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CONSERVATION

Research and conservation of historic decorative schemes in the built environment

Almshouse
Stydd, Ribchester
Render, mortar & paint analysis

Client: Halsall Lloyd Partnership

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1.0: Introduction

i) Lincoln Conservation was commissioned by Halsall Lloyd Partnership to analyse 1no. external render sample (north east facing gable) and 2no. plaster samples removed from the interior bedroom and living room (1no. from each) of flat 4 at Ribchester Almshouse. Further analysis was carried on the paints applied to the external render and interior plasters.

Site address

The Almshouse,
Stydd Lane
Ribchester
Preston PR3 3YQ

Figure 1: Images of the Almshouse

Flat 4 bounded in red

North east gable

ii) The building is listed grade II* (HE list entry no.1308488) and founded under the will of John Shireburne, who died in 1726[1]

iii) A plaque on the wall outside dates the building to c1740 and states it was re-furbished in 1990.

2.0: Executive Summary

i) The samples were obtained with a view to understanding the composition of the render and plasters. In order to achieve this, aggregate and binder portions were physically separated and then analysed by powder X-ray diffractometry (PXRD). The resulting diffraction patterns were cross-referenced against a database in order to determine the dominant and minor phases present.

ii) This report will define the type of render and plaster used, provide an indication of the mix ratios and in the case of the render the aggregate size.

iii) Physically, the render is a dark, extremely hard and inflexible material, which was noted when the sample was removed. The render has surface pebble dashing. The analysis indicates the render is a Portland Cement with a mix ratio of approx. 3 parts sand to 1 part cement, with a fine aggregate grain size of ≤0.5mm, probably applied at the time of the 1990 restoration.

iv) Both internal plasters are gypsum based (calcium sulphate) and again likely applied at the time of the 1990 restoration. It is unclear if they are plasterboard or trowelled.

v) There are two, possibly three coatings of a modern alkyd (plastic) masonry paint applied to the render. This paint coupled with the hard impervious nature of the underlying cement has created a layer completely lacking vapour permeability, trapping moisture in the underlying brickwork.

vi) The paints used on the internal plaster are also modern alkyds, likely applied post 1990.

[1] English Heritage listing notice, available on line

2.0: Method

2.1: Plaster & Render

i) The aggregate and binder material from each sample was physically separated and analysed by powder x-ray diffraction (PXRD) and under an optical microscope. The resulting diffraction patterns were cross-referenced against a database in order to determine the dominant and minor mineral phases present.

ii) Each sample was ground separately by hand to an even powder. A portion of the powder (~5g) was sieved, initially through a 1.7mm sieve to remove any unbroken mortar and then through 0.140 mm and 0.045 mm sieves respectively. For the purposes of PXRD analysis that fraction of the sample which was retained by the 0.140 mm sieve was designated aggregate whilst that fraction passing through the 0.045 mm sieve was determined to be binder. For the determination of aggregate and binder masses, that fraction which was > 0.045mm was designated aggregate whilst material < 0.045 mm was determined to be binder.

Both binder and aggregate were imaged using a Discover.V8 light stereo microscope (ZEISS) at x40 magnification. The sieved aggregate/ binder fractions were then analysed by powder X-Ray diffraction. *X*-Ray diffraction data were collected with a Bruker D8 Discover operating in parallel beam geometry collimated to 2 mm beam with Cu-Kα radiation (λ = 1.5406 Å). Data were initially collected from three separate sample sites with coupled θ-2θ scans in the 2θ-range 10-60° with dwell time of 0.5s for each 0.04° increment. The data collection was then repeated using θ-2θ scans in the 2θ-range 10-60° with dwell time of 1s for each 0.02° increment in an attempt to increase the peaks present. Data were merged for analysis.

Sample 1: External Render
Sample 2: Wall plaster (sitting room)
Sample 3: Wall plaster (bedroom)

2.2: Paint

i) Samples were mounted in casting resin and examined in cross section under an optical microscope at X100 magnification. The samples were illuminated using both reflected and ultra-violet light to determine the number of layers applied and the type of paint used. Annotated images of the paint cross sections are included within the body of this report.

