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Advance Green Building Technology for Smart Buildings in Smart Cities

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ABSTRACT: Buildings are one of the most essential needs of human beings and now the era is of Smart Technology therefore the paper deals with the Smart Buildings Techniques used to built smart houses with low energy consumption. The Paper deals briefly with use of Green Building Technology which can be used to decrease the load on Non- Renewable resources and increase the use of Renewable resources and eco-friendly materials in construction techniques to use Smart Buildings on large scale.

KEYWORDS: Smart Technology, Smart Buildings Techniques, Smart houses, low Energy Consumption, Non-Renewable resources, Renewable resources, eco-friendly materials, construction Techniques.

I.INTRODUCTION

Buildings are a fundamental part of our lives. We live, work and play in buildings almost 80% of our living existence, and this trend is set to continue. Due to the development of scientific methods, a small proportion of the world's population is now able to feed the rest, thereby enabling a rising share of the world to live in built environments. In 1950, the share of the world's population living in urban buildings was 29%, rising to 50% by 2007, and expected to reach a 60:40 split in 2030. What this means is that the demand for building space will expand dramatically; in Asia, for instance, roughly 500 million people will require new housing by 2025. There will be many challenges that lie ahead for the construction industry to come up with new ways to accommodate these densely concentrated populations efficiently, effectively and sustainably. Clearly, there are economies of scale in living in compact communities. Buildings with multiple residents and users share walls, floors and ceilings with their neighbors, which means less materials will be required to build structures as well as common systems. However, sustainable buildings will have to be designed for modern challenges like climate change, indoor comfort and, importantly, human factors. The three ways of designing sustainable buildings are smart buildings; green buildings; and people-friendly developments.

The mere existence of infrastructure does not ensure excellent and effective education; it depends on how well the infrastructure is design and used. An educational facility is much more than a passive container of the education process: it is, rather, an integral component of the conditions of learning. An educational facility at minimum should provide a physical environment that is comfortable, safe, secure, accessible, well illuminated, well ventilated, and aesthetically pleasing. Well, this project aims to look beyond these minimums and aims to provide a module wherein an education institute may be made smart and green.

To begin with, the intelligent building concept has been defined by such organizations as the Intelligent Building Institute Foundation (I.B.I.) in 1989, Associazione Italiana per l. Automazione degli Edifici (AIACE) in 1995 (Anon. 1995), the European Intelligent Buildings Group (EIBG) in 1998, and The Smart Homes Foundation (van Berlo 2001) (Lehto 2001a, Lehto 1999a, Lehto 1998a, Lehto 1996b, Lehto et al. 1993).

These definitions highlight

- The integration of all kinds of building systems, services and controls,
- The importance of techno economics, and

The needs of the owners and end-users

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II.LITERATURE SURVEY

Prakash (1991) uses OUB Centre as a case study to highlight the pros and cons of having an automated building system. An intelligence building attracts more tenants because it enables tenants to work in a more sophisticated environment that indirectly increases their productivity. As for the owner, with automated system, manpower level and energy consumption may decrease, thus it would directly reduce the monthly electricity costs. However, such saving could only be achieved if the system is properly utilized and managed.

Lim (1995) looked into factors an 'Intelligent Building' should have in order to be considered an intelligent building. Being Intelligent, the building should be at least able to control various systems like air-conditioning, lighting system and others and able to manage them in the most energy efficient manner.

Nyan (2000) focused on the lighting control techniques which could help in energy saving. Lighting not only consumes energy but also generates heats in the building, thus it adds to the cooling loads on the air conditioning system. In this thesis, two methods were introduced. First method was to shorten the operation time through the application of lighting control. Through this method, it was able to achieve 84% energy saving. Another method was to use 'infra-red' occupancy sensor whereby the energy saving of 50% can be realized.

Benjamin Arul (2014) discuss the home Automation Centre on recognition of voice commands and uses low power RF Zigbee wireless communication modules which are relatively cheap. The automation system is intended to control all lights and electrical appliances on office using voice command which is tested and verified.

Ashish Ingle, Bharti.W. Gawali (2011) discusses the detail technical aspects of the home automation technology. Home automation is associated with building automation wherever lightning; climatic control and security system are integrated for central or automated management.

