

# *“Seawater Piping System Design and Considerations”*



Presented by:

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# General Outline

- Review of Piping Construction
  - Construction Methods
  - Material Properties
- Joining Methods
- Approach to Buried Piping
- Above Ground Piping
- Pipe Stress Analysis
- Piping Support Arrangement
- Summary



# Piping Construction Methods – Continuous Hood Winding



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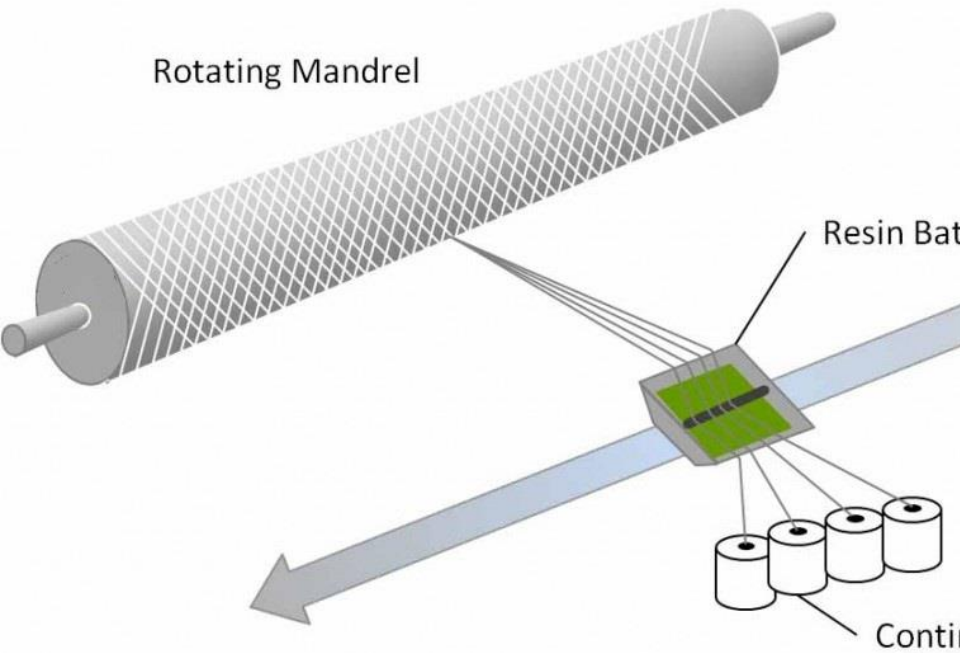
# *Continuous Hood Wound GRP with Chop or Axial Tape*



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# Helical Filament Wound GRP/GRE

