Stained glass used as ceiling enclosure:
background, technique, decay and conservation.

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Introduction

Since the second half of the 19th century stained glass started to be used for the first time as enclosure for ceilings, mainly in domestic, civil and profane buildings and generally in monumental size. This innovative solution for glazing ceilings came as a result of a new taste in architecture and the developments on the field of construction materials and methods. The installation of stained glass panels in a horizontal or semi-horizontal position involves also paying special attention to the design and construction of a skylight which will act as the supporting and protective structure for the stained glass window. In this sense, this type of windows need, perhaps more that any other, a reliable protection system. The skylight or protective glazing for the window is usually a complex structure of metal framework. Besides, the ventilation, drainage of water and lighting of these windows plays also an important role in its original design and construction. As for the deterioration and conservation aspects, these windows also differ from the traditional vertical ones. The tasks of accessing, dismantling, restoration, protection and installation, generally demand a different approach from the conventional conservation projects. Though ceiling windows are to be found in many different buildings and countries, the various typologies, alterations and conservation procedures are very similar. It is therefore for practical reasons that this article focuses mainly on the many Spanish examples that we have located and studied. After going through some general considerations and common features of this type of windows, the main aspects of their decay and conservation will be discussed with more detail, commenting also the peculiarities encountered during a particular conservation project.

Some common features of ceiling windows

Historical background

The obvious precedents for ceiling windows are to be found in the cast-iron and glass architecture which originated in the 19th century. These types of buildings developed mainly in Britain and expanded to other countries since the middle of the 19th century as a result of the achievements of the Industrial Revolution. This type of architecture was mainly used in profane and civil buildings like railroad stations, museums, exhibition halls, pavilions, greenhouses, conservatories, markets, arcades, etc. One of the best known examples of this kind of architecture was the Crystal Palace, build in London by Joseph Paxton between 1851 and 1852. Some of these buildings were massive and so was consequently the demand of iron and glass. Just as an illustrating example, it is known that 293.635 panes of glass were used in the construction of the Crystal Palace. In these early constructions glass sheets were mainly plain, colourless and without any decoration.

Development

The popularity of ceiling windows as an artistic genre of its own grew progressively during the second half of the 19th century in line mainly with the Neo-Classical and Historicism movements in architecture. We can also find these windows in other revival and eclectic architectural trends like Neo-Renaissance, Neo-Baroque or the Spanish Neo-Mudejar. By the end of the 19th century and beginning of the 20th century they fully developed during the Art Nouveau style. During the rest of the 20th century and until the present days this type of windows has continued being widely used, finding its place in many different buildings and architectonic styles. (Figure 1)

Functions

The two main practical functions of any window, namely letting light in while keeping the elements outside the building, are actually transferred, or rather shared, in the case of "ceiling enclosures", to the "roof enclosures". Besides letting zenith light in and protecting the building, these translucent skylights must act as an efficient support and protection for the stained glass window.

The distribution of weights and loads and the way in which gravity works on the leaded panels makes these horizontal windows very different to the vertical ones. There the weight of every panel is individually supported by T- and saddle-bars anchored to the fabric of the building. Besides, they do not necessarily need of any external protective glazing. On the contrary, in ceiling windows the supporting armature is generally interlinked with that of the skylight, of which it depends for its support. The design and construction of these two armatures (ceiling and roof) demands a different constructive approach, based on architectural and engineering technology.

The second function of ceiling windows is ornamental or decorative. We could say that the inner skin (stained glass) provides the aesthetic, decorative or ornamental values of the window while the outer skin (skylight) is in charge of the support and protection of the stained glass window and the sealing of the building. Since these windows are only visible from the inside due to the existence of the skylight, they do not contribute to any particular external legibility of the building, as vertical windows do.

In this sense, since roof skylights are structurally autonomous, ceiling windows could be regarded as a dispensable decorative addition and their absence does not affect the main functions of the roof enclosure. In fact, some buildings from this period have lost their ceiling windows, retaining just the skylight as the only enclosure. As we have previously seen clear zenith light, without any kind of decoration, has been used in architecture at least since the middle of the 19th century in railway stations, greenhouses, etc and continues to be very popular in modern architecture.

Location

Ceiling windows were mainly used in civil, profane and institutional buildings like Universities, Banks, Stock Exchange, Post Offices, City Halls and Governmental buildings, High Courts, Museums, Royal Academies, Hotels, Cinemas, Casinos, Auditoriums, etc. This type of windows was generally located at the most visited public areas of the building, like the staircase at the entrance, the main Hall, a board or meeting room, etc.

