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Towards new conceptual for architectural technologies (Lessons learned from Olympic Buildings)

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Abstract

The research deals with the study of the impact of Olympic events on architectural production by studying the developments in hosting events, especially Olympic sports events, and the availability of architectural and structural design capabilities. Structural systems technology is the source of creativity in architectural production. The research assumes that sports events provide an opportunity for architects to develop the creative field in the design and achieve the characteristics of the place and local identity. Therefore, the research aims to clarify the role of sporting events in creating architecture with advanced technologies by clarifying the relationship between architecture and the structural system, and the application of theoretical indicators for a number of architectural projects known for architectural excellence in their structural system. The research has indicated this relationship to be an incentive for architects in the development of their architectural productions and to be a source of inspiration and stimulus for creative processes.

Keywords: Event, Olympic, Architecture, Technology, Materials
2020 MSC: 97M80

1 Introduction

Mega events affect the type and path of city transformation. The World Exhibitions (EXPO), the Olympic Games, and the FIFA World Cup (FIFA) are located under the classification of mega-events. It is difficult to find a common definition that documents their key features and illustrates their transformative impact on host cities and countries [2]. Olympic events can be an opportunity to create new buildings and projects that attract visitors, tourists and local residents after the event ends [11]. The event sites provide an opportunity to realize the ideas of sustainability and flexibility and apply them in the designs of new projects, so that architecture is the engine and catalyst for change [6]. Sports buildings projects after the 1964 Tokyo Olympics took a new direction and vision in architectural and urban design, and it became a field of creativity in the architectural form distinguished by mega spaces, and the use of advanced structural systems [5]. The construction of Olympic events buildings faces structural difficulties, like other mega structures, in choosing the type of structural systems and the extent of its impact on the architectural form. In most cases, the structural form is part of the architectural idea of the designer, which is considered the strongest element of architectural expression when the structure expresses the power of design [4]. These megaprojects need an integrate, which is to join something else to form a unit or a comprehensive whole to show a combination of characteristics. [7]. Figure (1 and 2) illustrate the construction of the concept of integration in buildings.

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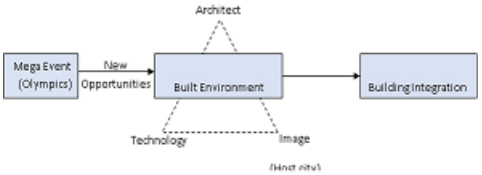

Figure 1: Illustrates the path to integration in the building through event opportunities and their employment by architects

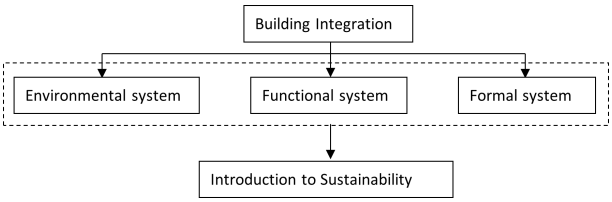

Figure 2: Illustrates the levels of integration in the building through which it is possible to reach the concepts of sustainability

Sports buildings, like other architectural structures, must meet the requirements mentioned by the Roman architect Vitruvius, which are: strength, utility and beauty. First, the correct and structurally efficient shapes are searched to ensure strength and stability, and then the functionally appropriate shapes are sought to achieve benefit, as the architectural needs of the space are among the important factors affecting the selection of the appropriate structural system [10]. Rush classifies that any building consisting of a group of structural systems whose interconnection achieves the physical form of four main systems, which are [9]:

1. (Structural system) (S)
2. (Envelope system) (E)
3. (Mechanical system) (M)
4. (Interior system) (I)

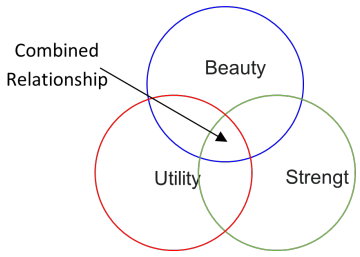

Figure 3: Illustrates the triple relationship of basic requirements in buildings

The testing of the structural system of these projects depends on the nature of the functional efficiency, the economic factor and the materials used in construction [1]. Achieving the greatest functional flexibility leads to a high degree of space efficiency, and the relationships that make up the structure may correspond to or conflict with the function of the building [3]. The relationship between architecture and Structural lies in the possibility of employing form with the elements of Structural and their uses as an expression by providing architectural meanings that represent innovation and technology [8]. Origin technologies offer high potential in formal transformation, achieving design flexibility, and finding control of the environmental balance between the inside and the outside through the techniques of movable or removable ceilings and walls, which characterize the architecture of sporting events [12].

