EMERGING TECHNOLOGIES FOR SUSTAINABILITY

PROCEEDINGS OF THE ANNUAL INTERNATIONAL CONFERENCE ON EMERGING RESEARCH AREAS (AICERA 2019), JULY 18-20, 2019, KOTTAYAM, KERALA

Edited by
P.C Thomas, Vishal John Mathai and Geevarghese Titus

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Emerging Technologies for Sustainability

Proceedings of the Annual International Conference on Emerging Research Areas (AICERA 2019), July 18–20, 2019, Kottayam, Kerala

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Preface

Amal Jyothi College of Engg., Kanjirappally, Kerala (www.ajce.in) has been organizing a series of International Conferences AICERA (International Conference on Emerging Research Areas) since inception in 2011. Specific Conferences have been held under the parent AICERA umbrella, the theme varying every year. The 2019 edition, being organized jointly by the Departments of Automobile, Civil, Electronics, Electrical and Mechanical Engineering on 18th and 19th of July 2019 has evolved into the International Conference on Emerging Technologies for Sustainability (IcETS). The Conference explored the myriad aspects of diverse Sustainable Technologies.

The Conference theme "Emerging Technologies for Sustainability" sought to raise the standard of living without draining limited resources. Sustainable issues are compounded by the splurge in manufacturing, automobiles, electronic accessories, captive power plants and their attendant problems. The Conference explored long-term development solutions that combine economic growth with environmental protection and energy efficiency while enabling us to meet social needs.

The two-day Conference featured various technical areas, which figured in the research findings of around 120 participating researchers, including faculty, scholars and industry specialists. The Conference acted as a platform for researchers to share knowledge, showcase their research findings and propose new solutions in policy formulation, green material selection and manufacturing, thereby contributing to the creation of a more sustainable world. The Conference also featured invited talks and paper presentations.

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Foreword

ICETS, the 8th AICERA edition, focused on topical technologies related to sustainability. The 2019 edition was organized jointly by the Departments of Automobile, Civil, Electronics, Electrical and Mechanical Engineering. It facilitated interaction among academicians, engineers and research scholars. The multifarious specialties covered the broad spectrum of current technologies related to Sustainable Engineering.

The Conference hosted several invited lectures on topical research areas by eminent academicians. The sessions provided a vibrant learning platform to all the participants.

- 3 plenary talks and 90 academic presentations on a range of topics including: Sustainable issues, Splurge in automobiles and electronic accessories, Captive power plants and attendant problems
- International speakers:
    - Dr. Bastien Seantier (Research Institute Depuy De Lome, France)
    - Dr. Mona Jani (Yachay Tech University, Ecuador)
    - Prof. Kyun Tae Kim (Hannam University, Daejon, South Korea)
- Discussions on the sidelines led by 6 Industry specialists on related topics in vogue

Dr. K. Jessy (Dept. of Mechanical Engg.)
Organizing Co-Chair

1. Water Purification using Natural Filter Media

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ABSTRACT: India is one of the leading countries in drinking water scarcity issue. Even though India is abundant in natural water bodies and precipitation, most of this water is unsuitable for human consumption. The drinking water scarcity of any locality can be solved using cheap and readily available materials. This paper deals with solving the drinking water scarcity of 31st mile in Mundakayam by creating slow sand filter. The slow sand filtration system is modified with activated coconut shell charcoal, activated bamboo charcoal and chitosan as filter media. Water filtration system with different media is a cost-effective method to improve household water quality without using electricity or wastage of water.

I. INTRODUCTION

India has a high number of people suffering from drinking water scarcity. Scarcity of drinking water has been a major issue in the locality of 31st mile near Mundakayam. Turbidity, taste, color, odor, etc are the physical problems of the water in the locality. The water samples from the locality showed yellow color and decayed smell. Water consumption has continuously caused health issues for the residents. The filter was constructed using activated coconut shell charcoal, activated bamboo charcoal and chitosan. These filter materials are natural and easily available so that common people can use it. The waste water from a sewage treatment plant was also analyzed.

Slow sand filtration has been recognized as an appropriate technology for drinking water treatment in rural areas, and is recognized as a suitable filtration technology for removing water borne pathogens and reducing turbidity. It is capable of improving the physical, chemical, and microbiological quality of water in a single treatment process without the addition of chemicals. Slow sand filtration process provides treatment through physical filtration of particles and biological removal of pathogens and organics in the upper biologically active layer of the sand bed known as biofilm. Slow sand filtration is a sustainable technology for rural water treatment because it is low cost and simple to operate.

In addition, it is able to produce excellent effluent quality without the use of treatment chemical. Filter Gravel is an extremely effective filter media because of its ability to hold back precipitates containing impurities. Sand can remove color, odor, turbidity, microorganisms and nitrogenous wof pathogens in the water. Activated carbon works via a process called adsorption, whereby pollutant molecules in the fluid to be treated are trapped inside the pore structure of the carbon substrate.

II. MATERIALS

Gravel and sand

Filter Gravel of size 10 mm and fine sand of 300 micron and 600 micron each were used in creation of slow sand filter.

Activated coconut shell charcoal

It is prepared by superheating coconut shell above 100^0C. Then the charcoal is chemically treated with argon and nitrogen, followed by a second round of superheating with the addition of oxygen and steam to create a porous structure. Size of charcoal used was 2mm.

Activated bamboo charcoal

Activated Bamboo charcoal comes from pieces of bamboo plants, harvested after at least five years, and burned in oven at temperatures ranging from 8000°C to 1200°C.

Chitosan

Chitosan is a polysaccharide formed by treating shrimp shells in an alkaline media. Chitosan powder of size 300 micron was used.

III. SPECIMEN PREPARATION AND TESTING

Prototype filter and filtration system

A prototype slow sand filter was designed using broken brick, fine sand of different grades, activated coconut shell charcoal and gravel. The prototype was designed in a PVC pipe of length 1.5 m and diameter of 6 inches. The layers and their depths are as follows:

- Broken brick (30 cm depth)
- 600-micron size fine sand (20 cm depth)
- 300-micron size fine sand (20 cm depth)
- Additional media (appropriate depth)
- 600-micron size fine sand (20 cm depth)
- 10 mm size Gravel (30 cm depth)

To determine the depth of additional media, parameters such as turbidity and dissolved oxygen were analyzed for water through each of the 3 medias. The depths from 5 cm to 50 cm were tested. It was found that the depth of 25-35 cm was economical for the increase of DO. Beyond the depth of 40 cm, the increase of DO was not significant. For turbidity removal, 40 cm depth was appropriate. The depth of charcoal media was chosen as 20-30 cm for feasibility. Chitosan showed increased turbidity beyond 10 cm. Therefore, the depth of chitosan for efficient turbidity removal was chosen as 10 cm.

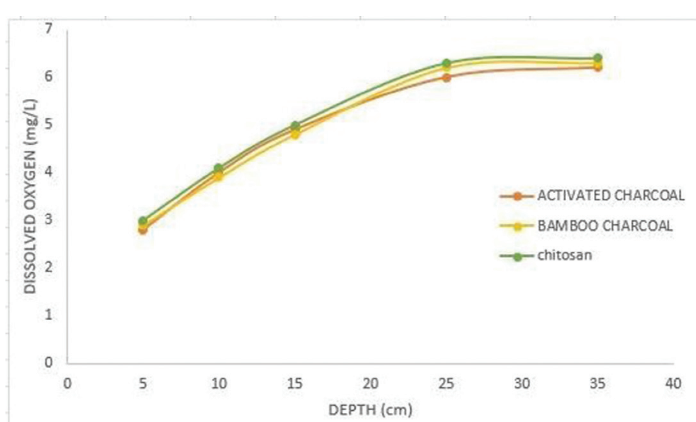

Figure 1.1 Graph of dissolved oxygen versus depth

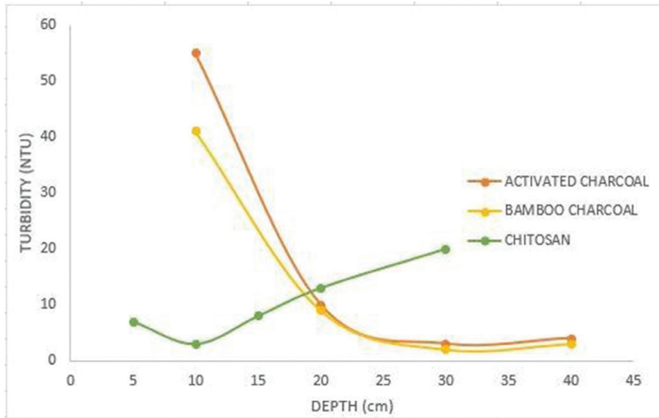

Figure 1.2 Graph of turbidity versus depth

Water quality analysis was conducted on this prototype filter by replacing the additional media by 2mm activated coconut shell charcoal. The analysis was conducted as per procedures in IS 3025.

