



## FOUNDATIONS for RECOVERY

### APPENDIX A DUNURE HARBOUR

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UK Government





**Job:** AP 3832 Dunure Harbour and Lighthouse

**Client:** ARPL Architects, Ayr

**Brief:** To advise on replacement masonry materials for the above

**Site visit and inspection:**

A site visit and inspection was undertaken by Roz Artis, Director, SLCT and Mitchell Fotheringham, Building Surveyor, SLCT together with Rebecca Cadie and colleague on 10 May 2022. The weather was inclement with wind and heavy rain. The structures were viewed from the harbour side at low tide.

Lighthouse

The stone masonry units displayed an advanced level of erosion and decay, and similar patterns of erosion can be seen on Culzean Estate where the same local blonde sandstone is not very durable, particularly in extreme marine environments. These local sandstones are specifically volcanigenic lithic arenites (quartz-rich sandstones containing feldspars, lithic fragments, clays and micas, cemented together with calcium carbonate). Their deterioration mechanisms include dissolution, particularly along lines of weakness and compositional variation. Clay minerals are also found in abundance in these sandstones. Of greatest importance are the clays which absorb water, particularly combinations of illite/smectite/chlorites which with access to ingressing solution and under confining pressures are particularly destructive for their size. The pore structure of these sandstones are of fundamental importance, as interconnecting pore channels increased permeability, this has allowed the presence of moisture at depth allowing salt crystallization/hydration cycles and chemical reactions to take place. The roles of temperature and humidity, controlling all aspects of moisture movement within these sandstones also affect the ability of the stone to dry out and thus where the zone of maximum moisture content is situated and consequently where soluble salt crystallization/hydration is heightened. This all results in dramatic stone decay controlled by the ingress of salts in solution into the stone, and the ineffectual drying out of the stone.

The walls of the lighthouse are also not particularly thick and this has not helped where the destructive forces of salt crystallization and ineffectual drying out of the stone have meant the stone decay has been prolific.

If the dimensions, coursing and profiles of the masonry can be recorded, then the most sensible option would be to replace the masonry wholesale with something more durable, similar in colour and texture (grain size), for example Catcastle or Clashach buff sandstones, jointed in an HL5 (modified hydraulic lime) based mortar.

Other options might include, indenting the existing structure with a locally recovered matching sandstone, however this would not be a long term solution. However, indenting with a locally recovered sandstone and then harling it may afford some additional protection, though it would present an ongoing maintenance liability and be viewed as a rather radical solution in terms of aesthetics and it would not be clear if this would gain listed building consent.

#### Harbour walls

The harbour walls are in remarkably good condition with very few areas of missing masonry or wholesale mortar work. We suggest the following mortars/ concrete repairs as follows:

#### ***Mortar work for above the usual high tide mark***

(nominally by volume) 1 part HL5 (eg Tradiblanco or Hourdex) to 2.5 parts sharp, concrete sand

***Underwater concrete system*** for missing masonry between the low and high tides (to fill large voids or gaps below the water line which cannot be dried out for normal stone requirements)

(nominally by volume) 1 part Prompt Natural Cement to 1 part clean, screened kiln dried sharp sand (6mm down) with set retarder Tempo, dosed at 160ml per 25kg of Prompt (this will give 10-15 minutes working time) – use to fill hessian bags and pushed into voids and gaps.

#### ***Mortar work under water***

Neat Prompt Natural Cement, mix to a stiff paste and apply immediately.

Scottish Lime Centre Trust

June 2022



## How to calculate sand volumes for full bag lime mixes!

Mortar mixes are always quoted as volume mixes, but as the relative bulk densities of lime binders differ, you need to measure lime binders by weight. The most accurate way of achieving this is by using full bags of lime binders as they are of a known weight (or accurately halved bags). The table below will help you determine the right amount of sand (in litres) for 4 different mix ratios for all the natural hydraulic lime binders currently available in the UK and RoI.

Qty Bags	Producer	Weight Kg	NHL	RBD	Mix Ratio 1:1.5	Mix Ratio 1:2	Mix Ratio 1:2.5	Mix Ratio 1:3
					Litres of Sand Required	Litres of Sand Required	Litres of Sand Required	Litres of Sand Required
1	Hanson	25	2	0.67	56	75	93	112
1	Hanson	25	3.5	0.72	52	69	87	104
1	Hanson	25	5	0.75	50	67	83	100
1	Singleton Birch	25	2	0.65	58	77	96	115
1	Singleton Birch	25	3.5	0.81	46	62	77	93
1	Singleton Birch	25	5	0.86	44	58	73	87
1	Otterbein	25	2	0.64	59	78	98	117
1	Otterbein	25	3.5	0.58	65	86	108	129
1	Otterbein	25	5	0.59	64	85	106	127
1	Roundtower	25	2	0.67	56	75	93	112
1	Roundtower GREY	25	3.5	0.85	44	59	74	88
1	Roundtower WHITE	25	3.5	0.72	52	69	87	104
1	Roundtower	25	5	0.75	50	67	83	100
1	Socli	25	2	0.67	56	75	93	112
1	Socli GREY	25	3.5	0.85	44	59	74	88
1	Socli WHITE	25	3.5	0.72	52	69	87	104
1	Socli	25	5	0.75	50	67	83	100
1	St Astier	25	2	0.58	65	86	108	129
1	St Astier	25	3.5	0.67	56	75	93	112
1	St Astier	25	5	0.79	47	63	79	95
1	Tarmac Blue Circle	25	3.5	0.58	65	86	108	129
1	Tarmac Blue Circle	25	5	0.59	64	85	106	127
1	Prompt	25	Natural Cement	1.1	34	45	57	68

Remember sand bulks when it is damp by as much as 10%, take this into account when measuring your sand. Saturated sand and bone dry sand have equal volumes. Note: Secil is sold by Singleton Birch in the UK.

**Happy mixing!**

**Last Updated: November 2017**