U. S. ARMY CORPS OF ENGINEERS LOUISVILLE DISTRICT

2016 LEVEE SAFETY MEETING

"SHARED RISKS, SHARED SOLUTIONS"

Sheraton Louisville Riverside Hotel,
Jeffersonville, IN

9-10 February 2016

AGENDA

Tuesday 9 February 2016

9:00 to 9:15	Opening Remarks - Day 1	Colonel Christopher Beck, P.E., Commander, Louisville District
9:15 to 10:15	Overview of the Levee Safety Program	Eric Halpin, P.E., HQ Assistant to Dam and Levee Safety
10:30 to 11:00	Presentation by Risk Cadre - Levee Risk Assessments	Greg Werncke, P.E., Senior Technical Advisor, Risk Management Center (RMC)
11:00 to 11:45	Understanding the Preservation of Large Diameter Gravity Pipes with Structural Epoxy - Spray-In-Place-Pipe Liner (SIPP)	Danny Warren, Warren Environmental Inc., A&W Maintenance Inc.
11:45 to 12:15	Interim Policy on Inspection	Matthew Whelan, P.E. - Levee Safety Area Representative (LSAR) Upper Wabash
1:15 to 1:45	Abandoning/Sealing/Removing Obsolete Project Components	Ross Wright, P.E. Levee Safety Area Representative (LSAR) Lower Ohio and Green Rivers
1:45 to 2:15	Controlling Water with Water - Dam-It Dams	Brian Francis, Dam-It Dams Product Specialist
2:15 to 2:45	Public Alerts and Warnings: What really matters?	Will Lehman, Economist at Hydrologic Engineering Center (HEC)
3:00 to 3:30	Installation and Inspection of Reinforced Concrete Pipes (RCP)	Trygve Hoff, American Concrete Pipe Association (ACPA) Region Engineer that serves KY, OH, & IN
3:30 to 4:30	Levee Safety Areas (LSA) - Levee sponsors will provide short discussions on lessons learned on their projects. For example - issues with gate replacements; rebuild of pumps, mowing techniques, etc.	Levee Safety Area Representatives (LSARs) - Alvey, Inspector; Bryan, PE; Lasoski, PE; Wright, PE; Whelan, PE.
7:30 to 8:00	**Presentation: Silver Jackets Overview**	Brandon Brummett, P.E., PMP - Louisville District Outreach Coordinator

"Life Safety is Paramount"

v 4.0

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Wednesday 10 February 2016

8:30 to 8:45	Opening Remarks - Day 2	John Bock, P.E., Chief, Engineering Division and Levee Safety Officer (LSO)
8:45 to 9:15	Painting and Repainting Waterfront Steel Structures	Mark Jelinek, Sherwin Williams
9:15 to 9:45	Programs and Project Management Studies	Amy Babey, PMP, Chief of Plan Formulation Section
9:45 to 10:15	Discuss Silver Jackets Study for Metro Louisville Emergency Preparedness Plan (EPP)	Nathan Bryan, P.E., Levee Safety, Geotechnical Engineer
10:30 to 11:00	Cannelton Relief Well Project	Rick Hockett, PG, Risk Cadre, Geologist
11:00 to 11:30	Overtopping Leading to Levee Breaches	Terry Sullivan, P.E., Geotechnical/Geology Branch Chief, Eastern Division, Risk Management Center, Institute of Water Resources
11:30 to 12:30	USACE Assistance During Emergency Operations	Don Walker, Emergency Operations Manager, Emergency Operations Center (EOC) Louisville District
1:30 to 2:00	Western Excelsior - Current Work on New Orleans Levee Systems	Lee Pierce, Western Excelsior
2:00 to 2:30	Mechanical Solutions to Pump Station & Levee Components	Mark Robertson, P.E., Regional Technical Specialist (RTS) Mechanical Engineer LRL
2:30 to 3:00	H&H Presentation on Revised Wabash River Discharges and Potential Impacts to Levee Sponsors Maintaining Levees Along the Wabash River; & Potential Update Study to Ohio River Discharges - Study.	Richard Pruitt, P.E., Chief of Hydrology & Hydraulics Section

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2016 LRL Levee Safety Meeting

Properly Abandoning Project Features

Ross Wright, P.E.

Geotechnical Engineer, LSAR for Lower Ohio and Green River Basins

Louisville District

10 February 2016

US Army Corps of Engineers
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Pipe Failure Along the Levee Toe

Failure of a Pipe through the Embankment

Permanently Sealing a Pipe

Steps to properly abandon a pipe:

- Clean the existing pipe to maximize the potential for a good bond between the grout and host pipe.
- Calculate the quantity of grout required to fill the pipe.
  $\frac{\pi}{4}$ x $(\text{Inner Diameter})^2$ x length
- Fill the pipe with grout – monitor volume to assure the
  volume of grout used ≥ the calculated quantity of grout required.
  - *Small quantity applications* - grout should meet the requirements of ASTM C-1107.
  - *Large quantity applications* – 3000 psi sanded grout with a shrinkage compensating admixture is acceptable.

Apply for a letter of no objection through your LSAR

Failing Toe Drains

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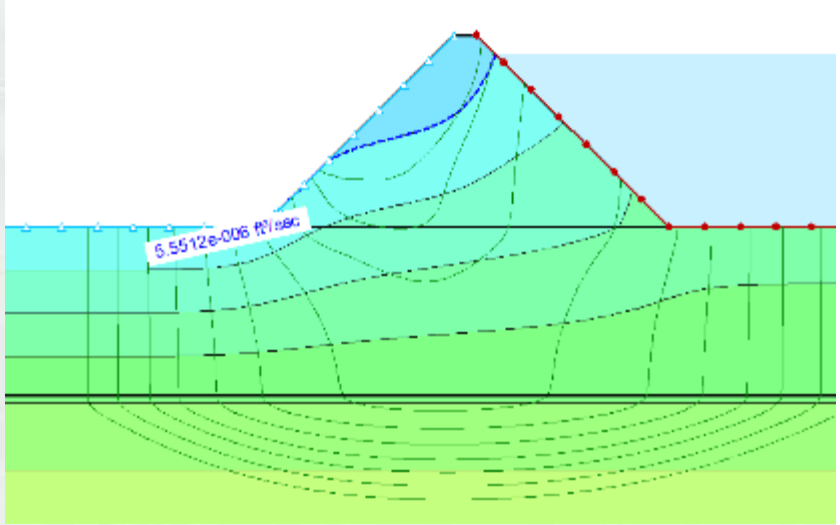
Toe Drain Analysis



Location			Factor		Effective Seepage Length (ft)		Head at	Computed Hydraulic	Critical Hydraulic	Factor of Safety for
Reach (Stations)		Critical Section Station			River Side	Land Side	Toe (ft)	Gradient	Gradient	Piping
			c_r	c_l	x_1	x_3	h_o	i_o	i_c	(i_c/i_o)
30+00	40+00	35+00	0.0016	0.0016	318.17	632.46	8.83	0.44	0.92	2.09
40+00	50+00	45+00	0.0016	0.0016	318.17	632.46	11.94	0.60	0.92	1.55
50+00	60+00	55+00	0.0016	0.0016	318.17	632.46	8.32	0.42	0.92	2.22
60+00	70+00	65+00	0.0016	0.0016	318.17	632.46	13.11	0.66	0.92	1.41
70+00	80+00	75+00	0.0016	0.0016	318.17	632.46	8.04	0.40	0.92	2.30
80+00	90+00	84+00	0.0016	0.0016	318.17	632.46	7.99	0.40	0.92	2.31
90+00	100+00	97+00	0.0050	0.0050	188.28	200.00	8.78	4.39	0.92	0.21
100+00	110+00	10+28	0.0018	0.0018	309.04	547.72	12.04	0.80	0.92	1.15
110+00	120+00	115+00	0.0018	0.0018	309.04	547.72	13.95	0.93	0.92	0.99
120+00	130+00	125+00	0.0018	0.0018	309.04	547.72	11.17	0.74	0.92	1.24
130+00	140+00	135+99	0.0016	0.0016	318.17	632.46	11.52	0.58	0.92	1.60
140+00	150+00	143+00	0.0016	0.0016	318.17	632.46	11.62	0.58	0.92	1.59
150+00	160+00	157+42	0.0016	0.0016	318.17	632.46	13.32	0.67	0.92	1.39
160+00	170+00	167+04	0.0016	0.0016	318.17	632.46	14.95	0.75	0.92	1.24
170+00	180+00	174+90	0.0016	0.0016	318.17	632.46	17.68	0.88	0.92	1.04
180+00	190+00	183+67	0.0016	0.0016	318.17	632.46	13.87	0.69	0.92	1.33
190+00	200+00	191+68	0.0016	0.0016	318.17	632.46	12.86	0.64	0.92	1.44
200+00	210+00	203+50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.92	#DIV/0!

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Permanently Abandoning Toe Drains

Steps to properly abandon toe drains:

- Consult with an Engineering Firm to conduct a seepage analysis.

The analysis must:

- Consider the full height of the levee embankment.
- Evaluate all reaches of levee with similar foundation characteristics and levee cross sections where toe drain abandonment is being considered.
- All foundation data and cross sections should be clearly laid out with foundation data assumptions highlighted.
- The analysis should consider loading to the full height of the levee in steady state conditions.
- The analysis must demonstrate performance with and without the toe drain system.

The engineering consultant should be in contact with your LSAR to assure the analysis is conducted properly. USACE Levee Safety will make a determination of which toe drains may be abandoned.

- Toe drains can then be removed or abandoned according to the standard operating procedure for permanently sealing pipes.

Permanently Sealing Closures

- If closure is no longer needed the sponsor should consider permanently sealing the closure
- Allows Local Sponsor to cease Operations and Maintenance activities for the closure
- Leaving movable closure systems erected at all times is not recommended since the metal parts are not designed to withstand long-term exposure to weather
- Local Sponsor must submit in writing a request for a Letter of No Objection (LNO) form USACE for approval prior to initiation of any field activity

Methods

- Cast-in-place (Doweled)
- Compacted Fill

One of these two methods will be used in most cases

- Cast-in-place (Gravity Block)
- Shotcrete

Cast-in-place (Doweled)- Construction Steps

Step 1: Remove anchorage recess cover plates & sill recess cover plates.

Step 2: Roughen entire concrete surface that will be in contact with new concrete.

Use either high pressure water jet or mechanical tools to provide a minimum ¼-inch surface profile

Step 3: Drill holes and place dowels. The holes need to be 1/8-inch diameter larger than the nominal bar diameters. The rebar must be bonded in the drilled holes using an approved chemical grout, epoxy grout or cement grout system. It needs to be specified that the contractor submit his proposed system for approval. The rebar dowels should be installed in strict accordance with the approved system's instructions and specifications.

Cast-in-place (Doweled)- Construction Steps

Step 4: Place a strip of expandable waterstop down the side slots and across the sill recess. Place no closer than 3-inches from any surface (the swelling pressure can damage concrete). Follow manufacturer's installation instructions.

