

PNWS AWWA Spring Conference

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# THRUST RESTRAINT FOR BURIED WATER SYSTEMS

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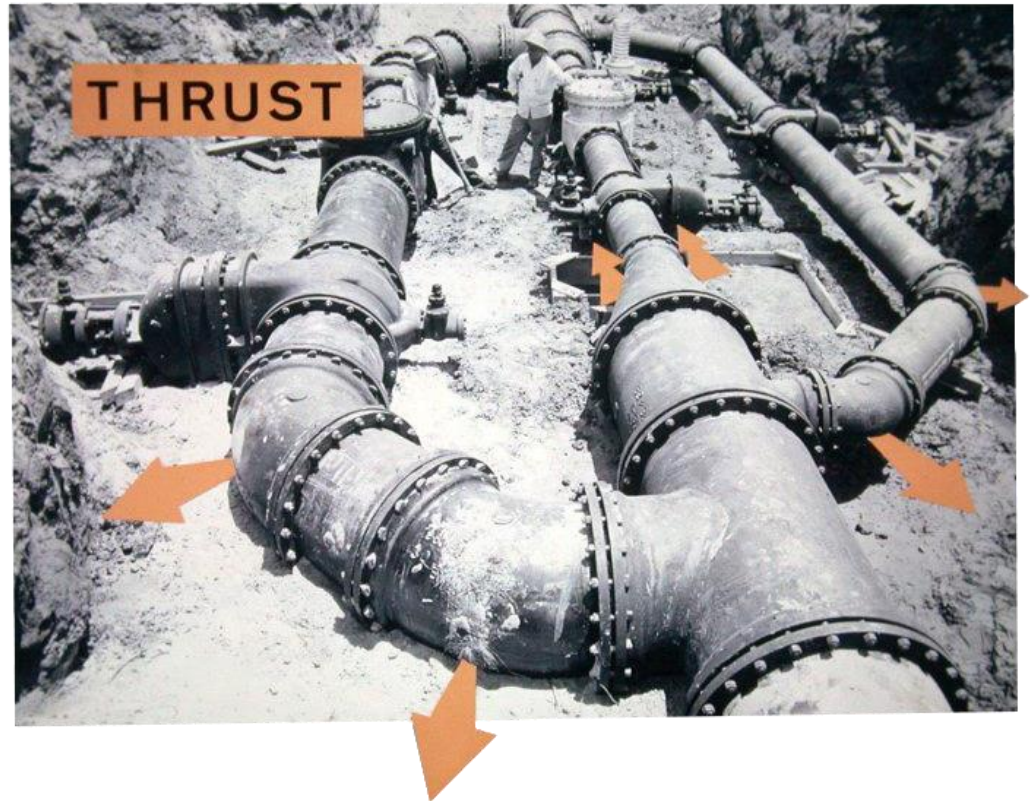
# FORCES CAUSING THRUST

