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Recent Advancements in Civil Engineering
(RACE-23)

Organized by

Department of Civil Engineering

Kongunadu College of Engineering and Technology

(Autonomous)

Tholurpatti (PO), Thottiam (TK), Trichy (Dt), Pin-621215

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About the Institution

Kongunadu College of Engineering and Technology (KNCET) is an Autonomous, self-financing Engineering College established in the year 2007, Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai, Accredited by NBA (CSE, ECE, EEE & Mech), NAAC, Recognized by UGC with 2(f) & 12(B) and Certified by ISO 9001:2015. The College has 9 UG courses (AD, AE, BME, Civil, CSE, ECE, EEE, IT, and Mechanical Engineering) and 2 PG courses such as Applied Electronics and CSE. ECE and Mechanical departments have been recognized as approved research centers by Anna University. A Separate department Campus to Corporate is to train the students in the area of communication, soft skills and aptitude etc., through which obtaining top notch placements with the facilitation of diverse options in IT industries, core industries, ITES and startup firms respectively. The Kongunadu International Cell assists students explore opportunities to work and study in foreign countries. The college has obtained many awards & recognition from various government/private authorities and received research grants from funding agencies for doing projects, establishing MODROBS labs, organizing FDPs, STTPs, National and International Conferences, Seminars and Workshops. MSME Incubation center and Unnat Bharat Abhiyan (UBA) schemes are approved by the Government of India. The College has signed MOUs with Industries, academics, hospitals and R&D Institutions. Various Professional societies, clubs and cells are supporting students to become industry ready graduates, to do higher studies and to become successful entrepreneurs. The sports teams have won many prizes in various events at National level including Zonal, Inter Zonal and University level Sports Championship. The College attracts outstanding students by virtue of its discipline, modern infrastructure, library and faculty members.

About the Department

The Department of Civil Engineering offers an excellent ambience for students to learn and obtain the essential skills that are much sought after by the industry. The department has experienced faculty members who are fully dedicated to teaching and research and ensure high quality education to the students. More than 200 students have enrolled in the Civil Engineering branch. An extensive range of research activities are carried out in the department, to make the students to gain modern knowledge about the real-life problems in the industry. The industry visits are regularly arranged for students to enhance their core curriculum.

Department Vision

To strive to graduate, quality civil engineers with ethical values, contributing to society and community.

Department Mission

- Providing quality Civil Engineering education through best teaching-learning process with modern laboratory, equipment and tools.
- Endeavour the students to become an entrepreneur and employable through industrial interaction.
- Inculcating moral and ethical values to serve the society and focus on student's overall development.

About The Conference

The vision of the National Conference on Recent Advancements in Civil Engineers (RACE-23) is to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research outcomes in the stream of alternative construction materials, green building materials, geo-environmental engineering, geopolymer technology, smart structures, disaster management etc, on all aspects of Civil Engineering. It also provides the interdisciplinary forum for researchers, practitioners and academicians to present and discuss the most recent innovations, trends, and practical challenges encountered and the solutions adopted in the field of Civil Engineering. The conference aims to provide a platform to learn new cutting-edge technologies in area of civil engineering field.

Call For Papers

Authors are invited to contribute to the conference by submitting a novel unpublished article in the following areas not restricted to the mentioned themes.

Conference Themes

- Structural Health Monitoring and IoT in Civil Engineering applications
- Steel and Composite Structures
- Innovations in Construction materials and Sustainable Management
- Sustainable developments in Concrete Technology
- Environmental Engineering and its Sustainability
- Sustainable Concepts in Geotechnical Engineering

- Applications of Remote Sensing and GIS
- Advances in Highway and Transportation Engineering
- Disaster Management and Mitigation Techniques
- Solid Waste Management
- Computational methods in Civil Engineering
- Earthquake Resistant Design Practices
- Irrigation and Water Resource Management
- Urban Planning and Design

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Chief Patron Message

Kongunadu College of Engineering and Technology (KNCET) was established in the year of 2007. KNCET is providing an excellent quality of education and mentoring for the students aspiring to be competent professionals in Engineering and Technology.

I am immensely happy that the Department of Civil Engineering of our college is organizing the 4th One Day National Conference on "RECENT ADVANCEMENTS IN CIVIL ENGINEERING (RACE'23)" on 15th April 2023.

