Construction of Multi-Storey Building using Advance Construction Materials and Techniques
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Abstract:
The paper deals with an introduction and implementation of super performing building materials and techniques all in terms of energy saving efficiency of the material, cost efficiency, application feasibility, availability, vernacular characteristics, life span, etc. A material is considered smart only when it contributes something to upgrade the quality of building. With all those advancements in construction techniques and also with the demand of end users for the smart buildings we as constructors and designers are ought to introduce something new and smart to fulfill their demands and needs. Smart structures and material technologies are a tool for sharing the knowledge of how various building materials can significantly increase production and profit using advanced communication, collaboration and management technologies. The paper provides an overview of the types of materials available giving a new insight into innovative methods and techniques that will be available, and open new doors for advancement and improvement in the construction industry. The new materials discussed in this paper present a small fraction of the options that are available for use by industry.

Keywords: Smart materials, Advanced concrete, Energy efficient, Cost Cutting, Time saving, Safety purposed construction material, Repurposed, Hyper-Performance.

1. INTRODUCTION
To understand all how and about of super performing construction materials we must study materials according to their use from very root to tip. By that way we can easily conclude and infer about the application, implementation and feasibility of that particular construction material. Elements of construction where these smart materials and techniques shall be implemented are:

- Foundation
- Plinth
- Beam
- Column
- Wall
- Sill
- Window
- Door
- Roof
- Parapet
- Skylights
- Finishing Works

Construction materials are said to be super performing when they
- Save overall building energy
- Make building aesthetically pleasing
- Cut cost of construction
- Easily available
- Increase life span of building
- Upgrade building quality
- Make the building safe for living

2. BUILDING DETAILS

![Figure. 1. Building plans](image1)
![Figure. 2. Elevation](image2)
3. SUPER PERFORMING MATERIALS

1. Advancements in Concrete

1.1 High Performance Concrete

Lafarge has developed a whole new family of concretes called Ductal. These concretes have high compressive and flexural strength, and their special characteristics enable the achievement of outstanding architectural feats. Ductal concrete incorporates strengthening fibres and opens the horizon to ultrahigh performance due to its special composition which provides it with outstanding strength, six to eight times greater than traditional concrete (under compression). "Fibre-reinforced" means that it contains metal fibres which make it a ductile material. Highly resistant to bending, its great flexural strength means it can withstand significant transformations without breaking. Ductal also comes with organic fibres for applications with less load and for advanced architectural applications. High performance concrete used in

1.1.1 Foundation work:

The pile foundations construction is envisaged in the project. The foundation consists of driven piles with section 350x350 mm and monolithic reinforced concrete grillage slab with 800mm thickness on the 100mm concrete preparation. For equipment descent into the pit for the period of pilling and the grillage the descent is arranged with crushed stone using a reinforced concrete pavement slabs coating with inclination angle 10°. Over the entire pit area a sandy preparation is arranged with 300mm thickness for the drilling in and crawler crane movements. Pile installation is permitted only after receiving positive results of static tests sample piles. Tested piles are determined by the supervision. Piles in accordance with the project are driven by using special equipment designed for piling with a length of 15m.

1.1.2 Column & slab casting work

Starters are needed to cast the column in proper alignment. To construct the column starter, shutters are made to the sizes of the column and the height of the shutter should be normally 75 to 100mm, the shutters are fixed at the bottom of the column according to the centre line. Check the shuttering and reinforcement of the starter for a vertically. After the curing period is over, remove the formwork of the starter. The shuttering of the remaining column should be fixed by overlapping shutter and casted starter. In case of footing and slab, the shuttering should be fixed and checked before placing the reinforcement. This is necessary as certain formwork defect can't be corrected after reinforcement is placed in position.

a. The reinforcement steel should be free from any loose scale, rust, mud or oil.
b. Main reinforcement and ring of column should be cut as per required length.
c. The stirrups should be carefully cut in length as extra length will result in large size of stirrups/ring resulting in less cover to concrete, which is never advisable.
d. Main reinforcing bars and stirrups should be tied tightly to each other.
e. Lapping should be provided in the central half of member length and lap length should be 45D.

In central half of member, the lapping of bar should be alternative if possible.
f. Before placing the concrete, check the reinforcement details with bar binding schedule and get an approval from structural consultant.

High performance concrete used in column casting-

1. Collect samples for maturity testing. Check the slump and temperature, concrete should not be freshen up with water or re-tempered in any way.
2. The surfaces of construction joints should be thoroughly wet, free from laitance before pouring fresh concrete.
3. For the casting, deposited concrete continuously. Make sure that concrete is cast as neatly as possible and avoid considerable height difference that promotes aggregates segregation.
Admixtures play an important role in the production of High Performance Concrete. Mineral Admixtures form an essential part of the High-Performance Concrete mix. They are used for various purposes depending upon their properties. Table-1 shows different types of mineral admixtures with their particle characteristics Table 1 Mineral Admixtures used in High-Performance Concrete (HPC)

<table>
<thead>
<tr>
<th>Mineral Admixtures</th>
<th>Classification</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground granulated blast furnace slag</td>
<td>Cementitious and pozzolanic</td>
<td>Unprocessed materials are grain like sand, ground to size less than 45 μm.</td>
</tr>
<tr>
<td>Fly ash</td>
<td>Cementitious and pozzolanic</td>
<td>Powder consists of particles size less than 45 μm</td>
</tr>
<tr>
<td>Silica fume</td>
<td>Highly active pozzolana</td>
<td>Fine powder consisting of solid spheres of 0.1 μm average diameter</td>
</tr>
</tbody>
</table>

Based on Characteristic Strength

Based on 28-days characteristic strength of concrete, the following classification has been suggested

(a) **Ordinary Concrete**: Concrete having 28-days compressive strength in the range of 10 to 20 MPa.

