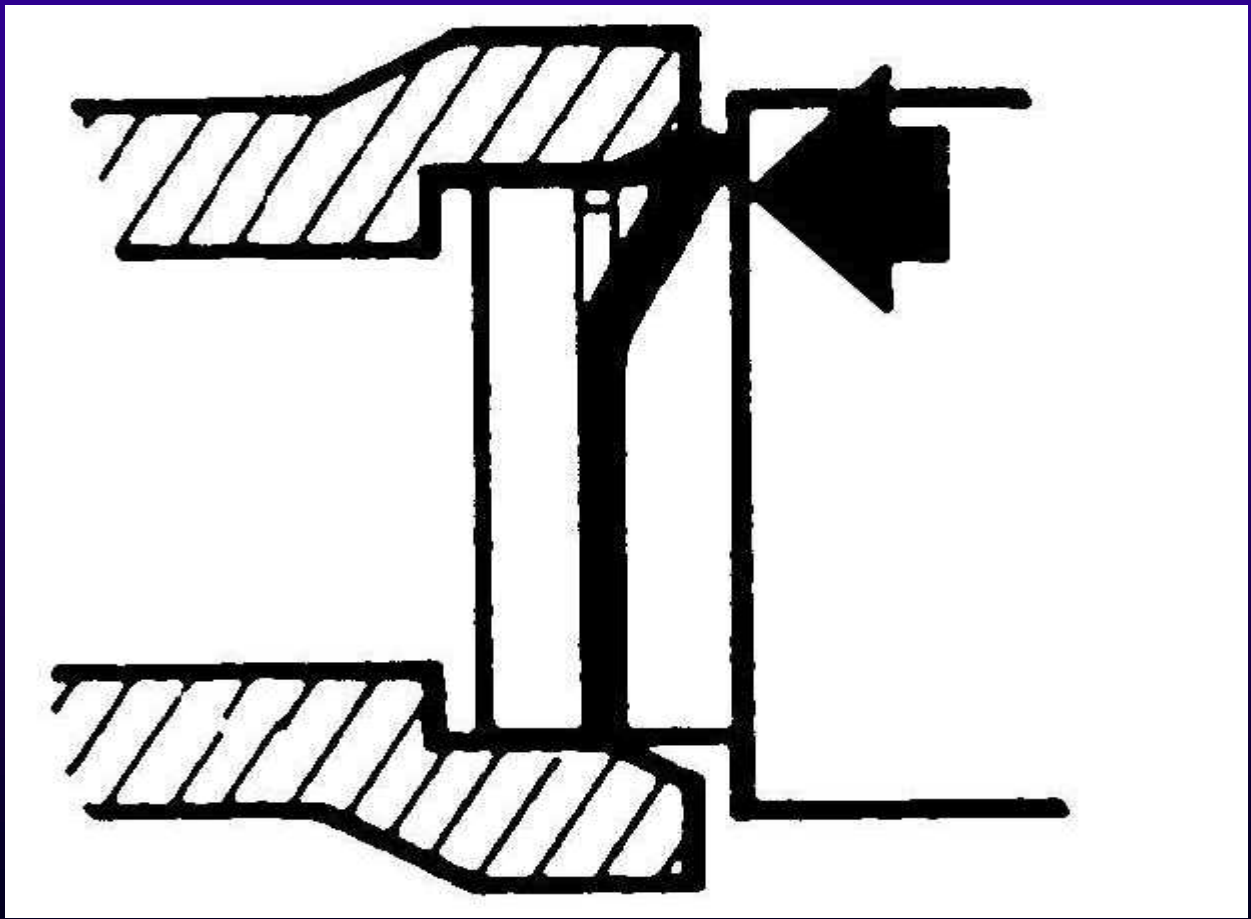


Lubricate o-ring

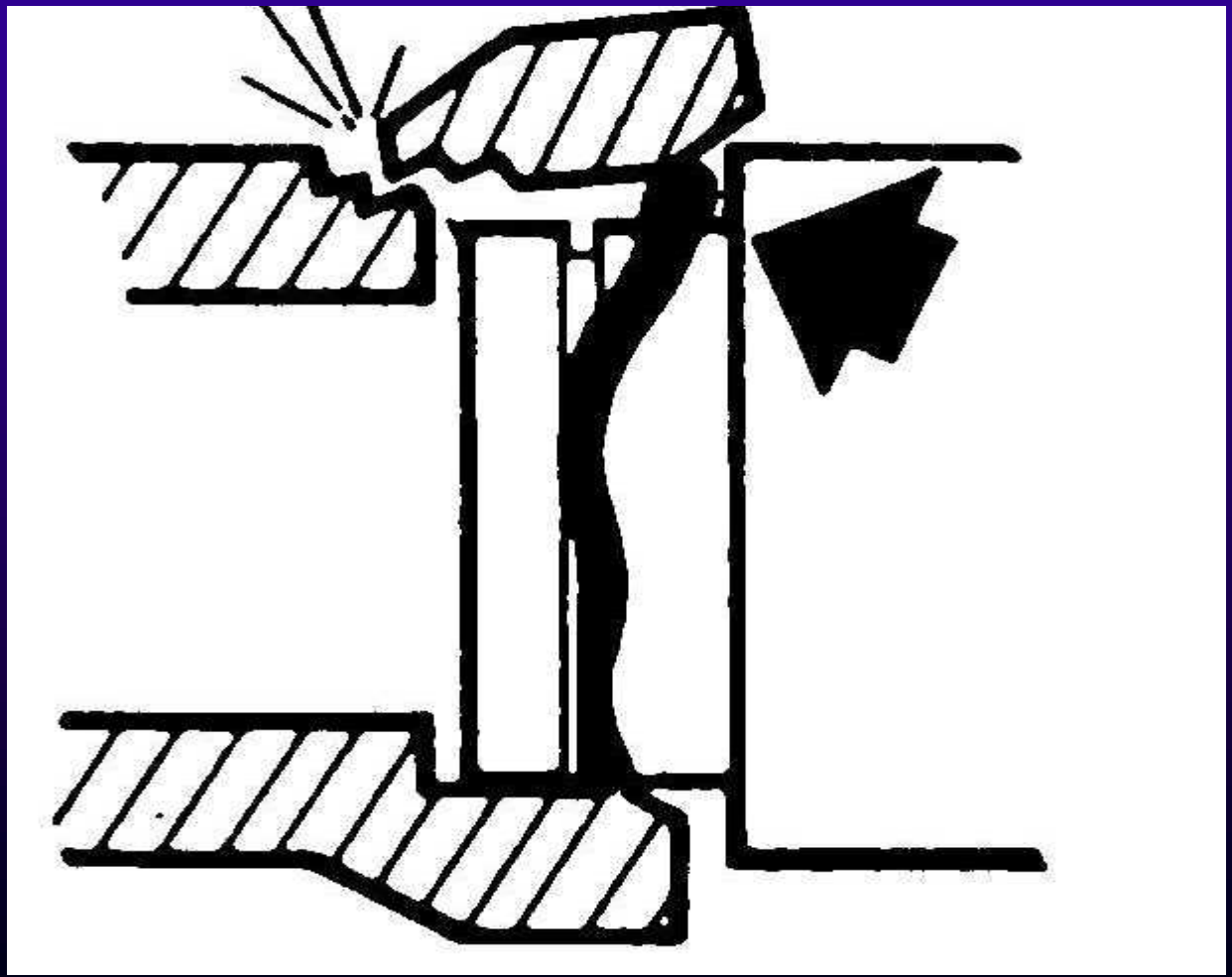
Tension o-ring with round-shaft screwdriver



Mis-aligned o-ring ...

