Utilization of plastic waste bottles in the development of wall panels using Ferro-Geopolymer Technology

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Abstract - Plastic bottles chokes up the natural water resources and it create the problems to the marine lives as well as it creates the adverse effect on human life, causes such as cancer. The management of plastic waste bottle is very tedious, other hand day by day the cost of construction materials increases rapidly. It is not possible to afford the good houses for the backward community from our country. To reduce the plastic impact from environment and to provide the affordable housing for each and every community of our country, the present models or research suggest the alternative materials used in the construction of wall panels by replacing brick with empty waste plastic bottle covered with chicken mesh and then with geopolymer mortar (i.e. ferrocement). Ferro cement is a highly versatile form of mesh reinforced cement mortar that possesses unique quality of strength and serviceability. A wall panels was prepared by covering empty Plastic bottles with chicken mesh and then covered by geopolymer mortar. The size of wall panel is considered as 500mm X 100mm X 300mm. the test result show that the strength of geopolymer matrix based wall panel is more-stronger than brick and cement matrix based wall panel. Also it saves up to 65% cost and 50-70% reduction in self-weight.

Key Words: Plastic bottle wall panels, Fly ash based geopolymer mortar, Alkaline Activators, Ferrocement techniques.

1. INTRODUCTION

Geopolymer mortar-The major problem that the world is facing today is the environmental pollution. In the construction industry mainly the production of ordinary Portland cement (OPC) will cause the emission of pollutants which results in environmental pollution. The emission of carbon dioxide during the production of ordinary Portland cement is tremendous because the production of one ton of Portland cement emits approximately one ton of CO_2 into the atmosphere. The geopolymer technology shows considerable promise for application in concrete industry as an alternative binder to the Portland cement. In terms of global warming, the geopolymer concrete/mortar significantly reduces the CO_2 emission to the atmosphere caused by the cement industries. Geopolymer concrete/mortar was produced by activating fly ash with a highly alkaline solution of sodium silicate containing 16.45% Na_2O, 34.35% SiO_2 and 49.20% H_2O. The specimens were cured in an oven for 4, 8, 12, 16, 20 and 24 hours at 90oC. The compressive strength results show that the fly ash fineness plays a vital role in the activation of geopolymer concrete/mortar. An increase in the fineness increased both workability and compressive strength.

This water is expelled from the mixture during the curing process leaves behind discontinuous nano pores in the matrix, which provide prosperity to the accomplishment of geopolymers. The water in a geopolymer mixture plays no role in the chemical reaction that takes place; it merely provides the workability to the mixture during manipulation. This is in resemblance to the chemical reaction of water in a Portland cement concrete mixture during the hydration process. Geopolymers exist to the group of strong and durable cementitious materials that harden at temperatures below 100°C

Plastic Waste- The India is an agricultural country, before 30-40, there is no more development in the industrialization or mechanization because of the most of the people are lives in a rural area but day by day the development in the industrial sector is carried out the world innovates the new techniques for development as well as population should goes increasing with rapid rate because of that consumption of natural resources increased frequently the ecological balance of environment destroyed**.** The ill effects of plastic on our environment are well known to us, plastic forms an integral part of our lives. Due to unawareness of the people in society they use the plastic and it thrown at anywhere on road, public places, etc. These plastic should not be degrade easily or rapidly. It will take so many years to decompose. It is a non-biodegradable substance composed of toxic chemicals, as well as it causes the so many health hazardous effect on human as well as environment. Plastic bottles are increasingly becoming a menace to the environment due to the chemicals used in the manufacture, improper use and disposal.

