

ECO FRIENDLY CONSTRUCTION MATERIALS and TECHNIQUES SUITABLE FOR INDIAN CONTEXT

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ABSTRACT

Eco friendly construction materials and techniques are used to reduce negative environmental impacts and are resource efficient. These building technologies promote a sustainable environment and will reduce the amount of energy and waste generated.

This paper studies on eco-friendly materials and techniques that can enhance the sustainability of a structure in India. It includes details and various applications of the materials and techniques for green construction which is also cost effective. The various materials discussed in this paper includes materials for concrete, walls and slabs. The buildings constructed by using conventional and ordinary materials have a substantial impact on users and the planet. They depend upon depletable resources leading to irreversible environmental impacts. During construction they use resources that can generate waste and emit toxic and greenhouse gases throughout their life cycle. This can cause serious damage to the environment. To minimize damage we must practice usage of eco-friendly building materials for construction.

This research will help us to understand that does all eco friendly materials and techniques have an equal impact on sustainability of a structure in India.

INTRODUCTION

The use of conventional building materials has led to depletion of the finite natural resources that are required for the production of these materials. The conventional building materials include brick, cement, steel, stone, timber, glass, etc.. So, better technology which leads to development of other alternative materials which can be used in the construction industry is required.



Flow chart showing impact of overuse of conventional building material(source-csir)

OBJECTIVE

Traditional construction techniques are said to be the most energy efficient, climate responsive and economical due to development of these over time. But these techniques are not feasible for modern day construction of multi-storied buildings. The objective of this paper is the need of more innovative material and construction techniques required to fulfill the needs of the industry keeping in mind the protection of the environment. This paper includes the details about various eco-friendly materials and techniques developed for the same.

AIM

The aim of the research is to make people aware about the various innovative and green materials available in the market and to create awareness about the use of the same.

METHODOLOGY

Research is conducted on the basis of visual research and observation by understanding various graphs, conclusions, analysis and photos, referring to research papers, case study, and secondary survey data. The research involves study of eco-friendly construction technology for the construction of slabs and walls and a detailed study about green concrete which is produced by using waste material. This can resolve the main problem of industries that is disposing waste. It also reduces environmental impact with reduction in CO₂ emission.

CASE STUDY

S.P.C.A OF TOMPKINS COUNTY

Architect: Pat Heller

S.P.C.A is an animal shelter in New York which got certified as the first green shelter in the country, The shelter is approximately 19500 square feet and was opened in 2004 .

Tompkins received a LEED silver rating from the U.S Green Building Council . Since then , other shelters have followed its lead.

As the area receives ample amount of precipitation, the design firm ARQ Architects of Kittery incorporated a water reuse system, where they installed 15000 gallon cistern to capture runoff water that can be recycled and used later for cleaning. Considering that shelters use gallons of water every month for the purpose of cleaning.

The parking lots are covered with a permeable surface to prevent runoff into nearby wetlands. This can cut down water contamination. Other eco-friendly aspects are sensors that control heating and ventilation system, as animals get stressed and physically uncomfortable as the temperature changes according to the climate so it is important to maintain the comfort temperature inside the shelter. They have used toxin free paint inside the shelter

which keeps the shelter interior with pure air.

They have also used dual pane windows such that it acts as an insulation .This helps in maintaining the inner temperature but with adequate natural lighting. The architect also thought about reusing or recycling construction waste as much as possible. This will reduce the landfill burden and can use doors and

windows of the demolished building after recycling.



Google earth view of the site showing Permeable surface for car parking and nearby wetland area.(source: Google earth)

LITERATURE REVIEW1

GREEN CONCRETE:

EAslani Samaneh and Ghorbani Param Afshin

Key word:environment friendly concrete, efficient concrete, green concrete,environmental friendly construction material.

Green concrete can be defined as concrete made after replacing cement or fine or coarse aggregate partially or completely .The substitution material can be of waste or residual product in the manufacturing process.Most commonly used materials are recycled demolition waste aggregate ,recycled concrete

aggregate, blast furnace slag, manufactured sand, glass aggregate and fly ash. Green concrete is often cheap because of the substitutes and their waste disposal has little cost.They require very less energy for production and have higher sustainability if not mixed with colour. Non organic materials like rock dust,worn concrete or marble wastes are applied in Green concrete as granular materials and substitution of cement with fly ash and silica increases the quality of new green concrete.India has a great scope in using green concrete as industries are having problem to dispose waste such as fly ash and other non biodegradable products. They fill acres of land to dispose of these waste.

