Ancient Monuments Laboratory Report 7/95

A STUDY OF THE PROPERTIES OF A PROPOSED ALTERNATIVE TO BUCKLAND SAND FOR SITE BURIAL

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Summary

This report outlines the results of tests for an alternative to Buckland sand for use in reburying archaeological sites. Particle size characteristics, soluble salts and iron coatings are all measured for both the Buckland sand, and the suggested alternative (Bucbricks). Although precise suitability limits for these parameters have never been set, the suggested alternative is recommended in view of its close similarity to Buckland sand in all three tests.

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1. Introduction

Buckland sand is a very high quality silica-sand that has been in use for some years as a covering when archaeological sites are being re-buried. It was used for the Huggin Hill Baths and Rose Theatre, and is now regularly specified for backfilling after test-pitting or keyhole excavations such as those at Bermondsey Abbey and the Roman Governor's Palace in London. Typically, the sand is placed on top of a geotextile such as 'Terram' to provide an inert filler with minimal detrimental properties for the underlying stratigraphy.

Although Buckland sand's high quality is not in question, it is expensive and cheaper alternatives may well exist. A possible candidate for this purpose has been identified by the London Division and offered to the Ancient Monuments Laboratory for testing. This report describes the rationale, methods and results of those tests.

2. Sand Details

Buckland Sand

Buckland sand is produced by:-

Buckland Sand and Silica Ltd.,
Trottiscliff Rd.,
Addington,
Kent.

English Heritage is currently using Buckland W60, from the Lower Cretaceous Folkestone Beds at TQ 652594.

Bucbricks Sands

The suggested alternatives are produced by:-

Bucbricks Co. Ltd.,
Martell's Pit,
Slough Lane,

Ardleigh,
Nr. Colchester,
Essex CO7 7RU

Bucbricks sand is extracted from the Pleistocene Kesgrave Sands and Gravels (Bridgland 1988a; 1988b). The grades offerred for testing consist of sharp, medium and soft.

3. The Qualities Needed For Reburial Sands

The purpose of re-burial is to minimise change in the underlying stratigraphy. To this end, the backfill must provide an inert covering which protects the stratigraphy from impact, does not introduce new salts, and is of fine enough particle size to fill all the cracks while porous enough to allow previous groundwater movements to continue (Ellen Barnes pers. comm.). It should therefore have:-

1) A high proportion of medium and fine sand-sized particles (2mm - 63μm).

2) A low proportion of silt and clay particles (<63 μm).

3) A minimal content of compounds capable of dissolving and re-precipitating under normal environmental conditions.

4. Analytical Details

4.1 Particle size analyses

The three Bucbricks samples were first compared to Buckland W60 by particle size analysis. The method used was a combination of sieves for the coarse fraction (>63um) and a Sedigraph 5000ET for the fine fraction (<63um). In practice, these sands contain very little fine material, so it is only the sieve results that are significant (see Canti (1991) for further details on particle size analysis).

Figure 1 shows the results of testing the three Bucbricks alternatives and the Buckland W60 sand. The very high sorting of the Buckland sand (large percentage of the bulk within small size limits or steepness of the curve) is striking, and none of the Bucbricks samples can match it. However, there is little obvious reason why such extreme sorting should be important for archaeological re-burial, except in so far as it implies a low proportion of fine material. A low clay content is also important to achieve chemical inertness, owing to the exceptionally high cation exchange capacity of clays relative to quartz grains. On this score, the Bucbricks medium and sharp compare well with the Buckland sand. In fact, they are indistinguishable from it within the resolution power of the analysis.

In general, until precise particle size limits are set, it is probably advisable to choose the sample that most closely mirrors Buckland's characteristics. It is certainly necessary to minimise the silt and fine sand content of the burial sand. These smaller particles drain more slowly and would be less easily removed in a possible future excavation. For these reasons, of the Bucbricks samples, only the medium sand is tested in the remainder of this report.

4.2 Iron content

Iron may cause problems in a re-burial medium because of its tendency to go into solution under reducing conditions, move with the groundwater, and then re-precipitate when it meets a more oxidized layer. If that layer is the archaeology, important remains will get coated with red iron oxides. This is unsightly and can lead to damage. The iron available for dissolution is found as a coating of insoluble (ferric) salts on the individual sand grains. It can be extracted with a strong reducing agent, (converting it to soluble ferrous salts) and then measured as a concentration in solution. Methods typically use a sodium dithionite-citrate system, with bicarbonate or citric acid (Carter 1994; Jackson 1969). This approach is widely recommended to quantify the iron coatings on grains whilst leaving the iron bound in lattices (e.g. in silicates) unaffected.

