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E3 SHELTER (Eco-friendly, Economic, Energy Efficient Shelter) by using AutoCAD software

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ABSTRACT

Introduction: Shelter being the primary need of all human beings, aesthetically designed hygienic affordable houses with basic amenities for all sections of society are our concern at the time. Waste materials are generated at an alarming rate due to their use and throw the concept of consumerism, and cycling the same for building purposes get important. But the suitability and durability along with its strength and local availability are is arere important for the cost-effectiveness and the durability of the structure erected. Locally available eco-friendly materials, innovative design and methods of construction will drastically reduce the cost of the shelters other than enhancing the look and improvement in the microclimatic conditions such as light and temperature inside the shelter. Arches being load-bearing components various types of the arched opening should be explored for the construction to bear the load of the structures. Glass Bottles of beer and other beverages (WOBO- Waste of Bottles) having enough strength and perfect dimensions can be utilised for the constructions with minimal cost in an eco-friendly manner to give enough light, thermal insulation and eco-friendly environment for the shelters. Doing this, will not only benefit low-income people by providing an E^3 - economical, energy-efficient, eco-friendly shelter but also helps in keeping the environment clean by reusing the materials.

Objectives: The primary objective of the project is to plan, design, estimate and construct an E^3

(Energy efficient, eco-friendly, economical) shell roofed shelter having various arched openings with Waste of Bottles (WOBO) masonry and coconut shell concrete shell roof to understand the efficiency and performance of the same.

Methodology: To achieve this objective, the layout, plan, design, 3D modelling and estimation of an 8'x8'x8' shelter of empty beer bottles (understanding the various engineering properties from the earlier studies) have been made on existing WOBO pillars erected by the previous batch. The innovative approach of using simple waste materials such as tyres, cardboard, gunny bags, coconut piths and a lot of scrap materials has been adopted in the centring and mould for roof and various arches viz: Tre foil arch, corbelled arch, lancet arch and segmental arch for windows and doors.

Results and Conclusion: The execution and experience of this construction project with empty glass bottles and used coconut shells proved that these waste materials can be effectively utilised for building shelters of utility without compromising on strength, durability, hygiene and aesthetic view. Translucency and thermal insulation of empty glass bottle walls being the known factors are added advantages to provide the

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required lighting and microclimatic control for the E^3 shelter.

Keywords: *E^3 Shelter, WOBO shelter (Waste of Bottles), Economic, Eco-friendly, Energy efficient shelters*

1. INTROUCTION

1.1 GENERAL INTRODUCTION:

Shelter being the primary need of all human beings, aesthetically designed hygienic affordable houses with basic amenities for all sections of society is the concern of the time. Waste materials being generated at an alarming rate due to the use and throw concept of consumerism, recycling the same for building purposes get importance. But the suitability and durability along with its strength and local availability is more important for the cost effectiveness and the durability of the structure erected. Locally available eco-friendly materials, innovative design and methods of construction will drastically reduce the cost of the shelters other than enhancing the look and improvement in the microclimatic conditions such as light and temperature inside the shelter. Arches being the load bearing components various types of arched opening could be explored for the construction to bear the load of the structures. Glass Bottles of beer and other beverages (WOBO- Waste of Bottles) having enough strength and perfect dimensions can be utilised for the constructions with minimal cost in an eco-friendly manner to give enough light, thermal insulation and eco-friendly environment for the shelters. By doing this, it will not only benefit the low-income people providing an E^3 - economical, energy efficient, eco-friendly shelter but also helps in keeping the environment clean by reusing the materials.

AIM OF PRESENT STUDY:

1. An E^3 shelter for a small family.
2. An effective design and construction methods for a E^3 shelter
3. Utilising the waste glass bottles for construction purposes to offer shelter
4. Educating the community about the eco-friendly construction
5. A live 8'x8' glass bottle shelter erected

OBJECTIVES:

The primary objective of the project is to plan, design, estimate and construct an E^3 (Energy efficient, eco-friendly, economical) shell roofed shelter having various arched openings with

Waste of Bottles (WOBO) masonry and coconut shell concrete shell roof to understand the efficiency and performance of the same.

METHODOLOGY

To achieve this objective, the layout, plan, design, 3D modelling and estimation of an 8'x8'x8' shelter of empty beer bottles (understanding the various engineering properties from the earlier studies) have been made on existing WOBO pillars erected by the previous bathe innovative approach of using simple waste materials such as tyres, cardboard, gunny bags, coconut piths and a lot of scrap materials has been adopted in the mould and centring for roof and various arches viz: Trefoil arch, corbelled arch, lancet arch and segmental arch for windows and doors. Considering the limitation of time, a minuscule live model has been planned and designed to build and test the expected characteristics of such construction.