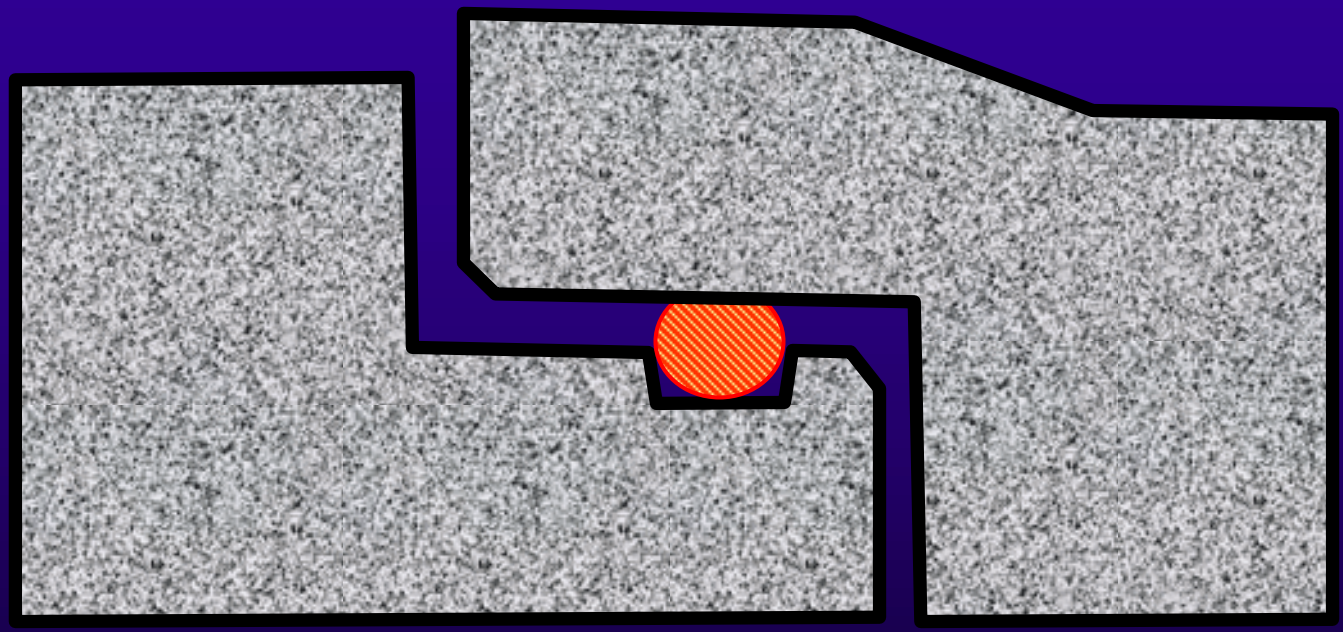


...causes broken bell



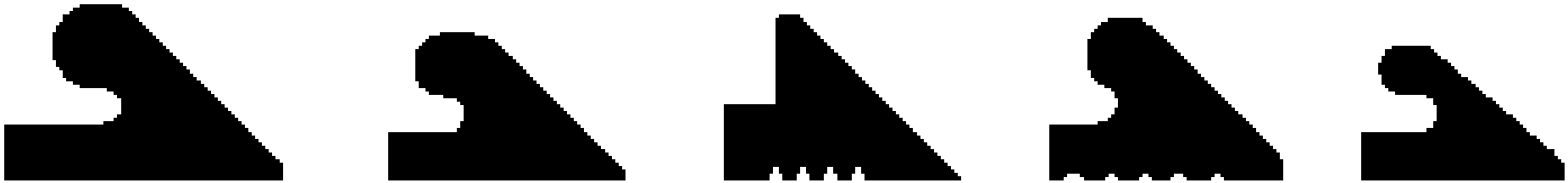
Gaskets for Concrete Pipe

Traditional O-ring joint



- Deep joint allows for substantial extensibility
- Symmetric design accommodates internal or external pressure

Newer “Profile Gaskets”

