

Mortar Analysis

Test Report No. 5961.

St Mary Magdalene, Stockland Bristol.

Bedding/core mortar.

Sample as received.

A sample (70.4g) of bedding/core mortar collected from the north wall of the North Aisle has been analysed chemically and microscopically. This sample is presumed to date from the rebuilding of the Church in 1865.

Sample Assessment and Microscopic Observations.

Intact cream-grey mortar fragments. Moderate strength (fragments could be broken by hand and partially crumbled in fingers with some difficulty; disrupted using pestle with moderate ease). Aggregate is principally reddish-brown quartz and limestone with much black kiln fuel ash (apparently charcoal). Nodules of under-burnt/unmixed lime noted. Hair or fibre reinforcement not present.

Preliminary Tests.

Dry sample. Fully carbonated (phenolphthalein carbonation test).
Calcareous aggregate (limestone) positively determined.
Apparent water permeability moderate/high (water droplet absorption on dried surface).
Vigorous effervescence on addition of dilute (10%) hydrochloric acid.

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

%	Initial Moisture (oven @ 100°C)	1.44
%	Total Calcium as CaO (titrimetric method)	28.3
%	Total Magnesium as MgO (ICP-OES method)	0.59
%	Acid & alkali soluble Silicon as SiO ₂ (gravimetric method)	2.62
%	Soluble Aluminium as Al ₂ O ₃ (ICP-OES method)	0.82
%	Soluble Iron as Fe ₂ O ₃ (ICP-OES method)	0.64
%	Total (acid-soluble) sulphate as SO ₃ (gravimetric method)	1.17
%	Total Acid Insolubles	39.2

BINDER

The binder in this sample is carbonated lime. Hydraulicity of mortar is confirmed by the soluble silica and aluminium test results. The sulphate is somewhat elevated and associated with the kiln ash and does not indicate that gypsum was a deliberate mix component. The lime source is very likely to be the local lias limestone.

AGGREGATE

Insoluble particle size range: 8mm to 63µm (90.7%) : <63µm (9.3%)

The acid-insoluble material principally comprises:

Reddish-brown quartz

Occasional particles of other geological types.

Black kiln-fuel ash particles (apparently charcoal)

Dark brown fines – principally clay, silt, quartz and powdered kiln ash.

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MORTAR BY VOLUME

Acid-soluble calcareous aggregate particles (limestone) were positively determined to be present and an allowance has therefore been made. The results, adjusted for typical bulk density, indicate a volumetric mix of **approximately**:

1 part	Lime (putty/hydrated)
2.5 parts	Aggregate

Note: If this mortar was produced by using the 'hot-mix' method the proportions would have been approximately 1 part hydraulic quicklime : 4 to 4.5 parts aggregate.

COMPARATIVE HYDRAULICITY

The hydraulicity determined is approximately equivalent to modern NHL2.

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	Natural Hydraulic Lime
1.25 parts	Reddish-brown quartz <2.36mm
1.10 parts	Cream limestone aggregate <6mm
0.15 parts	Charcoal 6mm to 1.18mm

***Note:** The grade of binder specified should be determined by the masonry condition and porosity, site/elevation exposure, and the nature of the proposed works.

SOURCES OF MATERIALS

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

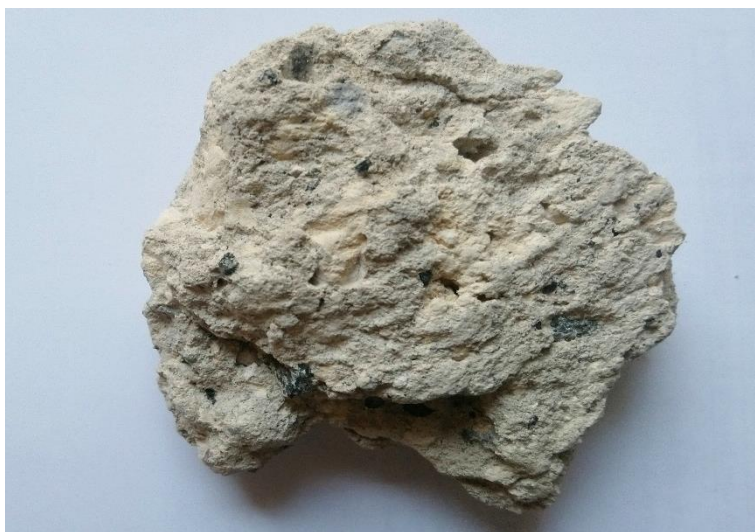
NOTES:

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. Mortars change over time. When analysing an aged material, one is determining 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
20.01.2025

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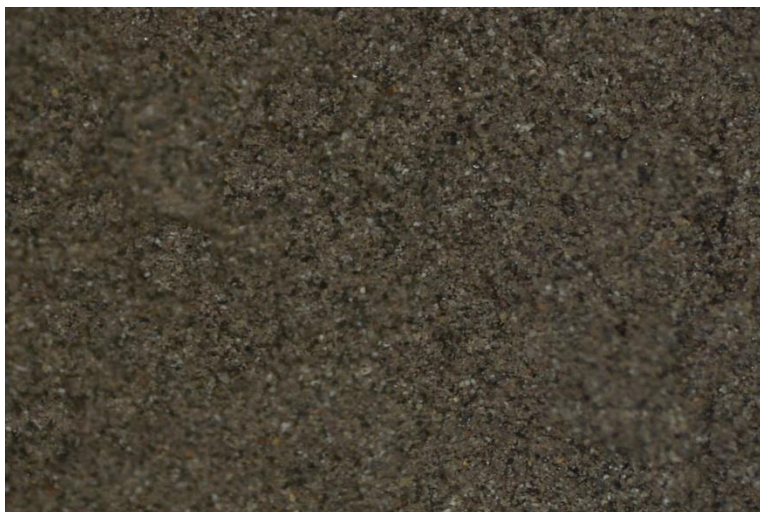
IMAGES OF SAMPLE & INSOLUBLE RESIDUES



5961 sample as received.



5961 Insolubles >63 μ m
Stereomicroscope x10



5961 Insoluble fines <63 μ m
Stereomicroscope x20