2012 4th International Conference on Computer Modeling and Simulation (ICCMS 2012)
IPCSIT vol.22 (2012) © (2012) IACSIT Press, Singapore

New Engineering Materials and Developing Countries Architecture

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Abstract. Utilization of *Smart Systems* is considered as a matter of significance in the world current construction industry. The study is to take the issue into analysis in Iran, as a developing country through answering the following questions: What are the main challenges regarding the usage of *Smart Materials* and *Structures* in Iranian Contemporary Architecture? And how can we describe a new horizon for the usage of *Smart Systems* in Iranian Contemporary Architecture?
The research is based on the survey method, adopting the case-study and combined strategies along with the descriptive-analytic and comparative-analytic tactics.
The study shows that the use of technology and especially *New Technologies* like *Smart Materials* and *Structure* has been sufficed to the buildings appearance aspects and there is no serious effort to improve the buildings qualitative features through the real technological potentials. The serious pragmatic attention to *New Technologies* capacities in both the theoretical and practical areas or the architectural education and profession is considered as the efficient solution for the discussed problem.

Keywords : New Technologies, Smart Material, Smart Structure, Iranian Contemporary Architecture

1. Introduction

The topics of architecture, materials and technology or the impact of modern technology and materials on architecture have been considered as the matter of significance in the current decades. The relationship between architecture and materials had been fairly straightforward until the Industrial Revolution. Previously, materials were chosen either pragmatically - for their utility and availability or they were chosen formally for their appearance and ornamented qualities. The role of materials changed dramatically with the advent of Industrial Revolution. Indeed the history of modern architecture can almost be viewed through the lens of architectural materials [1]. On the other hand, materials technology has had such a profound impact on the evolution of human civilization that historians have characterized periods in that evolution by such terms as the Stone Age, the Bronze Age and the Iron Age. The current synthetic materials age has been precipitated by humankind's demand for materials with superior performance characteristics, inspired primarily by the quest to conquer the last frontier of space [2]. It is clearly evident that progress in materials science stimulates the economy and largely dictates the standard of living enjoyed by society. Hence, sustainable development and technologic buildings are becoming one of the current highlights in the construction industry. However, these concepts appear to be more popular with researchers and academics than with building professionals.

The dawn of the 21st century witnessed the emergence of *Smart Materials* and *Structures* Age. A *Smart Structure* is a system containing multifunctional parts that can perform sensing, control, and actuation; it is a primitive analogue of a biological body. *Smart Materials* are used to construct these *Smart Structures*, which can perform both sensing and actuation functions [3]. A more sweeping definition comes from the Encyclopedia Chemical Technology '*Smart Materials* and *Structures* are those objects that sense environmental events, process that sensory information, and then act on the environment'[1]. In this way, a smart building presents itself as an interface between its users and the sorroundings [4]. There is no commonality of problem, such as you might find between architecture and ecology. *Smart Architecture* mediates between the demands and desires of users and environment. In recent years, more work has been done on so called adaptive building envelopes, which, in the ideal case, are able to react to their immidiate and adjacent sorroundings in a manner quite unlike earlier structures, depending on their design and sensory, and their passive and active structures and components [5]. So, instead of tolerationg or counteracting invoulentry changes in building caused by natural and/or anthropoligical influences, architecture can be designed to change or be changed in specific ways. In doing so, it is behaving intelligently; it uses its sensors to build up a 'momentry' and to learn.

In recent years with the considerable rise of public demand, especially in the developing countries like Iran for the buildings with technologic appearances, introduction and dissemination of new constructive systems has become an urgent necessity. In spite of such a neceesity, no pragmatic plan to take smart construction system as an effiecent new technology has been taken into practice. Although in the university syllabusses, the considerable hours have been allocated to the introduction of various constructive methods and strategies, but as a matter of concerning fact, *Smart Systems* has been considerably neglected in the theoretic area. Hence, due to the lack of strategic and purposeful education in this field, a wide variety of problems or shortages in the country's construction industry has been taken place. Moreovere, the building professionals rather than utilization of new technologies as the strategic medium for the pragmatic promotion of qualitative charecteristics of buildings, merely have suffied to utilize them appearencially to raise the buildings popular attractions. Therefore, the lack of adequate attention to *New Technologies* and especially *Smart Systems* in both theoretical and practical areas has entailed the inconsistency between the country's teccnological capabilities and practice. In other words, despite having sufficient technological potential in the country for improving the quality level of construction technology, the building professionals have been involved in the outward attractive technological features.

2. Smart Systems

Smart Systems are defined as miniaturized devices that incorporate functions of sensing, actuation and control. They are capable of describing and analyzing a situation, and taking decisions based on the available data in a predictive or adaptive manner, thereby performing smart actions. In most cases the "smartness" of the system can be attributed to autonomous operation based on closed loop control, energy efficiency and networking capabilities.