Design and subject

These windows generally have a marked ornamental or decorative character, mainly based on geometrical, floral, heraldic or allegorical motifs. The most stereotypical or recurrent designs in the rational and Neo-classical architecture from the 19th century generally follow serial, repetitive and symmetrical patterns. In most cases a central motif, surrounded by clear glass, is delimited by a border or frieze of darker colour. In this sense, due to the repetition of motifs, the same cartoon can be used for many panels, either for the undecorated clear-glass panels or for the border.

Due to the symmetry of the patterns and motifs commonly depicted in these windows, they often have various view-points. Glass painting is mostly limited to the border and the central subject which generally refers to the original use of the building. During the Art Nouveau period these windows were mainly decorated with colourful floral motifs. Borders or friezes of any kind are always present in ceiling windows though not so frequently the central subject is purely figurative. (Figure 2)

Size

Though generally these ceiling windows tend to be regarded as monumental-size works, we can find in many different sizes, depending on the size of the room where they are located. Windows of smaller size were mainly used in private and domestic houses.

Shape

When seen in a cross-section or elevation these windows can have a wide range of shapes, including horizontal, vaulted or barrelled, domed, totally or partially inverted, faceted, etc. In the same way, glass panels can be flat, concave and convex, or a combination of different shapes. When seen in plan or from the ground, the openings where they are inserted have mainly square, rectangular, circular or oval shape. Sometimes though, depending on the artistry of the design, other combination of shapes can be found, resulting in unique, original and very complicated windows. (Figure 3)

Lighting

These windows were originally lit with natural light and that is why, in order to allow for the maximum amount of light in, most of the glass which was used was clear or very lightly tinted, translucent and undecorated. Artificial lighting of these windows was later introduced, mainly in combination with natural light in order to prolong the enjoyment of the window beyond the daylight hours. Though they are not so common, in the past decades we can also find windows originally designed to be lit exclusively with artificial light.

Depending on the accessibility or the visibility of the skylight these artificial lighting systems can be placed either outside or inside the skylight. The type of lamps (fluorescent, halogen, etc.) and their quantity will depend on their location (outside or inside the skylight) and the desired type and intensity of light.

Materials in ceiling stained glass windows

Traditionally ceiling windows consist of glass panels installed on an ironwork structure (armature) and sealed with some kind of putty or fixed with wood strips or metal bars, glazing stops, reeds, beads or wedges. Generally this armature is structurally not strong enough to support the window for itself and, as we have

seen, its weight is actually supported by the armature of the skylight. Mainly in the Art Nouveau period, ironwork from the armature of the window can sometimes rival with glass in decoration, prominence and artistry. Occasionally, especially in dome-shape windows, the traditional supporting metal structure made of iron angles can be substituted by stone mullions.

These windows can be made of single glass panes or leaded glass panels and in both cases they can be either flat or curved. Depending on the design of the window, panels are often leaded up in straight geometric lines in order to allow for bending during their installation. Even more than in vertical windows made of leaded panels, saddle bars are crucial here since they are actually responsible for supporting the weight of the panels and avoiding buckling. Unlikely to what normally happens with vertical windows saddle bars are tied to the panels in the workshop and not on site. Ideally, in order for saddle bars to support the weight of the panels they should preferably be placed facing to their inner side.

Skylights

We have already stressed the fact that these windows invariably need some kind of skylight as support and protection. This translucent outer skin must actually perform just like any other roof in the building. The armature of these skylights, generally of monumental size, supports the window by means of a complex system of metal beams and tie rods, girders, angles, crosspieces, struts, braces, brackets, nuts, bolts, etc. The most common shapes in skylights are in two-, four- or multiple-sided ridge, dome-shaped, barrel or vault-shaped, combined forms, etc. The design of these supporting armatures, both for the outer glazing and for the stained glass, involves sometimes complex engineering structure calculations.

Originally the materials of these skylights were very similar to the ones we have aforementioned for the ceiling windows: basically an ironwork structure (armature) closed with glass panes and sealed with some kind of putty. In recent times polycarbonate sheets are frequently used instead of glass, silicone instead of the traditional putty and aluminium profiles instead of iron.

To allow the maximum of light in, the type of glass used is generally translucent and colourless. Similarly, to achieve an efficient protection against impacts and breakage different types of glasses are also available. Additionally, glass with some kind of light adsorption filters could be used to reduce the negative effects of UV and IR emissions from the sun. As for the aesthetics of the protective glazing, since neither the ceiling window nor the skylight are usually seen, we can find different solutions in the choice of glass or plastic sheets (polycarbonate, methacrylate, etc.), going from completely plain and transparent to textured, matted, etched, frosted, etc.

