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NEW “HERITAGE MATERIALS”

The conservation of metal frame windows

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About the Speaker

Peter McKenzie is a principal of Jackson Teece Chesterman Willis and is the Director responsible for heritage projects within the practice. The firm is interested in the conservation of 20th century architecture and recent major projects involving steel framed windows include Perpetual Trustees Building, The Wales House (Radisson Plaza Hotel) Royal Automobile Club and Park House.

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Historical Background

Hot-rolled steel windows became popular throughout the world from the 1890s onwards, until being superseded by extruded aluminium windows in the years after the Second World War.

The forerunners of steel windows were cast-metal framed windows. From the mid 18th century, these were in fairly widespread use in England, although still relatively rare in Australia.

Cast-metal windows [usually iron, but sometimes copper or other metals] came about with the advent of a more accurate casting method in the mid 18th century in England. As a result a comprehensive selection of window types and styles soon became available. Due to their “fire resistance”, improved security and choice of designs (usually based upon timber framed models), they were used for housing, factories and government buildings. By 1833, their acceptability had grown to such an extent that Loudon in his Encyclopaedia extolled: “Windows of cast iron, are very fit for cottages and are now made of different forms and very cheap”¹

The next major step in the evolution of metal windows occurred in 1856 when Bessemer first produced steel from pig-iron. Then as a result of developments in other production processes, hot-rolled steel sections for windows became available from about 1880 onwards. The English Crittal Manufacturing Company Ltd became the largest producer and played a leading role in the world-wide acceptance of steel windows; indeed, its name eventually became a generic term for steel windows.

After the First World War, the demand for steel windows grew rapidly and an entire new industry developed in the USA and UK in particular. Some idea of their popularity can be gauged from the American Sweets Architectural Catalogue of 1927/28 where 23 manufacturers were listed.

This time the perceived advantages of steel windows over timber were:

- the stronger steel frame permitted larger windows;
- a related advantage was improved ventilation resulting from the larger windows;
- the windows were fire resistant;
- reduced cost, brought about by standardization of frame sizes and fabrication methods. For example, the American manufacturer “Fenestra” used 12” x 18” and 14” x 20” as standard glass sizes for their range of horizontal pivot windows

¹ Peter Clement, Metal Windows: Article in [Building Conservation Directory](#), 1997.

- steel windows allowed an increase in usable floor area. This was particularly the case in buildings which used framed construction, a structural system which permitted much thinner external walls; the incorporation of thin profile steel windows still allowed the adoption of deep shadowed reveals.²

Steel windows were used in all forms of construction including commercial, industrial and high quality residential buildings. They were fabricated as casement, pivot and awning sashes, using different steel profiles, operating mechanisms and hardware. Their thin profiles contributed greatly to the distinctive character of Art Deco, Art Moderne and International Modern architecture.

True to tradition, the situation in Australia was parallel to that in the rest of the world. Manufacturers in Sydney included Wormald Bros at Waterloo and Dobson, Franks Ltd in Pitt Street. Their windows were widely publicised in the architectural journals of the period. Some examples from this time are the Commercial Bank in Martin Place (1925), Royal Automobile Club in Macquarie Street (1928) and the Sydney Morning Herald building (1929)

In England, and benefiting largely from mandatory hot-dip galvanizing in 1955, sales continued well into the 1970s, until eventually succumbing to the world-wide dominance of aluminium.

Steel windows continue to be manufactured throughout the world, including in Australia. A search of the Web reveals that there are 13 manufacturing members of the UK Steel Window Association and 5 members of the American Steel Windows Institute. In Australia 3 manufacturers are known.

These current manufacturers source their steel sections primarily from Switzerland and India, now that serious rolling of window sections essentially ceased in the UK in 1999,

Fabrication and Installation

The earliest form of joining of frame and sash members was by brazing of the gaps left after the members had been cut to length, then dovetailed, tenoned and riveted together. It was soon found that the brazing process led to corrosion and so welding was introduced as the preferred joining method.

The earliest sections imitated timber window profiles; and thus ovolo and lambs-tongue profiles are often seen. In line with the post World War 1 progression to simpler, cleaner lines all of these traditional sections were progressively superseded by simple, rectangular shapes devoid of decoration. It is contemporary versions of these profiles that are currently available for the fabrication of new or replacement windows.

