Date of issue: 14th June 2016

David Findlay
Quad Rock Ltd

BTS15108 – Certificate of Test: TR160112-4

Mechanical testing of Designa Schist Mortar

1. Objective

1.1. BEAL Testing Services were contracted by Quad Rock Ltd to quantify some of the mechanical properties of the "Original Designa Schist Co Mortar". The properties tested were adhesion strength to the Designa Schist brick, tensile strength, shear strength of embedded brick ties and the compression strength.

2. Methodology

2.1. Adhesion Strength
Standard: ASTM C297 – Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
Test Area: 2500 mm²
Grip Separation Speed: 4 mm/min

2.2. Tensile Strength
Standard: ASTM C297 – Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
Test Area: 2500 mm²
Grip Separation Speed: 4 mm/min

2.3. Shear Strength
Test Procedure: At ad-hoc test method was used
Test Area: Varied
Grip Separation Speed: 4 mm/min

2.4. Compression Strength – *Subcontracted to Ideals Hub Limited*
Standard: ASTM C579-B & EN 6319-2
Test Area: 5027 mm²
Grip Separation Speed: 4 mm/min

3. Criteria

3.1. Adhesion Strength
The adhesive strength of the mortar to brick bond shall be a minimum of 0.2 MPa *OR* the adhesive strength of the mortar shall exceed the internal bond strength of the substrate(s) it is adhered to.
Note that the purpose of this test is to verify that the adhesive is at least as strong as the substrate it is bonded to. This test is testing the mortar bond, not the tensile strength of the brick.

3.2. Tensile Strength
The tensile strength of the mortar shall be a minimum of 0.2 MPa after a 7-day cure as specified in AS 3700

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3.3. Shear Strength

A criterion was not set for this test. Instead the results are subject to review by an engineer or other suitably qualified person.

3.4. Compression Strength

The compression strength of the mortar shall be a minimum of 12.5 MPa after a 28-day cure as specified in NZS 3112.2:1986

4. Sample Preparation

4.1. Adhesion strength samples

Two pieces of the Designa Schist bricks were adhered to each other on the manufactured faces of the brick with the Designa Schist Mortar and allowed to cure for 28 days. 50 x 50 x 40 mm pieces were cut from this and flatwise test blocks were adhered to these to form the test samples. The bricks are made from a concrete-polystyrene mix with a natural stone finish. Only the concrete-polystyrene part of the brick was included in the samples.

4.2. Tensile strength samples

The Designa Schist Mortar was mixed at a 4:1 ratio with water and laid over plastic sheeting on a flat surface and covered with another plastic sheet to control the drying speed. Five 50 x 50 mm samples were cut from the centre of the mortar sample once the mortar had cured for 7 days. Flatwise blocks were adhered to these pieces for testing.

4.3. Shear strength samples

Ten nominal 120 x 120 x 50 mm pieces were cut from the concrete-polystyrene part of the Designa Schist bricks. Typical brick ties were set in between pairs of these pieces of brick with a nominal 3 mm gap between the pieces with the Designa Schist Mortar. These samples were allowed to cure for a 28 days before testing.
The brick ties were 25 mm in width and were embedded 50 mm into the mortar – see photos.

4.4. Compression strength samples

Samples were prepared and tested by Ideals Hub Limited.
The cylindrical samples 62.5 mm in length and 40 mm in diameter were cast in silicone rubber molds and ultrasonically compacted. The mix ratio of the mortar 4 parts mortar to 1 part water and mixed in a small hobart with a hook at 20 rpm for 10 minutes. The samples were allowed to cure for 72 hours before stripping from the molds and conditioning for 28 days at 20°C, 50% RH.

5. Test Equipment

5.1. Tinius Olsen H5KS Univarsal Testing Machine with grips to suit.
5.2. INSIZE Digital Calipers.

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6. Results

6.1. Adhesion strength of the Designa Schist Mortar to the Designa Schist brick

Sample #	Area (mm^2)	Max Force (N)	Max Stress (MPa)	Failure location
S583-1	2500	63.7	0.0255	Concrete-Polystyrene Substrate
S583-2	2500	137	0.0547	Concrete-Polystyrene Substrate (75%) and mortar adhesion (25%)
S583-3	2500	148	0.0593	Concrete-Polystyrene Substrate
S583-4	2500	178	0.0711	Concrete-Polystyrene Substrate
S583-5	2500	210	0.0839	Concrete-Polystyrene Substrate
	Average	**147**	**0.0589**	
	SD	**54.7**	**0.0219**	

6.2. Tensile strength of Designa Schist Mortar

Sample #	Area (mm^2)	Max Force (N)	Max Stress (MPa)	Failure location
S584-11	2500	5020	2.01	No failure
S584-12	2500	5090	2.04	No failure

Note: Tensile test samples exceeded the capacity of the test machine.

