Reflections on the Windows of the Savile Chapel

30th October 2010

The glass in the windows of the Savile Chapel at the church of St Michael and All Angels, Thornhill, is clearly at risk. In my view there is no conservation strategy which is without risk. Doing nothing would be perhaps the most risky strategy of all.

Measurements made on the East Window

Two previous documents refer to the measurements we have made ("Interim notes on Environmental Measurements", 5th August 2010, and "Notes on the First Chemical Analysis", 6th September 2010). The main conclusions were:

- Chemically, the crizzled glass is (compared with modern window glass) high in potash and lime, and low in silica content. This makes it vulnerable to attack by atmospheric moisture.
- Visual observation indicates that the damage to the vulnerable glass pieces is principally on the interior-facing surface.
- There is no visual evidence of water condensation as the principal cause of damage, so we conclude that the water vapour in the air inside the chapel is the main cause of damage.
- The glass of the East Window is more damaged that what remains of the glass in the North Windows.
- The measurements establish that, in the special circumstances at Thornhill, a significant risk to the vulnerable glass is posed by the central heating radiator. It has been agreed that use of that radiator will be discontinued.
- Temperature and the Relative Humidity of the atmosphere have been measured as on average 16°C plus or minus 6°C and RH 62% plus or minus 9% (the ranges quoted are plus or minus two standard deviations).

Meeting of the 5th October 2010

My notes of that meeting have been circulated ("Comments after the Meeting", 8th October 2010). The main outcomes were:

- Much of the iconography of the East Window has been irretrievably lost.
- Leads on that window are nearing the end of their working lives
- Cracking of the vulnerable glass pieces is so advanced that the removal of the window would present high risk of serious breakdown of those pieces. However if the window were to be left in place there would be

high risk of those pieces breaking down under the influence of ambient vibration, and effective in-situ protection seems non-feasible.

- It was agreed that the best conservation strategy for that window would be careful removal and display in a suitably constructed cabinet within the Savile chapel. The historic interior would be conserved by new "fit for purpose" glazing commensurate with the liturgical function of the window.
- Removal of the North Windows for conservation during the forthcoming monumental works was agreed. Re-installation in suitable framing inboard of the modern clear glazing was seen as a likely course of action.
- The precise conditions of temperature and relative humidity needed to provide the best chance of survival of this important glazing are still the subject of debate.

Reflections

Nominally similar York glass has survived better in other locations. This church has benefited from an unusually generous heating strategy for several centuries, which may have contributed to the damage.

We believe that attack on the vulnerable glass by atmospheric water vapour over the centuries creates a "hydrated" surface layer. Studies in context of museum artefacts indicates that if such a layer is subjected to a dry atmosphere there would be loss of water from that layer, resulting in shrinkage and cracking (either crazing with cracks extending through the full thickness of the glass, or spalling with cracks propagating roughly parallel with the surfaces resulting in glass flakes becoming detatched).

Potash glasses similar to that at Thornhill has been identified as particularly vulnerable to moisture attack (see for example Werner (1958) Annales du Premiere Congres des Journees Internationales du Verre, Liege, pp 189-205). These glasses are subject to developing moist droplets on the surface if the RH is high.

Studies by Prof Robert Brill at the Corning Museum of Glass seem to indicate that:

- Catastrophic failure is caused if the window is exposed to low RH values (less that 42%) when water loss from the hydrated surface layer leads to crizzling and spalling.
- This process can be extremely rapid, in some cases cracking developed in less that one day (see for example Brill (1975) Conservation in Archaeology and the Applied Arts, Stockholm, pp121-134).
- Brill concludes (based on high alkali low lime glasses) that conservation strategies should err on the side of moist rather than dry conditions. He identified the RH range of 40% to 60% as being lowest risk with RH higher that 60% becoming progressively less desirable as the rate of hydration increases.

- Vulnerable glasses subject to highly moist environments (as in the case of glasses used for accelerated testing of durability) were most likely to suffer catastrophic failure if the RH were to become lower than say 30%.
- Reference is made in Brill's paper to studies carried out on high potash high lime low silica glasses very similar to the Thornhill composition. Results were not quoted. The outcome of these studies should be sought.

For any vulnerable glass composition there should in principle be an equilibrium RH value for which moisture is neither lost nor gained by the hydrated surface layer. However our understanding of the fundamental mechanism of moisture attack is not I believe sufficient to allow us to identify this with certainty. One line of argument points to an equilibrium RH significantly less than 100%, another points to the equilibrium RH being related to the RH of the atmosphere in which the hydrated layer had been formed.

In my view, unless more definite experimental evidence becomes available, the following points are relevant to the treatment of the Thornhill windows:

- There is no conservation strategy which is free of risk, and there is no realistic likelihood of completely arresting the process of deterioration. Conservation objectives should therefore be to minimise assessed risk and to reduce the rate of deterioration.
- To that end, excursions of RH below (say) 40% should be avoided.
- Even though the damage to the vulnerable glass had occurred with surface RH higher that the values measured 50mm away from the glass (because the glass would have been chilled by the outside environment), it would be unwise to arrange for the humidity to be above 80%RH because of risk of further hydration, surface attack on the glass by mould growth, and formation of alkaline surface droplets.
- Ideally the RH should be maintained as constant as possible.
- If the current heating strategy of the church were to continue, the RH seen by the historic glass of the North windows in conventional "Isothermal Glazing" arrangements would be in the range 53% to 71%, a little on the moist side of the range Brill recommended for his museum specimens. The risk would be that during the preparation for this the glass would experience some further cracking.