

The image features a dark blue background on the left side, which transitions into a white background on the right. The dark blue area is filled with a complex pattern of thin, light blue lines that curve and overlap, creating a sense of depth and movement. The 'bre' logo is positioned in the lower-left quadrant of this dark blue area. On the right side, the text is aligned to the left, providing details about the report's preparation and date.

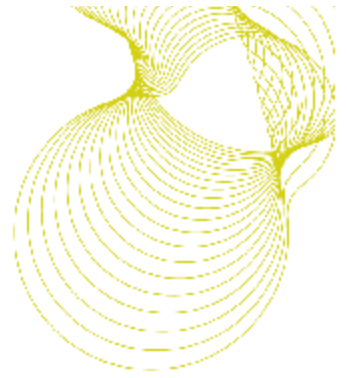
bre

## **Testing of Kentish Ragstone**

Prepared for: Vince Tourle  
Masonry Manager  
Gallagher Group  
Leitrim House  
Little Preston  
Aylesford  
Kent  
ME20 7NS

07 July 2014

Test report number 292893



**Prepared by**

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Name Geoff Ashall  
Position Principal Consultant, Building Technology Group  
Date 07/07/14

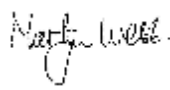
Signature 

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**Approved on behalf of BRE**

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Name Dr Martyn Webb  
Position Principal Consultant, Building Technology Group  
Date 07/07/14

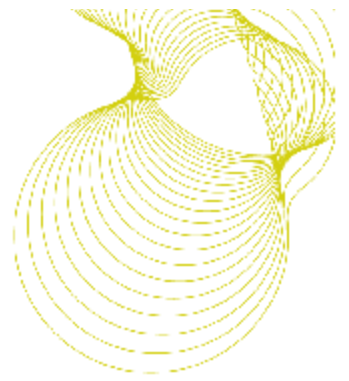
Signature 

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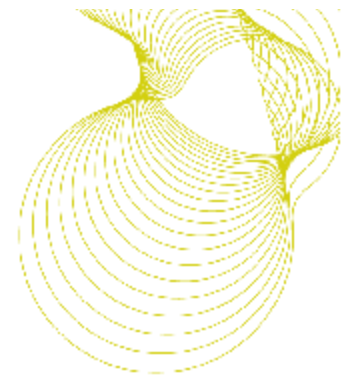
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## 1 Introduction

Following instructions from Vince Tourle (Gallagher Ltd.), BRE have completed a series of tests on a stone reported to be Kentish Rag stone. The stone was delivered to BRE on the 10/04/2014. This report provides a factual account of the testing carried out.

## 2 Test Details

BS EN 12407:, Natural stone test methods. Petrographic examination

BS EN 1936: Natural stone test methods. Determination of real density and apparent density, and of total and open porosity \*

BS EN 1936:2006, Natural stone test methods. Determination of real density and apparent density\*, and of total and open porosity\* After 20 cycles of thermal shock to BS EN 14066: 2003, Natural stone test methods. Determination of resistance to ageing by thermal shock\*

BS EN 13755, Natural stone test methods. Determination of water absorption at atmospheric pressure\*

EN 772-1 Natural stone test methods. Determination of uniaxial compressive strength\*

EN 772-1 Natural stone test methods. Determination of uniaxial compressive strength\* after 56 cycles of frost conditioning to BS EN 12371: 2001, Natural stone test methods. Determination of frost resistance

EN 772-11, Methods of test for masonry units - Part 11: Determination of water absorption of aggregate concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units.

