

Assessment of Silikal RU 321 Waterproofing Membranes for External Above-ground Use in accordance with AS 4654.1:2012

Materials Performance

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1 Introduction

This report describes the assessment of a waterproofing membrane in accordance with AS 4654.1:2012 'Waterproofing membranes for external above-ground use', with compliance against the performance criteria of "Requirements-Fully bonded membranes", "Classification of Membranes", "basic Properties of Membranes" and "Durability of Membranes".

2 Specimen Description

One type of the specimen was supplied by the client.

The specimen description as provided by the client:

Product trade name: Silikal RU 321

Manufacturer details: Silikal GmbH; Ostring 23; 63533 Mainhausen, Germany.

Description of the product:

*27 sheets 300x300mm of free cured film of waterproofing membrane, Silikal® RU 321 pigmented, (Film thickness appr. 1mm).

*10 concrete substrates (Silikal®RU 380 Primer coated) 160x100mm for bond strength test.

*500ml liquid sample of Silikal®RU 321 pigmented (waterproofing membrane) for bond strength test,

*100g Silikal®BP - powder hardener,

*Colour: RAL7031.

Type of sample: Wet membrane for External uses.

Thickness: 1.14 mm.

Specimens received:

27 sheets of 300x300mm sheets (our measurements).

The supplied specimen for assessment is shown below in Figure 1.

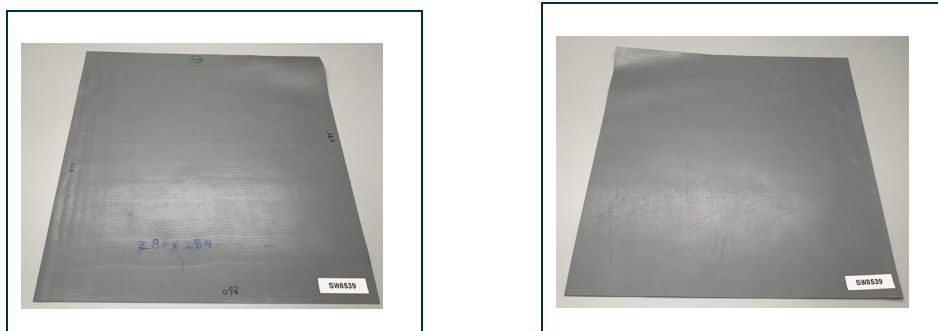


Figure 1 Top face and underside of the specimen

The specimens were received on 20/08/2024.

CSIRO were not involved in specimen selection.

The specimens were allocated with CSIRO specimen numbers SW8539-02/1 to SW8539-02/76.

3 Test Methods

3.1 Water Vapour Transmission of Materials

Water vapour transmission (WVT) through the membrane was determined in accordance with ASTM E96/E96M:2024 using the desiccant and dummy specimen method.

Four test samples were prepared by mechanical sealed using two neoprenes and a Teflon gasket placed onto the open side of the test cups. The test cups contain dried desiccant with the trafficable side facing up were placed in a climate-controlled environment with periodic weighing so that the rate of water vapour movement through the membrane to the desiccant can be determined.

The exposed area (test dish face) for each of the cups was 0.002827 m^2 . The test cups (all except the dummy sample, no desiccant) had a 6 mm gap between the desiccant and the underside of the membrane.

All test assemblies were kept in a Steridium environmental chamber, where chamber temperature and humidity are maintained at a temperature of $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity. The time to reach the equilibrium conditions would depend upon the thickness, some material take as long as 60 days to reach equilibrium conditions. The measurements are taken each afternoon (excluding weekends) over this period to determine the weight change and permeance of the membrane.

The testing was undertaken by A. Menisi over the period of 18/09/2024 – 01/11/ 2024 and the results relate to the specimens as supplied.

3.2 Resistance to Cyclic Movement

The resistance of membrane to cyclic movement was determined in accordance with AS 4654.1:2012 Appendix B.

A rectangular test sample of 65 x 25 x 1.06 mm was cut from a sheet, then held in the test grips (70(w) x 45(l) x 20(t) mm), exposing a 25 x 2 mm central portion of the sample.

An Applied Test Systems Series 904 Vertical Sealant Tester was used for testing. The vertical sealant testing machine used software for cyclic movement control. The vertical testing machine was set to elongate the clamped test sample for the cycling is 4 mm extension. Once the test piece reached full extension, it then returned to its original position, which completed one cycle of movement. The elongation and return were then repeated to complete a 50 cycles movement test, each cycle conducted over a nominal 2-hour period.