## Filament Winding



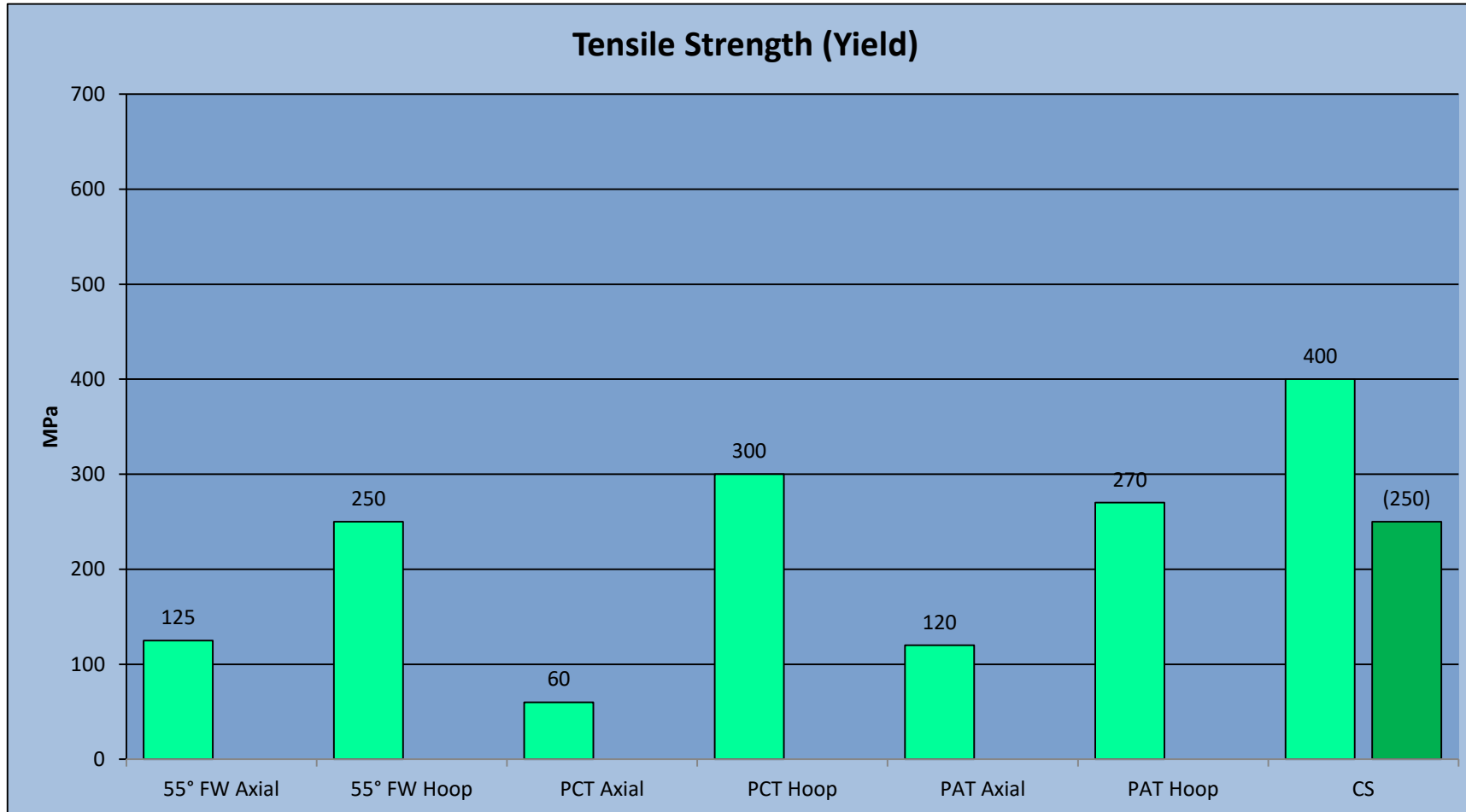
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# Hand Lay-up GRP Pipe



