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USE OF GREEN MATERIALS IN THE CONSTRUCTION OF BUILDINGS

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ABSTRACT

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from sitting to design, construction, operation, maintenance, renovation, and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment. Materials are the essential components of buildings construction. Chemical, physical and mechanical Properties of materials as well as an appropriate design are accountable of the building mechanical strength.

INTRODUCTION

In most countries, buildings are the largest driver for both energy use and CO2 emissions. The approximately 160 million buildings of the EU, for example, are estimated to use over 40% of Europe's energy and to drive over 40% of its carbon dioxide emissions. According to the US Energy Information Administration, the share of energy and greenhouse gas (GHG) emissions associated with buildings is even larger in the US, amounting to 48% of total emissions. In several developed countries, emissions from buildings, and their proportion on total emissions, have been steadily increasing over the last fifty years. Larger sized buildings and an increasing number of energy using appliances within these buildings have been the main drivers

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for such growth. In developing countries, on the other hand, the share of buildings on total energy use and emissions is much lower (e.g. in the order of 10% of the total in China).

However, with rapid industrialization and urbanization, energy use and the GHG emissions associated with buildings are increasing rapidly in those developing countries where dramatic economic growth is associated with a booming construction sector. A significant number of new buildings are therefore added every year in many developing countries. In the 2000-2005 periods, for example, China added about 6.5 billion square meters of new residential buildings. Projections for GHG emissions associated with buildings estimate that worldwide GHG emissions will reach about 15 billion CO2 by 2030, with Asian countries contributing to about 1/3 of such emissions. Reducing the energy and GHG footprint in both existing and new buildings represents therefore a key challenge and opportunity to tackle global warming.

ICT companies build and operate facilities that can demand large amounts of energy and material consumption in all phases of the life cycle. Increasing energy efficiency is always a key goal for ICT companies and it can begin with the facilities themselves. There are numerous schemes that have been adopted globally that can lead to more sustainable design, construction and operation of buildings. Sustainable building refers to both the structure and a process that is more environmentally responsible during the entire life cycle of a building. These life cycle stages are:

• site selection;

• design;

• construction;

• operation and maintenance;

• renovation; • demolition.

Looking at it more broadly, it could possibly be combined under three main headings:

1. Construction – site selection, design, construction

2. Lifetime use – operation and maintenance

3. Decommissioning – renovation and demolition.

New building technologies, and in particular ICT automation and new materials, are

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constantly being introduced to enhance the sustainable building process with the goal of reducing the impact of the building on the surrounding environment by:

• using resources more efficiently (e.g. energy, water);

• enhancing and protecting the health and well-being of the occupants;

• reducing negative impacts (e.g. waste, sewage, pollution).

Sustainable buildings optimize one or all of these objectives during all phases of the life cycle. Sustainable or "green" building codes and assessment schemes have been developed on a global basis to give guidance on the factors to review during a building's life cycle that enhance sustainability and minimize environmental impact. As an example, the Leadership in Energy and Environmental Design (LEED) standards have seen great adoption within the North American market in particular. LEED standards are guidelines to designing, building and operating more environmentally friendly buildings.

A final step in almost all sustainable or "green" building codes and schemes is an independent assessment to determine whether a building has met the requirements of a scheme and a final ranking that demonstrates how sustainable a building has been built or is being operated. Using LEED as an example, a building can be rated as Platinum, Gold, Silver or Certified after an assessment. To a large degree, decisions made at the budgeting, design, procurement and construction stages of a development affect the success of the building in terms of sustainability outcomes.

Therefore, sustainability and its implications for planning and design should be considered at the onset of all new-builds, as the earlier it is considered the more the sustainability benefits are maximized. For example, the on-site layout and form of the building offer the best opportunities to improve environmental benefits without major capital costs. In addition, choices about heating and cooling, which contribute largely to energy use, are important considerations to meet carbon targets. Failure to take sustainability into account at the onset can result in costly alterations having to be made at a later stage and opportunities missed to include sustainable measures into the design and structure of the building.