On this occasion, I would like to congratulate the organizing team of RACE'23 and the participants in this conference. I hope that this conference will certainly induce innovative ideas among the participants, paving the way for new inventions and new technologies in the field of Structural, Geotechnical, Environmental, Water Resource, Remote Sensing & GIS, and Highway Engineering.

I am sure that Civil Engineering will continue to contribute more effectively in order to achieve the ultimate goal for which the conference was established. I am confident that this conference will be a milestone in ensuring the highest standards in this profession.

I look forward to an exciting week of insightful presentations, discussions, and sharing of technical ideas with colleagues from colleges around the country.

Dr. PSK. R. Periaswamy

Chief Patron,

Chairman, Kongunadu Institutions

General Chair Message

It is my great pleasure to welcome all of you to the 4th One Day National Conference on "RECENT ADVANCEMENTS IN CIVIL ENGINEERING (RACE'23)," which will take place at Kongunadu College of Engineering and Technology in Trichy on April 15, 2023. It has been an honour and privilege to serve as the General Chair of this conference. RACE'23 provides a cross-disciplinary platform for researchers and practitioners to address advancements in Structural, Geotechnical, Environmental, Water Resource, Remote Sensing & GIS, and Highway Engineering. The program spans one day for conference paper presentations, featuring a keynote presentation and separate panels for presentations, offering ample opportunities for discussions, debates, and the exchange of ideas and information among conference participants.

The conference would not have been possible without the enthusiasm and hard work of numerous colleagues. I express our appreciation to the Conference Chair, Co-Chair, and Secretaries for their valuable contributions in organizing a high-quality conference program. A conference of this magnitude relies on the contributions of many volunteers, and I would like to acknowledge the efforts of our technical review committee members and referees for their valuable help in the review process.

I am also grateful to all the authors who entrusted the conference with their work. Special thanks to the Keynote speaker for sharing their views on current research topics.

I eagerly anticipate an exciting week filled with insightful presentations, discussions, and the sharing of technical ideas with colleagues from both national and international levels.

Dr. R. Asokan
General Chair,
Principal, KNCET

Conference Chair Messages

The RACE'23 conference has established itself as a nationwide reference for the dissemination of high-quality research in all aspects of Structural, Geotechnical, Environmental, Water Resource, Remote Sensing & GIS, and Highway Engineering, fostering interaction and the exchange of ideas.

RACE'23 was fortunate to attract high interest within the community, resulting in 35 submissions from various streams of Concrete, Geopolymer concrete, Materials Science, Soil Stabilization, Solid Waste Management and Water Resource Engineering. The significant number of submissions provided an excellent opportunity for a high-quality program but also required a demanding and laborious paper evaluation process. The members of the Technical Program Committee worked efficiently and responsibly under tight time constraints to produce quality reviews for each paper, forming the basis for the final paper selection. To provide conference participants with additional valuable and stimulating research outcomes, 21 papers were accepted for presentation alongside the main conference.

The program is further enriched by a keynote presentation from Dr. C. Rajasekaran, Assistant Professor, Department of Civil Engineering, National Institute of Technology Karnataka, Surathkal, Karnataka, India – 575025. I extend my thanks to our Keynote speaker for addressing recent technologies and providing guidance in organizing this conference. We are grateful to all the authors who entrusted us with their work; without them, there would be no conference. The final result would not have been possible without the dedication and hard work of many colleagues.

I express my gratitude to our beloved Chairman, Dr. PSK. R. Periaswamy, Chief Patron of RACE'23, who consistently motivates us to undertake innovative activities for the benefit of students. I also thank our dynamic Principal, Dr. R. Asokan, General Chair of RACE'23, for his vision and leadership. I would like to sincerely thank all session chairs for providing valuable comments to participants.

Special thanks go to the track chairs, members of the Technical Program Committees, and all external referees for the quality and depth of their reviews, as well as their sense of responsibility under various circumstances.

Dr. J. Yogapriya

Conference Chair,

Dean (R&D), KNCET

Convener Message

It is my immense pleasure to announce that our Civil Engineering Department is organizing the 4th One Day National Conference on "RECENT ADVANCEMENTS IN CIVIL ENGINEERING (RACE'23)" on 15/04/2023. RACE'23 aims to focus on emerging trends in Structural, Geotechnical, Environmental, Water Resource, Remote Sensing & GIS, and Highway Engineering.