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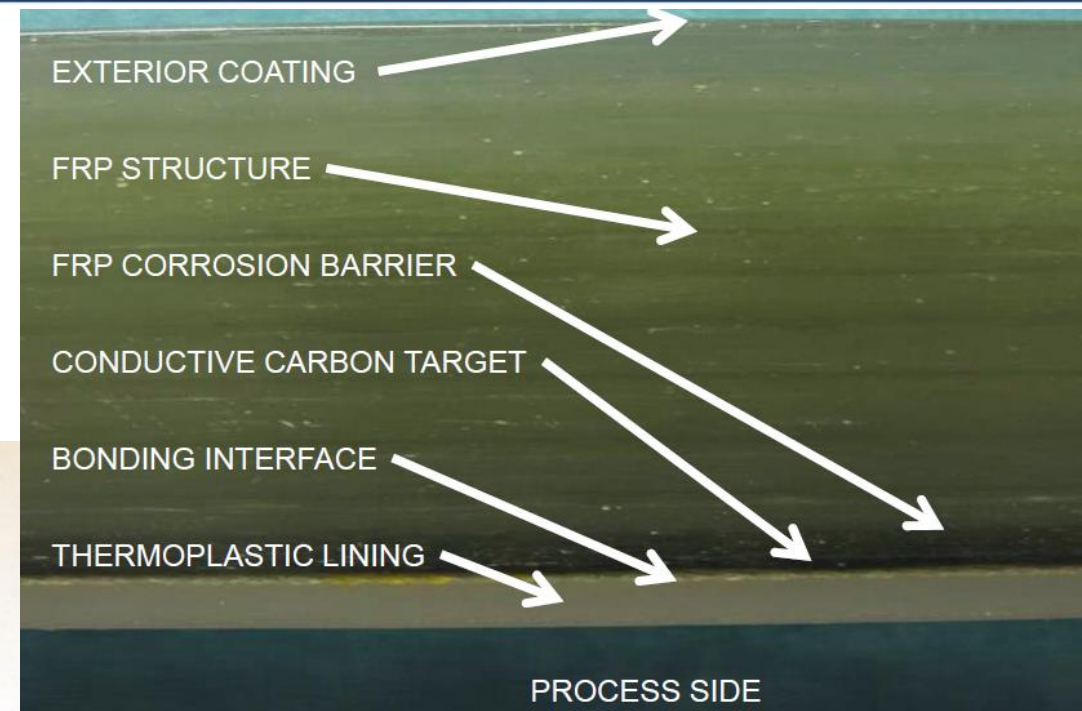
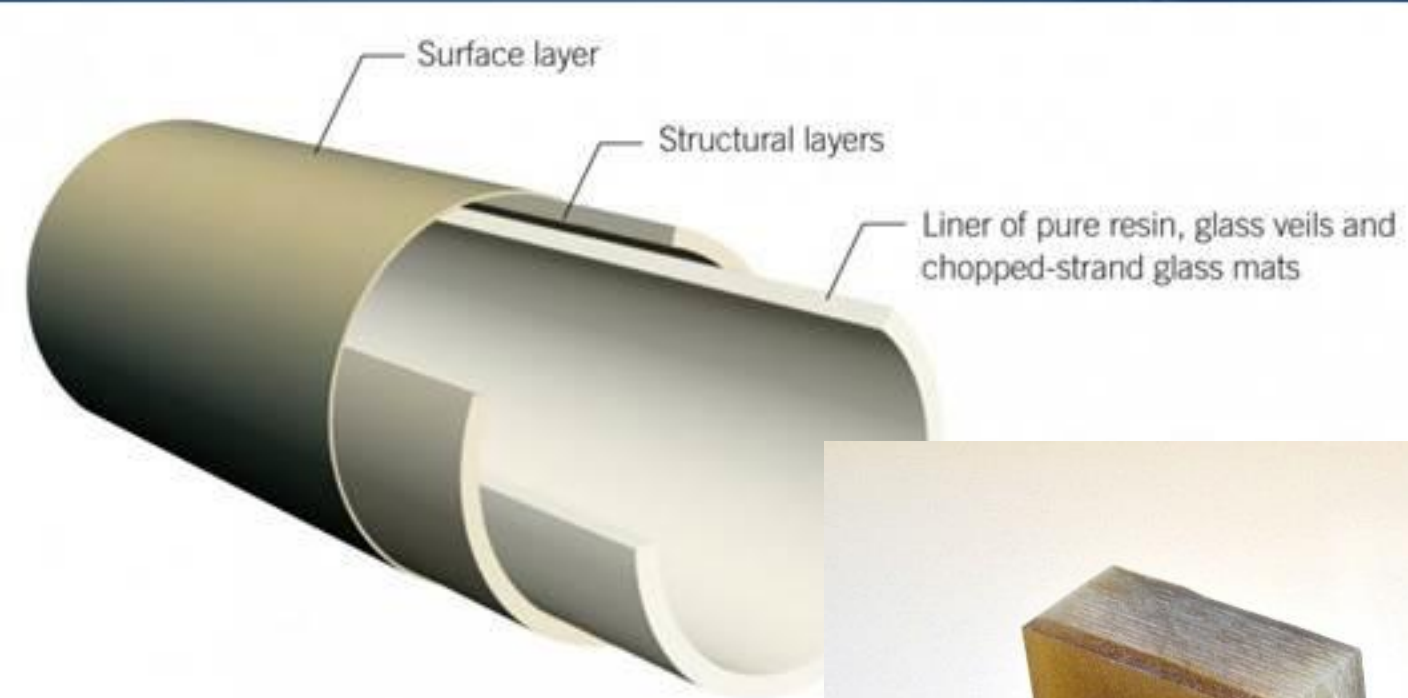
# Comparative Material Properties



