Stone Replacement

Problems of Stone Replacement in Building Restoration.

Although chemical preservation may be an answer to many problems of stone replacement, severe damage can be caused by incorrect procedures. Silicone waterproofing at Saint Paul's College, Sydney University, has caused exfoliation; the original surface is dark and the light-coloured areas reveal loss of surface of the Sydney sandstone.

Decayed masonry in old buildings and monuments is perhaps the most common reason for undertaking restoration as it may render the building unsightly or detract from its architectural form, reduce its function (for example the walls may not be weathertight), be a minor hazard (as detached fragments fall from cornices) or be sufficiently advanced to cause structural unsoundness.

Some building materials can be comparatively simply repaired or replaced (for example, artificial materials such as brick, concrete, mortar, plaster or render, or natural materials, such as timber) but substantial aesthetic and practical problems are faced in the restoration of decayed stone.

The common forms of treatment are: redressing, repair, reversal, replacement (including veneering) and chemical preservation.
Redressing

Loose fragments and decayed crumbling material are removed, cornices, mouldings etc. are re-profiled. This is an apparently simple process which, however, requires considerable skills by the mason and which, in most cases, will be of temporary benefit as accelerated decay may follow the removal of a hardened protective surface. Redressed sandstone in St Andrews Cathedral Sydney, showed advanced new decay in less than two years after redressing.

Repair

Loose material is removed or fixed in position, cracks are filled, and structural supports provided if required. Repair may be achieved by inserting shaped stone indents but use is generally made of plastic synthetic stone which hardens on exposure. Most such materials consist of an inorganic filler (sand or crushed stone) with cement (Portland cement, white oxychloride etc.) or a polymer. Synthetic patching in Australia has a poor record of success. Problems arise from mismatches in colour or texture, cracking or crazing within the synthetic, loss of adhesion between the synthetic and substrate, and reaction giving accelerated decay of the stone. The recommendations given in the United Kingdom Building Research Station Digest No. 21, although 30 years old, are still basically sound.

2 Bad modern technique in laying stone, Pilgrim Church, Adelaide.
Some examples of failures include the polymer-composite resurfacing on the Melbourne Club, Collins Street, the Treasury Buildings in Brisbane and Melbourne, and the joint repair at Newman College, Melbourne. Poor cement patching is prominent at the Old Law Building, Melbourne University, the Supreme Court, Melbourne, Adelaide Town Hall and countless other buildings.

Reversal

Individual blocks may be reversed to present a fresh unweathered (previously the back) surface. This procedure may be satisfactory if the units are symmetrical (e.g., the sandstock bricks of the Hyde Park Barracks in Sydney and the limestone random rubble at the Mounted Police Barracks, Adelaide) but difficulty is encountered with many stone blocks whose rear surface differs in mode of dressing, shape or colour.

3 Mismatch between light-coloured replacement-sandstone and highly soiled original; the contrast is reduced on cleaning.

Replacement

Individual blocks are replaced with fresh natural stone.

Veneering, or the application of a thin unit of fresh material is the most common form of replacement. The slab, 10 to 20 cm in thickness, applied to give a new surface, may be of new stone or of a split block from the building. It may be applied to the dressed-back old stone or to a newly placed brick (or stone) backing. The plinth on the Adelaide Town Hall is a successful example; that on the Metcalfe Bond, at The Rocks in Sydney, is less so.
A mismatch between original brown sandstone (upper) and light-coloured NSW sandstone (lower) at the 1847 Magistrates Court, Adelaide. The new stone had begun to decay within 10 years.

The quarries used for the sandstone of Nineteenth Century Buildings in Melbourne (namely, the Grampians sandstone from Stawell, the Darley and Bald Hill sandstones from Bacchus Marsh, the Lauriston sandstone from Kyneton and the Barrabool sandstone from Geelong) are all understood to be inoperative. However, Mr Peter Staughton, has found an alternative source for sandstone, similar to the Barrabool, and it is understood that the Stawell quarries could be reopened if the size of the restoration task warranted it.