SOURCES OF INFORMATION:

www.google.com
www.youtube.com

To construct a 3D model of the structure Solid Edge software was used.
The tips were taken from a book written by Laurie Baker.

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2. LITERATURE REVIEW

Mojtaba concluded that 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 CO^2 emission in manufacturing the cement by reducing the percentage of cement used. It is counted as one of the foundation's green projects 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 it is warm inside and vice versa. 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 and concrete block.

Shilpi concluded that by utilizing PET bottles in construction recycled materials, thermal comfort can be achieved in very low-cost housing, benefit in residents for those who cannot afford to buy and operate heating and cooling systems. Plastic is non-biodegradable, toxic, highly resistant to heat and electricity (best insulator) and not recyclable in true sense, plastic PET bottles use in bottle brick technique. This gives relief for the poor people of India to provide cheap and best houses for living.

Puttaraj examined that efficient usage of waste plastic in plastic-soil bricks has resulted in effective usage of plastic waste and thereby can solve the problem of safe disposal of plastics, also avoids its widespread littering and the utilization of quarry waste has reduced to some extent the problem of its disposal. Plastics are produced from the oil that is considered as non-renewable resource. Because plastic has the insolubility about 300 years in the nature, it is considered as a sustainable waste and environmental pollutant. So, reusing or recycling of it can be effectual in mitigation of environmental impacts relating to it. It has been proven that the use of plastic bottles as innovative materials for building can be a proper solution for the replacement of conventional materials.

3. PLANNING OF E^3 SHELTER

GENERAL INTRODUCTION:

Shelter is the basic human requirement. Even after 70 years of independence, the country is still grappling with the growing shelter problem, especially of the poor. The problem has further been compounded by the rapid increase in population. Constant migration of rural population to cities in search of jobs is causing unbearable strain on urban housing and basic services.

In India, housing is essentially a private activity. The state intervention is also necessary to meet the housing requirements of the vulnerable sections and to create a positive environment in achieving the goal of 'shelter for all'.

RURAL HOUSING IN KARNATAKA

In view of the above aim, the government introduced Housing and Habitat Policy in

1998, which aimed at ensuring the basic need 'Shelter for all' and better quality of life to all citizens by harnessing the unused potentials in the public, private and household sectors.

The Housing and Urban Development Corporation (HUDCO) also started functioning with the financial support provided by the Government of India. HUDCO's focus is on providing housing facilities for economically weaker sections and for low-income

Housing Policy for the state of Karnataka is expected to serve the larger overarching Housing has been recognized as a basic human need. The proposed State goal of "Affordable Housing for All".

Karnataka is the eighth largest state in India both in area and population. While nearly 69% of the population lives in rural areas, urbanization is rapidly increasing. At the macro level, there is growing State wide demand for housing, housing finance, land availability and supporting infrastructure.

NEED FOR HOUSING POLICY

Need for Karnataka Housing and Habitat Policy emerges from the growing requirements of shelter and related infrastructure both at rural and urban centres as also due to the change in economic and social environment, growing urbanization, mismatch in demand and supply of developed land and houses at affordable rates and inability of poorer sections of the population to have access to formal land markets and finances from financial institutions leading to a non-sustainable situation. Adequate housing is not just the mere provision of four walls and a roof but implies access to basic services such as water, sanitation, clean fuel, electricity, healthcare, education and livelihood – all of which are essential for living in society. In view of the distinctive social, geographic and climatic conditions, it is necessary to adopt efficient land planning for its optimal use keeping in view the alternative requirements, particularly for meeting the demand of land/housing for the lower income. Moreover, the concerns of affordability, quality and sustainability need to be addressed by harnessing appropriate technology.

PLANNING OF E^3 SHELTER

Waste materials being generated at an alarming rate due to the use and throw concept of consumerism, recycling the same for building purposes get importance.

But the suitability and durability along with its strength and local availability is more important for the cost effectiveness and the durability of the structure erected. Locally available eco-friendly materials, innovative design and methods of construction will drastically reduce the cost of the shelters other than enhancing the look and improvement in the microclimatic conditions such as light and temperature inside the shelter.

Glass Bottles of beer and other beverages (WOBO- Waste of Bottles) having enough strength and perfect dimensions can be utilised for the constructions with minimal cost in an eco-friendly manner to give enough light, thermal insulation and eco-friendly environment for the shelters. By doing this, it will not only benefit the low income people providing an E^3 - economical, energy efficient, eco-friendly - shelter but also helps in keeping the environment clean by reusing the materials.

The primary objective of the project is to plan, design, estimate and construct an E^3 (energy efficient, eco-friendly, economical) shell roofed shelter having various arched openings with Waste of Bottles (WOBO) masonry and coconut shell concrete shell roof to understand the efficiency and performance of the same.