Barry m. Flax (1991) has discussed intelligent buildings that maximize efficiency with minimum life time costs. An intelligent environment allows occupants to take advantage of new technology with minimum cost and productivity of work space. It interrelates various subsystem through a single control framework in a timely and cost-effective manners.

III.RESEARCH METHODOLOGY

Introduction

The production of Portland cement is not only costly and energy intensive, but it also produces large amounts of carbon emissions. The production of one ton of Portland cement produces approximately one ton of CO₂ in the atmosphere. Fly ash is byproduct of the combustion of pulverized coal and is collected by mechanical and electrostatic separators from the fuel gases of thermal power plants, where coal is used as a fuel. Limestone (CaCO₃) is a raw material available in nature, it is primary need for production of cement material.

Fly ash is commonly used in concrete in replacement ranging from 0% to 30% byweight of the total cementitious material. Large quantities of fly ash and lime are available around the world at low cost and the use of high volume fly ash and lime seems to offer the best solution to rising cement demands. These two materials reducesgreenhouse gas emission proportionately and result in a more "green concrete", through reduction of energy consumptions (energy required to produce cement) and prevent the depletion of natural resources. Additional benefits include minimization of waste disposal (land filling these industrial byproduct). The use of HVFA in concrete has recently gained popularity as a resource -efficient, durable cost -effective, sustainable option for ordinary Portland cement (OPC) concrete application.

Materials

Cement: The cement used was Jaypee Cement (OPC-53 GRADE), because of its fine nature, good particle size distribution, optimal phase composition, imparts the properties of higher strength to the structures and the chemical and physical lab properties of Jaypee Cement (OPC-53 Grade) surpasses the properties of OPC 53 Grade as defined in IS:12269-1987.

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Fly-ash: Fly ash, also known as Pulverized Fuel Ash (PFA), is an industrial ash created when coal is burned to create electrical power. Fly ash, which is largely made up of silicon dioxide and calcium oxide, can be used as a substitute for Portland cement, or as a supplement to it. The materials which make up fly ash are Pozzolanic, meaning that they can be used to bind or cement materials together. Pozzolanic materials, including fly ash cement, add durability and strength to concrete. Fly ash cement is also known as green concrete. Using fly ash cement in place of or in addition to Portland cement uses less energy, requires less invasive mining, and reduces both resource consumption and CO₂.

Aggregates: Aggregates are the major ingredients of concrete. They provide a rigid skeleton structure for concrete and act as economical space fillers. Sizes of aggregates used were 20mm, 10mm and crushed aggregates.

Limestone: Limestone is calcareous sedimentary rocks formed at the bottom of lakes and seas with the accumulation of shells, bones and other calcium rich goods. It is composed of calcite (CaCO₃). The organic matter upon which it settles in lakes or seas are preserved as fossils. The limestone used acts as a basic binding material.

Admixture: Concrete admixture enhances the workability of concrete by its powerful deflocculating and dispersing effect on the cement particles which in turn helps to produce high workable concrete or enables a significant reduction in free water content. The admixture to IS 9103-199 (Amendment 2nd August, 2007). The admixture used was H & R Johnson P.C. Base 28 & 163 of Endura brand.

Water: Water is the most important and least expensive ingredient of concrete. It distributes the cement evenly. It lubricates the mix. The quantity of water is the most important parameter and is controlled by the w/c ratio. As the quantity of water in a mix goes up, the following effects are noticed: the strength decreases, durability decreases, workability increases, cohesion decreases and the economy may increase at the expense of quality and reliability. Portable water is used in the study for both mixing and curing.

Concrete Mix Design: The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economically as possible is termed as the concrete mix design. The compressive strength of hardened concrete which is generally considered to be an index of its properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour.

Requirements of Concrete Mix Design

- The minimum compressive strength required from structural consideration.
- The adequate workability necessary for full compaction with the compacting equipment available.
- Maximum water-content ratio and/or maximum cement content to give
- adequate for the particular site conditions.

Factors to be considered for mix design

- The grade designation giving the characteristic strength requirement of concrete.
- The type of cement influences the rate of development of compressive strength of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS 456:2000.
- The cement content is to be limited from shrinkage, cracking and creep.
- The workability of concrete for satisfactory placing and compaction is related to the size and shape of section.
- Quantity and spacing of reinforcement and technique used for transportation, placing and compaction.

Procedure

Determine the mean target strength from the specified characteristic compressive strength at 28-day fck and the level of quality control.

