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Bim-Integrated Project Planning and Scheduling Using Primavera

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Abstract- — Building Information Modeling (BIM) has emerged as a transformative digital technology in the construction industry by enabling intelligent 3D modeling, improved collaboration, and efficient information management throughout the project lifecycle. However, successful project execution not only depends on accurate design representation but also requires effective project planning, scheduling, and resource control. Primavera P6 is widely recognized as a powerful project management software that supports detailed planning, time scheduling, cost estimation, and progress monitoring for complex construction projects. The integration of BIM with Primavera provides a highly efficient platform for developing realistic construction schedules, improving project visualization, and ensuring better decision-making during project execution.This study focuses on BIM-integrated project planning and scheduling using Primavera to enhance the effectiveness of construction project management. BIM models developed using software such as Revit are linked with Primavera schedules to establish a strong relationship between project activities and building components. This integration supports 4D planning, where the time dimension is combined with the 3D model to simulate construction sequencing and visualize the progress of project execution. Through BIM-based scheduling, construction stakeholders can identify logical activity sequences, detect clashes in time and space, and optimize the use of labor, materials, and equipment. The integrated approach improves coordination between architects, engineers, contractors, and project managers, thereby minimizing scheduling conflicts, reducing rework, and improving productivity.

Keywords: BIM, Primavera P6, Project Planning, Construction Scheduling, 4D BIM, Project Management, Critical Path Method (CPM), Resource Allocation, Time Management, Construction Simulation, Progress Monitoring, Cost Control, Risk Management, Revit Integration, Smart Construction.

I. INTRODUCTION

Construction is the second largest industry in India, only second to agriculture. With rapid urbanization and exponential growth of population, there is a huge demand for housing and other ancillary related to housing creating a shortage of conventional building materials. The production of conventional building materials consumes a lot of energy and pollutes air, water and land. Thus, to meet the ever-increasing demand of building materials, new sustainable materials are needed (Madurwar et al., 2013). At the same time, there is a growing issue of solid wastes from agriculture, which have become a major source of air pollution not only in India, but in almost all developing countries (Awasthi et al., 2010). The main aim of the research presented in this paper is to find a constructive method to turn solid, agricultural wastes into viable building materials, thereby addressing both pressing issues at the same time. The present paper explores the potential application of 'agro-waste', like hey or straw stubbles, leftover wood, et cetera, as the ingredient for alternative sustainable construction materials in the form of bricks. Based on the availability of agro-waste materials, these bio-bricks can be modified to suit the local market and building construction styles. The application of agro- waste as a construction material can result in the reduction of the usage of natural resources as well as of energy consumption. At the same time, it can add to the farmer's income, who can sell the leftover stubbles instead of burning them, thereby reducing air pollution. To achieve this goal, the process of up-cycling (the process of converting waste materials into new products of better environmental value than in their previous use) (Oyenuga et al., 2017) can be used to convert the agro-waste into usable bricks by combining it with lime, stone dust and water. The paper is divided into two parts, the first part highlights the growth of construction and agriculture sectors in developing countries like India and its adverse impact on environment. The second part of paper elaborates the process of making the bio-brick, its advantages, it's probable uses in construction industries and direct benefits to the environment. Thus, through our research paper we want to explore the

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potential use and possibilities of bio bricks in construction industries.

II. MATERIALS AND METHODOLOGY

Materials used in preparation of biobrick are as:

1. Ariculture waste (Paddy straws)
2. Lime
3. Flyash

Agriculture waste

Rice straw is a residual byproduct of rice production at harvest. The total biomass of this residue depends on various factors such as varieties, soils and nutrient management and weather. At harvest, rice straw is piled or spread in the field depending on the harvesting methods, using stationary threshers or self-propelled combine harvesters, respectively. The amount of rice straw taken off the field depends mainly on the cutting height (i.e., height of the stubble left in the field). Rice straw that remains in the field after harvest can be collected, burned, or left to decompose (soil incorporation). The "stubble"—the uncut portion of the rice straw after harvest—remains, and can be burned or incorporated into the soil in preparation for the next crop. The ratio of straw to paddy varies, ranging from 1.0 to 4.3 (Zafar 2015) and 0.74–0.79 (Nguyen-Hung et al. 2016a).

