The Role Of Detail In Sustainable Curtain Walls
Renovations Of Buildings' Elevations After Explosion Accidents In IRAQ

Anas H. Majeed Al-Jubori
Assistant Lecturer
Architectural Department
College of Engineering, University of Baghdad
Baghdad, Iraq

Abstract:-

The outer envelope is still one of the most important functional elements of the building; buildings' elevations represent fundamental components which define the architectural aspect of the building and reflect the critical role of energy performance and its interaction with the internal activities. As in the case with developed techniques which represent the modern technology that aim to provide the best, many options had become available to improve the performance of buildings' elevations as an envelope for building. The building envelope is considered as a first and direct line of defense against environmental and physical exposures just like the skin of a human. Curtain walls, as a type of building envelope, represent a key component as an outer surface with non-load bearing property and without affecting the structural stiffness.

Hence, the knowledge gap is defined as how to clarify the role of detail and its influence on the definition of curtain walls and the integration of its elements, as well as the functional and aesthetic vocabulary under the concept of sustainability, especially in the renovation of buildings' curtain walls that were subjected to explosions in Iraq, as in Karada explosions in July 2016 **Fig. 1**. This represents the research problem.

The research aims to highlight the role of detail and its impact on the curtain walls under the concept of sustainability through an integrated vision on the system to reflect new ideas with assembled details in a new system, focusing on function, components and mechanisms of curtain walls.

Keywords: - detail; curtain walls; sustainability.

Fig. 1. Karada Explosion in IRAQ.

I. INTRODUCTION

Curtain walls appeared with the spread of the industrialization era and the growth of prefabrication concept in the early nineteenth century through the first expression of a huge structure covered with glass represented by the Crystal Palace, London, Uk in 1851, as well as

Menier Chocolate Factory building near Paris in 1871, with a structure of independent framework systems. [1]

Curtain walls work on the integration and unity of several principles as heat saving, air conditioning, light provision, prevention of the negative impact of the sun and noise prevention to create a concept of modern day architecture with the integration of structural system design [2]. Curtain walls aim to achieve complementary requirements such as the prevention of water and air penetration, efficient resistance to wind loads in addition to the thermal response by controlling light transmission to internal space. Curtain Walls reflect - through their components as a mix of several systems- the expression of the architect's ability to define the nature of the building architecturally and aesthetically [3]. **The most important objective is to make this component subjected to the principle of sustainability through the role of detail in curtain walls.**

II. RESEARCH PROBLEM

The research problem is defined as the lack of knowledge in clarifying the role of detail and its influence on the definition of curtain walls and the integration of its elements, as well as the functional and aesthetic vocabulary under the concept of sustainability, especially in the renovation of buildings' elevations that were damaged by explosions.

III. RESEARCH AIM

The research aims to bridge the knowledge gap through clarifying the role of detail and its influence on the definition of curtain walls under the concept of sustainability through an integrated vision on the system to reflect new ideas and assembled details in a new system for **the maximum service life**, by shedding light on:

- Integration mechanisms of the curtain walls elements, functional and aesthetic vocabulary.
- Increasing the efficiency of curtain wall element details by creating a dual role as a rain water drain conductor and a climate barrier.
- The structure and architectural curtain wall components and the mechanisms of their functions and installation in order to mix several services systems in curtain walls under the concept of sustainability.

IV. DEFINITIONS

- **Detail**:
  - An individual fact or item which itemized information about something.
  - An architectural detail is a small piece of the whole, yet it has the power to characterize and define the entire building. Details are fundamental to the life and personality of a space. [4]

- The research defines the term (detail) as a component or part of structural element that works to perform specific and specialized function. Increasing the efficiency of any element can be achieved by increasing its number, weight, size, or change its shape. So, it needs to subordinate the advanced technology in its design.