Main 4 benefits of using green concrete are

Durability : green concrete gains strength faster and has lower shrinkage rate compared to concrete made of regular portland cement.It has better fire resistance where it can withstand 2400 degree F. It has a greater resistance to corrosion .

Usage of industrial waste: Instead of mixing 100percent Portland cement mixture,green concrete uses 25 to 100 percent fly ash. Fly ash is a by-product of coal combustion and is gathered from industrial plants that use coal as a power source.hundreds of acres of land are used to dispose of fly ash. A large increase in the use of green concrete in construction will provide a way to use up fly ash and hopefully free many acres of land.

Reduces energy consumption: If you use less portland cement and more fly ash when mixing concrete ,then you will use less eney .The materials that are used in portland cement require huge amounts of natural gas or coal to heat it up to the appropriate temperature to turn them into portland cement. Fly ash already is a byproduct of another industrial process so extra energy usage is not required to use it in green concrete.

Reduces co2 emissions: 5 to 8 percent of c02 emission worldwide is due to the production of portland cement. The process of heating cement ingredients using coal and natural gases emit carbon dioxide into the atmosphere. The manufacturing of green concrete releases 80 percent less co2 to the environment.in order to reduce emission globally switching over to green concrete for construction can help considerably.

OBSERVATIONS

This paper discusses why we should replace conventional concrete with green concrete and its benefits. It also tells us why it is important to use green concrete in a country like India where industries are finding difficulty in disposing waste, and filling up acres of land to dispose of it. By this technology, these wastes can be used and as a result,hundreds and thousands of acres of land will be free of waste.

LITERATURE REVIEW 2

TECHNOLOGICAL SOLUTION FOR SLAB CONSTRUCTION(source CBRI) RCC PLANK AND JOIST SYSTEM

Precast rcc plank and joist roof is an innovative building system in which reinforced cement concrete planks-rectangular slab elements are placed on the precast joist which are supported by the edge beams, The floor is then completed by pouring concrete on the haunches of the rcc planks and over the partially precast joists which makes them act as a monolithic structural element and provides strength to it. There are various components involved for this type of construction:

i) Precast rcc plank

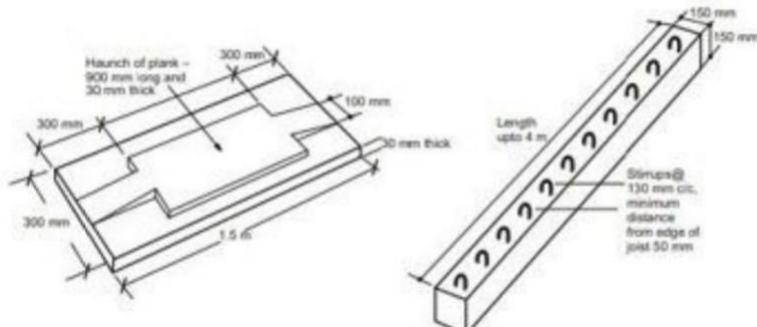
Rcc planks or rcc slabs which are manufactured in standard size of 30cm x 150cm long although there is option for varying lengths ranging between 1.2m to 1.8m . The planks are manufactured in such a way that it is partly 300mm thick and partly 600mm thick with a 100mm tapered concrete filling for strengthening which is required for transportation and handling of the planks during the construction process. The reinforcement used is a 6mm dia bar with concrete grade not less than M20.

ii)Precast rcc joist

The joists act as stringer beams which are used to support the rcc planks which act as a monolithic element and act as a roof.The joist is the part of a T beam formed together with both joist and planks .The rcc joists are casted for about medium spans for about 4m, a 150 x 150 mm section which has stirrups projecting out which helps to increase the overall depth of the floor to become about 210mm which includes the depth of concrete.

iii) Concrete filling

The combination of rcc planks and joists are placed completely and then concrete is poured over the haunches in site and monolithic action of the roofing system is ensured by adding reinforcement bars across the joists over the haunch portion of the planks tying them together by pouring concrete over it.



