Environmental and economic efficiency considerations for the lightweight building in the industrial field according to the principles of sustainability

Prof. Mohamed Metwaly Morsy
Professor of Design, Metal Furniture & Construction Dept, Faculty of applied arts, Helwan University
mohamed.mutwali@yahoo.com
Prof. Emad Shafik Abd Elrahman
Professor of Design, Metal Furniture & Construction Dept, Faculty of applied arts, Helwan University
omdash14@gmail.com
Researcher. Ahmed Saied Gharieb Elghannam
Free Metal Construction Designer
a_elghannam@yahoo.com

Research problem:

In view of the paucity of studies on environmental and economic efficiency related to achieving sustainability in the mineral establishments of the industrial field, and where evaluation is a supportive process for the designer in making design decisions and the extent of the correctness of those decisions, the need to infer considerations of environmental and economic efficiency in the lightweight mineralogical field in the industrial field to achieve sustainability in that type of facility.

The aim of the study:

to reach evaluation considerations for the lightweight mineralogical structure in the industrial field that contribute to supporting design decisions.

Research methodology:

In the context of the study, the research follows the descriptive approach.

Research axes:

To achieve the target of the research, the study is based on the following axes:

The first axis: the environmental and economic efficiency of the lightweight mineral structure in the industrial field according to the concept of sustainability:

First, environmental efficiency: means environmental efficiency by preserving natural materials and ecosystems of the environment for the benefit of future generations, as the environment includes everything that surrounds, influences and is affected by.

The determining elements of the environmental efficiency of a lightweight metal structure:

- **The first element:** meeting the functions of origin in a way that does not prejudice the achievement of the environmental balance of users and their needs.
- **The second element:** controlling the environmental impact resulting from the processes (manufacture of raw materials of origin, establishment of origin, operation of origin, products of demolition or removal of origin).

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Environmental equilibrium for users of lightweight mineral origin as one of the determinants of the environmental efficiency of lightweight mineral origin:

Environmental equilibrium is in four forms: (physical equilibrium, radiative equilibrium, chemical equilibrium, psychological equilibrium).

Secondly, economic efficiency: economic efficiency means the effective use of resources and the drive towards innovation, by meeting jobs with better use of raw materials to provide the best performance while reducing the negative impact throughout the life cycle of the entire facility and thus reducing the loss of the implicit value of the raw materials, by maintaining their circulation in Closed loops such as reuse, repair, recycle, or refurbish.

The specific elements of the economic efficiency of a lightweight metal structure

The first element: the value of the lightweight mineral origin, which includes the relationship between job creation and the different costs of the structure.

The second element: the origin of the material to the principles of circular design.

The value of the lightweight metal structure as one of the determinants of the economic efficiency of the lightweight metal structure:

The value of lightweight mineral origin can be expressed by the extent to which the required function is achieved for a part or component of a lightweight mineral origin and subtract the alternatives in which we achieve this function and what alternative is chosen which must provide the lowest cost and appropriate quality required for its job in addition to meeting the diverse needs required of the origin meaning that the value expresses the relationship of the job to the cost.

And, we can mean that the lightweight mineral origin is of good value by performing the functions, costs and quality are appropriate and this can be illustrated by the following formula: Value = (job) / (cost).

Circular design as a specific concept of the economic efficiency of a lightweight metal structure

The term circular design appears in accordance with a design framework that follows the circular economy method and is one of the sustainable economic models. Circular design requires a shift in thinking as circular design searches for a way to meet the job with better use of raw materials to provide the best performance while reducing its negative impact throughout the entire life cycle and thus Reducing the loss of the implied value of the materials, by keeping them circulated in closed loops such as reuse, repair, remanufacture, refurbishment, or recycling.

