Reeling of Pipe-in-Pipe

The (economic) benefits of the greater resistance of PiP systems against local buckling

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HMC EXPERIENCE — J-LAY

VARIED PIPES
CLAD Lined PiP

2 Pipelay vessels
Balder and Aegir

650 KM
Pipes installed since 1991
REELING TECHNOLOGY DEVELOPMENT

PIPES TESTED

- Thick coatings
- Seam welded
- Pipe-in-Pipe
- Mechanically lined
- Transition piece
HMC EXPERIENCE — REEL-LAY

2014
ANADARKO LUCIUS
GOLF OF MEXICO

2015
INPEX ICHTHYS
AUSTRALIA
THE SLIDING PIPE-IN-PIPE SYSTEM

OUTER PIPE

AIR

DRY INSULATION

INNER PIPE

FLUID

CENTRALIZER
PIPELINE FAILURE MODES

- Burst
- Collapse
- Local Buckling
- Global Buckling
- Fatigue
- Fracture

Photo credit: HMC, NTNU, C-FER
LOCAL BUCKLING DUE TO COMBINED LOADS

REEL

LOCAL BUCKLING

STRONG PIPE

WEAK PIPE

STRAIN > 5%

WEAK PIPE
(SOME) FAILURE MITIGATION FOR REELED PIPE-IN-PIPE

- **BURST**
  - Increase **INNER PIPE** wall thickness

- **COLLAPSE**
  - Increase **OUTER PIPE** wall thickness

- **Local BUCKLING**
  - Increase **OUTER PIPE** & sometimes **INNER PIPE** wall thickness
STIFFNESS MISMATCH BETWEEN JOINTS

SINGLE PIPE

PIPE-IN-PIPE

22% WT MISMATCH
BEND TESTING
BEND TEST RESULTS — CYCLE 1

SINGLE PIPE

BENDING

BUCKLE

STRAIGHTENING

FRACTURE
BEND TEST RESULTS — CYCLE 1

SINGLE PIPE

BENDING

BUCKLE

STRAIGHTENING

FRACTURE

PIPE-IN-PIPE

BENDING

LIFT-OFF

STRAIGHTENING

WRINKLE
BEND TEST RESULTS — CYCLE 2

SINGLE PIPE
Buckle after first cycle
Fracture after straightening

PIPE-IN-PIPE
Buckle of the outer pipe after two cycles
Inner pipe ovalized but not buckled
LOCAL BUCKLING AND OVALLY

PREDICTED OVALLY

DISTANCE ALONG PIPE [M]

SINGLE PIPE

PIPE-IN-PIPE
STABILITY OF REELED PIP TOWARDS LOCAL BUCKLING

Detailed Finite Element and reliability analysis permit to reduce some conservatism and optimize the wall thickness design.

Cost reduction is the first benefit of pipe wall thickness reduction.