Step 5: Place remaining rebar

Step 6: Construct forms

Step 7: Place concrete

Cast-in-place (Doweled) – Example Photos

Cast-in-place (Doweled) – Example Photos

Cast-in-place (Doweled) – Example Photos

Cast-in-place (Doweled) – Example Photos

Louisville 1989

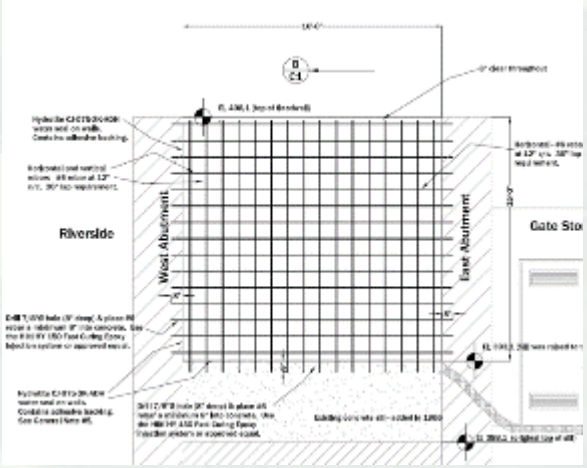
Cast-in-place (Doweled) – LNO Submittal

•Calculations must be performed by PE (and stamped) and submitted with LNO verifying the proposed reinforced concrete slab will adequately resist the load from flood waters to the top of the wall.

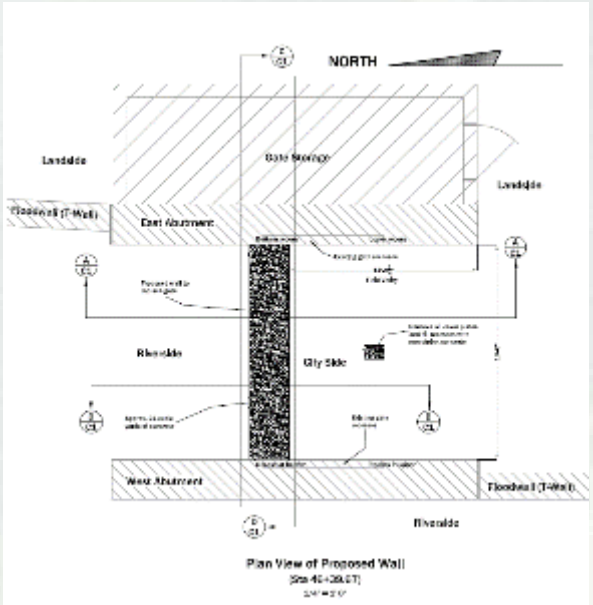
- These calculations need to reference current Corps design guidance. Your calculations need to meet the requirements of the Corps Engineering Manual, "Strength Design for Reinforced-Concrete Hydraulic Structures".

http://publications.usace.army.mil/publications/eng-manuals/EM_1110-2-2104_pflsec/EM_1110-2-2104.pdf

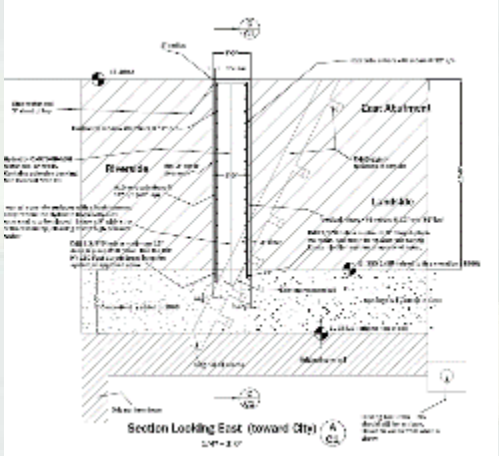
Cast-in-place (Doweled) – LNO Submittal



Elevation View
(Reinforcing Landside & Riverside)



Plan View



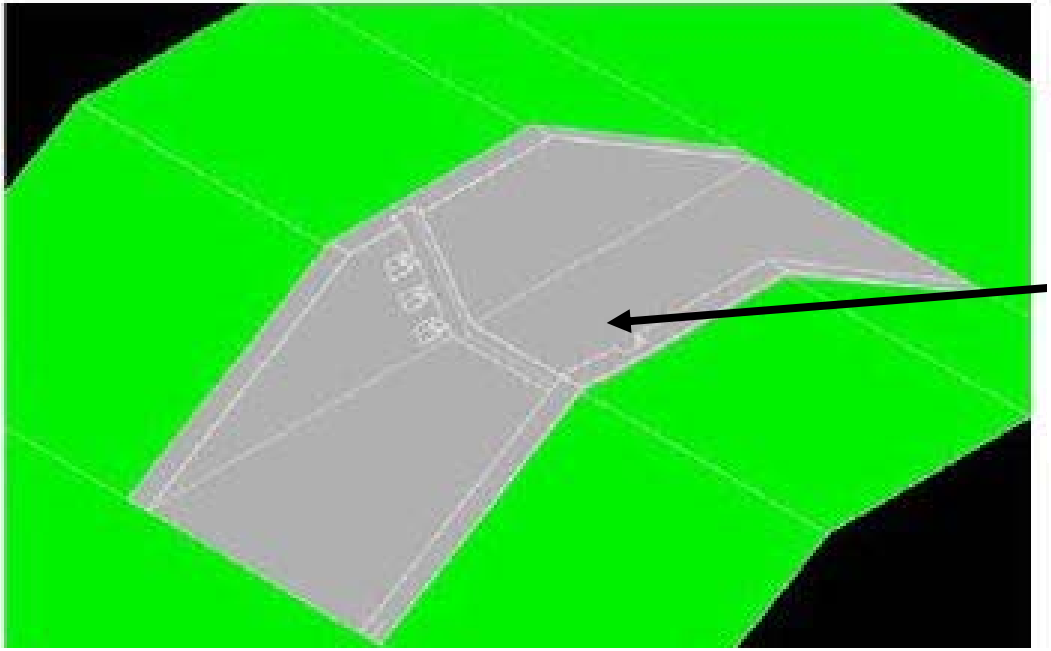
Section View

Alternative Methods

- Cast-in-place (Doweled)
- **Compacted Fill**
- Cast-in-place (Gravity Block)
- Shotcrete

Compacted Fill – Construction Steps

Standard Operating Procedure for Permanent Sealing of Road/Railroad Closures Through Levee Embankments – 30 November 2010

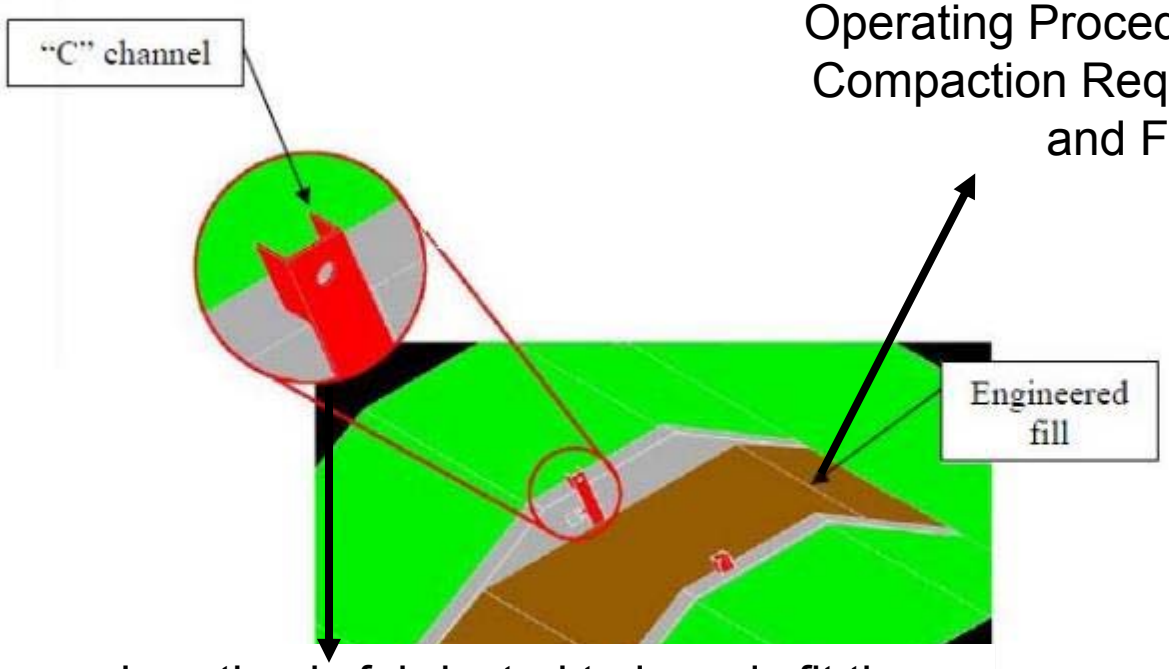


Closure sill must be opened and cleaned and all foreign material removed from the closure footprint

If a closure vault is located within the earthen levee, it is first sealed by permanently attaching the door (welding), and then filling the vault from the top with sand, sand and gravel, flowable fill, concrete, or other material that may be approved by the LSO.

Compacted Fill – Construction Steps

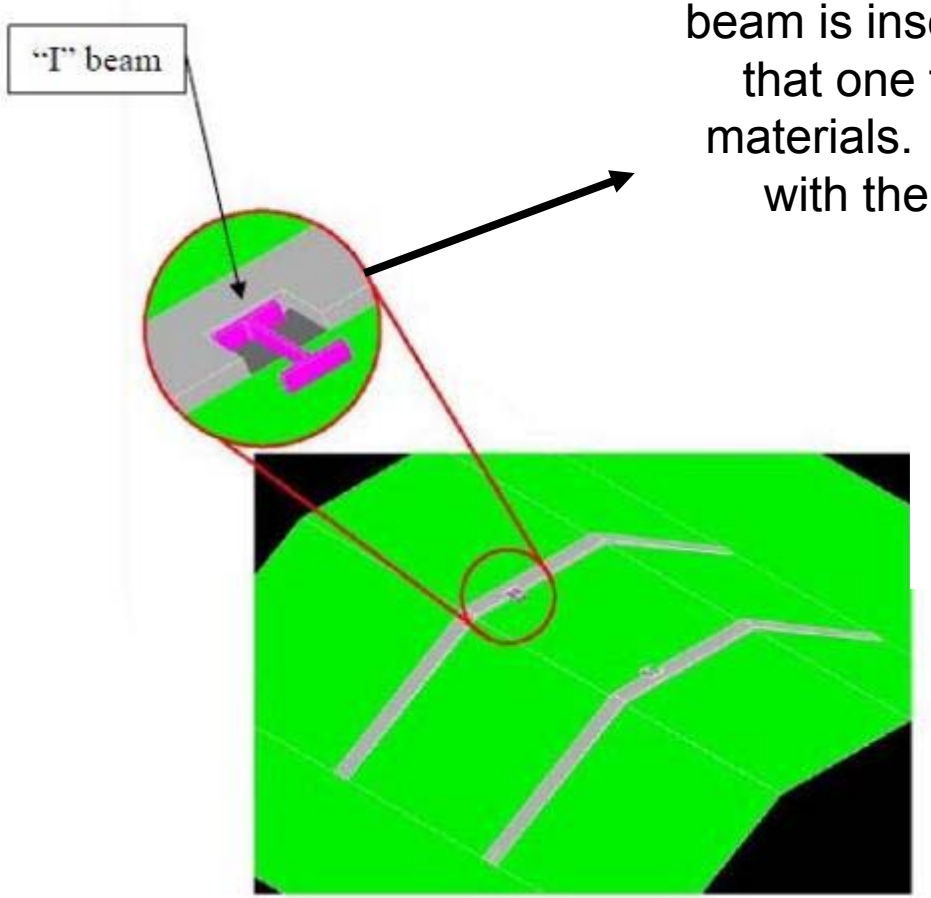
Fill the closure opening with compacted fill in accordance with "Standard Operating Procedure for Benching and Compaction Requirements for Levees and Floodwalls"



A "C" channel section is fabricated to loosely fit the closure slots in the concrete closure walls so that the channel is flush with the concrete face when installed.