- **Curtain Walls:**

- the vertical building envelope, which does not support any load but its self-weight (dead loads) and environmental loads, nor being as a helpful mean to support the structure. It is created by using factory-measured components which are assembled as independent-framed with complementary self-supplements [5], [3], [6].
- A curtain wall is defined as a thin, usually aluminum-framed wall, containing in-fills of glass, metal panels, or thin stone. The framing is attached to the building structure and does not carry the floor or roof loads of the building. The wind and gravity loads of the curtain wall are transferred to the building structure. [7]

- **Sustainability:**

- It is the study of how natural systems work, and produce all what the natural environment need in order to sustain it in balance with increasing chances of survival and reducing the consumption of natural resources daily with a maximum service life. So, improvements and changes must be made to maintain the sustainability of these resources. [8]

A. Curtain walls components

It must be dealt with aspects of the detail when designing curtain walls, especially under the principle of sustainability and its relationship with performance of the building, such as:

• Details of Materials Components.
• Mechanisms of Assemblage and installation.
• Maintenance.

Concerning structural aspect, a review of the curtain wall components and their functions is an important and essential factor in the performance of renovated building not for component choice only, but installing scheme chosen for the chosen system and the mechanism of subsequent maintenance to bring out the best performance of the curtain walls. [3]

Curtain walls consist of the following components: **Fig. 2**

- Multiple substrates: such as anchors which represent connection points that provide strength and stability for unstable aluminum frame through the structure of the building.
- Aluminum framing: vertical cross-sectional units (constant section with different lengths) from aluminum in form of frames

called Mullion. With horizontal cross-sectional units (constant section with different lengths) from aluminum in form of horizontal rail called Transom.
- Stainless steel components.
- Glazing: Consists of spandrel panel and vision glass, even single or double.
- Rubber gaskets.
- Sealants.
- Insulations.

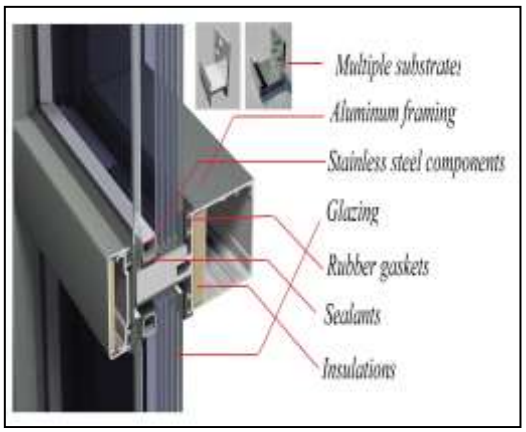

Fig. 2. Example of curtain walls

As for the architectural aspect, Curtain walls contain two main parts according to architectural performance:

- Vision area: it allows the natural light to enter into the interior spaces.
- Spandrel area: it hides structural members such as slabs and beams, and services such as electrical, mechanical, electronic, and sanitary services. [3]

The use of aluminum material provides high flexibility in design features through curtain walls profile, which provide complicated profile suitable to the clutch section. [3] **In addition to that, the research shows the use of aluminum with relatively low dead loads help to embed the services such as rain water drainage pipes, electrical wires, internet cables and security system wires especially that were subjected to explosions**.

B. Mechanisms and installation of curtain walls

Usually vertical mullion extends perfectly between one slab floor and other depending on the stick system by clamps. [6] These clamps, which are called (Wind Anchor), are suitable and efficient to carry the panels at a whole entire floor with a possibility of modification and an ease of implementation and installation. It also prefers to be used in the unitized system that has the ability to absorb large panels. [6]

Calculating the amount of thermal expansion of the frames should accompany the design expansion joints between the frames with silicon sealants, taking into account slipping joints which transmit shear forces infilling and finishing materials whether metal or glass. [6]

The architect usually deals, carefully and sensitively, with detail design of infilling and finishing materials. Such materials as glass with considerations of loads resistance

represent a thin flexible plate with weak resistance to fracture. So, according to those specifications it must deal with a lot of possibilities and expected negatives to increase the safety factor. [6]