Synthetic Replacement

Blocks of stone are replaced with synthetic material of similar appearance. Although common abroad, the only Australian example known to the author is that of the crenelations in Tasmanian sandstone on the 1856 Law Quadrangle (Melbourne University) which were replaced in 1930 by cast concrete of similar appearance. Difficulties encountered with cracking and crazing may be reduced by the use of appropriate additives and correct grading of the aggregate or by using proprietary compounds such as the German produced 'Mineros'.
For example, the problem of incompatibility between new and old stone of the same type is commonly not recognised. The Classic type of incompatibility occurs between limestone and sandstone where gypsum from limestone which has been attacked by atmospheric sulphur dioxide, migrates into sandstone and causes decay. Incompatibility during replacement occurs where the new stone has a higher suction (greater microporosity) than the adjacent old stone and hence, draws in moisture plus salts and suffers accelerated salt decay. Replacement sandstone commonly requires to be sealed off from adjacent decayed sandstone or limestone; a bitumen emulsion was used for this purpose at Scots' Church, Melbourne, and moisture-barriers such as polythene membranes may also be useful.

Obtaining supplies of appropriate stone for restoration is becoming increasingly difficult. If the new material is to resemble the old as closely as possible (for aesthetic, practical and historical reasons) then the following sources may be listed in order of decreasing desirability:

(i) Stone recovered from another part of the same building.
(ii) Identical stone from a demolished building.
(iii) Restoration-stone stockpiles.
(iv) New stone from the original quarry.
(v) New stone of similar lithology from a related quarry.
(vi) New, somewhat similar, stone from an unrelated quarry.

Selected stone from the same building (using blocks or material sliced into veneer, derived from internal plastered walls or from sections to be demolished for some reason), if in sound condition, may match the original in colour, texture, patina, mode of dressing and weathering characteristics. Similar stone from another building constructed of the same stone at about the same time may also produce a good match although differences in block-size or dressing may require redressing. However, the likelihood that an appropriate old building be demolished at the appropriate time is rather unlikely and there is a very good case for responsible authorities building up restoration stone stockpiles for future use as appropriate buildings are demolished.

The difficulty in obtaining stone from old quarries is mainly due to their having been over-run by urban sprawl. The sources of the most (historically) important building stones in Adelaide are no longer available (the Adelaide Limestone quarry closed in 1853; the Tea Tree Gully and Glen Ewin sandstone quarries which operated in the last century are now within the settled outer urban fringes, and the Tapley Hill Slate quarries are covered by a highway and by housing developments). The situation is similar in Sydney, as the quarries at Pyrmont ceased to operate years ago and those at Maroubra, Paddington, Hornsby, Asquith, Pymble, Somersby and Gosford have all closed since the 1960's.

The Bondi quarry is virtually inoperable because of the close proximity of housing and considerable pressure has been necessary to reopen the Wondabyne quarry recently to produce high grade stone (although even this is variable in quality).
Replacement is widely accepted as a desirable form of conservation although it should be noted that the Australian ICOMOS definition of restoration virtually precludes the use of new material. If the role of conservation is to retain the historically valid fabric then replacement of old stone by new is seldom the best course. Disadvantages include the problem of selecting and obtaining appropriate new stone with resultant mismatch in colour, texture or form, the loss of original authentic fabric and the risk of damage to adjacent masonry during removal and replacement.

The fundamental principle in the selection of stone for replacement in restoration, is that it should resemble the material it replaces as closely as possible. The major types of mismatch relate to colour, texture, block-size and shape, manner of dressing, durability, weathering characteristics, and laying technique (Figs 2,3,4).

Mismatch in colour is aesthetically the most offensive problem. Examples are innumerable; they include the replacement at Sydney University of old brown Pyrmont Sandstone by new grey Wondabyne Sandstone; at the Adelaide Magistrates Court of brown Finniss Sandstone by new, yellow Sydney Sandstone; at Parliament House Melbourne of brown Stawell Sandstone by pale Gosford Sandstone.

It is commonly assumed that such a mismatch will disappear in time as a patina develops, but this is rarely so. The mismatch at the Adelaide Magistrates Court is still as pronounced as ever after a decade.