6.3. Shear strength of typical brick tie set in the Designa Schist Mortar and bricks

Sample #	Max Force (N)	Yield Strength (N)	Failure location
S583-11	2820	1470	Concrete-Polystyrene Substrate
S583-12	1210	1200	Concrete-Polystyrene Substrate
S583-13	1170	1110	Concrete-Polystyrene Substrate
S583-14	1800	1180	Concrete-Polystyrene Substrate
S583-15	1530	1300	Concrete-Polystyrene Substrate
	Average	**1250**	
	SD	**140**	

6.4. Compression strength of Designa Schist Mortar

Sample #	Compressive strength at failure (MPa)	% Deformation at failure (N)
A	61	9
B	57	11
C	60	10
Average	**59**	**10**
SD	**2.1**	**1**

7. Comments

7.1. The results for specimens S583-1 to S583-5 show a high degree of variation. This is largely due to the variability in the substrate the mortar was adhered to.

7.2. The tensile test specimens exceeded the maximum capacity of the mechanical testing machine. Given this and the margin by which the specimens surpassed the minimum criteria, testing was stopped after the first two specimens to avoid the possibility of overloading the test machine.

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8. Conclusion

8.1. The Designa Schist Mortar has met the criteria set out in section 3.1 and is considered to have satisfactory adhesive strength to the Designa Schist brick.

8.2. The Designa Schist Mortar has met the criteria set out in section 3.2 and is considered to have satisfactory tensile strength.

8.3. The Designa Schist Mortar has met the criteria set out in section 3.4 and is considered to have satisfactory compressive strength.

9. Photos & Graphs

Authorized Signatory

Matthew van den Tillaart
Building Technician
Building Element Assessment Laboratory Limited

Colin R. Prouse
Principle Building Scientist

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Figure 1: Machine output - Adhesion of Designa Schist mortar to brick

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TR160112-4

Flatwise Tensile - Designa Schist Bricks
with Polymer Stone Adhesive
Adhesive Strength

Tinius Olsen

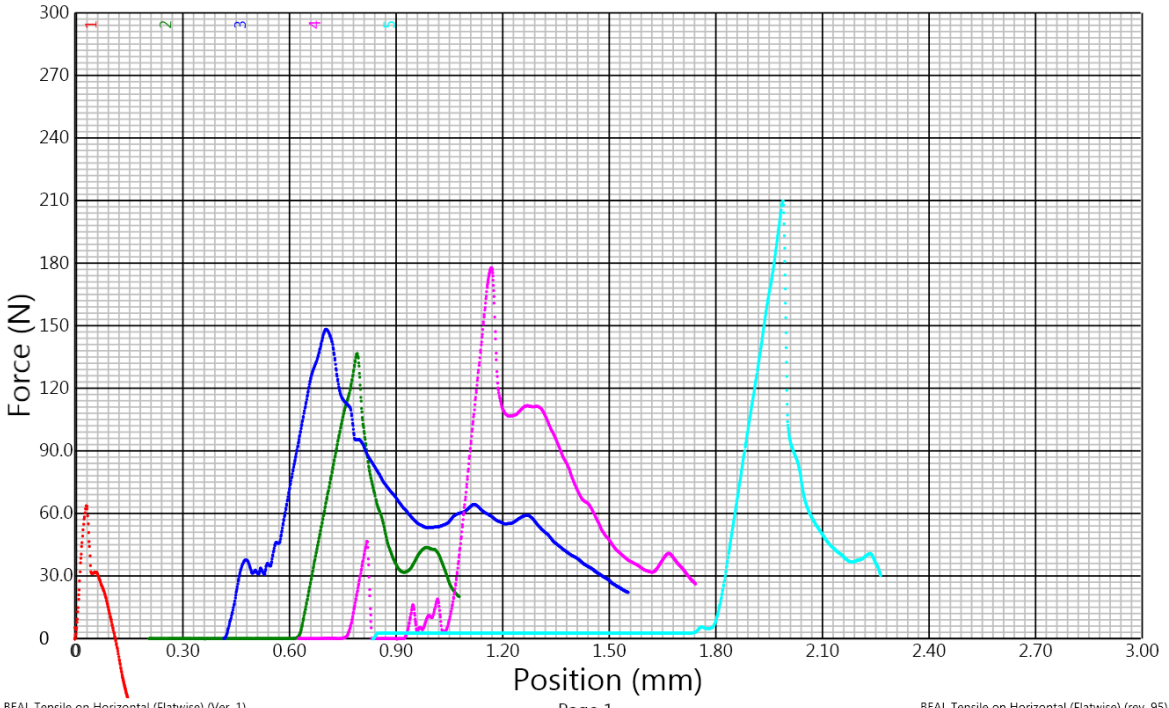
Client:	Designa Schist Bricks
Job Number:	BTS15108
Sample Designation:	S583
Tested by:	L. Presto

