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NEW AGE CONSTRUCTION MATERIALS - A REVIEW

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ABSTRACT

India is witnessing construction of fascinating projects in developing Infrastructures like high rise structures, RC chimneys etc. Majority of structures are utilizing structural concrete. The demand for structural concrete includes the usage of durable materials. Due to unexpected growth in population and increased use of natural resources for construction intimidates the environment in terms of emissions and waste. The use of conventional materials is intricately linked with change in climate. This necessitates the use of new and innovate materials and technologies in promoting and implementing better quality of structure and faster construction solutions without depleting the environment. The use of new and innovative materials and technologies is thermally efficient, produce less emissions and waste The present study broadly reviewed the literature and suggest the paradigm shift in utilization of natural energy resources to sustainable energy source. The comprehensive review highlights some of the recent developments on new-age construction material and technologies.

Keywords- New age Construction Material, Sustainability, New Technologies.

I. INTRODUCTION

Materials are so vital for the development of civilization that we associate Ages with them. Properties are the way the materials respond to the environment. New age materials and techniques usually designed for maximum performance, faster execution and low cost. These materials should be light, strong and resist high temperatures and strong like metals and resist corrosion like plastics. New age materials look at the conventional construction process objectively and realize that there are various short comings in the traditional approach. Traditional method puts a great burden on the natural resources. It requires sand from the rivers and ocean and also requires lot of water. Hence, these materials and approaches perform the ever-increasing demand without causing damage to the precious natural resources. These materials and techniques help in reducing the carbon footprint i.e., harmless to the environment and reusable. Approach to make these materials in best use of waste so to make effort on waste disposal gets reduced. To improve construction process by offering clean construction methods

Both materials and technologies offer benefits to environment and economics, while maintaining efficiency and quality parameters. The technologies have been chosen based on the following key parameters

- Reduced embodied energy and fuel consumption hence reduced carbon emissions
- Reduced environmental damage through optimal resource use and waste utilization
- Better Thermal efficiency and comfort
- Resistant to natural disasters
- Aligned to local production in terms of material and skill availability
- Cost efficiency

II. MATERIALS

Many new construction materials which are most cost effective, eco-friendly and last long to build sustainable habitat. Traditional construction materials which have more greener and smarter replacements such as finely powdered crystalline silica derived from rejected limestone against fine sand. This is replaced natural sand in concrete and plastics, which makes concrete denser than natural sand. These replacements results in increase of

compressive strength and durability. Clay Bricks have an alternative or replaced with eco-friendly, superior fly ash-based bricks.

Main and important component is concrete, its composition and adaptability are yet to be properly explored. PPC concrete mixes have predominate higher binding materials without any change in its governing or constitute properties and simultaneously has higher durability compared to OPC. Which increases its resistance against sulphates, restricts chloride-ion penetration, and improves resistance to aggressive environments. High performance concrete is porous within its composition and allows water penetration to lower surface, which improves ground water table. Thus, by utilizing this concrete, it gives way to drainage of water through its large pores which exists in no-fines concrete. This type of Concrete is also used for providing thermal comfort in the premises. The new age construction materials that are used for building are:

Durable Concrete:

Till Today, In Construction Practices, Concrete mixes are based on Strength. Grades up to M80 are used for major Infrastructure projects like Metro, high-rise buildings in India. Due to high grade of Concrete gave rise to durability issues because of high heat of Hydration which in turn rise in the repair and replacement costs. In this point of view, Concrete Durability needs to be considered. For which, following are the few materials available.