4. COST ESTIMATION OF E3 SHELTER COST ESTIMATION

Cost involved in a project is important in the success of any project since it should be affordable to the client. Here we have estimated the cost of E^3SHELTER which we have erected, and a comparison is made with the cost estimation of laterite brick shelter of same dimension. The real cost incurred for the present project is also given at the end as an example to show how we can reduce the cost by involving the physical labour of

the people who required the shelter and recycling the materials discarded around us for the construction.

Table 4.1 Cost Estimation for 64 Sq. Feet shelter Construction with Empty Beer Bottles

SL.	PARTICULARS	QUANTITY	RATE (Rs.)	COST. (Rs.)
1.	**WASTE BOTTLES**	1750 No's.	2/BOTTLE	3500
2.	**CEMENT**	11 BAGS	350/BAG	3850
3.	**SAND**	45 BAGS	57/BAG	2565
4.	**COARSE AGGREGATE**	80 BAGS	44/BAG	3520
5.	**PLYWOOD FORMWORK**	LUMPSUM	-	3000
6.	**NAILS, HAMMER, PLIER, PLUM BOB**	LUMPSUM	-	1000
7.	**CONCRETE BLOCKS FOR FLOOR**	64 sq. feet	35/sq. feet	2240
8.	**CENTERING FOR ROOF**	LUMPSUM	-	1000
9.	**LABOUR CHARGES**	LUMPSUM		25000
10.	**MISCELLANEOUS**	LUMPSUM	-	3000
	TOTAL			**48,675**

Table 4.2 Cost Estimation for 64 Sq. Feet shelter Construction with Laterite Bricks

SL.	PARTICULARS	QUANTITY	RATE (Rs.)	COST. (Rs.)
1.	**LATERITE**	168 No's.	30/BRICK	5040
2.	**CEMENT**	18 BAGS	350/BAG	6300
3.	**SAND**	49 BAGS	57/BAG	2793
4.	**COARSE AGGREGATE**	28 BAGS	44/BAG	1232
5.	**JUTE BAGS**	20 No's.	10/ BAG	200

6.	**BAMBOO**	32 No's.	25	800
7.	**TYRE**	4 No's.	25/ TYRE	100
8.	**PLYWOOD FORMWORK**	LUMPSUM	-	3000
9.	**NAILS, HAMMER, PLIER, PLUM BOB**	LUMPSUM	-	4000
10.	**CONCRETE BLOCKS FOR FLOOR**	64 sq. feet	46/sq. feet	2944
11.	**CENTERING FOR ROOF**	LUMPSUM	-	1000
12.	**STEEL BARS**	128 KG	45/KG	5760
13.	**TRANSPORTATION**	LUMPSUM	-	1000
14.	**LABOUR CHARGES**	LUMPSUM	-	25000
15.	**MISCELLANEOUS**	LUMPSUM	-	3000
	TOTAL			**62,169**

5. CONCLUSIONS

Although designing and building of E^3 shelter is still an upcoming practice and relatively new methodology of construction, it has enormous, uncapped potential in the construction sector.

The execution and experience of this construction project with empty glass bottles and used coconut shells proved that these waste materials can be effectively utilized for building eco-friendly, cost effective, energy efficient decent shelters of utility without compromising on strength, durability, hygiene and aesthetic view.

Translucency and thermal insulation of empty glass bottle walls being the known factors are added advantages to provide the required lighting and microclimatic control for the E^3 shelter. Generally, the bottle houses are bio-climatic in design, which means that when it is cold outside is warm inside and vice versa.

Re-using the glass 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 CO^2 emission in manufacturing the cement by reducing the percentage of cement used.

Recycling coconut shells and constructing funicular dome roof can save a lot of energy since they don't use any steel bars for reinforcement without compromising the stability of the structure. Moreover, these coconut shells or their dent will act as concave lenses for illuminating the room with solar powered LEDs.

The construction found to be easy without any skilled labours since the bottles are of light weight

compared to the heavy laterite bricks which required additional trimming and finishing.

The comparative analysis of the cost estimation with the laterite bricks shelter of same dimension revealed that up to 22% of the cost can be saved in empty beer bottle construction with coconut shell funicular dome roof.

Construction cost per square feet using empty beer bottles found to be Rs. 760.54 whereas those for laterite brick shelter is Rs. 971.5, demonstrating a saving of up to Rs. 3.29 per sq. feet construction.

It is found that about three fourth of the cost can be saved through the effective participation of the client or community and recycling the discarded materials in construction.

The construction cost of E^3 shelters of empty beer bottles and coconut shell funicular dome roof with community participation found to be highly affordable to low-income family since the cost of construction worked out to be as low as Rs. 255.39 per square feet.

This kind of construction can be adopted for construction of Bus shelters, kiosks, Traffic posts, Toll tax counter, small stationary shops, shelter for monuments, public toilets, etc.

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