## General Notes:

- 55°FW (Helical)
- PCT – Continuous Wound Pipe (w/ Chop or Hoop Only)
- PAT – Continuous Wound Pipe (w/ Axial Tape Interspersed)
- PAT – Properties can vary depending on the number of Axial Tape Layers added
- Polyester and Epoxy properties are similar
- Vinyl Ester properties could be better depending on resin.

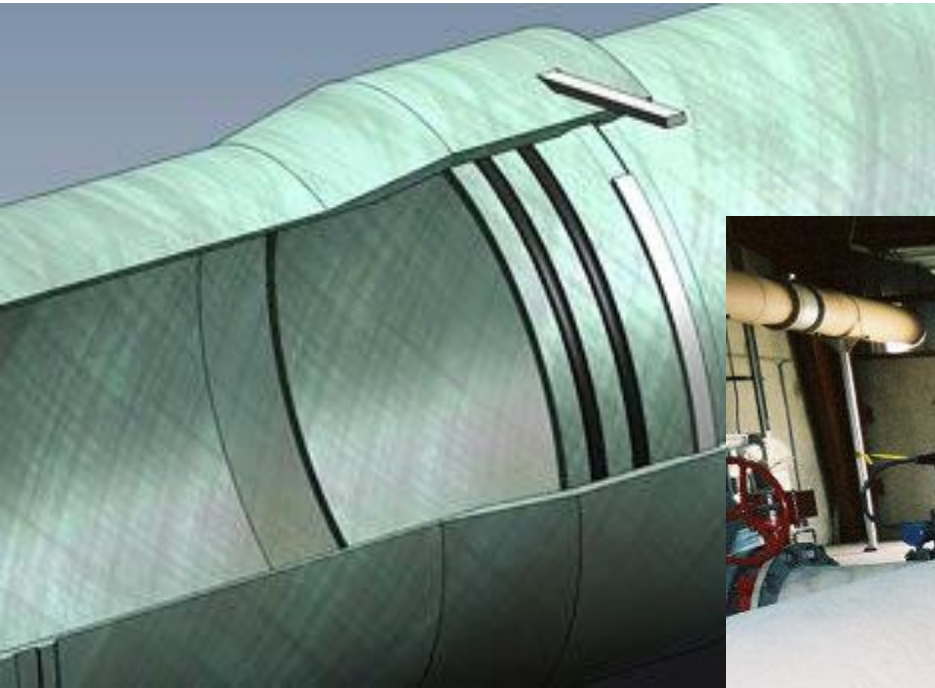
# GRP/GRE Pipe Wall



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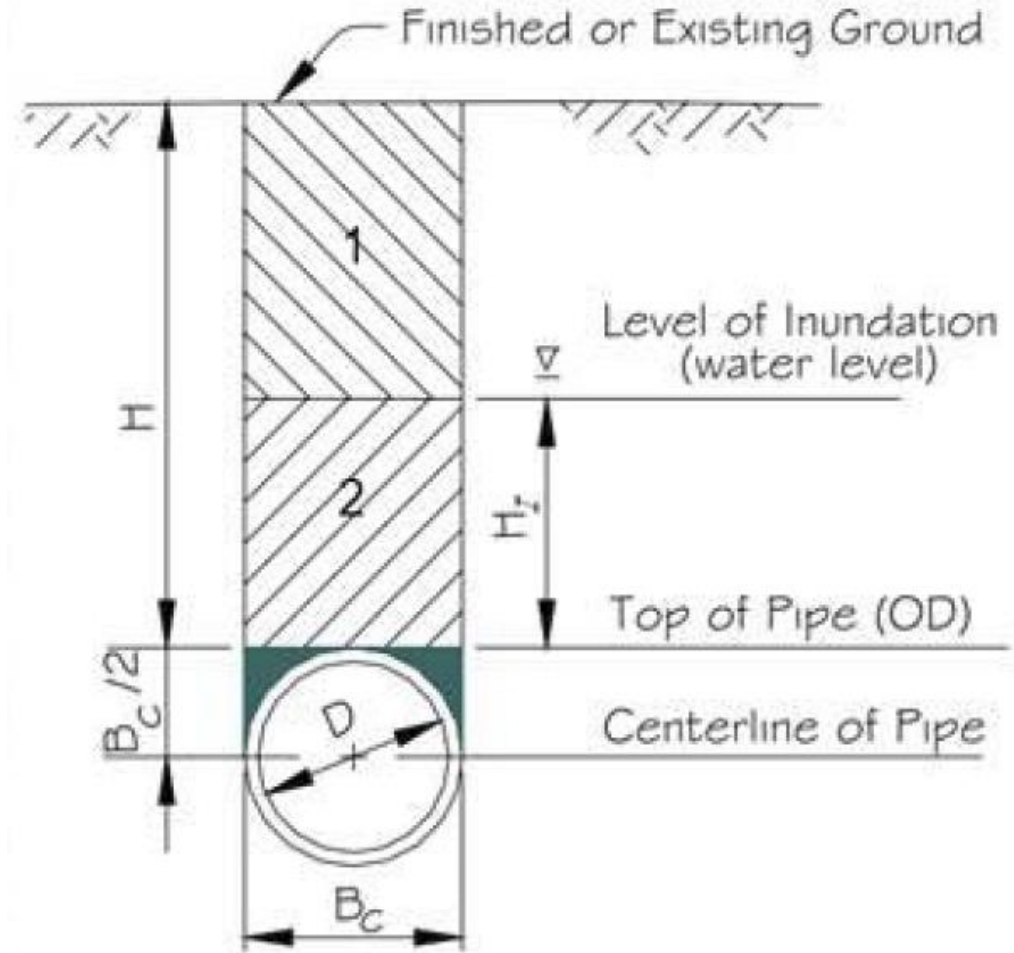
# Typical GRP Joints



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# Approach to Buried Piping

- Soil Loading
- Truck Loading
- Axial Thrust
- Buoyancy



# Discussion of Harness Length

- Natural Restraint by Soil
- What happens at the elbows
  - Soil Restraint
  - Bonded or Locked Joints
- Harness Length
  - Significant Axial Strength is Needed
- Thrust Blocks may be needed



# Discussion of Harness Length



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# Installation Concerns

## Soil Fill and Compaction

- Quality Fill Material
- Compacted Underneath
- Compacted in 300mm lifts
- Spacing needs to allow for stability
- Compaction to 90%-95% of Proctor



# Installation Concerns

## Examine Transitions

- Soil to Concrete
- Concrete to Air (Unrestrained)
- Cushioning is Recommended
  - Rubber
  - Dense Neoprene Foam



