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The Impact of the Contemporary Construction Materials on the Envelope of Buildings

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Abstract

The world is moving towards the economy and saving in using all available resources and going to natural resources to preserve and provide them for future generations. Developing countries are not excluded, because they are also keen to reduce public spending and reduce spending on building maintenance. One way to preserve it is to reduce its spending on building maintenance as the maintenance of buildings spend a lot of money to maintain it so that some countries use contemporary materials in reducing the number of times necessary to maintain the building without damage it, so it has been trending to use materials don't affected by external factors to reduce maintenance times. The study aims to identify the cost difference in maintenance between the use of traditional materials and new contemporary materials on the facades of buildings. To achieve the goals of the study, a comparison was made between the cost of maintenance using traditional materials and new materials used on the facade of buildings.

Keywords: Contemporary materials/ Traditional materials/ Building Envelop/Facade maintenance.

1. INTRODUCTION

Building is not a solid thing it's a part of our life that react with surrounding environment and with humans. After industrial revolution, the way designers and architects think in design building has been changed. They started using new technologies and new materials that has a huge Impact in building.

The materials impact on buildings have lots of types like (Thermal Treatment, Voice Processing, Maintenance, Environmental, Energy, Healthy,etc.). This research is focusing on maintenance because buildings maintenance especially high buildings consume lots of money. The main purpose of currant research is to reduce costs by using contemporary construction materials

Amobi C.O, 2006 showed that "maintenance could be defined in engineering vocabulary as the continuous upkeep, in good condition of a system to achieve operational reliability with maximum design output result, endurance and stability. This definition has been adapted for building maintenance as promising to keep or restore every facility, that is, every part of a site, building and content to acceptable standard. Thus maintenance aims at retaining components, equipment as well as the entire structure at specified level of performance [1].

There are many factors that affect the maintenance process These factors can improve maintenance and change it from its present shape to another which can be able to preserve the buildings, increase its life time and apply any environmental elements can save water and power resources . There are four types of maintenance (Corrective Maintenance- Predictive Maintenance- Periodic Maintenance- Risk-based Maintenance).

Material plays an important role in architecture design as a result of prosperity that happened in technology related to material science, deeper understanding of material performances and the way we address it as a construction materials. The relationship between architecture and material had been completely clear since the industrial revolution .Materials was chosen for their usefulness and availability or they were chosen for their appearance and decorative quality.

1.1 Materials in Engineering

Material plays an important role in architecture design as a result of prosperity that happened in technology related to material science, deeper understanding of material performances and the way we address it as a construction materials. Designing is an endless process of choosing and arranging elements trying to achieve the most important element and how these elements may play an important role in creation anew product [2]
There are three traditional material classification systems all engineers have to study them. Studying the structure of different material classification helps engineers to put materials in perfect place by understanding their behavior. These traditional material classification systems are:-
-Scientific classification:- The scientific classification aims to understand the basic of internal structure of material.
-Engineering classification:- Engineering classification helps engineer to mix properties to solve the problem better.
-Traditional architectural classification:- Architectural classification tends to be more descriptive, it's simply schedule material and use it according to standard construction requirements [3].

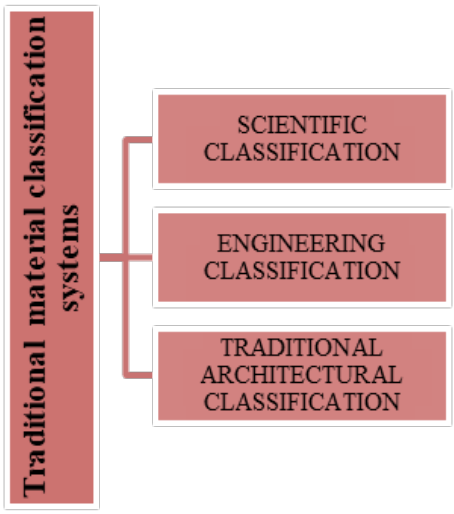

Fig. 1: Traditional material classification systems

2. LITERATURE REVIEW

2.1. Contemporary Construction Materials

Contemporary Construction Materials means any material used for a construction purpose. Many naturally occurring substances even twigs and leaves have been used to construct buildings

2.2. Types Contemporary Construction materials

2.1.1 Nanomaterials

The history of nanomaterials began immediately after the big bang when Nanostructures were formed in the early meteorites. Nature later evolved many other Nanostructures like seashells, skeletons etc. Nanoscaled smoke particles were formed during the fire use by early humans [4].
The nanomaterials field contains subfields that develop or study materials that have a unique characteristics arising from their nanoscale dimensions [5].