Method Name:	BEAL Tensile on Horizontal (Flatwise)
Standard:	ASTM C297
Test Speed:	4.00 mm/min
Batch Start Date and Time:	20/01/2016 2:18 p.m.
Graph Offset:	5.00 %

Sample Number	Area mm²	Max Force N	Ultimate Stress MPa
1	2500	63.7	0.0255
2	2500	137	0.0547
3	2500	148	0.0593
4	2500	178	0.0711
5	2500	210	0.0839
Average		147	0.0589
SD		54.7	0.0219

Comments:

The failure mode for sample S583-2 was approximately 25% adhesion failure of the polymer adhesive to the substrate, 75% internal bond failure of the substrate. The failure mode for the remaining samples was 100% internal bond failure of the substrate.



BEAL Tensile on Horizontal (Flatwise) (Ver. 1)
v10.0.12.1 - 605745GB - BEAL (Building Element Assessment Laboratory)

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BEAL Tensile on Horizontal (Flatwise) (rev. 95)
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Figure 2: Machine output - Tensile strength of Designa Schist Mortar

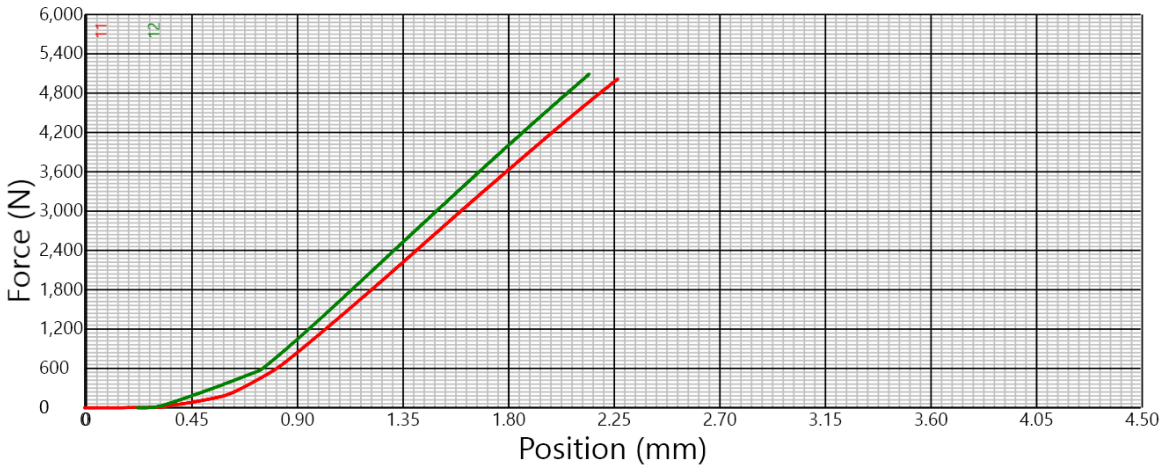
TR160209-1

Flatwise tensile of Designa Schist mortar
free of any substrate

Client:	Quad Rock
Job Number:	BTS15108
Sample Designation:	S584
Tested by:	M. van den Tillaart

