COMMENTARY ON TECHNICAL PROGRESS REPORT v 1.2

We received a copy of Borouge's Technical Progress Report. One must understand the rules of the test(s) being conducted and the context of the report, but the report was extremely positive for Tech-Bond and the Tech-Patch Repair System. We will begin by covering the instructions, shown in red below, for the test)s) given by Borouge. Our commentary on the instructions is in blue.

BACKGROUND

The aim of the requested tests is to get an impression on the performance of a HDPE crack suppression coating product that is planned to be used in Borouge Ruwais plant cracked stub-ends. The notched pipes that were coated in Tech-Bond (USA) were performed for Hydrostatic Pressure Testing (HPT)

Primary and secondary test schemes are to be followed with a total of 18 samples, **9 each**.

As described in the BACGROUND above and below in the descriptions of the Primary and Secondary Tests below, there was always going to be two tests on the **same nine pipes**. **The first test was to be run until each of the nine samples failed.**

Those nine samples, when all samples fail, are to be sent back to Tech-Bond. The intent of this step is to determine how effective the Tech-Patch Repair System is on repairing through wall damaged pipe. To repair these damaged pipes, we will use the Tech-Wrap. Currently,

- For the Primary Test, we used Tech-Patches. There is not a patch system, anywhere in the world, which will repair HDPE pipes or tanks.
- A patch system can be used in places where a wrap will not work.
- There are various iterations of the carbon fiber wraps for repairing through wall damage in pipes, but none of these are recommended for HDPE pipe.

One last point to make. Because of the small diameter of the HDPE pipe test samples, we were only able to use 2-inch wide A Patches. Normally, on repairs of this nature, we would use 4-inch wide A Patches. Since surface area is a multiplier, a 4-inch-wide patch will always have higher psi ratings than a 2-inch-wide patch.

Now the descriptions of the tests. BIC is an acronym for Borouge, the company for which we will be doing the pipe repairs.

MATERIAL

Borouge PE100 Pipe Grade HE3490LS

SAMPLE PREPARATION

1. **Primary test**
   - OD110mm SDR 11 Pipe extrusion (BIC)
   - Pipe notched (BIC)
   - Pipe coating after notched (Tech-Bond - USA)
2. **Secondary test**
   - Use a failed pipe after NPT test (BIC)
   - Pipe coating after notched (Tech-Bond - USA)

Again, for the secondary test, we will be wrapping all the damaged pipes with our Tech-Wrap.

TEST ANALYSIS

1. **Primary test.**
   **The coated Pipes from Tech-Bond were received by BIC on 14th Nov & tested on 29th Nov 2023*

   Purpose: to check the effectiveness of this solution on stopping crack propagation in the accompanying pictures, there is only one of the visible cracks that propagated, and that propagation was minimal. In other pictures, even where there was substantial blowout. of the pipe, the notch or crack did not propagate.

   (a) Use 110 mm OD pipe (SDR11) and notch as per ISO 13479
   (b) Use proposed solution on the notches made.
   (c) Perform HPT test on the pipe as per the following conditions:
      i. 80 deg C, 5.4 MPa and 5.7 MPa- for at least 1000 hours (3 pipes to be tested as per stress level)
      ii. 20 deg C, 12.4 MPa for at least 1000 hours (3 pipes)

Heat changes the molecular structure of polymers resulting in the lowering of ability of the pipes to handle stress. Therefor the test parameters were reduced from approximately 1800 to about 800 psi.

2. **Secondary test.**
   **Pipe not yet received yet from Tech-Bond*

   Purpose: to check the effectiveness of this solution on failed pipes
   (a) Use the pipe after NPT test.
   (b) Apply solution on all 4 notches.
   (c) Perform HPT test on the pipe as per the following conditions:
      i. 80 deg C, 5.4 MPa and 5.7 MPa- for at least 1000 hours (3 pipes to be tested as per stress level)
      ii. 20 deg C, 12.4 MPa for at least 1000 hours (3 pipes)

Tech Bond's Tech-Wrap will produce substantially higher results than the Tech-Patch did.

Test Method and Results

A. Test Method

Pressure Testing (HPT); BICM 90725 (ISO 1167-1: 2006); OD 110 mm SDR11 pipes (650 mm length) were conditioned after extrusion at least 15 hours in room temperature. Further conditioned in 80 °C (water bath) for 24 hours before test.

B. Results

1. Primary Test

Sample Code	Temperature (°C)	Pipe Dimension (mm)		Hoop Stress (MPa)	Actual Pressure (Bar)	Total Hours	Status	Failure Observation
		Mean OD	Min Thickness					
1_S1	20	110.2	10.25	12.4	***25.43***	***157***	*Failure*	*Coating layer broken*
1_S2	20	110.2	10.25	12.4	***25.43***	***156***	*Failure*	*Coating layer broken*
1_S3	20	110.2	10.23	12.4	***25.38***	***115***	*Failure*	*Coating layer broken*
1_S4	80	110.2	10.22	5.7	***11.65***	***11***	*Failure*	*Coating layer peeled of*
1_S5	80	110.2	10.29	5.7	***11.74***	***10***	*Failure*	*Coating layer peeled of*
1_S6	80	110.2	10.23	5.7	***11.67***	***13***	*Failure*	*Coating layer peeled of*
1_S7	80	110.2	10.22	5.4	***11.04***	***119***	*Failure*	*Coating layer peeled of*
1_S8	80	110.2	10.2	5.4	***11.02***	***162***	*Running*	
1_S9	80	110.2	10.24	5.4	***11.06***	***162***	*Running*	

In the only description of the ISO 1167 test guidelines for 20 degree Celsius that I could find online, the 12.4 bar pressure on the first three samples were only to be maintained for 100 hours, not 1000. May have been a previous version of the 1167 test.