## Static Forces

- Internal Pressures

## Dynamic Forces

- Water Hammer



# RESTRAINING TECHNIQUES

## Blocks

- Bearing (Thrust Block)
- Gravity
- Deadman

## Restrained Joint Systems

- Flange
- Glands
- Gaskets
- RJ Pipe

## Tie Rods

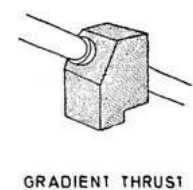
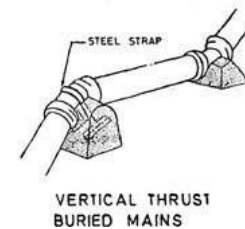
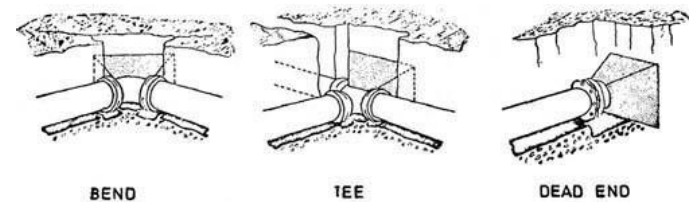
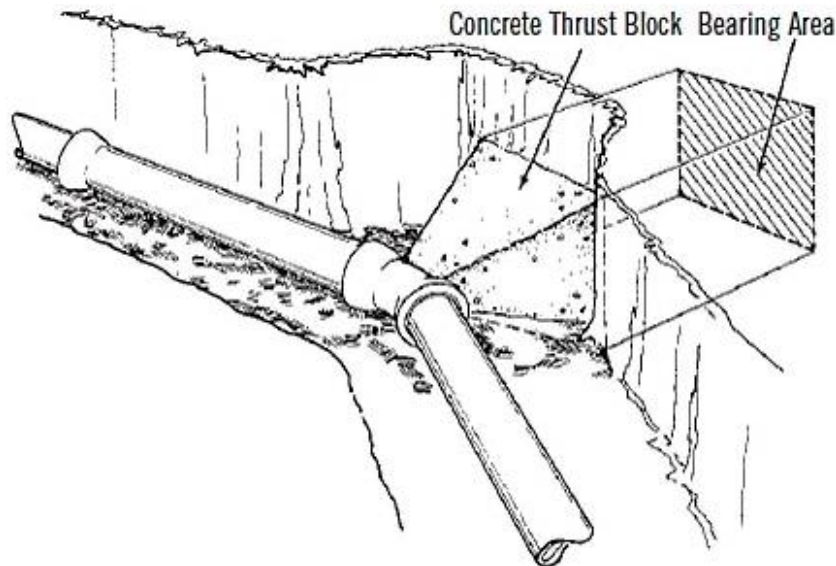
## Combined Systems

# THRUST BLOCK - BEARING

## Design

- Size varies with pipe size, soil and pressure
- Transfers thrust to bearing area

Soil	Bearing Strength $S_b$ (lb./ft <sup>2</sup> )
Muck	0
Soft Clay	1,000
Silt	1,500
Sandy Silt	3,000
Sandy Silt	4,000
Sandy Clay	6,000
Hard Clay	9,000



# THRUST BLOCK – BEARING

## Construction

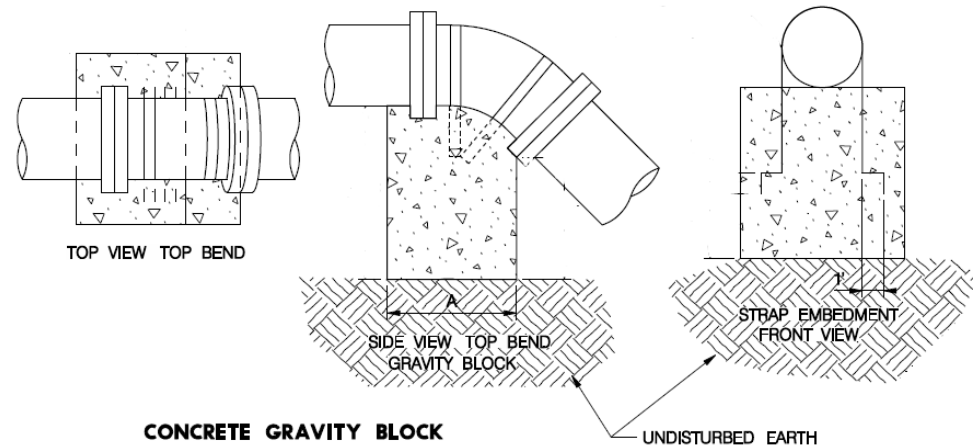
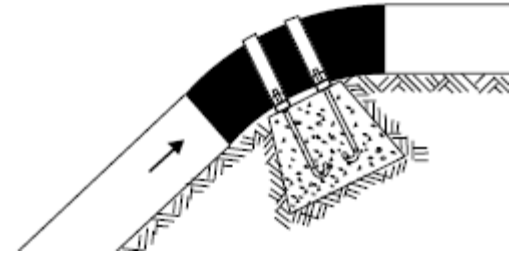
- Distribute load uniformly to bearing soils
- Align bearing face with pipe
- Preserve access to fitting and connections
- Use correct concrete mix design



