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Mortar Analysis

Test Report No. 5687.

Lincoln's Inn, New Square, London WC2A.

No 1 New Square (South).

Sample as received.

A core sample (51.6g) of external render collected from c.600mm above ground on the front elevation at basement level has been analysed chemically and microscopically. This is a late 19th or 20th century material and not original late 17th century render.

Sample Assessment and Microscopic Observations.

Multiple paint layers – white (apparently) masonry paint over earlier cream and pale brown probably oil-based paint layers; limewash not determined - removed prior to analysis. Intact brown render c.33mm thick. High strength (sample could not be broken by hand nor crumbled in fingers; crushed using pestle with difficulty). Aggregate is principally yellow-brown quartz. Calcareous aggregate not determined. Kiln-fuel particles not found. Hair or fibre reinforcement not present.

Preliminary Tests.

Dry sample. Generally carbonated (phenolphthalein carbonation test).
Apparent water permeability moderate/low (water droplet absorption on dried surface).
Moderate effervescence on addition of dilute (10%) hydrochloric acid.

Chemical Dissolution Analysis (% dry mass) to BS4551:2005+A2:2013 (+ICP-OES).

%	Initial Moisture (oven @ 40^0C)	0.74
%	Total Calcium as CaO (titrimetric method)	13.0
%	Total Magnesium as MgO (ICP-OES method)	0.202
%	Acid & alkali soluble Silicon as SiO_2 (gravimetric method)	3.58
%	Soluble Aluminium as Al_2O_3 (ICP-OES method)	1.71
%	Soluble Iron as Fe_2O_3 (ICP-OES method)	0.79
%	Total (acid-soluble) sulphate as SO_3 (gravimetric method)	0.332
%	Total Acid Insolubles	74.1

BINDER

The binder in this sample is generally carbonated Portland cement as confirmed by the soluble silica and alumina test results and the CaO:SiO_2 ratio.

AGGREGATE

Insoluble particle size range: 3.35mm to 63µm (93.8%) : <63µm (6.2%)

The acid-insoluble material principally comprises:

Yellow-brown quartz
Occasional particles of flint and other geological types.
Pale grey-brown fines – principally clay and silt.

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MORTAR BY VOLUME

Acid-soluble calcareous aggregate particles were not determined to be present and an allowance has therefore not been made. The results, adjusted for typical bulk density, indicate a calculated volumetric mix of **approximately:**

1 part	Portland cement
3 to 4 parts	Aggregate.

COMPARATIVE HYDRAULICITY

The hydraulicity determined is more hydraulic than modern NHL5.

SUGGESTED MATCHING MIX

This is not a specification for a repair mortar, nor must it be treated as one.

If this material is to be matched on a 'like-for-like' basis, the following approximate volumetric matching mix recipe might be helpful. This does not necessarily imply that we recommend a 'like-for-like' repair mortar mix design in this particular situation, as there are many relevant factors in addition to mortar analysis that must be taken into account.

1 part	Portland cement*
3.5 to 4 parts	Yellow-brown quartz sand <3.35mm

***Note:** This suggested matching-mix would only be appropriate for small patch-repairs. It is widely agreed that Portland cement-based mortars, plasters and renders are not appropriate for repairs to traditional buildings where permeability is important.

SOURCES OF MATERIALS

Many limes, sands, stonedusts and aggregates are available from **Rose of Jericho.**

NOTES:

1. Sample mixes must always be prepared to ensure suitability and an accurate colour and texture match.
2. Sands and aggregates conforming to the relevant British/European Standard and with a particle size and grading appropriate for the intended use must be selected.
3. Manufacturers advice should be sought and recommended application mix proportions and 'Best Practice' guides must be complied with.
4. It should be remembered that mortars change over time. When analysing an aged material, one is ascertaining what it now is and looking for evidence for what it originally was. Calcium hydroxide carbonates to form calcium carbonate, and calcium silicate hydrate (C-S-H), the principal reaction product in hydraulic limes and pozzolanic limes itself reacts over time with carbonic acid to produce calcium carbonate and hydrous siliceous, aluminate and silico-aluminate gels.

Peter Ellis FSA
29.11.2023

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PHOTOGRAPHIC IMAGES OF SAMPLE & INSOLUBLE RESIDUES

5687 sample as tested.

5687 Insolubles >63µm
Stereomicroscope x10

5687 Insoluble fines <63µm
Stereomicroscope x20