AML 7/2001 38d6.

INTERIM REPORT ON BRIXWORTH MORTARS

VISUAL EXAMINATION

The samples submitted for analysis were on the whole in a sound condition. None showed signs of excessive leaching. Most samples contained a few fragments of brick, iron stone and charcoal but in no case did this exceed approximately 1% of the observable aggregate. However 667 (red), 674,752 and 798 contained a high proportion of brick/tile and 646 had an appreciable amount of charcoal, accounting for approximatel 5% of the observable aggregate. In no sample did the chalk aggregate exceed 2%.

The samples showed a range of colours 667 (red), 674, 680, 709, 722, 752, 798 and 837 had a distinct pink colour and 646 a grey shade. The remaining samples had colours ranging from pale orange to dark brown.

EXPERIMENTAL

The samples were first dried at 110°C to constant weight. 100g of each sample was then treated with dilute hydrochloric acid to remove acid-soluble material (mainly calcium carbonate) and thus reduce the sample to its aggregate. The aggregate was filtered off, thoroughly washed and dried to a constant weight. It was then passed through a series of sieves and the various quantities retained noted. In order to enable comparison of the aggregates to be made, the weights retained were converted into a percentage of the total aggregate weight and plotted against sieve mesh size. A typical result of this exercise is attached. All analyses, wherever possible, were carried out in duplicate and the mean values employed.

Aggregate-size analysis assigned the samples to nine groups, details of which are shown in the table attached.

The major portions of the aggregate with the exceptions of 667 (red), 674, 752, 798 were composed of rounded to sub-rounded sand. Most samples contained a few fragments of brick, local iron stone and charcoal fragments. A few tiny fragments of coal ($\simeq$ 1.00mm) were observed in 831 and 839. Some samples in all groups contained the occasional piece of fuel-ash slag.

The finest fractions (those passing through the 0.075 mm sieve) generally had a dark brown colouration; a marked contrast to the buff coloured sands employed. This material was obviously derived from an iron-rich geological source. It may have originated from the weathering of the sand-iron stone present or have been present in the sand employed. The former seems unlikely as very few iron stone fragments were present in the preceeding sieved fractions. Additionally, the mortars showed little signs of weathering.

The fines obtained from 667 (red) 674, 680, 709, 722, 752, 798 and 837 had a distinct pink colouration which was caused by the presence of brick dust. The presence of this dust in those samples having substantial portions of brick in their aggregate (667 (red), 674, 752 and 798) is not surprising but its presence in the remaining samples is interesting. Oddly enough none of these latter samples had any brick aggregate systems. Its presence, therefore, could well be accidential and be the result of outwash, by rain etc, of dust into the sand pile from the brick crushing process.

The presence of substantial amount of brick in the coarser aggregates of 667 (red), 674, 752 and 798 was unlikely to have been an attempt to produce an opus signinum system as these samples mainly occur in different groups alongside the more usual sand/li e system. It is reasonable to assume that the bricks were readily available and provided a useful source of coarse aggregate when crushed.

As the presence of brick aggregate and dust imparts a pink colouration to the mortar the possibility of a decorative purpose for the 8 samples must also be considered. Only the architectural/archaeological evidence can support or refute this possibility.

646, 681, 831 and 839 had very grey fines possible consisting of coal or charcoal dust. As the presence of such substances has no obvious effect on the mortar's properties its presence is most likely accidential. Again it may have been washed into the sand heap from a neighbouring fire or its just conceivable that it was used as a colourant.

A very striking feature of all the groups is the peculiar mix employed. If such high levels of lime were used in a mortar one would have a 'fat' system (ie lime rich) which would be relatively slow setting and have a tendency to be squeezed out. Consequently a generous supply of spacers (wooden pegs, oyster shells, etc) would have been necessary between the building lifts to prevent the mortar from being squeezed out. Even then the mortar would have lacked strength and would most likely have degenerated or weathered quite rapidly. As most of the samples were in excellent condition this does not seem a satisfactory explanation . Furthermore such lime rich systems are usually associated with wall renderings or plasters and the origins of the samples rules such a possibility out. Equally the high solubility cannot be explained by the use of chall /limestone aggregate as no sample showed the necessary levels of such inclusions.

The dark fines, postulated earlier as weathered rock, suggest a possible explanation. If the sand system employed was contaminated by a complex iron carbonate than on chemical analysis the iron carbonate would decompose in a similar manner to calcium carbonate (produced by the setting of the lime) thus leading to an abnormally high solubility and consequently the apparent use of a lime rich mortar. This explanation seems reasonable as the degeneration of the iron carbonate complex would occur only during the acid dissolution stage. Hence the original mix would have been lean and thus more suitable for building purposes.

Examination of a few samples by differential thermal analysis was undertaken and the resulting data indicated the presence of iron carbonates, possibly a complex siderite.

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November 1982

The presence of op. sig. systems in group containing the more usual sand/lime mortars is strong evidence for sieving of aggregate prior to use.

