

PERCEPTION OF BUILDING MATERIALS IN ARCHITECTURE

O. A. Soliman¹

ABSTRACT

This research addresses the possibility of using the perception of building materials as a tool for upgrading the architecture. This issue is addressed by this search through two themes; the first theme handles the theoretical background of perception and the potential of using it for expressing the design's objective, idea or function, The second theme addresses the building material and its role in the building, its classification and the techniques of dealing with it for enhancing its properties, so that such material shall have new uses and alternatives changing its texture in terms of the form, function and benefit. Perception levels of the material representing an essential standard in selecting the material for design process for achieving a successful architectural building.

KEYWORDS: Perception, Impression, stereotype, Material Attributes, Texture, Properties.

1. INTRODUCTION

Currently, the increased diversity of architectural materials, which have been developed, has undoubtedly made the building material one of the successfulness and efficiency factors the architectural building's performance. The building material sometimes helps in confirming the design idea and perceiving a meaning or function in the building and you can perceive the building's orientation and designer via the used building material. There are well-known architects prefer using certain architectural material in their projects in a reiterated manner such as Architect Frank Gehery +Metals, Alvar Aalto +Brick, KengoKuma+Wood, Zaha Hadid +Composite Fibers and Oscar Neimeyer +Concrete [1].

¹ Lecturer, Department of Architecture, Faculty of Engineering, Mattaria, Helwan University.
Olfat_hlwa@yahoo.com

Due to the different techniques we have become unable to recognize our real perception of materials. The material can be given an impression by another material and the impression is mostly in terms of the form, the matters which affects the function and dispel the aesthetic perception and stereotype of the original material in the long run. For example: Selecting the material of ceramic with the texture of wood in a living space shall not be the most appropriate; whereas the perception is in form as to the wood but loses one of its properties represented in the feeling of warmth. The user of space loses the sense of relief while the same selection shall be good in another architectural space.

1.1. The Problem

The problem is represented in the following two basic themes:

-One tends to select natural building materials; the matter which negatively affects the natural resources and is opposite to the orientation towards sustainability.

- Orientation towards the fabricated and mixed material for producing materials with natural texture and only give form perception of natural materials results in a conflict in the impressions of the receiver or user. This conflict happens because the alternative material does not achieve the same properties of the original material, or due to using replacement materials don't achieve comfort to the users. The importance of perceiving the nature as a whole emerges in cactus cellular towers - harmony of nature- Arizona -USA [2]. Whereas the user shall have a conflicted perception and impression upon using a material out of its place - Conversion of a space of unused elevator into a bathroom and using a transparent floor in the 15th floor- Mexico- Perception of material and impression of fear of Architect Hernandez Silva in penthouse unit in Guadalajara[3]. Perception of a virtual wall made of laser for making the road cross more safe for the pedestrian; designed by Hanyoung Lee [4]. You even can perceive an idea or message without any material as done by a Chinese man who has drawn a three-dimensional boy and wrote "Don't ignore me" for attracting the society's attention towards the displaced children [5] (Fig. 1).



Fig.1. Impact of perception and the importance of using it as a tool for the design and to express of concepts, Source: Author, [2], [3], [4] & [5].

1.2. Objectives

-Study framework that represents the different aspects that relate to the material choice in architectural projects to achieve the perception and impression of the designer who wants to give him in the building [6].

-Considering the perception levels of the building material as a standard for selecting what is suitable for the spaces of the building and its architectural mass.

1.3. Approach

For reaching the research's objective, the study addresses following points:

-Basic conceptions of perception process and its types and importance.

-Considering the building material and factors affecting its selection in the architectural design and techniques of dealing with the material due to multiplicity of its perception more than any other material.

- Considering and analyzing examples of building materials, diversity of the alternatives of its perception by other materials and the factors of selecting such alternatives and techniques of dealing with the material for achieving the perception level required by the building user.

2. PERCEPTION

The term perception is derived from a Latin origin "Perceptio" means to feel, to comprehend and to take hold of. Via looking into dictionaries it has been found that the most accurate definition is the awareness through the senses [7].

The perception is the way through which the man contacts his environment. The man cannot practice his life and preserve his presence without recognizing the contents of his environment. The perception has a great importance in orienting the human behavior [8].

The texture is defined as a group of properties determining the feature of any surface whereas each material has a different texture such as the coarseness and softness. The man recognizes these properties at first sight by vision and then realized by touch. Such matter is obviously clear in the difference between the textures of the surfaces of concrete, wood, steel and plastic [9].

2.1 Perception Levels

a- The Sense Perception: is the reception of information by senses (sight, hear, touch, smell...).

b- Extrasensory Perception "ESP": Communication outside of normal sensory capability as in telepathy &clairvoyance, a mental process by which meanings are given to what has been received by the senses. (Selection, organize, interpretation)

2.2 Relationship between the Impression, Perception and Stereotype

The perception is defined as the comprehension of stimulators depending on the experience. It involves the two processes of receiving and comprehending the stimulator. It supplies the brain with information and internal and external changes to efficiently perform his functions. Perception depends on the awareness and attention .

The impression is an effect, feeling or preserving an image due to the experience. The word of impression means the initial feeling and the image stored by the person's memory about a person or something- cognitive experience. According to the studies, the first impression is formed during a period of 30 seconds from viewing

the other depending on many factors, including his overall appearance that involves his neatness and accessories, his facial features reflecting his psychological natures and the overall behavior and the manner of speech with the other parties. The stereotype is a concept used to indicating that the only feeling of any person about an event he never experienced is resulted from his mental fancy of the event and that what he undertakes does not depend on a certain knowledge or practice, but depending on an image he made or given to him.

Linking between these three elements results in building theories about the things and persons vary according to a certain order because it is considered like placing groups of people according the ages and sometimes according to the genera. Consequently, permanent hypotheses are to be built around each category; starts with the impression for forming your ideas .., then perception of coordinating it..., then the stereotype for fixing it.