The test sample was inspected for signs of breakage or cracks and measured for any necking. A reduction in width of more than 1 mm inwards from the edge of the test sample constitutes a failure.

The testing was undertaken by A. Menisi over the period of 14/10/2024 – 18/10/2024 and the results relate to the specimens as supplied.

The testing was conducted under routine conditions; $23 \pm 2^\circ\text{C}$ and $60 \pm 15\% \text{ RH}$.

3.3 Durability of Membrane

The standard outlines the method for determining resistance of the membrane's durability after conditioning in various solutions over set periods, then assessed against an unconditioned material.

The testing was carried out in accordance with AS 4654.1:2012 Appendix A 4.2 "Durability of membranes". As specified in CI A2.2.1, the membrane test samples were prepared in accordance with AS 1145.3-2001, Type 2, strip samples 10 mm width with a 50 mm gauge length. The test specimens were exposed and conditioned to those requirements specified in Table A1, A4 and Temperature Resistance of AS 4654.1:2012.

The test samples for durability of membranes were conditioned for 7 days at $23 \pm 2^\circ\text{C}$ and $65 \pm 15\%$ RH.

In accordance with CI A4.2.2.2, Instron 5585H (ERM.030.043) testing machine, fitted with a calibrated 5kN load cell, was used to record the elongation at break and tensile strength. The elongation at break of the immersed test specimens were compared to the control test specimens

The testing was undertaken by A. Menisi over the period of 11/09/2024 – 01/11/2024 and the results relate to the specimens as supplied.

The testing was conducted under routine conditions; $23 \pm 2^\circ\text{C}$ and $60 \pm 15\%$ RH.

3.4 Determination of Bond Strength

The bond strength was tested in accordance with ASTM C794:2018 "Standard test method for adhesion-in-peel of elastomeric joint sealants"

Eight strip test specimens of 100 x 25 x 4 mm were prepared on concrete by embedding a wire mesh screen between two layers of the membrane. The test specimens were kept in a conditioning room maintained at a temperature of $23 \pm 2^\circ\text{C}$ and $60 \pm 15\%$ relative humidity for the 20 days. These eight prepared specimens were equally divided into two groups.

Dry condition: The first group (4 specimens) was tested as dry condition.

Wet condition: The second group of four specimens were immersed in DI Water for 7 days at $23 \pm 2^\circ\text{C}$ The specimens were then removed and lightly dried with chamoe clothes, then tested within 10 min.

The specimens were placed on Instron 5585H (ERM.030.043) testing machine for Tensile test, in such a way that the test sample is peeled back from the substrates at 180° to the face of the sample. The exerted force was measured as well as the mode of failure of the membrane from substrates at the test rate of 50mm/min for 1 minute.

The testing was undertaken by A. Menisi over the period of 16/10/2024 – 13/11/ 2024 and the results relate to the specimens as supplied.

3.5 Determination of Thickness

The thickness of the membrane was determined in accordance with AS/NZS 4347.9:1995.

Three rectangular test strips of 290 x 50 mm were cut across middle width of supplied sheets. The sheet thickness measured three points, equally spaced across the strip.

The testing was undertaken by A. Menisi over the period of 06/11/2024 and the results relate to the specimens as supplied.

4 Results

4.1 Executive Summary

Table 1 Summary of test requirements and test specimen results for AS 4654.1:2012

TEST	METHOD	REQUIREMENTS	RESULT
(a) Water Moisture Transmission Rate	ASTM E 96 Desiccant method for Determining Water Vapour Transmission (WVT)	Record result Water Vapour transmission shall be $<8\text{g} / \text{m}^3 / 24\text{hrs}$. If $> 8\text{g} / \text{m}^3 / 24\text{hrs}$, additional testing will be required to establish suitability for use over particleboard.	WVT = $4.53\text{ g/m}^2/24\text{hrs}$ Permeance = 31.13 (ng/Pa.s.m^2)
(b) Acceptance of movement	AS 4654.1 Appendix B for assessment of cyclic movement of membrane	Compliance criteria - observing any cracking, rupture holing or extending through the thickness for more than 1 mm in from the edge of the specimen.	CLASS III / Complies
(c) Abrasion resistance 2.3.2 non-trafficable	AS 1580.403.2.1-2006 Paints and related materials	Non-trafficable: Areas subjected only to maintenance access; the depth of abrasion shall be less than 0.2 mm.	Not Requested by the client
(d) Durability 1. Control 2. Water immersion 3. Detergent immersion 4. Heat ageing at 80°C 5. Temperature resistance at -15°C to +85°C	AS4654.1 Appendix A for assessment of membranes durability AS4654.2 temperature resistance section 2.4.2 (c)	Pass or fail criteria; compared to control samples: - elongation at break shall be not less than 25 % for water and detergent immersion. - Whereas elongation at break shall be not less than 50 % for heat ageing samples.	ClassIII Complies Complies Complies Complies

