

COMPARATIVE ANALYSIS OF THE PHYSICAL CHARACTERISTICS OF

VALENTIA SLATE

WITH OTHER DIMENSION STONES



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COMPARATIVE ANALYSIS

Valentia Slate Company Ltd has requested Carrig Conservation International to carry out a comparative analysis of the architecturally-relevant physical properties of Valentia Slate and other dimension stones commonly used in construction. The following report addresses this request.

1 STONES COMPARED

In compiling this report, the following readily available dimension stones were compared. These stones are considered by Carrig Conservation International to be a representative illustrative sample of the dimension stones available in Europe, and Ireland in particular. The first table includes natural dimension stones and their background information. The second table includes modern man-made slab materials that are common and will be useful for further comparative analysis of the Valentia Slate.

Name	Rock type	Age (Ma)	Quarry location	Years in operation	Production volume p.a.
Valentia Slate	Slate	Devonian 385	Valentia Island, Ireland	204	1000m ³
Irish Limestone	Limestone	Carboniferous 340	County Kilkenny, Ireland	150	25,000m ³
Liscannor	Namurian Sandstone	Carboniferous 320	County Clare, Ireland	120	
Portland Stone	Oolitic limestone	Jurassic 145	Dorset, UK	390	7,800- 10,400m ³
Spanish Grey	Granite	?	Pontevedra, Galicia, Spain		
Moca Cream	Limestone	Jurassic 165	Alcanede, Portugal	45	
Chinese	Basalt		Hainan, China		
Stanton Moor	Buff Sandstone	Carboniferous 320	Matlock, Derbyshire, UK	120	28,300m ³
Locharbriggs	Red Sandstone	Permian 275	Dumfries, Scotland	130	2,000m ³

Name	Manufacturer	Location
Dekton	Cosentino	Cantoria, Spain
Silestone	Cosentino	Cantoria, Spain

2 RESULTS OF TESTING CARRIED OUT ON VALENTIA SLATE BY SANDBERG LLP

Please also see the original report from Sandberg LLP at www.valentiaslate.com. For convenience, the results of this testing are summarised below.