The "C" Channel extends above the concrete wall and is constructed with a hole or other attachment point in the section extending above the wall

Compacted Fill – Construction Steps



The "C" channel is removed, and an "I" beam is inserted into the closure slot so that one flange extends into the fill materials. This beam is cut to fit flush with the top of the concrete wall.

Void spaces around the "I" beam are then filled with flowable fill (per State DOT specification requirements) or cement-bentonite grout.

The "I" beam must be installed to form a barrier to prevent seepage along the concrete wall-soil fill interface

Compacted Fill- Example Pictures

Summary/Conclusions

- If closure is no longer needed the sponsor should consider permanently sealing the closure
- Decide on appropriate method for situation
  - Floodwall Section: Cast-in-place doweled, Cast-in-place gravity block
  - Earthen Levee: Compacted Fill
  - Swing or Rolling Gate: Shotcrete
- Submit LNO to USACE complete with calculations and drawings
- Sponsor should supervise the permanent sealing of the closure and submit documentation of the process to USACE

Questions???

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Other DamitDams water-barrier applications:

Wetland Management	Dredging	Haz-Mat Contamination
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Flood Barriers	Water Storage	De-Watering Construction Sites
Boat Ramp Dewatering	Bridge Pier Repair	Create Foot Causeway
Pipeline Crossings	Levees	In Environment Sensitive Areas
		Environmental Remediation

Dam Arrives at Jobsite

Dam is Placed at Shoreline

2 Identical pumps fill inner bladders

OVERSIZE LOAD

DAM IT DAMS.COM

8’ x 225’ Installation Time 6 Hours

PIPELINE PUMP AROUNDS

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DEERE

HIGH FLOW CAPABILITIES

Going with the Flow use a FLUME TUBE

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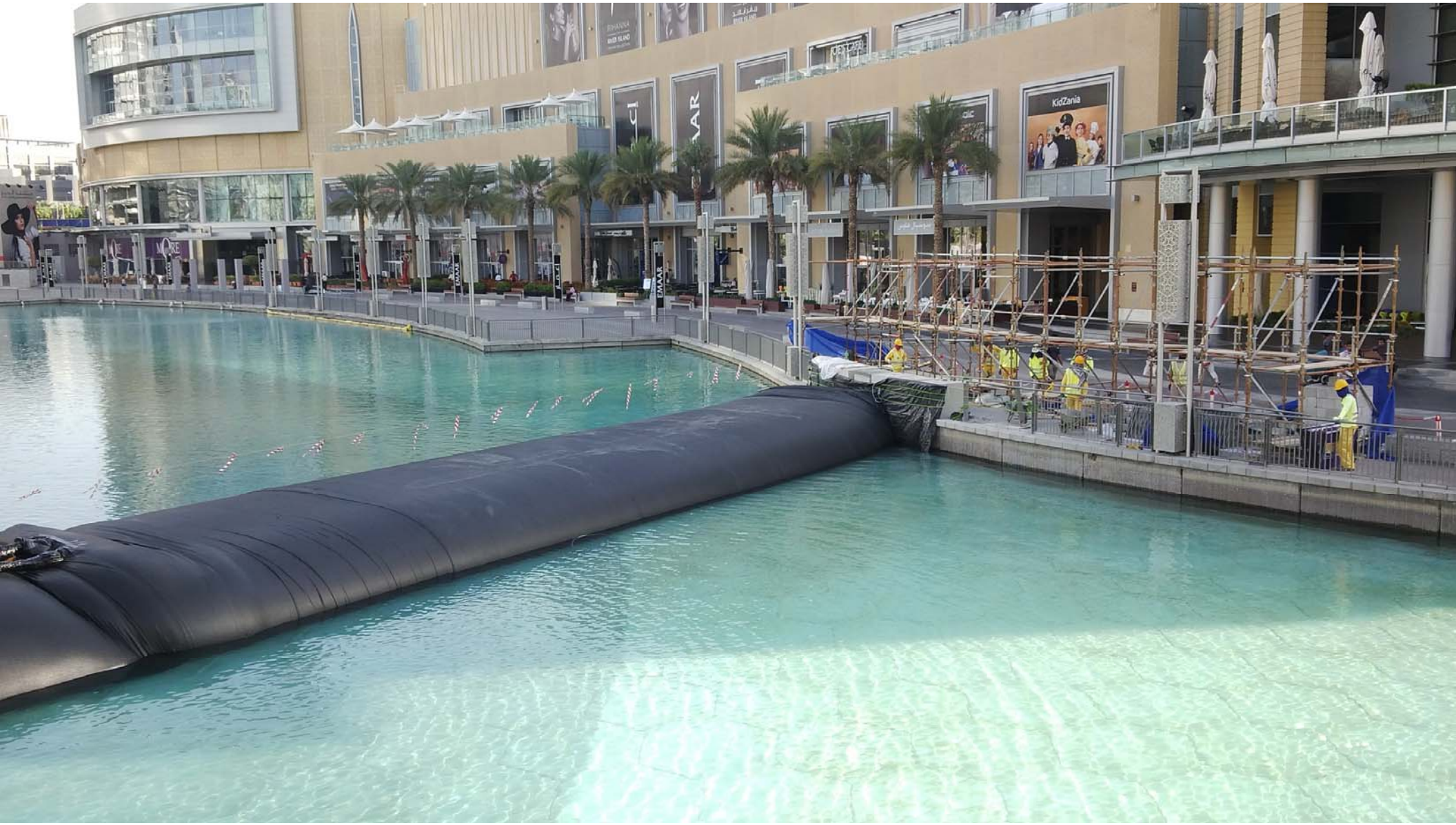
The only Dams that Bend

FLOOD CONTROL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Questions or did I put you to sleep?

Concrete On A Roll?
Geosynthetic Cementitious Composite Mat (GCCM)

A GCCM is a Simple-to-Use Geocomposite Protection Material

- *Install like a geotextile*
- *Hydrate using water*
- *In 24 hours, it cures into a hard fiber-reinforced concrete layer (5,000 psi, 80% strength in 24 hours)*

A GCCM can be used:

- *Anywhere a hardened protective surface is required.*
- *Especially where conventional construction methods are difficult.*
- *Where labor is expensive or scarce (or non-specialized labor).*

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Concrete On A Roll?
GCCM Applications as Storm Water Solutions

Ditch/Channel Lining (New & Repair)

Slope, Bank & Shoreline Erosion Protection

Culvert Invert Repair

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Concrete On A Roll?
How is a GCCM Installed?

GCCMs typically come in either bulk or batch roll sizes

Batch Rolls

Bulk Rolls

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Public Alerts and Warning for Dam and Levee Safety Emergencies

What Really Matters?

William Lehman
Economist
US Army Corps of Engineers
Hydrologic Engineering Center

US Army Corps of Engineers
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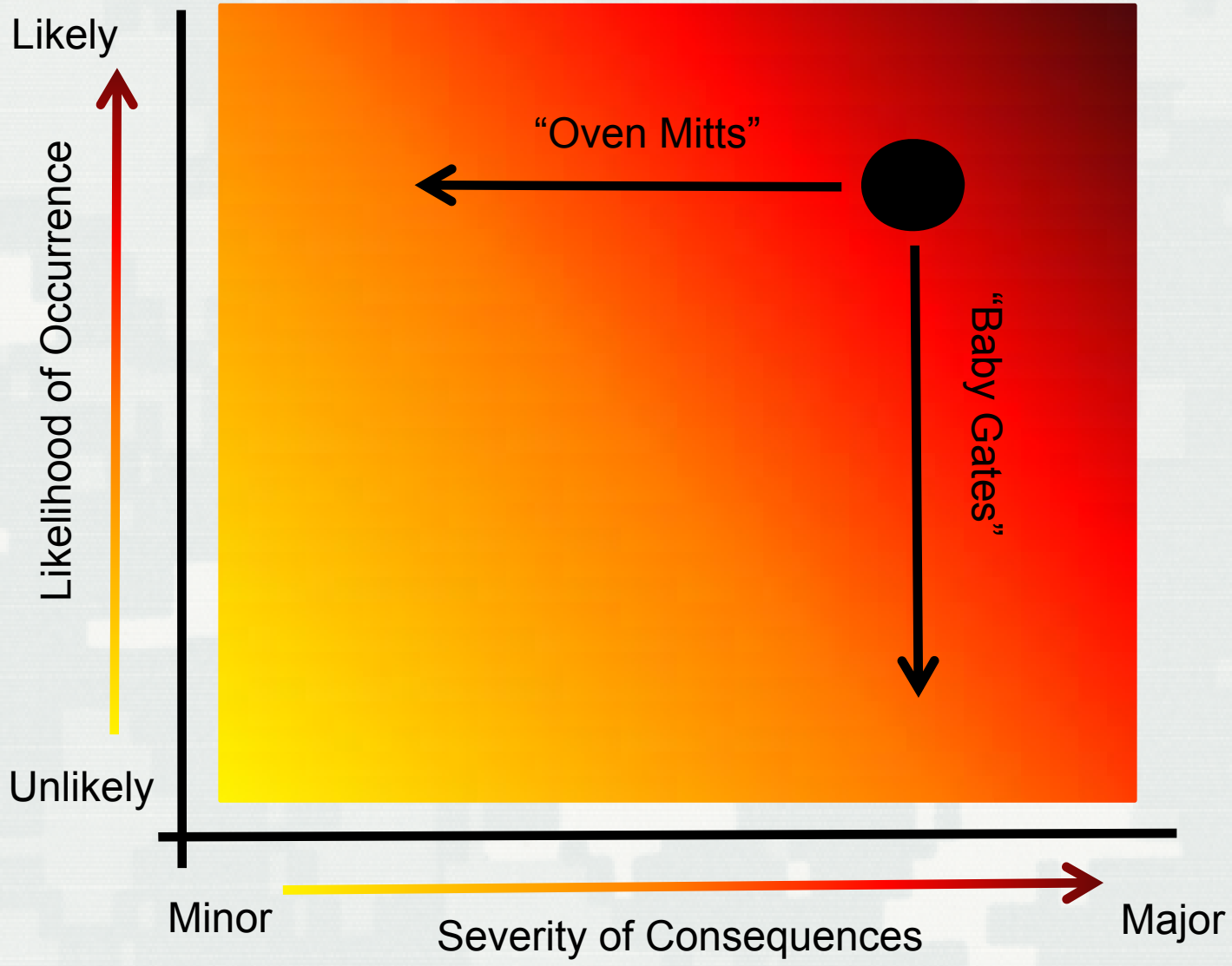
Perceived Risk of Toddler/Stove encounter