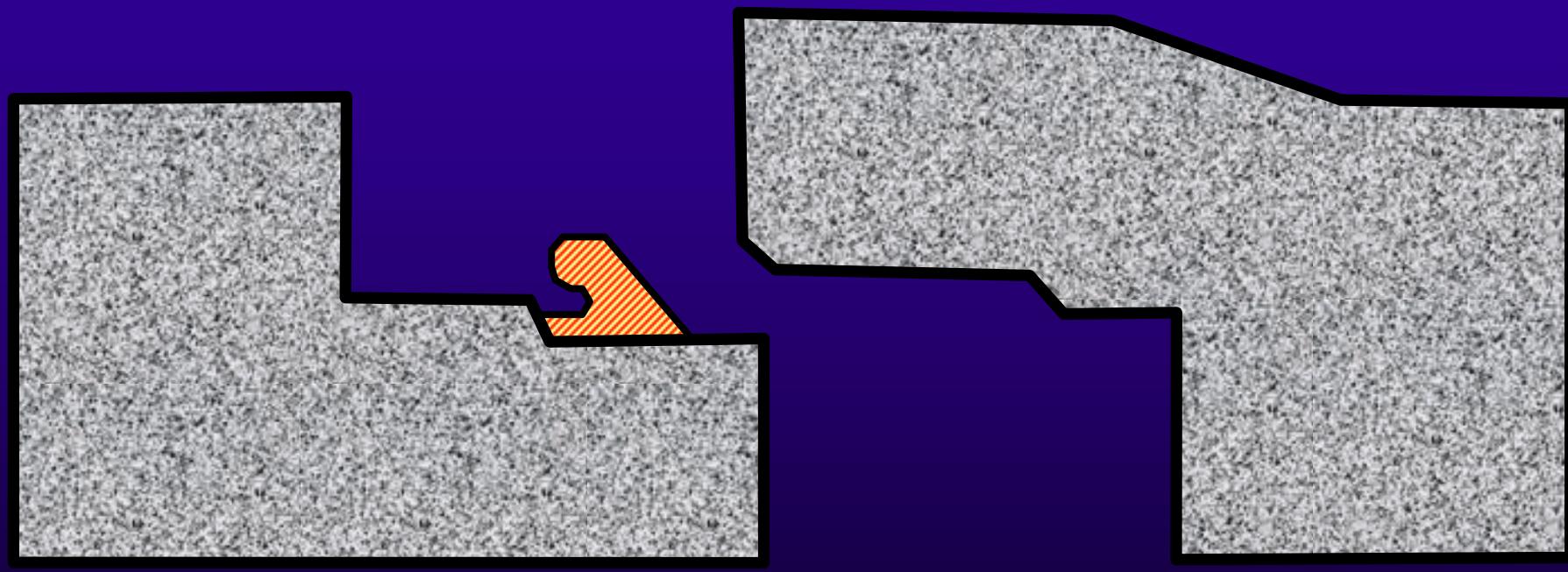


Press-Seal Gasket Company states these “advantages” over o-rings:

- **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

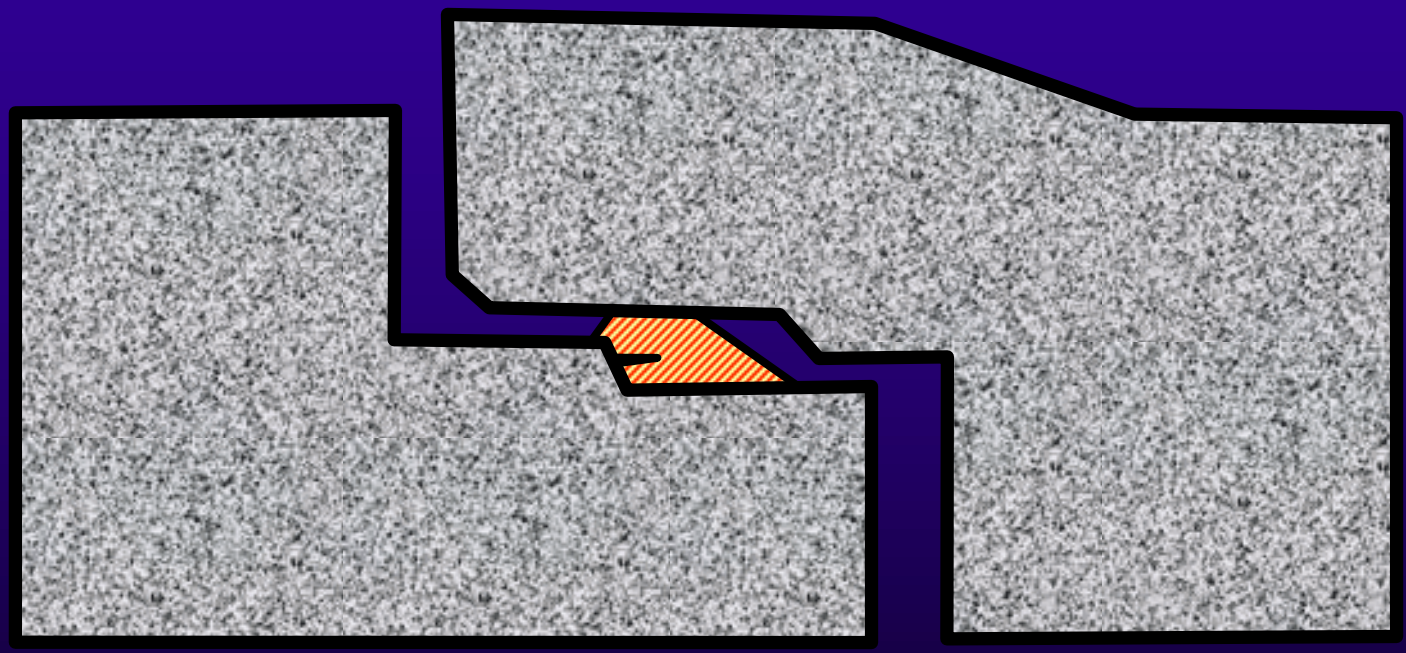
New style “Profile Joint”