# GRAVITY BLOCK

## Design and Construction

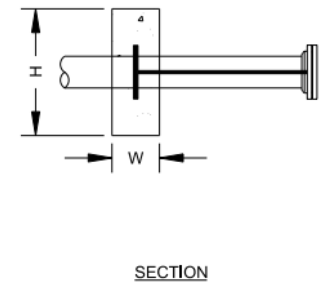
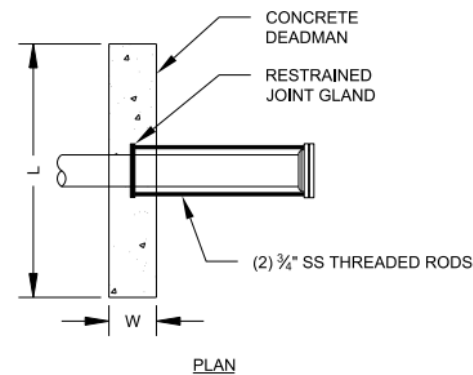
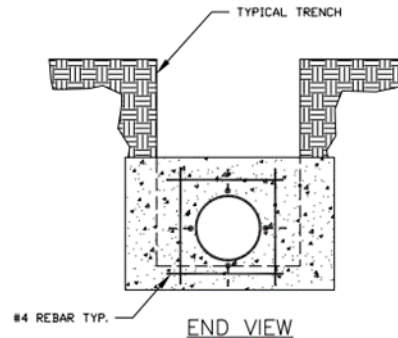
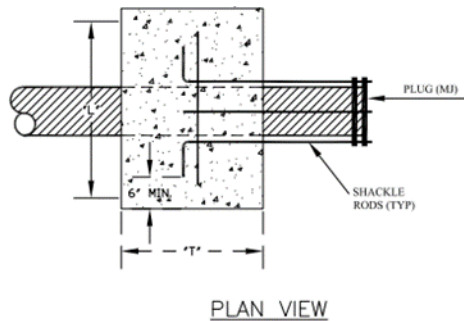
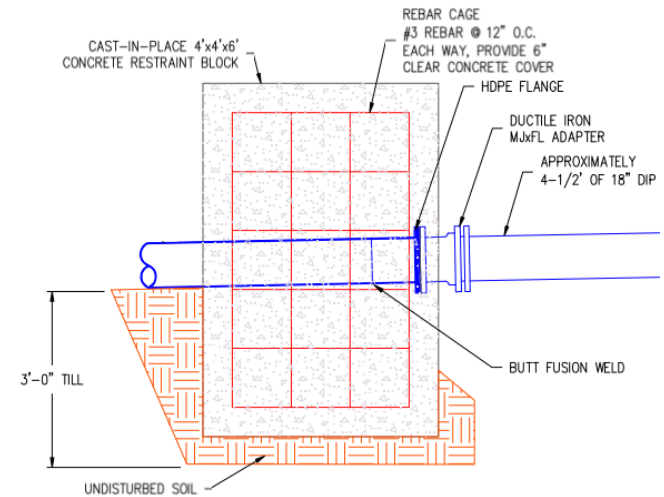
- Formwork
- Secure connection between block and pipe
- Proper concrete embedment
- Transfers thrust from pipe to strap to block



# DEAD MAN BLOCK

## Dead Man

- Dead weight restraint - skin friction
- Keyway thrust to soil
- Pipe/fitting and block connection
- Transfers thrust from fitting to block



# FLANGED JOINTS

## Flanged assemblies

- Valves to fittings
- Fitting to pipe
- Flange coupling adapter
- Rigid
- May or may not transfer thrust to pipe





# RESTRAINT GLANDS

## Restraint Glands

- Set Screw or wedge
- Mechanical Joints
- Transfers thrust from fitting to pipe
- Field installation



# RESTRAINT GASKETS

## Gasket Systems

- Push-on and Mechanical
- Locking teeth in gasket
- Field installation
- Push-on requires cut to remove
- Transfers thrust to pipe