Figure 1.3 Prototype filter

The locality of 31st mile in Mundakayam has been under severe drinking water shortage for a long time. The region is located beneath a valley. Analysis of water samples from 50 residential apartments followed by preliminary survey of the region showed that the wells contained polluted water which was unsuitable for drinking purposes. The contamination level in the wells in various houses varied and the cause of contamination was unknown to local residents. The residents relied on bottled water for their daily requirements. Water quality analysis of samples collected from various wells in the locality showed various parameters not conforming to permissible standards. The most polluted water sample was passed through activated charcoal containing slow sand filter. The results are tabulated in Table 1.1.

It was observed that the water quality significantly improved by passing through the prototype filter. Therefore, the filter was built in a residential apartment in 31st mile in Mundakayam and analyzed. The filtration system consists of a raw water storage tank, filtration tank and a filtered water tank. Each tank was 1.5 m deep with a capacity of 500 L. The depth and arrangement of filter media was similar to that of prototype filter. The water was passed and filtered through the system and then analyzed.

Table 1.1 Water quality analysis of raw and filtered water sample through prototype

Sl. No	Parameter	Raw Water	Filtered Value
1.	Turbidity	101 NTU	38 NTU
2.	pH	6.45	6.45
3.	DO	4 mg/L	8.76 mg/L
5.	COD	120 mg/L	24 mg/L
6.	Total Hardness	47.5 mg/L	37.5 mg/L
7.	Calcium Hardness	25 mg/L	12.5 mg/L
8.	Magnesium Hardness	22.5 mg/L	25 mg/L
9.	Chloride	74.97 mg/L	29.99 mg/L

Figure 1.4 Tanks in filtration system

Figure 1.5 Filtration system setup in an apartment

Table1.2 Water quality analysis of water through filtration system

Sl. No	Parameter	Initial Value	Final Value	Efficiency
1.	Turbidity	72 NTU	2 NTU	97.22
2.	Ph	6.75	6.86	1.6%

3.	DO	5.32 mg/L	8.07 mg/L	34.07%
4.	COD	390 mg/L	242 mg/L	37.94%
5.	Total Hardness	50 mg/L	50 mg/L	0%
6.	BOD	0.86 mg/L	0.39 mg/L	54.65%
7.	Sulphate	204 mg/L	172 mg/L	15.68%
8.	Iron	3.56 mg/L	0.501 mg/L	85.92%
9.	Nitrate	0.714 mg/L	0.357 mg/L	50%

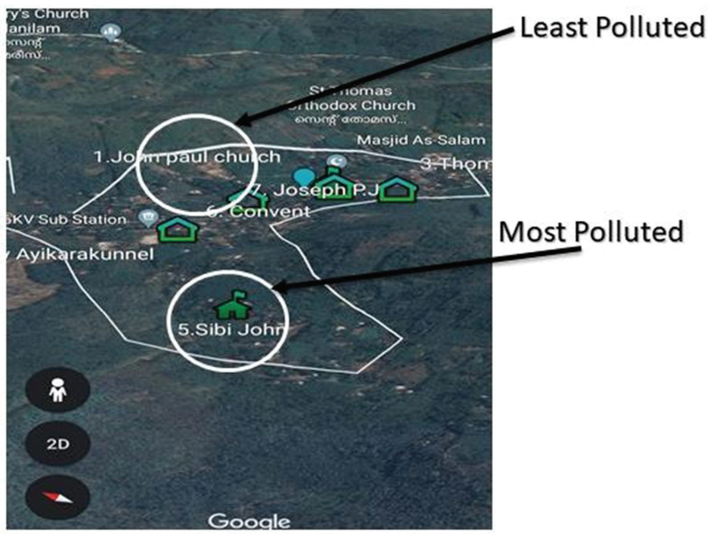

Figure 1.6 Map of locality of 31st mile in mundakayam

Analysis of sewage samples

Raw sewage samples collected from sewage treatment plant in Amal Jyothi College of Engineering, Kanjirappally were also analyzed. The samples were filtered through prototype filter by replacing the additional media with activated coconut shell charcoal, activated bamboo charcoal and chitosan media respectively. The water quality analysis for the combined filter employing all three additional media in slow sand filter was also conducted. The results are tabulated as follows.

Table 1.3 Water quality analysis of sewage water through activated charcoal

Sl. No	Parameter	Sewage Water	Filtered Water	Removal Efficiency
1.	Turbidity	135 NTU	4 NTU	97.03%
2.	pH	6.87	7.75	11.35%
3.	DO	1.18 mg/L	6.89 mg/L	82.87%
4.	COD	280 mg/L	104 mg/L	62.85%
5.	Total Hardness	40 mg/L	35 mg/L	12.5%
6.	Calcium Hardness	15 mg/L	15 mg/L	0%
7.	Magnesium Hardness	25 mg/L	20 mg/ L	20%
8.	Chloride	69.99 mg/L	49.98 mg/L	28.49%
9.	Nitrite	6.75 mg/L	0.51 mg/L	92.44%

10.	Nitrate	36.78 mg/L	32.87 mg/L	10.63%
11.	Iron	19.125 mg/L	2.31 mg/L	87.92%
12.	Phosphorous	0.249 mg/L	0.061 mg/L	75.50%
13.	BOD	1.17 mg/L	0.19 mg/L	83.76%
14.	Lead	0.2 mg/L	0.05 mg/L	75%
15.	Aluminum	0.404 mg/L	0.31 mg/L	23.26%
16.	E.coli	3271 MPN/100 ML	3 MPN/ 100 mL	99.90%

Table 1.4 Water quality analysis of sewage water through bamboo charcoal

Sl. No	Parameter	Sewage Water	Filtered Water	Removal Efficiency
1.	Turbidity	115 NTU	7 NTU	93.91%
2.	pH	6.87	7.24	22.22%
3.	DO	0.98 mg/L	7.48 mg/L	86.89%
4.	COD	280 mg/L	27 mg/L	91.42%
5.	Total Hardness	45 mg/L	35 mg/L	29.73%
6.	Calcium Hardness	20 mg/L	15 mg/L	6.07%
7.	Magnesium Hardness	25 mg/L	20 mg/L	20%
8.	Chloride	92.47 mg/L	64.47 mg/L	25%
9.	Nitrite	6.75 mg/L	3.567 mg/L	47.15%
10.	Nitrate	36.78 mg/L	14.41 mg/L	60.82%
11.	Iron	19.125 mg/L	1.875 mg/L	90.19%
12.	Phosphorous	0.249 mg/L	0.04 mg/L	83.93%
13.	BOD	1.17 mg/L	0.17 mg/L	85.47%
14.	Lead	0.214 mg/L	0.001 mg/L	99.53%
15.	Aluminum	0.404 mg/L	0.25 mg/L	38.11%
16.	E.coli	3271 MPN/100 mL	2 MPN/100 mL	99.93%

Table 1.5 Water quality analysis of sewage water through chitosan

Sl. No	Parameter	Sewage Water	Filtered Water	Removal Efficiency
1.	Turbidity	90 NTU	3 NTU	96.66%
2.	pH	6.50	7.68	15.36%
3.	DO	1.12 mg/L	7 mg/L	84%
4.	COD	328 mg/L	280 mg/L	14.63%
5.	Total Hardness	95 mg/L	80 mg/L	15.78%
6.	Calcium Hardness	65 mg/L	55 mg/L	18%
7.	Magnesium Hardness	30 mg/L	25 mg/L	20%
8.	Chloride	94.97 mg/L	57.48 mg/L	39.47%
9.	Nitrite	20.43 mg/L	0.003 mg/L	99.9%
10.	Nitrate	0.675 mg/L	0.002 mg/L	99.7%
11.	Iron	4.06 mg/L	3.12 mg/L	11.89%
12.	Phosphorous	0.34 mg/L	0.004 mg/L	23.15%

13.	BOD	1.17 mg/L	0.97 mg/L	17.09%
14.	Lead	0.214 mg/L	0 mg/L	100%
15.	Aluminum	0.404 mg/L	0.211 mg/L	47.77%
16.	E.coli	3271 MPN/100 mL	1 MPN/ 100 mL	99.96%

Table 1.6 Water quality analysis of sewage water through combination of filter medias