3. BUILDING MATERIAL

The building materials are critical elements affecting the architectural output. Along with the development of possibilities of traditional building materials and the increasing knowledge of its architectural and constructional properties and possibilities in addition to the other influencing factors, such as political, social and economic factors, the architecture has developed across the different civilizations [10]. The material, as one of the architectural formation, has developed in terms of the engineering properties, its special features have changed and the suggestive meanings and impressions as to the viewer have become numerous [11]. There are some natural materials containing inscriptions, such as marble and wood, Architect can exploit these properties in the architectural formation of the internal and external designs .The area of material also affects the architectural formation, for example, although the large areas of marble lead to increasing the vitality, yet there are fears that such matter may lead to a negative effect on the architectural expression intended to be achieved in the building; through giving a sense of heavy .

3.1 Classification of building materials

The material is used in the architecture whether in its natural form, such as stones and wood, prepared in accordance with special specifications, such as brick or concrete, or manufactured, such as cement, glass or ceramic. For obtaining the best form results of using the material, its physical, chemical and mechanical properties must be suitable for its functional purpose. Some materials are designated for internal use and some are designated for external use due its resistance to weather.

3.2 The Role of building material in Architecture

It involves one of the three utilities; structural, finishing or complementary. The material sometimes undertake more than one role at the same time across all the design levels, whether the Interior design, architectural design, landscape and urban design.

4. TECHNIQUES

4.1 Techniques of Dealing with the Building Material

4.1.1 Manufacturing

The relationship between the building material and architecture has remained simple until the industrial revolution. Whereas the selection of material was based on its availability or external form and the selection of architects before the 19th century was based on the form and functional jointly (this matter was logical). Furthermore, at that time there was no classification or global measures of the building materials. The role of building material has changed due to the progression of industrial revolution. In the past, the architect used the traditional building materials, such as the stone and wood, with its advantages and disadvantages jointly. Then the science of building materials has developed and these material's properties have become adjustable to fit to design proposed by the architect.

4.1.2 Smart technology

The smart materials have provided greatly and efficiently solutions to adjust the materials. For example, photochromic materials' color is changed according to Light

intensity; when the more lightening environment, the more dark colors and vice versa. This matter creates a balance in terms of the color makes the human eye comfortable, so that we find that the smart materials ought to closely relate to the architecture due to the permanently changed nature of the architecture designs.

4.1.3 Nanotechnology

Applications of Nanotechnology have contributed to the production and development of many environmental-friendly products, such as the production of paints and coating materials of wooden buildings, via using Nanotechnology-treated compounds instead of organic compounds in the traditional coating to resist the Sun's ultraviolet without affecting the coating quality and life, decreasing the costs of maintenance, energy and enhancing the quality of air and internal temperature of houses due to the reduction of water and humidity absorption, consequently, reducing the invoices of air-conditioning and heating, preventing the growth of bacteria, and it is easy to be cleaned using water.

Hopefully, in progress for developing a similar technology for protecting the concrete, glass and metals. The Green Buildings Project (environmental-friendly) can be completed without any additional cost compared with the normal buildings and, sometimes, with a less cost.

4.2 Reasons of Using the Technologies for Changing the Perception of Material and Texture in Architecture

The alternatives of material perception using the technologies have multiplied. The researcher attempted to classify the reasons according to principles of design:

Aesthetic: Such as the nature, dazzle, rates of comfort, local environment, achieving the designer's idea and the ability of change and transformation.

Utility: The functional and flexibility of design, availability, health reasons, sustainability achievement and smartness achievement.

Durability: Quality, cost-limited maintenance, installation easiness, protection against fire, thermal and acoustic properties, water permeability and light weight.

5. THE TECHNOLOGIES' IMPACT ON BUILDING MATERIAL PERCEPTION IN ARCHITECTURE

Whereas an analytical study is made concerning examples of the building materials in terms of the alternatives of material perception and development of material, whether structural, finishing or complementary, according to the used technology and the reasons of using the technologies for changing the perception of material and texture.

5.1 Natural Materials

5.1.1 Soil Materials

Such as Stone, whether Igneous Rocks, metamorphic rocks like Marble or Sedimentary Rocks. Alternatives of material perception: Paints with stone's influence and texture, ceramic, stamped concrete, wall paper and plastic.

Example: Planet Africa Restaurant, Triumph Square, Heliopolis. The building is structural made of reinforced concrete, but the project's design idea depends on the life of African caves. The designer has resort to use GRC material to give an impression of rocks and perceive the texture of stone material for enabling the users to perceive the building according to the designer's vision (Fig.2).

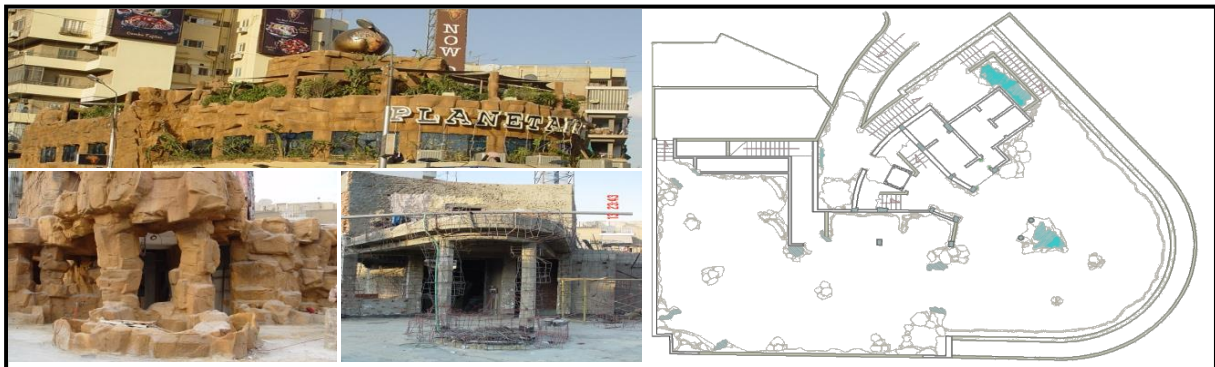


Fig.2. the GRC material for the perception of rock and texture of stone .Planet Africa Restaurant, Heliopolis .Source: Author

5.1.2 Organic Materials

a- Wood

The Wood has advantages such as comfort, nature and providing warmth and disadvantages such as cost, color change, maintenance, humidity and insects.