# Installation Concerns

## Flange Installation

- Flatness
- Stress Free Alignment
- Bolting Torquing



# Above Ground GRP Piping

## Design Concerns

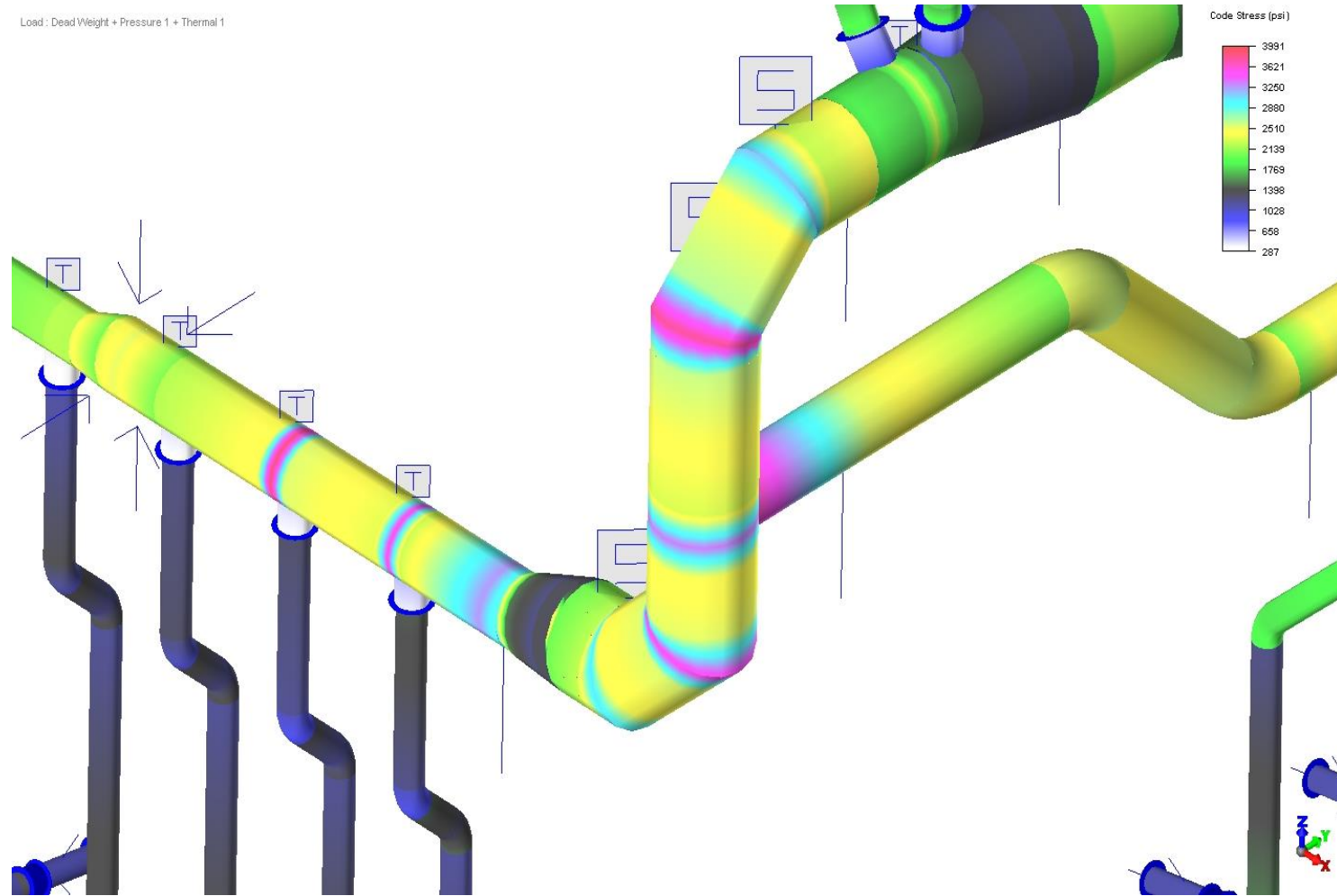
- Biaxial Stress
- Thermal Expansion
- Local Reinforcements
- Pipe Support Strategy
- Proper Pipe Supports