Sl. No	Parameter	Sewage Water	Filtered Water	Removal Efficiency
1.	Turbidity	130 NTU	2 NTU	98.46%
2.	pH	6.86	7.28	5.76%
3.	Dissolved Oxygen	0.57 mg/L	7.48 mg/L	92.11%
4.	COD	328 mg/L	48 mg/L	85.36%
5.	Total hardness	47.5 mg/L	32.5 mg/L	31.57%
6.	Chloride	49.98 mg/L	10.96 mg/L	78.07%
7.	Nitrite	22.43 mg/L	0.002 mg/L	99.9%
8.	Nitrate	0.744 mg/L	0.002 mg/L	99.74%
9.	Iron	6.07 mg/L	1.31 mg/L	78.41%
10.	Phosphorous	0.61 mg/L	0.005 mg/L	99.18%
11.	BOD	1.81 mg/L	0.51 mg/L	71.82%
12.	Lead	0.214 mg/L	0 mg/L	100%
13.	Aluminum	0.404 mg/L	0.201 mg/L	50.24%
14.	E.coli	3271 MPN/100 mL	1 MPN/100 mL	99.96%

Comparison of removal efficiency of different media

Turbidity: Coconut Shell charcoal showed highest removal of Turbidity with 97.03%. The activated charcoal has slightly high specific surface area and porosity, which could enhance sedimentation and other filtration processes such as adsorption. Activated charcoal traps toxins and chemicals in the gut and by absorption. The pore size of activated charcoal ranges with 2-50 nm. The combined filter was excellent in removal of turbidity with 98.46% removal efficiency.

DO: Bamboo charcoal has property to replenish dissolved oxygen in water by 86.89%. Dissolved oxygen levels are increased by supplementing wind and wave action caused by the turbulence of motion of wastewater through the filter. The small particle size of bamboo charcoal cause large turbulence and increase in DO. The combined media filter proved to be most effective in increasing DO with efficiency of 92.11%.

BOD: The reduction of BOD was maximum for Bamboo charcoal filter which was due to its adsorptive capability. It showed an efficiency of 85.47%. The combined media filter was less efficient than charcoal filters but was more efficient than chitosan filter.

COD: Removal of COD was maximum in Bamboo charcoal filters with an efficiency of 91.42%. The removal of combined filter was less than that of bamboo charcoal filter.

Total Hardness: Hardness was most effectively removed by bamboo charcoal with an efficiency of 29.73%. Greater availability of exchangeable sites on the surface of bamboo charcoal is the reason for efficient removal of hardness. Combined media filter was more efficient than individual media filters as it had 31.57% efficiency.

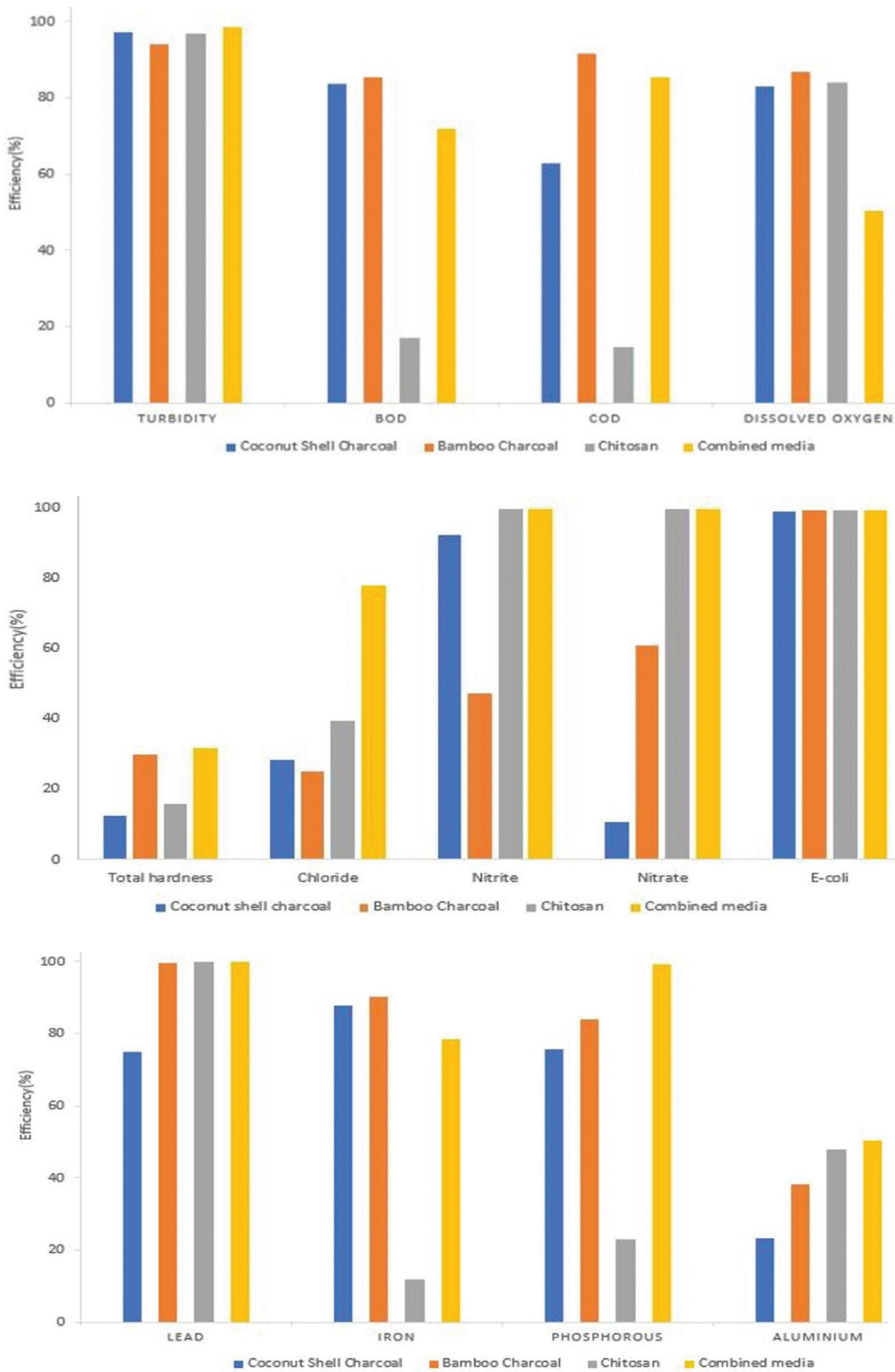

Figure 1.7 Percentage removal of various parameter

Iron: Activated Bamboo Charcoal was effective in treating iron content with removal efficiency of 90.19%. The contaminant-carbon surface interaction occurs through Van der waal forces and induced dipole interactions. The combined filter was more efficient than charcoal filters as it had efficiency of only 78.41%.

Chlorides: The removal of chloride is maximum for chitosan media filter due to its smaller voids between the chitosan particles. It had an efficiency of 39.47%. The combined media filter was more efficient than individual media filters with 78.07%.

E.coli: All the medias showed about equal efficiency in removing E.coli. The removal of E.coli was maximum for chitosan media filter with 99.6% efficiency. Chitosan removes E.coli by interparticle bridging and charge neutralization. The combined filter media was equally efficient as chitosan in E.coli removal.

Nitrate and Nitrite: Chitosan was most effective in removal of nitrate and nitrite with 99.70% and 99.9% efficiency. Particle diffusion in the adsorption process is the controlling step for nitrate and nitrite uptake by chitosan. The efficiency of combined filter in removing nitrate and nitrite was similar to that of chitosan media.

Phosphorous: Maximum removal of phosphorous was achieved by activated bamboo charcoal filter due to adsorption. It had 83.93% efficiency. The charcoal porous texture has negative electric charges during activation thereby attract opposite charged particles. The high zeta potential of bamboo charcoal causes the impurities to be trapped in the microspores of the charcoal. The combined media filter was better than individual media filters with 99.18% efficiency.

Lead and Aluminum: Maximum removal of heavy metals such as lead and aluminum was obtained by chitosan with 100% and 48% efficiency by ion-exchange and chelating mechanisms. The combined filter was overall better in removing heavy metals due to combined action of bamboo charcoal and chitosan. It had 100% and 50.24% efficiency in removal of lead and aluminum respectively.