2 Materials and Methods

(4) Different samples were elected for the Olympic pool centers, which are (1964 Tokyo Olympics), (1972 Munich Olympics), (2008 Beijing Olympics) and (2012 London Olympics). These samples were analyzed according to design ideas and knowing the impact of technology for each project and what the Olympic event provided. These host cities

on the one hand and the integration of architectural thought with the technological capabilities of the other hand, the classification of the technological aspects of these samples according to the techniques of Structural and materials techniques was adopted to show the design capabilities provided by the Olympic events in these cities as in Figure (4).

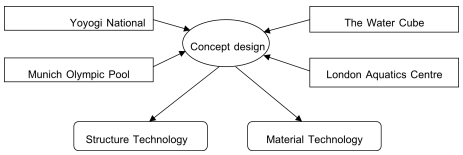

Figure 4: The method of analysis adopted in the study samples

The research used the opinions of (20) specialists in the field of architecture and construction technology to extract the verification results (at five levels) according to the Likert scale, and the values resulting from the questionnaire were dealt with the arithmetic mean measurement according to equation:

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{1}{n}\sum_{i=1}^{n} n_i$$

where, $\bar{x}$ =The Arithmetic Average, x = The result of each value, and n = Total number of values. To check the results and find out the expected deviation, the two equations for knowing the variance and the deviation standard were used:

$$\sigma^2 = \sqrt{1/n\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

$$\sigma = \sqrt{1/n\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

where, σ =Standard deviation and $(x_i - \bar{x})$ =The deviation of the data from their mean.

3 Results and Discussion

1. Olympic events in Tokyo (Tokyo / 1964): (Yoyogi National Swimming) Project
   (a) Concept design: The Olympic swimming pool building is characterized by providing thought that supports the trends of late modern architecture. The architect Kenzo Tange was inspired by the Japanese pagoda, influenced by the works of architects Le Corbusier and Eero Saarinen, by creating the curved shapes resulting from the structural structure of the building.
   (b) Structure Technology: Two peripheral concrete columns carrying the suspended ceiling were designed by means of cables with a total length of (280) m. They represent the backbone linking the two columns and the ceiling carrier, ensuring the design of the ceiling ensures the passage of light and achieving the view of the external gardens through openings designed in the side within the structure of the building.
   (c) Material Technology: Folded concrete panels and load-bearing iron cables were merged as a new technology, as the hall was characterized by having the largest suspended ceiling at that time. Figure 5 illustrates the technology elements of the national swimming pool (Tokyo 1964 Olympics)
2. Olympic events in Munich (Munich / 1972): (Munich Olympic Pool) Project:
   (a) Concept design: The sports buildings in the Olympic Park in Munich are an example of unity and harmony, as the company (Behnisch and Partners) borrowed designs from the shape of a spider's web using metal cables that can cover large areas.
   (b) Structure Technology: Metal pegs were used to support the cable grid, and the roof was covered with a transparent polyester insulation layer with an inner layer of polyvinyl chloride (PVC) that carries most of the weight of the roof, with the use of glass panels on the sides to give openness between the parts of the complex.
   (c) Material Technology: Acrylic glass panels with a thickness of 4 mm were used and fixed to a grid of cables. Figure 6 illustrates the technological elements of the Olympic swimming pool (1972 Munich Olympics).

