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Plastic Bottle – As a new Renewable Construction Material

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Abstract —*Everyday Millions of people drink water from plastic bottle. So, there is lots of waste generated every day. After consumption of water the bottle should be crushed and dropped into the dustbin. But it is not practically effectively. So, instead to telling them to do so, a new method to use plastic bottle is effective method. Plastic is a renewable material so, we can produce a material from waste plastic and it is a environment friendly material.The objective of this paper is to investigate the using of plastic bottles as municipal wastes in the buildings, the key and positive characteristics of this product and the benefits obtained by using it in building.*

Keywords-*Plastic bottle, waste, environmental friendly, municipal wastes, building*

I INTRODUCTION

Plastic is one of the most disposable materials in the modern world. plastic bottles are increasingly becoming a menace to the environment due to the chemicals used in the manufacture, improper use and disposal. waste plastic bottles are used for filling up landfills which polluted to soil, choking water bodies and causing serious environmental consequences. on the other hand, world human population continually increase so needed more houses and land for construction. now a day, it is difficult to make own house for poor people of the world by using costly construction material. can we use waste bottles for construction? yes, it is difficult to think of a bottle as a brick. but a mud-filled bottle is as strong as a brick and whatever you can do with a brick; you can do with a bottle, too. when the bottles are filled with soil or sand they work as bricks and form a framework for walls or pillars. plaster made of clay or a cement mixture fills the space between all bottles while a roof made of wood or corrugated metal completes the house. as only regional products are used the houses are cheap and can be afforded even by poor families. our project intends to investigate the application of waste plastic bottles as one of the urban wastage in buildings construction and that how it can lead to sustainable development.

II LITERATURE REVIEW

Nowadays, large amount of plastic bottles are wasted and disposed every day. People are thrown away them without considering that what those plastic bottles can have impact on the humans and/or environment. Andreas Froese, the founder of Eco-Tec Environmental Solution, in searching for finding an inventive solution to junk, established the innovation of building plastic bottle houses. The first bottles house was built using 10000 glass beer bottles by William F. peck in 1902 in Tonopah, Nevada. After that the newer innovative concept has been using plastic bottle instead of glass bottles in constructing the houses. This innovative idea took to account for some reasons such as providing a cost-efficient construction method for pauperized third-world countries, reusing the plastic bottles due to their not indecomposable characteristic, and etc. The first plastic bottles house in Africa was constructed in the village of Yelda in Nigeria by Andreas Foresee. Foresee used the plastic bottles instead of bricks, bound the bottles together with string and at the end applied the plaster. Anyway beside the Eco-Tec, various other institutions and groups have initiated the concept of reusing the plastic bottles for building construction. However nowadays, the concept has spread to countries all over the world. Various kinds of homes have been built from plastic bottles such as: ecological house constructed using 8000 bottles in Honduras; an Eco-Tec home in Bolivia constructed using the PET and wine bottle; a house of waste plastic bottles built in Serbia by Tomi Slav Radovan; Taiwan's plastic bottle building; ecological bottle house built using 1200 PET plastic bottles for the walls near the luau Falls, Misiones, Argentina; and etc. The purpose of this paper is to look into the using of plastic bottles as a municipal waste in the buildings, the key and positive characteristics of this product and the benefits obtained by using it in building.

III. SUSTAINABLE DEVELOPMENT

Sustainable Development (SD) is the development which meets the needs of the present without compromising the needs of future generations.Some purposes of SD can be as following:

- Resource conservation: To conserve the non-renewable resources such as fuel, mineral and etc to ensure sufficient supply for present and future generations.
- Built development: To integrate environmental considerations into planning and development to respect the natural environment.

- Environmental quality: To prevent or reduce processes such as land filling which can lead to environment degradation and develop the culture of reusing and recycling process.
- Social equity: To impede development that increases the gap between the rich and the poor, and to encourage for reach to the social equality.

Inhabitation needs of the sustainability are based on three aspects including environmental, social and economical. At current time, the SD can be achieved through the partial integration of these three aspects. But the alternative face of SD is the full integration of these aspects such that:

- Economic exists entirely within the society as all parts of the human economy are achieved through interaction among people.
- Economy and society merely depend on the environment because if something is un-environmental then the society will be affected.
- When the society affected, then it will be uneconomical for the nation to create sustainable development.