RONG®

The Water
is
Rising
Pleas

SOURCE: say who the message is from

THREAT: describe the flooding

LOCATION: state the impact area

GUIDANCE/TIME: tell people what protective action to take

EXPIRATION TIME: tell people when the warning expires

EXAMPLE:

LCPD Check and monitor local media now Explosion at Superior dam Potential damage and flooding in Sherman Heights Message expires 8:00 AM PDT

®

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A Guide to Public Alerts and Warnings for Dam and Levee Emergencies

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More Information

- william.p.lehman@usace.army.mil
- "A guide to public alerts and warnings for dam and levee safety emergencies"
  - http://silverjackets.nfrmp.us/Home/Newsroom

Installation & Inspection of RCP

Trygve Hoff, PE
ACPA Northeast
Region Engineer

American
Concrete Pipe
Association

USACE LEVEE SAFETY PROGRAM
Shared Risks.
Shared Solutions.
Louisville
District

Pipe Installation

USACE Specifications:

- Manual No. 1110-2-1913 – Design & Construction of Levees
- Section 33 40 00 – Storm Drainage Utilities
- Public Law 84-99 – Levee Owner's Manual

American Concrete Pipe Association

Pipe Installation

USACE Specifications:

- Section 33 40 00 – Storm Drainage Utilities
  - ➢ Correct, Technical & Complete Specification
  - ➢ Requires the designer to:
    - Match project requirements with correct specification decisions
    - Have solid product knowledge (experience)
    - Make several decisions
  - ➢ Key Decisions:
    - Piping material
    - Pipe Installation
    - Joint requirements / Testing
    - Inspection requirements

Key Decision: Piping Material

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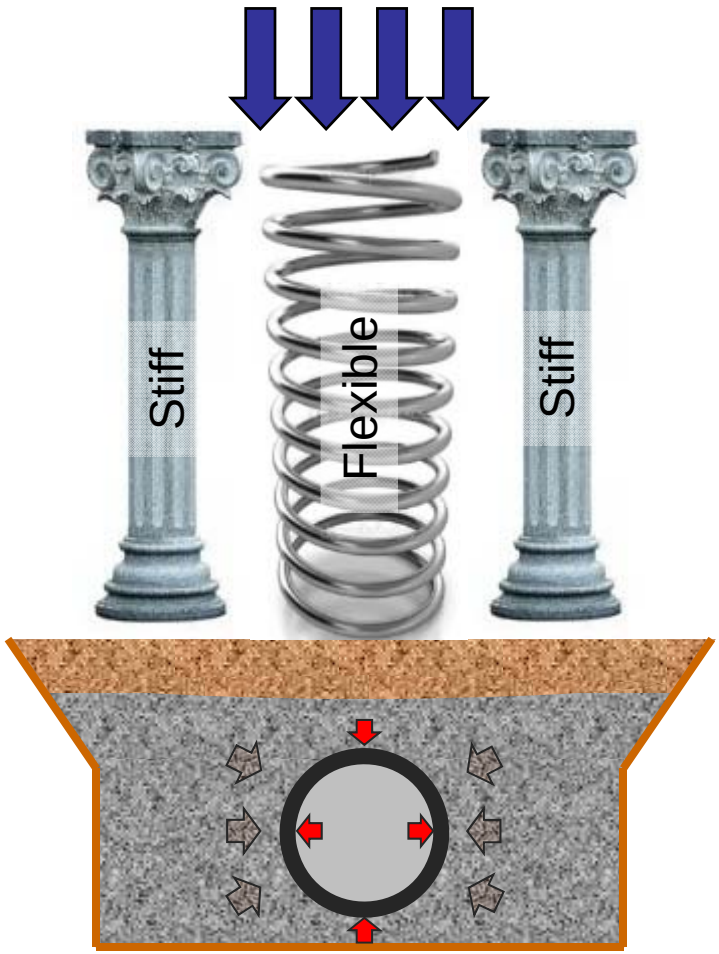
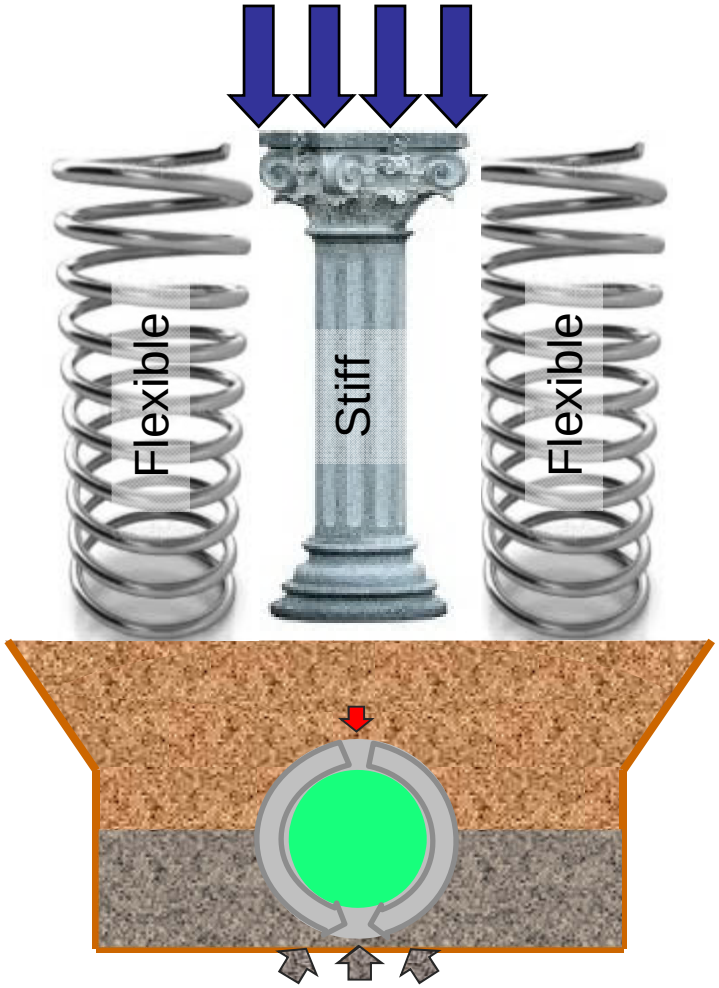
Key Decision: Piping Material





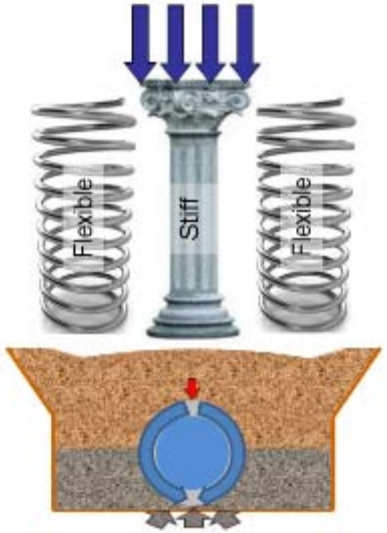
Flexible pipe – embedment soil <u>must</u> carry most of the load.

Rigid pipe – the pipe carries the majority of the load.

Piping Materials

Flexible

Different Pipe



Rigid

Requires:

- **Different Design**
- **Different Installation**
- **Different Inspection**

Pipeline Functions

What 2 functions ***must*** an underground pipe provide?

Conduit

Structure

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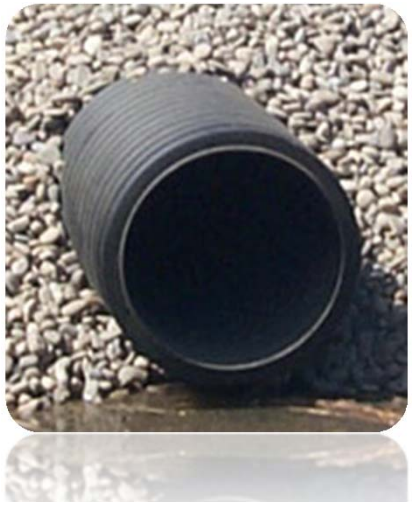
Buried Pipelines:

All buried pipelines are a **structural system** incorporating the properties of what two things?

Pipe



Soil

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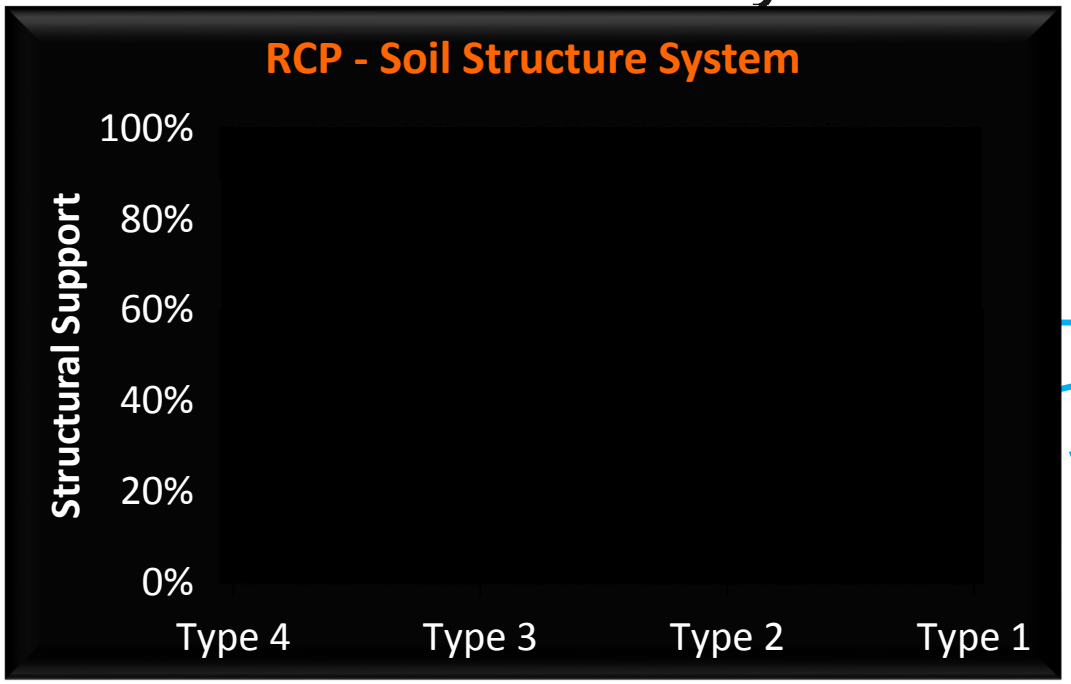
RCP – Soil System

Structural System:

- RCP Pipe Wall
  - 60-90% of System Strength
- Foundation & Bedding
  - 40-10% of System Strength