BS EN 13364:2002, Natural stone test methods. Determination of the breaking load at dowel hole

BS EN 14231: 2003, Natural stone test methods. Determination of the slip resistance by means of the pendulum tester

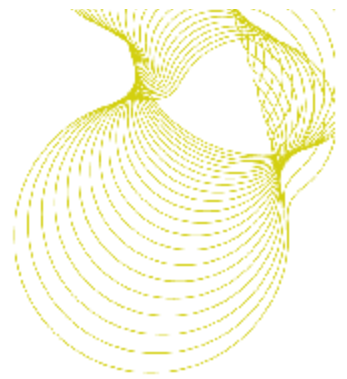
BS EN 14157: 2004, Natural stone test methods. Determination of abrasion resistance Method A\*\*

BSEN 12524, Building materials and products. Hygrothermal properties. Tabulated design values

BSEN 13501 – 1, Fire classification of construction products and building elements. Classification using test data from reaction to fire tests

\* Please note BRE is UKAS accredited for this test.

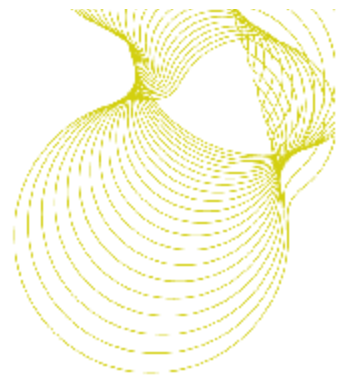
\*\* Please note this test is carried out by an Independent test laboratory which is on BRE's approved contractors list.



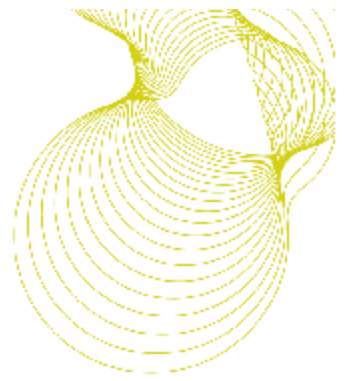
### 3 Test results



Given below is a summary of the test results, full details can be found in the Appendix.

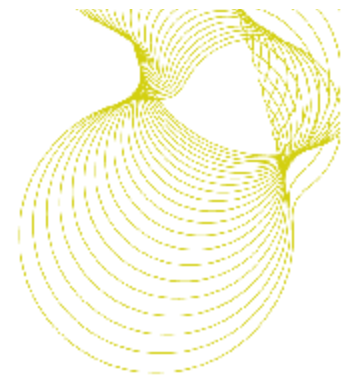
Kentish Ragstone	Value	Units
Porosity	1.3	% by vol
Porosity after thermal shock	1.1	% by vol
Density	2640	Kgm-3
Density after thermal shock	2650	Kgm-3
Water Absorption	0.6	% by mass
Water Absorption by Capillarity	1.1	$\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-0.5}$
Compressive strength	159	MPa
Compressive strength LEV	123	MPa
Compressive strength after freeze thaw (56 cycles)	159	MPa
Compressive strength LEV after freeze thaw (56 cycles)	124	MPa
Breaking load at Dowel hole 50 mm thick	3000	N
Slip Resistance dry	65	
Slip Resistance dry	52	
Abrasion	18.5	
Design Thermal conductivity	2.3	$\text{W}(\text{m}\cdot\text{k})^{-1}$
Specific Heat Capacity	1000	$\text{J}/(\text{Kg}\cdot\text{K})$
Water Vapour Resistance Factor Dry	250	
Water Vapour Resistance Factor Wet	200	
Reaction to fire (Declared value) Without testing (see decision 96/603/EC , as amended)	A1	
Petrographic Examination	<b>Glauconitic Limestone</b>	





