**Research entitle**

# The Technological Progress of Glass Usage in Buildings

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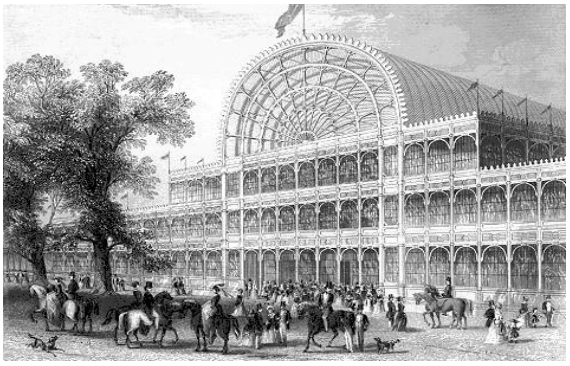
**Abstract:**
The research discusses the modern technological progress and development of glass usage in buildings. Such as the modern techniques of the types of glassed curtain walls is clarified with figures and pictures. Glass as a building element is considered in our age as an important building unit. It is an essential component in formation and elevation composition. The research shows types of glazed curtain walls used in buildings façades such as Stick System Curtain Wall, Unitised Curtain Walling, Panelized Curtain Walling, Spandrel Panel Ribbon Glazing and Structural Sealant Glazing.
As a development of the glass used in curtain walls, it is discussed through the research solar cells which has been added. That is to add more usages for the building façades. As well as, the selfcleaning technology as one of the smart techniques is discussed. The research proves the role of technology in developing glass as one of the most important elements which is used in forming buildings in terms of design, performance and operating and sustainability techniques.
**Key words:** Technological Progress, Glass Usage, Glass, Building Technology, Glass Technology.

**Research problem:**
Glass is one of the most important elements that forming the buildings elevations in our age. Here comes the research problem in studying and mention some types of modern techniques in the modern technological progress of glass usage in buildings.

**Research objectives:**
Prove the role of technology in developing the glass as an important modern element in formation and elevation composition in terms of design, performance and operating and sustainability techniques.

## 1- Glass Usage in Curtain Walls:

Concerning the age of industrial revolution, the development of the formation of steel buildings controlled the building history in the nineteenth century as a new construction element. Glass has been used in a narrow range in the industrial buildings till year 1840. That is because of its high price, limited glass sheets and lack of its production.[1]



Picture (1): Crystal Palace – England- 1851. The Precast glass and steel were used.

[1] Mohamed Reda Kamel, Hussin Ali Hussin Saleh, **Curtain Walls**

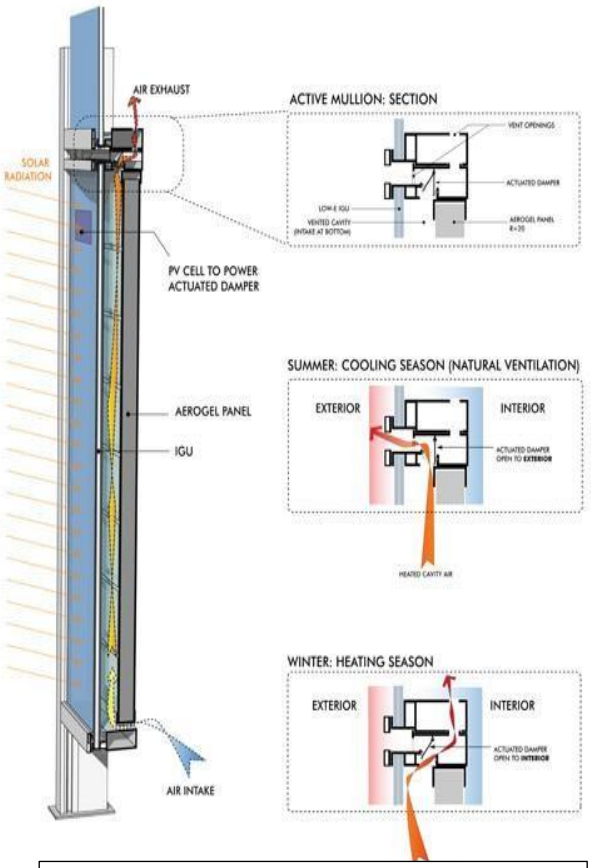
The famous building which was built with the prefab way and from glass and steel was "The Crystal Palace" in England 1851. The Glass in the elevations was used to be an environmental barrier between the insider and outsider the building.

From then, technological and construction methods have been developed. Steel and concrete were used together to form the structure of the building. Till steel, aluminum and glass was used to produce the glazed curtain walls. The traditional elevations have changed and has become kind of art and creativity. Then curtain walls has been used in walling and covering skyscrapers elevations.

**1-1 Definition of Glassed Curtain Walls:**

It is a system of walling to cover the external elevations. Curtain walls contains aluminum and metal frames and trusses carry the glass. It is connected with the building by fixing them in the columns and slabs.

This system was not helping in carrying the load of the building or the weather factors that effecting on it. Later on, it is used to help in carrying the load of the building. The way of fixing the curtain walls depends on the kind of the metal and the glass used.




