REPORT

Lap Tensile Test of Elastomeric Sealant

Project Number: 04-371
Building Envelope Consultants Ltd

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Introduction

Envelope Seal is a single component copolymer sealant used to seal the window/wall interface. In a typical application the sealant is applied 7.5cm (min.) wide x 4-6mm thick overlapping the nailing fin and wall joint. Over most temperature ranges the sealant remains very flexible, however at extreme cold it tends to stiffen. One concern is that the sealant might fail due to the differential thermal contraction of the window and the wall at extreme cold temperatures. It is the purpose of this test to demonstrate that even at extreme cold temperatures the sealant has enough flexibility to not fail in these conditions.

One of the goals of the test was to simulate the loading condition that is experienced in the field. Most cold temperature sealant tests use a bend test to determine if the material remains flexible, such as a mandrel bend test. However, in real world conditions the sealant is subject to in-plane loads at the joint and not bending loads.

A test based upon a lap shear test was proposed to demonstrate the elongation of the sealant at different temperatures. Unlike a lap shear test, where the sealant would be between the two sides of the specimen, in this test the sealant is overlapping the joint. This represents an approximation of the loading condition in the field.

Test coupons were prepared that were approximately 8.5" long by 1" wide, with PVC nailing strip and OSB with an overlapping layer of sealant joining the two materials. The test coupons were conditioned and tensile tested at set temperatures (23,-20,-30,-40°C). The Peak Load and Maximum Displacement were recorded. For this test, the Maximum Displacement is of greatest importance since it is related to the elongation of the sealant.

Test Apparatus

- Instron 4302 Table Top Test Frame
- Screw Side Action Grips
- 1 KN Load Cell
- Environment Chamber (cooled by $C0_2$)

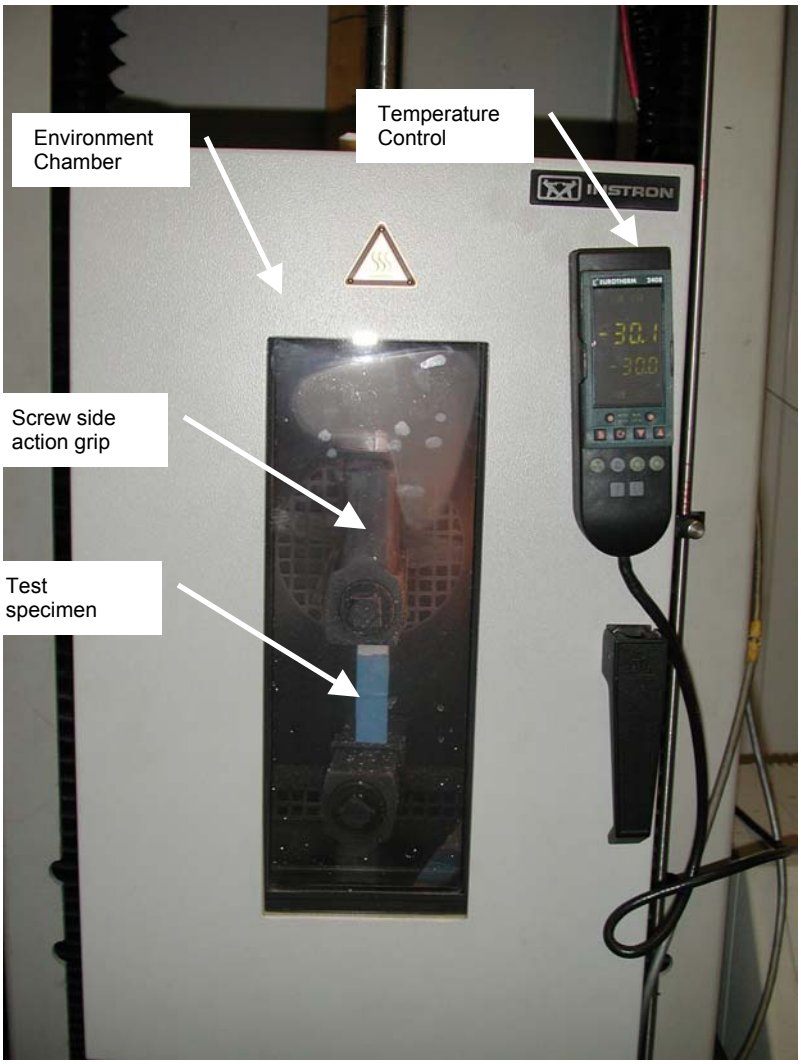

Figure 1 Test Setup

Test Specimens

- 1" x 6" x ¼" OSB
- 1"x 4.5" PVC Nailer Strip
- Overall Length = 8.5"
- Envelope Seal 2.75" wide