IV. CONCLUSION

Coconut shell activated charcoal and activated bamboo charcoal remove contaminants by adsorption of minerals and by trapping pollutants within the void spaces between the particles. Bamboo Charcoal is more efficient in removing contaminants due to its high zeta potential and surface porosity. Activated Bamboo Charcoal was the most efficient media in treating COD, DO, total hardness, iron and phosphorous with a percentage removal of 91.42%, 86.89%, 29.73%, 90.19% and 83.93% respectively. The slow sand filter with chitosan media was proved to be the most efficient in treating nitrate and nitrite with a removal efficiency of 99.9% and 99.7% respectively. It removed heavy metals such as lead and aluminum by removal efficiency of 100% and 47.77%. Chitosan showed excellent efficiency in removing E.coli with a removal of about 99.96%. Activated coconut shell charcoal was suitable for removal of turbidity and chloride with a removal efficiency of 97.03% and 28.49% respectively. The filter combining the above media was effective in treating water. The combined filter was proved to be most efficient in removing parameters such as turbidity DO, nitrite, nitrate, lead and E.coli than the individual layers. The removal efficiency of the above parameters was 98.49%, 92.11%, 99.9%, 99.74%, 100% and 99.96% respectively. The excellent efficiency of the combined media filter for certain parameters was attributed by each media coherently contributing their characteristic removal properties

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2. Study on the Effect of Hydrogel on Plant Growth

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ABSTRACT: In order to avoid water scarcity issues and to promote kitchen grading, hydrogel a super absorbent polymer is incorporated in soil for planting vegetables both chilly and ladies finger in agro bags. The main objective of this study is to identify the effect of hydrogel on growth and yield of both chilly and ladies finger. The various properties of the plant like the height of the plant, the number of leaves, yield, root structure etc. were analyzed for 0.2% of hydrogel by weight of soil. Study showed that hydrogel improves the vegetative growth of plants by retaining more moisture and nutrients within the soil. It modifies the plant-soil interaction resulting in the better use of absorption of water and nutrient from the soil. The comparison between plants cultivated in normal soil and 0.2% hydrogel mixed soil were done. It was found that even for minimum requirement of 0.2% of hydrogel can reduce the water consumption up to 50% as that of the normal plants without comprising the yield.

Keywords: Hydrogel, Lady's finger, Chilly.

I. INTRODUCTION

India is facing severe water scarcity issues during summer months, people are struggling to get potable water for their daily needs. In addition, water scarcity in India is expected to worsen by year 2050 due to increased urbanization, increase in population, unscientific waste management etc. Farmers are unable to manage their crop and vegetables due to unavailability of both surface and subsurface water. Recently kitchen gardening or organic farming is hitting in India especially in cities and villages of Kerala. The population especially youngsters are aware about the need of cultivating their own vegetables and fruits. In urban area, most of them have space to do farming and plants grown either in containers or grow bags. Plants grown in containers and in grow bags with limited soil require frequent irrigation to maintain adequate moisture especially in summer. Hydrogels are three-dimensional, hydrophilic, polymeric networks proficient in absorbing a great amount of water or biological fluids. Owing to their increased water content, porosity and soft consistency, they intently simulate natural living tissue, more so than any other category of synthetic biomaterials. Hydrogels can either be chemically durable or they may eventually disintegrate and dissolve. Generally,

PUSA hydrogel is used in the agricultural field. Hydrogel a super absorbent able to retain water and plant nutrients and release it to the plants when surrounding soil near the root zone of plants start to dry up. Hydrogel are three-dimensional, hydrophilic, polymeric networks proficient in absorbing a great amount of water or biological fluids. Owing to their high-water content, porosity and soft consistency, they intently simulate natural living tissue, more so than any other category of synthetic biomaterials [4]

The Effect of hydrogel on growth, fresh yield and essential oil content of ginger. In this Pusa Hydrogel plays an important role in enhancement of absorption capacity and retention of water in soil [1], fighting against water shortage and decreasing harmful effects of drought stress. The results indicated that hydrogel had a remarkable effect on enhancement of growth, yield and oil content of ginger. The Effects of hydrogel and nitrogen fertilization on the production of arugula in successive crops. The hydrogel had no effect on the fresh and dry mass of arugula, regardless of the cultivation period [5].

Soilless cultivation conditions could lead to a progressive loss of effectiveness of the hydrogel, due to the periodic dehydration and hydration cycles and the high fertilization rate. The tested hydrogel showed to be suitable for potential use in agriculture, with potential benefit in particular for short growing cycle crops in the Biodegradable Superabsorbent Hydrogel Increases Water Retention Properties of Growing Media and Plant Growth [3]. Improving biological activity of the soil expressed as total count of bacteria and Hydrogels have the ability to absorb a lot of water in soil, the existing nutrients in the soil which dissolve in soil solution can be absorbed into it or on its surface. At the same time absorbed nutrients can be released or desorbed slowly through the exchange of free water or minerals between soil solution and RS-based hydrogels [2]. The main objective of this study is to analyze the effect of hydrogel at 0.2% of weight of soil on vegetable growth and yield for chilly and ladies finger which is cultivated in agro bags.

II. EXPERIMENTAL METHODOLOGY AND MATERIALS USED

The experiment was conducted at Amal Jyothi College of Engineering, Kanjirappally, Kottayam, Kerala, India. First, the saplings of ladies' finger and chilly were made in paper cups. Agro bags were used for the cultivation of both the vegetable plants. The experiment was conducted by filling soil, cow dung, and coir pith in the proportion 1:1:1 The normal 20 plants of both chilly and ladies' finger were cultivated. Also, another 20 plants were cultivated in 0.2% hydrogel by weight of soil mixed with the same media. The normal plants were noted as N1, N2…N20 and the hydrogel incorporated plants were denoted as H1, H2…H20 for both ladies' finger and chilly. The plants were irrigated at regular intervals such that the water should not go away from the soil. The height of the plant, the number of leaves, the temperature of the locality, the amount of rainfall, and the yield of the plants were measured and analyzed.

III. RESULTS AND DISCUSSION

The growth of the plant was analyzed based on the height of plants, weight of fruits. For the normal plants, the irrigation provided was 1000 ml and for plants with hydrogel, it was 500 ml per day to maintain constant capillary water for the plants.

I. Growth rate analysis of lady's finger plant

Table 2.1: shows the height of lady's finger for normal and hydrogel incorporated plants after cultivation for different periods.

Table 2.1 Height of lady's finger for normal and hydrogel soil

Height of the Plant (cm)		
No. of Days	**Hydrogel**	**Normal**
26	13.350±2.058	12.133±1.959
33	17.575±2.369	17.533±2.587
40	28.700±2.5567	29.333±4.011
43	33.250±3.006	33.466±4.189
55	47.300±7.0494	53.767±6.491
62	51.375±6.569	55.767±6.697
70	54.825±6.454	56.933±6.670

76	57.150±5.931	57.833±6.393
84	58.775±5.413	58.533±6.165
91	59.950±5.512	59.167±5.969

Fig. 2.1 shows the height of hydrogel plants and normal plants of ladies' finger grown in normal soil and soil incorporated with hydrogel. At the initial stage, the plants with hydrogel has more growth compared with normal plant. But from 55th day to 70th day the growth of normal plant and hydrogel plant became same. After that height of hydrogel plants increased. These show that hydrogel has a greater influence on plant growth.

Table. 2.2 and Fig. 2.2. shows the comparison of mean fruit weight of normal and hydrogel incorporated plants of ladies' finger. At the 50th day of the plantation, the weight of fruit was measured. And it shows that yield from hydrogel plants is greater than normal lady's finger plants

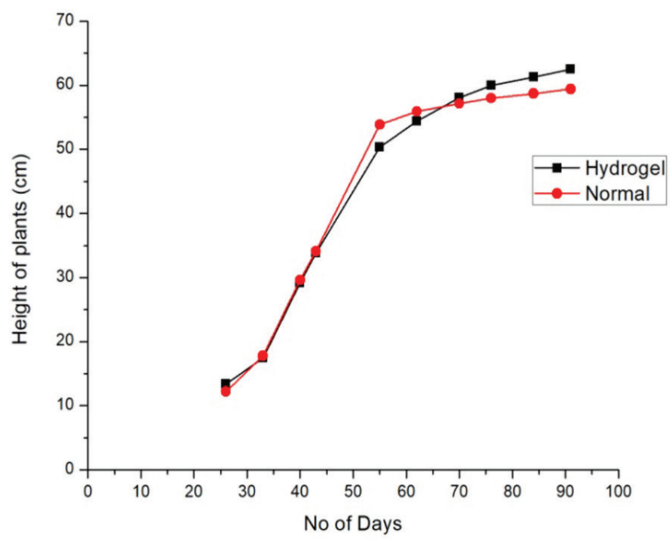

Figure 2.1 Comparison of mean height of lady's finger for normal and hydrogel plants

Table 2.2 Yield of lady's finger for normal and hydrogel plants

Weight of Fruit (gm)		
No. of Days	**Hydrogel**	**Normal**
51	15.111±5.820	14.00±3.464
57	34.000±12.961	32.666±7.257
65	34.667±13.840	27.777±5.711
74	33.000±4.123	27.111±8.225
84	44.889±17.965	37.200±8.022
91	29.440±9.673	28.777±5.883