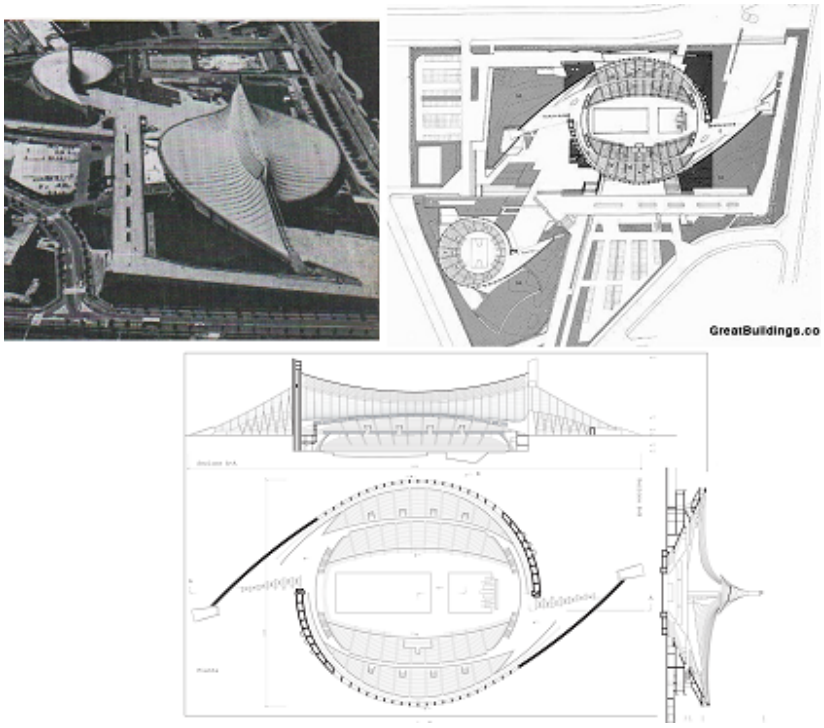

Figure 5: Structure techniques at Tokyo's National Swimming Pool

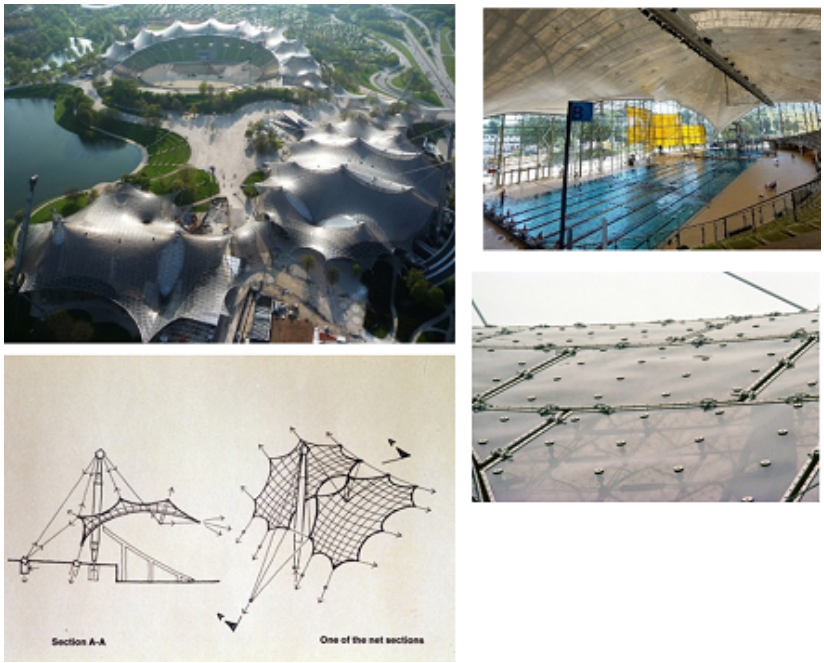

Figure 6: Structure techniques in the Olympic swimming pool in Munich Park

3. Olympic events in Beijing (Beijing / 2008): (National Aquatic Center (the Water Cube)) Project
   (a) Concept design: The Olympic swimming pool in Beijing is one of the features of the Olympic Park, which was designed by (PTW Architects) in the form of a cube that reflects the external shape as covered in water bubbles.
   (b) Structure Technology: Steel structure was used in the space frame system, forming a two-layer envelope that allows the use of environmental treatments and the preservation of the internal temperatures of the pool hall.

(c) Material Technology: More than 3000 design models manufactured under customized production techniques were used for the membranes covering the building's external structure and made of ethylene tetrafluoroethylene (ETFE) material, which are heat and fire resistant materials with a high degree and allow more light to pass through than traditional glass. Figure (7) shows the technology elements of the Olympic swimming pool (Beijing Olympics 2008).