Picture (2): Detailed shows technology of warming and cooling in one type of a glassed curtain wall.

**1-2 Architectural Advantages of Glassed Curtain Walls:**

- Can be used in covering and walling several numbers of floors.
- The unite width and length can be controlled in the design.
- Easy to install and speed of execution.
- Allows a wider vision for the building users.
- Gives aesthetic, creative and modern form for the building.
- In the beginning of its usage, it was only carrying its own load. Later on, it is developed to help to carry the building load.[2]

**1-3 Architectural Disadvantages of Glassed Curtain Walls:**

- Using the glassed curtain walls made the architect designer ignore the original directions.
- Raising the heat degree for the internal space, that is because the glass locks up the temperature and interfacing the sun for the entire the building elevation.

[2] Lamis Abdelkader**, The Role of Technology in the development of the Traditional Architecture elements**.

- Raising the cost of the building trying to overcome the high temperature of the internal space by using ways to cool the glassed curtain wall and using air-conditions.

**1-4 Types of Glassed Curtain walls:**

There are several Types of Glassed Curtain walls Techniques Such as:

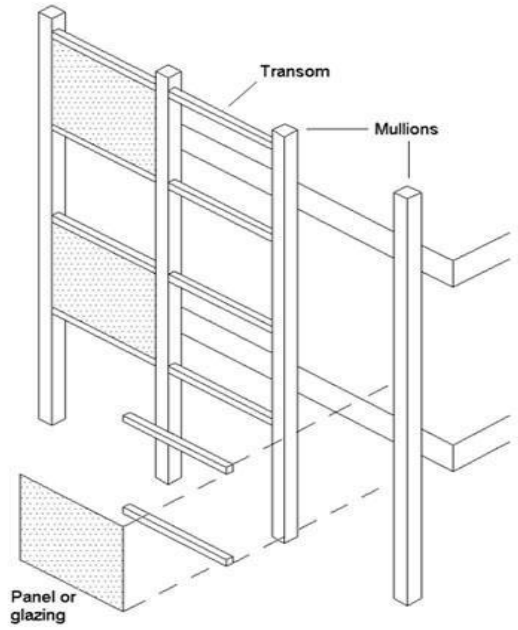
- Stick System Curtain Wall
- Unitised Curtain Walling
- Panellized Curtain Walling
- Spandrel Panel Ribbon Glazing
- Structural Sealant Glazing
- Structural Glazing

The process of choosing between the types of the glassed curtain walls depends on the function objectives, Timing of construction and design, construction precautions and price.

**1-4-1 Stick System Curtain Wall :**

This type of glassed curtain walls is very popular. It can be used to cover a tower contained 10 floors or an elevation of a shop. It is suitable for the irregular building's shapes and forms. It is also suitable for the movements and changes in the framework of the building.

This type of curtain walls is fixed in the floor slabs from the main vertical sticks. Then install the horizontal sticks in the vertical ones. This stick is from aluminum and sometimes from steel for firefighting.




Picture (3): Displaying fixing glass in Stick System Curtain Wall.

**1-4-2 Unitised Curtain Walling:**

This curtain walls type is contained from frames of aluminum or steel with one floor height. It is installed and fixed in site. Machines is used to place unites and link them with the concrete slab and columns. This type of curtain wall is very rare in usage unlike the stick system because it is more complicated and more expensive.

Picture (4): A unite of one floor height is ready to be fixed "Unitised Curtain Walling".

**1-4-3 Panellized Curtain Walling:**

Its parts are precast and fixed parts. Its measures are as the same distance between columns and height of one floor. It is installed to the building columns and concrete slabs, that is preferred to be fixed to the columns to avoid curvature in the middle of the slabs

that might affect the whole system which called "Truss-Wall". Due to factory installation, gives control to the quality more than site installation and a smaller number of joints "Site-Sealed Joints" used in site for installation as well.

The usage of this type of curtain wall is uncommon and more expensive than unitized system. The difference between unitized and panelized might be unknown. But panellized curtain wall has internal steel which has great importance for helping in carrying the building load where it is fabricated from concrete with window openings that fixed in the site.

**1-4-4 Spandrel Panel Ribbon Glazing:**

It is contained of long striped parts of transparent glass between solid parts fixed in slabs and columns. The striped parts are installed in the horizontal solid parts which commonly made of concrete. As for structural sealant glazing and structural glazing are not used commonly because of the difficulty of their applications and changes. [3]

**2- Technology of Adding Photocells to the Glassed Curtain Wall:**

Picture (5): The elevation of the glasses curtain wall that is developed by adding photocells to glass sheets near Beijing Olympics – China 2008.

The company Simone Giostra has developed the function of the glazed curtain walls by designing a great displayed screen on a whole of a building's elevation. This Screen considered as one of the biggest colored displayed screen in the world and the first screen held on a curtain wall in China. This screen doesn't need any sort of energy consumption as it is one of the green and sustainability architectural projects. Photocells has been added to the glassed sheets to reduce the thickness of the external building elevation. And also, to let the natural light go through to the internal spaces in order to reduce the heat gain and transform the light to excessive energy for the displayed screen. The photocells save the solar energy in the daylight and use this stored energy to display media on the screen and to reflect a picture of the climate conditions in the sky during the day. Because this technology in the beginning the resolution of the picture is low but the displaying area is big. So, the picture displayed converted to "pixels". The big displayed screen was made from RGB LED's light units which was put more than 2200 $m^2$ in it to enhance the image.