#### **4 Detailed Test Results**



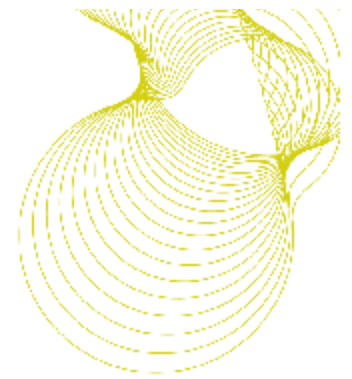
BSEN 1936: 2006: Determination of Open Porosity And Apparent Density					
Name of Stone:	Kentish Rag		Petrographic Nature:	Limestone	
Quarry	Data not supplied		Anisotropic Features:	Not visible	
Supplier:	Gallagher Ltd		Country of Origin:	UK	
Dimensions:	50 x 50 x 50 mm		Project Reference:	Data not supplied	
Surface Finish:	Sawn		Preparation /Conditioning:	Prepared to BSEN 1936	
Date Tested:	28/04/2014	01/05/2014	Tested by:	Ian Rance	
BRE No	Wo+24h	W1	W2	Apparent Density	Open Porosity
292893/14/	g	g	g		
221	338.794	212.890	339.598	2670	0.6
222	337.169	210.899	338.506	2640	1.0
223	337.709	212.146	339.244	2650	1.2
224	334.888	210.548	337.890	2620	2.4
225	333.904	209.014	335.290	2640	1.1
226	341.446	213.338	343.181	2620	1.3
			<b>Mean</b>	2640	1.3
<p>* The calculation of apparent density assumes the density of water to be 998Kgm<sup>-3</sup> at 20<sup>0</sup>C            Open Porosity is defined as the ratio of volume of open pores to the apparent volume of the specimen            Apparent Density is defined as the ratio of the mass of the dry specimen to its apparent volume</p>					
<b>Mean open porosity (%):</b>				<b>1.3</b>	
<b>Mean apparent density (Kgm<sup>-3</sup>)</b>				<b>2640</b>	
Approved by:			Date:	07/07/2014	
Name:	Mr Geoff Ashall				
Position:	Principal Consultant		Building Technology Group		
 4378					



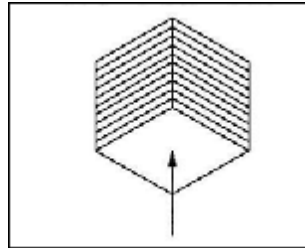
<b>BSEN 1936: 2006: Determination of Open Porosity And Apparent Density after 20 cycles of Thermal Shock to BSEN 14066</b>					
Name of Stone:	Kentish Rag		Petrographic Nature:	Limestone	
Quarry	Data not supplied		Anisotropic Features:	Not visible	
Supplier:	Gallagher Ltd		Country of Origin:	UK	
Dimensions:	50 x 50 x 50 mm		Project Reference:	Data not supplied	
Surface Finish:	Sawn		Preparation /Conditioning:	Prepared to BSEN 1936	
Date Tested:	27/05/2014	29/05/2014	Tested by:	Ian Rance	
BRE No	Wo+24h	W1	W2	Apparent Density	Open Porosity
292893/14/	g	g	g		
280	336.290	210.757	337.639	2650	1.1
281	347.273	218.466	348.249	2670	0.8
282	334.065	208.996	335.856	2630	1.4
283	337.055	211.327	338.340	2650	1.0
284	344.354	215.685	345.900	2640	1.2
285	333.515	209.284	335.063	2650	1.2
			<b>Mean</b>	2650	1.1
<p>* The calculation of apparent density assumes the density of water to be 998Kgm<sup>-3</sup> at 20<sup>0</sup>C            Open Porosity is defined as the ratio of volume of open pores to the apparent volume of the specimen            Apparent Density is defined as the ratio of the mass of the dry specimen to its apparent volume</p>					
<b>Mean open porosity (%):</b>				<b>1.1</b>	
<b>Mean apparent density (Kgm<sup>-3</sup>)</b>				<b>2650</b>	
Approved by:			Date:	07/07/2014	
Name:	Mr Geoff Ashall				
Position:	Principal Consultant		Building Technology Group		
					