Method Name:	BEAL Tensile - Force vs. Position
Standard:	ASTM D412
Speed:	4.00 mm/min
Test Start Date and Time:	09/02/2016
Graph Offset:	5.00 %

Sample Number	Area mm²	Ultimate Force N	Ultimate Stress MPa	Break Distance mm
11	2500	5020	2.01	2.27
12	2500	5090	2.04	1.92
Average		5050		2.10
SD		53.6		0.245



BEAL Tensile - Force vs. Position (Ver. 1)
v10.0.12.1 - 605745GB - BEAL (Building Element Assessment Laboratory)

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BEAL Tensile - Force vs. Position (rev. 292)
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Figure 3: Machine output - Shear strength of a typical brick tie embedded in Designa Schist mortar and bricks

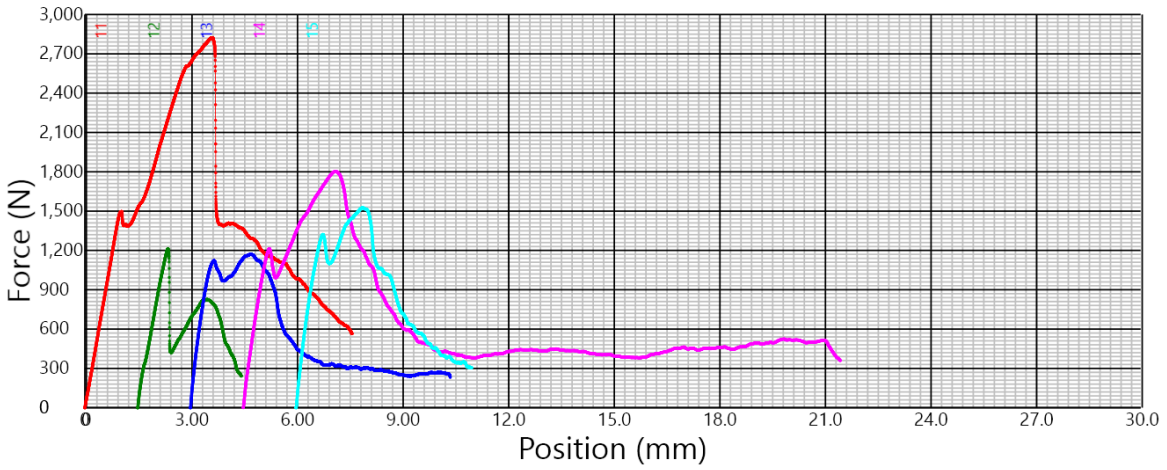
TR160302-2

Shear test of brick tie set in Designa Schist polystyrene an concrete bricks with masonry adhesive with masonry adhesive

Client:	Quad Rock Ltd
Job Number:	BTS15108
Sample Designation:	S583 & S584
Tested by:	M. van den Tillaart

Method Name:	BEAL Tensile - Force vs. Position
Standard:	N/A
Speed:	4.00 mm/min
Test Start Date and Time:	04/02/2016
Graph Offset:	5.00 %

Sample Number	Ultimate Force N	Break Distance mm
11	2820	7.59
12	1210	2.95
13	1170	7.38
14	1800	17.0
15	1530	4.99
Average	1710	7.97
SD	675	5.37



BEAL Tensile - Force vs. Position (Ver. 1)
v10.0.12.1 - 605745GB - BEAL (Building Element Assessment Laboratory)

