



PLASTICS AS CONTEMPORARY MATERIAL IN ARCHITECTURE FOR HEALTH AND SUSTAINABLE CONSTRUCTION

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Abstract:

Nowadays plastics have become one of the main construction materials with a wide range of use in product design as well as construction industry of medium or large elements including buildings. Elements like pipes' and cables insulation, storage tanks, skylights, roofing, windows and doors, insulation and temporary structures can be made entirely, partly or as a bonding compound in new material mixes like WPCs wood plastic composites, carbon or natural fiber reinforced plastic. Material of this study has a vast application in the field of tensile structures construction or tents in smaller scale. One of the most common uses of plastic in the building construction is insulation of large surfaces such are walls, roofs or floors that can come in different forms commonly in foam which amounts can be adjusted to fit any form, in a prefabricated form like SIP panels as well as to securely insulate smaller details like pipes or cables. It is frequently used in the timing of the exterior building planes too. A rife problem is allergies from raw organic material objects and building components like down, sisal, cotton, coir, sea grass, etc. that can cause serious sequels like asthma, eyes and other mucous maladies can be completely eliminated with synthetic plastic-based materials-nylon, polyester, and polypropylene. This paper intends to stream how different plastic-based materials can help attain sustainable position in modern contemporary architecture.

Keywords: Contemporary Materials; Plastics; Sustainable Construction; Polyester; Polypropylene.

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1. Introduction

Natural plastic existed in nature in the form of rubber long time before an artificial material was invented but only then it became revolutionary for all levels of society and technology. The topic of plastic and its effects is verily controversial in the light of latest industry expansion. Plastic has easily penetrated to all spheres of our lives and transformed it and thus society due to many unique qualities comprised of one material. A universal material made many products available to more people. Nowadays, the use of plastic is difficult to ignore; it became one of the most commonly seen material, an essential part of our everyday life and our building's design and construction. According to Jambeck etal., (2015, p.768) the rapid of growth of plastics production is astonishing

and how it has surpassed most other man-made materials In the further research, the relationship between plastic and its user within the sphere of construction will be investigated.



Figure 1: A woman in Sri Lanka harvesting rubber. 1920

Source: A. W. Plate & Co.

2. History of Plastic; its Use and Application in Construction

In order to penetrate to the subject of the research, we must first understand the etymology and thereby expectations entrusted to the ‘plastic’ material from the time when it was invented. The word originated from French word known as “plastique” (from Latin “plasticus” which means moldable) meaning flexible and easily shaped in form, appeared in the mid-17th century. Plastics are built up by long chains of polymers; large or macromolecules. Polymers can be differentiated between organic called biopolymers and synthetic called plastic. Biopolymers include RNA, DNA, protein, amino acids, and polysaccharides but apart of being an essential part of an organic living world they can also be used in construction and include natural rubber, suberin, melanin, etc. First inventions of an organic plastic started in 1838 by Anselme Payen extruding cellulose (carbohydrate cellulose) from the plant matter. It provoked the long chain of discoveries continued by Alexander Parkes who invented first man-made plastic also called Parkesine in 1862 and presented it on a Great international exhibition in London, England. Later in 1868 John Wesley Hyatt created celluloid by a chemical reaction of cellulose and camphor. However, the polymer age really started in 1907 with an introduction of Bakelite- first synthetic thermosetting plastic by Leo Baekeland. Composition wise synthetic plastics have much longer polymer chains and are made using carbon atoms that can be found in gas, coal or crude oil. Later on, in 1920s further research studies and laboratory tests followed and presented urea formaldehyde, polyvinyl chloride (also called as vinyl or PVC), nylon and many others (Harper C.A & Petrie E.M 2003, p.324-325).

Nowadays it became one of the main construction materials with a wide range of use in product design as well as construction industry of medium or large elements including buildings. Elements

like pipes' and cables' insulation, storage tanks, skylights, roofing, windows and doors, insulation and temporary structures can be made entirely, partly or as a bonding compound in new material mixes like WPCs- wood-plastic composites, carbon or natural fiber reinforced plastic. Material of this study has a vast application in the field of tensile structures construction or tents in smaller scale. One of the most common uses of plastic in the building construction is insulation of large surfaces such are walls, roofs or floors that can come in different forms-commonly in foam which amounts can be adjusted to fit any forms, in a prefabricated form like SIP panels. As well as to securely insulate smaller details like pipes or cables, it is frequently used in the tiling of the exterior building planes too (Hopewell J; Dvorak R & Kosior E 2009, p.1-2).