(e) Bond strength to concrete and villa flooring substrate	ASTM C794 Standard test method for adhesion-in-peel of elastomeric joint sealants	Test samples exposed to dry and wet conditions, then tested for adhesion-in-peel strength.	- 207 N with 65% adhesive failure loss for concrete (Dry Method), -206 N with 96% adhesive failure loss for concrete (Wet Method).	-
(f) Membrane thickness	AS/NZS 4347.9:1995 (Reconfirmed) 2014 Damp-proof courses and flashings.	The film thickness shall be measured at a minimum of five points and a maximum of 10 points, equally spaced across the strip.	1.11mm	-

Note: The above is only a summary of the overall results and must be read in conjunction with the relevant sections of this report.

4.2 Water Vapour Transmission of Materials

Table 2: Water Vapour Transmission test results:

Specimens No.	Water Vapour Transmission (g/m ² 24hr)	Permeance (ng/Pa.s.m ²)
Average	4.53	31.13

The performance criteria set out in AS 4654.1 – 2012, specifies a water vapour transmission rate of less than 8 g/m² 24 hr, or 0.33 g/m² hr.

4.3 Resistance to cyclic Movement

Table 3: Test sample holding during cyclic movement and test results:

Specimen No:	SW8539-02 / 55
Test Specimen:	65 (l) mm x 25 (w) mm x 1.06 (t) mm section
Membrane Classification:	CLASS III
Elongation at break:	Maximum strain used for the cycling shall be 50% the elongation at break
Observations:	No defect
Day 1 – Day 4	No defect
Surface Defects	No raptures observed

Crazing	Not Detected
Surface Tear	Not Detected
Membrane Rupture	Not Detected
Result:	Complies 50 cycles

The performance criteria set out in AS 4654.1 – 2012, Table 8.1 (c) and section B4, by observing any cracking, rupture or necking of more than 1 mm down from original width.

4.4 Durability of membrane

Table 4: Durability test results-control:

Control Specimens						
Specimen No#	Break Force (N)	Thickness (mm)	Tensile strength (F/A) (MPa)	Elongation at break		Class
				(mm)	(%)	
SW8539-02/1	77.92	1.24	6.28	150.75	302	III
SW8539-02/2	67.63	1.12	6.04	151.80	304	
SW8539-02/3	64.17	1.08	5.94	152.83	306	
SW8539-02/4	62.54	1.27	4.92	145.49	291	
SW8539-02/5	67.75	1.10	6.16	148.98	298	
Average	66.57	1.14	5.58	149.22	300	
CLASS I – Elongation at break <59%						
CLASS II – Elongation at break 60-299%						
CLASS III – Elongation at break ≥300%						
Class II membrane, a 35mm wide bond breaker/tape should be applied over a joint to accommodate the joint opening by up to 5 mm.						

Table 5: Durability test results – Water immersion:

Water Immersion Specimens						
	Average Break Force (N)	Average Thickness (mm)	Average Tensile strength (F/A) (MPa)	Average Elongation at break		Complies/ Not complying
				(mm)	(%)	
7 day period	52.27	1.08	4.83	149.78	300	Complies
28 day period	63.87	1.13	5.67	151.00	302	Complies
56 day period	64.12	1.04	6.16	153.64	307	Complies
Compliance – Elongation at break shall not be less than 25% retention of elongation at break of the controls						

Table 6: Durability test results – Detergent immersion:

Detergent Immersion Specimens						
	Average Break Force (N)	Average Thickness (mm)	Average Tensile strength (F/A) (MPa)	Average Elongation at break		Complies/ Not complying
				(mm)	(%)	
7 day period	49.06	1.05	4.72	146.36	292	Complies
28 day period	49.83	1.05	4.78	137.83	276	Complies
56 day period	65.27	1.06	6.14	155.82	312	Complies
Compliance – Elongation at break shall not be less than 50% retention of elongation at break of the controls.						