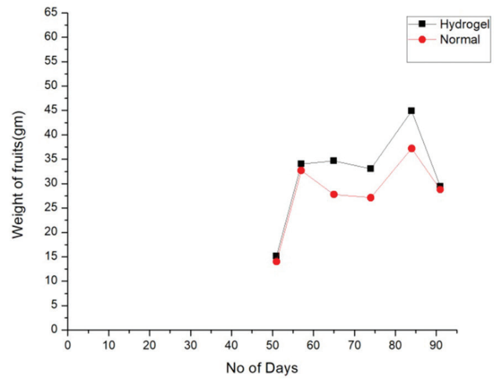

Figure 2.2 Comparison of mean fruit weight of lady's finger for both normal and hydrogel plants

Table. 2.3. and Fig. 2.3. Shows the height of hydrogel incorporated plants and normal plants of chilly for varying periods after cultivation

Table 2.3 Height of chilly for normal and hydrogel incorporated plants

Height (cm)		
No. of Days after Cultivation	**Hydrogel Incorporated Plants**	**Normal Plants**
26	12.9±3.314	10.1±3.562
33	18.6±4.176	15.3±4.100
40	28.4±5.678	5.3±6.270
43	34.8±7.400	30.3±7.900
55	48.8±7.820	46.0±7.589
62	66.7±6.100	64.2±6.144
70	74.6±5.043	73.0±5.157
76	81.3±5.119	80.3±4.770
84	87.4±3.929	86.4±4.360
91	93.2±3.762	90.4±3.770

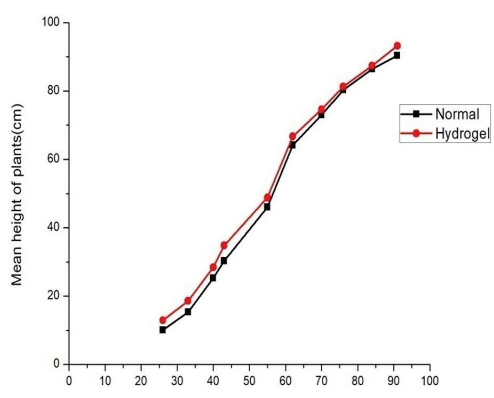

Figure 2.3 Comparison of mean height of chilly both for hydrogel incorporated and normal

Table 2.4 Weight of chilly both for hydrogel incorporated and normal

Weight of Fruit (gm)		
No. of Days after Cultivation	**Hydrogel Incorporated Plants**	**Normal**
44	5.8±5.820	7.20±1.980
51	22.4±3.440	20.6±3.230
59	26.5±4.080	24.0±3.970
65	24.1±2.624	20.9±4.085
71	39.2±2.891	37.1±2.808
76	29.2±2.749	26.4±2.970
81	34.5±2.291	32.3±2.830
86	33.7±2.830	31.0±2.144
91	33.8±2.561	31.0±2.440
96	35.3±3.769	32.2±3.490

Table 2.4. and Fig. 2.4. shows the comparison of mean fruit weight of hydrogel plants and normal plants of chilly. From the 44th day of plantation the weight of fruit was measured. It also shows that weight of fruit from hydrogel incorporated plants is greater than normal chilly plants.

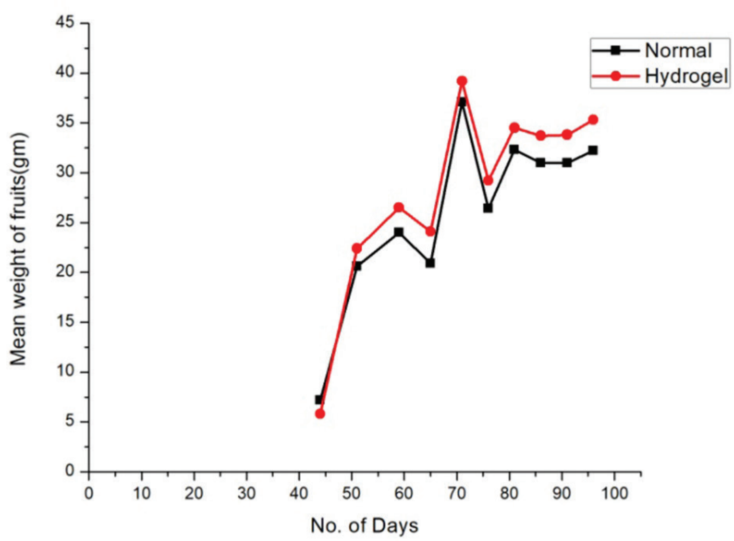

Figure 2.4 Comparison of mean fruit weight of chilly

Fig. 2.5 and Fig. 2.6 shows the root growth of the Lady's finger for hydrogel incorporated and normal after the plant life.

Figure 2.5 Root growth of normal lady's finger plants

Figure 2.6 Root growth of hydrogel lady's finger plants

IV. CONCLUSION

The effect of 0.2% of hydrogel on vegetables such as ladies finger and chilly were studied. Hydrogels have been successfully used to increase the water-holding capacity by reducing the irrigation than normal plants both for chilly and ladies finger. It was found that even for 0.2% of hydrogel can reduce the water consumption up to 50% as that of the normal plants without any significant reduction of yield.

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3. Experimental Analysis on the Characteristics of Geopolymer Brick using Bentonite as Additive

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ABSTRACT: Brick represents one of the most used materials for the construction of buildings, but the rising demand of building materials and increased construction and demolition wastes has encouraged the development of new building materials. However, the traditional brick production causes several environmental and human health impacts, so there is a clear need of searching and replacing for more efficient and durable alternatives far beyond the limitations of the conventional brick production. Geopolymer that emerged as an eco-friendly alternative to cement binders has distinct advantages such as excellent mechanical properties, low energy in its production and emits fewer dioxides. This project work is an attempt to discover an eco-friendly brick for the development purposes by totally replacing the normal brick components by wastes from many industries. For the investigation purpose, we made geopolymer bricks by utilizing fly ash as the binder (fly ash is the by-product from burning coal in electric power generating plants and it is wealthy in silica and alumina), foundry sand as the fine aggregate which is the by-product from ferrous and non-ferrous metal casting industries, bentonite as an additive for improving its properties and finally the alkaline arrangement (blend of NaOH and Na_2SiO_3). Fly ash combines with alkalis such as Sodium Hydroxide (NaOH) and Sodium Silicate (Na_2SiO_3) creating alumino silicate gel, that shows properties similar to that of cement and it can be used as the binding material. Also, there is no carbon dioxide emission as in the case of cement production. Here water is needed only for making sodium hydroxide solution from solid pellets of NaOH. As fly ash is a fine material, it has more surface area for reacting with the chemicals, thereby increasing the pozzolonic activity and hence there will be an increase in compressive strength. Also, a combination of foundry sand and bentonite is very good for moulding purposes. In ordinary brick making, kiln burning is needed for curing purposes and huge energy is consumed during this process. But when it comes to geopolymer brick, only 24 hours oven drying at 1100^{o}C is required. The remaining curing processes are under normal air temperature. The mix design was obtained to be 10 M for NaOH and the ratio of solutions to fly ash is 0.5. The ratio of Na_2SiO_3 to NaOH is 1.5. The geopolymer bricks were then produced and the blocks were held under rest period for about 3 days after moulding. The demoulded bricks are dried under oven for about 24 hours and henceforth the strength parameters such as compressive strength, water absorption, efflorescence, sound test and hardness were tested on the brick on the day after oven drying, 7th day, 14th day and 28th day. Hence the final results were made by comparing these properties with ordinary clay brick. From the experimental results, it is seen that the geopolymer bricks presented a high compressive and a low-water absorption capacity. The bricks were rated as slight-effloresced without any flaking of brick surfaces. The presence of efflorescence is ultimately due to the presence of alkali. Accordingly, 10 M solution can be taken as the design mix because as molarity increases there will be more efflorescence and at the same time as molarity decreases there will be decrease in compressive strength.

Keywords: Fly ash, Foundry sand, Bentonite, Sodium hydroxide (NaOH), Sodium silicate (Na_2SiO_3)

I. INTRODUCTION

Blocks are comprehensively used material in advancement and building material. In the United States, around the scope of 9 billion blocks are used a year. A traditional block normally uses earth and shale as the source material. Other than creation of block by utilizing earth, there is additional generation of Ordinary Portland Cement (OPC) block. It releases ozone depleting substances, which is carbon dioxide (CO_2), into the environment during its manufacturing process. There is generally about 1.5 kWh of vitality for around 1 kg of CO_2 released to the air for assembling of 1 kg of OPC. Subsequently, by introducing geopolymer on planning of block, it can apportion every single issue caused by dirt block and OPC block. In India, mud blocks have been extensively used from long time and are the staggering advancement material even today. The Indian block industry, which is the second greatest creator on earth, close to China, eats up in excess of 150 million tons of coal yearly without incorporating the power used in block age. The diesel for transporting the blocks alone makes precisely 180 million tons of CO_2.