Figure 3: foam spray wall insulation



Figure 3: House in Shinkawa / Yoshichika Takagi

Source: Just another Roof Design



Figure 4: Glacier Restaurant, Klein Matterhorn, Zermatt, Switzerland

Source: Peak Architekten

Another fact of a big importance is that green buildings are using plastics in many various ways. Nontoxic bio plastics can be biodegradable and are mainly composed of the plant matter like cassava roots, cotton, corn and sugar cane plant or soy protein (Grabowski et al., 2015). Environmental systems or structures are including plastic due to its unique physical qualities. One of the uses is the integration of the solar panels or cells into the PVC membranes. This system is mostly used to cover facades and roofs and is shown in the example of the Glacier Restaurant in Zermatt that successfully applied this innovation to harness solar energy and keep interior insulated from the year of 2008 (Webb H.K et al., 2013, p.2).

3. How Does Plastic in Construction help in Reducing the Risk of Ailments on Occupants?

Ailments of building occupants can be caused both by the building indoor sources, outdoor surrounding sources or ways of maintaining both. Apart of illnesses got from lawn and garden chemicals, so called SBS– sick building syndrome or BRI– building related illness are causing severe diseases and increase affects in time in not eliminated. Which nowadays became a vast area of research and therefore has presented some operative solutions that include the use of plastic (Joshi S.M 2008, p.2)

A rife problem is allergies from raw organic material objects and building components like down, sisal, cotton, coir, sea-grass, etc. that can cause serious sequels like asthma, eyes and other mucous maladies if not eliminated on time. Known as dust allergies are commonly caused by dust mites (bed or carpet mites) that appear in humid and warm areas of the house. It can be partially eliminated by changing indoor conditions in cold and dry climates, however, for complete elimination natural fabrics and materials have to be replaced with synthetic plastic based materials-

nylon, polyester, polypropylene, etc. This problem needs an immediate solution in humid climates, climates with rainy seasons or in an old styled houses that cover walls and ceilings with fabrics or carpets that are very susceptible to microscopic vermin.

Another cause of building diseases is high moisture that accumulated in absorbent building materials and may result in mycotoxins produces by visible and invisible fungal, spore or mold formations. One of the most prevalent scenarios is to use great resistant and repulsive properties of plastic in wall insulation systems or additional membrane water segregations in order to reduce ailments of building occupants (Kuhn D. M. and Ghannoum M.A 2003, p.147).

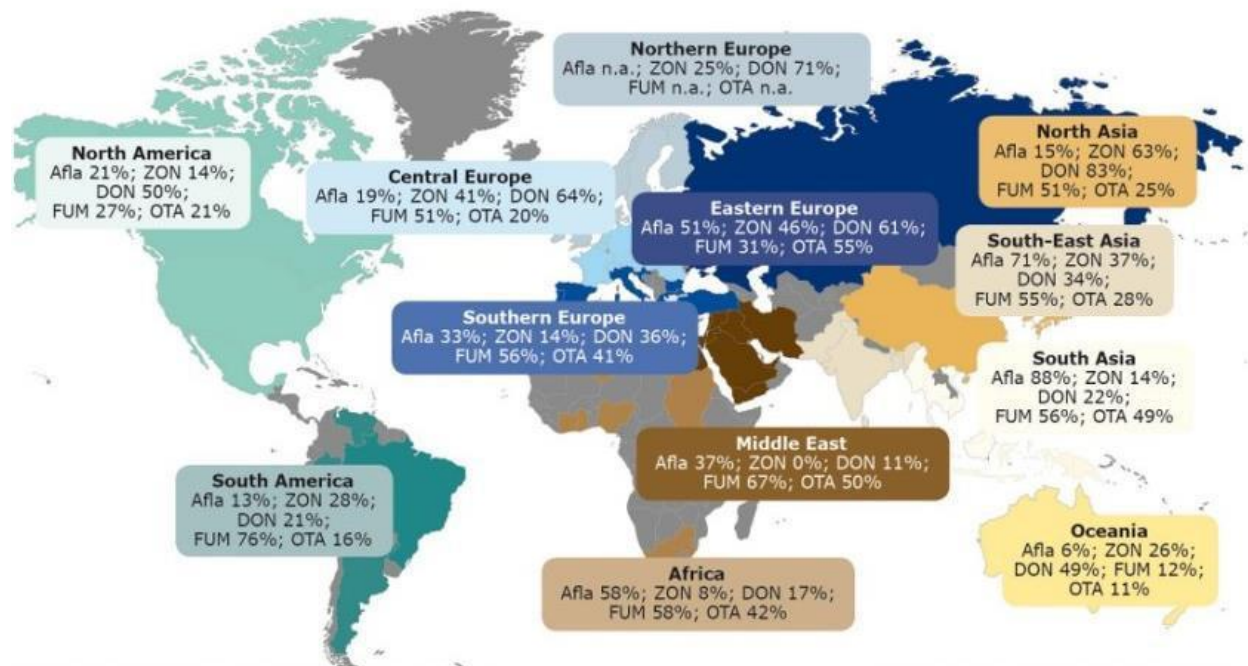


Figure 6: Mycotoxin contamination overview worldwide

Source: BIOMIN Mycotoxin Report

As Dave Asprey noted “mold exposure can cause about 40 different symptoms” (Asprey, 2016). It can cause some serious health problems like chronic fatigue and drowsiness, loss of orientation, blocked ears, sinus, eyes twitch or psychological problems like causeless anxiety, brain fog, and emotional instability to people in general and especially to 28% who are genetically susceptible to the fungal mold.