Figure 1: Agriculture waste (Rice straw)

Figure 2 Chopped rice straw

Preparation of Biolime
Preparation of extract from Papaya leaves

Papaya extract was prepared from 100 g of thoroughly washed papaya leaves. It was then boiled in 200 mL of distilled water for half an hour, filtered with Whatmann no 1 filter paper and the resulting extract was cooled and used for synthesis of metal oxide nanoparticles.

Figure 3: Boiling of Papaya leaves

Figure 4: Leaf extract of papaya leaves

Figure 5: Ingredients of papaya leaf extract

Synthesis of Calcium Oxide Nanoparticles Using Plant Extracts

Ten mL of calcium nitrate solution was added to 10 mL of papaya extract. Then, the mixture was stirred in a magnetic stirrer for about half an hour. NaOH was added dropwise while stirring till a white precipitate of calcium hydroxide was obtained. The precipitate was filtered and dried in an air oven for an hour. The content was washed repeatedly with distilled water to remove the basicity of the solution. Further, the calcination was done in the muffle furnace at 500ºC for three hours.

Figure 6: Leaf extract+Calcium nitrate

Figure 7: Sodium hydroxide solution

Figure 8: Titration of (NaoH) with (Ca(NO3)2

Figure 9 : Filtration process

Figure 10 : Drying of precipitate

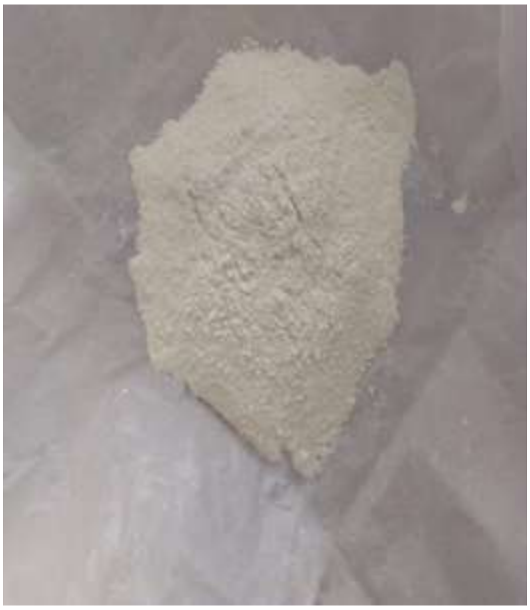
Figure11 : CaO precipitate

Preparation and Testing of Biobrick

- The Bagasse from agricultural waste is chopped to desired size.
- Materials are mixed based on mix proportions as given above (1:3).
- Water is added based on water cement ratio i.e,0.46
- The mixture is placed in the brick mould of size 19*9*9cm.
- The moulds are then rammed with wooden blocks to create compact bricks.
- Demould the brick after 24hours. And keep it for atmospheric drying for 28 days.
- The bricks attain strength after a month of air drying.


Figure 12: Chopped Agriculture waste


Figure13: Flyash

Figure14: Lime Figure20:Biolime

Figure 15: Mixing of materials

Figure 16 : Filling the mixture in the mould

Figure 16 :Casted brick mould

Figure 17 :Model of Biobrick

III. TESTING OF BIOBRICK

- Test performed on biobrick is compressive strength test.
- Results
- Results of compressive strength test are as follows:

S. No	Type of Mix	Compressive strength(kn/m2)

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1	Mix(A)	62
2	Mix(A1)	64.5
3	Mix(B)	76

- **Significance**

- The bricks are made from agro-waste like paddy straw.
- By the results we have observed strength of biobrick is more with the usage of biolime than lime .
- Bio-bricks are more sustainable than clay bricks.
- They also act as carbon sinks as they fix more carbon dioxide than they produce during their lifecycle.
- The bricks also provide good insulation to heat and sound
- They help in maintaining humidity of buildings and make the house more suitable for hot-humid climates.