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$$f_t = f_{ck} + 1.65S$$

Where S is the standard deviation obtained from the table of contents given after the design mix. Obtain the water cement ratio for the desired mean target using the empirical relationship between compressive strength and water cement ratio so chosen is checked against the limiting water cement ration. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirements of durability given in table and adopts the lower of the two values.

Estimate the amount of entrapped air for maximum nominal size of the aggregate from the table. Select the water content, for the required workability and maximum size of aggregates (for aggregates in saturated surface dry condition) from table.

Determine the percentage of fine aggregate in total aggregate by absolute volume from table for the concrete using crushed coarse aggregates.

Adjust the values of water content and percentage of sand as provided in the table for any difference in workability, water cement ratio, grading of fine aggregate and for rounded aggregate the values are given in table.

Calculate the cement content from the water-cement ratio and the final water content as arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability, and greater of the two values is adopted.

From the quantities of water and cement per unit volume of concrete and the percentage of sand already determined in steps 6 and 7 above, calculate the content of coarse and fine aggregates per unit volume of concrete.

Determine the concrete mix proportions for the first trial mix. Prepare the concrete using the calculated proportions and cast three cubes of 150mm size and test them wet after 28 days moist curing and check for the strength.

Prepare trial mixes with suitable adjustments till the final mix proportions are arrived at.

IV. EXPERIMENTS

Test Programs

- The Indian standard (IS 10262-1982) is followed to design the mix for m40 grade concrete with above parameter.
- In M40 grade, the control mix (without fly ash) was designed and further 30, 40, 50, 60 and 65% of cement was replaced respectively with the fly ash.
- And also, the new control mix was designed in which 65 and 75% of cement was replaced with the fly ash + lime. (Lime was taken 5% to 10% of that cementitious material used).

Trial Mixes

Following the instruction of test programs, we have designed M40 Grade concrete mix using 100% cement content as binding material. Now by keeping this design as a datum we have repeated the same design by making slight change in binding material, that means we are replacing the actual binding material i.e. cement to another binding material i.e. by fly ash and lime.

TRIAL MIX - A: - Combination of Cement + Fly ash

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TRIAL MIX-B: -Combination of Cement + Fly ash + Lime

MATERIAL	For 1m3 (kg)			
	0% w/c - 0.30	30% w/c - 0.28	40% w/c - 0.26	50% w/c - 0.25
Cement	440	308	264	220
Fly ash	0	132	176	220
C-Sand	805	805	805	805
10 mm	392	392	392	392
20 mm	705	705	705	705
Water	167	132	114.4	114.4
Admixture	4.20	4.20	4.20	4.20
Strengt h (Mpa)	7 Days	53.11	34.22	31.44
	28 Days	71.11	50.81	47.56
	56 Days	-	-	-

Table: Trial mix - A

MATERIAL For 1m3 (kg)

MATERIAL	FOR 1m3(kg)			
	0% Wc 0.3	65% Wc 0.25	70% Wc 0.25	75% Wc 0.25
CEMENT	440	146.3	132	110
FLYASH	0	271.7	286	286
LIME	0	22	22	44
C-SAND	805	805	805	805
10MM	392	392	392	392
20MM	705	705	705	705
WATER	167	110	110	110
ADMIXTURE	4.02	4.50	4.50	4.50
STRENGTH 7D	53.11	30.07	28.54	17.92
28 DAYS	71.11	55.40	45.36	39.12

Table: Trial mix - B: - Combination of Cement + Fly ash + Lime

Cost Analysis

Cost of concrete is depending upon the quantity, quality and proportion of materials used. As M40 Grade concrete is high grade concrete, use of cement is more to achieve early high strength. Replacement of cement by other material not only changes the strength properties of cement but also changes the cost of that particular design. List of material used for trials and their respective cost as per market value is given below: -

1. Cement (brand Jaypee Cement)-350 Rs per 50kg bag (i.e. 1kg = 7lit).
2. Fly ash of F-grade-1000Rs per Ton (i.e. 1kg = 1Rs).
3. Admixture- H.R. Johnson P C base 163-32Rs per lit (consider 1kg = 1lit).
4. Crush Sand-1 brass = 2205Rs (i.e. 0.3rs/kg).
5. 10 mm aggregate-1 brass = 1572Rs (i.e. 0.202rs/kg).
6. 20 mm aggregate-1 brass = 1572Rs (i.e. 0.202rs/kg).
7. Lime-10Rs per kg.