The Possibility of Material Perception: Paints with wood's influence and texture, ceramic easy to be cleaned, cheaper and resistant to fire and water and needs no maintenance like wood, Vinyl, wall paper with the impact of wood, stamped concrete and aluminum.

Examples: Al Nabawi Medina moving domes with metal structure moving on metal bars. The move of such domes is controlled by a main control center in the mosque. Its mechanical possibilities give a healthy environment to the depths of the mosque through bringing air and light refreshing the place and man. The domes are distinguished by aesthetic specifications; whereas the users and prayers recognize that it made of ornamented wood [12] (Fig.3).



Fig.3. Al Nabawi Medina moving domes and perception from inside, ornamented wood .Source: [12].

-Natural wood for achieving the comfort to the space of physical therapy and rehabilitation, Wadi El Nil Hospital, Hadayek El Kobba, Cairo.

-The RaiffeisenWohn center (Residential Centre) in the energy-saving ,house made of larch wood, purely natural and best protected by NANOSTONE particle (silane) coating Protects, the high-performance water-based wood preservative. The environmental-friendly and climate-friendly passive or zero-energy house that captivates with a facade made of unplanned wood that conveys a sense of natural un sophistication [13].

-The material of WOOD.E can be connected to 12v power supply. It consists of conducting layers insulated from each other and compressed in a form with parts of wood. These layers allow for unprecedented possibilities for sound, light, and motion to be combined seamlessly with wood and furniture [16].

Or using a special wood and treated to resist the humidity and water as the products of Russian Avanti [17] (Fig. 4).



Fig.4. Diversity of perception of wood by more than one material or by the wood material itself after making treatments for changing some of its properties.

Source: Author, [13], [14], [15], [16], [17], [18], [19] & [20].

b- Leather

The Possibility of Material Perception: The diversity of the original material; the leather, or by many material, such as ceramic, gypsum boards, GRC and paints. For example, center blue max ateliers apparatus, whereas the real perception of leather in a building within a group of buildings and workshops external facade covered with leather, the matter which give a different personality of the building. The leather is used for achieving the design idea expressing the productive workshops [21].

Leather-textured paints have emerged using the technology of painting by sponge or paints like Scib decorative acrylic paints with soft texture containing micro granules give the effect of chamois or wall leather.

The Role of Material in the Architectural Space: The role of leather in the past was a structural role in the constructions made of tents and the perception possibility of the leather material, as a finishing of the internal facades and sometimes the external ones became real after the development of technology. The leather also has a complementary role in furnishing the space and finishing the doors for instance.

Material Perception: It is a positive impression at first because it was rarely used and it is used due to its aesthetic properties, but not for its function. Consequently, the form perception is achieved through any material and achieves the design objective as well; i.e. (Fig.5).



Fig.5. Alternative of perception of leather by more than one building material
Source: [15], [21] & [22].

5.2 Mixed Materials

5.2.1 Concrete

Although it is not a natural material for working producing perception alternatives of it, yet a great rise has been made in enhancing the concrete properties and producing types of it like :

-High-Performance Concrete, Light- Transmitting Concrete, Translucent Concrete, Pervious Concrete, Autoclaved Aerated Concrete& Floating Concrete[23].

-The smart concrete developed by University of Rhode Island engineering.To create her unique form of self-healing concrete. Tiny capsules of a sodium silicate healing material that ruptures when cracks form in the concrete. The gel spills out, repairing the cracks, the self-healing concrete regained about 2.5 times more of its original strength than traditional concrete [24].

-Novacem Carbon-Eating Cement, a cement substitute made of magnesium silicate, actually absorbs CO₂ from the atmosphere. It could potentially achieve one of the single largest reductions in CO₂ emissions in construction, cutting out 800kg of carbon emissions per ton of poured concrete and absorbing another 50kg [25].

-Biological Concrete. That captures rainwater to create living walls of moss and fungi. Unlike existing vertical garden systems which require complex supporting structures, Reduce the Cost of Maintenance, the new "biological concrete" supports the growth of organisms on its own surface, according to researchers from Universitat Politècnica de Catalunya in Barcelona [26](Fig. 6).



Fig.6. Diversity of perception of concrete after making treatments for changing some of its properties and functions. Source: [23], [24], [25] & [26].

5.2.2 Clay

Example: Badran Residence, Al-Mohandeseen, Giza, Architect Gamal Bakry (1970).At first, the Constructional idea was based on the idea of building using clay

and simulating the nature but it was an idea that is far from the available possibilities, so that the usage of reinforced concrete has emerged[27].The color of the building gives a suggestion that it is made of clay despite of it is made of reinforced concrete and the designer shall be exposure to criticism because of this point; whereas the suggestion here is different from the constructional reality as to the common viewer, but this matter is attributed to the weakness of skills and available possibilities that did not enable the designer to execute the idea. The example stated here explains the impediments of innovation in one of the aspects.

-There is also a perception of clay-textured boards made from light smart materials and with recycled materials[22].