Detail of rc plank and joist system (source -CBRI)

<https://law.resource.org/pub/in/bis/S03/is.13990.1994.pdf>

RCC WAFFLE UNIT

Rcc waffle shells are precast units which are in the shape of a box with upto 1.2m in size . The casting of these waffle shells are done by using timber or steel weld mesh reinforcement. After curing these waffle shells are assembled on the shuttering and are fixed in grid pattern leaving a space of 10 to 17cm between the units. The space in between is used to cast internal beams with minimum reinforcement to make the waffles act as monolithic structure , and concrete is poured . This Type of structural system reduces the volume of concrete by about 30 percent.This type of roofing is generally used in long span structures like airports , parking,garages etc.



Reinforcement of waffle slab(source-CBRI)

<https://cbri.res.in/precast-rc-waffle-units/>

OBSERVATIONS

This paper discusses a technological solution for slab construction which is efficient and eco friendly compared to conventional techniques. It provides a safe and cleaner environment for the workers. This technique has a reduction on 40 percent on waste produced on the site. (Vivian et al. 2006).

LITERATURE REVIEW 3

FLY ASH BRICK

Dr. Jayeshkumar, Laxmansinh b, Mr Sameer Mistry

Fly ash is a material largely produced by the burning of coal, this fly ash is now transported to various factories and it is used to produce fly ash bricks which are being used for construction of buildings. It has a good scope in India, as the brick is being manufactured from the waste material fly ash which generally comes from the industrial waste in mass, in a country like India with dense population availability of land for dumping waste is minimum. By adopting this technology of fly ash brick, manufacturers can avoid the difficulty of dumping fly ash. As the natural resources are getting limited and easy to manufacture, scope for this will increase rapidly in India. It also has less pollution during its construction work which is not the same in all brick manufacturing. High compressive strength, better workability, fire resistance ...and all these qualities of brick will increase its future scope of construction work.

The process of manufacturing fly ash bricks is based on the reaction of lime with silica of fly ash to form calcium silicate hydrate which binds the ingredients to form brick. The quality of the brick depends upon the quality of fly ash used.



Mixing of ingredients (source: the engineer blog)

<https://constructionduniya.blogspot.com/2012/02/fly-ash-bricks.html>



Brick pressed developed by CBRI(The engineer blog)

<https://constructionduniya.blogspot.com/2012/02/fly-ash-bricks.html>

After mixing and pressing ,curing is very important.If it is not cured properly then the proper strength will not be gained and as a result final bricks form cannot be used for any type of form work .It is cured for a period of 2 weeks .

Benefits of fly ash brick over conventional clay brick are
Uniform in shape and smooth finish ,lighter in weight,better finish, environment friendly, less thermal conductivity , saves fertile land and pure water, durable, lower water absorption, low mortar usage, economical and no emission of greenhouse gases.

OBSERVATIONS

This paper studies on how fly ash brick is manufactured and its importance in the construction field. It also deals with its possibility of replacing bricks and other blocks which are used for construction purposes. In a country like India ,with decreasing natural resources and a boom in the construction field ,demand for fly ash brick will increase.

SURVEY(SECONDARY)