² Architecture, May 15, 1923, pp xxviii – xxx.

Each manufacturer used their standard range of solid sections for frames, stiles, rails, mullions, transoms, glazing bars, drip moulds and other sections; copper drip moulds and sill flashings were also available. Sash operating mechanisms were usually fixed by tapped screws, as were drip moulds, hinges and hardware.

As one might expect, various manufacturers developed and, in some cases, patented their own fabrication details. For example, the American "Fenestra" windows used glazing bars that were threaded through each other and mechanically locked together.

After fabrication, frames and sashes were sandblasted and then tank-dipped in paint primer, principally to protect them from surface corrosion and damage during transport and installation. This was the standard corrosion protection method; however, as an additional-cost option some manufacturers offered zinc-spray processes or, later, hot-dip galvanizing for superior protection.

Contemporary technical literature produced by the manufacturers was widely available and contained details for installation in all the usual walls. Installation was typically by means of countersunk screws fixed into timber or lead plugs in masonry walls. Alternatively, when the frame was built directly into the walls, head sill and jamb steel anchor plates were embedded in joints as the masonry work proceeded .

In England, it was usual until the mid 1910's to fit steel windows into rebated timber, brick or stone frames, an expensive and architecturally limiting treatment. Consequently, this installation method was soon superseded by one where the frame was fixed directly into the opening. This is the installation most often seen in Australia.

Windows were typically glazed with 1/8" or 1/4" glass, Georgian-wired where needed for "fire resistance". In the same manner as timber windows the rebates were back-puttied, and glass held in place with steel or lead sprigs or spring-clips which fitted into holes in the members, before finishing the assembly with face putty. Alternatively, steel glazing beads were sometimes used, screw-fixed to the members.

Because steel does not absorb oils from glazing putty, a steel window putty was developed to speed up the curing process. Despite this, curing took much longer than with timber windows and the recommended time before painting the putty was then 3 weeks.

To complete the installation the frame to masonry wall joints were typically caulked with a "mastic", one such being a mixture of stone dust and putty.

Finally, the windows were site-painted to the standard specification of the day, typically primer followed by two coats of full gloss oil-based exterior paint.

Condition Assessment

Following is an outline of the types of defects likely to be encountered when considering the conservation of steel windows:

- Windows can't be opened or closed properly. This problem is usually caused by paint build-up or malfunctioning hardware.
- An associated defect will be sashes that are out-of-alignment or distorted. This is often caused by excessive paint build-up or damaged hinges.
- Associated with the previous defects will be air leakage due to loss of contact between the frame and opening sashes; air gaps lead to noise problems and air conditioning and heating difficulties.
- A major problem is corrosion of the various framing members. This is usually simply caused by lack of paint on components exposed to the weather.
- A related cause of corrosion, particularly of sill members, is blockage of drainholes by paint build-up and collected detritus.
- Cracked glass, often caused by contact between the glass and corroding components
- The face-putty will be brittle, dried-out and entirely missing in places, caused by lack of maintenance painting
- In some windows, all or part of some sections might be missing. These crude modifications were often undertaken for the installation, for example, of window mounted air conditioning units.
- Finally, hardware will be missing, stiff or rusty due to lack of simple maintenance

Repair Strategy

In developing a repair strategy it is first important to understand the original installation method. For example, if the windows are fixed into a timber sub-frame it is most likely that they will be easily removable for repairs. By contrast, if the windows are anchored in place in masonry walls and were rendered in after installation, their removal will entail major disruption and this is unlikely to be a cost-effective repair approach. In the latter example, in situ repair work is preferred.

Whichever repair approach is considered, a prudent first step, particularly where a large number of windows is involved, is to undertake a sample repair on a typical window and preferably one that exhibits the worst defects. This might involve removal of a window so that its details of installation become apparent. The full range of issues likely to be encountered relating both to installation and to a practical repair methodology will be exposed, and the opportunity then exists to adjust the repair strategy, before entering into any works contract

Repairs

Corrosion of components can be dealt with in several ways.