-Casita Nuaanarpoq House at Taos, New Mexico, USA. Architects: Edge Architects; Ken Anderson, Pamela Freund, 2004.The house is autonomous in energy terms, with photovoltaic cells supplying the required electricity. The passive harvesting of solar energy by the glass front, as well as the massive loam storage wall within and the highly effective thermal insulation provided by the outer walls, formed of balls of hay, result in adequate climate control for this house, set in a desert climate with extreme temperature differences [28](Fig. 7).

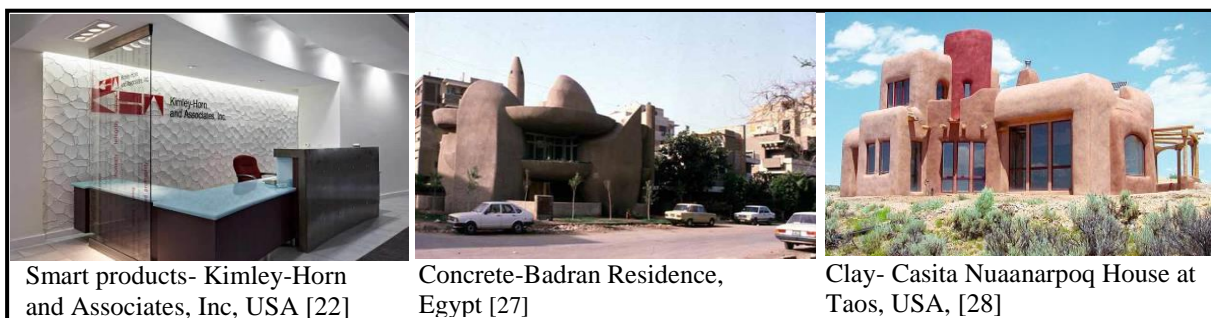


Fig.7. Diversity of perception of clay by more than one building material.
Source: [22], [27] & [28].

5.3 Fabricated Materials

Include the metals (steel, Aluminum, copper and bronze) brick, glass, refractories, ceramic, plastic and paints, such as:

5.3.1 Metals

Metals like steel, Aluminum, copper and bronze. Are fabricated materials but there were alternative of perception by paints, ceramic and others. In addition to the enhancement of the material properties, types of steel have emerged, such as:

Bio steel, Woven Stainless Steel and Creative Weave Metal Mesh

Example: Selection of the natural copper to simulate the texture of Archeological bells (the design idea) in project, Swan Bells in Perth, Australia. The copper was initially clear-coated to prevent gradual oxidation within the marine environment of the harbor [30].

- A structure designed with metal fabric sun screens can achieve significant energy savings by minimizing heat gain during warm month's .High-relief impression patterns add visual interest, enhance durability and expand the customization potential of stainless steel and Fused Metal surfaces [31] (Fig. 8).

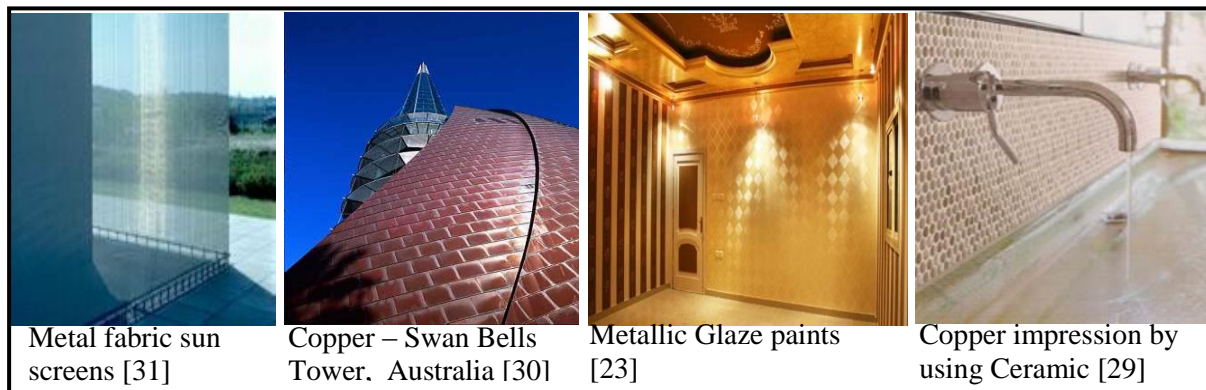


Fig.8. metals perception by Technologies and others materials

Source: [29], [23], [30] & [31].

5.3.2 Glass

Glass has been developed; many types and treatments have emerged, such as:

-A new material called ‘living glass’ could monitor CO₂ levels in the air, automatically opening and closing its ‘gills’ in response to the breathing of humans in the room. It’s made of silicone embedded with wires that contract due to electrical stimulus, allowing the gills to regulate air quality when carbon dioxide levels are high[32].

PERCEPTION OF BUILDING MATERIAL IN ARCHITECTURE

-Transparent media façade, Port Authority Bus Terminal, New York. It allows natural views from inside to out. Illuminated metal fabric system allows system integrated LED lighting to project light onto the reflective metal mesh surface creating a brilliant projection [33].

-Windowpane will become valuable for more than the view. Newly developed electrochromic "smart" glass can cloud up for privacy, block the sun's rays to cool you down, or absorb them to power the place. Scientists say the glass will soon enable your office windows to turn into multitouch screens for PowerPoint presentations or video conferences [34].Multimedia interactive- hologram tables and office windows that turn into TV screens [35].

The glass became a tool for displaying the wealth and unfamiliar design ideas, such as making the whole building or toilets of glass (Fig. 9). The role of glass no longer confined to the illumination, but also many functions can be recognized with it.