Installation of curtain walls are four types (generations) according to assemblage:

- Stick System is a frame work that consists of factories components which are installed at the site, it is called by that because of the vertical structure sticks (mullion) fixing on the building structure, then horizontal elements (transom) are added. Glazing panels and spandrels are filled later. [5]

  Stick system allows direct adjustment in the location providing high flexibility in design. Its performance depends on the quality of the installation and is economically efficient if designed and produced correctly. Disadvantages of this system are the slow assembly process which is not suitable for rapid construction projects. [5] **Fig. 3**

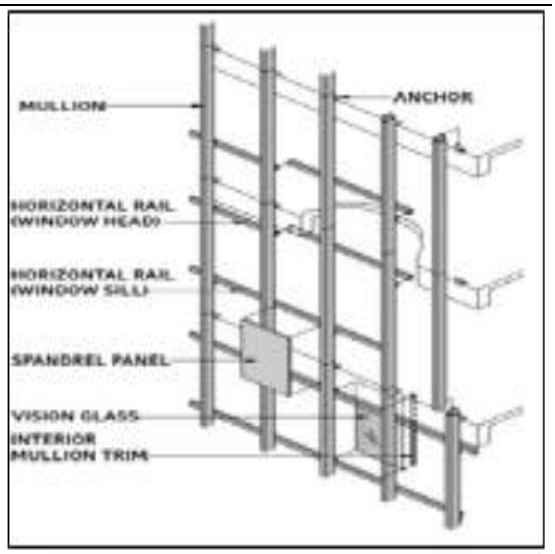

Fig. 3. Example of stick system curtain walls

- Unitized System consists of factory assembled frames by intersecting horizontal and vertical elements. Glazing and spandrel panels are prefabricated with factory tight. Usually, this system is suitable for buildings that suffer from movements because of settlement. [5]

  Advantages of this system are rapid installation, a reduction in construction time, a few employments in site, and a reduction in installation cost. Disadvantages of this system are the need for extra stores and expensive means of transport such as tower crane. [5], [2] **Fig. 4**

Fig. 4. Example of unitized system curtain walls

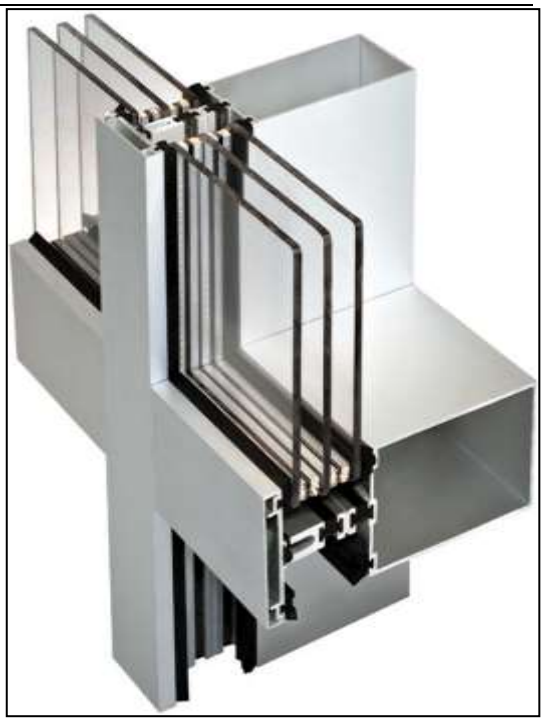

Fig.5 Example developed glazing svstem

- Developed Glazing System has an innovative production lines seeking to improve acoustic and thermal properties beside walls materials improvement such as sealants, adhesives and glass with efficient performance to integrate with aluminum claddings and finishing. [2], where are many types of available glass according to coating efficiency such as reflective coating, low emission coating and pyrolytic coating. [2] **Fig. 5**