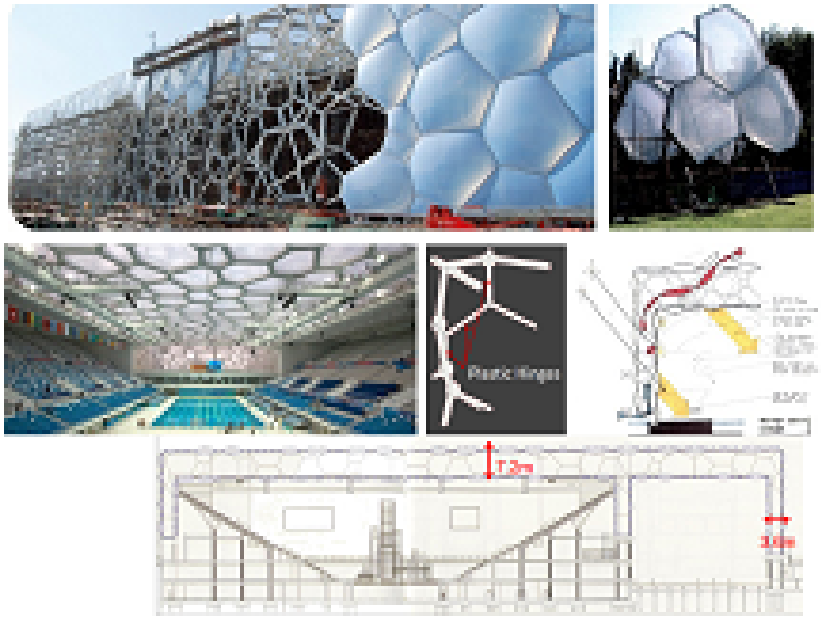

Figure 7: Structure and material technology at the Beijing Olympic Swimming Pool

4. Olympic events in London (London / 2012): (London Aquatics Centre) project
   (a) Concept design: The building is one of the main buildings of the London 2012 Olympic Games, which was designed by architect Zaha Hadid. the design idea was inspired by the movement and ripples of water during diving, and this appears on the roof of the building.
   (b) Structure Technology: The Structure Technology was characterized by the building based on only three pillars, representing the main structure of the building to ensure an excellent vision of the spectators, and its capacity was during the Olympic event (17500) seats, and the temporary part was removed after the event ended to be with a capacity of (2500) seats.
   (c) Material Technology: (314) Explosion-proof glass panels were used to cover an area of (2800) square meters, and plastic molds supported by glass fibers (GRP) were used to implement curved forms of concrete to achieve the required architectural aesthetics. Figure (8) shows technology elements of the Water Game Center (London 2012 Olympics).

Figure 8: Structure Technology and materials at the London Aquatics Centre

4 Conclusion

The results of the values of the opinions of specialists varied between the strongly degree and degree for the selected samples, the chart shown below these results.

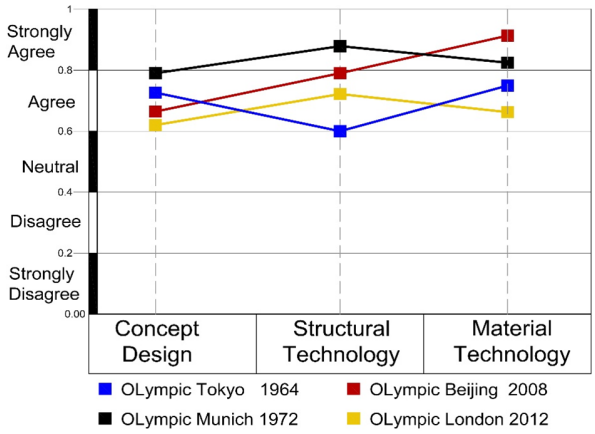

Figure 9: Shows the results of the final values obtained from the specialists questionnaire

The research reached the importance of the role of Olympic events as a motive for designing buildings with a clear impact in the technological aspects; this represents an opportunity for architects to employ new concepts related to structure technology and materials and to make these designs an applied field to enhance these concepts. As the era after the sixties of the last century was characterized by the use of Olympic buildings as a manifestation of the trends of modern and innovative structure techniques to be a clear example of the potential of technology at that time, The designs of the Olympic event buildings during the last two decades have also adopted orientations towards sustainability concepts, as the national swimming pool in Beijing 2008 was a clear example of the potential of energy conservation and enhancing the environmental aspect, while the Olympic swimming pool in London 2012 represented the concept of adaptation and functional flexibility in use, thus achieving the concepts of the economic dimension in sustainable development.

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