The old and new stone should have a similar durability. If the new is more durable than the old, a mismatch will develop in time, however, this seems not to be a common problem and the main difficulty arises either, where the old stone is of known low durability, or the replacement stone is less durable than the original.

Stone replacement in buildings constructed of Barrabool Sandstone which has known low durability and poor performance (e.g., in the Geelong Customs House, and in Scots Church and Newman College, Melbourne) presents a problem. Correct procedure would require that genuine Barrabool Sandstone be used for replacement but in today's polluted atmospheres, the life of the new stone may be only a few decades. The question must be asked: is it better to use a matching genuine stone which will surely decay, or a different but more durable stone which will not match? The solution may be in chemical preservation as discussed later.

There are many examples in Australia where inappropriate stone of low-durability has been used in restoration, apparently on the grounds that it was cheaper and more readily available than a better quality or more appropriate material. Most examples involve the use of Sydney Sandstone in the last 20 years and include the following: Martindale Hall, the Adelaide Town Hall, and the Magistrates Court in South Australia; the Supreme Court and Public Library in Melbourne, Port Denison in Sydney, the Supreme Court in Hobart and the Asylum at Port Arthur. In each case the new stone produced an initial mis-match in colour which has increased as the new stone has deteriorated rapidly to become more decayed than the adjacent original (Fig.4).

The selection of stone for replacement is very difficult and is a matter for specialists; it is beyond the competence of most architects and engineers involved in restoration and reconstruction.
Chemical Preservation

Old stone may be preserved by the application of a liquid which penetrates, solidifies and consolidates.\(^3\) Decayed stone is best conserved by retaining the original fabric by preventing its further deterioration. That the rewards for successful preservation are so great as to warrant very serious attention, has been recognised from time immemorial as records of potions extend back for 3000 years\(^4\) and there have been hundreds of formulations devised.

Chemical treatment is intended to preserve and consolidate by increasing cohesion, strength and hardness, reducing porosity, permeability and water absorption and immobilising salts. Consolidants differ from water-proofers or repellents, such as silicone emulsions, mainly in their greater depth of penetration.

Earlier processes (lime wash, waxes, varnishes, barium salts, fluosilicates, alkali silicates etc.) have not been found to be successful, and attention is now being concentrated on three groups: the silicon esters, the alkylalkoxy-silanes \(\text{(silanes)}\) and some polymers. Problems are encountered with obtaining an adequate depth of penetration, with retaining physical compatibility between the impregnated material and the substrate, with costs of raw material and labour, and with toxicity or other difficulties associated with application. The possible application of a consolidant requires preliminary laboratory testing of the stone, and of the consolidants under consideration, to ensure that penetration is adequate, that the properties of the stone are improved and that no damage will be caused by the treatment. Inappropriate application of silicone resins \(\text{(which are not consolidants)}\) at St Paul’s College, Sydney and Martindale Hall, South Australia, has caused extensive spalling of the thin treated surface within a few years \(\text{(Fig.1)}\).

Recent experiments at AMDEL indicate that the silanes improve the properties of decayed stone to a useful extent and field trials have commenced on sandstone and limestone buildings in Sydney, Melbourne and Adelaide.

CONCLUSIONS

Restoration of heritage-type buildings containing decayed stone is not a simple matter and it must not be assumed that replacement is always the best solution. Development of optimum procedures requires the services of skilled and experienced materials scientists to identify the stone, to diagnose the cause of the deterioration, and to identify an appropriate replacement if required. Many examples of restoration over the last two decades in Australia have been unsuccessful because of the mismatch of stone, the use of inappropriate or non-durable stone and the application of inadequate techniques in placing the new material. Current research in Australia into chemical preservation, particularly with the silanes, shows promise.

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NOTES


3. (a) Ibid.
   (b) A. Spry, (1978). Protective coatings on masonry, (In Masonry Walls, National Trust of Aust. NSW), pp 26-33


5. New bricks in the parapet of the reconstructed Old Legislative Council Building, Adelaide, the hard straight lines and overcleaned appearance of much 'restoration'.