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BEAL Tensile - Force vs. Position (rev. 291)
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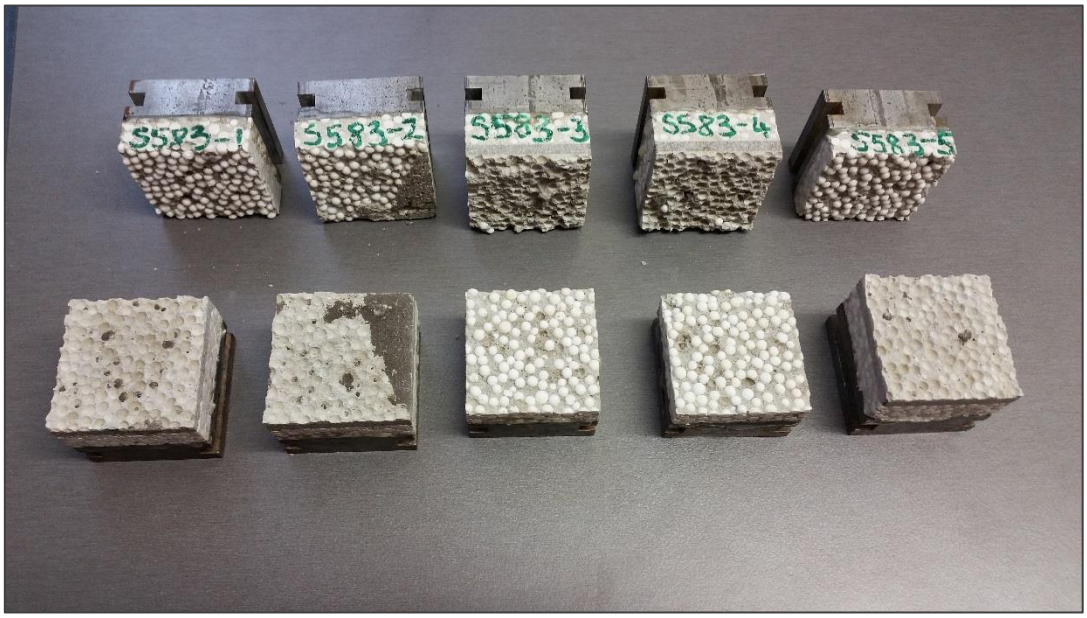

