LOAD AND DEFLECTION OBSERVATION OF PIPE SUPPORTS AT AMBIENT AND OPERATIONAL TEMPERATURE

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TABLE OF CONTENTS

1. INTRODUCTION

Rilco Pipe Supports are designed to withstand the process application load as well as the additional load caused by the process pipe temperature. The supports are installed with the initial preload on the bolts, which increases with the rising temperature.

This experiment was performed to witness the actual force exerted by the Belleville washers, as well as the deflection, both at ambient and process operational temperature. Overall, this experiment displayed the deflection of the Belleville Washers and the additional load on the bolts caused by the pipe expansion due to the increased temperature.

2. TEST EQUIPMENT

- Omega 25k Through Hole Load cell (force transducer)
- Digital Caliper
- Omega PDAQ unit and software

3. TEST SPECIMEN

- 12” Resting Pipe Support (top and bottom half shells) by Rilco
- 16” Resting Pipe Support (top and bottom half shells) by Rilco

4. TEST PROCEDURE

Both Pipe supports were tested in the same manner with their respective Belleville Washer quantity and Install height.

Measurement Procedure of the Overall Install Height

- As the Belleville Washers (BW) are not accessible from the side of the bolts to measure the Install Height, the measurement was taken from the top of the washers
- One edge of the main arm of the caliper was placed on top of the top flat washer and the depth measuring probe was pulled down to touch the support shoulder (steel under the bottom flat washer) to measure the Overall Install Height, which includes two flat washers as well

Fig1. Placement of the Caliper

(a) (b)

Fig2. (a) Edge of the main arm on top of the top flat washer
(b) Depth measuring probe pulled down till the support shoulder

- The thickness of two flat washers was added with the Belleville Washer Install Height to get the Overall Install Height

- Overall Install Height Measurement

Support	BW Install Height (mm)	2 Flat Washer Thickness (mm)	Overall Install Height (mm)
16” Pipe Support	38	5	43
12” Pipe Support	29	5	34

Experimental Procedure

- The half shells were clamped around the pipe and the Belleville Washers were compressed at Overall Install Height by tightening the bolts.
- Force Transducer (Load cell) was placed in one bolt with the Belleville Washer assembly to measure the force exerted by the washers
- One K-Type stainless steel braided thermocouple was attached to the pipe to measure the pipe temperature

Fig3. Load Cell setup with the Belleville Washer assembly

- Once the support was setup for the test, the Overall Install Height of the Belleville Washers, on each bolt, was measured at ambient temperature by following the appropriate procedure
- The load was then recorded using the load cell and omega PDAQ software
- Once the BW height and load was recorded at ambient temperature, the pipe was then heated up to the process operational temperature, 150 ^{0} C (302^{0} F), by using a torch with a soft flame which allows more even heating
- A hand-held thermocouple meter was used to measure the pipe temperature
- As soon as the pipe temperature reached at 302^{0} F, the deflection of the Belleville Washers, on both side, was measured following the same procedure
- The load cell measurement of the increased load was also recorded

- The increment of load and deflection, due to the pipe expansion, was recorded and compared with the initial values

Fig4. Thermocouple attached to the pipe

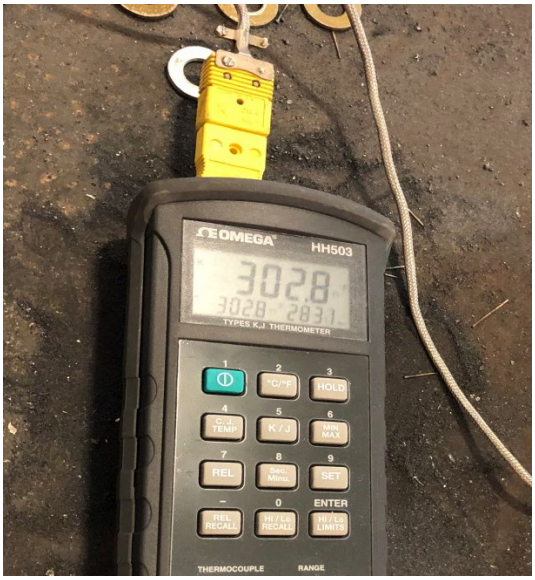

Fig5. Hand-held Thermocouple Meter

5. TEST RESULTS

Deflection

16” Pipe Support	Overall Install Height (mm)		Increment in Deflection due to Pipe Expansion (mm)
	At Ambient Temperature	At Operational Temperature (302^0 F)	
Bolt 1	42.99	41.81	1.18
Bolt 2	42.86	41.96	0.9

