Full-Scale Pipe-in-Pipe (PIP) Testing for Offshore Application

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Abstract

In this study, polymer based grouts (with and without aggregate) were tested to determine their suitability to be used as a shear stop in pipe-in-pipe (PIP) flowline. In this PIP configuration, 10" carrier pipe and 16" casing pipe were used. The PIP capacities of the grouts tested varied from 100,000 lb/ft to 150,000 lb/ft respectively.

1. Introduction

Pipeline installation loads, planned or unplanned, could shear the electrical heating tabs (connections) to the inner pipes at the joints and damage the corrosion protection in the Pipe-in-Pipe (PIP) system; hence the force transfer mechanisms in the PIP systems during installation and operation are of interest in order to protect the electrical heating tabs (connections) [1, 2]. One method of achieving the optimum PIP configuration is to fill the annular space with dielectric quality grout. In this study, the behavior of PIP with pipes of 10 in. and 16 in. diameters held together by two grouts in an annular space was investigated. Two full-scale tests were performed in the study.

2. Objective

The objective of the study is to determine the shear bonding strength of the selected grouts in the PIP configuration.

3. Materials and Testing Program

Materials

Polymer based grouts were selected and tested. The physical properties of the tested grouts are summarized in Table 1.

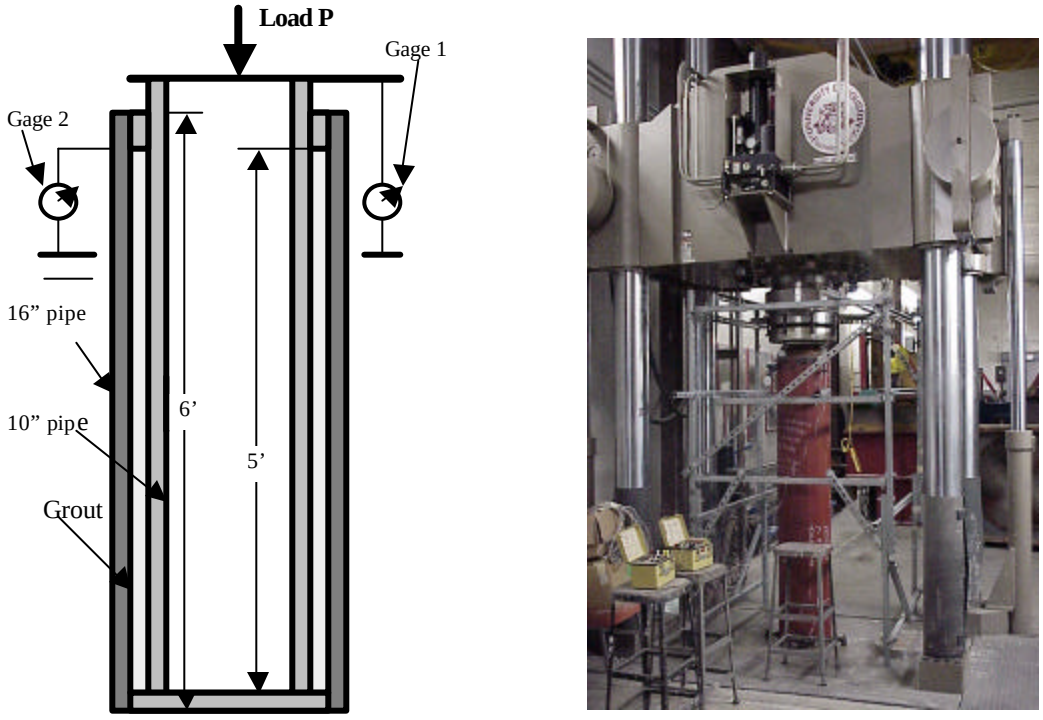
Table 1. Properties of the Grouts

	Density (kg/m^3)	Pulse Velocity (m/s)	Shear Velocity (m/s)	E (MPa)		Hardness
				μ=0.2	μ=0.4	Average
Grout properties	750 ~ 1800	2400 ~ 3100	930 ~ 1600	4,000 ~ 15,000	2,000 ~ 8,000	32 ~ 40

Notations: PV: pulse velocity; SV: shear velocity; E: elastic modulus
μ : Poisson's ratio.

Testing Program

The full-scale test was designed to determine the PIP load capacity with the selected grouts under installation conditions. The test configuration and setup is shown in Fig. 1. The grouted length varied from 60 to 70 inches. The test was performed 30 minutes after the specimen was prepared to simulate offshore cycle time.



(a) (b)

Gage 1 – measures the total deflection of the specimen,
Gage 2 – measures the deflection of the 16” pipe.

Figure 1. Full-Scale Test Configuration and Setup

4. Test Results

The test specimens were loaded at 200 lb/sec. The failure loads varied from 600 kips to 900 kips. The average shear bonding strength varied from 200 to 300 psi depending on the grout and pipe surface conditions. Both interface and grout failures were observed in the tests.

5. Conclusion

Polymer grouts (with & without aggregates) can be used to develop high shear capacity in the PIP configuration.

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References

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