Where corrosion is only light to moderate and generally restricted to isolated locations, a feasible and cost-effective option will be to undertake in situ repairs. This involves cutting-out the affected frame section and site-welding a new piece in its place. The operation is not necessarily as straightforward as it might appear, for the actions of cutting and welding have considerable potential for drastic damage to flashings, fixings and adjoining window and wall fabric.

Where corrosion is advanced and widely and uniformly spread over the windows, it is probable that the most cost-effective approach will be to remove all the windows and install new ones. This is almost certain to be the situation in buildings where the tenants are to remain in occupation throughout the repair program

If replacement profiles are needed, three main options exist:

Option 1 is to select a replacement from the available range of new production profiles. .

It should be noted that the current range does not include decorated sections, such as ovolo

Option 2 is to use sections salvaged from windows demolished elsewhere. Some second-hand building materials suppliers keep stocks available. The success of this option is, of course, subject to the vagaries of the market, so this can not be relied upon to achieve an acceptable outcome.

Option 3 is to build-up sections to match existing eg construct T-section glazing bars. For those components that originally were screwed on, e.g. drip-moulds, it is feasible, depending on the profile to be matched, to recreate new components from stock steel sections.

Depending on the heritage significance of the building, it might be acceptable to install new components that do not exactly match the profile of the original, where such profiles are no longer obtainable. To the casual observer, the differences will be insignificant, if they are noticed at all. In my view, it is preferable to reinstate the fenestration pattern, at the expense of detail correctness, in order that the overall architectural quality of the original external (and internal) appearance is reinstated.

With regard to painting of existing windows in place, at its simplest, repainting involves removal of excessive paint build-up, preparation of the substrate by means of scrapers and sandpaper in the usual way, and finishing with an appropriate exterior coating system.

If the condition of the coatings indicates the need for their removal back to base-metal, this can be done by means of small angle grinders, needle guns or paint stripper. Care should be taken so that coatings are not removed unnecessarily, as over-enthusiastic removal might also remove the original factory-applied protective coatings. In addition, earlier coatings are likely to contain lead and its controlled removal will add significant cost to the project. Other factors that need to be considered are:

- the potential for damage to walls, frames and glass by errant tools;
- the loss of coatings history

New paint is applied to the usual specification, i.e. spot prime plus finishing coats. The application of expensive, "high-performance" coatings over less-than-optimal substrates is a sophistication that is hard to justify both on the grounds of costs and the likely performance gains.

In those situations where frames are removed and shot-blasted back to bare metal, or where new frames are to be installed, the full range of protection and coating options is available, ranging from paint only to hot-dip galvanise and powdercoat

Defective face putty can be removed fairly simply and replaced with new steel window glazing putty.

Localised, corroded steel exposed after removal of putty should be cleaned back to base metal, followed by rust-treatment and painting prior to replacement of putty

A consideration that must be borne in mind is where new steel-window face putty is installed it cannot be over-painted until four weeks after installation.

When dealing with hardware the preferable approach is to remove, refurbish and reinstate the existing hardware. Any shortfall in numbers will need to be made up by hardware from other sources.

The supply of replacement hardware is generally limited to what's available from steel window manufacturers or in the "restoration" marketplace. However the range of available new handles, locks, keepers, stays, etc is not particularly comprehensive and does not compare well to the types traditionally manufactured for steel windows. Second-hand building materials suppliers can be a source of small numbers of "make-up" hardware.

Where all windows are to be deglazed, the reglazing process presents the opportunity to install higher performance glass either to improve noise attenuation or to reduce energy transmission, or both. At the Perpetual Trustees building in Hunter Street, Sydney, and as an outcome of noise monitoring studies, 10mm thick glass was installed in the existing rebates to achieve a substantial improvement in noise attenuation. This improvement was further assisted by the owner's decision to keep all the refurbished windows screwed shut thereby allowing the application of acrylic sealant beads around the perimeters of all operable sashes.

The sealant beads also minimized air leakage. The owner further decided that all external glass cleaning would be by rope-access methods, rather than from the interior by opening sashes

Conclusion

It is my experience over a range of projects that generally the condition of steel windows is rarely as bad as first appearances suggest. Their deterioration and failure to operate properly is always a consequence of lack of maintenance, and with a rigorous assessment of their defects they are capable of restoration at costs comparable to their replacement with less appropriate windows.

USEFUL REFERENCES

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