Figure 4: Adesion strength samples after testing

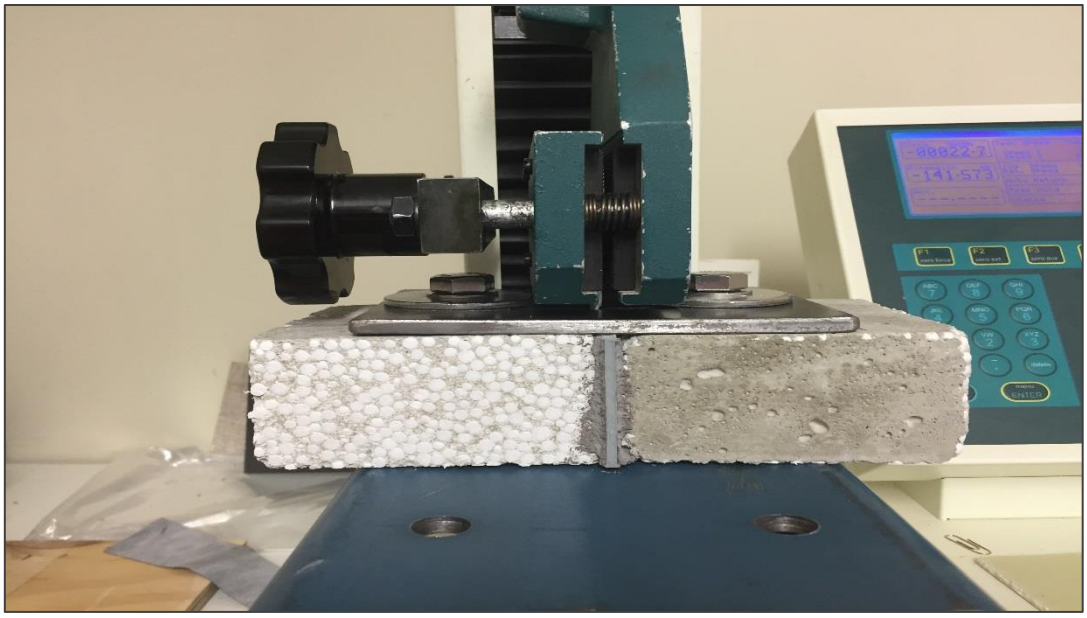

Figure 5: Shear sample test setup

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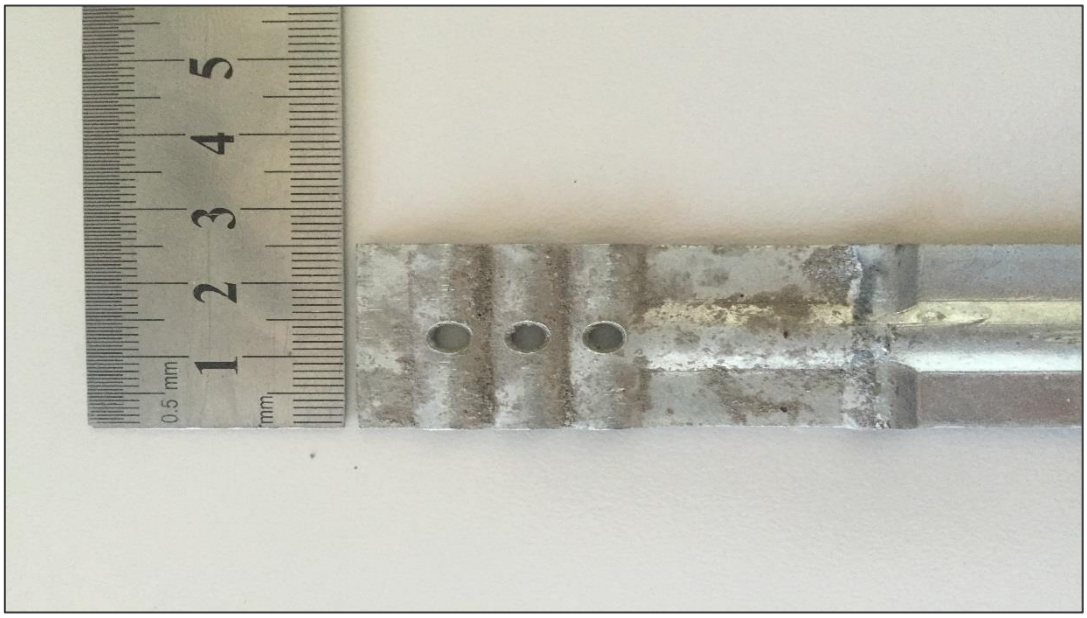

Figure 6: Brick tie - after testing

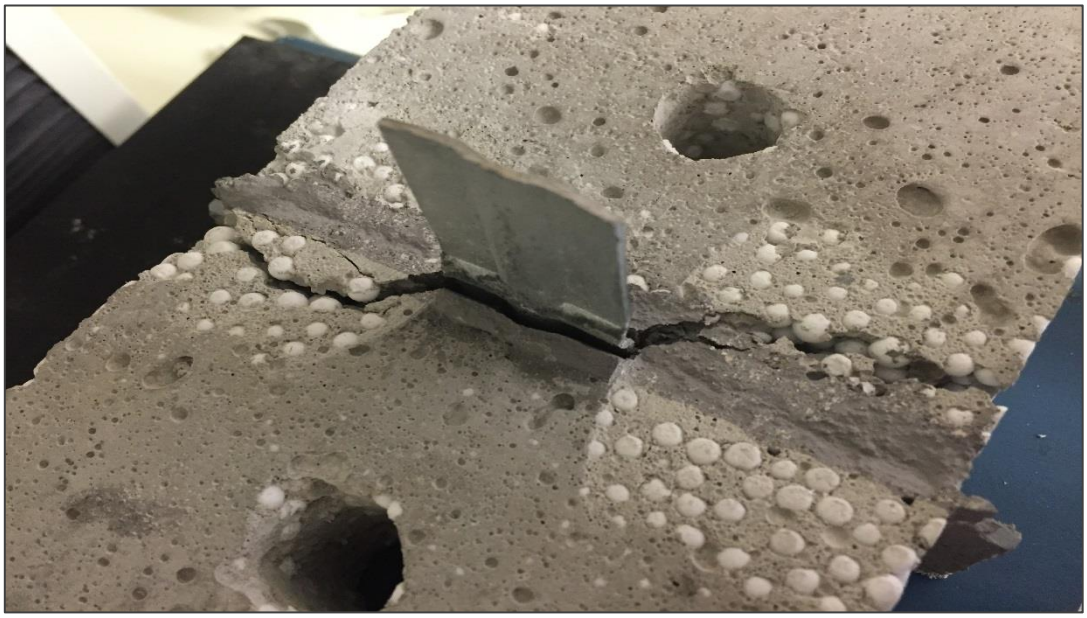

Figure 7: Shear sample - typical failure

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Figure 8: Shear sample - typical failure cross section

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