An active structure consists of a structure provided with a set of actuators and sensors coupled by a controller; if the bandwidth of the controller includes some vibration modes of the structure, its dynamic response must be considered. If the set of actuators and sensors are located at discrete points of the structure, they can be treated separately. The distinctive feature of *Smart Structures* is that the actuators and sensors are often distributed and have a high degree of integration inside the structure, which makes a separate modeling impossible.

Smart Materials can adaptively change or respond to an external environmental stimulus and produce a useful phisical or chemical effect such as volume, mechanical stress change, reversibility oxidization-deoxidization and so on. The stimula may include mechanical stress, temperature, an electric or magnetic feild, photon irradiation, or chemicals (pH, ionic strength). A very important feature of the changes or response of *Smart Materials* is reversibility, which means that the useful physical or chemical effect is easily tunable through simply changing the environmental stimuli conditions [6].

In this way, a *Smart Architecture* is considered as an intermediate between its users and the sorroundings. It mediates between the demands and desires of users and environment. In doing so, it behaves intelligently. Such an architecture can be designed to change or be changed in specific ways. So, instead of tolerationg or counteracting invoulentry changes in building caused by natural and/or anthropoligical influences, they are ready to react reversibly to their sorroundings over a long period of time. This task requires materials and products with reversible properties [5].


Fig.1 Library, Golestan Cultural Center, Tehran [8]


Fig.2 Plasma Purification & Research Center, Tehran [8]


Fig.3 Khajouy-e-Kermani ibrary and Park, Tehran [8]


Fig.4 Kian Administrative/ Commercial Complex and Hotel Apartment, Tehran [8]


Fig.5 Farmaniyeh Residential Complex, Tehran [8]


Fig.6 Golgun Cultural/ Sports Complex, Tehran [8]

3. Inference Mechanism

3.1. Research Questions: What are the main challenges regarding the usage of *Smart Materials* in Iranian Contemporary Architecture? What are the main challenges regarding the usage of *Smart Structures* in Iranian Contemporary Architecture? And how can we describe the new horizon for the usage of *Smart Systems* in Iranian contemporary architecture?

3.2. Research Case-studies: Thirty buildings among from all Iranian Contemporary Architectures from 1990 to 2010, discussed in the specialized journals or textbooks have been selected as the research case-studies.

3.3. Research Method: The research is based on the survey method, adopting the case-study and combined strategies along with the descriptive-analytic and comparative-analytic tactics. Survey methods have been adopted as data gathering techniques [7].

4. Case-Studies

As mentioned before, thirty buildings among from all Iranian Contemporary Architectures from 1990 to 2010, discussed in the specialized journals or textbooks have been selected as the research case-studies (Fig.1-6). All the cases have been taken into consideration from four aspects including the façades technological appearance, the use of imported materials, smart materials and smart structures. A summary of analyses results has been shown in Table 1.

According to the case-studies analyses results, all the buildings have taken the advantage of technological facades. In other words, although the different types of technological elements have been utilized in other parts of buildings including the entrance, section and plan too, but the main usage of them has been sufficed to the buildings appearances which seems so meaningful.

Moreover, in about (%63.3) of all the buildings, the imported materials like aluminum composite panels have been used. In none of buildings, *Smart Materials* and *Structures* has been utilized. Hence, the architects have allocated the least attention to *New Technologies* and especially *Smart Systems,* suggesting the fact that due to the increasing public interest and demand for the buildings with the technologic appearances, the emphasis has been on the popular outward technologic components. Therefore, instead of utilization of technology for improving the buildings qualitative features, the use of technology has been limited to the buildings appearances.

5. Conclusion

The study shows that although paying attention to the technologic issues in the construction industry is considered as a common trend in Iranian contemporary architectural circles as well as the public, but the utilization of technologic construction systems such as *Smart Systems* has been neglected apparently in both the theoretical and practical areas and there is no definite plan at the educational and professional levels for its efficient and purposeful use. Hence, the technology has not been seriously taken in to consideration by the building specialists and professionals at the same time and anything has been just limited to the appearance aspects to satisfy the public.