**BSEN 1925:1999: Determination of Water Absorption Coefficient by Capillarity  
Perpendicular to Bedding**



Name of Stone:	Kentish Rag	Petrographic Nature:	Limestone
Quarry	Data not supplied	Anisotropic Features:	Visible
Supplier:	Gallagher Ltd	Country of Origin:	UK
Dimensions:	50 x 50 x 50 mm	Project Reference:	Data not supplied
Surface Finish:	Sawn	Preparation /Conditioning:	BSEN 1925
Date Tested:	11/06/2014	12/06/2014	Tested by: Ian Rance

	Width 1	Width 2	Mass gain after 60 mins	Water absorption *
BRE No	m	m	g/m <sup>2</sup>	gm <sup>2</sup> s <sup>-0.5</sup>
292893/14/				
231	0.0497	0.0507	37.717	0.5
232	0.0486	0.0509	92.461	1.5
233	0.0495	0.0506	69.995	0.9
234	0.0507	0.0497	80.943	1.3
235	0.0511	0.0517	33.682	0.5
236	0.0511	0.0503	158.282	2.0

\*Calculated following procedure in note 1

**Mean Water absorption: 1.1 gm<sup>2</sup>s<sup>-0.5</sup>**

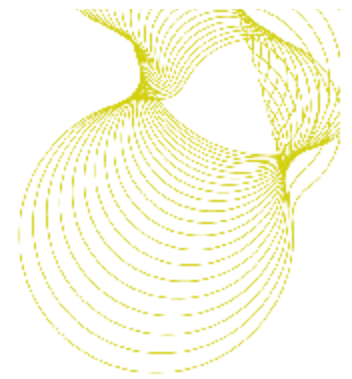
Approved by: 

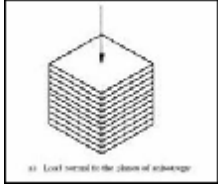


Date: 07/07/2014

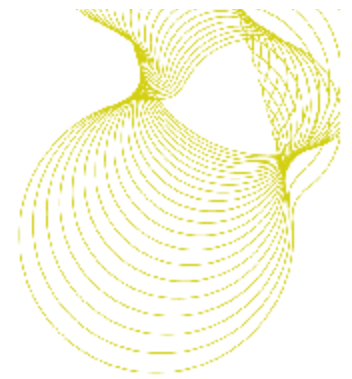


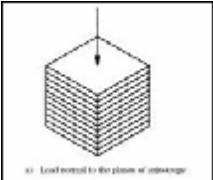


Name: Mr Geoff Ashall

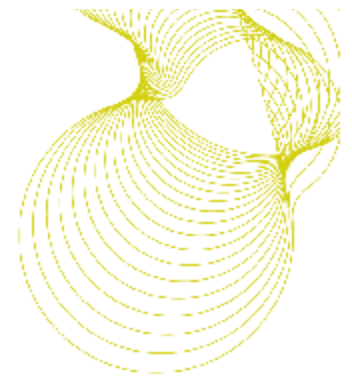
Position: Principal Consultant, Building Technology Group



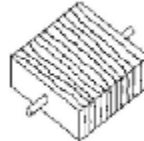
<b>BSEN 772 -1 Methods of test for masonry units. Determination of compressive strength</b>						
						