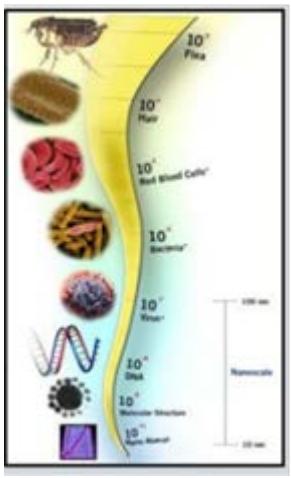

Fig. 2: images showing the various levels of nano scale

2.1.2 Smart Materials

Smart materials are those objects that are sense environmental events, process that sensory information, and then act on the environment. The basic characteristics of most smart materials, the traditional materials used in architecture are selectivity, immediacy; self-actuation and directness architecture are selectivity, immediacy, self-actuation and directness [6].

2.1.3 Sustainable Materials

Sustainability is considered as an appropriate framework to gather all efforts aimed at improving the built environment through the development of social, economic and environmental aspects. Sustainability is defined on the basis that regeneration brings changes to the local environment, economy and society and these three dimensions are often used to measure sustainability [7].

2.1.4 Biomimic Materials

The word biomimicry originates from the Greek word bios, meaning life, and mimesis, meaning to imitate. Biomimetic is a new system that studies the best ideas in nature and then imitates these designs and processes to solve human problems. It is a way of observing nature in action and using that knowledge to inspire new ideas [8].

2.3. The concept of maintenance

Maintenance can simply be defined as" a group of tasks and steps that should be performed in order to keep the building or one of its parts in an acceptable state, increase its lifetime, improve it, prevent the fast deterioration of the building and ensure the safety of the users[9].

2.3.1. Maintenance Planning

Maintenance planning is the advance preparation of selected jobs so that they can be executed in an efficient and effective method when the job is performed at some future date.

1. Requirements of Maintenance Planning Process
2. The Roles of Maintenance Planning Office [10].

2.3.2. Types of maintenance Operation

1. Preventive Maintenance
2. Corrective Maintenance
3. Condition Based Maintenance

4. Deferred Maintenance
5. Building Repairs/ Breakdown Maintenance [11].

2.4. The new characteristics of contemporary materials

As a result of the development of the technology specially building materials technology, and with the trying of the designers and architects to benefit of that development and use it in designing, a new characteristics of contemporary materials appeared which helped development in architecture [12].

2.4. 1 Self-cleaning

For the function to work, UV light present in normal daylight is sufficient to activate the photocatalytic reaction. Organic dirt on the surface of a material is decomposed with the help of a catalyst – usually titanium dioxide that has been used in all kinds of products. Photocatalytic surface coatings are often applied to façade panels made of glass or ceramics or to membranes [13].

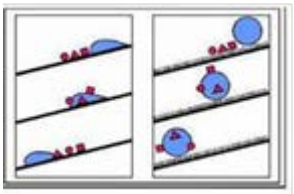

Fig. 3: The difference between a flat surface and self-cleaning surface

2.4. 2 Easy to clean

Easy-to-clean surfaces are smooth rather than rough [15]. As a result it reduces surface adhesion, this results in water to be repelled and in forming droplets and running off. Easy to-clean surfaces are therefore hydrophobic, water- repellent and often also oil-repellent [13].

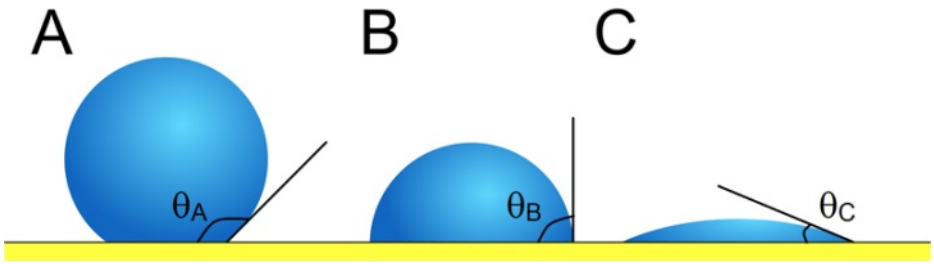

Fig. 4: The angel of contact determines the hydrophobic degree of a surface. The contact angle describes the degree of wetting, and is a function of the relative surface tensions of the solids, water and air.

2.4.3 Anti-fogging

Anti-fogging surface coating is technology that warms the surface. On hydrophilic surfaces moisture forms an ultra-thin film instead of water droplets. It still settles on the surface but remains invisible .The film is transparent, creating a fog-free clear appearance [16].

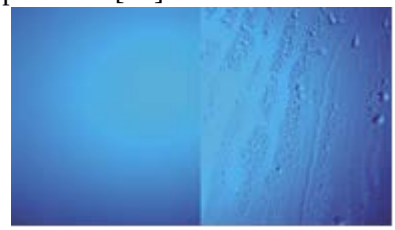

Fig. 5: Anti-fogging.

