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Ancient Monuments Laboratory
Report 164/87

ANALYSIS OF FOUR MORTAR SAMPLES FROM DARBY OLD FURNACE, IRONBRIDGE (SAM 345).

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Summary

Analysis of four samples from the Darby Old furnace showed them to be highly variable. Such variation in a relatively small structure suggests accidental formation.

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ANALYSIS OF FOUR MORTAR SAMPLES FROM DARBY OLD FURNACE, IRONBRIDGE, (SAM 345).

Analysis of mortar, concretes and plasters does not give absolute dating evidence. No period, apart possibly from Roman military material, used a unique recipe. The gravel:sand:lime ratios employed for various building tasks in the past were much the same as those used today. At best, analysis can only relative dating evidence, ie which walls are likely to be contemporary with each other. Even here interpretation usually depends on the use of sand, gravel, etc having quite distinct characteristics.

Chemical analysis will provide two basic pieces of information. First it will provide the weight of acid-insoluble aggregate and secondly the amount of lime probably used in the original mixture. Additional information may be obtained by seiving the insoluble aggregate. The particle-size distribution can be diagnostic and may also provide help in recognising geological sources of aggregate. Examination of the sample before and after analysis may provide information about the preparative practices of the builders, ie whether the sand was seived, washed, etc proir to use.

Microscopic examination of the seived material may give useful data as it is possible to assess the shape of the quartz grains and the quantity (and nature) of non-quartz inclusions.

Certain problems must be borne in mind when carrying out analyses. For instance the use of shell or chalk/limestone aggregate can give rise to misleading data as these will disappear in the acid treatment phase. This can be overcome to some extent by careful visual examination of the sample prior to the chemical analysis. The use of secondary aggregates such as crushed tile or building stone can also give rise to anomalous data especially in the size and character of the finer fractions. Additionally one assumes that the mixing process prior to building was reasonably thorough and thus the final products were relatively homogeneous. In practice, however. this may not always have been the case. Secondary building processes such as re-pointing can also give rise to anomalies.

ANALYSIS:

Four samples were submitted for analysis. 1,2 and 4 were in good condition and showed little or no leaching out of calcium salts. Sample 3 contained several voids which could have been caused by leaching, but were more reminiscent of air voids produced by inferior application. No sample contained any shell or similar material.

The samples were first dried at 110°C to a constant weight. 25 g of each sample was then treated with dilute hydrochloric acid to remove acid-soluble aggregate (mainly carbonates) and thus reduce the sample to its insoluble aggregate. This aggregate was filtered off, thoroughly washed and dried to a constant weight. It was then passed through a series of standard sieves and the various quantities retained noted. In order to enable inter-sample comparisons to be made, the raw data were converted into percentages of the total insoluble aggregate. All analyses were carried out in duplicate and mean values used for comparisons.

Examination of the aggregates indicated that the larger materials (ie 1.00mm) in all samples were composed of slag, broken tile/brick and daub/burnt clay. One or two fragments of coal were also noted. The finer aggregates were similarly composed with the addition of sub-angular quartz. Additionally, a quantity of a fine white material was noted that appeared to be very similar to the ash obtained from burning coal.

It can be seen from the aggregate-size distribution curves that the four samples have little in common. Such variations could suggest four distinct phases of building or repair, but in view of the care taken to avoid re-pointing material when the samples were taken, this seems unlikely.

At the time of writing, two possible explanations suggest themselves. One, the mortars were very badly mixed, which seems unlikely in light of the nature of the structure where such poor quality work could lead to a major catastrophe. Secondly, the mortars were not formally mixed ie they are accidental concretions. The nature of the aggregate is indicative of waste material, probably crushed slag and ash. It seems possible that fragments of slag, coal and ash etc have been swept into gaps in the floor structure and have subsequently become wet or damp. The calcium oxide in the ash phase has consequently hydrated to calcium hydroxide which in turn has reacted with atmospheric carbon dioxide to produce calcium carbonate and thus a 'set mortar'.