The PVC nail strip overlapped the OSB by approximately 2" (see figures 1-3). Several specimens were placed side to side when the sealant was spread over the lap joints, so they would be uniform. The sealant was spread in a 2.75" wide band over the lap joint. A small piece of OSB was used as a tab on the end of the PVC and a small tab of PVC was used on the OSB so that the grip thickness at both ends of the specimen would be the same; this reduces eccentric loading at the lap joint.

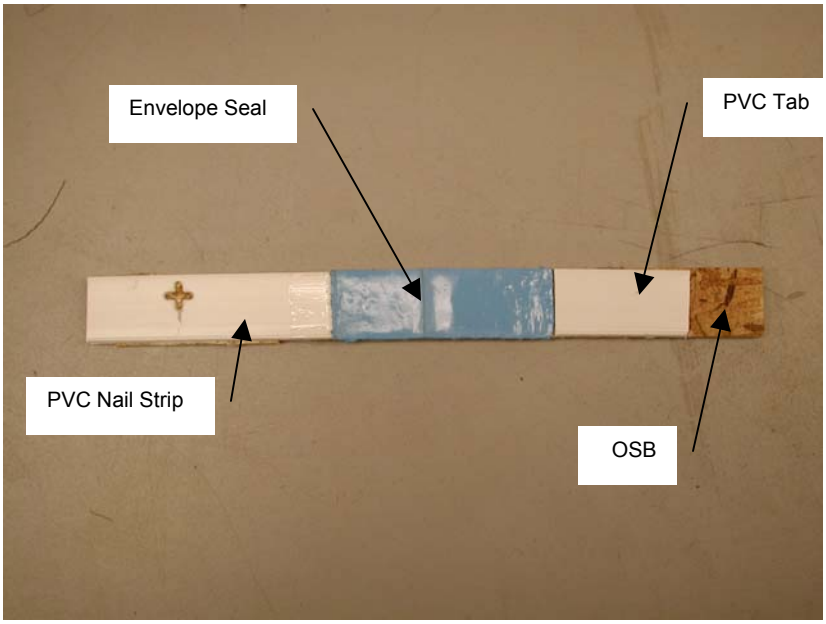

Figure 2. Typical test specimen, top view.

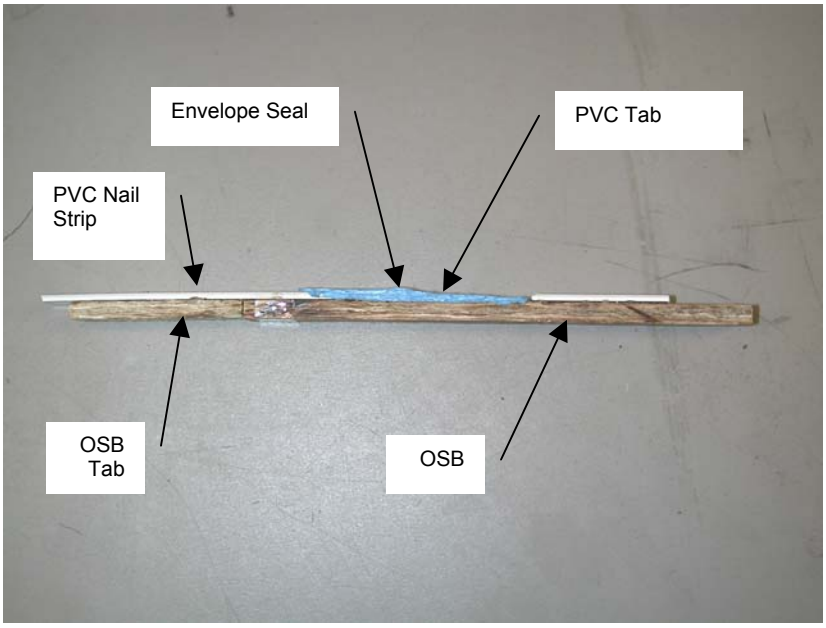

Figure 3. Typical test specimen, side view

Figure 4. Close-up of overlap between PVC and OSB

Test Procedure

Conditioning: Specimens conditioned at test temperature for a minimum of 15 minutes
Crosshead Speed: 2mm/min (-20°C, -30°C), 0.5mm/min (-40°C), 10mm/min (RT)
Test End: Test end at specimen failure or extension exceeded 26mm
Test Temperatures: RT (23°C), -20°C, -30°C, -40°C

Results

A minimum of three test specimens were tested at each of the temperatures.