- High Performance Concrete: High performance concrete possess high durability and high strength. HP concrete contains one or more of cementious or binder materials such as fly ash, Silica fume or GGBS along with a super plasticizer. High performance concrete is in line with Normal concrete but with addition of mineral admixtures for enhancing strength, durability and workability qualities to a very high extent.
- Self–compacting Concrete (SCC): SCC was developed as a Quality Assurance measure for components of the structures with heavy reinforcement since it is difficult to place and compact normal concrete without honeycombs and weaker concrete. SCC is in semi-fluid state and can be placed into the formwork without the use of any compactors or vibrators. Due to its fluidity, SCC is able to find its way into the formwork and in between the reinforcement and gets self-compacted in the process. SCC is particularly useful for components of structures which are heavily reinforced. In addition to cement, coarse and fine aggregates, water, special new generation polymer-based admixtures are used to increase the fluidity of the concrete without increasing the water content.
- Geopolymer concrete: GPC is an alternative to normal cement concrete, which is eco-friendly, lower carbon di oxide emission. It can be produced by adding regular aggregates to geopolymer cement slurry. It is made from inorganic alumino-silicate (Al-Si) polymer compounds that can utilize 100% recycled industrial waste (e.g. fly ash, GGBS, copper slag) as the constituents resulting in up to 80% lower carbon dioxide emissions. Better chemical, thermal resistances, durability and mechanical properties are achieved at both atmospheric and extreme conditions for GPC.
- Use of Mineral Admixtures: For the same sake of Durable concrete structures, the composition of normal concrete has undergone changes by adding Mineral Admixtures. As Classic Concrete being a mixture constituent of three to four materials (cement, aggregates and water), Now a day, a typical durable concrete consists of six or more materials. Going for low water cement ratio which enables in reduction of the volume and size of capillary voids in concrete; which leads to micro-cracking due to thermal shrinkage and drying shrinkage. To reduce the cement-based content, both the water content and cement content must be reduced as much as possible.
- Fly Ash: Fly ash is a byproduct generated at power thermal stations and a mineral admixture should conform to IS: 3812.
- High Volume Fly Ash Concrete (HVFA): The high-volume fly ash concrete (HVFA) represents a rising technology for highly robust and resource efficient concrete structures. When used in large volume (typically 50 - 60% by mass of total cementitious materials content,) is able to impart excellent workability in fresh concrete at a water content that is 15 – 20% less than without fly ash.
- Ground Granulated Blast Furnace Slag (GGBS): The short falls of fly ash gave rise to use of GGBS, as the produce is necessarily the outcome of grinding to the required particle size.
- Portland Slag Cement (PSC): PSC is useful for ensuring durability of concrete structures. PSC is generally produced in locations locally near to steel plants.

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- Condensed Silica Fume (CSF): CSF is a by-product of Ferro-Silicon industry. The particle size is about 100 times smaller than that of cement. It can occupy the voids in between cement particles in a concrete mix, reduce the water demand and thus contribute to a very dense concrete of high durability.
- Ternary Blends: Ternary blends of mineral admixtures are now recommended for improving the durability of important concrete structures.

Durability Enhancing Products:

A typical corrosion inhibiting admixture helps in preventing deleterious expansion and cracks caused during formation of rust on over-induced corrosion. These products penetrate as sealants to protect new and repaired concrete from the corrosive effects of chloride. It transforms concrete into a water-resistant barrier by becoming an integral part of the concrete matrix.

- Corrosion Inhibiters for Reinforced Concrete: Calcium nitrate has been established to inhibit reinforcement corrosion. About 3–4% calcium nitrate of cement by weight is adequate to protect the reinforcement steel against corrosion.
- Recycled Aggregates: Coarse aggregates from natural sources or crushed rock is decreasing; on the other hand, demolition of old structures, roads etc., a large amount of debris are produced, and disposal of these debris poses problem. Debris can are crushed, treated and recycled as coarse aggregate for fresh concrete.
- Carbon Dioxide (CO_2): As part of a future global atmospheric balance strategy, Use large amounts of carbon dioxide. CO_2 may be used for curing pre-cast concrete units. Steam curing which is conventionally used is energy intensive. Although CO_2 curing provides slower strength development than steam curing, the performance can be improved if the blocks are properly pre-conditioned before CO_2 curing. It has also been noted that the water absorption of CO_2 cured blocks is lower than that of steam cured blocks.
- Application of Nano-Technology: Particle size of a material to nano–scale often imparts new properties or enhances existing ones. This is typical of nano particles of titanium dioxide, which maintains its photo catalytic activity even when mixed with cement. External cement-based surfaces become strongly photo catalytic, leading to a much better presence and a significant decrease in concentration of pollutants in the surrounding air.