The conference will feature selected papers from researchers, academicians, and students on various topics, with separate divisions based on Structural, Geotechnical, Environmental, Water Resource, Remote Sensing & GIS, and Highway Engineering.

We are honoured to have Dr. C. Rajasekaran, Assistant Professor, Department of Civil Engineering, National Institute of Technology Karnataka, Surathkal, Karnataka, India – 575025, as our keynote speaker. I express my gratitude to the keynote speaker for accepting our invitation.

I would like to extend my thanks to our esteemed Chairman, Dr. PSK. R. Periaswamy, the Chief Patron of RACE'23, for his unwavering support in all our activities. I also express my gratitude to our Principal, Dr. R. Asokan, for his valuable guidance in ensuring the successful completion of this conference. Additionally, I thank our Dean of Research and Development, Dr. J. Yogapriya, for her continuous motivation in organizing this National conference.

I would like to express my appreciation to all session chairs and review committee members for providing valuable comments to the participants. Finally, I extend my thanks to all the faculty members and students for their efforts in organizing this conference and making it a resounding success.

Dr. S. Kavipriya

Conference Co-Chair,

HoD (Civil), KNCET

Editorial Members

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A Critical Review on Water Pollution in India

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Abstract

Water is one of the most vital components for the origin of life. Humans utilize water to satisfy their domestic and industrial needs. Water pollution occurs when unwanted materials that harm the environment and human health enter the water source. Toxic heavy metals that get disposed of from industries get accumulated in lakes and rivers causing several deteriorating effects on humans and animals. These toxic pollutants cause diseases such as immune suppression, reproductive failure, and acute poisoning. According to the world health organization (WHO), 80% of the diseases that occur in human beings are caused due to water pollution. In India, more than 70% of the freshwater is unconsumable due to pollution and the problem is common in other countries too. These problems related to water pollution have been clearly explained with the help of references and the sources of contamination caused due to sewage discharge and their potential in deteriorating the water resources have also been discussed in this study. The physical and chemical standards of the current inland water bodies such as rivers, canals, reservoirs, tanks, and ponds have also been explained in this paper.

Keywords: Sewage; Heavy metals; Pesticides; Toxicity; Pollution; Turbidity

Introduction

Water pollution can cause water to become toxic to humans. If a water source becomes contaminated due to pollution, it can lead to health issues in humans. Contaminated water causes many diseases such as diarrhea, dysentery, cholera, hepatitis A, and typhoid. More than fifty kinds of diseases are caused by poor drinking water quality, and fifty percent of baby deaths are related to poor drinking water in the world. More than 2 million people worldwide die each year. polluted water affects the present and upcoming generations. The Bhopal gas tragedy case can be named as an example of groundwater contamination. In Bhopal (December 3 1984) over forty tons of gas (methyl isocyanate) leaked from the pesticide plant which is

located in India, killing thousands of people immediately and creating panic among others. The final death rate was estimated to be between 15,000 and 20,000. Bhopal gas tragedy which is considered as World's worst industrial disaster. Official scientific agencies show that water found two miles from the factory contained pesticides at levels 40 times higher and UK-based Bhopal Medical Appeal (BMA) found a chemical cocktail in the local drinking water such as carcinogen, carbon tetra fluoride. It has spread 40 meters deep and up to 3.5km from the abandoned factory. Almost thousands of people consumed this polluted water for past 20 years and it leads to many diseases like lungs, kidney and liver. The use of water is multiple. Water is essential for human life. Some people can survive for weeks without food, while others can survive only a few days without water Drinking water may help prevent dehydration. Without water, dehydration can quickly affect the body. Pure and pollution free water is needful for a healthy life. If water is polluted in any area, creatures are forced to drink the contaminated water because they have no other choices. In upcoming years, water pollution has become a serious problem, mostly due to the presence of untreated effluents. This untreated effluent directly contributes to increased diarrhoeal diseases, such as typhoid fever, cholera. There are many causes of water pollution. These causes can be eliminated or at least controlled through awareness among people and strong implementation of legal measures.