Name of Stone:	Kentish Rag	Petrographic Nature:	Limestone			
Quarry	Data not supplied	Anisotropic Features:	Not visible			
Supplier:	Gallagher Ltd	Country of Origin:	UK			
Dimensions:	50 x 50 x 50 mm	Project Reference:	Data not supplied			
Surface Finish:	Sawn	Preparation /Conditioning:	Prepared to BSEN 772-1			
Date Tested:	05/06/2014	Tested by:	Ian Rance			
	Load	Height	Mean	Mean	Failure	Comp.
BRE No	Rate		Length	Width	Load	Strength
292893/14/	MPa s-1	mm	mm	mm	kN	MPa
171	1± 0.5	50.8	51.2	50.0	373	146
172	1± 0.5	50.9	51.3	50.3	483	187
173	1± 0.5	50.5	50.3	51.6	363	140
174	1± 0.5	51.0	50.4	49.9	378	150
175	1± 0.5	50.5	45.8	49.3	371	164
176	1± 0.5	50.7	49.9	50.0	383	154
177	1± 0.5	50.7	51.3	51.1	434	166
178	1± 0.5	51.2	50.3	50.4	478	189
179	1± 0.5	50.9	50.6	50.3	410	161
180	1± 0.6	51.0	51.5	50.4	336	129
					<b>Mean</b>	<b>159</b>
					<b>St. Dev</b>	<b>19.02</b>
					<b>Co of var</b>	<b>0.12</b>
					<b>LEV</b>	<b>123</b>
Approved by:			Date:		07/07/2014	
Name:	Mr Geoff Ashall					
Position:	Principal Consultant		Building Technology Group			
						



<b>BSEN 772 -1 Methods of test for masonry units. Determination of compressive strength Tested Dry after 56 cycles freeze thaw conditioning to BSEN 12371</b>						
						
Name of Stone:	Kentish Rag		Petrographic Nature:		Limestone	
Quarry	Data not supplied		Anisotropic Features:		Not visible	
Supplier:	Gallagher Ltd		Country of Origin:		UK	
Dimensions:	50 x 50 x 50 mm		Project Reference:		Data not supplied	
Surface Finish:	Sawn		Preparation /Conditioning:		Prepared to BSEN 772-1	
Date Tested:	05/06//2014		Tested by:		Ian Rance	
	Load	Height	Mean	Mean	Failure	Comp.
BRE No	Rate		Length	Width	Load	Strength
292893/14/	MPa s-1	mm	mm	mm	kN	MPa
81	1± 0.5	49.5	49.3	50.7	392	157
82	1± 0.5	50.3	50.4	51.2	335	130
83	1± 0.5	50.8	50.9	49.8	448	177
84	1± 0.5	48.6	48.6	50.5	432	176
85	1± 0.5	49.7	49.8	50.6	340	135
86	1± 0.5	50.7	50.8	49.8	378	149
87	1± 0.5	51.1	50.9	50.6	445	173
88	1± 0.5	49.6	49.7	50.8	452	179
89	1± 0.5	50.6	50.8	49.9	417	165
90	1± 0.6	50.8	50.8	49.8	375	148
					<b>Mean</b>	<b>159</b>
					<b>St. Dev</b>	<b>17.89</b>
					<b>Co of var</b>	<b>0.11</b>
					<b>LEV</b>	<b>124</b>
Approved by:			Date:		07/07/2014	
Name:	Mr Geoff Ashall					
Position:	Principal Consultant		Building Technology Group			
						



**BSEN 13364: 2002 Determination of the breaking load at dowel hole  
with the load applied parallel to the bedding type IIb**



Name of Stone:	Kentish Rag	Petrographic Nature:	Limestone
Block No:	Data not supplied	Anisotropic Features:	Visible
Supplier:	Gallagher Ltd	Country of Origin:	UK
Dimensions:	200 x 200 x 50 mm	Project Reference:	Data not supplied
Surface Finish:	Sawn	Preparation /Conditioning:	Prepared to BSEN 13364
Dowel diameter:	6mm	Tested by:	Ian Rance
Date Tested:	04/06/2014		

BRE no.	Load Rate	Breadth	Width	Thickness	d1	bA	Failure Load	
292893/14/	N.s <sup>-1</sup>	mm	mm	mm	mm	mm	N	
240	50	200	200	50.45	20.53	70.99	3250	
241	50	200	200	50.94	20.44	67.00	3300	
242	50	200	200	49.53	20.66	57.51	4050	
243	50	200	200	49.02	18.08	63.15	2950	
244	50	200	200	49.88	19.54	67.49	4150	
245	50	200	200	49.03	19.55	98.52	1450	
246	50	200	200	49.67	22.10	52.95	2300	
247	50	200	200	50.00	21.45	65.86	2150	
248	50	200	200	49.71	20.67	58.14	3900	
249	50	200	200	49.00	19.63	73.93	2550	
				<b>Mean</b>	<b>49.72</b>	<b>20.27</b>	<b>68</b>	<b>3000</b>
				<b>St. Dev</b>				<b>895</b>
				<b>Co of var</b>				<b>0.30</b>