Table 7: Durability test results – Heat ageing:

Heat Ageing @ 80°C						
	Average Break Force (N)	Average Thickness (mm)	Average Tensile strength (F/A) (MPa)	Average Elongation at break		Complies/ Not complying
				(mm)	(%)	
7 day period	65.08	1.02	6.39	147.84	296	Complies
Compliance – Elongation at break shall not be less than 50% retention of elongation at break of the controls						

Table 8: Durability test results – Temperature resistance:

Temperature Resistance						
	Average Break Force (N)	Average Thickness (mm)	Average Tensile strength (F/A) (MPa)	Average Elongation at break		Complies/ Not complying
				(mm)	(%)	
7 Days @-15°C	67.77	1.05	6.46	153.56	307	Complies
7 Days @+85°C	73.44	1.07	6.87	152.49	305	Complies
Compliance – Elongation at break shall not be less than 50% retention of elongation at break of the controls						

4.6 Determination of Bond strength

Table 9: Adhesion-in-Peel strength test results:

Product	Samples	Length and Width of test samples	Concrete (Dry Conditions)		Concrete (DI Water- Wet Conditions)	
			Peel Adhesion strength in Dry condition	Adhesive Failure Loss	Peel Adhesion strength in Dry condition	Substrate Failure Loss
		mm	N	%	N	%
Silikal RU321 - Waterproofing Membrane	SW8539-02 /59	25x100	207	50%	279	95%
	/60	25x100	165	95%	222	95%
	/61	25x100	218	25%	198	97%
	/62	25x100	237	90%	124	96%
			Average = 207 N	65 %	Average = 206 N	96%

4.7 Determination of Thickness

Table 10: Thickness tests results:

Specimen No#	Length (mm)	Width (mm)	Thickness (mm)
SW8539-02/56 Average thickness	290	50	1.1
SW8539-02/57 Average thickness	290	50	1.13
SW8539-02/58 Average thickness	290	50	1.11

5 Conclusion

The Silikal RU 321 wet area membrane, as described herein, when subjected to the test methods of AS 4654.1:2012 the properties of (a) moisture vapour transmission, (b) cyclic movement (Class III), (d) Durability, (e) Bond strength to concrete substrate and (f) membrane thickness met the performance criteria to AS 4654.1:2012 Waterproofing membranes for external above-ground use Part 1: Materials.

6 Limitations

The test results relate only to the specimen of the product in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and will therefore invalidate the test results. It is the responsibility of the supplier for the product to ensure that the product which is supplied to industry is identical with the specimens which were tested. This report does not provide an endorsement by CSIRO of the actual products supplied to the industry. This report can therefore only relate to the actual prototype test specimens, testing conditions and methodology described in the supporting data, and does not imply any performance abilities of construction of subsequent manufacture.

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Appendix A Specimen Photos

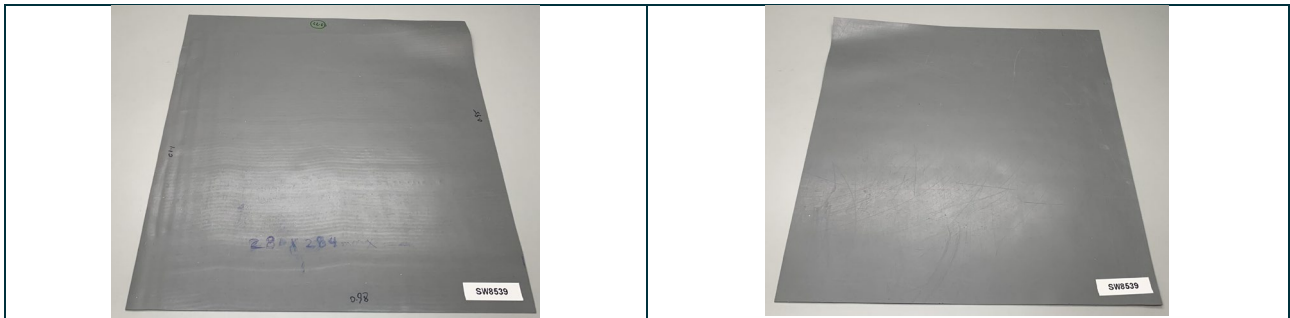


Figure 2: Photograph of Specimen- Specimen as supplied.

