Oct. 2017

Performance Test of Steel Pipe for crossing fault (SPF) in United States







1. What SPF is

2. Performance Tests of SPF (Cornell Univ.)

3. Summary

Surface Earthquake Fault



Chi-Chi Earthquake (1999 Taiwan)

Example of Pipe Damage by Fault Offset



Chi-Chi Earthquake (1999 Taiwan)

Example of Pipe Damage by Fault Offset

Gas Pipe 200mm (8in.)

Chi-Chi Earthquake (1999 Taiwan)

Deformation of Welded Steel Pipe

 The tensile and compressive deformation generates the pipelines at the equal distance across the fault plane.

Deformation of SPF

Concept of SPF

Concept of Steel Pipe for Crossing Fault (SPF)

XAllowable Value

1. What SPF is

2. Performance Tests of SPF (Cornell Univ.)

Axial Compression Test
Axial Tension Test
Bending Test
Split-basin Test

3. Summary

Collaborative Research with Cornell Univ.

Axial Compression Test

- To confirm axial compressive performance
- Diameter 216mm (8.5in.), Thickness 2.3mm (0.091in.)
- To pressurize with water to 0.55MPa (80psi)

Axial Compression Test / Result

(1) Allowable value \rightarrow No crack / no leakage

Axial Compression Test / Result

(2) Deformation: 86.4mm(3.40in.)(twice the deformation of allowable value)

Displacement (mm)

(2)Twice the deformation \rightarrow No crack / no leakage

Axial Compression Test / Result / FE analysis

Deformation can be accurately simulated by FE analysis.

Axial Tension Test

- To confirm axial tensile performance
- Diameter 216mm (8.5in.), Thickness 2.3mm (0.091in.)
- To pressurize with water to 0.55MPa (80psi)

Axial Tension Test / Result

FE Analysis — Experiment (1) Deformation of wave feature: 700 57mm(2.25in.) 600 = allowable value Load (kN) 500 400 300 200 100 HL 0 20 40 60 $\mathbf{0}$

Wave Displacement (mm)

- (1) Allowable value \rightarrow No crack / no leakage
- Deformation moved to straight pipe until 127mm(5.0in.).

(2) Deformation: 127mm(5.0in.)

Deformation can be accurately simulated by FE analysis.

Bending Test

- To confirm bending performance
- Diameter 216mm (8.5in.), Thickness 2.3mm (0.091in.)
- To pressurize with water to 0.55MPa (80psi)

Bending Test / Result

(1)Allowable value \rightarrow No crack / no leakage

Bending Test / Result

(2)Bending angle: 36.6° (twice the angle of allowable value)

(2) Twice the bending angle \rightarrow No crack / no leakage

Bending Test / Result

(1)Bending angle: 18.0° at metal-to-metal contact

(2)Bending angle: 36.6° (twice the angle of allowable value)

Deformation can be accurately simulated by FE analysis.

Underground Test

Underground Test

- Boundary condition: Fixed at both ends
- To pressurize with water to 0.55MPa (80psi)

Underground / Result

Underground Test / Result

[Before deformation]

- Absorption of fault displacement is only on the SPF wave.
- It can secure the area of 88%, even after 42° bending.

Underground Test / Result

Deformation can be accurately simulated by FE analysis.

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Experimental Results

To confirm the effectiveness of SPF,

in the test that simulates Hayward fault.

• No crack and no leakage, even after large displacements, which are more than the allowable values.

Conclusion

- In the collaborative research with Cornell Univ., it could be proved that SPF is applicable in US faults.
- SPF was recognized in the US as well, as a countermeasure of pipeline crossing faults.

I'd be happy to answer any questions.