LITERATURE

A.S.M. Abdul Awal, A.A.K. Mariyana and M.Z. Hossain (2016) Concrete is the most significant component of construction industry. The production and consumption of concrete is the key factor in the development of a nation. Concrete is a mixture of different raw materials like coarse aggregate, fine aggregate, cement, water and sometimes admixtures. The major portion of the concrete is formed by coarse aggregate comprising 60-65% of concrete. Rocks like granite, quartzite, basalt, limestone etc. are predominantly used as coarse aggregate in India. Due to rapid urbanization and infrastructure development, the availability of these aggregates varies from place to place. Depletion of these natural resources, restricted mining areas and judicial bans for want of environmental protection have made their availability a major issue. This has also resulted in illegal mining, a common phenomenon in developing countries like India. As sustainability is becoming a fundamental requirement for all construction industries various research on viable alternate material are being done on waste concrete, blast furnace slag, broken glass waste, waste from other industries as source of aggregates. In this paper a comparative analysis on conventionally used aggregate granite, quartzite and demolished waste concrete as an alternate material is carried out. This study covers the various aspects of their usage.

Adewuyi A.P and Adegoke T (2016) Assessment of natural sand being used as fine aggregate for concrete production in Ibadan and its environs was carried out. Ten sources (F1 – F10) were selected for the study; four (F5, F6, F7, F8) were river sand sources while six (F1, F2, F3, F4, F9, F10) were burrow pit sand sources. Samples from each source were subjected to sieve analysis, atter berg limit, bulk density, specific gravity, water absorption, sand equivalent, clay lumps and friable particles, amount of materials passing 75μm and organic impurities adopting ASTM standard procedures. Results revealed that sand from river sources met all the criteria for concrete production stated in ASTM standard while sand from burrow pits deviated from limits of the standard in some respects.

Agbede O.I and Monash J (2016) This paper deals with the possibility of using fresh concrete waste as recycled aggregates in concrete. An experimental program based on two variables (proportion of fine aggregates replacement and proportion of coarse aggregates replacement) was implemented. The proportions of replacement were 0%, 50%, and 100% by mass of aggregates. Several mechanical properties were tested as compressive and tensile strengths. The results show a good correlation between aggregates replacement percentage and concrete properties. Concerning mechanical properties, a gradual decrease in compressive, splitting, and flexural strengthn with the increase in recycled aggregate percentage is shown.

Ahmed E Ahmed, Ahemed AE Kourd (1989) This paper reports on experimental investigations on the effect of replacing fine aggregate with sawdust on the properties of concrete. A concrete mix of 1:1.5:3 is used while sawdust was used to replace 10%, 20%, 50% and 100% of sand by volume. The percentage reduction in density is 4.02%, 5.54%, 9.15% and 19.20% respectively while the corresponding percentage reduction in compressive strength was 28.54%, 53.95%, 67.10%,and 75.92% respectively, with respect to conventional concrete mix. As per the experimental results it was found that both the density and compressive strength of concrete decreased as the fraction of sawdust increased

Albert M Joy, Aayena K Jolly, Anju Merlin Raju, Bobina Elizabeth Joseph (1980) Copper slag is one of the materials which is considered as waste materials in the production of copper, which can be used as partial replacement of fine aggregates in concrete. This paper presents the results of an experimental study on various durability tests on concrete containing copper slag as partial replacement of sand. In this report, M30 grade of concrete was designed and tests were conducted with different percentage of copper slag as fine aggregate in concrete. The results indicate that workability increases with increases in the copper slag percentages. The Compressive Strength is increased upto 8.63 % as compared to normal concrete. The Rapid chloride penetration test is carried out to know the chloride ion penetrability. Also, accelerated corrosion process by galvano static weight loss method is carried out to know the corrosion rate of concrete

METHODOLOGY

In this work we used cement, fine aggregates, coarse aggregate andchemical admixtures such as Conplast SP - 430 ES2 are used. The cement used in this study has 43 grade ordinary Portland cement (OPC) which is having specific gravity of 3.15.Coarse aggregate of 20 mm down size is used.Fine aggregates used for normal concrete were natural river sand and copper slag. Copper slag is procured from Mythri Metallizing India Company, Bangalore, Karnataka, India.The Physical and Chemical of Fine aggregates are shown

Testing Methods

Compressive Strength

Cube specimens of size 150 × 150 × 150 mm were used for determining characteristic compressive strength. The cubes were tested in a compression testing machine of capacity 3000 kN.The compression test was conducted after curing the concrete cubes at 7 days and 28 days.