(b) **Standard/Normal Concrete**: Concrete having 28 days compressive strength in the range of 25 to 55 MPa.

(c) **High-Performance Concrete**: Concrete having 28 days compressive strength in the range of 60 to 100 MPa.

(d) **Very High-Performance Concrete**: Concrete having 28 days compressive strength in the range of 100 to 150 MPa.

(e) **Exceptional Concrete**: Concrete having 28 days compressive strength more than 150 MPa.

2. **Porotherm smart bricks**:

Porotherm are advanced smart clay brick or walling material designed for all building formats (multistorey buildings, individual houses, large apartments, villas, educational institutions, hospitals, hotels, commercial complexes). This is a product specially created keeping in mind the changing climatic conditions, keeping homes naturally cool & comfortable throughout the year for generations.

Advantages of brick

- Light weight (60% less weight than conventional walling material),
- Strong & durable- high Compressive strength
- Excellent Thermal and Sound Insulation
- Low water absorption of ~ 15%, thus minimal risk of dampness, cracks or shrinkage of walls
- Non-susceptible to carbonation thus providing greater durability
- Fire protection
- Easy installation

3. **Cool paint (Heat Reflective paint)**

Cool paint is Heat Reflective paint and this paint has been designed to reflect more sunlight and absorb less heat than a standard roof. Its application reduces roof temperature and correspondingly reduces room temperature. In the case of air-conditioned spaces, the power consumption is reduced due to the temperature gradient across the slab. Just as wearing light-coloured clothing can help keep you on a sunny day, cool paint material that is designed to reflect more sunlight and absorb less heat than a standard roof. Cool Paint is made of highly reflective type of paint by emissivity aqueous coating based on acrylic resins. It is an eco-friendly paint which upon application to cementaceous, asbestos or MS roofing increases the emissivity of that surface, which results in reflection of heat energy. Apart from this the non-conductive properties. It also provides insulated effectiveness through it uniformity.

![Figure 7. Porotherm smart brick](image-url)

**Application of Cool Paint:**

1. Cleaned ores to be washed with water, Bleaching Powder (If Required)
2. Stir the paint thoroughly before each use.
3. Apply first coat with brush on the cleaned & washed surface.
4. Apply second coat after a gap of minimum 3 to 4 hours.
5. Ensure that the coated area does not come in contact with water for at least 2 hours.
6. After completion of full coating, it should be allowed to cure.

It can be applied by spraying, roller or brush, making it a very simple-labour product that is easy to apply and can replace the traditional methods.
bulky conventional and standard insulation materials, and can enhance or replace those existing materials.

**Benefits of cool paint:**

1. Ultraviolet and Infrared Resistant – Continuous rejection of solar heat resulting in drastic reduction of roof heat. Increase in temperature due to heat radiation from the roof is stopped, keeping the coated area comfortable even in peak summer afternoons.
2. Reflecting UV and IR rays back to the atmosphere.
3. Eliminates the necessity for false ceiling.
4. Can be coated on any roofing material / side walls.
5. Prevents Island effect.
6. Helps in reducing the emission of greenhouse gasses and global warming.
7. In warm, moist locations, cool roof surfaces can be more susceptible to algae or mould grown than hot roofs. Some roof coatings include special chemicals that prevent mould or algae growth for a few years.
8. Contains no solvents, cleans up with water. No toxic substance included.

4. **AAC Blocks (Aerated Autoclaved Concrete Blocks):**

AAC blocks are light weight Aerated Autoclaved Concrete Blocks. It is manufactured through a reaction of aluminium and a proportionate blend of lime, cement and fly ash. During this process, the hydrogen gas that escapes creates millions of tiny air cells, rendering AAC with a strong cellular structure. AAC blocks are further strengthened by high pressure steam curing in autoclaves. The product thus formed is not only light weight but also has higher Compressive strength. Density of these AAC lightweight blocks usually ranges between 550 – 650 kg/m³. Which is superior to most types of light weight blocks. AAC blocks are 25% stronger than other products of the same density.

5. **Modular form work:**

Formwork has been used widely in construction practice since the discovery and establishment of Portland cement concrete as a favored building material. Formwork is a temporary structure that can be incorporated into the permanent structure or removed after the concrete has reached design strength. Formwork costs can constitute from 35 to 60 percent of the concrete cost on projects involving large quantities of concrete work. Formwork is significantly important activity for concreting. Good quality of formwork can contribute a great to good quality of concrete. It not only holds the concrete during its wet stage but has many other important functions in this activity of concreting. Bad formwork has often yielded failures of minor as well as major magnitude. It is also fairly popular as shuttering. Its functional as well as financial share in the entire concreting activity can’t be ignored.

1. **Column system form work:**

The column formwork systems now available are normally modular in nature and allow quick assembly and erection on-site while minimizing labour and crane time. They are available in steel, aluminium and even cardboard and have a variety of internal face surfaces depending on the concrete finish required, innovations have led to adjustable, reusable column forms which can be clamped on site to give different column sizes.
4. CONCLUSION:

The new building system is illustrated as combination of horizontal and vertical urban structures using innovative structural materials. Features of innovative material-based structures are identified as to enable multi-purpose use, step-wise development and integration of public spaces. To implement new building systems, technical and organizational issues are to be solved with a clear scenario of research and development with innovative material-based structures. Since the essential subject to develop new building systems using innovative materials is to solve environmental issues and human settlement in cities by introducing social infrastructures in high flexibility, performance and sustainability. The innovative materials and new building systems are to be applied in various types of urban redevelopment projects, to realize future sustainable buildings and urban structures with high economic ripple effect.

5. REFERENCES:

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