

Appendix VII – Mortar Analysis

MORTAR ANALYSIS REPORT

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ANALYSIS DATE	June 2022
SITE	John Rylands, Manchester University
CLIENT	Mather & Ellis Ltd
DATE/ TAKEN RECEIVED	June 2022
CLIENT REQUIREMENTS	Analyse mortar samples
MORTAR DATING	No
LOCATION/ FUNCTION IN BUILDING	Building and pointing mortar to Wood Street
CONDITION OF SAMPLE RECEIVED/ COLLECTED	Bound and loose mortar

GENERAL COMMENTS/ SUMMARY

From the nature of the binding matrix of the mortar sample and from information gained from the analysis it is probable that the mortar was made up by volume from a combination of 1 part impure slaked lime: 1 fine quartz sand and ash. The hydraulic residue left in the analysis suggests that a feebly hydraulic lime was used originally and/or that the fine ash reacted with the lime to create more of a hydraulic set.

SUGGESTED REPLACEMENT MORTAR (Taking account of prevailing site conditions, building materials and condition, location, and function of the new mortar, building details, exposure, seasonal working etc.)

If possible, re-point with a weak hydraulic lime, ash and sharp sand based mix. One such mix could be 1 part Ionic 2: 1 part moist pink silica sand: 1 part Waddington fell grit: ¼ parts clinker based ash: ¼ part PFA

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ANALYTICAL PROCEDURES

The selected sample of material was dried, weighed and examined both by eye and under a binocular microscope at x 20 & x 35 magnification. The sample was crushed, the binder separated from the aggregate by dissolution in dilute hydrochloric acid and the relative proportions of binder (lime, cement and gypsum) to aggregate determined. Aggregate (and other acid-insoluble materials) characterisation was undertaken by means of sieve separation and further microscopic examination.

The analysis and interpretation provide information on the composition and characteristics of the mortar sample(s) received by us. Assuming that the sample was representative of the mortar generally, then analysis will give a reasonable indication of the original materials and provide a basis for specification of repair or replacement mortars.

If more detailed information is required (for example for purposes of historic research) more sophisticated analytical procedures can be undertaken to determine chemistry and mineralogical composition.

MORTAR EXAMINATION AND ANALYSIS

PROCEDURE	DESCRIPTION / COMMENTS
PRELIMINARY EXAMINATION OF SAMPLE BY EYE	A dark pink mortar coloured with clinker ash
EXAMINATION OF PREPARED SAMPLE BY BINOCULAR MICROSCOPE x20 MAG	An open textured sand and lime mortar, with denser ash bound aggregate

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ACID DISSOLUTION

PROCEDURE	DESCRIPTION ~ COMMENTS
10% HCL ACID DISSOLUTION	Easy to crush.
FILTER GRADE (PORE SIZE) & TYPE	Whatman Type 1

AGGREGATE SEPARATION

BS SIEVE Mesh Size	Residue Retained in g's	Undissolved binder %	Aggregate wt excluding undissolved binder - gs	Aggregate weight %	Comments
4.75 mm	0				
2.36 mm	0.4	30	0.28	n/a	Pink and clear quartz; and clinker ash
1.18 mm	0.66	30	0.46	n/a	Pink and clear quartz; and clinker ash
0.60 mm (600µm)	0.31	30	0.22	n/a	Pink and clear quartz; and clinker ash
300 µm	1.56	5	1.48	n/a	Pink and clear quartz; and clinker ash
150 µm	0.64	0	0.64	n/a	Pink and clear quartz; and ash
< 150 µm including filter residue	1.03	5	0.98	n/a	Clear quartz and ash

All the quartz aggregate is sub-angular

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AGGREGATE CHARACTERISTICS

Quartz sand and clinker ash former the main aggregate, some of which would have been larger than the analysis suggests as the analysis process crushes larger light weight aggregate

Because sand and gravel aggregates are ultimately derived from the weathering of solid rock most aggregates contain coarse grained rock fragments and finer mineral grains. Weathering breaks down the rock fragments within the aggregate into the constituent minerals, resulting in smaller and rounder particles; chemical weathering breaks down unstable minerals, such as feldspars, into clays which may be washed away, both processes eventually result in a quartz-rich sand.

CONSTITUENTS OF ANALYSIS SAMPLE

<i>MATERIAL</i>	<i>WEIGHT (g)</i>	<i>COMMENTS</i>
A: DRY WEIGHT OF- ANALYSIS SAMPLE	10.38	
B: DRY WEIGHT OF ALL INSOLUBLES	4.6	
C: DRY WEIGHT OF INSOLUBLE BINDER	0.54	
D: (B-C) DRY WEIGHT OF AGGREGATE	4.06	
E: (A-B+C)) DRY WEIGHT OF LIME & BINDERS	6.32	
DRY WEIGHT OF LIME	5.78	
OTHER		

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PROPORTIONS OF ANALYSIS SAMPLE

The sample proportions gives the relative weights of aggregate and carbonated or set lime.

LIME: AGGREGATE RATIO

1.5:1

PROBABLE ORIGINAL MIX

The probable original mix set out below gives the relative weights of the mortar constituents as mixed on site and before carbonation. From the nature of the binding matrix of the mortar sample and from information gained from the analysis it is probable that the mortar was made up by volume from a combination of 1 part impure slaked lime: 1 fine quartz sand and ash. The hydraulic residue left in the analysis suggests that a feebly hydraulic lime was used originally and/or that the fine ash reacted with the lime to create more of a hydraulic set.

Sample analysis, interpretation and report carried out by: Mark Womersley