As noted by Plastics Industry (2011) reusing plastic bottles may seem safe, but a chemical found in reusable plastic bottles, known as Biphenyl A, is suspected of posing a health risk to human beings. Plastic is one of the most disposable materials in the modern world. It makes up much of the street side litter in urban and rural areas. It

is rapidly filling up landfills as choking water bodies. Plastic bottles make up approx. 11% of the content landfills, causing serious environmental consequences significant increase in housing demands in many urban areas among urban poor households in India is becoming a growing concern now. According to the technical committee under the Ministry of Housing, the estimated housing shortage is found to be 18.78 million during the 12th Five Year Plan. Such problems mainly pertain to 95% of Economically Weaker Section (EWS) and Low-Income Groups (LIG). At city level, around 30-50 percent of population are urban poor and do not have access to adequate infrastructure. If we look further into the cause of this problem; it can be noted that cost of construction, materials, land and transportation are some of main factors leading to increase in housing unaffordability. Use of locally available materials, low-quality components and utilization of waste in construction are some of the reliable solutions for low-cost housing.

OBJECTIVVES

- To reduce the self-weight of wall by using the waste plastic bottle instead of bricks.
- To provide the safety and economy in the housing construction
- To reduce the pollution impact on environment due to plastic waste.
- To provide affordable housing especially for poor people.
- Full utilisation of industrial waste like fly ash.
- To compare the strength and cost of brick wall panel and RCC wall panel with waste plastic bottle wall panel.
- To construct the structural element with low cost, minimum impact on environment and minimum time period.

1.1 NECESSITY OF PLASTIC BOTTLE HOUSING

Plastic are produced from the oil that is considered as nonrenewable resources. Because plastic has an insolubility about 300 years in the nature. It is considered as a sustainable waste and environmental pollution. So reusing or recycling of it can be effectual in society gets affected then it will be economical to the nation to create sustainable development. Plastic bottle is the source which can fill the gap between the rich and poor people housing. Now a day the whole world can face a various dangerous problems such a global warming, ozone depletion because of pollution. So it is very important to control the pollution. Each and every person in the society is addicted by the plastic sources, and on sources should be result to effect on environment. These plastic waste produces not only human hazards but also it chokes up the water resources and create pollution. So it is very necessary to find a way or option to reuse these plastic in a sustainable development for environment, society, etc. By using the plastic bottles in the construction we reduce the waste from society as well as we provide the optional a low cost material for construction of housing.

2 This construction provides stability, economy, durability and thermal expansion to the structure. Also by replacing the brick by plastic bottles less cost or money should be saved. Finally these techniques introduce low costing model or sustainable model in construction of housing. It creates a new innovation in construction section. Also it provides the good house in low price for the people which have the dream to live in a good attractive and economic house such as poor people. We want to setup the option for high cost RCC structure by replacing it with plastic bottle and bamboo frame housing as called low cost housing.

3 Today the plastic becomes a prevalent that we find them everywhere even inside the bodies of marine animals. One average we use 168 bottles (plastic) each year (source Ecodez.com) and more than half of them are not recycled. It dumped over the land; it will take choke up the water resources. It creates water pollution, etc. But to overcome these plastic wastage as well as plastic bottles difficulties or problem, these plastic bottles are used in the construction section by replacing the brick. Generally plastic bottles are waste in the society and it is easily available. Bricks are more expensive a compared to bottles. Also using the plastic bottles any bamboo we create a framework of low cost housing which should be ecofriendly energy saving.

1.2 BENEFITS OF PLASTC BOTTE MASONRY WALL

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

A. 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.

B. 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 walls can lead to cost reduction up to 75% compared to building the walls using the brick and concrete block. It must be noted that the sophisticated manpower can lead to reducing the construction time and the relative costs also become lower.

C. 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.

D. Absorbs abrupt shock loads: Flexibility is a characteristic which makes the buildings 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 buildings bearing capacity against the earthquake.

E. 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.

Bottle brick construction will provide excellent solution for shelters in poverty stricken country. It will prove to the best use for reused per bottle construction, construction based on bottle brick technology will be 20 times stronger than brick construction. It also provides the efficient solution to worldwide problem of plastic bottle garbage.

2. COMPARISON BETWEEN THE PLASTIC BOTTLE AND BRICK WALL PANEL

PLASTIC BOTTEL WALL PANEL	BRICK WALL PANEL
Time of execution is faster.	Time require more.
Saving in cement, water and fitting	More weight, more materials.
Lighter and higher volume, easy and cheap displacement	High weight and loss of material.
Strength 10 Times more than brick.	Strength- Greater wall thickness, lower strength.

