LEAD CAME: RESEARCH BY ENGLISH HERITAGE

Introduction

The literature on the performance of lead came emphasises the importance of the following factors in determining the durability of came in leaded glass panels: the lead alloy and its associated properties, the method of manufacture, the crystallography or physical structure of the lead, the size and profile of the came, the design of the leaded panel, the glazing techniques employed and the surrounding environment.

The current phase of the English Heritage / BSMGP Research Project on lead came, begun in 1999, is focused on identifying and comparing the metallurgy of lead came of the post medieval period. Lead came samples dating from the seventeenth century to the present have been collected, documented, catalogued, and analysed over the past 12 months in order to make a preliminary assessment of alloy types. Where available information has been collected concerning the performance of the lead came *in situ*. Although more work will be required to consider the other factors cited above, it is hoped that this first phase of work will help to define the objectives of future research, leading ultimately to a better understanding of the performance of lead cames within leaded glass panels.

The Lead Collection

In partnership with the BSMGP, English Heritage has amassed over 150 lead samples from buildings throughout England, dating from the sixteenth to the twentieth centuries. The earliest dated lead in the collection is a 1530 cast lead from Stanbourne, in Essex, and the latest dated lead, a cast lead made by David Mitchell in 1999. A wide array of came profiles is also evidenced in the collection, from narrow, rounded fourteenth century leads to wide, thin-hearted Victorian came. By far the most useful leads from a research point of view, are those that are accompanied by detailed documentation on place of origin, location, position in the panel, names of studios, etc. A number of the fragments contain milling marks along the heart that give the name and date of either the glazier or lead supplier. Some have been supplied with photographs showing the window before dismantling. The collection also includes leads installed by known studios at a known date (e.g. by George Rogers, at St Mary the Virgin, Fretherne, Glos., 1857). The collection has been developed as a result of the generous donations of glaziers and interested conservators, and. fragments are currently being analysed by specialists in materials technology at the Central Archaeology Service, Fort Cumberland, Portsmouth.

Data Collection and Analysis

Record photographs are being made and each of the lead came fragments in the collection has been catalogued and entered into an Access97 database. The database allows for the collection to be queried by the date and origin of the lead, evidence of milling marks, the condition of the leaded window or for traces of glazing mastic, paint or glass fragments, and other features. From the information in the database, representative samples were selected giving a broad date range. Small slices from each of these were cut from the came and mounted in acrylic resin to show cross-sections. The mounted samples have been ground and polished using a number of different techniques. Conventional grinding and polishing using silicon carbide abrasive papers and diamond suspensions have limited success as they leave large quantities of abrasive particles embedded in the surface. However, some refined techniques have been developed to yield a clearer specimen suitable for chemical analysis using X-ray Fluorescence (XRF).

Early Results

It must be emphasised that results of XRF studies to date are not conclusive. The technique cannot give a 100% accurate breakdown of all metal elements present, especially those present in trace quantities. It is already known that quantities of antimony, silver, bismuth and other metals can significantly alter the mechanical and physical properties of lead even in quantities as small as 0.1% or less. Such effects are also partly conditioned by the way in which other metals are dispersed or incorporated within the granular structure of the metal during heating, cooling and working of the lead. The difficulty in preparing of lead samples also makes it difficult to analyse. Results must therefore be approached with caution until they can be corroborated using more involved methods, and until the distribution of impurities within the grain structure can be closely scrutinised.

However, from analysis of roughly 30 specimens from the collection, its has been observed that:

- There appears to be no particular trend over time in terms of overall quantity of impurities found. Thus, samples from 1635, 1850 and 1940 may all appear to contain around the same percentage (which is typically a figure somewhere between 0.1 and 3%) of other metals
- There is no evidence as yet to support the theory that Victorian and early twentieth-century leads were generally more pure than earlier leads.
- Leads from the same window, in the same building, installed at the same date, vary considerably in alloy composition. For instance, of the nine Victorian leads recovered from St Mary & St Hugh, Old Harlow, there appears to be a variation in lead content of between 94 and 99%

Glaziers will probably not be surprised by this, lead being a raw material of varied composition, and leads of many different sizes and sources being necessary in order to re-lead a panel.

The exact impact (in terms of durability) of variations in alloy type is yet to be evaluated, and may not be possible using the specimens obtained, as a precise account of the condition of the lead at the time of its removal from the panel is, for the most part, not available. Work is now proposed to look at the relationship of crystal size/structure and mechanical failures using scanning electron microscopy and other analytical techniques. Results could then be correlated with the findings from alloy studies. For the purposes of this phase of study, the effects of panel design and workmanship in the performance of lead came have not been considered. Equally essential to future studies will be the examination of actual panels in situ, in order to gauge the behaviour of leadwork in relation to design, fabrication and environmental factors.

Any readers who may be able to supply fully documented leads removed from panels in areas of recorded failure (such as splitting, tearing or breaking of leads close to soldered joints), are asked to contact the project team at English Heritage, and photograph examples (both the full panel and the failure points) carefully before dismantling.

If current conclusions are borne out in further metallurgy studies, much more work will be needed, not only on microstructure, but also on traditional methods of manufacture, re-use, handling, and other practical aspects of leadwork, as well as on the construction, siting and mechanical performance of entire leaded and glazed panels, before any reliable guidance can be afforded on the performance of leads. Any information will be gratefully received.

David Mason

David has now taken a 'long period of sabbatical leave'. He writes, 'The lead research will carry on.. I'm handing the file to my colleague, Bill Martin (Tel 0207 973 3073). Jill Channer is also keeping a close interest in developments at Fort Cumberland. .....Jill and Bill at English Heritage can be contacted for news on research progress.'