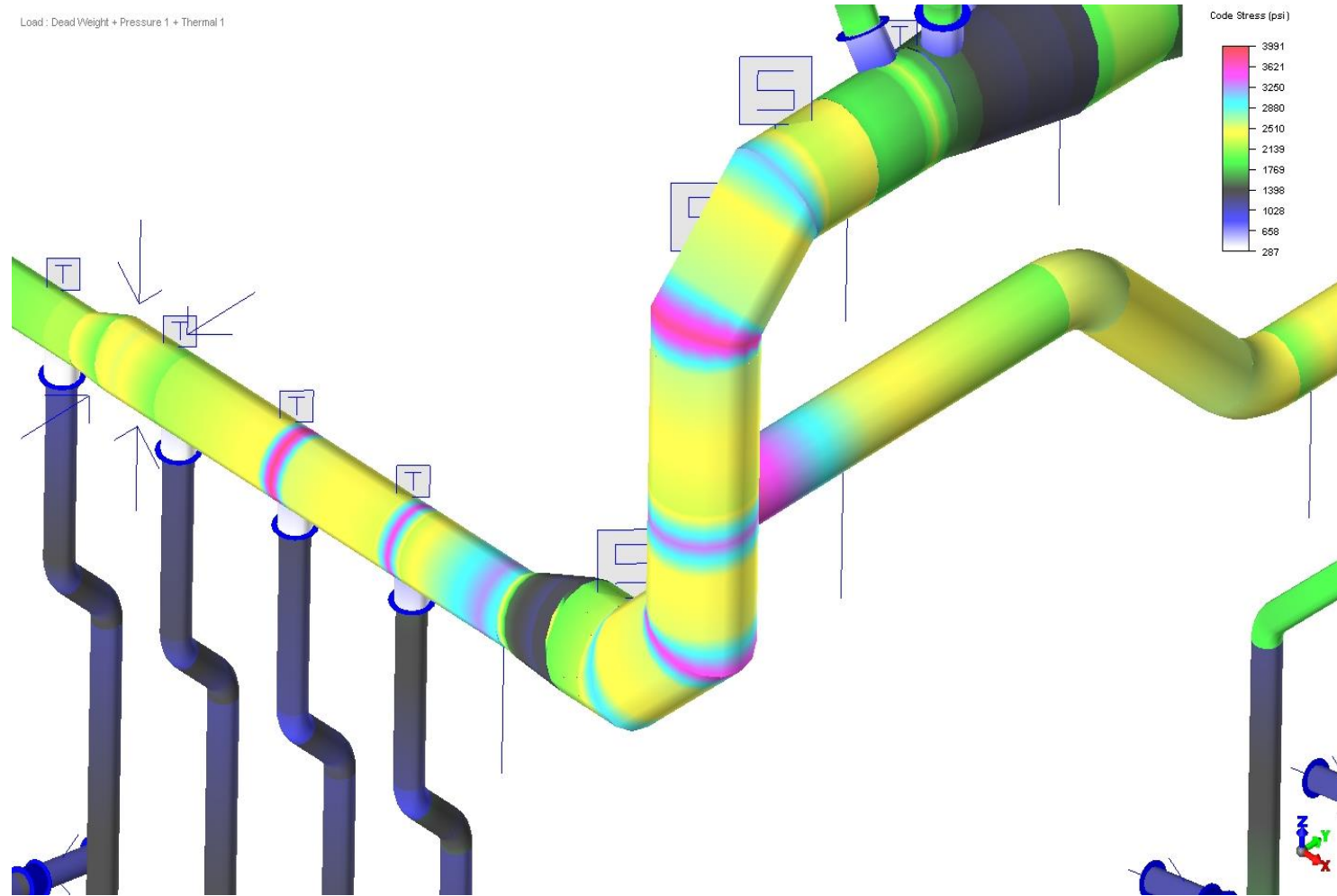
# Pipe Stress Analysis

- Geometry
  - Terminal Points
- Material
  - Pipe
  - Fittings
  - Reinforcements



# Pipe Stress Analysis

- Design Conditions
  - Max Operating
  - Max Achievable
- Load Cases
  - W+P
  - W+P+T
  - W+P+OCC