Rice Husk Ash Concrete:

India being major producers of rice and a huge quantity of husk is produced. Husks are mostly used as a source of fuel for generating steam. About 25% of ash residual is formed during burning of husk. The ash which is generated is known as Rice Husk Ash. Normal concrete containing calcium oxide weakens performances of concrete, whereas using RHA, Silica mixed with calcium hydroxide as admixture to improve solidity and workability of the concrete. Rice Husk Ash concrete is durable, affordable and reduces greenhouse emissions.

Rice Husk Ash Concrete

Blocks over bricks:

Blocks are a great substitute for the more conventional bricks. Concrete Hollow Block is a fairly modern material used for construction purposes. They are found in residential, industrial and commercial buildings. These blocks are

made from cement, sand and aggregates. The main uses of these hollow blocks are to build walls to conceal wires, water and sewer pipes. These Concrete Hollow Blocks are cost effective, fire resistant and larger in size compared to clay bricks.

Concrete Hollow Block

Fly Ash Bricks / Blocks:

Fly ash is a byproduct generated at power thermal stations. Flyash is used as a mineral admixture in concrete bricks / blocks and known as Siporex blocks. Red mud can also be used in Fly ash bricks. 80% fly ash and 20% red mud can form a fly ash brick and these bricks not only possess the qualities of cement and also cost effective. Fly ash bricks are highly resistant to fire and are non-porous.

Fly Ash Bricks

Manufactured sand:

This sand is prepared by crushing hard granite stone. It is devoid of impurities that and in the conventional river sand and gives a stronger foothold during the construction.

Bamboo Corrugated Sheets:

Bamboo Corrugated Sheets is an industrial product created using bamboo wood and mainly good for roofing purposes. These bamboo corrugated sheets are strong, eco-friendly and fire resistant. On the downside, these sheets require great care and are prone to attacks from fungus or insects.

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Bamboo Corrugated Sheets

III. TECHNOLOGY

The construction industry is at the cusp of disruptive change with new materials, building technology, software, digitization and artificial intelligence changing the way we conceptualize, build, and use for buildings. It has become eminent to adopt New Age Construction Technologies, which reduce time consumption, conserves labour, save material costs and reduces environmental concerns. Few are self-climbing formwork, aluminum shuttering, precast concrete techniques and drywall systems. These technologies are not only cost-effective. Such technologies not only reduce the turnaround time but also improve the quality and durability of construction.

Self-Climbing Formwork:
The construction of tall vertical structures such as skyscrapers requires the use of same formwork in identical sections. The self-climbing formwork which uses mechanical or hydraulic machineries allows the pouring of concrete to form large concrete structures at once in a single pouring. The patterned working system optimizes material costs, enhances the safety levels and builds seamless structures with great efficiency.

Prefabricated Construction Technology:
A smart method which does not require in situ concrete pouring but uses highly durable precast structures. It is produced in a controlled environment which makes it easy to control the quality of structures while simultaneously reducing the consumption of steel, labour and concrete. A wide range of structures which are ready to use and just need to be installed can be made in a highly specific way to avoid hardening of concrete too fast or too slow.

Aluminium Formwork Technology:
With the feature to control the quality of concrete in any component of a building, it removes the requirement of brick works in construction. It is environment friendly as it eliminates the use of traditional timber and plywood formwork which are unsuitable at high pressures. It takes less the total time required for construction.

Drywall Systems:
Acoustically insulated, less water consumption, flexible, lightweight and speedy installations are a few of the many advantages that drywall construction offers. It is an interior wall system which has a steel frame sheathed in gypsum plasterboard. It is also reusable and hence is very environment friendly.

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IV. CONCLUSIONS

- New Age Construction materials are highly durable and cost effective.
- New Technologies which speed up construction conserve time and reduces energy consumption

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