BRANZ

ISSUE 636 **BULLETIN**

PROTECTING GLASS FROM DAMAGE

April 2019

- The surface of glass is susceptible to damage by corrosion, scratching, staining and etching.
- Coatings applied to glass to alter its optical and/or thermal performance are also vulnerable to damage.
- This bulletin describes the key causes of damage and how glazing can be protected. It updates and replaces Bulletin 337 *Protecting window glass from surface damage*.

1 INTRODUCTION

1.0.1 Glass is often seen as hard, durable, corrosion-resistant and invisible, requiring little care and maintenance other than cleaning. However, in addition to the risk of glass breakage, the surface of glass can be damaged by corrosion, scratching, staining and etching.

1.0.2 Damage to glazing during and after construction is common. Surface damage to glass can result in:
- loss of optical clarity
- reduced durability
- visible defects
- loss of strength
- significant costs to replace damaged glass.

1.0.3 Glass may be laminated, toughened and tinted and have a range of reflective and low-emissivity (low-e) coatings or films applied to improve thermal performance. Self-cleaning coatings (that are not reflective or low-e) may also be applied.

1.0.4 This bulletin describes the main causes of surface damage to glass and how window glass and coatings can be protected from damage. It updates and replaces Bulletin 337 *Protecting window glass from surface damage*.

2 GLASS MANUFACTURE

2.0.1 Glass is made by heating silicon dioxide (SiO_2) (sand) with other components in a furnace to a high temperature. A small quantity of broken glass may be added.

2.0.2 The mix is poured onto a surface of molten tin and left to cool and harden. This produces float glass – a glass of uniform thickness with a very flat surface. Other processes are used for tempered and toughened glass.

2.0.3 Glass can be tinted different colours by adding metallic oxides to the molten glass during manufacture. For example, nickel oxide (NiO) produces a grey tint, selenium oxide (SeO) a bronze tint, iron oxide (Fe_2O_3) a green tint and cobalt oxide (CoO) a blue or grey tint.

2.0.4 Metallic oxides may also be applied as a film or coating to the surface of float glass to alter its optical and thermal performance. There are two types of application:
- Pyrolytic coatings are applied while the glass is being made. The metal oxide is fused onto the surface of the glass at high temperature, producing a hard and durable coating.
- Sputtered coatings are metal particles applied to the surface of hardened glass. Sputtered coatings give better solar control performance, but the coatings are also softer and more easily damaged.

2.0.5 These applications typically produce coatings that both reflect and absorb much of the sun's shortwave radiation. Low-emissivity (low-e) coatings are generally non-reflective and highly transparent. They minimise heat loss by allowing shortwave radiation from the sun to pass through while reflecting internal longwave radiation back inside the building.

2.0.6 Coatings are applied to different surfaces depending on requirements. Reflective coatings are typically applied to the outside surface. Low-e coatings perform best when used in insulating glass units (IGUs) and should be on an inside surface, typically surface 2, where they are protected from possible damage (Figure 1).

2.0.7 Other glazing finishes vulnerable to damage include:
- reflective films
- tinted films
- impact-resistant films
- decorative films