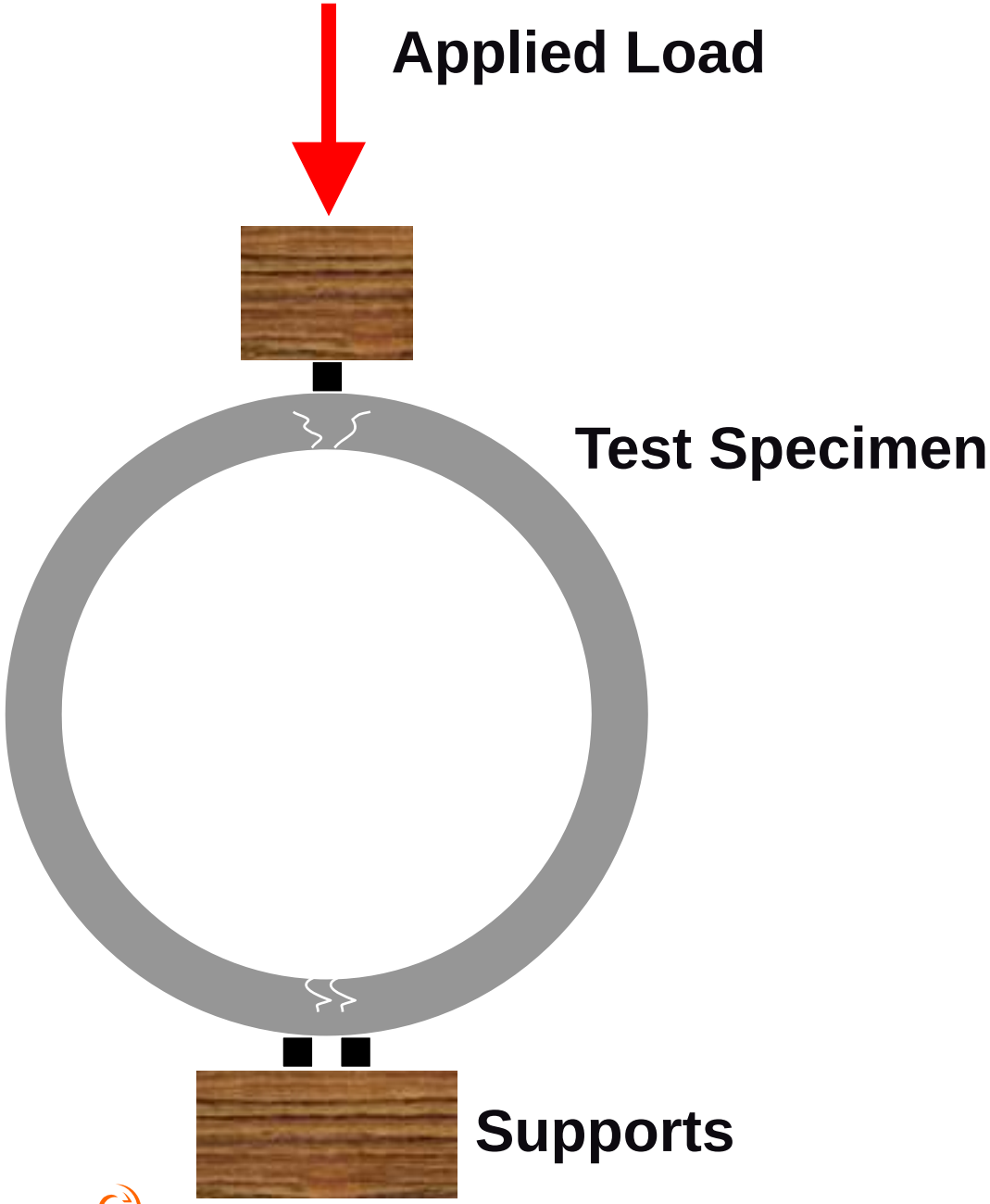


Flexible Pipe – Soil System

Structural System:

- Flexible Pipe Wall
  - 5%-10% of System Strength
- Foundation & Bedding
  - 90%-95% of System Strength

Pipe Material Proof of Design



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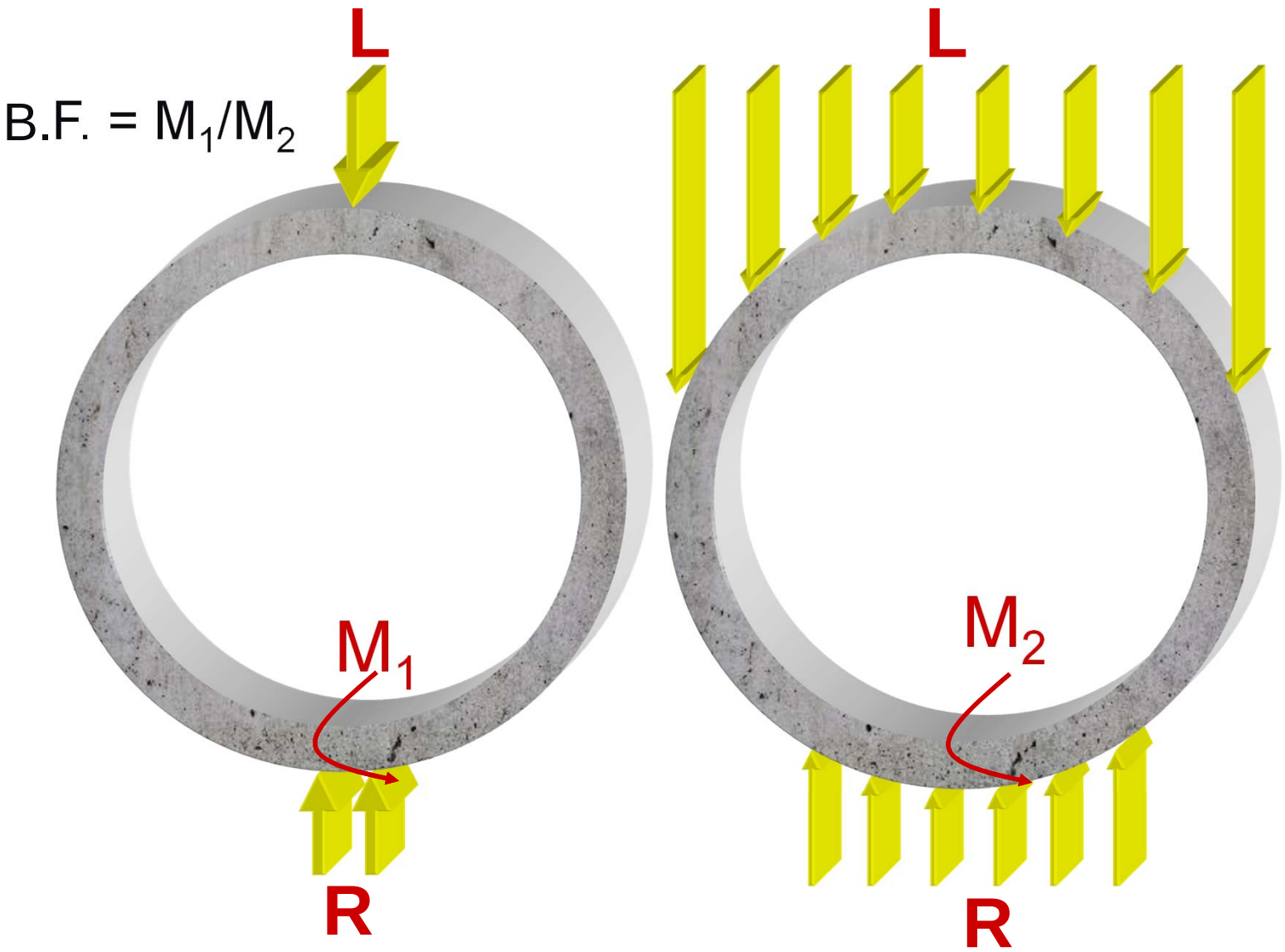
Three Edge Bearing vs In Situ Loads



3 - Edge Bearing

In Situ

RCP Three Edge Bearing Test

60” ASTM C-76 Class IV:

D_{Design} = 2000 lb/ft/ft

D_{ULT} = 3000 lb/ft/ft

Total Load Required:

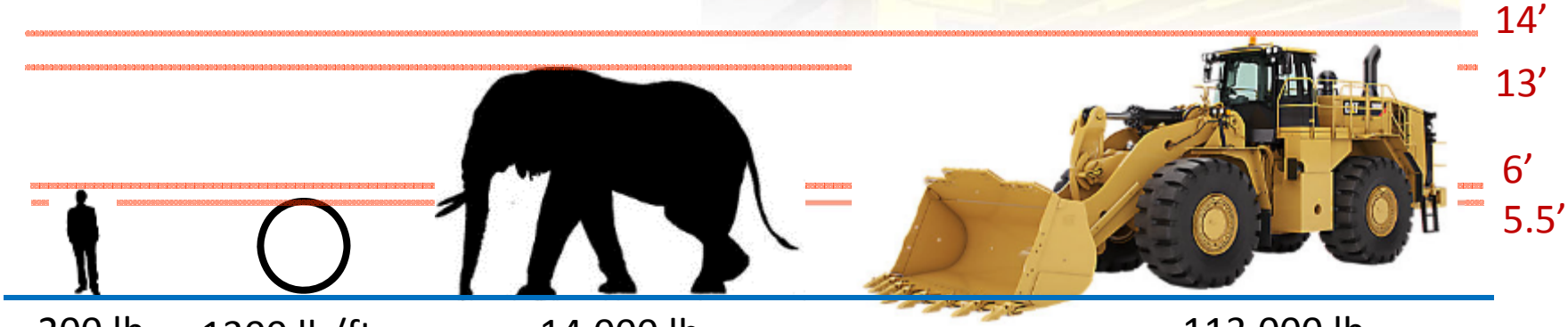
D_{Design} = (60”/12)(8’)(2000)

= 80,000 lbs.

D_{ULT} = (60”/12)(8’)(3000)

= 120,000 lbs.