As we will now further discuss, skylights play an important role in the ventilation and the water drainage of the building. Besides, one of their obvious advantages, as compared with unprotected horizontal windows, is that they also improve considerably the soundproofing and insulation of the building. (Figure 4)

Ventilation

Generally, a sealed and air-tight skylight should always be avoided and that's why the original design of ceiling windows always included some kind of natural or passive ventilation system. This ventilation system, based on the principles of natural stack ventilation, has a two-fold nature: on one hand the air flows between the inside of the building and the skylight chamber and on the other hand between the skylight chamber and the

exterior. In order for this system to work effectively, either in the stained glass window itself or in the wall just below it different openings are needed to evacuate the air from the room.

In the same way, the skylight must also have some openings to allow for the natural circulation of air towards the exterior. These openings in the skylight will be more efficient if they are located at its upper part. Sometimes these ventilation openings consist of a window, closed with glass or just with a wire mesh, a wind turbine, a cap, etc. Whatever the shape or the type of the ventilation opening it is important not to forget that water should never get into the skylight. The aim of this ventilation is to avoid the excessive warming-up of the building and particularly of the skylight chamber, hinder the so called greenhouse effect and facilitate a sufficient air renewal in the chamber. Therefore, the proper working and maintenance of the ventilation system is crucial to guarantee a better conservation of the window.

Water drainage

As we have just mentioned, another important function of skylights is the drainage of rain water. Whatever the shape of the skylight might be, rain water must somehow be channeled and evacuated away from the stained glass window and outside the building. For that purpose different systems may be used, just like with any other roof in a building. Once more, the proper working and maintenance of the drainage system is very important to avoid water getting in contact with the window and entering the building.

Mechanical climate control systems

The installation of some kind of mechanical climate control system for ceiling windows, whether heating, cooling, ventilation or all together, has become more frequent in recent times. Sometimes these different devices can be grouped under the name of HVAC (Heating, Ventilating and Air Conditioning). Though these systems can without any doubt have a beneficial effect for the conservation of the window, when added to historical ceiling windows they can easily alter and disturb their original appearance.

Causes and effects of decay

The causes of alteration and decay in these types of windows can be very diverse and of a very varied nature. Since the skylight has an important protective function, most of the damages or alterations on the historical glass can be directly related to it. As it might happen with any other element or material in a building, one of the main causes of decay of these windows is the lack of supervision and maintenance. It is therefore advisable to inspect regularly the state of the skylight and its materials, both inside and outside, as well as of all the elements related to it, like the ventilation, drainage and lighting systems. An excessive increase in the humidity and temperature levels in the skylight chamber can be due to a blockage or malfunction of the ventilation system or to the presence of too many or too powerful spotlights. Similarly, serious leaking in the building may occur if the drainage system gets obstructed due to the build-up of dirt in the water evacuation pipes and sewers.

In any case, particular attention must be paid to avoid that the different elements from the lighting and ventilation installation could be seen from inside the building and through the stained glass window, disturbing its legibility.

After mentioning the main causes of decay related to the skylight we can easily deduce which are the most frequent effects of it: deposition of dirt outside and inside the skylight; building of nests; breakage and loss of the protective glass due to the impact of objects or to movements or vibrations in the supporting structure; crackling and loss of adhesion of the glazing sealants as a result of ageing and alteration of their properties, which results in water leakage onto the stained glass; finally, mechanical failure, oxidation or corrosion of the metal supporting structure.

As for the stained glass window itself, the causes of alteration can also be varied. One of the main problems normally encountered in these windows is the buckling of the leaded panels due to the gradual effects of gravity, the failure of the saddle bars, an insufficient amount of these on every panel and the high temperatures that often build up in the skylight chamber; the deposition of dirt on the external side of the historical glass is also a common problem as a result of the openings in the skylight and the obvious difficulties for regular cleaning; presence of water on the external side of the historical glass due to the failure of the protective glazing sealants; breakage and loss of the historical glass as a consequence of buckling of the panel and vibrations or failure of its supporting armature.

Particularities of the conservation and restoration of ceiling windows

One of the most distinguishing features of the conservation and restoration of ceiling windows is related to the work on-site rather than in the workshop. Indeed, the tasks of accessing, dismantling and installing the window demand quite a different approach to those in vertical windows. Depending on the peculiarities of every window the panels could be removed either from the outer or from the inner side, though generally they are originally mounted from the outside. In any case, it would be advisable if possible to have access to the window from both sides. When dismantling takes place from the inside, sometimes the traditional scaffolding system will not always be the best option. If the window is very large a platform scaffold could be installed, but perhaps it might be more practical to use an articulated telescopic or scissor lifting platform instead. Similarly, these two alternative access systems could be used when the window is located in an area of difficult access, like in the ceiling of a staircase. When dismantling takes place from the outside, accessing and working inside of the skylight chamber can be quite challenging, tricky and hazardous, particularly in large-sized windows, and therefore the necessary security measures should always be respected. The intricate metal structure formed by the armature of the historical window and the skylight does not always have and easy access and it will make necessary for the conservator to be experienced with the use of a harness and works at heights.