In the two sets of test at 80 degrees C, the difference is a somewhat minor difference in hoop stress. Our assumption is that failure is normal at this range of hoop stress. The fact that a patch system met the ISO 1167 standards is significant.

Figure 3. ***Primary Test – Failure Pipes for HPT test at 80 °C***

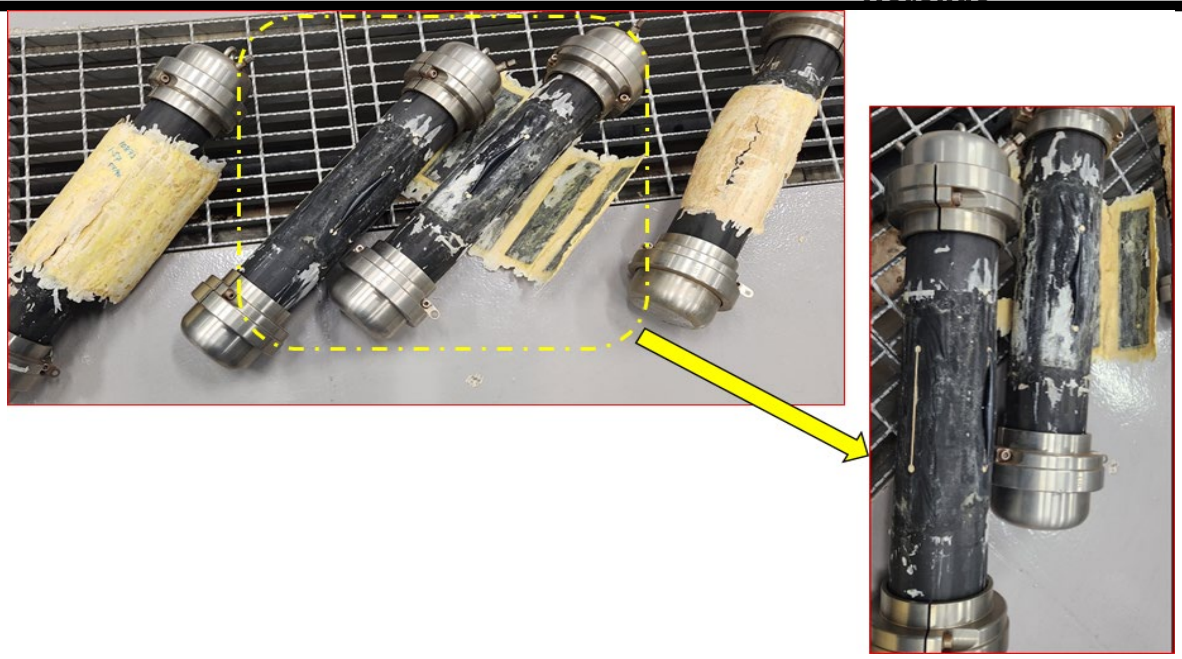

Figure 3 on the Primary Test has two pictures. The picture on the left side of the page shows:

1. A blown out crack.
2. A crack where our Poly Fill is still maintaining the structural integrity of the pipe.

It is important to note that, even with the blowout, the crack did not propagate. Our circles of Poly Fill are still at each end of the crack. Blow outs can be prevented by wrapping the cracked pipe.

Explaining the "peeling"

Outside of certain solvents, the only things that breaks bonds is energy. One form of energy is vibration. It has been documented high levels of sustained vibration can break the bonds of cyanoacrylates. At 1800 psi, it is our belief that the vibration, in combination with what the affect that the heat had on the pipe and the adhesive, caused the "peel" to occur.

Figure 4. ***Primary Test – Failure Pipes for HPT test at 20 °C***

On these pipes, we want to wait for the failed samples to be returned to examine the samples before we comment.

We want to thank Borouge for conducting the tests. As almost always, more is learned by "failure" than by success.

TBS

Conclusion

I have searched the internet to find copies of ISO 1167 testing. Could not find any. We will post summaries of this report on an "ISO 1167 Results" page of the tbbonding.com website. We will also include pictures and a video that we will take when we are preparing the second set of samples. All of this will server two purposes.

- **We will get a top ranking on Google for the repair of HDPE pipe. This ranking will produce additional jobs.**
- **In fact, we have our first US bad Services contract for the repair of HDOPE pipe in hand. The first of many.**
- **We will have a page that we can send the doubting Thomas's, the disparagers, the sceptics to. Of course, some of these individuals will simply deny the facts.**

BIC is obligated by contract to provide us engineering reports. We will post these on the website as we receive them.

Tech-Bond Solutions
381 S. 30th St., Heath, OH 43056
877 565 7225 · Fax: 866 411 0032 · tbbonding.com · sales@tech-bond.net