The second axis is the pillars of environmental and economic efficiency in accordance with the objectives of sustainable design of the lightweight mineral structure in the industrial field:

First, the environmental and economic efficiency of the site:

The site environment of the lightweight mineral structure is considered part of the natural environment of the earth, which passes sustainable equilibrium cycles for the various components of the environment, and when the lightweight mineral origin of these courses is penetrated, it affects them and is affected by them. To achieve the environmental balance in the

site surrounding the lightweight mineral structure, ways of exchanging benefit and avoiding The negative impact of lightweight mineral origin eventually becoming part of the in situ ecosystem.

Elements affecting the environmental and economic efficiency of a site of lightweight mineral origin:

The first component is spatial characteristics: it includes topography, climatic conditions.
The second element is the urban structure: it includes (the general plan - ease of movement and access to transportation).

Environmental and economic considerations for the horizontal assembly of the site's lightweight metal structure:

Horizontal assembly refers to the method of placing the lightweight mineral origin in the horizontal direction from the urban perspective, that is, its connection with each other, which are groups of units that may be separate, semi-connected, or continuous. The method of horizontal assembly greatly affects the cost of lightweight mineral origin in general, and in general the economic efficiency of horizontal assembly is achieved. In the industrial field through (achieving industrial partnership and solidarity between establishments and grouping activities, ease of access between establishments and the possibility of integration and suitability of spaces for the nature of the industrial field, achieving progression according to climatic data, controlling the relationship between the area of origin and the area of services, T space methods depending on the type of industry).
Second, the environmental and economic efficiency of the formal authority:
The concept of the formal body of lightweight metal structure: The formal body is the external sensory body of lightweight metal structure.

Elements affecting the environmental and economic efficiency of the performance of the formal authority:

- Radiation gain of the formal body: Radiation gain is the amount of direct and dispersed solar radiation that the origin acquires through the exposure of the formal body to these rays, and that amount varies depending on the duration of the sun's brightness, radiation intensity, and incidence angle.
- Shading means: They are elements attached to the formal body of the structure and are intended for protection from sunlight-weight, and mainly aim to prevent sunlight-weight from falling on the outer covering of the structure when there is a need to provide protection from direct sunlight-weight without blocking visibility or reducing the effectiveness of ventilation Natural.

Air movement around the formal body: The air moves as a result of the presence of areas of low pressure to which air is drawn from areas of high pressure.

- The openings in the origin (windows and doors) and its effect on the internal ventilation: The openings of the doors and windows affect the movement of air inside the origin where the air moves inside the formal body due to the difference and variation in the temperature of the internal air and the temperature of the outside air, this leads to a variation in the air density, thus due to the different atmospheric pressure, therefore, the air moves inside the vacuum due to the thermal impulse.

- The ratio of the surface area of the walls of lightweight metallic origin to the area of the origin floor: Adjusting the ratio of the surface area of the walls of lightweight metal origin to the floor area of origin is one of the controlling elements for the unit of cost measurement of origin, and several studies have been conducted on the relationship of cost to the external form, the most important study carried out by a team. The work formed by the British Royal Institute (Reiners Research reiners) in the sixties of the previous century, on several different buildings in shape, height, and equal in area and the rest of the elements, and it turns out that the total cost of that group of buildings rises as the ratio of the building circumference to the area of the building increases. The more satisfied, the more complex the shape of the building.
- The structural effectiveness of the formal body: The structural effectiveness of the formal body expresses the use of structural configurations that accommodate the properties and nature of construction materials by achieving compatibility of the shape construction with a strong distribution of loads.
Utilitarian loss: It is the difference between the lost surface of the lightweight mineral origin to achieve a required benefit and the surface used to achieve that benefit.

Interaction of the formal body and outer envelope with the environmental surroundings of the lightweight metal structure:

The results of the study of Victor Olgyay showed that the environmental conditions are translated into the abstract forms of the structures, so that these formations express the different environments.

Cool areas: The low winter temperature affects the elongation of origin the light-weight in the western direction, while keeping the shape close to the square shape and achieving a ratio of 1: 1.1 as an ideal ratio, which may practically extend to 1: 1.3.

Temperate regions: The range of simple thermal change permits greater freedom in the forms of origin and allows for a greater elongation and achieves a ratio of 1: 1.6 as an ideal ratio and practically extends to 1: 2.4.