Table 1. Case-studies analysis results

N	Building	Architect	Date	Technology Location	Façade technological appearance	Imported Materials	Smart material	Smart structure
1	International Trade center, Tehran	Yahya Fiuzi-Yousefi	1999	Façade (Composite panels)	*	*	-	-
2	Golgun Cultural Sports Complex, Tehran	Abdolreza Zoka'i	1993	Structure	*	*	-	-
3	Tehran Gardens Book Fair, Tehran	Cyrus Bozorg-Gerayeli	2004	Façade (Steel and glass)	*	-	-	-
4	International Pilgrims Terminal, Mashhad Airport	Farrokh Ghahramanpour	1998	Façade and section (Steel, concrete and glass)	*	-	-	-
5	No-Avar Administrative/Commercial Center, Tehran	Hossein Sheikh-Zeineddin	2005	Façade (Steel and glass)	*	-	-	-
6	The Islamic Republic of Iran's International Conference Center, Tehran	Yahya Fiuzi-Yousefi	1997	Façade, section, structure and lighting (Aluminum composite panels, glass)	*	*	-	-
7	Bank Maskan Headquarters, Ahvaz	Aliakbar Saremi	2004	Façade, lighting, entrance (Steel, Composite panels and glass)	*	*	-	-
8	Ministiry of Welfare Headquarters, Tehran	Farrokh Ghahramanpour	2005	Façade, section, plan (Aluminum composite panels, glass and concrete)	*	*	-	-
9	Tehran Bar Association, Tehran	Seyed Hadi Mirmiran	1998	Façade, lighting (Stone, glass and steel)	*	-	-	-
10	Commercial/Administrative Building, Tehran	Yadollah Razzaghi	**2003**	Façade and section (Composite panels, Stone and glass)	*	*	-	-
11	Saman Park Office Building, Tehran	Hossein Naseri	1996	Façade (Stone and glass)	*	-	-	-
12	Khorshid Hall, Tehran	Kian Mokhtari-Saghafi	1999	Façade, structure and section (Steel, glass, concrete and wood)	*	-	-	-
13	Exhibition Center and Administrative Complex, Kish Island	Ali Akbar Saremi	2005	Façade, section, furniture and lighting (Space frames, stone, steel and glass)	*	-	-	-
14	Yazd Commercial Complex, Yazd	Seyed Hamid Nourkeihani	2004	Façade, section (Steel truss, Concrete and glass)	*	-	-	-
15	Farmaniyeh Residential Complex, Tehran	Mohammad Soltani-Nassab	2003	Façade and entrance, section (Brick, steel, glass and composite panels)	*	*	-	-
16	Grand Hall of Markazi Province, Arak	Behrouz Nikakhtar	2005	Façade, entrance, section, furniture (Steel, stone, glass and composite panels)	*	*	-	-
17	Horr Cultural Center, Tehran	Parviz Mokhtari	1992	Façade, entrance (Concrete, steel and glass)	*	-	-	-
18	Headquarters for Oil Industry Investment Company (OIIC), Tehran	Yahya Fiuzi-Yousefi	2004	Façade, section (Steel, composite panels, steel truss and glass)	*	*	-	-
19	Pars Oil Headquarters, Tehran	Yahya Fiuzi-Yousefi	2002	Façade, entrance and section (Steel, glass, composite panels and photovoltaic panels)	*	*	-	-
20	Khajouy-e-Kermani Library and Park	Abdolreza Zoka'i	1995	Façade, section (Expose concrete, steel and glass)	*	-	-	-

21	Plasma Purification and Research Center, Tehran	Abdolreza Zoka'i	1994	Façade (Exposed structure, steel, glass and stone)	*	-	-	-
22	Kian Administrative/Commercial Complex and Hotel Apartment, Tehran	Cyrus Bozorg-Gerayeli	2002	Façade, entrance, section and lighting (Space frames, steel and glass)	*	-	-	-
23	Zafar 164 Office Building, Tehran	Seyed Hamid Nourkeihani	2004	Façade, structure, entrance and furniture (Steel, exposed structure, aluminum composite panels, stone and glass)	*	*	-	-
24	Dariush Residential Complex, Tehran	Hossein Sheikh-Zeineddin	2005	Façade, section, lighting and entrance (Steel, glass and composite panels)	*	*	-	-
25	Ministry of Science, Research and Technology Headquarters, Tehran	Ahmad Abrishami		Façade and section (Space frames, stone and glass, steel and glass)	*	-	-	-
26	Library, Golestan Cultural Center, Tehran	Hassanali Lagha'i	1993	Façade, section, entrance (Steel and glass)	*	-	-	-
27	Mellat Bank Headquarters, Karaj	Kamran Shahinfar	2008	Façade, section, entrance (Concrete, steel and glass)	*	-	-	-
28	Khaneh Hamayesh Cultural Center, Tehran	Seyed Hamid Nourkeihani	2006	Façade, entrance and lighting (Concrete, aluminum composite panels and brick)	*	*	-	-
29	Etela'at Cultural Press Institute, Tehran	Kiumars Bayat	1995	Façade, entrance and lighting (Steel, stone and glass)	*	-	-	-
30	Cultural/Commercial Complex and the City Council, Mashhad	Aliakbar Saremi	2004	Façade, section, entrance and lighting (Steel, concrete, stone and glass)	*	-	-	-

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