Status of Groundwater

India is the largest user of groundwater which stand in the fourth position. From the assessment of 2022, groundwater extraction is the lowest. The total extraction of the groundwater is about 13% which is 30.69 BCM for Domestic & Industrial use. The total annual groundwater recharge in India is 437.60 Billion Cubic Meters (BCM) and the annual groundwater extraction in India is 239.16 BCM. In India, the data from 2021 shows that 90 percent of groundwater is used for irrigation purposes. About 48% of the groundwater is used by Indian cities. The distribution of water through time and space is impacted by climate change. Variable rainfall, urban flooding, and rising temperatures that cause drought could make it more difficult to meet Sustainable Development Goals. As per the Central government of India, the groundwater is highly polluted by means of fluoride, arsenic, etc., Even though there has been good infrastructural development, there will still be problems with water and food security, which will increase poverty in the cities.

River Pollution in India

Water pollution is the big environmental, social issue all across the world and it has reached to the critical point. In India, Almost, every river system is polluted. According to National Environmental Engineering Research Institute (NEERI), In Nagpur, it has been acknowledged that around 70% of river water is polluted. River Ganga pollution has been studied by Mirzapur (1989) and in Varanasi (1989), chemical characterization of the river was investigated by Shukla (1989). The bacterial pollution of river Ganga (1992) and the river Varuna (1998), was studied by Shukla *et al*. In 1964, The Bacterial study of the river was conducted in Yamuna, Delhi by Kaushik and smith D.G. Similar studies in river Gomathi was conducted by Prasath and Saxena (1980) with respect to blue-green algae. Study of river Mahanadi in Orissa was studied by Patra *et al* in 1984. Development of river water quality indices by Arief dhany sutadian and Nithin muttil (2016). Evaluation of water quality for drinking water was studied by De Rosemond and Duro (2009). Study of water quality index for river was conducted by Deininger (2002) in Malaysia. An objective water quality index was studied by Hebert (2005). Water research for a better water quality indexing system for rivers and streams was studied by smith D.G (1990).

International Studies in River Pollution

At international level, social impact assessment of water pollution, a case study on Banshi was done by Muhammed Rezaul Kabir (2014). Matthew S. Landis, Eric S. Edgerton and Emily M. White (2018) studied the impact of the 2016 Fort McMurray Horse River Wildfire pollution levels in the Canada. Ellis (1937). Microplastic pollution in St. Lawrence River sediments. Canadian Journal of Fisheries and Aquatic Sciences was done by Castaneda RA, Avlijas S, Simard MA, and Ricciardi A. (2014). Plastics and other anthropogenic debris in freshwater birds from Canada was published by Holland ER, Mallory ML, and Shutler D (2016).

A potpourri of plastic litter outnumbers fish larvae in Europe's second largest river was studied by Lechner A, Keckeis H, Lumesberger-Loisl F, Zens B, Krusch R, Tritthart M, *et al*., (2014). Screening of microplastic particles in and down-stream a wastewater treatment plant was conducted by Magnusson K, and Noren F (2014). Marshall and Falconer (1973) studied the lake Mellwaine in Rhodesia. Jannalagadda and Mhere (2001) studied the Chemistry of river Odzi in Zimbabwe. Lazaridou *et al*., (1999) studied the Multidisciplinary study of river Aliakman in Greece. Jannalagadda and Mhere (2001) studied the Chemistry of river Odzi in

Zimbabwe. The whole research shows about the water pollution problem is not confined to India, but the entire world is suffering.

Sources of Pollution

Normally, Pollutants occur from these three major sources-

1) Untreated drain is released into rivers
2) Industrial effluents are released into ponds and rivers without any preprocessing
3) Agricultural processes can cause water pollution where manure, fertilizers, pesticides are used.

This makes river water unfit for daily purpose. Our waterways are polluted by nutrients, sediment, heavy metals. when sediment enters fresh water, it can degrade the water quality. It enters when soil is compacted and soil is eroded by heavy rain. When nutrients enter freshwater, it can cause algal blooms. Too much of fertilizer is applied to the land can cause algal blooms. Algal blooms degrade the water qualities. When heavy metals enter freshwater, it can contaminate the water through surface water seepage and run-off. When people consume high levels of heavy metals it leads to diseases like anemia, cancer, and intestinal damage (Tripathi *et al*., 1990). Change of polluted water was studied by Roberto Revelli and Luca Ridolfi (2005). Michele Munafo and Giuliano Cecchi explained the Silicon and nitrate present in the fresh water (2005). The biological characters of physic-chemical properties were studied by Niti B. and Rakesh Kumar (2022). In Kanpur, river Ganga quality was studied by Elsevier (1999). Ramachandra, S Suresha (2014) repeated the same study in Patna (2014). Oake studied the heavy metals in sewage (1985). Runoff water effects was studied by AP Bariweni (2001). The activated sludge process of sewage disposal of water bodies had been studied by TG Tomlinson, AG Boon (1966). Biology of sewage treatment and water pollution was studied by K Mudrack, S Kunst (1986). DJ Balmforth studied the Overflow of storm-sewage in 1990. F Worrall, T Burt (2003) studied the Controls of birds' waste and animals' waste.