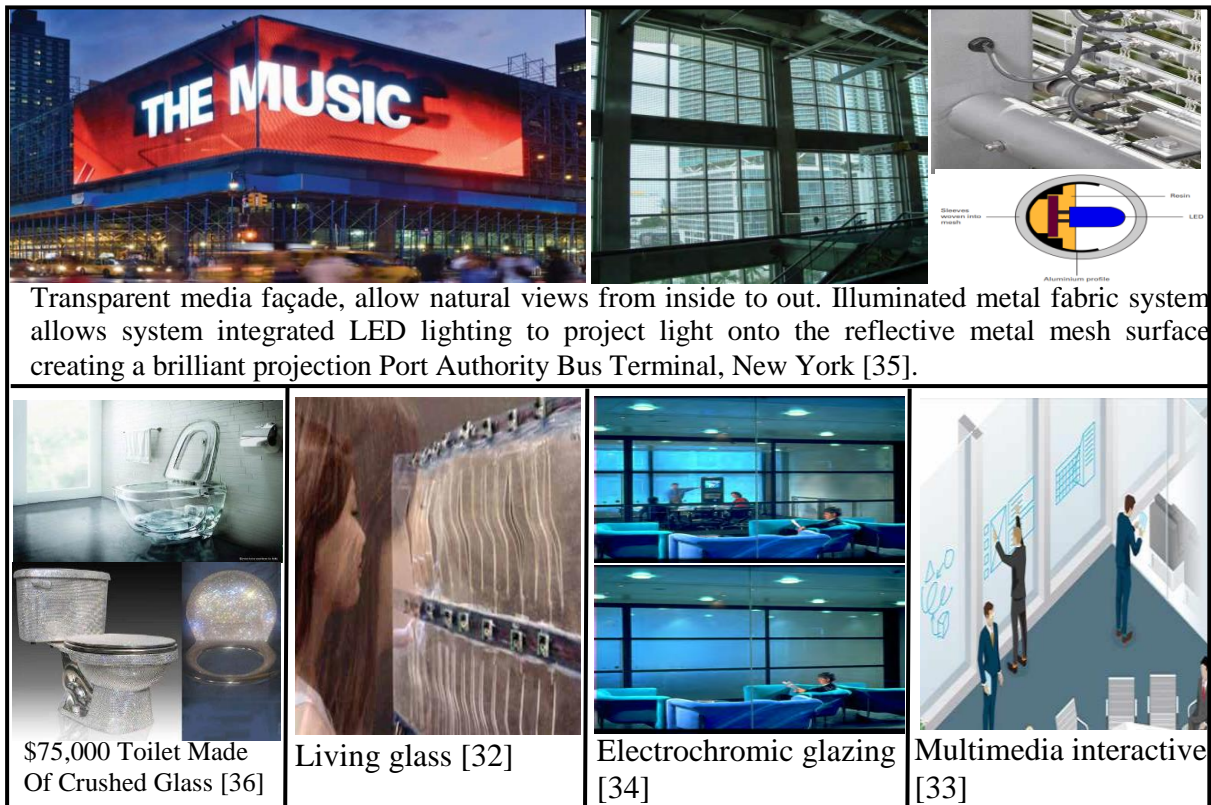


Fig.9. Alternatives of the perception of glass by another material and treatments of glass for enhancing its properties. Source: [32], [33], [34], [35] & [36].

6. PERCEPTION LEVELS OF MATERIAL IN ARCHITECTURE

It is clear from the analytical study that the technologies play an essential role in proposing the re-classification of perception levels to the following:

6.1 Form (aesthetic) Perception Level

Perception a material by using another material, simulating only its shape and texture. It does not exceed the stage of impression of the original material only.

6.2 Functional Perception Level

Perception a material by using another material, simulating its shape, texture and some of its properties for achieving the same function of the original material.

6.3 Interactive Perception Level

Perception of an idea or interactive motion using technologies , via more than one material or the perception of material in an interactive status with the user of the space or surroundings by enhancing its properties. In the level, the stereotype of material is changed as to the user (Fig.10).



Fig.10. Diversity of technologies and building materials for the perception of facades with 3D images. The perception of drawings is varied according to the illumination, shades and building vision angle, Source: [19], [37] & [38]

6.4 Virtual Perception Level

It is found in virtual architecture and selecting textures of materials for the spaces and masses for giving the impression of realism. Whereas perception shall be increased with the increase of the clarity of image, rather, the whole virtual space.

6.5 Non-Perception Level of Building Material

A level in which the material is not recognized, and sometimes the whole building, But what recognized is the nature or the architect's design idea or message. This level can be achieved by technologies starting from hiding the building by nature, such as the herbs, or using the glass and mirrors reaching to the Nanotechnology.

- Example: A group of students of Professor Susumu Tachi at Tokyo University 2003 developed a technology that enables making objects invisible depending on the optical camouflage technologies. Whereas this technology was demonstrated by wearing an invisibility jacket by one of the students and going around the followers of the event who can see through his body to things behind him using nanotube sheets. Whereas the path of light around the object intended to be invisible is "bent" as if the light has pass through it without any presence of it. This technology uses a material named retro-reflective material or Metaflex who's its properties were discovered using what is called Meta materials [39].

- INVISIBLE Project: Whereas young men named Daniel Siering & Mario Shu whose made the illusion of hovering tree by wrapping a section of a tree trunk with spray makes anyone looks at the tree believes that it hovering in the air far from its base. The matter is just represented in that this material is a reflecting material as a mirror and this tree exists in Postdam- Germany. This idea is an invitation to encourage the environment preservation, against trees cutting, to raise awareness of the presence of urban trees and their benefits [14] (Fig. 11).



Fig.11. Diversity of non-perception starting from drawing, selection of reflecting materials and reaching to Nanotechnology. Source: [39], [40] & [41].

- Blur Building, Switzerland Wing, World Expo 2002., Designed by Elizabeth diller & ricardoscofidio. A metal construction of 60x100x20m in the shape of vague object that collects water from the lake filters it and sprays it from 35,000 jets with a diameter of 120 microns to always cover the construction with a white blur. The strength of spray is adjusted by a computer according to the different weather conditions including, temperature, humidity and speed and direction of winds. For adding the influence, the blur building stands above the water surface with many meters on pillars for making the users believe that it is moving. Visitors can enter into the floating island through a bridge with length of 400m. The only sound to be heard is the white noise of pulsing and the perception of the building users is changed according to the air motion. The volume of blur affects the perception of the remaining users with each other [42].