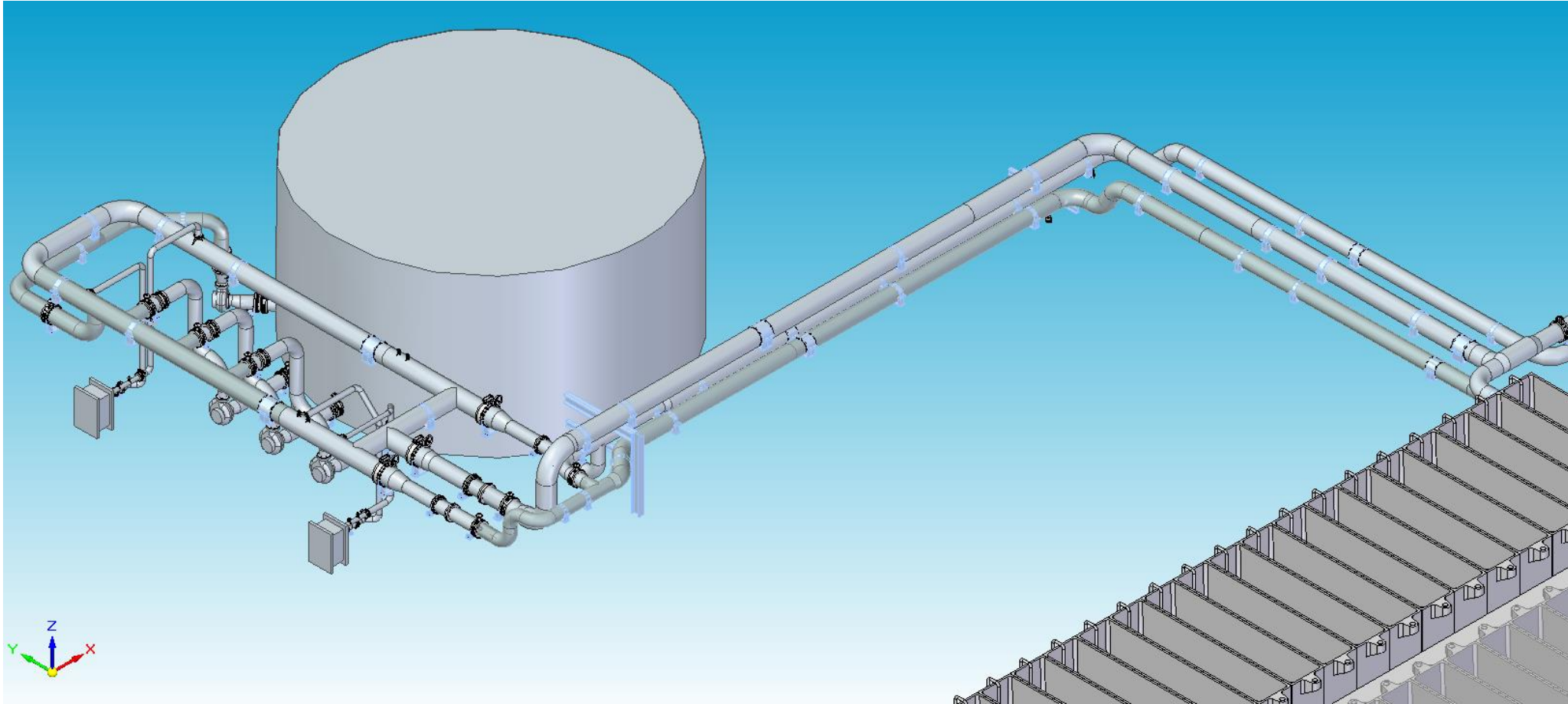


## Within Limits

- Manage Thermal Expansion
- Protect Tees
- Manage Stress



# Flexible Pipe Support Arrangement



*A Strategic Pipe Support Arrangement is Essential!*

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# Keys to Success and Reliability

- Review Piping Materials
- Design is about the Details
  - Review Calculations
  - Verify Materials
- Inspect with Diligence
  - Fabrication
  - Installation
- Operational Controls



*“Reliability is about Expertise and  
Follow Through.”*

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