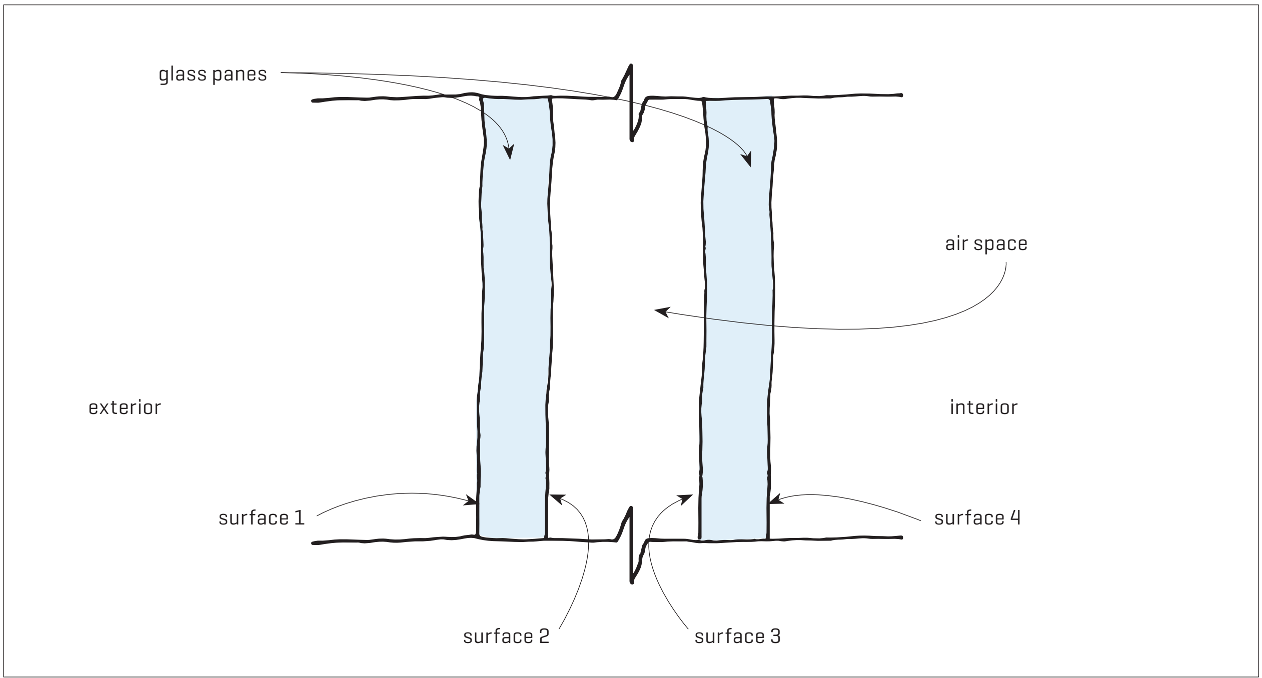

Figure 1. Surfaces of an IGU.

- mirroring
- on-glass digital and screen printing.

3 CAUSES OF DAMAGE

3.0.1 To reduce the risk of damage to the glass surface and coatings, take care during:
- building design – to ensure that incompatible materials are not in contact with the glass
- construction – to protect glass before and after installation
- building cleaning and maintenance – the most common cause of damage is inappropriate cleaning methods, and the use of razor blades, metal scrapers, cloths with debris, and/or scourer-type cleaning pads must be avoided.

3.0.2 While glass resists most acids and solvents, it is vulnerable to alkali attack. Cement-based products such as concrete, fibre-cement, mortar and plaster contain a high concentration of lime, which forms an alkaline solution when mixed with water. Run-off from these building materials over glass can cause surface corrosion and etching.

3.0.3 Other causes of etching and staining:
- Run-off from leached or exuded solvents, oils, plasticisers or pigments from sealants.
- Silicone sealant smears.
- Run-off from metals, particularly iron, zinc, lead and copper, which release oxides as they weather.
- Atmospheric pollution.
- Salt spray.
- Weathering metals and timber.
- Abrasive construction debris and dust.
- Iridescence (a greasy or oily film on the glass) from leaching of alkali-bearing substances. (When iridescence involves large areas of glass, the practical remedy is replacement. With small areas, it can sometimes be removed by polishing with cerium oxide.)
- High concentrations of silica or hydrogen sulphide in geothermal areas.

3.0.4 Causes of mechanical damage:
- Using metal scrapers to remove hardened paint, concrete splashes or plaster.
- Abrading the glass surface with a rough material, such as wiping to remove wet concrete.
- Dragging hard building materials across the glass surface during construction.
- Spatter from welding sparks, grinding steel, sandblasting or general construction debris that can scratch when the glass is cleaned.

3.1 SURFACE CORROSION

3.1.1 Surface corrosion can be dynamic or static.

3.1.2 Dynamic corrosion occurs when alkaline run-off from adjacent building materials, particularly cement-based, flows over the glass. The run-off will continue to corrode the glass until all accessible alkali has been leached out of the material or neutralised by atmospheric carbon dioxide. By the time this happens, the glass is likely to be significantly damaged. The corrosion is less apparent when caused by uniform wetting from washing or rain, as the loss of clarity is slow and over the entire surface. Irregular wetting from localised water run-off will cause uneven, more visible corrosion.

3.1.3 Static corrosion occurs in two ways:
- The surface of glass is hydrophilic – it attracts moisture from the air. A chemical reaction between sodium ions in the glass and hydrogen ions in the surface water produces an alkaline solution that gradually breaks down the surface layers. The same chemical reaction leaves a higher proportion of calcium in the surface layers of the glass that reacts with carbon dioxide in the atmosphere to form insoluble alkaline residues. This further increases the rate of corrosion.
- Troughs in the glass surface trap contaminants that can also react chemically with the glass surface causing staining and degradation. (Although glass appears smooth, the view through a microscope shows it has a rough surface.)

3.1.4 Surface corrosion can also be caused by:
- residual cement dust that becomes damp
- moisture such as condensation, particularly if it is trapped between stored sheets of glass.

4 DESIGNING TO PREVENT DAMAGE

4.0.1 Building design should reduce the risk of damage to glass surfaces. It is more cost-effective to prevent damage than to later repair or replace glass.