- A house hidden behind a mirror, France. the non-perception of the building and hiding it using huge mirrors placed on the facade to reflect the nature around it and hid the house itself, although the house is made of steel and the entrance gives an impression of vagueness inside the nature as if it a door in the space. Consequently, the usage of material helped in achieving the designer's thought concerning the invisibility and isolationism [44] (Fig. 12).

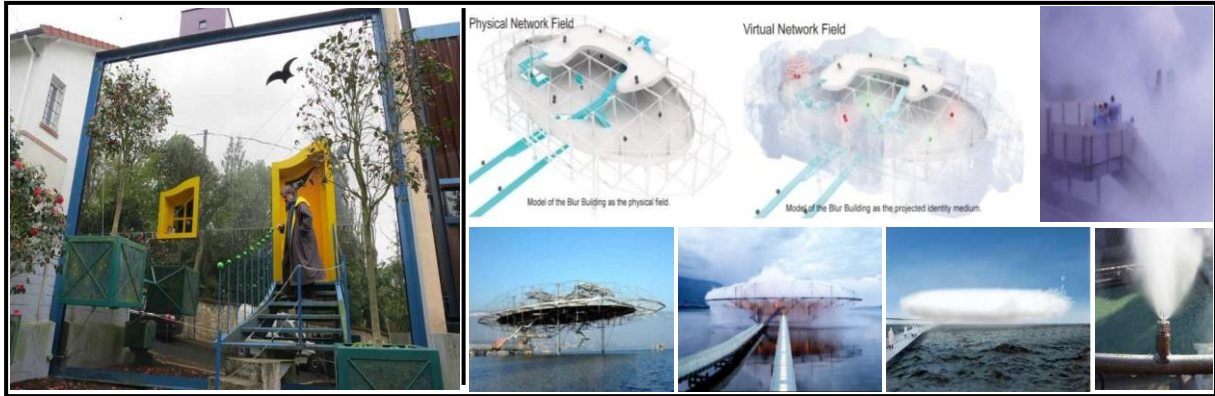


Fig.12. Diversity of non-perception in architecture using high technology - Blur Building, non-perception using mirrors and glass. Source: [43] & [44].

- Infinity Tower in South Korea, designed by a USA company. In a competition conducted on 2008 and is under progress. It shall be constructed by glass with a length of 450m and its location is near Incheon International Airport. It shall be constructed for entertainment purposes, like a water garden, landscape and 4D theatre.

Making the tower invisible will depend on light-reflecting LED technology which does not consume a great deal of energy via mounting HD cameras transmit the image instantaneously over the tower's internal area to reflect what is happening in the outside. These photos shall be purified and the full image of what is happening outside shall be transmitted to inside via screens make who inside the tower believe that they are in an open place. Different levels of illumination shall be used for obtaining different degrees of "invisibility". The place of screens shall enable the tower to be invisible as to planes and birds, there will be always a flashing red light [45] (Fig. 13).

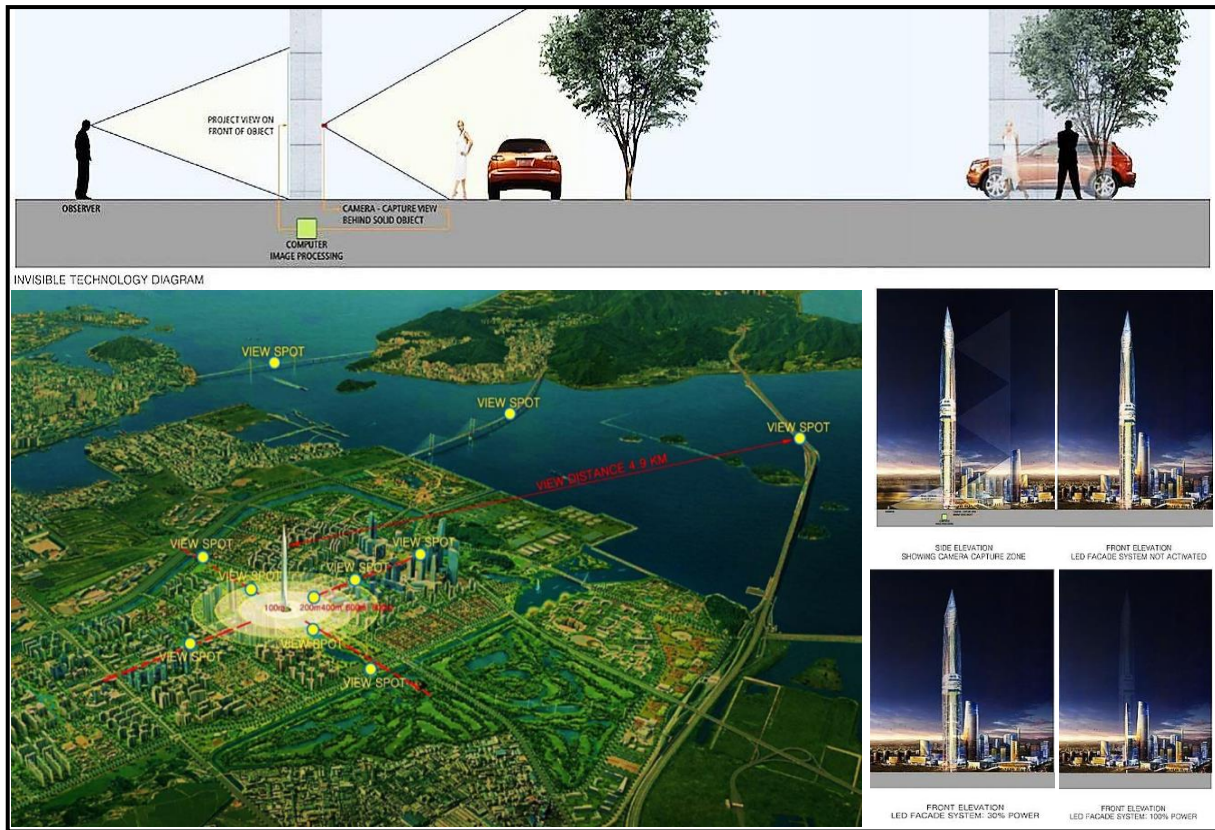


Fig.13. Invisible Tower - Infinity Tower in South Korea .Source: [45].