Approved by:

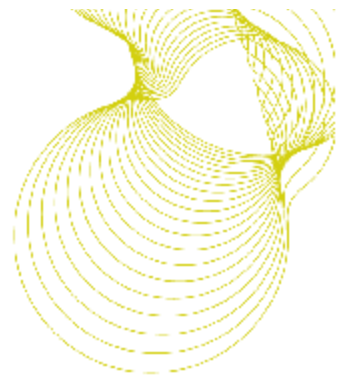
Date: 07/07/2014





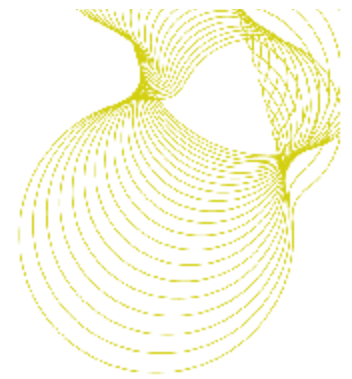
Name:



Geoff Ashall

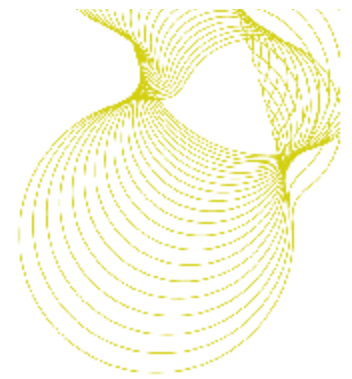
Principal Consultant, Building Technology Group

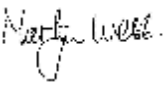


BS EN 14231: 2003, Natural stone test methods. Determination of the slip resistance by means of the pendulum tester						
Name of Stone:	Kentish Rag		Petrographic Nature:	Limestone		
Block No:	Data not supplied		Anisotropic Features:	Not visible		
Supplier:	Gallagher Ltd		Country of Origin:	UK		
Dimensions:	200 x 100 x 50 mm		Project Reference:	Data not supplied		
Surface Finish:	Sawn		Preparation /Conditioning:	BS EN 14231		
Date Tested:	30/05/2014		Tested by:	Ian Rance		
Slider	TRRL	Slider 55				
BRE no						
Condition: Dry						
292893/14/	461	462	463	464	465	466
Direction 0°	71	68	64	64	63	64
Direction 180°	70	67	61	61	60	61
Mean	<b>71</b>	<b>68</b>	<b>63</b>	<b>62</b>	<b>62</b>	<b>63</b>
<b>Overall Mean Dry: 65</b>						
BRE no						
Condition: Wet						
292893/14/	461	462	463	464	465	466
Direction 0°	59	59	50	50	49	48
Direction 180°	57	59	51	49	50	48
Mean	<b>58</b>	<b>59</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>48</b>
<b>Overall Mean Wet: 52</b>						
Approved by: 						
			Date:	07/07/2014		
Name:	Geoff Ashall					
Position:	Principal Consultant		Building Technology Group			
						 <small>0578</small>