# RESTRAINED JOINT PIPE

## RJ Systems

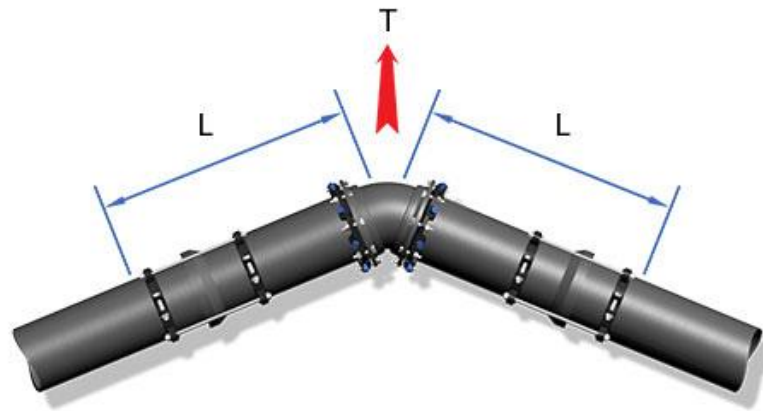
- Push-on and Mechanical
- Welded bead on male end with restraining gland
- Specific design lengths
- Transfers thrust to pipe



# RESTRAINED JOINT SYSTEMS

## Development Length

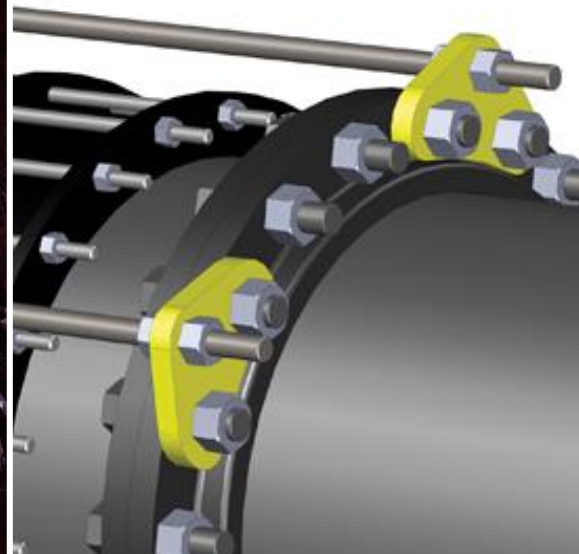
- Transfer of thrust to pipe
- Relies on skin friction between pipe and soil
- Function of pressure, pipe size, bedding and soil type



# TIE RODS

## Rod restrain systems

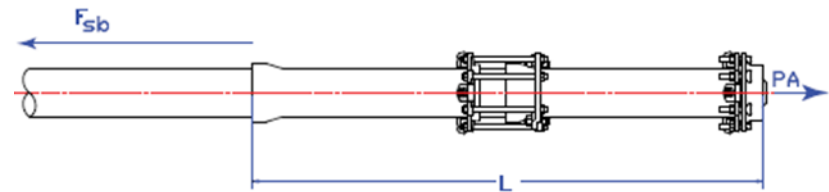
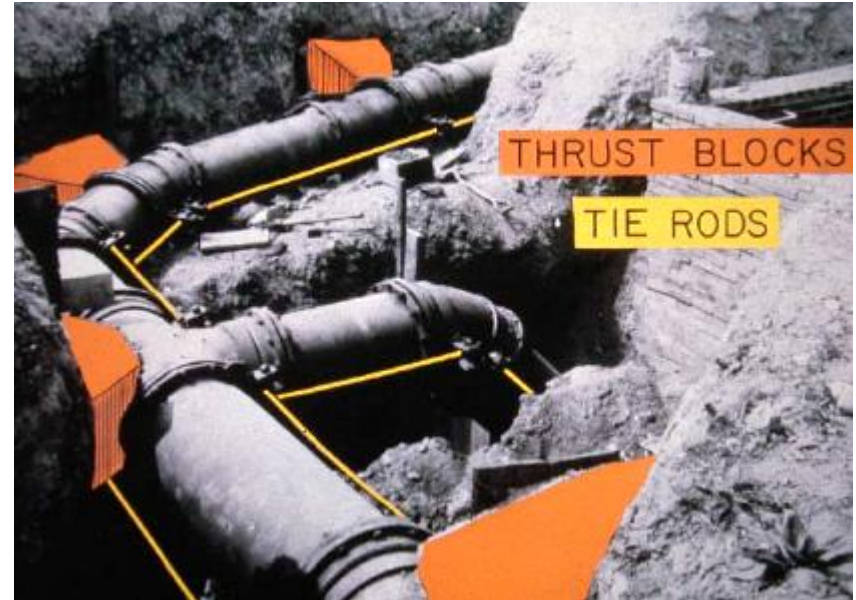
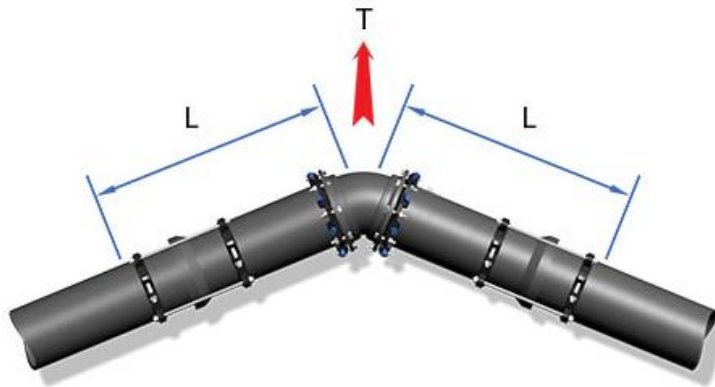
- Hydrants, dead man, RJ pipe systems
- Transfers thrust through rods to point of connection
- Number of rods and size designed