Plant Proof of Design

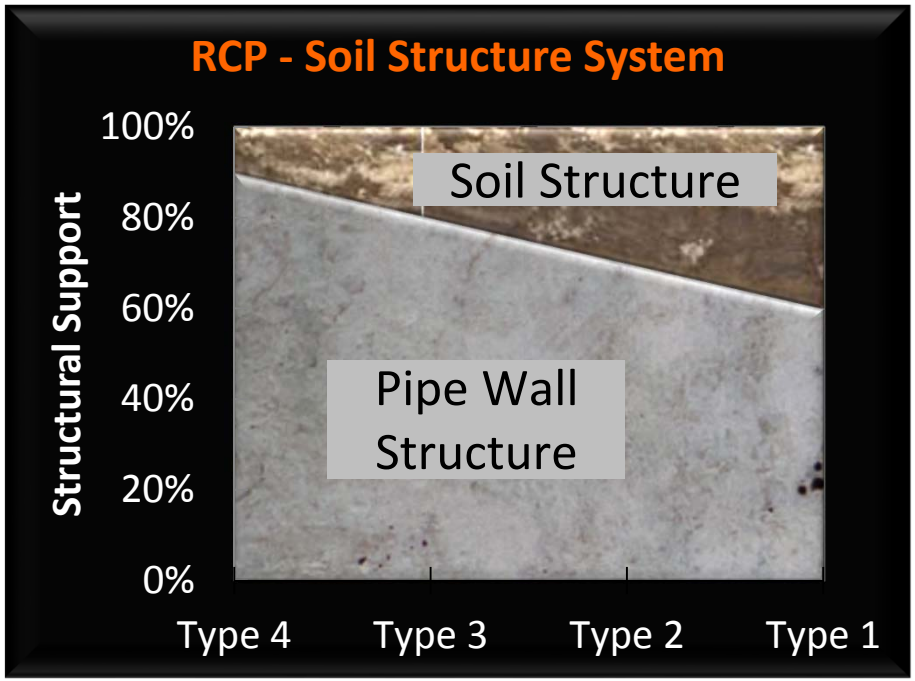


200 lb man | 1300 lb/ft 60” RCP | 14,000 lb African Elephant | 113,000 lb CAT 988K

RCP Classes

ASTM C76

Class	D-Load .01	D-Load ult.
I	800	1200
II	1000	1500
III	1350	2000
IV	2000	3000
V	3000	3750



$$D-Load_{.01} = \frac{W_E + W_L}{B.F. \times D} \times F.S.$$

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Key Decision: Pipe Installation

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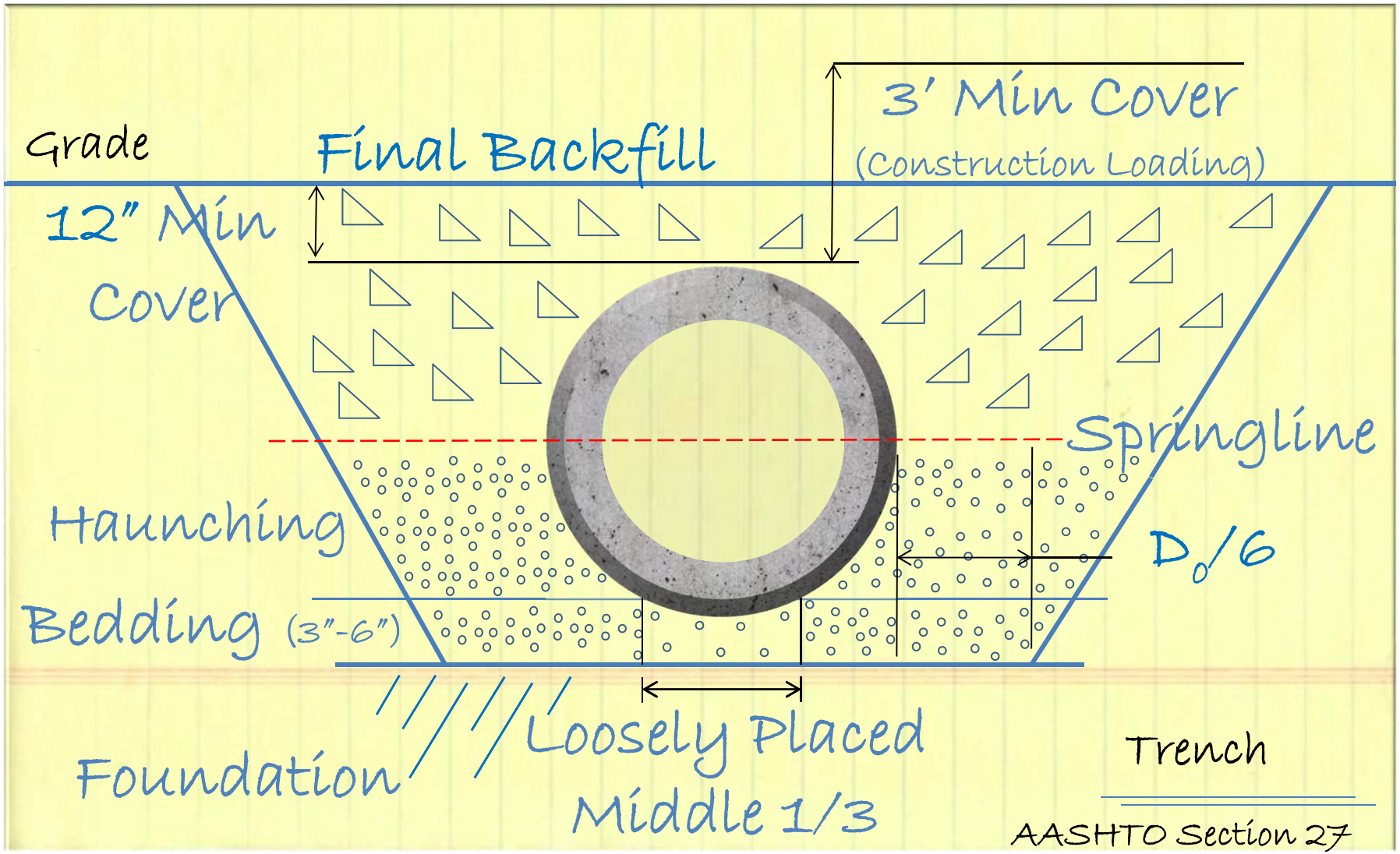
RCP Trench Terminology:



RCP Design

Installation Type	Bedding Thickness	Haunch & Outer Bedding	Lower Side
Type 1	D_o/24 minimum, not less than 3 in. (75 mm). If rock foundation, use D_o/12 minimum, not less than 6 in. (150 mm).	95% Category I	90% Category I 95% Category II 100% Category III
Type 2	D_o/24 minimum, not less than 3 in. (75 mm). If rock foundation, use D_o/12 minimum, not less than 6 in. (150 mm).	90% Category I 95% Category II	85% Category I 90% Category II 95% Category III
Type 3	D_o/24 minimum, not less than 3 in. (75 mm). If rock foundation, use D_o/12 minimum, not less than 6 in. (150 mm).	85% Category I 90% Category II 95% Category III	85% Category I 90% Category II 95% Category III
Type 4	No bedding required except if rock foundation, use D_o/12 minimum, not less than 6 in. (150 mm)	No compaction required, except if Category III, use 85%	No compaction required, except if Category III, use 85%

EQUIVALENT USCS AND AASHTO SOIL CLASSIFICATIONS FOR SIDD SOIL DESIGNATIONS

SIDD Soil	Representative Soil Types		Percent Compaction	
	USCS	AASHTO	Standard Proctor	Modified Proctor
Gravelly sand (Category I)	SW, SP GW, GP	A1, A3	100 95 90 85 80 61	95 90 85 80 75 59
Sandy Silt (Category II)	GM, SM, ML Also GC, SC with less than 20% passing #200 sieve	A2, A4	100 95 90 85 80 49	95 90 85 80 75 46
Silty Clay (Category III)	CL, MH GC, SC	A5, A6	100 95 90 85 80 45	90 85 80 75 70 40

Soil Strength for Embedment

Weakest
10 %

organic silt, organic clay, peat, fat clay, elastic silt and/or gravel

lean clay, silt, silty clay containing less than 30 sand/gravel

sandy lean clay, sandy silt, sandy silty clay with 30% or more sand

silty gravel, clayey gravel, calyey sand, silty sand

well graded gravel, poorly graded gravel, well graded sand, poorly graded sand

crushed rock with 100% passing 75mm (3 in) sieve, less than 25% passing 9.5mm (3/8 in) sieve, and less than 12% passing the No. 200 sieve

Strongest
90 %

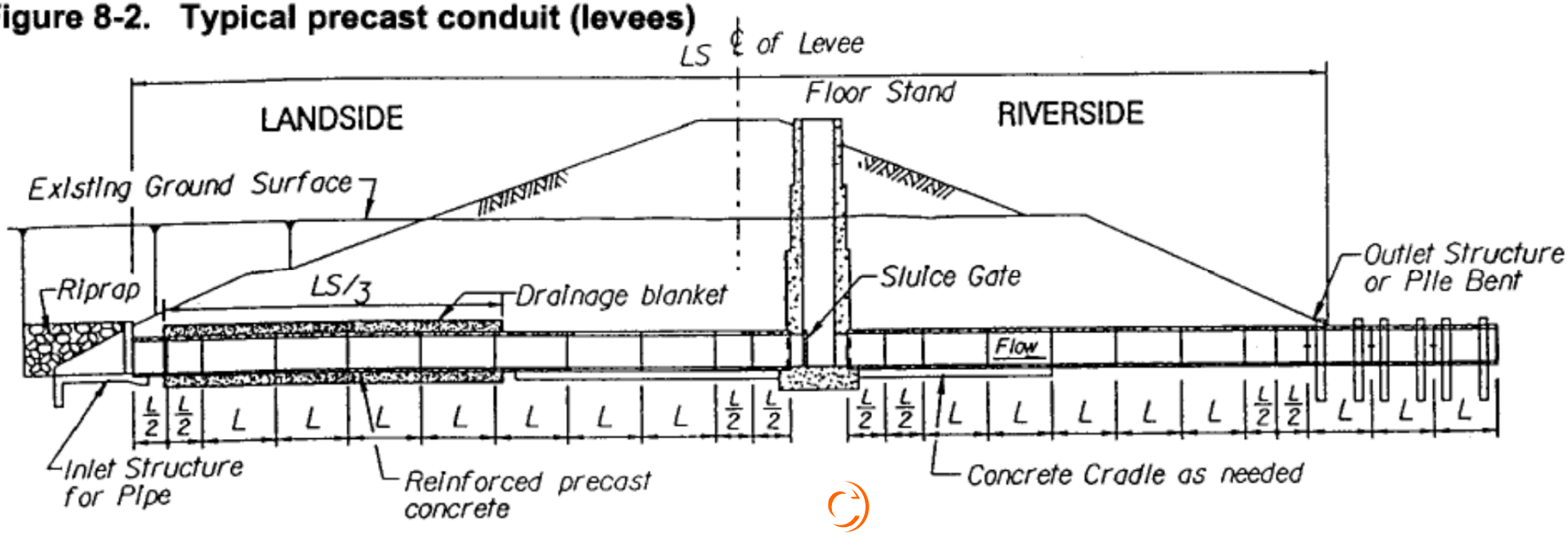
Pipe Through a Levee/Dam

USACE Manual No. 1110-2-1913, Chapter 8:

Principle Requirements:

- **Structural Strength** – must handle soil & construction loads
- **Joints** – Capable of withstanding some settling and resisting leaks
- **Backfill** – Adequate backfill materials with proper compaction
- ***Hydraulic Capacity*** – *Must have adequate flow rates*
- Chapter 8-4a – ...even above economy...the overriding factor should be safety.