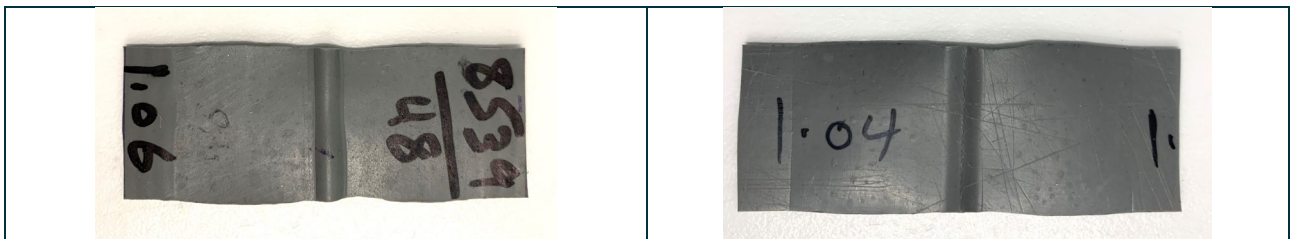


Figure 3: Photograph of Specimen - Cyclic movement test specimens.

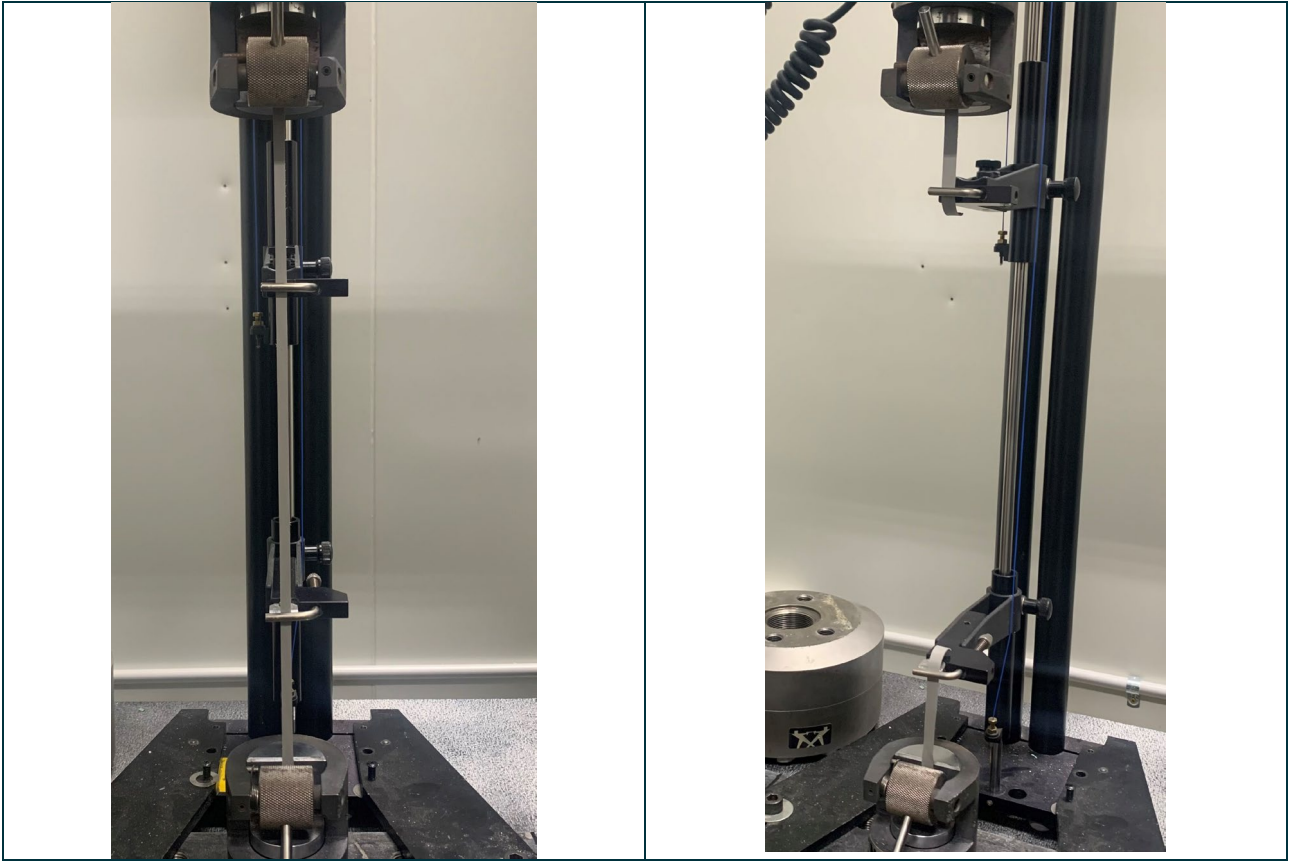


Figure 4: Photograph of Specimen - Durability test specimens.

