This Technical Note describes common causes of damage to architectural glass, their effects and possible remediation techniques. These include: cleaning, polishing, grinding and filling of glass.

Introduction

Glass may be damaged during construction or subsequently during use of the building. Minor damage may be acceptable but more significant damage requires remedial action. This will often mean replacement of the glass but this may be expensive and have practical difficulties due to the time to obtain replacement glass hence the option to repair the glass may be attractive.

A number of techniques which are available for the repair of architectural glass are described in this Technical Note. Some of these techniques have been used for a number of years for windscreen repairs where their use is closely controlled by British Standards and vehicle regulations. Their use on architectural glass may not be constrained to the same extent.

Methods of repair

Cleaning

Glass is normally cleaned with water and stubborn dirt may be removed by addition of a mild household detergent to the water. However staining and build-up of dirt which is not removed by these methods can be removed by specialist chemical cleaners. Staining and dirt build up can arise from:

- Mortar splashes which harden on the glass and risk scratching the glass if removed by physical means
- Stains from alkaline run-off which attacks the glass surface
- Traffic film
- Metal staining from water flowing over metal surfaces and flashings
- Train stain from metal particles generated by braking systems
- Acid etching from careless use of cleaning chemicals on adjacent building materials.

Proprietary materials are used and the chemicals may affect other materials.

Following chemical treatment to remove deposits, polishing may be required to restore the appearance of the surface.

Trials of cleaning methods on less conspicuous areas may be carried out before more widespread use.

Removal of scratches

Scratches may be caused accidentally during handling and installation of the glass or subsequently during cleaning and maintenance. Scratches are also caused deliberately in the form of graffiti.

Scratches can be removed by polishing with abrasives however this can lead to visually apparent distortion of the glass surface. Several organisations claim to be able to remove scratches leaving the glass free of distortion. The processes appear to be a combination of grinding and polishing but precise details of the methods are kept confidential for commercial reasons. Claims that the glass surface is caused to flow to repair scratches seem fanciful.

It is claimed that scratches up to 0.1mm deep can be removed.

Any visual distortion should be apparent immediately the treatment is completed but inspection may be required in different lighting conditions to check appearance under reflected and transmitted light.
**Removal of weldspatter/grinder sparks**

Insufficient care during construction and maintenance work can result in small particles of hot metal becoming embedded in the glass surface. The metal particles will affect the appearance of the glass and subsequent corrosion of the metal particles will increase the effect.

Acid treatment can be used to remove the embedded metal and the resulting craters can be polished out. Deep craters may require resin filling before polishing.

**Resin filling of cracks and chips**

Cracks in laminated glass and chips can be filled with resin. UV curable acrylic resins are usually used and in the case of cracks, low viscosity resin must be used to fill the crack. Use of resin with the same refractive index as the glass reduces the visual impact of repairs. Repairs require polishing after curing to remove excess resin.

Filling of cracks is only likely to be effective where the cause of the original crack is no longer present.

Stress concentrations resulting from chips are likely to remain hence the risk of cracking should be assessed.

When viewed in reflected light, slight differences in polish between the resin and glass may be apparent.

**Standards**

There are two British Standards relevant to the repair of glass windscreens.

BS AU 251 Specification for performance of automotive laminated windshield systems and BS AU 242 Code of practice for automotive windshield repair. The scope of these standards is limited to repair of laminated glass windscreen using resin to fill cracks and spalls. They do not relate to the other forms of repair discussed above.

BS AU 251 is concerned with repair systems using resin to repair spalls and cracks. It includes tests on sample repairs for

- Visual appearance
- Optical distortion
- Light scatter
- Impact resistance (2.26 kg ball)
- Impact resistance (headform)
- Mechanical strength

BS AU 242a gives guidance on carrying out repairs including limits on the extent of repairs, the need for repair systems to meet the requirements of BS AU 251 and training of operatives. Limits on the size of defects that are repairable vary according to location on the windshield but the maximum size of crater is limited to 5mm diameter and the overall size of the defect is limited to an area of 25 mm diameter except in the case of single cracks which are allowed up to a length of 150 mm.

Whilst the use of methods complying with BS AU 251 will give some assurance of quality and effectiveness, the requirements for windscreen repairs and architectural glass may differ. Windscreen repairs are required to prevent further deterioration of the screen such as delamination due to moisture ingress, provide a smooth surface for the use of windshield wipers, provide a standard of optical quality that does not affect the driver’s view and retains safe performance under impact.

The main difference with architectural glass is that the required life of the repair may be greater. Repairs to architectural glass during construction will be required to have a life of 25 years or more whereas repairs to windscreen are unlikely to be required to last more than 10 years.

**Effectiveness**

**Visual quality**

Visual quality of repairs can be checked at the time they are carried out.

Repairs comprising cleaning and scratch removal are unlikely to deteriorate unless the original cause of the defect continues and further defects occur.

Repairs involving resin may deteriorate due to discoloration of the resin, change in reflectance of the resin due to photodegradation or abrasion and debonding of the resin. Whilst the use of resins complying with the requirements of BS AU 251 will limit the risk of such
deterioration, the longer life of architectural glass will put greater demands on the repair.

These treatments will not be appropriate where the glass surface has a coating on the surface to be treated. Most coatings will be protected by use on a glass surface facing the cavity of a glazing unit but some coatings, such as those on self cleaning glass, are on exposed surfaces.

Strength
Scratch removal will reduce the glass thickness slightly but for the normal thicknesses of architectural glass the effect on glass strength is unlikely to be significant. Loss of 0.2mm on a 6mm pane would result in a 10% reduction in bending strength of the section however the effect on the strength of a pane will be less as the reduced strength will only apply to a small area. The effect will be less for thicker glass or where the glass is used in glazing units.

If repairs to structural glazing are proposed, a structural engineer should confirm that the strength of the repaired glass is adequate.

Strength tests carried out as part of the BS AU 251 assessment show that the resin injection of cracks can restore significant strength to the glass.

Where resin is used to fill chips and spalls in the glass, differences in modulus of the glass and resin mean that the stress concentrating effects of the defects in the glass are likely to remain.

Deterioration of the resin may reduce its strength or its bond to the glass such that the strength of the repaired glass reduces with time.

Responsibility and liability

During construction replacement of damaged glass is likely to be preferred by clients to maintain warranties however factors such as the need for completion on programme may make repairs an attractive solution.

For occupied buildings the cost savings from carrying out repair rather than replacement may compensate for any loss of quality or risk of premature failure.

References