Mix Design for M30 Grade Concrete

The mix design is calculated as per IS code 10262:2009 [7]. In this present work we varied the copper slag from 0 to 100% by replacing the river sand. To reduce the water content from the concrete 2% of Super Plasticizers by mass of cement. The mix proportions for M30grade concrete is 1:2.04:3.32. (Cement: fine aggregate: coarse aggregate).

Rapid Chloride Permeability Test (RCPT)

The RCPT is a table or bench mounted unit, which measures the electrical charges passed through a 2-inch thick slice of 4-inch nominal diameter concrete core or cylinder during a period of 6 hours. A potential difference of 60 volts D.C. is maintained across the ends of the specimen. One end of the cell is filled with sodium chloride solution while the other end of the cell is filled with sodium hydroxide solution. The total charge passed, in coulombs, is related to the resistance of the specimen to chloride ion penetration.

Accelerated corrosion process

Galvano static weight loss method weighed TMT steel of 8 mm diameter specimens were embedded in concrete cylinder of size 150 mm diameter and 300 mm height. The concrete samples were subjected to alternate wetting and drying exposure in 3.0 % NaCl solution. Regular D.C power supply of 0.3A is supplied continuously throughout the corrosion period of 7 days. Positive terminal is connected to the bar with soldered wires and negative terminal is connected with graphite rod. After the process of accelerated corrosion was over, all the specimens were disconnected and removed from tank. After the corrosion period, the rod was taken out and weighed. The loss in weight was calculated.From the weight loss values,[1] the corrosion rates were obtained from the relationship:

$$\text{Corrosion Rate} = (K \times W) / (A \times T \times D)$$

Where K is a constant,

K = 87.6 in case of expressing Corrosion rate in mm/yr.

T is the exposure time expressed in hours.

A is the surface area in cm2.

W is the mass loss in milli gram. And

D is the density of the corroding metal (7.85g/cm3).

Saw dust: Sawdust is also known as wood dust. It is the by-product of cutting, drilling wood with a saw or any other tool; it is composed of fine particles of wood. Certain animals, birds and insects which live in wood, such as the carpenter ant are also responsible for producing the saw dust. Sawdust's are produced as a small discontinuous chips or small fragments of wood during sawing of logs of timber into different sizes. The chips flow from the cutting edges of the saw blade to the floor during sawing operation.

Cement: Cement used in the experiment work is ordinary Portland cement of grade 43 conforming to IS: 8112: 2013.

Ordinary Portland cement of grade 43 was used as a binding material which satisfies the requirements according to Indian standards, IS 8112: 2013. Coarse aggregate was obtained from a local quarry work. Sand was sourced from a local supplier in Noida. While sawdust of timber wood was obtained from a local carpenter. A concrete mix of ratio 1:1.5:3 by volume was used as control;

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to which the properties of the other mixes were compared. Sawdust was used to replace sand at percentages of 10%, 20%, 50% and 100% by volume. A water cement ratio of 0.45 was adopted. Sieve analyses of sawdust were carried out by using standard sizes of sieves. Concrete was produced by mixing the constituent raw materials in an electric concrete mixer. Twelve specimens of each mix were produced. Concrete was casted in cast iron moulds measuring 150mm× 150mm× 150mm internally. A total of sixty (60) specimens were casted in accordance with IS: 456-2000. After twenty four (24) hours of casting, the specimens were demoulded and placed in a curing tank until the day of testing. The compressive strengths of the samples were determined at 7, 14, 21 and 28 days of curing using a 1000kn compression testing machine. On the day of crushing, the specimens were removed from the curing tank, wiped clean with a soft towel and placed on the surface of the laboratory for approx two hours before crushing. The densities of the samples were decided by weighing and calculation of volume. The results presented are the intermediate value of three samples of the same mixture.