- Smaller joint separation allowance
- Designed for internal pressure

Gaskets for Concrete Pipe

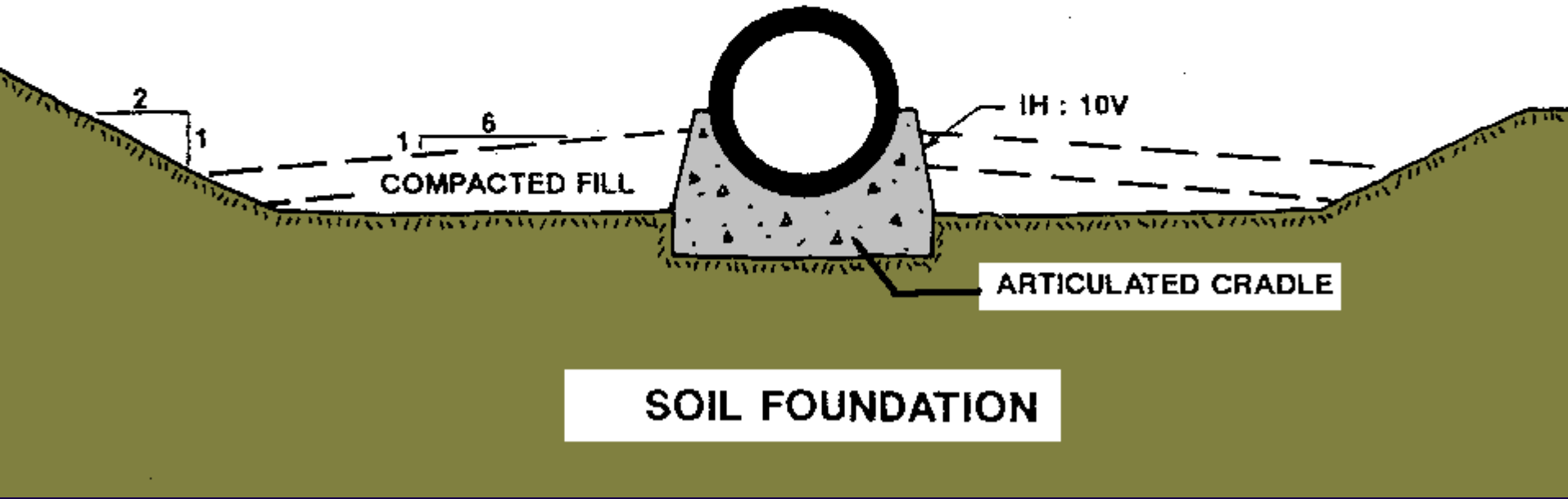
New style “Profile Joint”