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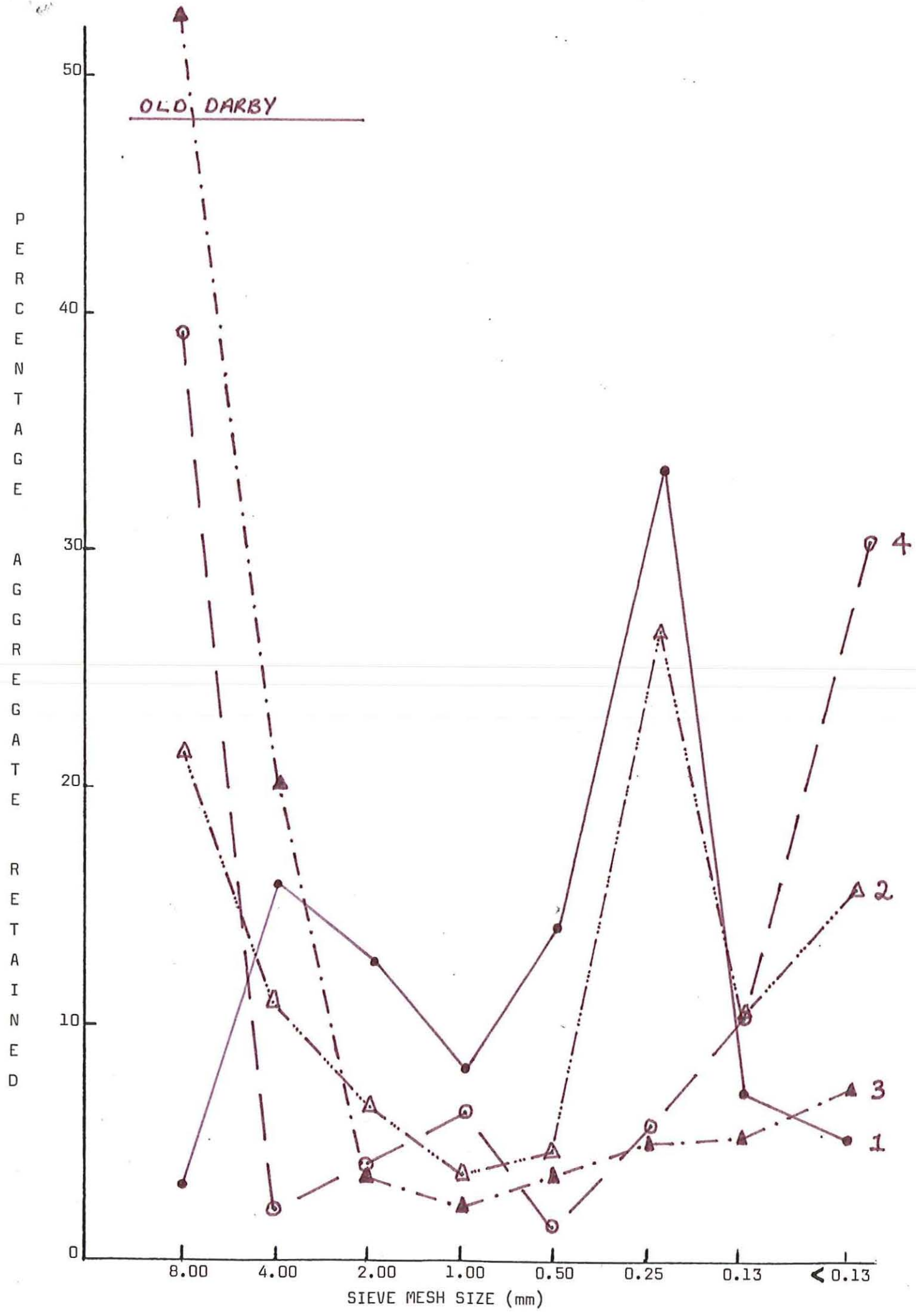
OLD DARBY
PERCENTAGE AGGREGATE RETAINED
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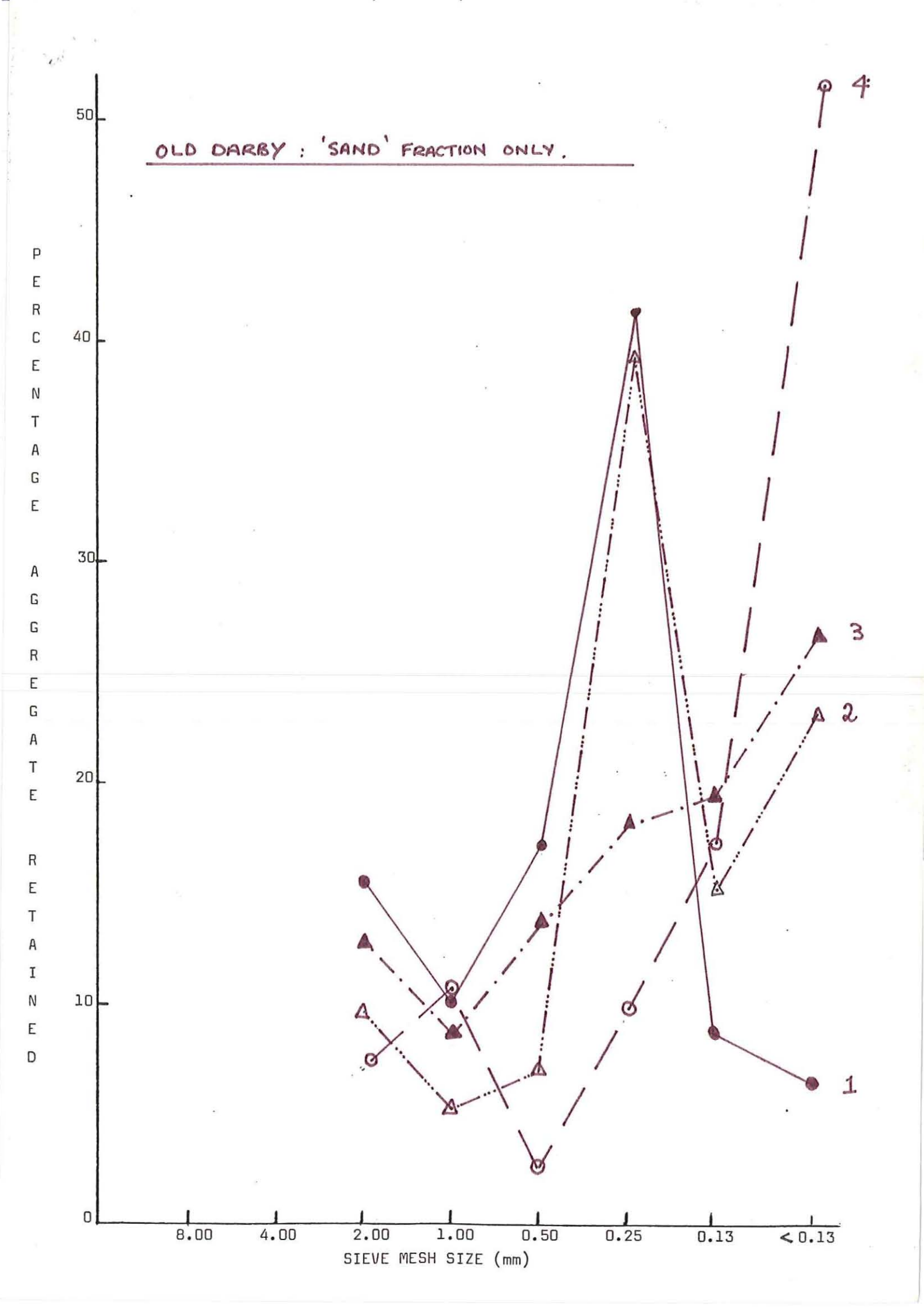
40
30
20
10
0
8.00
4.00
2.00
1.00
0.50
0.25
0.13
< 0.13
SIEVE MESH SIZE (mm)
1
2
3
4


OLD DARBY : 'SAND' FRACTION ONLY.
PERCENTAGE AGGREGATE RETAINED
50
40
30
20
10
0
8.00
4.00
2.00
1.00
0.50
0.25
0.13
< 0.13
SIEVE MESH SIZE (mm)
1
2
3
4