Hot - Arid: Winter conditions allow the rectangular shape, while the high thermal pressures in the summer require reducing this elongation again so that the buildings come closer to the square shape and achieve a ratio of 1: 1.3 as an ideal ratio and practically extend to 1: 1.6.

Hot Humid: The fall of sunlight weight on the northern and western sides of the origin greatly affects the elongation of origin in these two directions. This shape helps in providing better ventilation cases and is required in these areas in an urgent way and achieves the ratio 1: 1.7 as an ideal ratio and extends practically to 1: 3, and can be used. The free shape in these areas while providing suitable shading means for the exposed window to sunlight weight.

Third, the environmental and economic efficiency of the internal environment:

To achieve the efficiency of the internal environment of the lightweight metal structure in the industrial field, it is necessary to achieve these considerations

The third axis: Environmental and economic efficiency control systems for lightweight metal structures:

There are many ways to control environmental and economic efficiency, but we can generally divide them into active and passive systems.

The first method is negative systems: negative systems is the use of design elements that are environmentally compatible with natural energies in their original form, for an environment that is comfortable and appropriate without consuming traditional non-renewable energy.
The second method is active systems:
Active systems are systems that depend on taking advantage of natural energies in the environment around the lightweight mineral origin with the conversion of those energies by various techniques to other forms to take advantage of them.

Results:

1- The design of the lightweight mineral origin in the industrial field, preferably according to the working models, which include:
- To meet the functions of origin in a way that does not prejudice the achievement of the environmental balance of users and their needs.
- Control the environmental impact resulting from the processes (manufacture of origin materials, construction of origin, operation of origin, products of demolition or removal of origin).
The value of the mineral origin, which includes the costs and functions of the lightweight mineral origin.
Circular design which includes (design for the life cycle of origin, design for the function of origin, design for reuse in manufacturing, design for material recovery).
2- The achievement of the environmental and economic efficiency of the lightweight mineral structure depends on achieving the following points, including:
- The level of horizontal planning, which should achieve industrial partnership and solidarity between the establishments and achieve progression according to climatic data, support the concept of ecological park as a strategy to support efficiency
- The level of the formal body, which must be adjusted (the radiation acquisition of the formal body, the means of shadowing, the size of the openings and the direction, the movement of air around the formal body, the ratio of the surface area of the walls of lightweight metal origin to the area of the ground of origin, the structural effectiveness of the shape, controlling the ratio of utilitarian loss).
- The level of the internal environment, which must control the raw materials used internally to achieve environmental balance, and adjust the internal arrangement of the facility according to any of its different images, adjust the size of the internal space according to the production processes, the movement of the materials, and the number of occupants.
- The energy level which must be adjusted (the total energy cost of the construction process, the cost of energy during the operation of the origin and the performance of its function, the energy cost of disassociation and replacement).
3 - Achieving the environmental and economic efficiency of the lightweight metal structure requires combining the use of passive and active systems with the lightweight metal structure to achieve the environmental and economic efficiency.

Recommendations:

- Conducting a comprehensive study from all disciplines to formulate an Egyptian code concerned with sustainability and achieving its principles and goals in industrial facilities in general and lightweight mineral installations in particular because of the importance of these installations.
- Supporting studies related to environmental and economic efficiency control systems for the lightweight mineral structure in the industrial field, which are supportive of innovation and to achieve a priority in performance for these facilities.

Conclusions:

- The designer of lightweight mineral origin when carrying out the process of designing a structure for an industrial field should set the functional requirements of the structure side by side with each of the environmental impacts resulting from the processes (manufacture of origin materials, establishment of origin, operation of origin, products of demolition or removal of origin), the value of mineral origin Lightweight, circular design included.

Achieving the environmental and economic efficiency of the lightweight metal structure requires taking into account the comprehensiveness of the design at all levels (the level of horizontal planning, the level of the formal body, the level of the internal environment, the level of energy) using negative and active systems to achieve the desired efficiency.

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