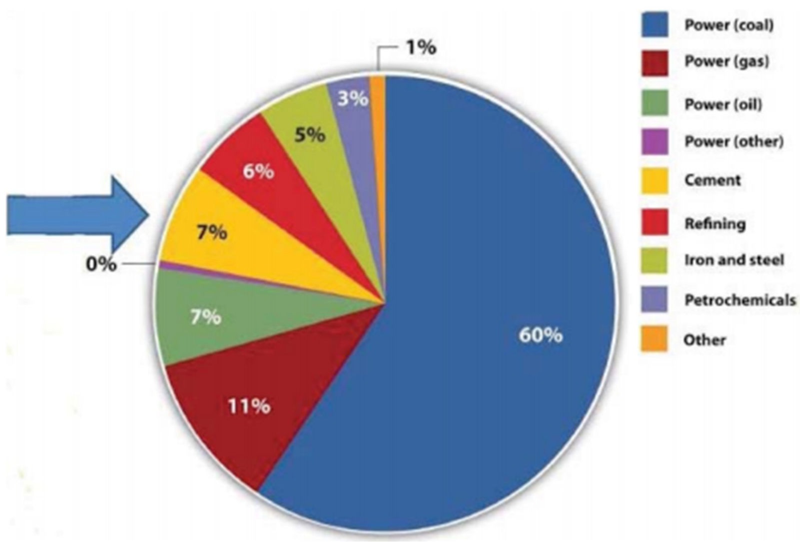

Figure 3.1 CO_2 emission by industries

Geopolymers was at first actualized by Davidovits in 1979. It is an inorganic alumina silicate polymer that is mixed fantastically from silicon and aluminum materials or from materials like fly fiery debris. For instance, fly powder responds with alkali activators to make a cementitious material yet it doesn't transmit carbon dioxide.

Geopolymer not just gives exhibitions basically indistinguishable to OPC in various demands; anyway it has additional focal points, joining unlimited rough material resources, quick progression of mechanical quality, remarkable quality, and its capacity to immobilize contaminants. These characteristics have make geopolymer one of the brilliant researches connects as an ideal material for reasonable advancement. Geopolymer blocks are made with less vitality utilization and simpler contrasted with assembling of earth and blocks. The improvement of geopolymer block is essential advancement towards procedure blocks with better mechanical properties and environmental material.

This paper mainly deals with the manufacturing and mix proportions of fly ash based geopolymer brick and also the experimental work determined on the compressive strength on the day after oven drying, 7^{th}, 14^{th}, and 28^{th} day, water absorption after the 28^{th} day, efflorescence, sound and hardness tests. Finally the comparison of normal clay brick and geopolymer brick are carried out based on their common properties.

II. LITERATURE REVIEW

Bhasker T. et al. [1] did investigations to examine the conduct of geopolymer blocks utilizing fly fiery debris and quarry dust. As the level of fly ash decreases below quarry dust, water absorption and compressive quality increases.

Preetinder Singh et al. [2] carried out trials on geopolymer blocks utilizing fly slag and foundry sand. This investigation depends on the creation of geopolymer blocks utilizing fly fiery remains, mineral material, foundry sand and basic arrangement. The reasonable work done throwing a block of 230×110×75 mm size of geopolymer block with substitution of sand by foundry sand and mineral material. T. Subramani et al. [3] cast bricks using fly ash, eco-sand and alkaline activators and the solid to liquid ratio was 3:1. Then obtained brick specimens with low density (light weight), high compressive strength (6-25 Mpa), poor water absorption (5-12%) and high flexibility and also the bricks were tested for its color, dimension and efflorescence value.

Banupriyal et al. [4] did examinations to think about the conduct of eco-friendly blocks utilizing fly ash and Ground Granulated Blast Furnace Slag (GGBS). The test outcomes affirmed that geopolymer block utilizing 65% fly ash and 35% of above introduced waste material delivered great compressive quality. S. R. Sanjaiyan et al. [5] cast geopolymer blocks utilizing fly fiery debris and dyeing sludge. Dyeing sludge is a waste material acquired as the last buildup in the wake of treating the gushing from the coloring business. Blocks of size 230×115×75 mm were arranged and restored under oven relieving for 24 hours.

The inference from of literature indicates a big importance for geopolymer bricks in the near future, in the construction sector. Compressive strength of conventional clay bricks and concrete blocks are 3.5 N/mm^2. But for geopolymer brick the range increases and it ranges from 6-25% depending on the different types of constituents and curing period. Also the water absorption is comparatively low when comparing to normal bricks, that is it ranges from 6-12% and it is about 20-25% for conventional clay bricks. In this study, it is proposed to study the characteristics of geopolymer bricks using fly ash as basic component and many other components which are different from the components already discussed in many journals. Hence there is a scope for this study.

III. PROBLEM IDENTIFICATION

From the Literature Survey, it is apparent that there is a ton of issues in the presently used normal clay brick. After further examination on different building bricks, the following conclusions were drawn. Clay brick is unable to sustain years of extreme changes in temperature and can start cracking. Snow and water can get into the pores in brick and mortar and then expand when it freezes. This causes a gradual breakdown of the brick that will require replacement over time.

A dirt block house requires a solid fascination between the block and cement to stay stable for a long time. Downpour and cold altogether lessen the adequacy of mortar and make block development unsteady. The untreated block necessitates to be shielded from climate conditions all through the structure procedure to keep a breakdown in the block and a debilitating of the introduced mortar. Frost assault/harm is a typical issue that generally happens in more established blocks, and those that were under burnt amid the terminating procedure. Limit dividers are especially inclined to ice assault

Common blocks can retain a lot of water (up to around 20%) and numerous sorts are powerless to ice harm. In a few occasions the presence of blocks is influenced by the advancement of efflorescence or stains. These may begin from materials in the block or mortar. Lime spillover is the place abundance water moves through cementatious material. Water can break down calcium hydroxide (free lime) which is then saved on the block face. The calcium hydroxide is a solvent type of lime which is made as Portland concrete hydrates.

Vanadium salts produce a yellow or green efflorescence in the core of light-hued block on new brickwork. The salts happen normally in certain dirt (as a rule, however not only those that are utilized to deliver buff/lighter shaded blocks). There is more vitality utilization and ozone harming substance discharge because of the creation of ordinary structure blocks

IV. MATERIALS AND METHODS

Materials used and their properties

Main components used for the preparation of geopolymer bricks are:

- Fly ash
- Foundry sand
- Bentonite
- Alkaline solution

The properties of components used are illustrated below:

Fly ash: Fly ash is a loss from warm influence plant units. It is wealthy in siliceous and aluminous material and a lot of progressively different constituents. Fundamental constituents of fly fiery debris are Silicon dioxide (25-60%) Aluminum oxide (10-30%) Ferric oxide (5-25%) and Calcium oxide. Class F fly fiery debris is kind of fly ash in which the absolute level of these three constituents is 70% or above 70% and responsive calcium oxide is under 10%. Fly ash is finely divided material and hence has more surface area to react with chemicals which thereby improves its pozzolanic activity and thereby increases its cementious properties.

Foundry sand: Foundry sand is high class silica sand and it is a side-effect of ferrous and non-ferrous metal throwing enterprises. This sand has been utilized for trim material as a result of its warm conductivity.

Figure 3.2 Fly ash

Figure 3.3 Foundry sand

Bentonite: It is a kind of dirt framed by the change of glass particles from volcanic cinder. Bentonite blended with foundry sand gives more strength to block and is utilized as a binder. It can be used as a binding material for many casting works and has properties such as viscosity and plasticity.

Alkaline solution: The soluble arrangement is consolidated blend of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and Sodium silicate otherwise called water glass (Na_2SiO_3). The sodium hydroxide arrangement can be set up by dissolving the pellets of NaOH in one liter of water for various molar fixations by various mass. Both the arrangements ought to be premixed of 24 hours before use. They have a soapy or slippery feel to touch and they are also used in products such as soap, medicines, etc

Figure 3.4 Bentonite

Figure 3.5 Sodium hydroxide and sodium silicate

Manufacturing of bricks

Brick mould preparation: 22.5×10.5×7.5 cm size mould is used for the making of geopolymer brick.

