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The Palace of Westminster Courtyards Project: Sourcing Stone for Repair and Conservation

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1 Overview

The deterioration of the stonework of the Palace of Westminster is commonly said to be evidence of the generally poor durability of the magnesian limestone. Certainly, it is well recorded that the stonework began to show signs of degradation soon after completion. In order to effect a repair, a study was undertaken to pinpoint potential sources from sites which most closely matched the majority of the fabric, as well as currently commercially available stone. Additionally, durability testing using a variety of methods was carried out to give reassurances of likely future performance of the replacements proposed.

2 Aim

The aim of this work was to identify the provenance of the magnesian limestone used in the construction of the Palace of Westminster courtyards, in order to specify durable stone for repair.

3 Methodologies

Work commenced with study both of documented sources of the stone, and ancillary literature on the processing and handling of this material. It was postulated that the problems historically encountered with the supply of stone, between 1839 and about 1852, may well have resulted in individual elevations utilising building stones from Bolsover Moor, Mansfield Woodhouse or North Anston, possibly with of all three types being present in at least some of the elevations (Lott & Richardson, 1997). Following a site visit, appropriate and sensitive sampling from the façade was undertaken from all seven courtyards, hoping to identify any significant variations in the stone and their distribution. The material collected was analysed petrographically. A two-part project looked at the durability characteristics under a variety of laboratory tests (Laycock et al, 2008). Freeze-thaw testing used a cycle informed by a study of the data from the Meteorological Office. Ten cycles of freezing were carried out over each day from +8 to -10ºC with 2 minutes of simulated rain. Two test walls were constructed, and each wall was tested for 300 freeze/thaw cycles. Additionally, Sodium sulphate crystallisation (EN 12370) and salt decay by capillary rise and evaporation were evaluated.

4 Results

Petrographic analysis indicated that all the stones were originally detrital limestones, formed in a lagoonal environment, which were heavily recrystallised during the dolomitisation process. The area for the replacement stone was narrowed to within approximately 20 kilometres of Anston and potential sources were reviewed. There was no obvious pattern in the use of the stone and apparent mixing of stone types within the fabric does have an advantage when conservation is undertaken. Providing that the replacement material originated in a similar limestone facies to the original stone, and the degree and type of is similar, the most appropriate new stone for the location, within the building, can be selected. Although there were a considerable number of quarries, in the identified area, during the second half of the 19th century, very few now remain. The result of the field studies indicated that Tarmac's quarry at Harrycroft was potentially a suitable source of stone for the repairs and conservation at the Palace of Westminster. The second phase of testing was undertaken using stone from the Cadeby Quarry. Cadeby and Anston stones were shown to be little affected by the principle mechanisms of decay and could both be considered potential sources of replacement stone for the repair and for future conservation.

5 Conclusions

This paper challenges the assumption that magnesian limestone is unsuitable. Historically project management was poor due to the high quantity of stone demanded in a relatively short period within a tight budget, evidenced both from archival sources and by the mixture of stone petrographies identified. This is compounded by distance the stone was brought from and the potential for stone from different extraction areas to be mixed at the various points of loading and unloading. Accepted good practice is to select the appropriate stone for a specific location in the fabric at the quarry. Potentially unsuitable stone was used on occasion, for features such as windows or copings, and these factors all contributed to the reported weathering of some of the stone soon after the building was completed. Where used elsewhere, and with due diligence, magnesian limestone has had a perfectly acceptable durability. There is no reason why the fabric should not be repaired with magnesian limestone if the factors in Technical Advice Note 2016 (Jefferson and Henry 2016) are considered. The work presented in this paper assessed sources of carefully selected magnesian limestone which were deemed to be compatible with the original stone from South Yorkshire. In the large-scale frost testing very little damage, and that of a cosmetic nature, was observed. Salt crystallisation testing also showed low levels of loss in standard and non-standard regimes. It is anticipated after an extended period that Cadeby stone is likely to decay surface blistering due to magnesium sulphate crystallisation. In conclusion the magnesian limestone materials tested were durable and where representative of the materials found in the quarry, suggest an extended life span. The work highlights the difficulties in performance evaluation of stone from a single test. By using a variety of methods, the differential performance observed can be balanced. The results show that the magnesian limestone can be expected to be durable, but that the natural variability of the stone is such that considerable care must be exercised to ensure that the correct quality of stone is used.

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