2.4.4 Anti-graffiti

An anti-graffiti function is intended as a preventative measure to avoid unsightly graffiti to buildings or construction such as noise barriers, walls and bridges piers that can be protected efficiently by using such nano-based coatings [14].

Fig. 6: Graffiti on Alnahda statue

2.4.5 Anti-reflective

Anti-reflection coatings are designed to reduce surface glare, increase substrate transmission and brightness and offer better contrast definition by reducing surface reflections over a specific wavelength range [17].

Fig. 7: Anti-reflective Glass

2.4.6 Anti-fingerprint

An anti-fingerprint coating can offer a suitable solution for this problem and in some cases makes it possible to employ such materials in the first place [17]

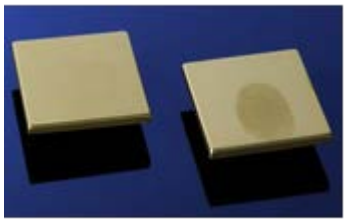

Fig. 8: Anti-fingerprint

2.4.7 Anti-bacterial

Photocatalytic surfaces have an antibacterial side effect due to their ability to break down organic substances in dirt. With the help of silver nanoparticles – for its antimicrobial properties, it is possible to manufacture surfaces specifically designed to be antibacterial or germicidal [15].

Fig. 9: Anti-bacterial

2.4.8 Air-purifying

The air purifying properties are beneficial in both cases, and play an important role both for indoor as well as increasingly for outdoor environments [14].

Fig. 10: Concrete paving panels with photo catalytic air purifying properties used as a design element in a car park.

2.4.9 Anti-moisture

It's used in areas prone to constantly high degrees of humidity such as coastal areas and places which significantly take care of healthy [17].

Fig 11: Anti- moisture paint

10- Fire proof

In the event of fire, the fire-resistant layer expands in the form of foam preventing the fire from spreading and keeping escape routes accessible for users and firemen alike [19].

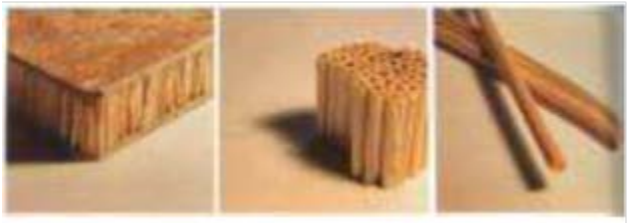

Fig 12: A robust sandwich panel made of straw and hemp with a glassy coating that serves as bonding agent and is also fire-resistant. When exposed to fire the product and extinguishes

11- Nano Concrete

Nanomaterials that added to concrete are extremely effective [20]. That shown great results in concrete properties and its quality, it gives the way to the emersion of new types of cement, concrete and admixtures, such as carbon nanotubes that can be effectively added to concrete in order to reinforce it [21].

Fig 13: Concrete under force, small and narrow cracks happen instead of one big crack

3- ANALYTICAL STUDIES

3.1. Building Classifications

Health Care Building - Agricultural Building
Commercial Building - Residential Building
Educational Building - Assembly Building
Government Building - Industrial Building
Military Building - Religious Building
Transport Building

3.2. Case Study Selection

One or two example of each classification is studied in the research case study like (2 examples of educational buildings- 2 examples of health buildings- 1 example of social building- 1 example of administrative building) to represent almost all building classification

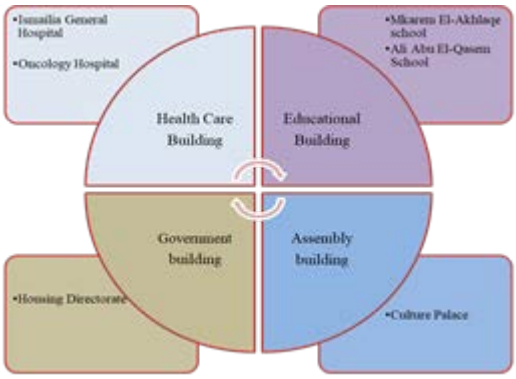

Fig 14: Case study

3.3. Case Study

3.3.1 Health Care Buildings

Because of the nature of the building and where it deals with all categories of society, some damage occurs to external materials and as the materials used in the facades are traditional materials with a short lifetime in addition to the activity in the building and its nature, so the building's facade affected with all of it.

❖The effect of the activity in the building and its nature on the exterior materials.

- Accumulation of dust on facade paint.
- Change the color of the facade paint due to direct exposure to sunlight.
- Accumulation of dust resulting from using the incinerator on facade paint.
- The facades paint is affected by the fingerprints of the patients and the existence of blood on the walls.
- Effect of patient bed movement and its hit on walls.