Mixing and moulding: In experimental work the material used for casting brick is fly ash, foundry sand, alkaline solution and bentonite. Fly ash (54%), foundry sand (44%), bentonite (4%) and a molarity of 10 M used for final experimental work. The ratio of alkaline solution to fly ash is 0.5 ratio of Na_2SiO_3 to NaOH is 1.5.

Collection of materials by weight: Size of brick is 22.5×10.5×7.5 cm, volume of brick with 20% extra is 2126.244 cm^3, Ratio of fly ash: foundry sand: bentonite is 0.54:0.44:0.04.

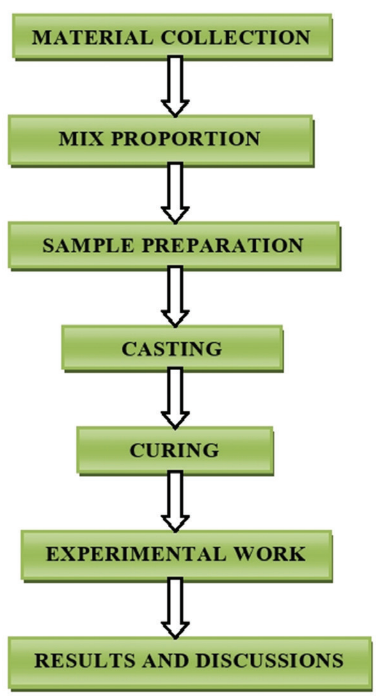

Figure 3.6 Methodology block diagram

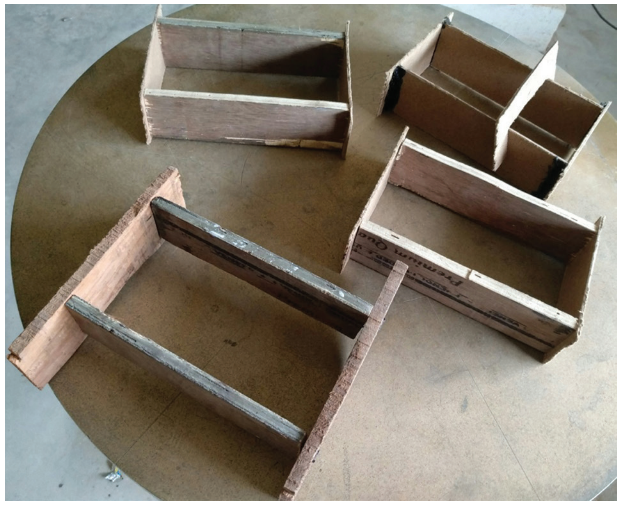

Figure 3.7 Brick mould

Amount of materials to be taken

Fly ash

Density of fly ash is 1.5 g/cm^3

Weight of fly ash = 2126.244×0.53×1.5 = 1690.36 g = 1.6 kg

Foundry sand

Density of foundry sand is 2.2 g/cm^3

Weight of foundry sand = 2126.244×0.43×2.2 = 2011.43 g = 2.01 kg

Bentonite

Density of bentonite is 0.593 g/cm^3

Weight of bentonite = 2126.244×0.04×0.593 = 50.43 g = 0.05 kg

Alkaline solution

Basic equation is EVN/1000

E-Equivalent weight of NaOH

V-Volume of water

N-Normality

10 M Solution

EVN/1000 = 40×1000×10/1000 = 400 g

Figure 3.8 Mixing of materials

Casting

The block shape was made utilizing plywood of internal measurements 225×105×75 mm. The Fly fiery debris, foundry sand and bentonite were blend physically in a holder and then, the alkali arrangement was added to set up the geopolymer block. The blended materials were put in 225×105×75 mm shape in three layers, and each layer was compacted by giving 25 blows with a 16 mm diameter tamping rod.

Figure 3.9 Casting of bricks

Curing

The geopolymer block will solidify at steam relieving or sight-seeing curing and the base restoring period will be 24 hours. Subsequent to casting the examples, they were kept in rest period under room temperature for 3 days. The term rest period is the time taken from the consummation of casting of test example to the beginning of restoring at a raised temperature. The geopolymer block was demoulded and transferred into an oven for high temperature restoring at 110°C for 24 hours. The blocks were then permitted to cool at room temperature for the coming days.

Figure 3.10 Oven drying

V. EXPERIMENTAL WORK

Compressive Strength Test: Compressive quality of a block is dictated by testing the block under standard conditions utilizing a compression testing machine. The technique referenced in IS 3495 (Part-2) will be utilized to decide the compressive quality of block work.

The following apparatus is required for testing the brick:

- Measure scale
- Compression testing machine

Figure 3.11 Demoulded bricks

Figure 3.12 Compressive strength testing machine

The minimum compressive strength required for a burnt clay brick as per IS code is 3.5 N/mm^2. Compressive strength of the brick is calculated in the following way.

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{Maximum load at failure (in N)}}{\text{Average area of bed faces(in mm}^2\text{)}}.$$

Compressive strength on the day after oven drying, 7^{th}, 14^{th}, and 28^{th} day were noted

Water Absorption Test: Water absorption test on blocks are done to decide toughness property of blocks, for example, level of consuming, quality and conduct of blocks in enduring. A block with water ingestion of under 7% gives better protection from harm by solidifying. The level of minimization of blocks can be acquired by water retention test, as pores in blocks consume water.

The water retention by blocks increases with increase in number of pores. In this way, the blocks, which have water retention under 3%, can be called as vitrified. This test gives the level of water assimilation of blocks.

Water absorption,% by mass, after 24 hours immersion in cold water in given by the formula,

$$\text{Water absorption\% by mass, W} = \frac{M_2 - M_1}{M_2} \times 100 \quad \frac{M_1 - M_2}{M_1}$$

Where,

M_1-Dry weight in kg

M_2-Wet weight in kg

Figure 3.13 Water absorption test

Sound Test: The two bricks are struck with each other. For a good brick; they should produce clear ringing sound. The sound should not be dull.

Hardness Test: For this, a simple field test is to scratch the brick with nail. No impression is marked on the surface of a good building brick.

Efflorescence Test: The presence of alkalis in brick is not desirable because they form patches of gray powder by absorbing moisture. Hence to determine the presence of alkalis this test is performed, that is explained below:

Place the brick specimen in a glass dish containing water to a depth of 25 mm in a well-ventilated room. After the water is absorbed completely or evaporated again add water for a depth of 25 mm. After second evaporation observe the bricks for white/grey patches.

VI. RESULT AND DISCUSSION

Compressive Strength Test Results

Table 3.1 Compressive strength for developed bricks

Sl. No	Time (Days)	Load at Failure (N)	Size of Brick (mm^2)	Compressive Strength (Mpa)
1	After oven drying	20000	225×105	0.85
2	7^{th}	40000	225×105	1.69
3	14^{th}	90000	225×105	3.81
4	28^{th}	140000	225×105	5.93

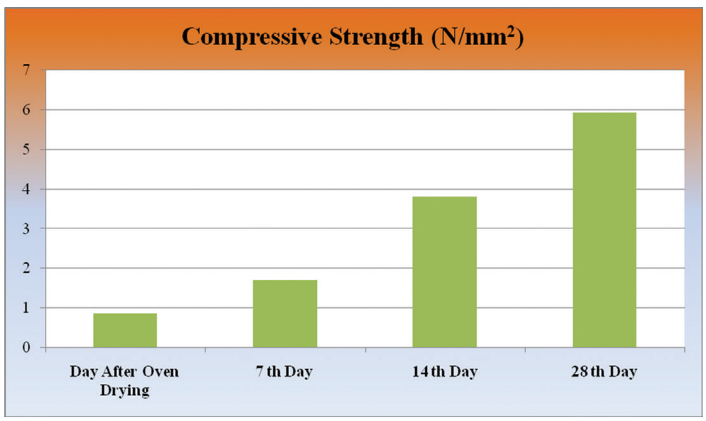

Figure 3.14 Compressive strength graph

From the graph shown and table shown above, it can be seen that the compressive strength increases with an increase in age. It is due to the general fact that the compressive strength increases with increase in curing period (3 days rest period after moulding, 24 hours oven drying and remaining curing at normal room temperature).

Water Absorption Test Results

Dry weight of brick = 2.608 kg
Wet weight of brick = 2.829 kg
Water absorption = ((2.829–2.608)/2.608)×100 = 8.47%

From the above value of water absorption for geopolymer brick, it can be concluded that these types of bricks has less water absorption capacity due to the limited number of pores in these bricks. For normal clay brick, it is in between 20-25%, but for geopolymer brick we get a value of 8.47%, which is less than normal clay brick, which means geopolymer brick has less water absorption and hence it is an advantage of our work.