Plastic bottle is considered as a sustainable material which can help in achieving the SD. Using the plastic bottle can follow the objectives of SD. It can abstain from the resource depletion, assist in protecting the environment; prevent or reduce the environmental degradation process such as land filling through reusing process and it can assist to obtain a social equity by avoiding the gap between the rich and the poor people in the society.

Figure 1 and 2 indicate the face of SD at current time and alternative face of SD in the future respectively.

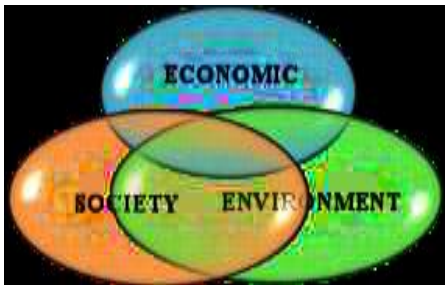

Fig. 1 Face of SD at current time.

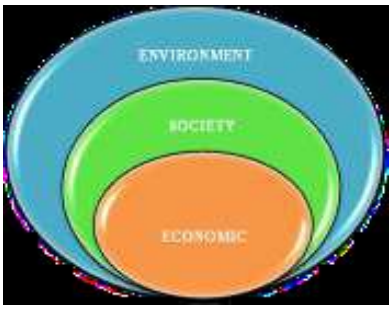

Fig. 2 Alternative face of SD in future.

IV. SUSTAINABLE AND GREEN BUILDING

Green building is defined as an environmentally sustainable building constructed and operated with the aim of mitigation of environmental impacts such as natural resource depletion as well as CO2 emission. It addresses sustainable site planning, energy efficiency, conservation of material and resources by using renewable resources as well as recycling and reusing and indoor air quality (US green building design).

Using renewable resources and also some unusable things in building construction can help in conserving the nonrenewable resources and obtaining to the green building. Plastic bottle is considered as a kind of junk which can be used in construction of some parts of the building such as wall, roof and etc. By using this kind of junk as the material,

we can help in saving the energy consumed in the factory for baking the bricks; saving the energy and reducing the CO2 emission by reducing the amount of cement usage and so on.

V. SPECIFICATIONS OF THE PLASTIC BOTTLE AS A BUILDING MATERIAL

Everyday many junks are produced in various sectors. Plastic bottles as a kind of junk produced a lot everyday can be used instead of some construction materials such as brick. It is so interesting to be stated that the plastic bottles has as same strength as bricks, ceramic block and concrete block but with the difference that the plastic bottle has got lots of advantages too.
As mentioned before, this innovative idea was first introduced by Andreas Froese who also founder ―ECO-TECestablished with the aim of providing advice on environmental management and utilization of solid waste. The green building ECOTEC technique is used for replacing the brick by disposal plastic bottle. As the plastic can remain as the junk on the earth for a long time due to its slow disintegration process, reusing the plastic can be an effective solution for this problem.

The most important benefits of these alternative innovative materials compared to conventional materials such as brick can include:

5.1. Good construction ability: -

The walls built by these bottles are lighter than the walls built by brick and block, and that makes these buildings to show a good response against earthquake. Due to the compaction of filling materials in each bottle, resistance of each bottle against the load is 20 times higher compared to brick. And these compressed filling materials, makes the plastic bottle to be prevented from passing the shot that makes the building as a bulletproof shelter.

The other factor that makes the bottle wall as an ideal wall is its self- supporting property such that the bottles are placed on each other crinkly. A cross-shape cable front and back of the bottle will cause the conflicts among them and this makes the whole unit that causes the cables to create equal forces against each other. The Figures 3 and 4 demonstrate the shape of bottles and that how they should be put on each other respectively which were simulated in 3D Max software.

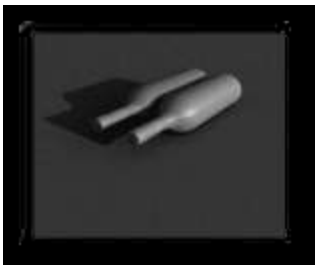

Fig. 3 Shape of plastic bottles.