P Paiga, S Sousa, J Vera detected the pesticides in river waters and in wastewaters (2021). Herbicides used in agriculture was also found in river waters. As shown above, A positive test contains pesticides and heavy metals in fruits and vegetables. These elements may directly or indirectly reach such a target and accumulate due to biomagnification. The cremated remains increase the organic matter in the river (MP Pearson,1999). Aquatic systems are affected by industrial discharges which leads to acute pollution. Main reason for the growth of

the industry is resultant of chemicals results in the formation of dangerous substances have been steadily increasing over past few decades.

Table 1 State-wise consumption of pesticides

States of India	Total consumption in Tonnes		
	2008-09	2015-16	2016-17
Bihar	915	831	0.11
Tamilnadu	2317	2096	0.33
Kerala	273	1123	0.41
Mahatastra	2400	11665	0.57
Uttar Pradesh	8968	10457	0.39
Rajasthan	3333	2475	0.05
Karnataka	1675	1434	0.10
Gujarat	2650	19980	0.13

A large number of effluents are produced by mushrooming industries. Industrial effluents pose a serious threat to aquatic ecosystems. Wetland wastewater effluent was studied by C Tocchi, E Federici (2012). Paper mill effluents affects the plant distributions was studied by B Karrasch (2006). Kudesia and Verma conducted the river kali chemistry (1986). Water pollution in river was conducted by Ganapati and Alikunhi (1950). Gajghate and Reddy observed that the industrial effluents are affected by BOD and COD. Impact of sugar mill effluent to environment was studied by P Saranraj (2014). Pharmaceutical industrial waste affects the natural microbial was studied by P Grenni (2015).

The above studies show a wide range of sources of water pollution. All efforts in water pollution studies are no use If the recommended cure measures are not followed, it's our conclusion. In fact, a lot of amounts spent on projects to solve a specific problem. Solving the problem needs immense manpower, time and money but in most cases, innovations suggested by great minds are ignored by the force.

Water Quality Standards

Conventional water quality standards have been successful in reducing the concentration of toxic substances in US waters. Different health agencies have been prescribed different categories of standards of water. The Case for Regime-based Water Quality Standards published by Geoffrey C. Poole, Jason B. Dunham about conventional water quality standards has been successful in reducing the concentration of toxic substances in US waters (2004). Related to this there are many types of agencies are there U.S. Public Health Service Drinking Water Standards (201Y2) and water quality standards (Natural factors that fundamentally

influence aquatic ecosystems) published by Birkeland S (2001). In (2023) water quality assessment based on index values incorporating WHO guidelines and Bangladesh standards published by Ahmed *et al*. in rural Bangladesh the water quality measures: a cross-sectional study published by Akter, F.T. Jhohura, F. Akter in the year (2016). E. Asadi, M. Isazadeh, S. Samadianfard, M.F. Ramli, A. Mosavi, N studies the Groundwater quality assessment for sustainable drinking and irrigation in (2020).

Table 2 Sample location with depth

Sample ID	Depth (ft)	Lat.	Long.	Sample ID	Depth (ft)	Lat.	Long.
PE 1	500	23.21	89.17	PE 5	95	23.25	89.78
PE 2	320	23.12	89.12	PE 6	150	23.22	89.36
PE 3	120	23.14	89.12	PE 7	320	23.78	89.78
PE 4	80	23.88	89.15	PE 8	520	23.10	89.02

Table 3 Water Quality Standards

Chemical Parameter	Assigned weight	WHO Standards	Relative weight
pH	4	8.0	0.091
TDS (mg/l)	5	510	0.015
Total hardness(mg/l)	5	300	0.014
Calcium (Ca) (mg/l)	3	70	0.063
Sodium (Na) (mg/l)	4	220	0.085
Chloride (Cl−) (mg/l)	3	270	0.052
Sulphate (SO42−) (mg/l)	3	250	0.047

Components of Polluted Water

- pH

Measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values smaller than 7.0 indicate acidity, pH values larger than 7.0 indicate alkalinity is known as pH. Basically, Water becomes more corrosive with decreasing pH and alkaline water also corrosive. The pH of natural water depends on many factors such as CO2 concentration, carbonate system; pH of clean water depends mostly on the concentration of carbonates and carbon dioxide; carbonate waters are usually acidic. It also depends on rock, from which acidic compound can be weathered, types of soil and nature of discharged pollutants was studied by Saleh *et al*., (2009).