3.0: Results

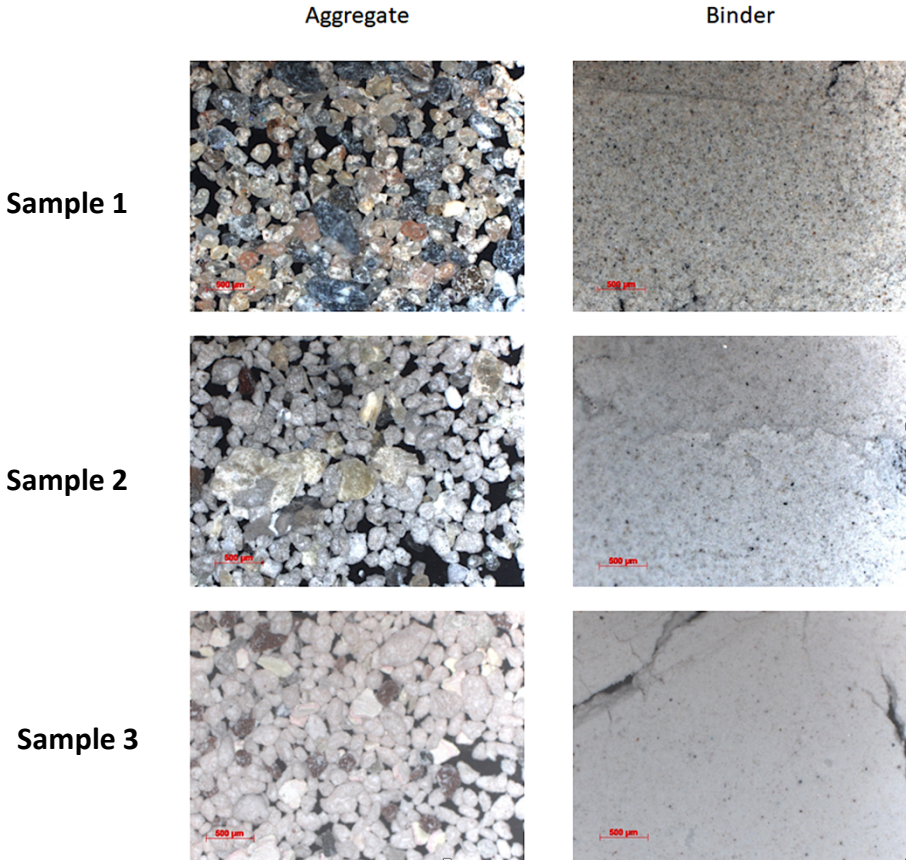
General Observations and aggregate:binder ratios

ii) Visual inspection of the aggregate fractions revealed sample 1 to be distinct in possessing a coloured aggregate typical of sand with fine grains observed (typically < 0.5mm). The aggregates of samples 2 & 3 were visually similar comprising of white/ grey fine grains (again typically < 0.5mm). The binder fractions were all off-white powders with dark specks interspersed throughout. Micrographs of each aggregate and binder sample are shown below in Figure 2. The aggregate: binder ratio of sample 1 was also distinct with a ratio of ~3:1 (aggregate:binder) observed for this sample compared to ~0.5:1 for samples 2 & 3 (Table 1).

Table 1: Indicative aggregate:binder ratios for each mortar sample by weight and volume

Sample	Aggregate		Binder		Aggregate:Binder		Aggregate Grain Size
	(g)	(cm^3)	(g)	(cm^3)	By weight	By volume	(mm)
1	3.31	2.76	1.27	0.97	2.6:1	2.9:1	≤0.5
2	1.37	1.14	3.50	2.67	0.4:1	0.4:1	≤0.5
3	1.85	1.54	2.91	2.22	0.6:1	0.7:1	≤0.5

Figure 2: Microscope images for aggregate and binder



3.1: Mortar Mineralogy

The results from the powder X-ray diffraction analysis are summarised in Table 2. The findings are summarised for each sample in turn below.

Sample 1 Aggregate
Quartz was the dominant phase present with calcite present as a minor phase.

Sample 1 Binder
Again quartz was the dominant phase with calcite also present as a major phase. Gypsum was detected as a minor phase with possible presence of alite and larnite also identified.

Sample 1 Summary
The presence of calcite along with the possible identification of hydrated silicates taken together with the visual observation of the sample indicates that the mortar is most likely an **Ordinary Portland Cement** (OPC).

Sample 2 Aggregate
Gypsum was the dominant phase with quartz present as a minor phase.

Sample 2 Binder
As per the aggregate.

Sample 2 Summary
The sample did not appear to be a lime/ cement mortar. The dominant presence of gypsum and to a lesser extent quartz indicates the sample is a **gypsum plaster**.