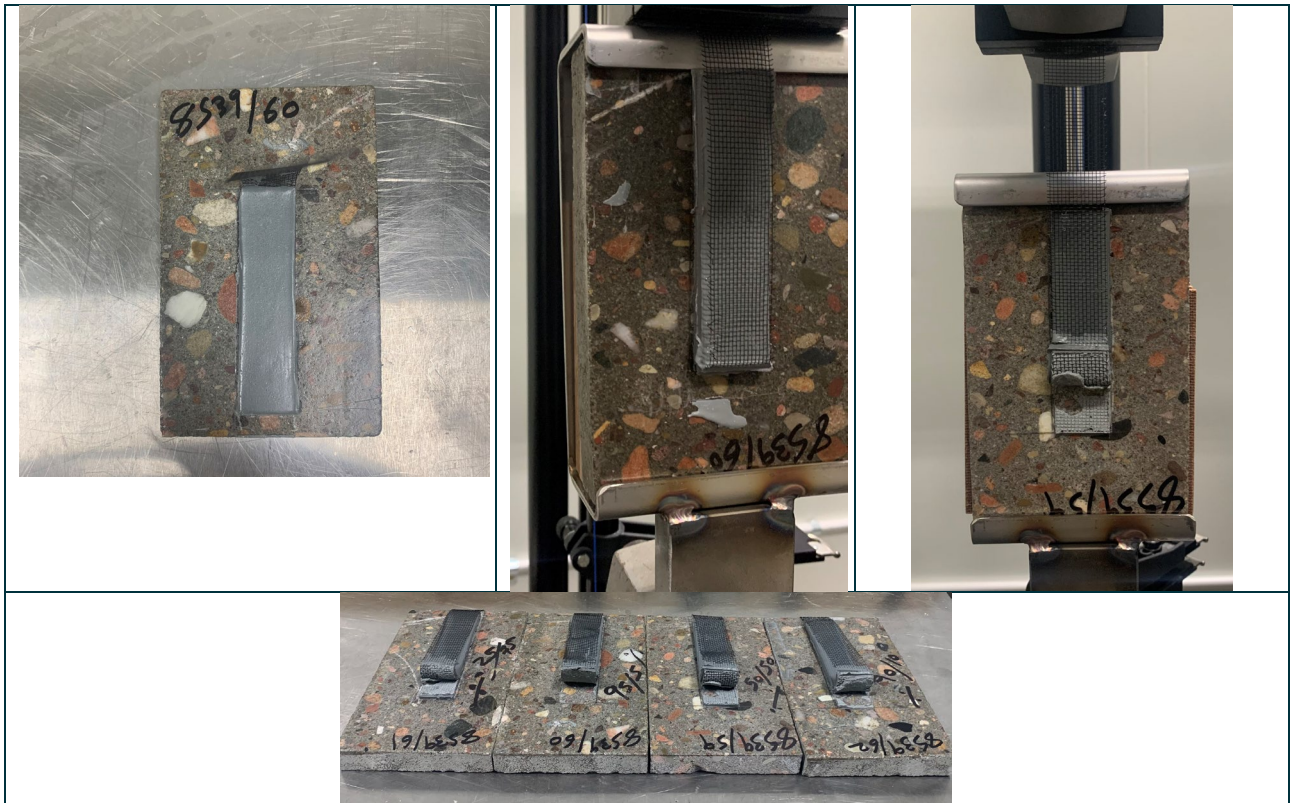


Figure 5: Photograph of Specimen – Bond strength test specimens.

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