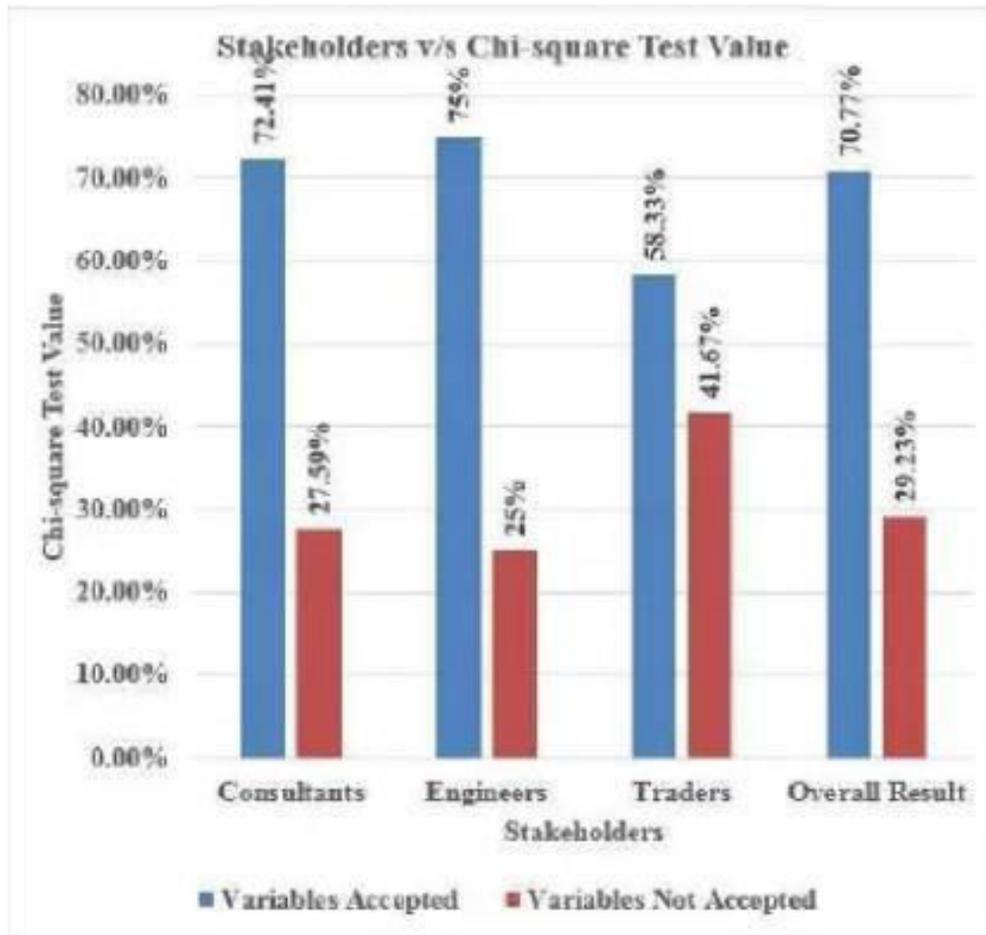
1. These conclusions are derived from the survey conducted by International journal for research in applied science and engineering technology (IJRASET) on green concrete.



Analysis of compressive strength test result after 28 days

<https://1library.net/document/zln119rq-comparative-study-conventional-concrete-green-concrete.html>

2.The following conclusions are drawn by drJayeshkumar Pitroda after conducting a questionnaire of 30 questions with consultants, engineers and traders.The chart shows the acceptance of fly ash (variable) by stakeholders.



Comparative study on test values of different stakeholders.

https://www.academia.edu/35117791/A_Competitive_Assessment_on_Fly_Ash_Bricks_and_Clay_Bricks_in_Central_Gujarat_Region_of_India_Using_Chi_Square_Test_CF872_through_SPSS_Software

ANALYSIS

Animal shelters are mainly managed by non profit groups, donations and other fundraising activities . So it is important to construct it economically and sustainably.Using these eco friendly materials and technologies we can reduce its material cost as green concrete ,rc plank and joist ,and fly ash bricks are less costly compared to conventional technologies. and as it has less thermal conductivity the temperature

inside the shelter will be constant. Which is suitable for the animals sheltered inside. As the study shows, using green concrete is cheap and more durable than conventional concrete . And using waffle slab units we can reduce the use of cement by 30 percent of its total use and can have long spans of slab.

CONCLUSION

Traditional construction techniques are said to be more energy efficient ,climate responsive and economical due to development of these techniques over time. The local materials like mud, cob, adobe, stone roofing materials , bamboo etc were the main materials used for construction. But these techniques are not feasible for modern day construction requirements like fast and quick construction . This creates the need for innovative materials to fulfill the need of the industry keeping in mind the protection of the environment . After referring to research papers and case studies.

After referring to research papers and case studies we can understand that these green construction materials and technologies are important and can replace conventional techniques and materials in the future. With decreasing natural resources and a boom in the construction field, the demand for green construction can increase . This can directly help industries in disposing of their waste .

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