Air pollution, active or passive smoking might be shared throughout centralized ventilation in buildings with a high number of users like hotels, restaurants, bars, universities and schools and can cause diseases to occupants of all ages due to the absorbent qualities of raw organic materials. A research team involved in the study of negative effects of passive smoking primarily on children showed that “sidestream cigarette smoke is one of the major sources of indoor pollution” (Ferris, Ware, Berkey, Dockery, Spiro, Speizer; 1985). Their “clinical studies of both patients and normal subjects have demonstrated pathologic changes in airways that are both indirectly and directly attributable to cigarette smoking” (1985 October, 62). This particular and other air pollution

example are showing the importance of innovative man-made synthetic options more frequent uses to prevent air pollution particles to be absorbed by exposed materials.

4. Advantages of Plastics in Construction Over Other Materials

Adaptability, flexibility and versatility let plastics displace many raw materials. Un-renewable materials like wood with good sound, heat, cold and sound isolative properties that were used in most building constructions around the globe for centuries especially in the countries with cold climate like Canada, Russia, Sweden, Norway, and other Scandinavian and north European countries are now commonly replaced with plastic due to several reasons. Plastic is lightweight yet strong and durable, it is water, oil and solvents resistant, and relatively non-corrosive. It has low electricity, heat, and cold and wind conduction therefore window frames, doors and wall insulations are now made entirely or partly from this material. Going back to the history record, it firstly replaced horn and bone to answer high demand of the society for luxury goods but nowadays plastic can be an alternative with more unexceptional physical qualities and cost-efficiency for construction materials mentioned above like wood or glass as well as ceramics, rubber, metal foils, or even fabrics. Last ones in their turn have a greater load bearing capability, are extremely durable under very harsh conditions and can be easily modified to meet any sizes, forms and textures. Plastic is easily formed to any shape, therefore, is a preferred material in small detailed constructions too. As mentioned above, it can be presented in many colors or even be transparent, becoming a substitute for heavy and fragile glass, also rising economic efficiency of the built structure. Due to recyclability, plastic can be considered an environmentally friendly option over other un-renewable materials and thus help to eliminate deforestation. Plastic composites like WPCs are widely used in areas of high moisture replacing previously used wood or steel. Plastic membranes like PVC are used in harsh climates with wide temperature ratios throughout the year and fast temperature changes in a day (Kasapoğlu E 2008, p.3-6).

5. Limitations of the Study

The topic of research is very wide and due to the scarce time and many concomitant segments of the study, more detailed researches could not be included and covered in this paper. Many studies show that some disadvantages of plastic include its toxic effect on human health when melted that even provokes severe deceases like cancer. Moreover, even being recyclable this process is very costly and is almost not performed nowadays, in the USA for example only 9 percent of plastic is recycled according to the Worldwatch Institute (Gourmelon, 2015). Above mentioned SBS and BSI can be also caused by “volatile organic compounds, including formaldehyde and manufactured plastic” (Knott, 2014). All these are obviously causing drastically negative impact on all leaving creatures and earth itself. However, there are many environmentally friendly options and modifications of the plastic materials some of them mentioned above, that appeared in the last century brought with the advance of technology that has to be studied more carefully.

6. Conclusion

The collective facts put together in the body of this paper have basically buttressed on the significance of using plastic materials for sustainable construction. Flexibility, versatility, adaptability and aesthetics features are inherent features of plastic-based building materials that

have put plastic materials ahead over other traditional building materials. The fact that they are organic and efficient in shaping has also enabled the emergence of different kinds and types of design that have gained special recognition and popularity among architects. This also means that advancement in the use of plastic materials for various designs has no limit therefore new products with improved features can be manufactured. In addition, certain additives have also improved the resistant ability of plastic-based materials to fire, UV ray and other disadvantages. The benefits of using plastic-based building materials in construction are not limited to their various advantageous features but also found relevant in the aspect of health. This explains that there is certain health privileges that occupants of building made with plastic materials could enjoy compare with the use of other traditional materials as already explained in the body of this paper.

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