2.1. ADVANTAGES OF PLASTIC BOTTELS PANEL COVERED WITH FERRO-GEO MATRIX

1. Reducing environment pollution especially in cities, village, rivers, lakes and seas.

2. Simple recycling system, applicable worldwide.

3. Recycling system uses human thus renewable energy.

4. Provide new livelihood activities for people working at dumping sites, new skills for masons, new opportunities for construction companies.

5. Avoid the purchase and transport of conventional construction material. It can be sourced locally.

6. Effective isolating material.

7. Earthquake resistant material.

8. Reduces high CO2 emission and deforestation caused by bricks making which production requires lots of energy of wood and generates lots of CO2.

2.2. METHODOLOGY

Bottle brick construction will provide excellent solution for shelters in poverty stricken country it will prove to the best use for reused plastic bottle construction .construction based on bottle brick technology will be 20 times stronger than brick construction. It also provide the efficient solution to worldwide problem of plastic bottle garbage. To constructing the low cost house as well as elements of houses such as wall, column, slab we have accrued the following method and material are adopted.

- **FLY-ASH-** fly ash also known as “pulverized fuel

ash, is one of the coal combustion product composed of fine particles that are driven out of the boilers with the flue gases. Fly ash includes substantial amounts of silicon dioxides, aluminum oxides, and calcium oxide the main mineral compounds in coal bearing rock strata**.**

- **PLASTIC WASTE BOTTLE -**By the survey of ecodez.com the one person uses the 168 bottles per year and only 38% plastic bottles are reuse or recycled, remaining bottles are thrown anywhere in the society because of that it will be lead the hygienic causes on human health as well as it chokes up water resources to overcome the problems we are suggest to use it as a construction material which is replaced the, it also provides economy, durability, safety and strength.

CONSTRUCTION PROCESS

- Collection of plastic as well as waste bottles from the garbage
- Collecting bamboos from natural source.
- These fly-ash filled bottles work as brick in the structure.
- Foundation will be laid down with bottle bricks as well as cement.
- The whole frame of element should be made by bamboo.
- After this process by using the cement plastering of these elements are done.
- Lastly the painting coat should be applied.

CONSTRUCTED ELEMENTS

Testing of materials

Compressive strength of plastic bottle filled with fly ash

Compressive strength test for each bottle was determined on universal testing machine and the average value was considered for analysis. Weight of empty PET bottles and completely filled PET bottles were noted and amount of fly ash used was calculated for the same. Similarly, compressive strength of brick was calculated by taking the average value and the results were compared and analyzed.

- The formula used is:
- Compressive strength =P/A (N/mm^2)
- Where,
- P = Load at failure in N.
- A = Area subjected to compression in mm^2

2.3. Experimental observations

After compressive strength testing done on about 2bottles and a calculation for concluding a result is done. The Data obtained as per universal testing machine is tabulated in table

TYPE OF SAMPLE	SAMPLE 1	LOCAL BRICK
MATERIAL	FLY ASH FILLED PLASTIC BOTTLES	BRICK
LENGTH	26.5 CM	21.6 CM
DIAMETER	7.0 CM	-
WEIGHT	860 gm	2030 gm
UTM LOAD CARRING CAPACITY	354 KN	87 KN

2.4. RESULT OF WALL BLOCK

TYPE OF SAMPLE	BLOCK 2	BLOCK 3
DIMENSIONS (mm)	350 x 200 x 125	350 x 200 x 125
WEIGHT (kg)	18.170	19.470
LOAD CARRYING CAPACITY (kN)	500	600

3. CONCLUSIONS

- Use of the innovative materials with sustainable applications such as plastic bottles can have considerable benefits including finding the best optimization in energy consumption of the region, reducing environmental degradation.
- Reusing the plastic bottles as the building material can have substantial effects on saving the embedded energy by using them instead of bricks in walls and provide greater strength than bricks.
- Cost comparison between bottle wall is roughly half than conventional brick masonry

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BIOGRAPHIES

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