In the present study, M30 grade with design mix as per IS 10262:2009 was used Compressive Strengt , Z =fck+1.65s 30+1.65x5=38.25N/mm2.

Following materials were used in experimental work:

Cement {OPC): Ordinary Portland cement (make J K Laxmi Cement 53 Grade having specific gravity 3.16, consistency 32% and compressive strength 53 Mpa).

Cement(PPC): Pozzalanic Portland Cement(make JKLaxmi Cement 53 Grade having specific gravity 3.15, consistency 32% and compressive strength 33 Mpa).

Fine Aggregate: Natural Sand Zone (II) with maximum size of 4.75mm was used with specific gravity 2.597 and fineness modulus 2.

Different test results are shown in below tables. Compressive strength test, Split tensile strength, Flexural strength of concrete and result comparisons with NDT test, Schmidt rebound hammer number.

1. Slump cone test

The following tables give the flow test results of effect of recycled concrete

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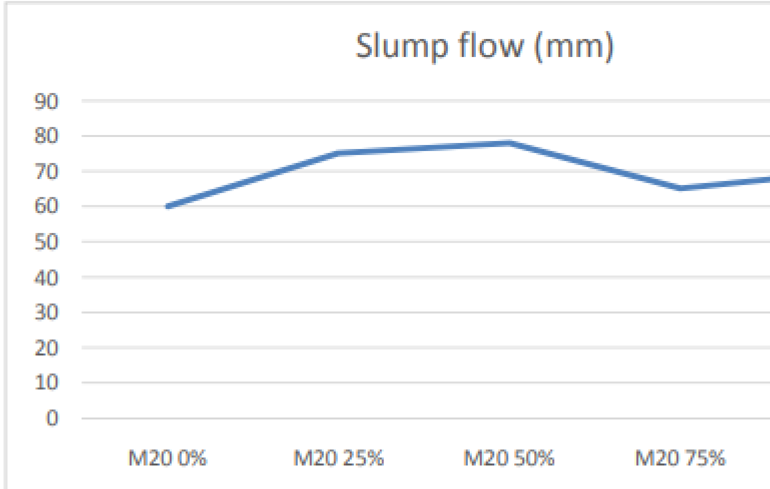
aggregate in various percentages on the properties of concrete containing different mixture of concrete mix with different percentage of recycled aggregate of 0% and 50%.

Table Slump flow test Result

Design	Slump flow (mm)
M20 0%	60
M20 25%	75
M20 50%	78
M20 75%	65
M20 100%	70



Graph Slump flow test Result

Slump flow test result shows the workability of concrete and how to behave and flow of concrete during placement of concreting. There is great achievement in workability when 50% Recycled aggregate replacement and

Mechanical Concrete test

Compressive strength of concrete

IS: 516-1959 IS: 1199-1959 At initial level different percentage of recycled aggregate replacement and design of M20 and doing curing with accelerated curing tank for 24 hours and doing compressive strength for initial level to determine optimum moisture content. Replacement % C.

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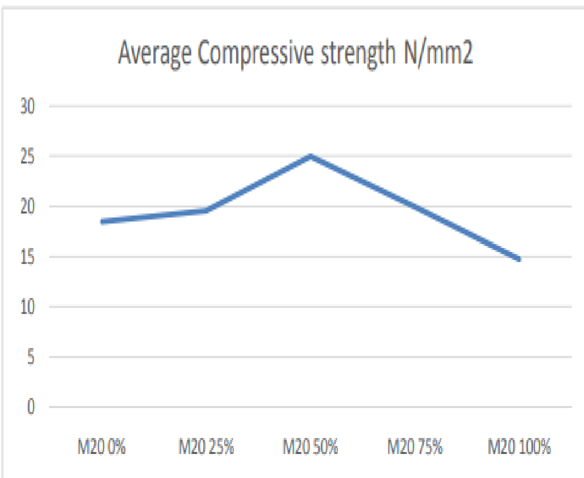
Replacement %	Compressive strength (1) N/mm2	Compressive strength (2) N/mm2	Compressive strength (3) N/mm2	Average Compressive strength N/mm2
M20 0%	14.417	19.1867	21.195	18.43
M20 25%	17.36	24.33	16.97	19.55
M20 50%	27.297	24.435	23.1244	24.95
M20 75%	22.87	22.084	14.746	19.90
M20 100%	14.457	16.26	13.47	14.73