Sample 3 Aggregate
Gypsum was the dominant phase with quartz present as a trace phase.

Sample 3 Binder
As per the aggregate.

Sample 3 Summary
As for sample 2. Again, the dominance of gypsum and quartz indicates that the sample is a **gypsum plaster.**

Table 2: Mineral phases present

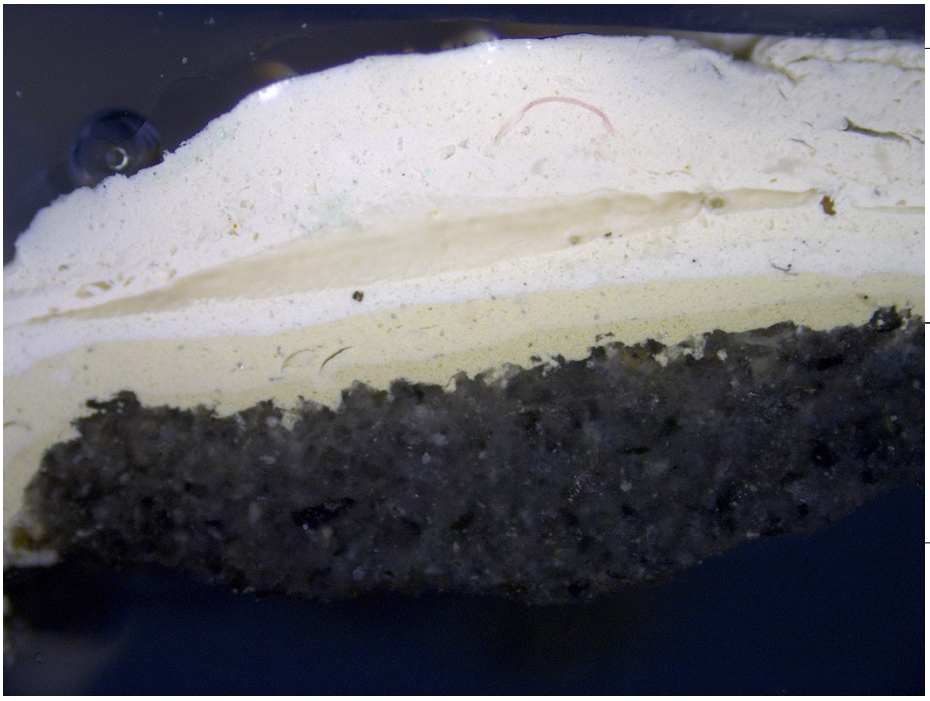
Sample	Fraction	Calcite	Quartz	Alite	Larnite	Tricalcium aluminate	Gypsum	Jennite	Tobermorite	Suolunite	Cristobalite	
BLPr_00102_001	Aggregate	+++	+++++									
	Binder	++++	+++++	+	+		+++					
BLPr_00102_002	Aggregate		+++				+++++					
	Binder		+++				+++++					
BLPr_00102_003	Aggregate		++				+++++					
	Binder		++				+++++					

+++++ dominant
++++ major
+++minor

++ trace
+ possible

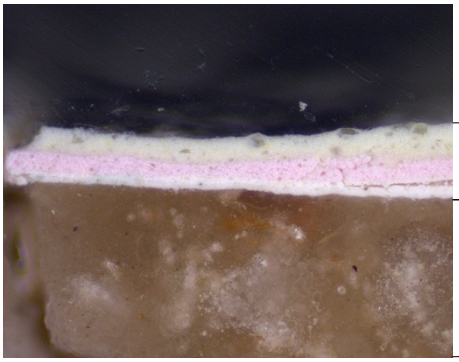
4.0: Paint Cross Sections

4.1: External Render

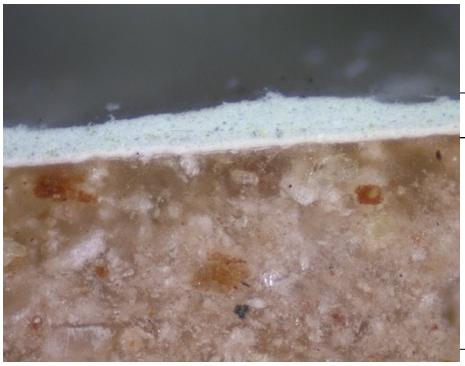


4.2 Interior plaster

Bedroom



Sitting Room



HISTORIC MATERIALS ANALYSIS

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