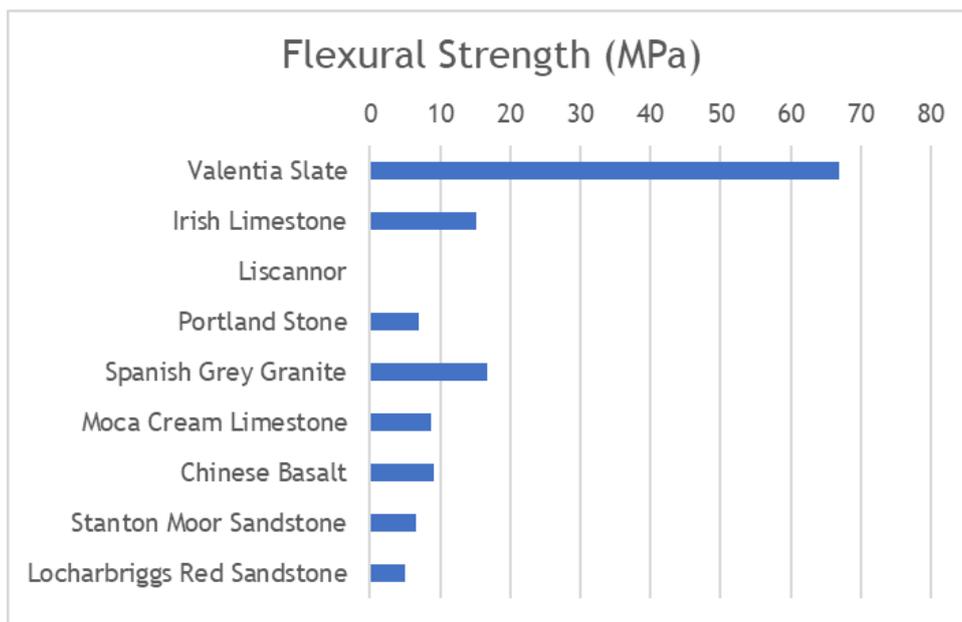
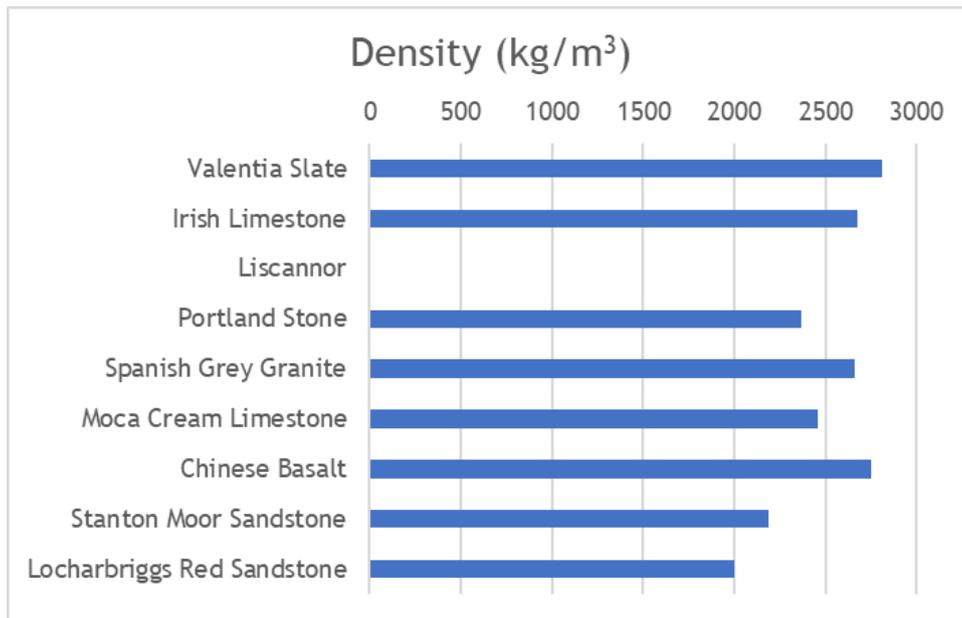
Test	Sandberg Reference	Range	Mean	Lowest Expected Value
Apparent Density (kg/m ³)	G49533	2790-2810	2810	--
Open Porosity (%)	G49533	0.2-0.2	0.2	--
Water Absorption at Atmospheric Pressure (%)	G49533	0.1-0.1	0.1	--
Water Absorption Coefficient Capillarity (g/m ² ·sec ^{0.5})	G49534	--	0.4	--
Flexural Strength (3-point) Under Concentrated Load, Perpendicular-dry (MPa)	G49535	31.0-90.5	49.9	24.1
Frost Resistance, Post-cycling, Perpendicular-dry, 56 cycles (MPa)	G49536	59.0-77.6	67.6	56.3
Thermal Shock Resistance, Post-cycling, Perpendicular-dry (MPa)	G49537	21.0-76.8	41.5	16.2
Salt Crystallisation	G45939	0.00-0.01	0.00	--
Breaking Load at Dowel Hole, Perpendicular (Type 1), dry (kN)	G49538	3.30-7.76	4.80	2.84