7. CONCLUSIONS

-In architectural design, we bend towards selecting the natural building materials. Due to the common orientation towards the sustainability and scarcity of natural resources, researchers resorted to the materials mixed and fabricated for producing materials giving an impression and the user can percept it as if it is natural materials .

-We can recognize an architectural material, based on its optical properties. It is called the impression and identification is increased to reach the stage of recognizing it depending on its properties. The stereotype of material is to be fixed via the experience of the user in the building and his previous experiences about material .

This impression or perception of the building material advances step by step from the form perception to reach to achieving the same function and properties of the natural material that it is required to be recognized by the user.

Technologies of dealing with the building material have contributed to make a rise in the perception of the building material in terms of the material role and enhancing its properties to be used in more than one usage (structural - finishing - complementary), in terms of the extent of achieving the alternatives of material perception (Durability - Utility - Aesthetic) and then producing perception levels of material in architecture (Fig.14).

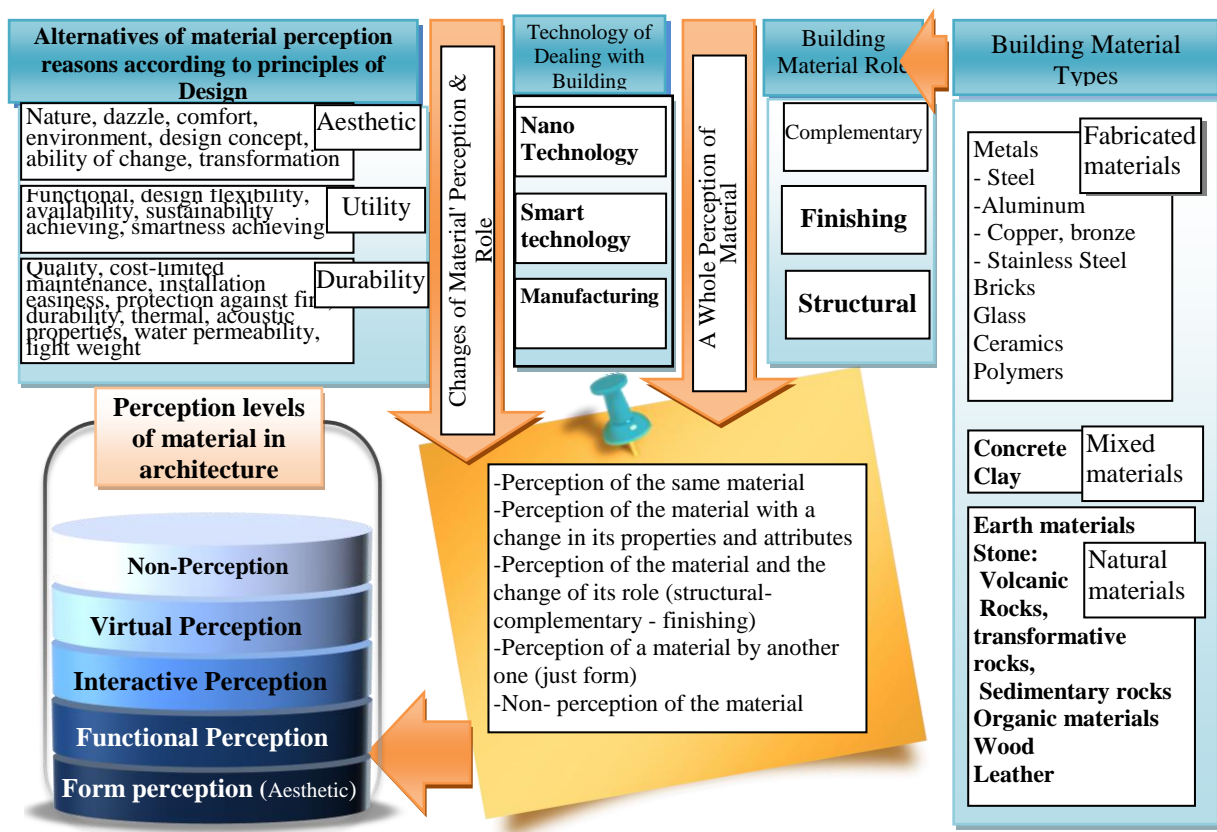


Fig.14. Reading in perception of building material in architecture .Source: Author.

8. RECOMMENDATION

- The necessity of establishing a new standard upon selecting the building material in the architectural design; is the perception level required for the material is form, functional, interactive, virtual or even the non-perception of the material, not just the selection depending on the cost, strength, availability or environmentally compatible.

- The architect must be aware of the developments of building materials and their technical specifications, architectural possibilities and physical properties as well (such as texture, form, color and dimensions) for selecting the suitable material for the architectural spaces and using it appropriately.