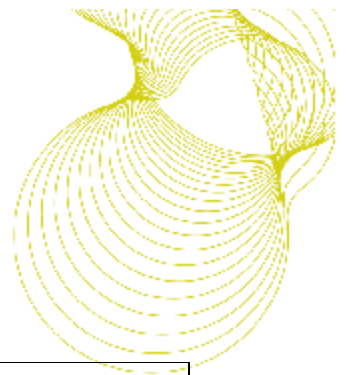


<b>Thameside Test &amp; Research Limited</b> Unit C2, Lomer Farm, Wrotham Road, Meopham, Kent DA13 0AN Tel: 01474 814466			
		Sample Number: <b>T14/109AMD</b> Page 1 of 1 Lab. Scheme Number: 1866	
<b>Client:</b> BRE <b>Site ref:</b> 292893/14/01 <b>Stone type:</b> Grey limestone <b>Date Received:</b> 30-Apr-14 <b>Date tested:</b> 7-May-14		<b>Sampled by</b> Client <b>Source</b> n/a <b>Date Prepared</b> 1-6 May-14	
Test Method BSEN 14157:2004      Natural stones - Determination of abrasion resistance - Method A			
<b>WIDE WHEEL ABRASION VALUE</b>			
Specimen reference	Individual abrasion value (mm)	Mean abrasion value (mm)	
71	18.5	<b>18.5</b>	
72	18.5		
73	16.5		
74	19.0		
75	19.5		
76	18.5		
Remarks 1. Specimens were tested on a sawn finish 2. The test results apply only to the specimens tested 3. Specimen 73 tested across buff coloured inclusion			
Distribution: Building Research Establishment Bucknalls Lane Garston, Watford Herts WD2 7JR Geoff Ashall		Authorised by <div style="text-align: right;">   <b>Paul Shrubsole</b>                      Approved Signatory                      PG Shrubsole ( ) Principal Materials Engineer                      Date 10/06/2014                 </div>	
<small>Thameside Test &amp; Research Limited, Registered Office: Lakeside, Rhododendron Avenue, Culverden Green, Gravesend, Kent DA13 0TT. Registered in England and Wales No: 7302145                  Note: Thameside Test &amp; Research Limited only accepts responsibility for the accuracy of the results contained in this report. No responsibility can be accepted for the results being representative of the material or the samples unless sampling has been carried out by the Thameside Test &amp; Research Staff. This report cannot be reproduced either in part or in full without the written consent of Thameside Test &amp; Research Limited.</small>			



<b>EN 12524:2000 Building materials and products - Hygrothermal properties - Tabulated design values</b>																			
Name of Stone:	Kentish Rag																		
Block No:	Data not supplied.																		
Country of Origin:	UK																		
Supplier:	Gallagher Ltd																		
Date Assessed	10/06/2014																		
Petrographic Nature:	Limestone																		
<table border="1" style="width: 80%; margin: auto; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Property</th> <th style="width: 20%;">Value</th> <th style="width: 20%;">units</th> </tr> </thead> <tbody> <tr> <td>Density</td> <td style="text-align: center;">2640</td> <td style="text-align: center;">Kgm-3</td> </tr> <tr> <td>Design thermal conductivity</td> <td style="text-align: center;">2,3</td> <td style="text-align: center;">W/(mK)</td> </tr> <tr> <td>Specific heat capacity</td> <td style="text-align: center;">1000</td> <td style="text-align: center;">J/(kgK)</td> </tr> <tr> <td>Water vapour resistance factor dry</td> <td style="text-align: center;">250</td> <td></td> </tr> <tr> <td>Water vapour resistance factor wet</td> <td style="text-align: center;">200</td> <td></td> </tr> </tbody> </table>		Property	Value	units	Density	2640	Kgm-3	Design thermal conductivity	2,3	W/(mK)	Specific heat capacity	1000	J/(kgK)	Water vapour resistance factor dry	250		Water vapour resistance factor wet	200	
Property	Value	units																	
Density	2640	Kgm-3																	
Design thermal conductivity	2,3	W/(mK)																	
Specific heat capacity	1000	J/(kgK)																	
Water vapour resistance factor dry	250																		
Water vapour resistance factor wet	200																		
Approved by:																			
	Date: 07/07/2014																		
Name:	Dr. Martyn Webb																		
Position:	Principal Consultant Building Technology Group																		