- The frequent use of disinfectants led to the deterioration of internal materials resulting problems with facades such as leaching.
- The appearance of a filtration on the facades of buildings due to poor drainage condition

So perfect materials must be used in health care building that save maintenance cost is :-

Table 1: Comparison between materials to find maintenance cost, and savings in health care building

Used material	M2/15year	Contemporary Materials	M2/15year	Saving
Coating Material	64.15	Self-Cleaning/ Easy to clean/ Anti-bacterial/ Anti-moist	38	59%
Glass	82.11	Self-Cleaning/ Easy to clean/Anti-finger print	48.5	59%
Granite	88.53	Self-Cleaning/ Easy to clean/ Anti-graffiti	52.3	59%

3.3.2 Educational Buildings

Because of the nature of the building and where it deals with student from 3 to 22 years old, some damage occurs to external materials and as the materials used in the facades are traditional materials with a short lifetime in addition to the activity in the building and its nature, so the building's facade affected with all of it

❖ Some damages external materials such as:

-Writing on the walls.
-Student’s footprints and fingerprints on walls.
-Bad condition of drainage and water cycle which cause filtration on building facades

So perfect materials must be used in educational building that save maintenance cost is :-

Table 2: Comparison between materials to find maintenance cost, and savings in educational building

Used material	M2/15year	Contemporary Materials	M2/15year	Saving
Coating Material	57	Self-Cleaning/ Easy to clean/ Anti-bacterial/ Anti-moist	43.8	76%
Glass	22.2	Self-Cleaning/ Easy to clean/Anti-finger print	32.2	-45%
wood	249	Fire proof/ anti moist	240	4%

3.3.3 Assembly Buildings

Because of the nature of the building and where it deals with all categories of society, some damage occurs to external materials and as the materials used in the facades are traditional materials with a short lifetime in addition to the activity in the building and its nature, so the building's facade affected with all of it.

The nature of these buildings deals with different types of people such as the owner, customers, and tenant, so the exterior materials of the building were affected by all of that. Some damages external materials such as:

-Writing on the walls.
-Client’s footprints and fingerprints on walls.
-Bad condition of drainage and water cycle which cause a filtration on building facades.

So perfect materials must be used in Assembly building that save maintenance cost is :-

Table 3: Comparison between materials to find maintenance cost, and savings in Assembly building

Used material	M2/15year	Contemporary Materials	M2/15year	Saving
Coating Material	57	Self-Cleaning/ Easy to clean/ Anti-bacterial/ Anti-moist	43	75%
Glass	88.8	Self-Cleaning/ Easy to clean/Anti-finger print	7.6	91%
Granite	43.6	Fire proof/ anti moist	14.6	66.5%

3.3.4 Government Buildings

Because of the nature of the building and where it deals with all categories of society, some damage occurs to external materials and as the materials used in the facades are traditional materials with a short lifetime in addition to the activity in the building and its nature, so the building's facade affected with all of it.

The nature of these buildings deals with different types of people such as the owner, customers, and tenant, so the exterior materials of the building were affected by all of that. Some damages external materials such as:

-Writing on the walls.

-Client’s footprints and fingerprints on walls.

-Bad condition of drainage and water cycle which cause a filtration on building facades.

So perfect materials must be used in Government building that save maintenance cost is :-

Table 4: Comparison between materials to find maintenance cost, and savings in Government building

Used material	M2/15year	Contemporary Materials	M2/15year	Saving
Coating Material	57	Self-Cleaning/ Easy to clean/ Anti-bacterial/ Anti-moist	43	75%
Glass	88.8	Self-Cleaning/ Easy to clean/Anti-finger print	90	-1.4%

4. Conclusions

-The building is influenced with its surround environment

-Because each building has different characteristics from any other building, whether the nature of the activity or the factors that are exposed to it, so the materials used in each building should be different from the other.

-Economic management is one of the most important parts in the maintenance operations as it has an effective impact to complete the maintenance successfully.

-While there is an international consensus on the philosophy of building conservation, which recognizes the importance of maintenance as a positive benefit, maintenance is a neglected issue in many countries.

-Types of maintenance plans have significant role in achieving sustainability of buildings. The periodic and productive maintenance have high role in preserving building in good condition.

-Using contemporary material in right way improves buildings lifespan and reduce maintenance coast

-The concept of maintenance was, until recently, considered a luxury, considering the costs of maintenance work as a burden that must be reduced and a waste of money that must be rationalized - however, the series

of buildings collapse had a positive role in forming a public opinion in the community of the importance of the role of maintenance and restoration in protecting lives and achieving security and social peace.
-Material is a strong variable factor which influences the design process, it is our focusing area to be investigated

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