- Double Glaze elevation System represents the concept of double elevation/double protection by adopting dual interfaces. Modern and contemporary idea of the systems used in building elevations by environmental comfort standards that are parallel to the technical, aesthetic and economic properties. The main idea for this system -which represents the inner walls of the elevations with thermal insulation under the principles of smart climate-, can be achieved through the integration of previous systems. [2] **Fig. 6**

Fig. 6. Example of double glaze elevation system of curtain walls

C. Design considerations for curtain walls

Curtain walls quality is measured by achieving two main principle aims:

- Improve the internal conditions through daylight and suitable temperature.
- Reduce the transmission of internal temperature heat through the building envelope.

The technological developments which accompany the glazing process have been associated with the development of finishing materials and improvement of specifications depending on the heat and sound transmission and explosions resistance. [1]

Thus, **the research concludes the necessity of achieving a third task under the concept of sustainability; by the reduction of resources and the merge of detail role in more than one task which was found for.**

D. Effectiveness and efficiency in detail performance.

Effectiveness and efficiency can be considered as the most important criteria which measure the detail performance that achieves the desired aim, so the detail will be multi task to integrate with continuous interactive process.

Effectiveness and efficiency aim to lead functions of the individual parts with a whole system towards achieving a common goal - or goals - using the least possible available resources with the highest degree, to achieve the principle of sustainability. [9]

Effectiveness is simply known as (a process to do right things). Therefore it is necessary to know the right things, define and identified them in order to perform effectively. In other words, it represents the degree of objectives accomplishment.

Efficiency is known as (a process to do things right). So, effectiveness and efficiency are: to do right things in right way. [9]

Effectiveness is achieved when there are clear and specific objectives with principles of growth and development. Efficiency is achieved when there

is a regulating, monitoring, following-up and maintenance. When there is effectiveness without efficiency, the goals cannot be achieved correctly. Otherwise, if effectiveness is absent with efficiency present, the element or detail will be accomplished without clear goals, like sustainability. [9]. Also we can differentiate between effectiveness and efficiency that effectiveness is the utilization of available resources to achieve specific objectives and goals, in other words, it is concerned with achieving results. Efficiency is related with the means that is followed to access these results.

So, **the research concludes that the performance is an interaction of two factors: the way in the use of resources –efficiency-, and results of such use –effectiveness-. Hence, the greater effectiveness and efficiency tend to high rate of successful performance.**

V. PRACTICAL STUDY

In order to reflect the main concept of the research depending on detail profiles of curtain walls **[Fig. 7]** with different angles to discover more possibilities for their assemblage in a new system to reach an integrated vision on the system of curtain walls. The first step in reducing resources of curtain walls, i.e. the detail of framing in curtain walls as well as the creation of channels to pass the rainwater drain conductors instead of drainage pipes that need later to the way packaging or hide.

Fig. 7. Example of curtain walls profile (different angles)

The research suggests that the components of curtain walls must be subjected to the principle of sustainability by mixing several services systems. Increasing the efficiency of detail by making it plays a dual role as a first step in reducing resources of curtain walls, i.e. the detail of framing in curtain walls as well as the creation of channels to pass the rainwater drain conductors instead of drainage pipes that will later need to be hidden. **[Fig. 8]** represents a sample –A- which is suggested by researcher that shows the concept of making the curtain wall detail plays a dual role as a rainwater drain conductor besides the farming principle**.**