Once the panels are dismantled and moved to the workshop, the different operations which involve the restoration process are generally very similar, if not the same, to those in vertical windows. A particular situation can be met though when, due to the design of the window, panels are not flat but have an originally curved form. In those cases it would be advisable to build two moulds (concave and convex) to enable us to work on them on the bench. These moulds could be made either with a thin plywood sheet mounted on wood blocks or with an easy to work with material like polyurethane or polystyrene. In the same way, the transport of these curved panels is a very delicate operation and therefore maximum care must be taken.

If the panels show some degree of buckling, as it so often happens with these windows, it will probably be as a result of a bad or weak leading or due to the saddle bars. Saddle bars can be insufficient in number and thus we should make sure to add new ones to every panel, spaced at a distance of at least 20 or 25 cm between them. It can also be that the saddle bars are too thin or too weak and then it would be more responsible to replace them by new thicker and stronger ones.

In recent years the installation of smoke and heat detectors in many buildings has become a compulsory measure in accordance with fire codes legislation. This can sometimes create a complicated situation where a balance must be found between the compliance of laws and the conservation of the esthetic and material values of historical windows.

In the case of historical windows which in later interventions have been sealed off from natural light, we should evaluate the possibility or the need to restore their original natural lighting source.

Finally, as we have already pointed out, we should always make sure that the ventilation and drainage systems are properly working for they can have a major influence on the conservation of both the skylight and the historical glass.

A practical case study: the conservation of the Gernika Assembly House window

During 2009 the ceiling window at the Assembly House in Gernika (at present Museum of Biscayan History) was restored by the glazier Mikel Delika from Vitoria-Gasteiz. This monumental stained glass window of 20m long, 10m width and a total of 372 leaded panels, was made by the firm "Vidrieras de Arte" from Bilbao in 1984. (Figure 5)

For its restoration the window was removed by sections and transferred to the workshop. Immediately after dismantling every panel was temporarily replaced by a serigraphic reproduction on 4mm polycarbonate sheets. The conservation project involved the usual procedures for this type of windows (documenting, cleaning, mending cracks and missing areas, cementing, etc.). Two of the main problems that this window presented were the buckling of the panels and the sealing and ventilation of the skyline.

The buckling of the panels was due to an insufficient number of saddle bars on every panel as well as to the excessive warming of the lead as a result of the heat build-up in the skylight chamber. After flattening the panels by means of progressively applying weights on them new cement was applied on both sides. In order to avoid further future buckling of the panels, they were reinforced by the addition of new saddle bars, in between the originally existing ones.

As for the ventilation of the skylight, an air-conditioning system had been originally installed on the wall immediately below the window, creating a closed air flow between the inside of the building and the skylight chamber but not with the exterior. Therefore, to avoid the high levels of temperature and relative humidity which built-up in the skylight chamber, a new ventilation gap was opened on its central upper part. This opening, in the shape of a gable roof, consisted on a metal armature covered with translucent polycarbonate sheets and closed wire-mesh along its perimeter to prevent the entrance of minor objects. Additionally, a new temperature control sensor was installed inside the skylight chamber, programmed to activate the already existing air conditioning system when the air temperature should reach the 30º C. (Figure 6)

Figures

Figure 1. Top: stained glass window at the H&M Warehouse in Barcelona, previously known as *Casa Damians*. Bottom: Stained glass window at the Municipal Conservatory of Music in Barcelona. Photographs by Fernando Cortés Pizano.

Figure 2. Original cartoon and stained glass ceiling-window by Maumejean at the Geo-mining Museum in Madrid. Photographs by Geo-mining Museum in Madrid.

Figure 3. Top: stained glass window at the staircase of the Valencian Royal Society of Agriculture and Sports. Bottom: stained glass window at the Central Post Office in Valencia. Photographs by Maria José Prieto Pedregal.

Figure 4. Top: skylight chamber at the Valencia Town Hall window. Bottom: skylight chamber at the Headquarters of the Superior Council of Scientific Research (CSIC) in Madrid. Photographs by Fernando Cortés Pizano.

Figure 5. Interior sight of the Assembly House window at Gernika (Biscay) during dismantling works in 2009. Photographs by Mikel Delika.

Figure 6. Exterior sight of the skylight at the Assembly House window at Gernika (Biscay) before and after the installation of a new ventilation opening in 2009. Photographs by Mikel Delika.

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