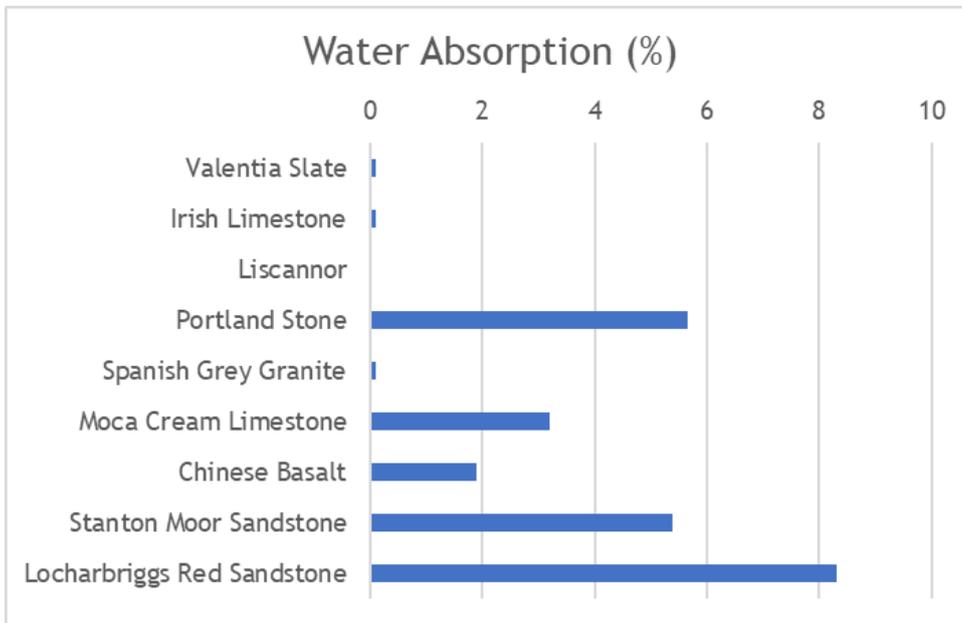
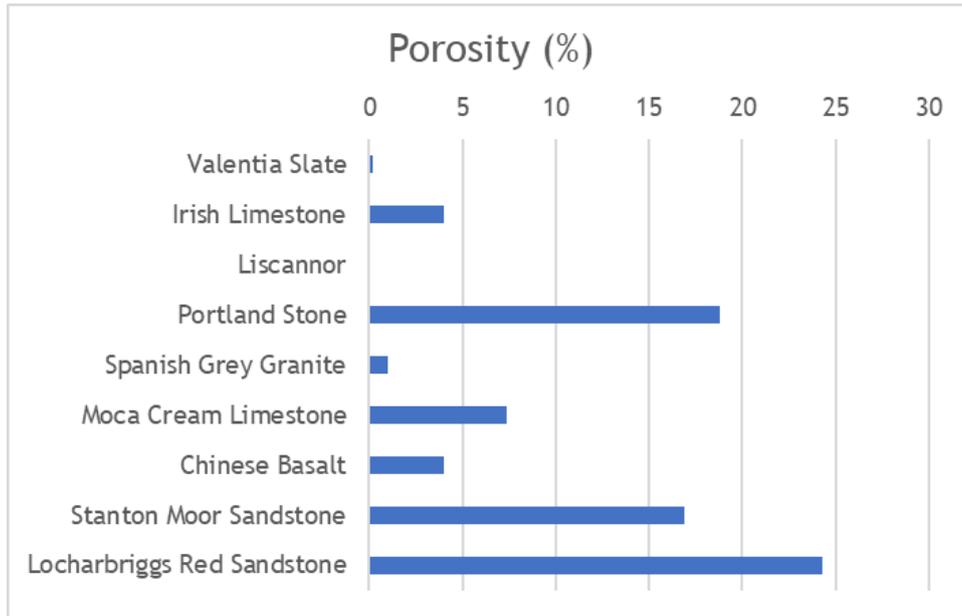
3 COMPARISON OF PHYSICAL PROPERTIES

A summary of technical data from common natural dimension stones in Europe and Ireland is presented below.

Stone Type	Density (kg/m ³)	Flexural Strength (MPa)	Porosity (% Vol)	Water Absorption (% Weight)
Valentia Slate	2810	67.00	0.20	0.10
Irish Limestone	2680	15.20	4.00	0.11
Liscannor	?	?	?	?
Portland Stone	2371	6.85	18.81	5.67
Spanish Grey Granite	2660	16.80	1.00	0.10
Moca Cream Limestone	2460	8.70	7.40	3.20
Chinese Basalt	2750	9.00	4.00	1.91
Stanton Moor Sandstone	2190	6.60	16.90	5.40
Locharbriggs Red Sandstone	2000	5.00	24.30	8.30

The following four plots depict the technical data for the common dimension stones under consideration from the previous table to further illustrate the results.





For comparison with the latest composite man-made slab material, the following data is provided for Silestone and Dekton. Silestone is composed of resin-bound quartz and other minerals while Dekton is manufactured from mineral components bound together by heat and pressure alone, without a resin binder. Both Dekton and Silestone include a range of products and, therefore, a value range is given for certain characteristics. The information is sourced from Cosentino, one of the leading manufacturers of these materials. It is noteworthy that these materials are advertised as being stronger than any natural stone which is a claim that is not consistent with these Valentia Slate test results.

Stone Type	Density (kg/m ³)	Flexural Strength (MPa)	Porosity (% Vol)	Water Absorption (% Weight)
Dekton	2440-2610	45-55	0.20	0.10
Silestone	2133-2453	25-65	0.00	0.05

4 INTERNATIONAL STANDARDS

The Sandberg test results referred to in this document demonstrate compliance by Valentia Slate with the parameters specified in the various European and British standards listed in the results document. Carrig Conservation International is therefore of the view that these results demonstrate that Valentia Slate is more than fit for purpose for all applications of dimension stone in the European market.