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Estimating of each trial for 1m³ concrete is done by taking above cost of each material multiplied to the quantity used in it. Total estimation of each trial mix proportion will give exact differences of cost at the time of replacement.

material	0% REP	30% REP	40% REP	50% REP	60% REP	65% REP
Cement	3080	2156	1848	1540	1232	1078
Flyash	0	132	176	220	264	286
c-sand	234.25	234.25	234.25	234.25	234.25	234.25
10mm	78.39	78.36	78.39	78.39	78.39	78.39
20mm	142.09	142.09	142.09	142.09	142.09	142.09
water	0	0	0	0	0	0
admixture	134.04	134.40	134.40	134.40	134.40	134.40
Total cost	3669.13	2877.14	2613.14	2348.66	2084.45	1953.03

Table: Estimation cost of each trial carried in Trial Mix Design A.

material	0% REP	65% REP	70% REP	75% REP
Cement	3080	1078	924	770
Flyash	0	264	286	286
c-sand	0	220	220	440
10mm	234.25	234.25	234.25	233.67
20mm	78.39	280.39	78.39	78.39
water	142.09	142.09	142.09	142.09
admixture	134.40	144.0	144.00	144
Total cost	3669.13	2160.73	2028.73	2172.82

Table: Estimation cost of each trial carried in Trial Mix Design B.

V. RESULTS

General Results:

- Using fly ash reduces the expenses on (energy & cost) cement.
- Reduce leaching of lime from concrete.
- Make cement structures denser and thus improve their durability.

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- By adding fly ash rate of hydration get reduced therefore expected results achieve later than 100% cement is used.
- Replacing cement by Lime and fly-ash gives arises to Green Concrete Technology, which has low emission of CO₂ and CO directly or indirectly in the environment.
- Using proper admixtures in mix gives high variations in there result, like early strength, high workability and water reducer.
- Addition of other binding material in place of cement reduces the w/c ratio.
- Only sufficient water is used to hydrate the cement to gain whole strength from it.

Results of Trial Mix A

- From the various trials testing taken by us, we have concluded that replacement of cement by only fly ash can be done up to 65%.
- We have observed that, as we go on adding fly ash in mix design workability gets increased.
- Replacing cement by fly ash up to 65% gives about 46.77% cost beneficial to that of original mix cost. Hence it is more economical.
- By overlooking all the results, we have come to know that, cement content in mix gets completely hydrated to achieve the target strength M40.

Results of Trial Mix B

- Using Lime in mix design increases the strength about 5-10% to that of Trial Mix A.
 - Lime has a property of hydration and also acts as a binding material, so the results of combined mixture of cement and lime get desired results.
 - As the combination of lime and fly ash increases the strength, so we can replace the cement about 75% to that of cementitious material.
 - Replacing cement by fly ash + lime up to 75% gives about 40.78% cost beneficial to that of original mix cost. Hence it is more economical because only 25% of cement is used to get M40 grade cement.

As we observed that hydration of cementitious material performs in two types of hydration, primary hydration- by cement content and secondary hydration by lime content.

VI.CONCLUSION

Smart educational building incorporates the use of modern and smart technologies that help in reducing the consumption of energy that an educational building requires it also takes in the various aspects of green building technology. These green building technologies help in reducing the load on conventional sources of energy by using nonconventional sources and also help in changing the construction techniques and raw materials that are required. The use of new or alternate leads to the less impact during construction Various technologies help in conserving water during construction and while using the building on daily basis.

The non-conventional resources of energy usage also help in conserving the valuable fossil fuel and lessening the carbon footprint from any building. These green technology, modern equipment, alternate raw materials lead to high initial cost. But educational building is intended to serve on a long-term basis. These new techniques benefit on a long-term basis and prove to beneficial from environment and financial scope as they help in reducing consumption and reduce the impact on earth while serving on daily basis.

By implementing all the systems mentioned in the project, the final cost of the entire project comes up to------. The cost of project without these systems will account to------. The additional expenses done for the systems can be recurred substantially within few years without any harm to the environment. Therefore, if the provisions of such systems are done in EDUCATIONAL BULDING, there will be a major boost in the percentage wise savings of various resources making Earth a better place to live and classrooms a better place to study in.

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