TABLE OF MORTAR GROUPS

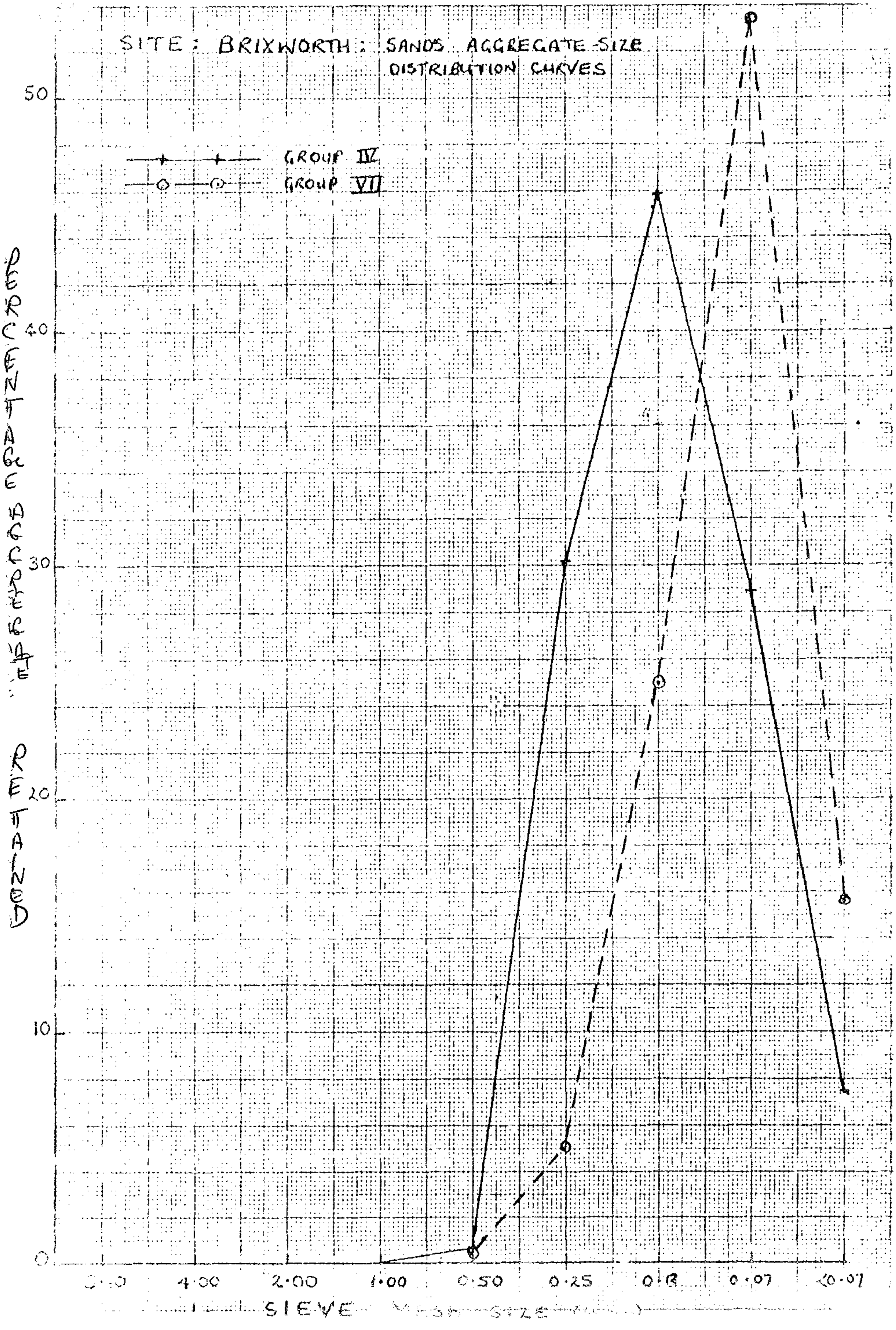
GROUP	SAMPLE NUMBERS	TOTAL	% DISSOLVED	APPROXIMATE MIX GRAVEL : SAND : LIME
I	629, 634, 681 674	4	51.3-60.4 43.4	- 0.8 : 1 0.7 : 0.7 : 1
II	576, 733	2	48.0-61.9	- : 0.8 : 1
III	587, 590, 611, 641, 667 (yellow) 689, 777, 784	8	58.8-68.5	- : 0.7 : 1
IV+	555, 561, 566, 570. 572, 575, 579,580,581 633,639, 644, 646, 649, 653, 668, 671, 683 685, 694, 699, 701, 717, 730, 729, 731,732 734, 738, 740, 745, 760, 773, 774, 775,782 790, 798, 831, 838, 842, 843, 844	43	53.8-72.7	0.8 : 1
V	680, 722, 752, 837	4	29.8-40.5	0.4 : 1.5 : 1
VI	676, 754, 755, 778, 839	5	55.4-61.2	0.2 : 0.6 : 1
VII	801	1	63.2	- : 0.6 : 1
VIII	667 (red), 709	2	60.6-71.5	- : 0.6 : 1
IX	690	1	65.2	0.1 : 0.5 : 1
	TOTAL	70		

* Includes 740 & 745 Group IV, split of 667 into 'red' & 'yellow' mortars

\+ Possible sub-group 581, 644, 653, 579, 683, 699, 694, 738, 761, 782

MEAN DATA FOR AGGREGATE-SIZE DISTRIBUTION OF SANDS

GROUP	< 0.075	0.075	0.125	0.250	0.500
I	3.78	6.51	48.73	39.23	1.24
II	2.16	6.93	39.79	50.56	0.32
III	9.14	31.70	42.99	16.00	0.16
IV	7.50	28.92	45.88	30.20	0.72
V	4.90	5.60	15.55	59.08	4.88
VI	3.77	13.58	63.64	18.79	0.59
VII	15.67	53.40	25.00	5.15	0.46
VIII	10.63	14.74	28.75	39.94	5.95
IX	13.62	17.96	46.95	19.39	2.05


SITE: BRIXWORTH: SANDS AGGREGATE SIZE DISTRIBUTION CURVES
GROUP IV
GROUP VII
PERCENTAGE AGGREGATE RETAINED
50
40
30
20
10
0
4·00
2·00
1·00
0·50
0·25
0·13
0·07
<0·07
SIEVE MESH SIZE