**BS EN 12407 Petrographic Examination of Natural Stone**

**Sample Description**

Commercial name of stone:	Kentish Rag	Petrographic Nature:	Limestone
Quarry name:	Data not supplied	Veining and fossils	None
Quarry location:	Kent, UK	Country of Origin:	UK
Supplier:	Gallagher	Project Reference:	Data not supplied
Surface Finish:	Cut	Preparation /Conditioning:	Prepared to BS EN 12407
Date Tested:	4/06/14	Tested By:	Martyn Webb
Project no	292893	Sample I.D Number	292893/14/117



**Figure 1:** Image of hand specimen, side length approximately 50 mm

**Results summary**

Based on the mineralogy identified in the thin section and the texture seen in hand specimen, the stone has been given the classification of **Glauconitic Limestone**.

Final approved by:

*G. Ashall*

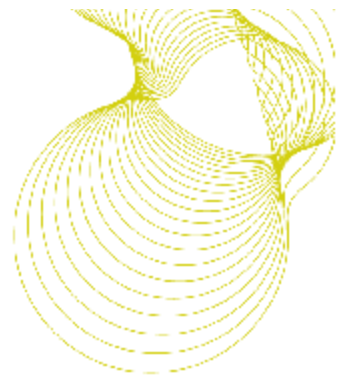
Date: 10/06/14

Name:

Geoff Ashall

Position:

Principal Consultant



### Macroscopic Examination of 292893/14/117

In hand specimen the sample was speckled grey-beige in colour, and generally had a dense hard fabric (Figure 1). The speckles were a distinctive green-black and rounded in shape. Other constituents were white, beige and colourless and held within a colourless cement. There was a vigorous reaction to dilute hydrochloric acid and very slow absorption in the water drop test.

There were no visible signs of cracks or significant weathering/degradation at this level of examination.

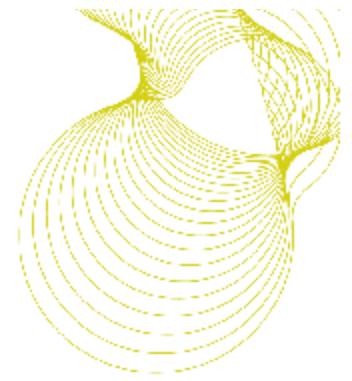
### Microscopic Examination of 292893/14/117

In thin section the stone consisted primarily of calcite, together with quartz and glauconite (Figure 2). A dominant constituent was highly fragmented fossil shell debris which included bivalves, gastropods, ooliths, bryozoa and various microfossils. A few were micritic in nature, but most were either fine or coarsely crystallised sparite. Also present were widely distributed rounded particles of glauconite (dark green in hand specimen) and quartz (colourless and white in hand specimen – Figures 2 and 3). The particles were densely packed and held within a sparite carbonate cement, resulting in a low proportion of pore spaces.



**Figure 2:** Typical appearance of the stone in thin section showing glauconite (green), quartz (grey and white) and calcite (beige and brown). Cross polarised light, magnification x25

Some individual particles and zones within the stone were organic rich which significantly darkened the overall colour in these locations. It was often problematic to distinguish between the fossil particles and the cement, but an estimate of the composition is given below:



An approximate visual estimation of mineral proportions is given below:

Constituent	Proportion as a visual estimate (%)
Calcite (as fossil fragments and cement)	80 - 84
Glaucanite	8 - 10
Quartz	8 - 10



**Figure 3:** Image showing the fabric at high magnification, showing fossil fragments, quartz and glauconite amongst the calcite cement. Plane polarised light, magnification x100

Based on the mineralogy identified in the thin section and the texture seen in hand specimen, the stone has been given the classification of **Glaucanitic Limestone**.

=====REPORT ENDS=====