- The bricks will help in building climate change resilient homes. In India as 84 to 141 million tons of agricultural wastes are burnt causing severe air pollution, these steps help in reducing these incidents.

- **Salient Features**

- More sustainable than clay bricks.
- Suited for non-load bearing walls.
- Density of Bio-Brick is 455.5 kg/m3 as against density of fired clay brick: 2000 ~ 2400 kg/m3 and concrete block: 1800 ~ 2100 kg/m3.

Being lighter in weight, the overall weight of structure is reduced giving economical design.

Better seismic resistance being lighter in weight.

Fire retardant.

- Serves as carbon sinks as they fix more CO2 than they produce during their lifecycle.

- Good insulation to heat and sound and helps in maintaining humidity in a building.

- Recycling agro waste in this way reduces air pollution, which might have been caused if this waste was burnt instead.

- Eco friendly sustainable Building Materials.

Economic Aspects

- Owing to its low density, bio-bricks can effectively reduce the load on the column and beams structure, thereby reducing the amount of steel and concrete thereby reducing the overall cost of the building.

- Thin sections of bio-bricks can be used as insulation boards in existing buildings to reduce the heat gain from the surrounding, these can help in reducing the air conditioning load and can save lot of energy, making our building more greener and sustainable.

- The researchers have shown that cost reduction in walls for a typical EWS house of 25 sqm. will be around Rs. 70,950 per DU. The cost of bio-brick as claimed by IIT Hyderabad is Rs.3 as against Rs.8.50 for burnt clay bricks.

First House Constructed With Biobricks

Sustainability Aspects

Most of the manufacturing process in India movs in a linear path of “resource-product- waste” leading to unsustainable development.

- The development of Bio-Bricks was based on the three fundamentals of Circular Economy, i.e., "reduce, reuse and recycle".

- Bio-Bricks recycle and reduce the agro-wastes to create new building materials and at the End Of Life (EOL) it can be crushed and reused as raw materials for creating new bio-bricks thereby confirming to the three paradigms of Circular Economy.

- Bio-bricks can give additional income to formers from the agro-wastes there by making the whole process economically viable. This will lead to reduction of stubble burning and air pollution.

- These bricks can substitute a part of burnt clay bricks there by reducing loss of topsoil.

The demand for such bio-bricks will lead to development of new green and sustainable industries and create new jobs at grassroot levels

Sustainability and Availability

- Suitable in all climate conditions.

- Use of local available agricultural waste material .

- Can be used in low cost Housing with combination of wooden or metal structural framework.

IV. CONCLUSION

India is home to a diverse range of agricultural crops and is among the top three producers of waste in the world. This generates a huge amount of agro-waste that needs to be disposed. At the same time, the demand for raw materials, especially bricks, is ever increasing for Indian construction industries. The bio bricks we generated from common agro-waste, have a tremendously better net carbon footprint than standard building materials and, at the same time, are very cheap and simple in production. Though they may not be suitable for larger loads, they have huge application potential in less-load bearing wall construction, sounds reduction and insulation, particularly in the low-cost sector, which, after all, is a substantial market in India. Thus, converting agro-waste into bio-bricks could help mitigating the pertinent issues of raw material required by construction industry and the agro-waste created in agricultural sector.

Given the identified limitations of the load-bearing capacities of bio-bricks, we expect government support and public awareness will be needed to make bio-bricks production turn into a self-sustaining industry. Following steps could help in proper development of this new material:

- Government initiative and incentives are required to promote and propagate the new material.
- Large scale awareness campaigns and training programs for grassroots' level masons and builders.
- Campaigns that are directed at informing target users (e.g. the farmers) by showcasing how the conversion of waste into bricks can benefit them.
- Showcasing how bio-bricks can become a major impact in improving the sustainable practice of Indian construction industry.

Further research and development is required to develop bio-bricks for pan-India application where local agricultural waste can be used as a building material. We will also need to explore options for how the load-bearing capacity of the bricks can be improved.

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