REFERENCES

1. Fouad, Samar. "Six Materials for Global Architects Projects", Ana Memare Magazine. Vol.22, P. 4-5, JEN.2014. www.ar.engineering-Portal.com
2. <http://ar.jodepot.com>
3. <http://inhabitat.com/hernandez-silva-arquitectos-design-dizzying-bathroom-in-15th-floor-of-an-elevator-shaft/>
4. <http://www.toxel.com/tech/2009/11/18/innovative-laser-crosswalk-concept/>
5. www.elfarra.net
6. Wastiels, Lisa. & Wouters S., "Material Considerations in Architectural Design: A Study of the Aspects I Identified by Architects for Selecting Materials", Sheffield Hallam University Research Archive (SHURA), <http://shura.shu.ac.uk/511/1/fulltext.pdf>, P. 379/4, 2009.
7. Rapoport, Ames, "Human Aspects of Urban Form", Pergamon Press, P. 178, 1977.
8. Abeer Mohammed Ansari Meselhy., "Reciprocal Relationship Between Man and the Built Environment - Urban Formation and Its Relationship to Sensory Perception and Spatial Guidance", Master Thesis, Department of Architecture, Faculty of Engineering, Mattaria, Helwan University, p 40,2000.
9. Smithies, k. O., Translation Mohamed Abdel Rahman Alhussayen: "The Principles of Design in Architecture", P 156.
10. Fernandez, j., "Material Architecture: Emergent Materials for Innovative Buildings and Ecological Construction" .Oxford: Architectural Press.2006.P.75.
11. Nouby Muhammad Hassan., "Theories of Architecture", First Edition , Modern Offset Printing Press, Assiut, P. 136-138,2001.
12. MEDINA. Architecture .Interiors. Fine Arts. V13.P38, May –June 2000
13. <http://www.nanoprotect.co.uk/>
14. <http://www.kabnoury.net/> (Accessed 12/2/2014)
15. <http://www.scibpaints.com/>
16. <http://www.transalpin.net/downloads/CUBIX-dt.pdf>, P. 7
17. http://media.wix.com/ugd//c450f8_727800074aa0128545beee1881e53cb7.pdf
18. <http://luxuryinprogress.com/exploring-the-surface/> (Accessed 20/12/2013)
19. <http://www.reckli.net/>
20. <http://www.pinterest.com/explore/wood-ceramic-tile/>
21. "1000x European Architecture", ISBN-10:393878010X .Publisher: Braun 68, Publication Date: September 28, 2007.
22. <http://www.modulararts.com/panels/designs.html>

23. Blaine Brownell, "Transmaterial a Catalog of Materials that Redefine Our Physical Environment", Princeton Architectural Press, New York, P.5
http://www.eskyiu.com/aainter1/index_files/transmaterial.pdf
24. <http://weburbanist.com/2013/02/27/making-it-10-more-futuristic-materials-that-exist-today/>
25. <http://www2.technologyreview.com/article/418542/tr10-green-concrete/>
26. <http://www.dezeen.com/2013/01/03/spanish-researchers-develop-biological-concrete-for-moss-covered-walls/>
27. Private residence in Cairo, "The World of Construction, The Center of The Architectural and Planning Studies", Issue 45, P. 17- 18- 19, May 1984.
www.cpas-egypt.com
28. Gernot Minke., "Building with Earth-Design and Technology of a Sustainable Architecture", Birkhäuser – Publishers for Architecture Basel. Berlin, Boston, P.166, 2006.
29. <http://www.bellavitatile.com/pdf-library/documents/Metal.pdf> ,P3
30. Lyons, Arthur, "Materials for Architects and Builders", Third edition. British Library Cataloguing in Publication Data. Published by Elsevier, ISBN-13: 978-0-7506-69405. P175, 2007.
31. Michael McGinn., "GKD Metal Fabrics", GKD-USA Company. GKD Overview, v1, P29, 2010, gkdmetailfabrics.com
32. <http://weburbanist.com/2013/02/27/making-it-10-more-futuristic-materials-that-exist-today/>
33. <http://www.gkdmetailfabrics.com/projects.html>
34. Axel Ritter: "Smart Materials in Architecture, Interior Architecture and Design", Birkhäuser – Publishers for Architecture, Switzerland, P.95, 2007.
35. <http://www.rb.ru/article/kakim-budet-ofis-budushhego-foto/6853157.html>
36. <http://www.wired.com/gadgetlab/2007/11/75000-toilet-ma/>
37. <http://www.architonic.com/pmsht/powerglass-media-facade-subaru-glas-platz/1140735>
38. www.dri-design.com
39. <http://www.independent.co.uk>
40. <http://www.yourdailymedia.com/post/18-pictures-of-mirrored-houses-the-bend-perception/>
41. <http://www.journal-du-design.fr/art/trompe-loeil-par-daniel-siering-mario-shu-39222/>
42. Diller & Scofidio: " The Blur Building",
http://web.mit.edu/lira/www/fall02_indStudy/dillerscofidio.pdf
43. "Walking on Clouds at the Blur Building",
<http://unitone1213.wordpress.com/category/missions/>
44. <http://www.batiactu.com/edito/jacques-emile-lecaron-l-architecte-portraitiste--d-p8-31972.php>
45. <http://www.e-architect.co.uk/korea/tower-infinity>(Accessed 12/2/2014)

ادراك مواد البناء فى العمارة

يتناول البحث دراسة امكانية استخدام ادراك مادة البناء كأداة في الإرتقاء بالعمارة ويُناقش البحث هذا الموضوع من خلال محورين ، يتعرض المحور الاول للخلفية النظرية للادراك وإمكانية استخدامه للتعبير عن هدف أو فكرة أو وظيفة للتصميم ، بينما يتناول المحور الثاني مادة البناء ودورها في المبنى وتصنيفها وتقنيات التعامل معها لتحسين خواصها فتصبح لهذه المادة استخدامات جديدة، وبدائل تغيير ملامسها من حيث الشكل والوظيفة والمنفعة .واستنباط مستويات ادراك المادة التى تُمثل معيار هام فى اختيار المادة لتكامل العملية التصميمية و تحقيق مبنى معمارى ناجح.