The following procedure was carried out on the Buckland W60 and the Bucbricks medium sand:-

20.00 g Sand
5.00 g Sodium dithionite $Na_2S_2O_4$
8.80 g Trisodium citrate $Na_3C_6H_5O_7.2H_2O$
2.10 g Citric acid $C(OH)(COOH)(CH_2.COOH)_2.H_2O$
200 ml Distilled water

The above mixture was allowed to stand for 24 hours with occasional stirring. The supernatant liquid was decanted and the iron content determined against a blank by inductively coupled plasma spectrometry. For comparison with common sands, four samples of commercial building sands were washed on a 250 μm sieve and then tested in the same way.

Results

Sand Type	Total Iron (mg/l)
Homebase	758
Flixborough	578
Lane and Wenden	564
Building Sand	379
Bucbricks	63.3
Buckland W60	57.3
(Blank	0.24)

4.3 Solubles content

Numerous soluble salts could be present in commercial sands but, so long as non-marine material is bought, they will be present in only minute amounts. Building sands have to be more-or-less salt-free for work with cement. In addition, the particle size requirements for re-burial ensure that only sands wet-sieved at the quarry will be suitable - a procedure which removes the rapidly soluble materials.

In practice, only calcium carbonate is a slight risk because of its slow solubility. Using a calcareous sand for re-burial would have the effect of gently enriching the leachate with

$CaCO_3$ promoting bacterial decomposition of organic remains.

For the purposes of this test, the solubles (mainly calcium carbonate) can conveniently be dissolved in a weak solution of acid, and the overall weight loss measured. The following procedure was carried out on all the samples:-

20g sand
200 ml of 2% HCl

The above mixture was left for 10 minutes, then washed on filter paper until acid-free, dried and re-weighed.

Results

Sand Type	Weight	% Acid-soluble
Flixborough	19.778	1.110%
Homebase	19.763	1.185%
Lane and Wenden	19.964	0.180%
Bucbricks	19.967	0.165%
Building Sand	19.970	0.150%
Buckland W60	19.998	0.010%

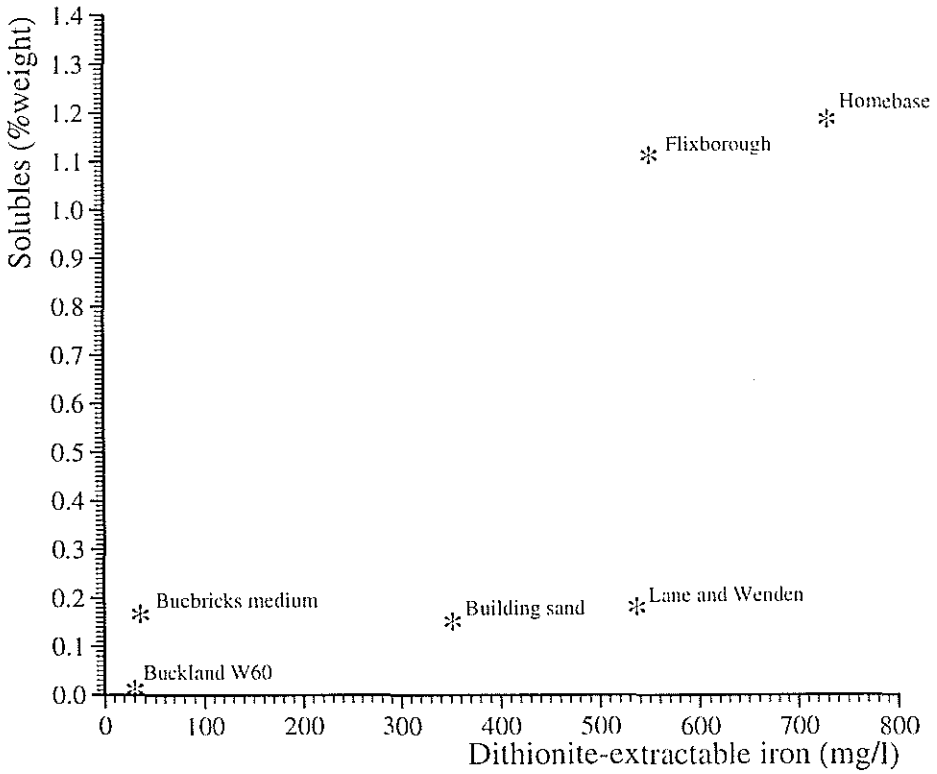

Figure 2. Scattergram to show iron and solubles contents of the tested samples.

5. Discussion

The results from the tests for iron and other solubles are shown on Figure 2. Four of the sands are very low in solubles (less than 0.2%) but only two are also very low in iron (less than 100mg per litre of the reducing solution). These two are the target samples from Bucklands and Bucbricks.

No absolute limits have been set for suitability of sands for use in re-burial of archaeological sites. There are complicating factors in the analyses (e.g. the effect of sand surface area on iron content) which need to be considered if limits are to be set for future testing. These and other issues will form part of a future research project utilising the existing test format and the sand collection built up by Architectural Conservation Branch.

For the moment, purely by comparison with Buckland sand, it seems clear that the Bucbricks product will make a good alternative, if money can be saved by using it.

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