Sound Test Results: For a good building brick, it produces a clear ringing sound when two bricks strike each other. Here, our brick sample produces a clear ringing sound when they struck each other. If a dull sound is produced when the two bricks strike each other, it is not suitable for building purposes.

Hardness Test Results: When the surface of the brick is scratched using the finger nail, no nail mark is formed on the surface. For a good building brick, there should not be any scratch mark on the brick; hence we can say that it is ideal for construction purposes, because the brick is hard enough.

Efflorescence Test Results: A slight amount of white powder is formed on the brick surface. It is ultimately due to the presence of alkali and lack of burning of bricks.

Density Calculation

The standard value of density for ordinary burned clay brick is 2400 kg/m^3.

Mass of geopolymer brick is 2.608 kg

Volume of geopolymer brick is 2126.244 cm^3

Therefore, from our work we got a density value of 1226.57 kg/m^3. It means that geopolymer bricks are lighter in weight than normally burned clay brick, as due to lower density value.

Figure 3.15 Efflorescence on the surface of brick

VII. CONCLUSIONS

From this study we have epitomized various advantages that geopolymer bricks hold over normal clay bricks. Using this brick in construction field, waste materials such as fly ash, foundry sand and bentonite can be effectively used. Thus, the amount of waste disposing can be reduced which in turn can save the environment. There are chances of emission of carbon dioxide and other greenhouse gases during the production of normal clay brick and it can be avoided by this proposed method of production. The compressive strength of geopolymer brick is normally greater than clay brick and it is in between 6 to 25 MPa. Normally a good building brick should have a compressive strength equal to or greater than 3.5MPa. From our study we got a compressive strength of 5.93MPa. Geopolymer bricks are lighter in weight than normal clay brick and it also has relatively less water absorption property than normal brick due to less number of pores in it that is 8.47%. For a geopolymer brick, the water absorption rate will be in the range of 5-12%, but a normal clay brick has a water absorption rate in between 20-25%.

When two geopolymer bricks strike each other, it produces a clear ringing sound and no scratches are formed when scratched with nail. These are the noteworthy advantages of geopolymer bricks. From an environmental point of view, it has considerably greater advantages. A fly ash brick is known as geopolymer brick because of the usage of alkaline solution. When fly ash comes in contact with alkali solution it shows properties similar to cement. But this gives way to the formation of a white powder on the surface of the brick, which is known as efflorescence. This is because of the presence of alkali on the surface of the brick, which ultimately leads to efflorescence.

Even though the main constituents are cheap waste materials, the alkali activators such as Sodium Hydroxide and Sodium Silicate are costly. Hence, we cannot conclude that geopolymer bricks are cost effective. Also, the use of chemicals during mixing of constituents may lead to health issues such as skin problems; allergy etc. It can be avoided by using gloves and masks.

The prime reason that led us to choose this topic was to find an eco-friendly brick that has more compressive strength and better properties than a normal clay brick. From our studies it can be concluded that the increasing need for cement can be reduced and consequently, the emission of greenhouse gases can be reduced. This is because in geopolymer brick, cement is completely replaced by fly ash and instead of sand, foundry sand is used. Ultimately, the waste materials from many industries can be effectively utilized, instead of dumping or disposing it. Hence, it can be concluded that geopolymer bricks are eco-friendly and eco sustainable bricks.

VIII. SCOPE OF FUTURE WORK

This analysis can be extended to the following areas;

- Studies could be made with some other cheaper chemicals to reduce cost.
- Molarity can be reduced, so as to reduce consumption of chemicals.
- Properties of binders can be varied by using different types of wastes such as paper waste, green leaf etc.
- Temperature effect can be studied by burning the bricks in high temperature as other normal bricks.
- Burning of bricks can be performed to analyze the effect of efflorescence on the surface of brick.
- Test can be conducted by using admixtures other than bentonite to study the variations in strength and other properties of brick.

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4. Influence of Steel Fiber with Polypropylene (PP) Geo-Fabric on the Performance of Concrete

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ABSTRACT: Geotextiles are highly recommended to use as a composite material to enhance the tensile properties of brittle materials in construction. Polypropylene (PP) is a bi-axial type of geo-fabric shows better performance and exhibits good tensile characteristics along both the directions. Recently PP geo-fabrics widely used in weak subgrades as well as in many infrastructural works for strengthening purpose. In other hand concrete is heterogeneous mixture and because of its weak ductile characteristics researchers' insights more on this area. In this present work an attempt is made to study the behavior of concrete using steel fiber with PP geo-grids in concrete. The experimental studies conducted on basic concrete elements like Cubes, Prisms and Cylinders with and without percentage of steel fiber with PP geo-fabrics. The experimental result shows that enhance in strength and ductility of concrete elements compared with normal conventional concrete specimens.

Keywords: Polypropylene, Infrastructure, Performance, Composite material, Ductility.

I. INTRODUCTION

Concrete is a heterogeneous mix its characteristics shows high versatility in presence of other construction materials. In recent wide range of research has been going to replace construction materials. Searching an alternative plays a major role and it needs proper studies and experimental investigation. The behavior of concrete structures under different varieties of combinations of loads are highly unpredictable. Recent advances in the construction field is to invent variety of new concrete to satisfy both strength and durability condition by considering different environmental factors.

The geo-fabrics are extensively used in construction projects and these fabrics are emerged as new constituent materials to enhance the properties. Polypropylene geo-fabrics have been extensively used in the field of Geotechnical engineering to enhance the properties of weak soil sub grade and also used in reinforcing massive earth work [1]. These fabrics further used in concrete pavements particularly in different layers of soil media to enhance the strength as well as to maintain connectivity by better bonding [2]. More recently researchers used PP geo-fabrics in concrete elements and stated the importance of PP fabrics by conducting several experiments [3]. An experimental investigation has been carried out to study the behavior of plain cement concrete beams reinforced with two and three biaxial geo-fabrics and showed the importance of bi-axial geo-fabrics [4]. The objective of the present research paper is to understand the basic structural strength properties of concrete at different ages of curing at 7 and 28 days with different volume of fraction of bi-axial polypropylene (PP) geo-fabrics.

II. LITERATURE SURVEY

S. Sivakamasundari et al. [5] carried out research work on flexural behavior of steel fiber reinforced concrete beams confined with bi-axial geo-grids. Three-point loading flexure tests were done on two types of beam specimens with different configurations of transverse reinforcements with and without geo-grid specimens. The experimental results were found that geo-grid confined specimen shows improvement in strength, stiffness, degradation, Energy dissipation capacity and displacement ductility. El Meski et al. [3] conducted an experimental investigation on conventional and geo-fabric reinforced concrete beam specimens under four-point loading flexure test. Results from test confirm the benefits of geo-fabrics are evident from experimental results in terms of post peak behavior, load capacity and failure mode.

Sreekeshava K S et al. (2018) conducted a series of basic tests on geo-fabrics proportioned concrete elements and reported the advantages of geo-fabrics presence at plastic hinge regions in concrete elements. Saranyadevi et al. (2016) worked on behavior of strengthening techniques using geo-fabrics in concrete beams and reported the importance of bi-axial geo-grids. The experimental results are validated through analytical methods using finite element analysis. The past study showed that geo-fabrics can be beneficial in improving the performance of concrete elements. Hence polypropylene (PP) geo-fabric with steel fibers in concrete has been promoted in this present research paper.

III. EXPERIMENTAL INVESTIGATIONS

I. Materials specifications

The specimens were casted using mix proportions of 1:1:2 in ordinary Portland cement (OPC) with water cement ratio of 0.45. Hooked end steel fibers with a specification of 30mm length, 0.5mm diameter has an aspect ratio 60, has nominal tensile strength of 1000 Nmm^2/ed to prepare steel fiber reinforced concrete having a constant volume fraction of 0.5%, 1% and 1.5%. The polypropylene (PP) geo-fabric used in this study has a tensile strength of 100 kN/m in machine and cross machine direction. Table 4.1 and Table 4.2 represents the properties of aggregates used.

Table 4.1 Properties of coarse aggregates

Property	Coarse Aggregates
Specific Gravity	2.7
Fineness Modulus	6.2
Water Absorption	0.8%

Table 4.2 Properties of fine aggregates

Property	Fine Aggregates
Specific Gravity	2.74
Fineness Modulus	2.2
Water Absorption	1%

II. Polypropylene geo-fabrics

The Polypropylene (PP) bi-axial geo-fabrics are used in this study is stiff geo-grids made up of polymers. Variations exist in the aperture geometry and dimensions and in the physical and mechanical properties.