In addition, Valentia Slate's compliance with these standards implies compliance with all relevant US standards for dimension stone. Please contact us for any project-specific enquiries in this regard.

We note that Valentia Slate's Declaration of Performance and the Factory Production Control document is available for download on the Valentia Slate website.

5 PERFORMANCE OF VALENTIA SLATE IN THIS ANALYSIS; DISCUSSION

The results show that Valentia Slate has a higher density, a much higher flexural strength, and a much lower porosity than most, if not all, of the stones compared. All three of these properties are key factors in the quality and long-term performance of a construction or dimension stone.

The result for flexural strength illustrates not only that slate, in general, has a higher flexural strength than all other dimension stones, but that Valentia Slate, having a flexural strength of 67 MPa, is at the top end of the range for slate. The comparison with man-made slab materials shows Valentia Slate's flexural strength is equal to the strongest form of Dekton/Silestone.

Similarly, the results for salt crystallisation are excellent and indicate the suitability of Valentia Slate for use in aggressive environments, such as windy coastal locations.

The mineralogy of Valentia Slate is conducive to a long life. The very fine grain size, the dominance of quartz and iron oxide, and the penetrative nature of the slaty cleavage means that no minerals prone to weathering are present or are presented to the elements. It is well known that limestone, in its entirety, as regards carbonate elements, is subject to attack from the carbonic acid naturally occurring in rainwater. With granite, large crystals of both mica and feldspar are presented to the elements and both minerals are relatively unstable at the temperatures and pressures on the earth's surface. For this reason, both break down relatively rapidly under natural chemical weathering and this effect can be seen in any old church yard where original granite headstones are present.

The porosity of Valentia Slate, as 0.1%, is very low. This has great advantages in the long term weathering capability of the material for two reasons. Firstly, in relevant areas, salt does not accumulate and crystallise in pores. The crystallisation pressure of salt is very large and will rupture the surface of stone with any porosity. Because of its very low porosity, this will occur far less with Valentia Slate than with almost any other dimension stone. Secondly, the freezing of water in pores in stone also exerts a very strong rupturing pressure on the surface. Again, because of its low porosity and closed pore structure, this will not occur to any significant degree with Valentia Slate. The ability of Valentia Slate to withstand windblown salt is readily observed on its home island of Valentia in the extreme southwest coast of Ireland.

In comparison to limestone in particular, Valentia Slate is not dissolved by rainwater. This effect can readily be seen in any old churchyard where there are both slate and limestone headstones. You will see that the inscriptions on limestone can be effaced almost completely whereas those on Valentia Slate can be flawless after almost 200 years.

The uniformity of colour and texture of Valentia Slate is also a benefit in the visualisation and presentation of buildings. It is an understated and classic heritage stone that will not go off-trend.

We are advised that Valentia Slate has also applied to be listed as a Global Heritage Stone Resource and has been included on the 2020 interim list. Further details may be found at: <http://globalheritagestone.com/other-projects/ghsr/interim-list/>.

6 FURTHER INFORMATION

Carrig Conservation International are available to provide further independent information and/or advice to potential clients and specifiers of Valentia Slate, if information is required beyond the scope of the reports issued to Valentia Slate.

7 SOURCES OF INFORMATION

The information used in this analysis was obtained from the following sources.

Name	Source
Valentia Slate	Sandberg LLP testing carried out in 2020, available on the Valentia Slate website www.valentiaslate.com .
Irish limestone	Technical specifications available from Kilkenny Limestone at: www.kilkennylimestone.com
Portland Stone	DoP available from Albion Stone at: www.albionstone.com Technical Specifications available in report from Global Heritage Stone .
Spanish Grey Granite	Technical specifications available from Diazpa at: www.diazpa.com
Moca Cream Limestone	Technical specifications available from Mocapor at: www.mocapor.com
Stanton Moor Sandstone	Technical specifications available from Cumbrian Stone at: www.cumbrianstone.co.uk Additional quarry details available from Peak District Planning Application .
Locharbriggs Red Sandstone	DoP and technical specifications available from Cumbrian Stone at: www.cumbrianstone.co.uk Additional quarry details available from Dumfries and Galloway Council . Additional technical specifications available from Stancliffe Stone .
Dekton	Technical specifications available from Cosentino in the Dekton Technical Datasheet
Silestone	Technical specifications available from Cosentino in the Silestone Technical Datasheet