- **Turbidity**

The quality of the water is cloudy, opaque, thick with suspended matter, and not in clear condition this is known as turbidity. The significance of a river logger and a device to track the aquatic SPM have been developed by Mitchell and Furnas in 2001. Sinclair studied Numerous rivers, notably the Australian Yarra River, which have trace elements recorded in their SPMs. (1989). The biotic community was affected by SPM as studied by Cairns in 1968. Leonard et al investigated how the chemistry of water affects the chemistry of sediments and SPM (2001). In addition to having a chemical impact on the water, turbidity also lowers the water body's capacity for photosynthetic activity.

- **Heavy Metals**

Various industrial effluents contain heavy metals. Removal of heavy metals with low-cost adsorbents in the developing world as studied by Lesley joseph, Byung-Moon jun and Joseph (2019). In 2009 Heavy metals are removal from water or waste water was studied by SO lesmana and N febriana. Heavy metals are removal by using banana and orange peels waste was publiched by G.Annadurai and D.J Lee (2003). Process of chemical coagulation for removal of heavy metals from water bodies was studied by Xiaomin Tang and Huaili Zheng (2014). Recent studies have reported many types of cancer, the most prominent being gallbladder cancer due to the accumulation of heavy metals such as cadmium, copper and nickel. These ranges are food chain destination.

- **Microbial pollution**

Microorganisms in marine sediments have been reported by Volterra *et al*. (1985). In 1989, Tam Wang studied how the microorganisms helps to remove minerals from water (Tam and Wang, 1989). Bacteria have also described in groundwater by Anderson (1987). Hiraishi *et al*., studied the Relationship between coliform bacteria and organic pollution levels (1987). Hades *et al* studied the coliform number in the Jordan River (2000). Microbial pollution effects in the river water were studied by A Tornevi (2014).

- **Water Pollution and its Effects**

Water pollution is defined as the introduction of other pollutants into water bodies, which causes major health issues, and illness in humans and other living organisms, even if it can cause death in the organisms.

- Water pollution affects human health drastically.
- Toxicity of the polluted river can cause major defects in aquatic life.

- Water pollution also affects the ecosystem.
- Chemicals from the polluted water may impact the growth of the plants and other organisms in the river.

The study of Pollution and Water Quality, Neighbourhood water quality assessment was conducted by Letchinger M (2000), M. Ahmed and M. Rahman studied the Water Supply and Sanitation (2000), and Smith has drawn attention to the concentration of pollutants in the sediment (2001), Impact of informal regulation of pollution on water quality in rivers in India by Bishwanath and Nandini Banerjee (2004), the study Water pollution by agriculture was conducted Brian Moss (2007), Water pollution by agriculture was studied by Brian (2008), The study of Human health risk through fish intake was conducted by Amirah, M. N., *et al*., (2013), Nitrate exposure in the good water and it's impact in the intensive agriculture area was conducted by Jamaludin, N., *et al*., (2013), Heavy metal water pollution is a case study of Rashmi Verma and Pratima Dwivedi (2013), The Effects of Water Pollution on Human Health carried out by Joshua Nizel, *et al.,* (2015), the study of microbes and watersheds was conducted by Chris Swann (2016), Health Impact of River Water Pollution was studied by Rafia Afroz and Ataur Rahman (2017).