So from the graph and initial basis analysis the optimum content for replacement is 50%. The highest strength is getting in 50% replacement in recycled aggregate in M20 design. Test is done with nominal concrete and 50% replacement of recycled aggregate concrete for compressive strength for cubes 3, 28 and 56 days, split tensile cylinder and flexural strength for beams at 28 day and 56 day.

Figure Compressive strength of cubes

Test is done with nominal concrete and 50% replacement of recycled aggregate for compressive strength for cubes and split tensile cylinder and flexural strength for beams at 28 day and 56 day. For optimum content nominal concrete and 50% replacement concrete 3, 28 and 56 day compressive strength is shown in below table.

Spilt tensile strength of concrete cylinder

There is no method by means of which tensile strength is determined directly. Indirect test of splitting a cylindrical specimen along diagonal compressive load is used. This test gives more uniform result. The strength determined in splitting tests is

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believed to be closer to the true tensile strength ranges [approximately] from 50 to 75 percent of flexural strength; with high strength concretes the ratio is relatively lower. The split tensile strength of cylinder for 28 day and 56day is shown in table. At the end of 28 day spilt tensile strength is decreased from 3.967 to 3.655 and 0.92% and at end of 56 day it is increased from 3.7197 to 3.739 and 0.99% increased.

Figure Split tensile Cylinder test

This test is very simple and convenient because same types of specimen as in cylinder in compression test are used. While loading, plywood strips of size 3mm* 25mm are used to avoid concentration of stress under load. Such packing also compensates for surface irregularities.

28 day spilt tensile cylinder test				
Replacement %	Split Tensile strength (1) N/mm2	Split Tensile strength (2) N/mm2	Split Tensile strength (2) N/mm2	Average Split Tensile strength N/mm2
M20 0%	3.83	3.96	4.11	3.967
M20 50%	3.94	3.82	3.806	3.655

56 day spilt tensile cylinder test				
Replacement %	Split Tensile strength (1) N/mm2	Split Tensile strength (2) N/mm2	Split Tensile strength (2) N/mm2	Average Split Tensile strength N/mm2
M20 0%	3.5626	3.7636	3.8329	3.7197
M20 50%	3.348	4.046	3.806	3.739

At the end of result we get 3.967 N/mm2 and 3.655 N/mm2 at the end of 28 day for nominal concrete to recycled concrete aggregate and 3.7197 N/mm2 and 3.739

N/mm2 for 56 day split cylinder tensile strength result. Generally concrete is brittle material and it has low tensile strength.

Flexural bending strength of concrete beam

The size of beam is 700*150*150 mm and 28 day flexural strength beam. Normally concrete is not used to take tensile stresses because its strength is tension is appreciably less than the strength in compression. In flexure, this strength is soon exceeded well below working loads, the concrete cracks and the tensile stresses have than to be fully taken up by steel reinforcement.

CONCLUSION

We have studied features of all construction material which are socially, economically benefits for construction industry and human health. Green construction material reduces side effects on environment.to make efficient sustainable structure as well as will lessens the environmental pollution content, and like greenhouse gas emission, resource depletion, soil pollution , health hazards , ozone depletion etc. Hence there is an urge to use the eco-friendly materials for the better tomorrow and healthy life of coming generation. Green building reduces the impact on environment and indirectly helps to reduce the global warming effects. Green buildings and the concept of smarter living offers tremendous opportunity for changing an average Indian's lifestyle. As the general public becomes more aware of the benefits of green buildings, developers will get creative and find new ways to brand, market and sell green buildings, hence creating a conductive atmosphere for the sector to grow exponentially.

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