Formed concrete cradle

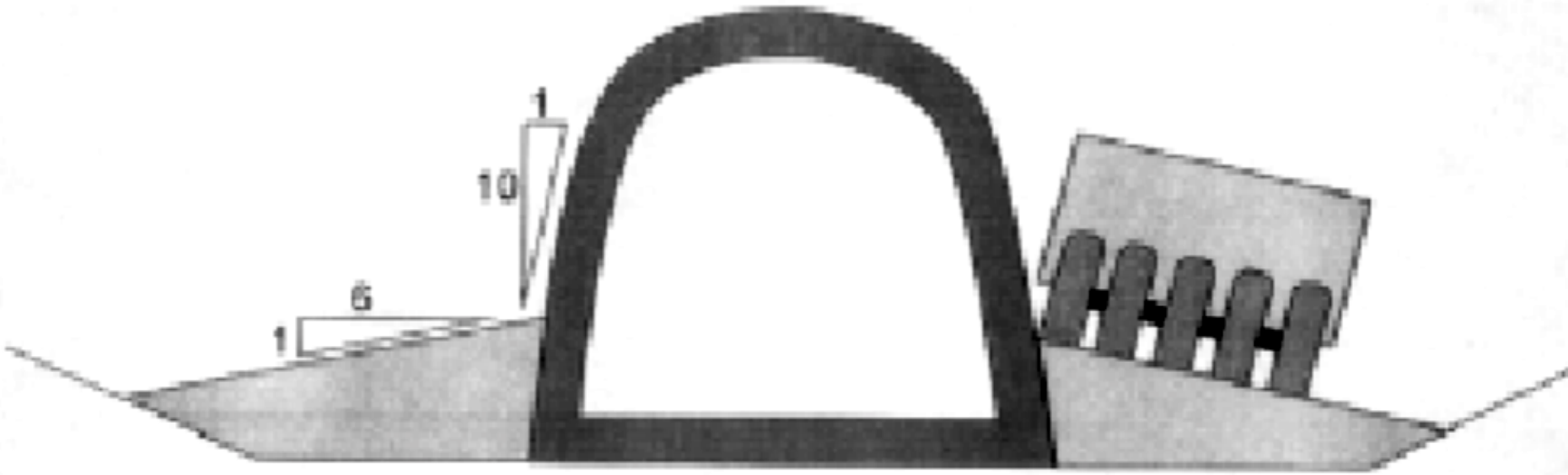
Cradle poured against soil


Poor
installation



SOIL FOUNDATION

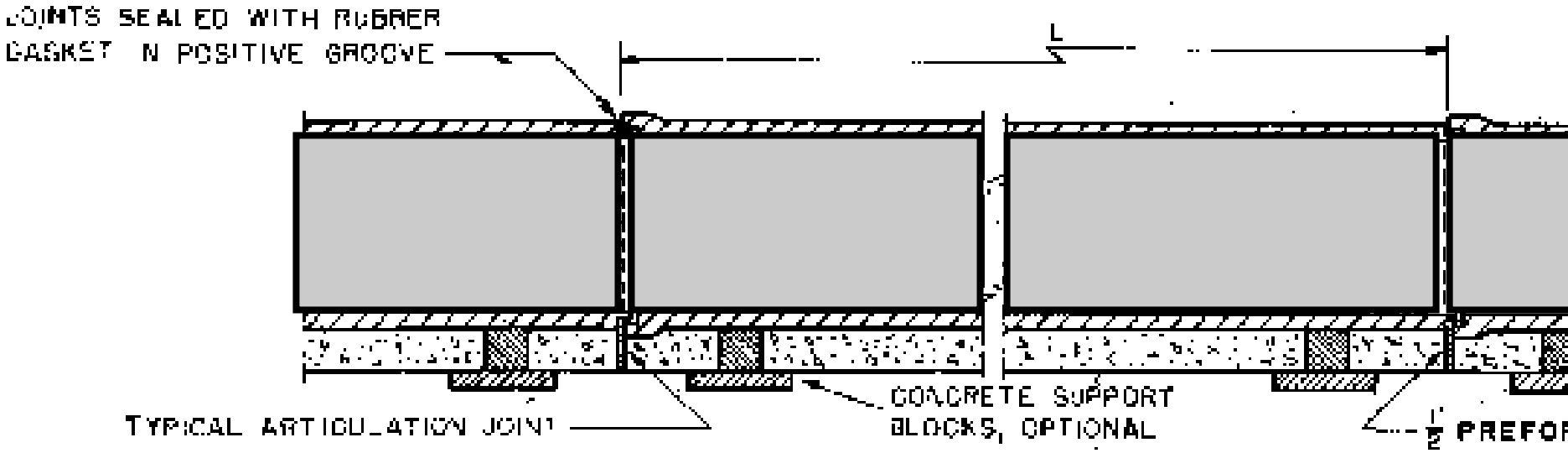
USBR Guidelines - ACER Tech. Memo. No. 9 (1987)