4.0.2 Avoid designs where glass sits at a shallow angle. Low-angled glass such as for rooflights is more likely to suffer surface breakdown than glass in a vertical window as water is likely to remain on the glass for longer. Water is less likely to run freely from glass pitched below 5°. Where shallow-angle glass is unavoidable, leave installation until work above the glass is completed.

4.0.3 Design window heads so that water run-off from above is directed away from the glass. (This will also stop rain washing from removing contaminants, so a regular window cleaning programme should be put in place.) Window head design options include:
- installing a drip edge above windows
- installing guttering or a diverting channel above the window
- recessing the windows by at least 200 mm.

4.0.4 Apply a waterproof coating such as paint to cement-based materials that may result in run-off over glass. The coating must be maintained to remain effective.

4.0.5 Ensure that sealants in direct contact with or adjacent to glazing are compatible with glass. Silicone sealants are electrostatic and tend to attract dirt that, when mixed with water, may damage glass. Where possible, avoid horizontal silicone joints or joints that may hold water. If possible, locate joints to minimise the likelihood of staining from rainwater run-off.

4.0.6 For taller buildings, specify an automatic window-washing system or a permanent building maintenance unit or swinging stage.

4.0.7 Specify self-cleaning glass.

5 CARE OF GLASS DURING CONSTRUCTION

5.0.1 Carelessness during construction often leads to glass being scratched, scraped and spattered from welding, concreting and painting.

5.0.2 To reduce the likelihood of damage:
- Delay glass delivery to site until just before it is required.
- Where possible, do not install glazing until all work involving materials corrosive to glass (such as cement-based products) has been completed.
- Protect glass once it has been installed.
- Ensure that all trades on site including window installers, painters, plasterers, textured-coating applicators and cleaners are instructed on how to take care of and clean the glass.
- If glass is delivered with a protective film, leave it on for as long as possible.
- Clean the glass carefully but frequently during construction (Table 1).

5.0.3 Transporting and storing glass on site:
- Stack sheets at an angle 4–7° from vertical on the long edge and with sufficient lateral support to prevent bowing. Place sheets on rubber, felt or soft plastic-covered supports so the glass is not resting on the floor.
- Do not stack more than six sheets deep without some form of intermediate support.
- Store in a clean, dry, well ventilated space out of direct sunlight.
- Ensure the edge of the glass (particularly IGUs) is not immersed in water.
- Inspect glass regularly. If any moisture or condensation occurs between the sheets of stacked glass, separate immediately and dry thoroughly. Water allowed to remain in contact with glass for an extended period can form a concentrated alkaline solution that permanently damages the glass surfaces and, in extreme cases, can even weld sheets together.
- Use an absorbent, non-alkaline (pH 5.5–7) packing between the sheets to help to prevent water from being drawn up by capillary action.
- Cover sheets.
- Store away from construction traffic and work, overhead debris and the possibility of wind gusts.

5.0.4 Handling glass:
- Carry using manufacturers' recommended methods, removing suction cup marks afterwards.
- Take care to prevent edge or surface damage.
- Do not allow glass to impact with metal framing or surrounding building materials.
- Take particular care to avoid damaging the edge seals of IGUs.
- Avoid sliding one sheet over another when removing from storage.

5.0.5 When it is not possible to complete work involving materials corrosive to glass before installing glass:
- Protect glass and frames with masking, plastic adhesive film, a tarpaulin or other suitable cover, particularly before spraying paint or plaster or carrying out any welding or grinding work.
- Do not allow spatter from welding or grinding to get onto the glass as it melts into the surface of the glass. If damaged in this way, the glass must be replaced.
- Do not allow paint or plaster to splash or run onto the glass.
- Immediately (and carefully) remove contaminants such as cement-based dust, mortar and plaster run-off and paint.
- Remove production labels from the glass within 24 hours of installation. The adhesives may be difficult to remove after long exposure to sunlight. If labels do not come off easily, use a solvent such as acetone to spot clean. Take care to prevent acetone coming into contact with glazing seals, gaskets or the perimeter edge seal of IGUs.

6 CLEANING AND MAINTENANCE

6.0.1 How often window glass should be cleaned depends on the building location (urban or rural), level of environmental pollutants and salt spray, amount of natural rain washing that occurs and requirements of building occupants. Recommendations are shown in Table 1.

6.0.2 General cleaning steps:
- Determine the type of glass and any coating (clear, tinted, reflective). Avoid cleaning tinted and reflective glass in direct sunlight.
- Clean windows starting from the top of the building and the top of the glass and work down. Check and ensure any and all drainage holes are clear.
- Remove any residual marks from suction cups as soon as possible. If marks are hard to remove, use a pad with a little cerium oxide.
- Remove grease marks, glazing compounds and sealants before washing using isopropyl alcohol or a solvent recommended by the glass manufacturer. Test clean a small area of glass in an unobtrusive location first.
- Start cleaning by soaking the glass surfaces with

Table 1. Glass cleaning frequency.