Note: Load Cell attached with Bolt 2

12” Pipe Support	Overall Install Height (mm)		Increment in Deflection due to Pipe Expansion (mm)
	At Ambient Temperature	At Operational Temperature (302^0 F)	
Bolt 1	33.92	33.89	0.03
Bolt 2	34.06	33.77	0.3

Note: Load Cell attached with Bolt 2

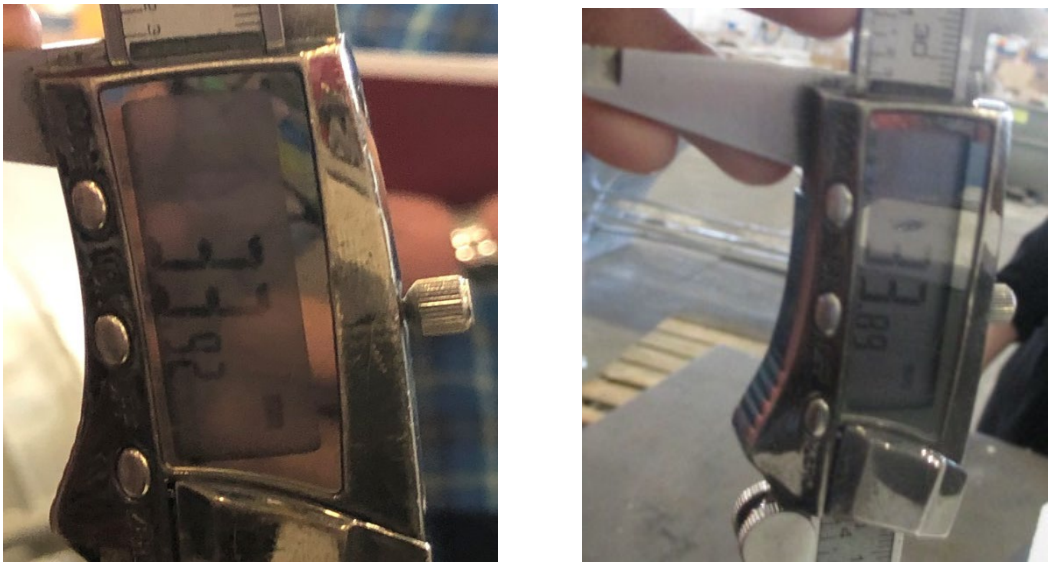

Fig6. Digital Caliper Reading, before and after pipe expansion (12” Pipe Support)

Load

Support	Load (lb)		Increase in Load due to Pipe Expansion (lb)
	At Ambient Temperature	At Operational Temperature (302^0 F)	
16” Pipe Support	1879	2341	462
12” Pipe Support	2016	2317	301

6. DISCUSSION AND CONCLUSION

This test was performed to measure the washer deflection and load increment due to pipe expansion at operational temperature.

Under ideal conditions, both sets of bellevilles would undergo equal compression due to the pipe expansion. The outer surface of the test fixture pipe was left “as is” with no additional effort put forth to eliminate or equalize the friction between the pipe and the insulation support. Therefore, it would be expected to see a differential between the two sets of bellevilles.

The 16” Pipe Support, the deflections observed in Bolt 1 and Bolt 2 are 1.18 and 0.9 mm respectively. The compression of the each Belleville washer group was similar showing an equalized friction component on the surface of the test fixture pipe.

The Load Cell was attached with Bolt 2 to record the load increased due to the heat. In 16” Pipe Support, the bolt load increased by 462 lb and no sign of damage was found due to the increased amount of load.

For the 12” Pipe Support, the deflections observed in Bolt 1 and Bolt 2 are 0.03 and 0.3 mm respectively. Due to smaller pipe diameter, the expansion was very minimal. In this case, the deflection in each bolt varied from the other one, because of the inconsistency in pipe surface and friction between the pipe and the insulation.

The Load Cell was attached with Bolt 2 and load increased by 301 lb because of the heat. No sign of damage was found due to the increased load.

Overall, both supports comply with expected results in terms of deflection, load increment and bolt resistance against the additional load.