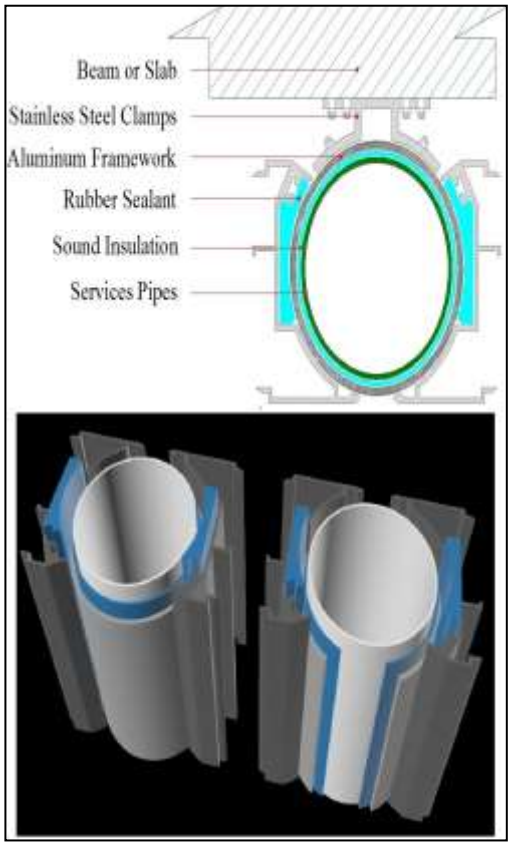

Fig. 8. Sample –A- Curtain walls profile with rainwater drain

Under the effectiveness and efficiency principles, the research aim to lead functions of the individual parts or details with the integrated system towards achieving a common goal - or goals - using the least possible available resources with the highest degree of benefit in order to achieve the principle of sustainability. **[Fig. 9]** represents a sample –B- which is suggested by researcher that shows the concept of making the curtain wall detail reduces the available resources with maximum benefits by assemblage several services systems (electricity, internet, security and other services) in pipes and installing them in curtain walls profile with pipe frame supports. Besides, these pipe frames support curtain walls profile from inside.

The proposed system represents a **conceptual model** that attempts to focus exclusively on the role of detail in increasing the efficiency and effectiveness of the curtain wall performance contributing to the concept of sustainability. This model can be viewed as providing a basis upon which to develop a practical methodology to direct experimental implementation and evaluation in future research.

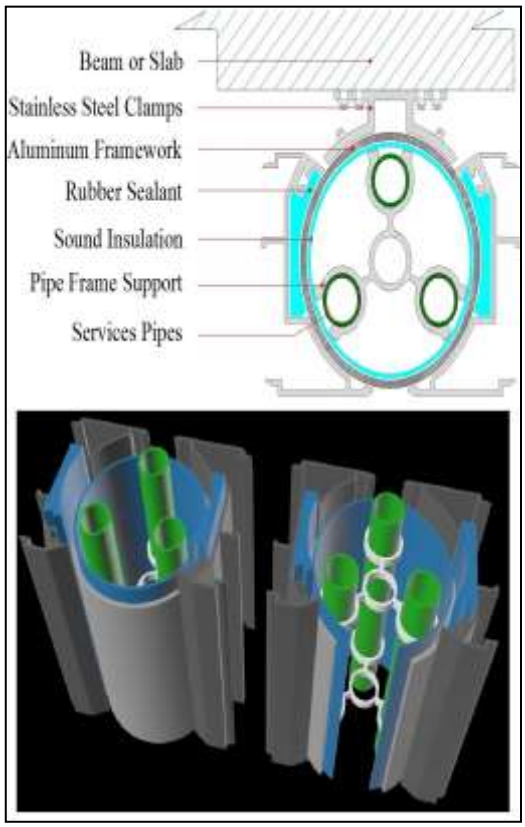

Fig. 9 Sample –B- Curtain walls

CONCLUSIONS

- Curtain walls are considered one of several ways that improve the performance of buildings' elevations as an envelope especially for buildings that are subjected to car explosion or other terrorist acts.
- The research clarified the role of detail in the definition of curtain walls that supports the integration of its elements, as well as the functional and aesthetic vocabulary under the concept of sustainability.
- The practical study introduced a model of curtain wall detail reflecting its role to attain sustainability through an integrated vision to produce new ideas and assembled details in a new system for the maximum service life as well as reducing the consumption of natural resources.
- The introduced model featured the increase of the efficiency and effectiveness of detail emphasizing its dual role as a first step in reducing resources through mixing several services systems under the concept of sustainability.