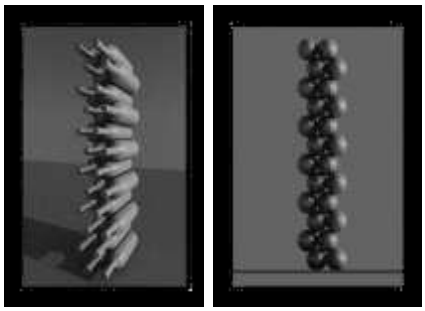

Fig.4 The way of putting the bottles on each other

5.2. Low cost

Constructing a house by plastic bottles used for the walls, joist ceiling and concrete column offers us 45% diminution in the final cost. Separation of various components of cost shows that the use of local manpower in making bottle panels can lead to cost reduction up to 75% compared to building the walls using the brick. It must be noted that the sophisticated manpower can lead to reducing the construction time and the relative costs also become lower.

5.3. Suitable thermal behavior

For insulation of these panels against the exchange of heat, the innovative solution is filling each bottle by three layers. Front and back of the bottle should be filled by sand and compact gravel and the middle of bottle should be filled by cork or wood particles. Cork is considered as an impenetrable insulation that is used in cylinder parts for blocking the bottle and glass. About 60% of the world total production of cork are used as the bottle caps, and are discarded after being used that can be used as recycled product in these panels which can bring a good and effective work. For building the panel, the variety of materials tailored to desired location can be used. But the material that cause to a good result is mud. The mud can be used as either thatch or mixture of mud and wood particle to fill the pores between the bottles and increase the beauty.

Fig. 5 Method of filling the plastic bottles for using in the building.

So in the current world economic situation, using these innovative materials can be efficient in reducing the cost of building construction, while the thermal comfort of the building is also supplied and may cause protecting the environment.

5.4. Non-brittle characteristic

Using the non-brittle materials can reduce construction waste. Unlike brick, plastic bottle is non-brittle. So due to the frangibility property, the percentage of producing construction waste in brick is more than plastic bottles.
Figure 6 shows a sample of broken brick used in the walls.

Fig. 6 Brittleness characteristic of the brick.

5.5. Absorbs abrupt shock

Flexibility is a characteristic which makes the building's performance higher against the unexpected load. Since the plastic bottles are not fragile, they can be flexible and tolerates sudden loads without failure. This characteristic can also increase the building's bearing capacity against the earthquake.

5.6. Green Construction

Plastic bottles can cause the green construction by saving energy and resources, recycling materials, minimizing the emission, having significant operational savings and increasing work place productivity. Figure 7 shows sample of real green building built using the plastic bottles.

Fig. 7 Green building built using plastic bottles.

VI. ENVIRONMENTAL IMPACTS OF REUSING THE BOTTLE PANELS IN BUILDING

Reusing the plastic bottle is considered as sustainable
consumption pattern which has a feedback loop after the consumption. The pattern will not lead to the waste which means it follows the reusing and recycling process.Reusing process in sustainable consumption pattern can save substantial amount of embodied energy which would otherwise be wasted. So using plastic bottles in building construction can have significant role in saving high embodied energy due to their reusing. This significant reduction in embodied energy can lead to mitigation of global warming; reducing resource consumption and reduction of biodiversity and in the long term consideration can improve built environment and human health.
The bottle panel technology mitigates the carbon emission emitted during the baking of an ordinary brick. The amount of cement used for the building's wall can be reduced by this technology which can reduce the heat generation from the cement factories. This leads to reducing the emission of greenhouse gases which mitigates the global warming and in the long-term prevents ozone depletion.
This material can also be used for the building's roof which leads to a better insulation compared to the conventional roofs. It can cause to lowering heating and cooling cost. Therefore it can be deduced that the bottle brick is much more energy-efficient than the clay brick.

VII. CONCLUSION

Plastic bottles are considered as a kind of indecomposable junk which can have substantial dangerous impact on environment. On the other hand, using the non-renewable resource cannot lead to sustainable development and causes to the resource depletion which can bring a destructive concern for the future generation. It has been demonstrated that the plastic bottles can be used in some parts of building construction such as walls, roof and etc. Reusing the plastic bottles as the building materials can have substantial effects on saving the building embodied energy by using them instead of bricks in walls and reducing the CO2 emission in manufacturing the cement by reducing the percentage of cement used. It is counted as one of the foundation's green project and has caught the attention of the architecture and construction industry. Generally, the bottle houses are bioclimatic in design, which means that when it is cold outside is warm inside and vice versa.

Use of innovative materials with sustainable application such as plastic bottles can have considerable benefits including finding the best optimization in energy consumption of the region, reducing environmental degradation, establishment of the appropriate structural behavior in building such as causing to the light weight structure and can also be applied in a project to construct buildings considered temporary.

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