Figure 8-2. Typical precast conduit (levees)



RCP Through a Levee/Dam:

- **Proper Bedding Type**
  - Use Type 3 Bedding
  - 3” - 6” Layer of fine well graded granular material for bedding (Non granular in impervious zones)
  - Well compacted clay in haunch and structural embedment zone
  - Cut-off system to insure no piping through bedding
- **Good Joint Design**
- **Proper Inspection**

Inspection

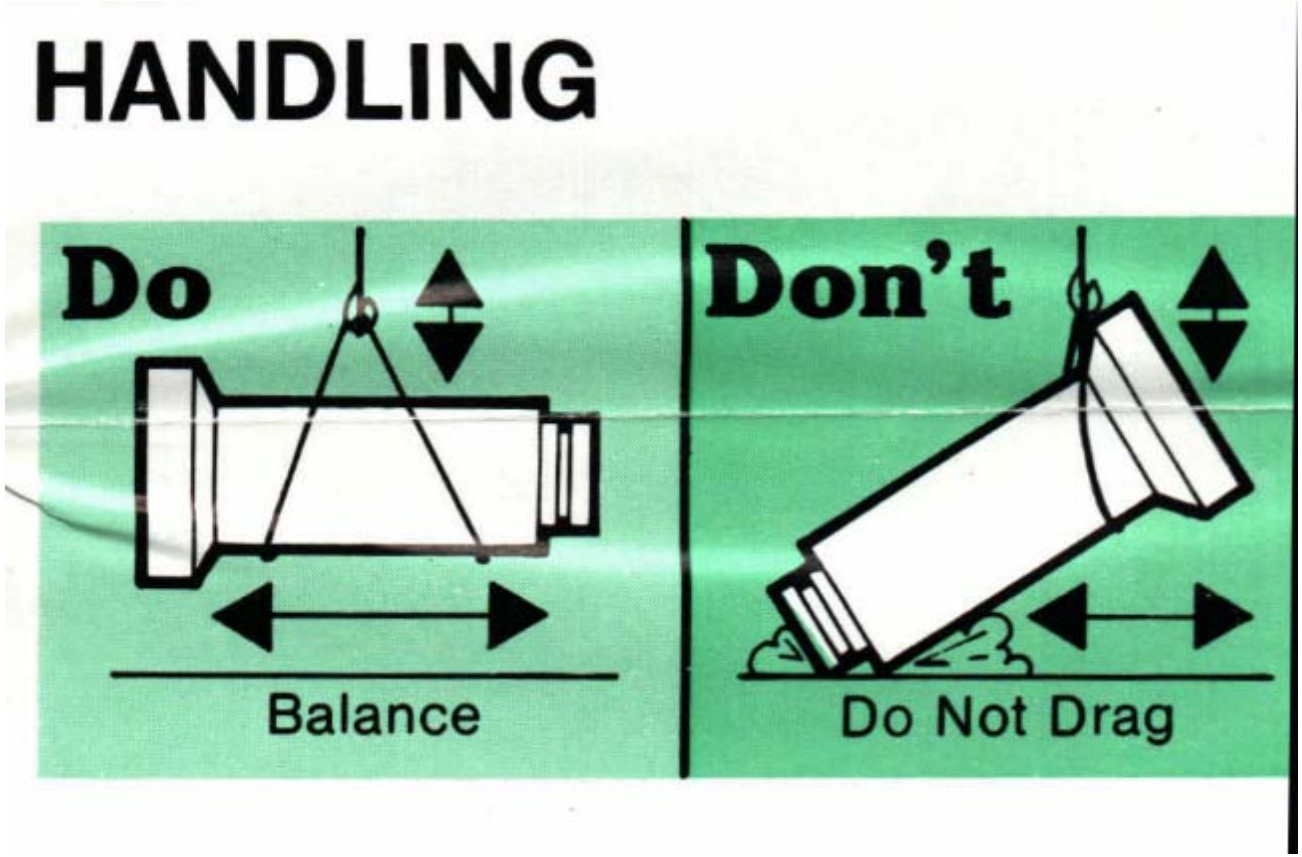
Inspection Milestones

- **Delivery/Storage/Handling**
  (Installer & Owner Rep.)

- **During Installation**
  - Structural Components
  - Joint Integrity
  (Installer & Owner Rep.)

- **Post Installation**
  - Joint Integrity
  - General confirmation of Installation
  (Owner Rep. or Unbiased Third Party)

Delivery/Storage/Handling



Delivery/Storage/Handling

Delivery/Storage/Handling

Delivery/Storage/Handling

Delivery/Storage/Handling

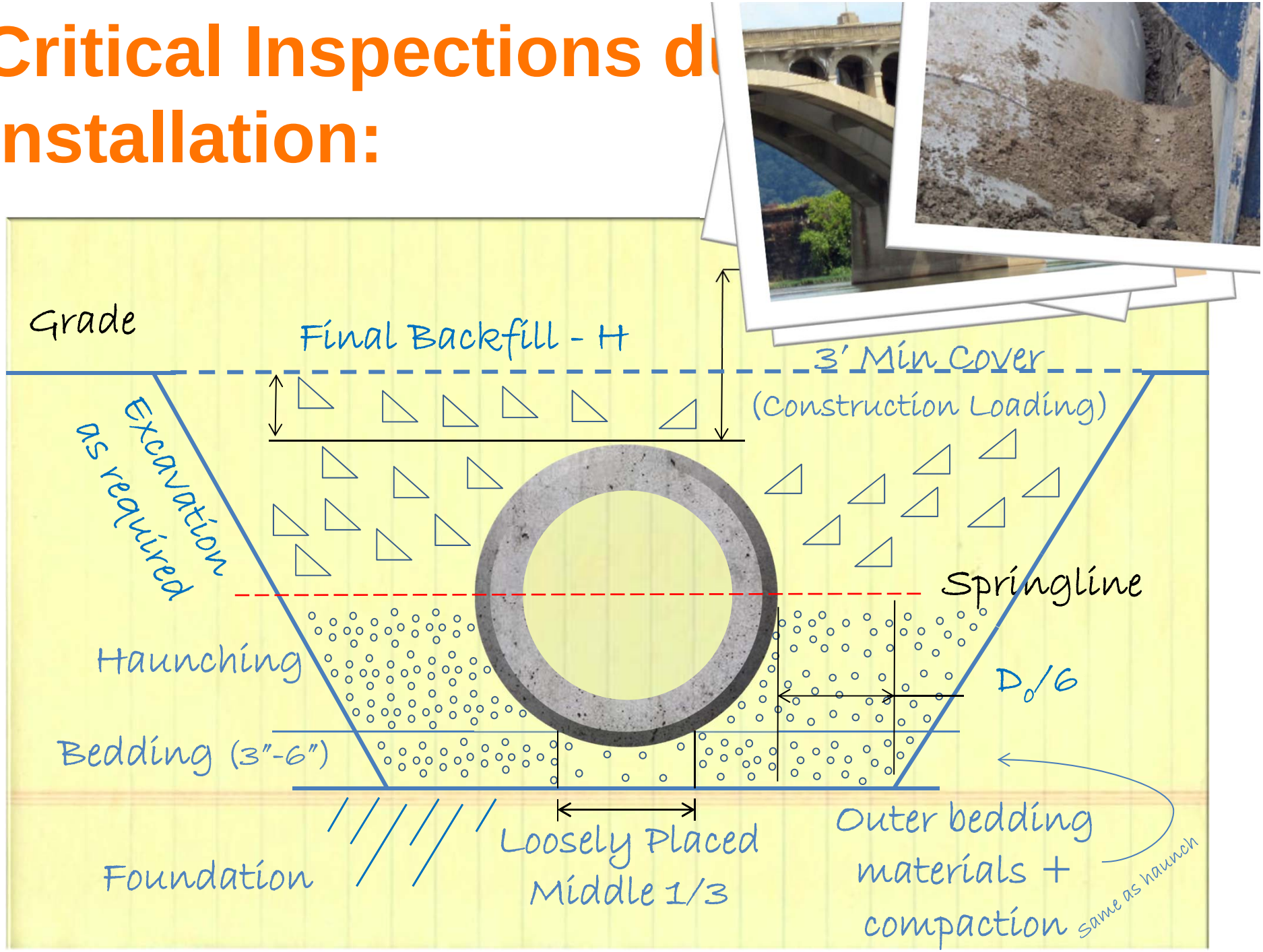
Delivery/Storage/Handling

American **Concrete Pipe** Association

Inspection During Installation

- #1 Follow all OSHA & Safety Regulations
- Trench excavation
- Foundation
- Bedding
- Pipe Laying & Joints
- Initial backfill
- Final backfill
- Compaction

Critical Inspections du
Installation:



Inspection During Installation

American **Concrete Pipe** Association

Inspection During Installation

Stable Foundation Critical

Inspection During Installation

Stable Foundation Critical

- Foundation for Pipe - This is a critical aspect to ensure crack free & soil tight installations.
- The trench bottom must be stable, give uniform support and have sufficient bearing capacity to maintain pipe alignment and carry the loads.
- Check It!

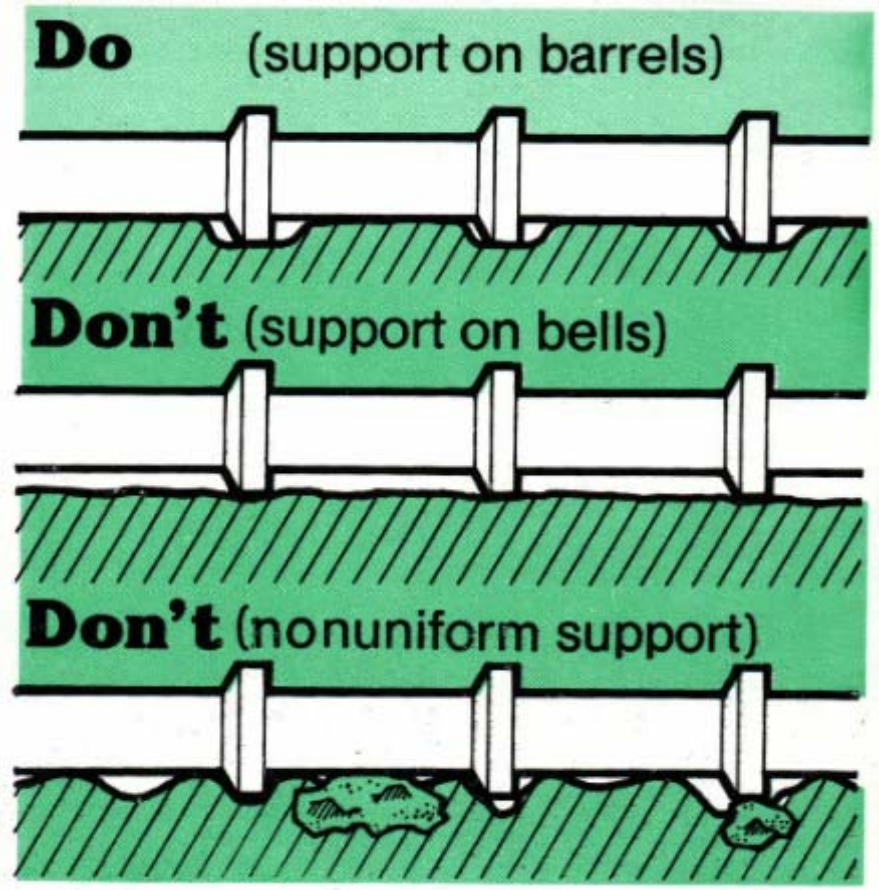
Inspection During Installation

Inspection of Bedding

- **Mattress for the Pipe…The bedding levels out irregularities in the trench bottom and ensures uniform support of the barrel.**
- **The bedding directs load through pipe into the foundation.**
- **TOO HARD = EXCESS Stress on Pipe**
- **Bedding sets the “Grade” check it often.**