The technology of construction and building materials has been developed. "Intelligent skin" is been made as a new formation for the external coating for the building. The building's elevations is an in separatable part from streets and squares. It is possible now to deal with the elevations deferentially. As an example, Xicui Square in The United States contained a lot of displayed screens on the buildings elevations which achieves great commercial gains when depended on the ability of surrounded communication. Of course, it is fascinating when a building elevation responds to the entertainment and participation.[4]

[3] Lamis Abdelkader**, The Role of Technology in the development of the Traditional Architecture elements**.

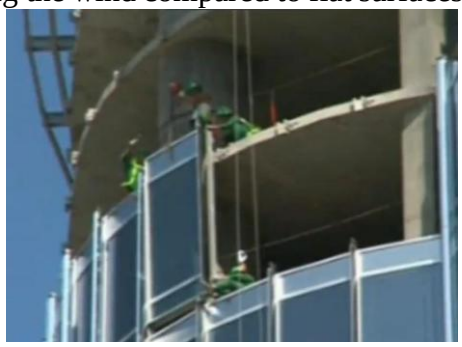
[4] www.yuanda.com.cn

**3- Technology of Developing Glass used in Curtain Wall in the Highest Skyscraper (Khalifa Tower):**

The concept of designing the elevation was "Lily Flower" which has lots of curves to provide wider view for a larger number of people and to reduce the area facing the wind compared to flat surfaces.

The glassed curtain walls were over 3000 units contained two layers. The outer one is covered with a thin layer of pure silver that is to reflect the sun rays. The curtain walls of the whole building with that technology was cost over 100 million dollars.

In addition to this, there was a special machine designed to cool water at night and pump it up with special pumps to the highest floor of the building to cool the outer glass of the elevation's curtain walls which consumes a lot of energy.[5]



Picture (6): Closer picture for fixing and installing one unit of the glassed curtain wall used in the Skyscraper "Khalifa Tower" Dubai-UAE 2010.

**4- Nanotechnology and Developing Glass:**

Nanotechnology has a great impact in developing glass. It helped for creation of a new type of strong and unbreakable glass. Nanotechnology helped to overcome fragility caused by voids between atoms. That is to reduce voids between atoms to the minimum. And it has been added lots of positive qualities to glass such as:

- Preventing thermal leakage through windows which will reduce air-conditions usage that consumes a lot of energy. That is by coating the outer surface of glass with a material called "Thermocromatic" which work on thermal insulation with preventing suitable lighting for internal areas. As well as coating the internal surface of the window's glass of between glass sheets nano silica dioxide particles (Sio2) for heat protection.
- Developing glass to store heat comes from the sun and pass it to the inner space and make it work even in the cloudy days. [6]
- Develop it to be reflective to the sun's harmful rays "UV".
- Developed to be SELF-CLEANING:

• "LOTUS-EFFECT": Hydrophobic - water trickles off: This is one of the best-known means of designing surfaces with nanomaterials. In other countries, for example Japan, photocatalysis is the more popular alternative. The name "Lotus-Effect" is evocative, conjuring up associations of beads of water droplets, and therefore the effect is often confused with "Easy-to-clean" surfaces or with photocatalysis, which is also self-cleaning.

• "PHOTOCATALYSIS": With properties: Hydrophilic surfaces. Deposited dirt is broken down and lies loose on the surface. A water film washes dirt away. UV light and water are required. Reduces maintenance requirement.[7]

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[5] Al Jazeera Documentary Channel - "**Closely**" Program.

[6] Lamis Abdelkader, **Rooting the Concept of Nanotechnology to Achieve the Upgrading in the Field of Architecture and Urbanism "Special Study for the Visual and Environmental Upgrading in Egypt"**,

[7] Sylvia Leydecker, Nano Materials in Architecture, Interior Architecture and Design.

- EASY-TO-CLEAN Smooth surfaces with reduced surface attraction. Surface repellence without using the Lotus-Effect.
- ANTI-FOGGING: Clarity for steamed-up surfaces
- Developing it for firefighting.
- Nanotechnology developed glass to control the intensity of lighting and change color.[8]
  The technological progress that nanotechnology has made to glass not only allowing us to increase the windows areas but also constructing a building totally from glass starting from floors, walls and even roofs. After it's possible to control thermal performance, being self-cleaned, organic dirt analysis and selection spectroscopy.

## 5- Research results:

1- Technology has the most important impact in developing glass as a building element.
2- Curtain walls is considered as an important factor in forming the external buildings elevations in our age.
3- Adding photocells to the outer surface of the glassed curtain walls can reduce energy consuming.
4- Glassed curtain walls usage in high temperature areas will increase energy consuming and the cost of the building.
5- Nanotechnology is a boom in building and construction materials. Especially glass as an essential component in formation and elevation composition.

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