# COMBINATION SYSTEMS

## Combined Restraint Systems

- Inadequate space
- Economics
- Redundancy

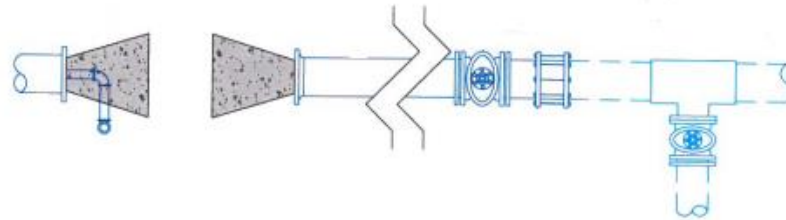


$$L = S_f \cdot P \cdot A / F_{sb}$$

# TEMPORARY RESTRAINTS

## Dead End

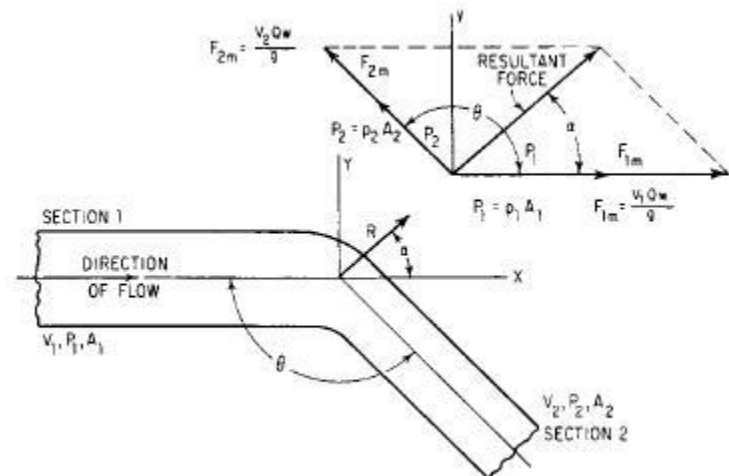
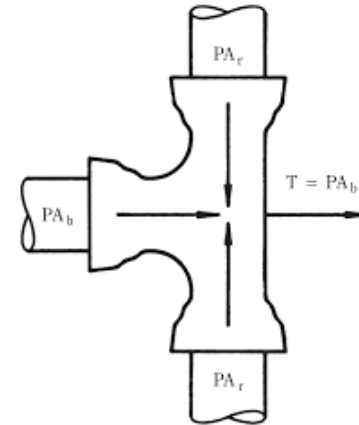
- Timbers
- Ecology or Thrust Blocks
- RJ Pipe and Fittings
- Closed Valve?



# FREE BODY DIAGRAM

## Resultant force

- Pressure and area
- Opposing forces
- Methods to resist resultant force
  - Thrust, gravity or dead man blocks
  - Shackle rods
  - RJ pipe and fittings





# SYSTEM FAILURE

Design and construct to avoid system failure

- Know the conditions
- Understand the design
- Factor of safety