Temperature	Average Maximum Displacement	Comments
RT (23°C)	28.64	Test stopped due to maximum extension exceeded
-20°C	26.63 mm	Test stopped due to maximum extension within environment chamber
-30°C	14.07 mm	
-40°C	1.97 mm	Used slower cross head speed

Discussion

The sealant shows good elongation for temperatures down to –30°C (Figure 5). From –30°C to –40°C the elongation is reduced significantly; at –40°C the average elongation was 1.97mm. PVC has a thermal expansion coefficient of 79.2x10-6 cm/cm/°C, so for a 10ft (3.05m) wide window the total linear shrinkage would be 2.41mm, which would result in an increased gap by 1.2mm.

It should be noted that this test is conservative because it does not take into account the visco-elastic properties of the sealant. The strain rate of this test is much higher than would be seen in actual use. In this test the sealant is initially unstressed at the test temperature and then a stress is applied. However in real world conditions, the sealant will be continually stressed as the temperature decreases. This would result in creep of the sealant, which would allow greater elongation without failure.

To determine the visco-elastic properties would require a series of creep tests performed at different temperatures.

The test at –40°C was performed at a slower cross head speed to reduce the scatter of the results. When tested at –20°C (Figure 6) the sealant showed normal elongation, as if at room temperature, so tests were not performed for –10°C or 0°C.

There was no indication in any of the tests of the sealant disbonding from the OSB or PVC materials. Failures occurred in the sealant at the overlap between the OSB and the PVC.

A minimum of three specimens was tested at each temperature. However, there was significant scatter in the results of the test, in particular for the colder temperatures. Hence, these results are useful for research but should not be used for design or approval purposes. A much larger sample would be required to meet the requirements for design or approval.

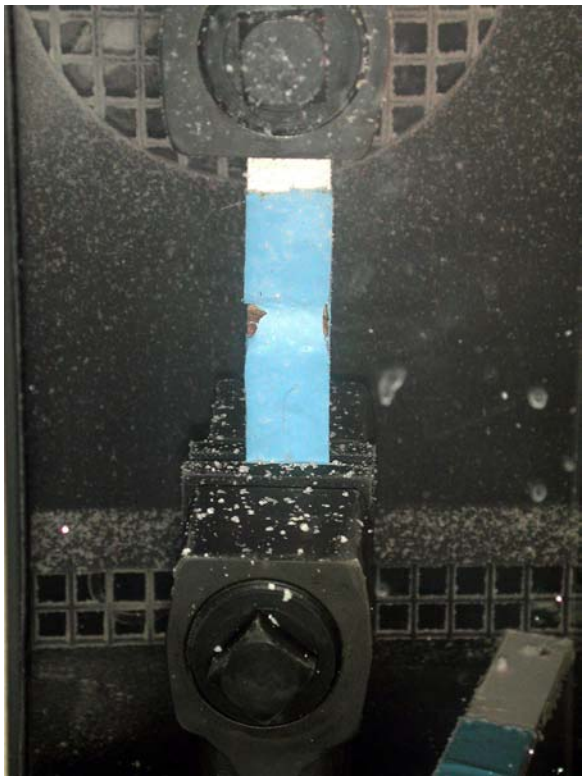

Figure 5. Specimen failing at -30°C

Figure 6. Specimen failing at -20°C

Conclusion

The Envelope Seal sealant shows excellent elongation at temperatures down to –30°C. From –30°C to –40°C the material becomes stiffer, but the expected thermal contraction over this temperature range is small, so it should not cause failure.

The test method used is conservative, since the visco-elastic properties of the sealant were not considered. If the visco-elastic nature of the material was included it is expected that the elongation would be greater, reducing the chance of failure.

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