Inspection During Installation

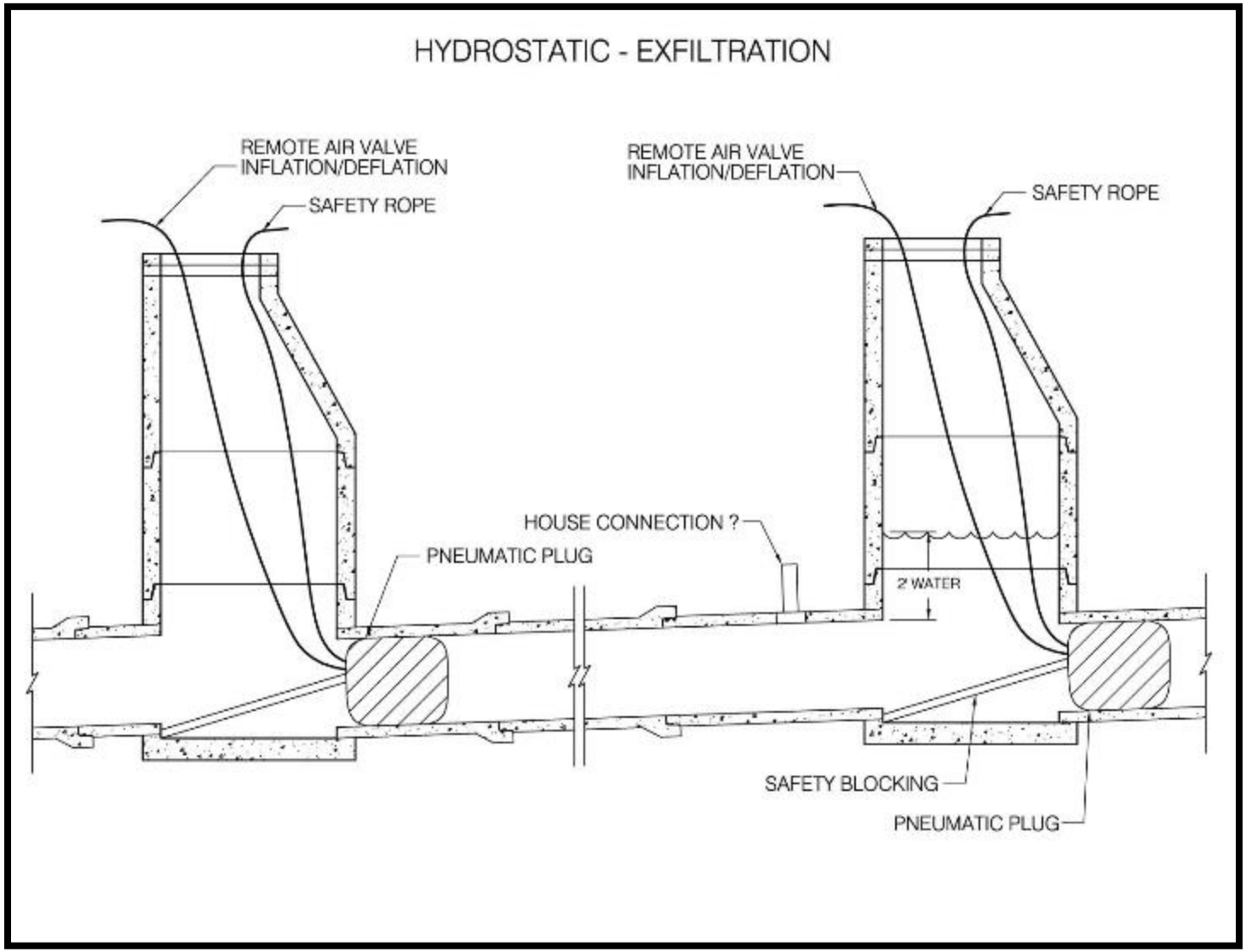
Inspection of Bedding



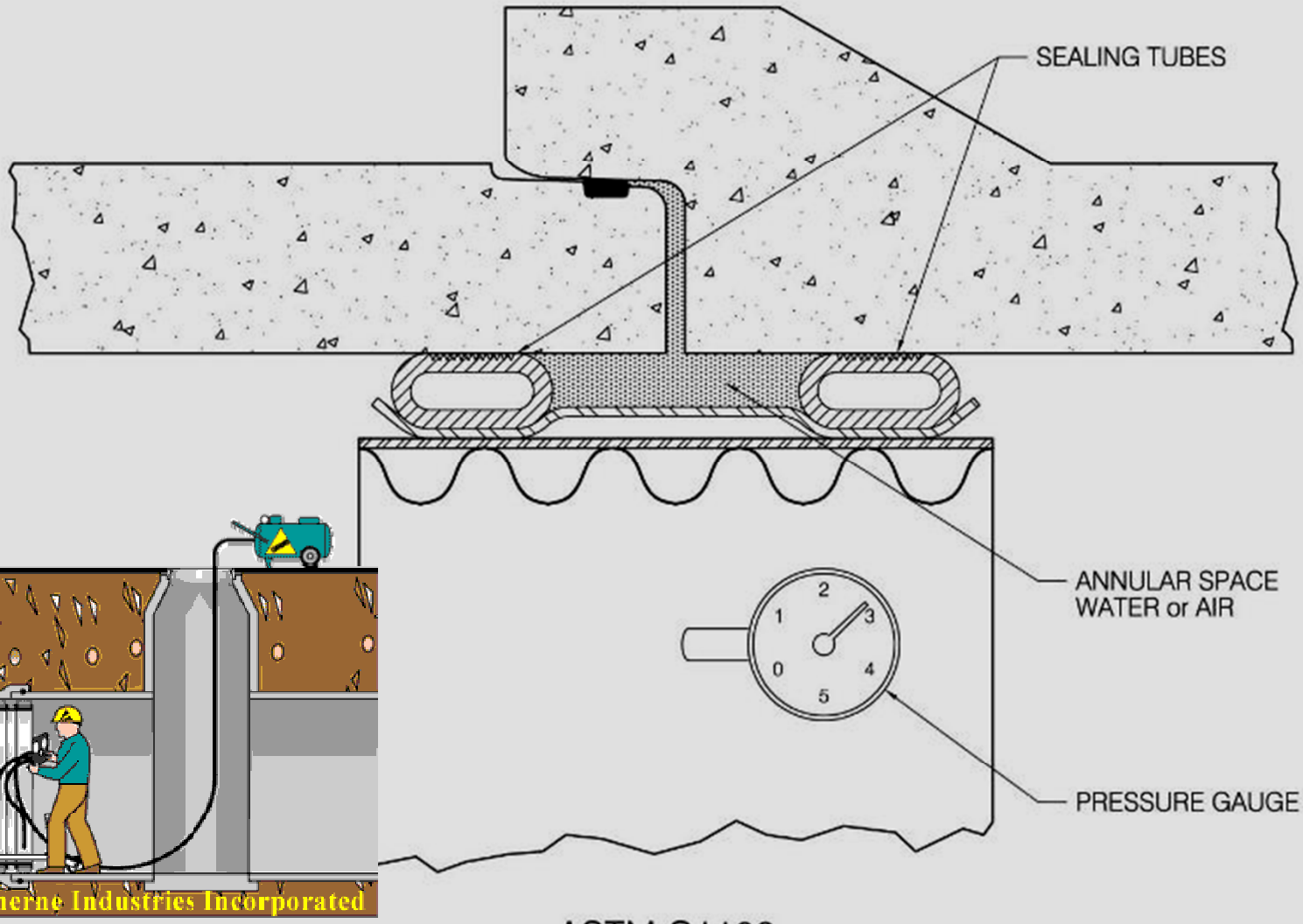
Inspection Before Installation Joints

In Plant or Laboratory Hydrostatic Testing

Inspection during Installation Joints



INDIVIDUAL JOINT TESTER



ASTM C1103
STANDARD PRACTICE FOR JOINT ACCEPTANCE TESTING
OF INSTALLED PRECAST CONCRETE PIPE SEWER LINES

Post Installation Inspection

- When diameters and water flow permit- the entire culvert length should be visually inspected. Small Diameters must also be inspected.
- The severity, extent, and location of conditions should be documented by words, actual measurements, drawings or photos.
- Advanced Inspection Tools are a Must
- Proper Evaluation of Data is Critical!

Post Installation Inspection

National Standards – AASHTO

- **CMP – Section 26.5.7**
- **RCP – Section 27.6.1**
- **HDPE – Section 30.5.6**

USACE

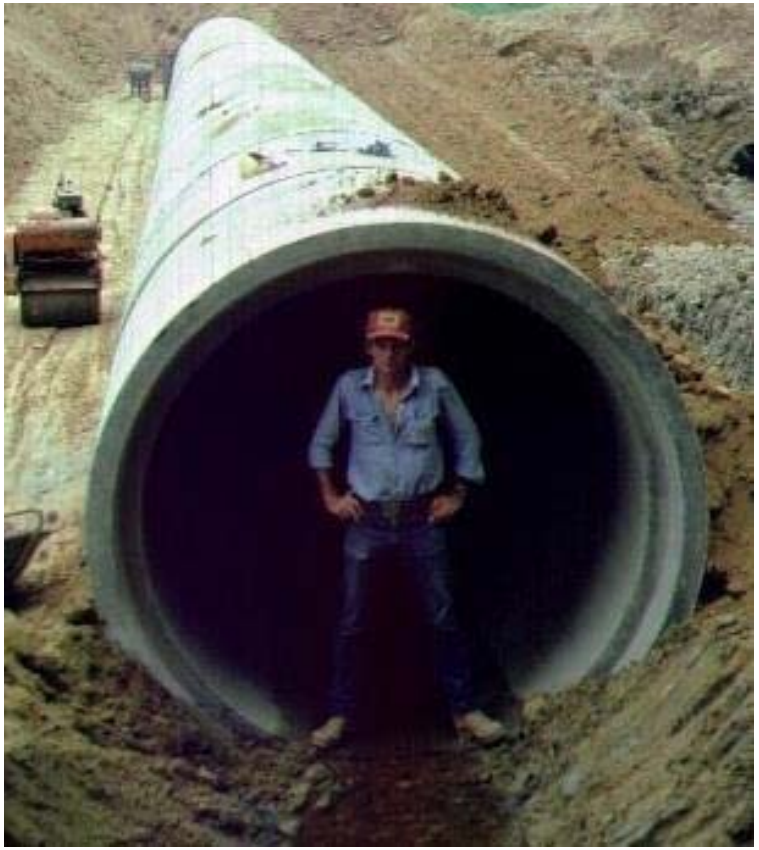
- **33 40 00 – Excellent!**

Use it every time flexible pipe is used

Post Installation Inspection

Concrete Pipes / Culverts

- Misalignment
- Joints
- Cracks
- Spalls
- Slabbing



Pipeline Functions

What 2 functions ***must*** an underground pipe provide?

Conduit

Structure

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Questions?

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Association