1 on 10 slope on sides of conduit (concrete)

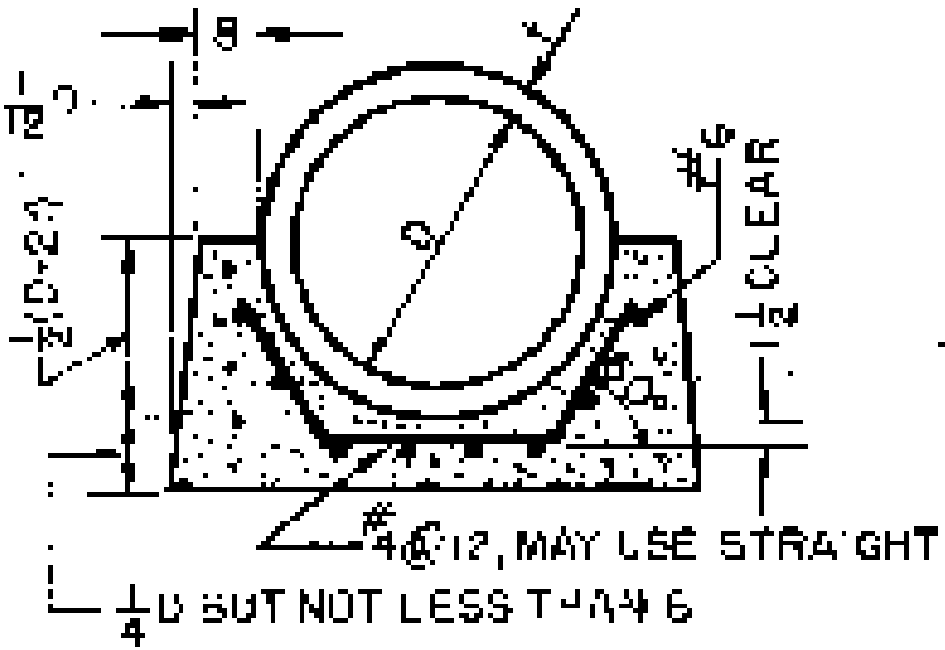
6 on 1 slope on fill against conduit

Same fill level on both sides +/– 2 feet

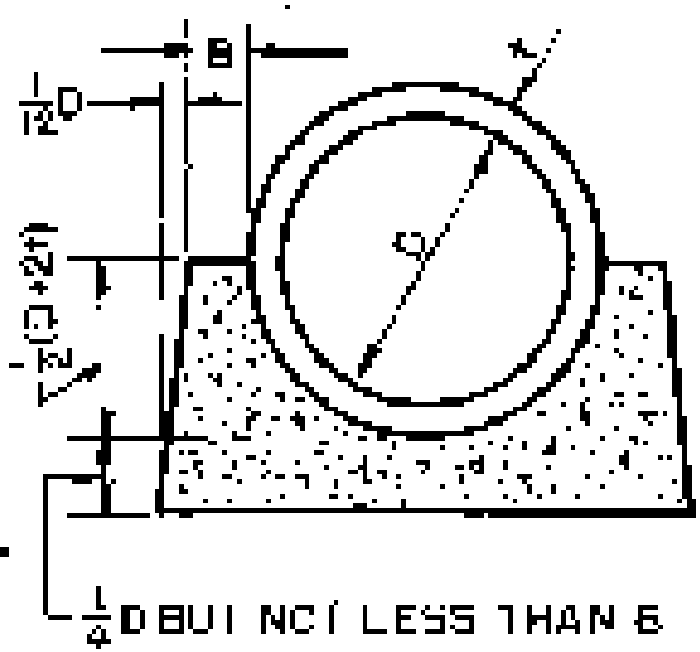


DETAIL OF PIPE CONDUIT
SECTION ON ℄—A2 CRADLE SHOWN

WHEN A1 CRADLE USED:
CUT LONGITUDINAL BARS AT 3" FROM EACH
SIDE OF ARTICULATION JOINT. USE NO DOWELS.



A1 CRADLE



A2 CRADLE

Dam on Soft Foundation