REFERENCES

[1] K. Kazmierczak, "Review of Curtain walls, focusing on Design problems and solutions", Design and Rehabilitation - session EE 4-1. 2008, pp. 3,10.

[2] J. Choi, Design & Implementation of limited Curtain Wall System, April 2005, Hong Kong, pp. 3,3,3,5,29.

[3] T. M. Boake, "Understanding the General Principles of the Double Skin Façade System," Associate Professor & School of Architecture, University of Waterloo, Nov. 2003, pp. 2,1,,1,3,4.

[4] http://sameer.alrehaili.net/?p=21. pp. 1,29.

[5] Kawneer White – An Alcoa Company. pp. 1,3,3,3,3,

[6] B. Kaskel, CURTAIN WALL STRUCTURES, lecturer in Elstner Associates, Inc. pp. 3,26,28,29,31.

[7] https://www.wbdg.org/systems-specifications/building-envelope-design-guide/fenestration-systems/curtain-walls. pp. 1.

[8] https://en.wikipedia.org/wiki/Sustainable_developmenthttps://www.google.iq/?gws_rd=ssl#q=definition+of+detail+in+architecture. pp. 1.

[9] https://ar.wikipedia.org/wiki/%D8%A5%D8%B9%D8%A7%D8%AF%D8%A9_%D8%AA%D8%AF%D9%88%D9%8A%D8%B1_%D8%A7%D9%84%D8%A3%D9%84%D9%88%D9%85%D9%86%D9%8A%D9%88%D9%85

دور التفصيل في الجدران الستائرية المستدامة تجديد واجهات الأبنية بعد حوادث الإنفجار في العراق

أنس حميد مجيد الجبوري
مدرس مساعد
قسم هندسة العمارة
كلية الهندسة / جامعة بغداد
بغداد / العراق

الخلاصة :-

لا يزال غلاف المبنى الخارجي واحداً من أكثر عناصر المبنى أهمية من الناحية الوظيفية، كما تمثل الواجهات مكون أساس يعرّف الجانب المعماري للمبنى وإمتلاكها للدور الحرج المتعلق بإدائية الطاقة وتفاعلها مع الوظيفة الداخلية. وكما هو حال التكنولوجيا الحديثة المتمثلة بالتقنية المتطورة في سعيها لتقديم الأفضل فإن العديد من الخيارات أصبحت متوفرة لتحسين إداية واجهات الأبنية كغلاف للمبنى. كما يعد غلاف المبنى خط الدفاع الأول والمباشر ضد التعرضات البيئية والفيزيائية شأنه شأن الجلد عند الإنسان، وتمثل الجدران الستائرية أحد المكونات المفتاحية لغلاف المبنى كونها القشرة الخارجية التي لا تحمل الأحمال المنشأية وبدون التاثير على جساءة منشأ المبنى. ومن هنا يمكن بيان الفجوة المعرفية في كيفية إيضاح دور التفصيل وتأثيره في مفهوم الجدران الستائرية وتكامل عناصرها ومفرداتها الوظيفية والجمالية تحت مفهوم الإستدامة لاسيما في تشكيل واجهات الأبنية المحدثة، ليمثل بذلك مشكلة البحث.

يهدف البحث إلى محاولة إبراز دور التفصيل وتأثيره في مفهوم الجدران الستائرية تحت مفهوم الإستدامة من خلال رؤية متكاملة للنظام تعكس أفكار جديدة وتجمع التفاصيل في نظام جديد، وتسليط الضوء آليات وعمل ومكونات الجدران الستائرية.

الكلمات المفتاحية: - التفصيل، الجدران الستائرية، الإستدامة.