Location	Frequency	Comments
Construction sites	Monthly	Check weekly for dirt build-up and clean more often as necessary.
Industrial sites	1–2 months	
Marine areas	Monthly	Check weekly for salt build-up.
Urban areas	3-monthly	
Rural areas	6-monthly	Carry out more frequently if crop spraying occurs or bore water is used.

clean water and a soap solution to loosen dirt. Apply a mild, non-abrasive commercial window-washing solution evenly with a non-abrasive applicator. Check that the intended cleaning materials will not be harmful to the window or other surrounding finishes. Follow with a squeegee to remove all the solution from the glass surface.

6.0.3 Cleaning clear, tinted and reflective-coated glass:
- Apply a mild detergent or proprietary window-washing solution with a soft cloth.
- Use a circular motion and light pressure to wipe over the glass and frame.
- Dry the glass with a clean, grit-free squeegee and/or a soft cloth.
- Wash and dry all window gaskets, frames and sealants at the same time.

6.0.4 Do not:
- allow any cleaning solution or solvent to come into contact with the edges of laminated glass or IGUs
- use metal tools or scrapers
- use abrasive cleaning materials or solvents
- allow metal parts of cleaning equipment to come into contact with glass
- trap abrasive particles between the cleaning materials and the glass surface
- allow dirt or concrete or mortar slurry to stay on glass for any length of time
- allow water or cleaning solution to remain on the glass or adjacent materials.

6.0.5 The glass industry does not recommend scraping glass surfaces with metal blades because of the risk of scratching. If paint or other construction material spatter cannot be removed by normal cleaning procedures:
- use a new razor blade
- use for spot removal only
- scrape gently in one direction – not back and forth.

6.1 SAFETY GLASS MARKINGS

6.1.1 The surface of laminated and toughened safety glass close to the standards compliance mark may have 'pickup'. This is a deposit of very small particles of glass that fused onto the glass surface during the marking process. Blades or scrapers are likely to dislodge pickup and cause scratching, so only clean the area around the compliance mark with a soft cloth.

6.2 SELF-CLEANING COATINGS

6.2.1 Self-cleaning glass has a titanium dioxide coating designed to repel dirt and water. These coatings work in two ways:
- Photocatalysis – a chemical reaction that occurs in the presence of ultraviolet light (sunlight) between the titanium dioxide and organic dirt on the glass. Dirt is broken down into smaller particles that can be rinsed away with water. Titanium dioxide acts on organic compounds only, so it will not break down salt deposits, paint spatters and so on.
- Hydrophilicity – a property of the titanium dioxide coating that means that water flows in a thin layer rather than as droplets. The thin sheet of water washes the broken-down dirt particles away. As water is required for this process, the glass will require washing during dry periods and in places where rainfall does not reach.

6.2.2 Washing self-cleaning glass:
- Generally, rinse with water only, moving from top to bottom.
- Allow the surface to dry naturally.
- If the glass is extremely dirty, use warm soapy water and a soft cloth. Rinse thoroughly with clean water and allow to dry naturally.
- Avoid using hard water (water with dissolved inorganic minerals). If hard water is the only option, use a mild solvent-free detergent with a suitable applicator.
- Avoid rinsing the glass in full sun or at the hottest time of day.
- Silver-coloured or grease-like marks that appear on the glass surface indicate that the coating is working. These marks will be washed away in the next rinsing or rainfall.

6.2.3 When the self-cleaning coating is first applied, and after cleaning the glass with soapy water and a soft cloth, an activation period of 5–7 days is required before the photocatalysis chemical action begins. Once it starts, it will be continuous.

6.2.4 Abrasive cleaners and harsh chemicals easily damage self-cleaning coatings. When cleaning self-cleaning glass, do not use:
- soap containing any type of dye
- any type of abrasive
- a squeegee
- high-pressure washers to rinse the glass.

7 FURTHER INFORMATION

BRANZ

Bulletin 547 *Selecting glass*

Bulletin 566 *Applied window films*

Bulletin 598 *Insulating glass units (IGUs)*

Bulletin 599 *Solar-control glazing*

Bulletin 605 *Residential glazing safety*

STANDARDS NEW ZEALAND

AS/NZS 4666:2012 *Insulating glass units*

AS/NZS 4668:2000 (Reconfirmed 2016) *Glossary of terms used in the glass and glazing industry*

NZS 4223.1:2008 *Code of practice for glazing in buildings – Glass selection and glazing*

NZS 4223.2:2016 *Glazing in buildings – Part 2: Insulating glass units*

NZS 4223.3:2016 *Glazing in buildings – Part 3: Human impact safety requirements*

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