Conclusions

In the above study, we conclude that water pollution level has reached a dangerous situation. While India's situation is dire, water quality has declined in most parts of the world. Indian philosophers say, A persons with rely on the kind of food and water he is fed. Above discussion is well scientific in view of the fact that our consumption of polluted water and food affects the standard physiology. Our body contains over thousands of enzymes and hormones which are very particular in their needs and dynamics. When any undesirable substance enters into our body, the functions of hormone or enzyme is affected. In addition to various heavy metals, we are unaware of the fact that we ingest significant amount of many pesticides in our food. Entry of these substances must be excluded. Pre-season fruits and vegetables require large amounts of substances such as chemical fertilizers, pesticides and manure to grow in bad situations, so we may not use it. We are beating the nature to pollute it, but still fail to understand less than 10% of nature's principles. Large number of deaths are reported daily which are imputed to heart attacks. The big query before medics is heart which is the most sensible body part in our body? That's why the concentration of xenobiotic substances has been

reported in different particular body parts due to a lot of deaths now a days but its factual pattern has not been investigated. Not at all compounds in nature is a drug or a poison but a substance that manifests itself. Therefore, it is our credibility to check out the high concentration of some composite at the environment. The need of the hour is to pass towards economic growth. We must conceive about the generations still to arise on this globe. We should note about the last generation to blossom on this globe is not ours, keep in mind, they may even be our blood.

References

[1] Abaychi, J. K. (1987), "Concentrations of trace elements in aquatic vascular plants from Arab river", Iraq. J. of Biological Sciences Res. 18(2):123-129.

[2] Agami, M., Litav, M. and Waisel, Y. (1976), "The effects of various components of water pollution on the behavior of some aquatic macrophytes of the coastal rivers of Israel", Aquat. Bot. (2) 203-213.

[3] Agrawal, I.C., and Srivastava, H.C. (1984), "Pollution Survey of major drains discharged into river Ganga and Yamuna at Allahabad", Instn. Pub. Lic. Hlth. Engrs. TS III –39. TS III – 48.

[4] Agrawal, S.K. (1983), "Water quality of sewage drains entering in to Chambal River at kota", Acta. Ecol. 5:2.

[5] Ajmal, M. (1980), "Detrimental effects of pharmaceutical Industrial waste on microorganisms", J. Water, Air and Soil Pollution. 13 (4): 447-452.

[6] Anderson, Y., and Stentrom, T.A. (1987), "Waterborne outbreak in Sweden – causes and etiology", Wat. Sci. Tech.19: 375-380.

[7] Azad, A.S., Arora, B.R. and Sekhar, G.S. (1982), "Nature and extent of heavy metal pollution from industrial units in Ludhiana", Indian J. of Ecology. 11(1): 1-5.

[8] Badola, S.P. and Singh, H.R. (1981), "Hydrobiology of the river Alaknnanda at the Garhwal", Himalaya. Ind. J. Ecol. 8(2):269-276.

[9] Balchand, A. N., and Nambisan, P. N. K. (1986), "Effect of pulp paper effluent on the water quality of Muvattupuzha river emptying into cochin backwaters", Indian J. Marine Sciences. 15: 253-259.

[10] Balmforth, D.J. (1990), "The pollution aspects of storm sewage overflows", Water and Environmental management. 4 (3): 219-226.

[11] Bandy, J.T. (1984), "Water characteristics", J. Wat. Poll. Cont. Fed. 56(6):544-548.

[12] Bansho, K. and Miyazaki, A. (1983), "Analysis of waste water and effluents", Bunsek. 11: 862-868.

[13] Basu A.K. (1966), "Studies in effluents from pulp paper mill and its role in bringing the physico-chemical changes around several discharge point in the Hooghly Estuary". Indian J. Int. Eng. 46:108-116.

[14] Beckett, R.P. and Brown, D.H. (1984), "The control of cadmium uptake in the lichen genus Peltigera". J. Exp. Bot. (35) 1071-1082.

[15] Berner, L.M. (1951), Limnology of the lower Missouri river. Ecol. 3(1):1.

[16] Bhuyan B.R. (1970), "Physico-chemical qualities of the water of some ancient tanks in Sibsapur", Environ. Hlth., 12:129-134.

[17] Blanchard, P.E. and Lerch, R.N. (2000), "Watershed vulnerability to losses of agricultural chemicals: Interactions of chemistry, hydrology, and land-use", Environmental Sci. and Technology. 34(16):3315.

[18] Bollinger, J.E., Steinberge, L.J., Harrison, M.J., Crews, J.P., Englande, A.J., VelascoGonzales, C., White, L.E., and George, W.J. (1999), "Comparative analysis of nutrient data in the lower Mississippi River", Water Res. 33 (11): 2627-2632.

[19] Boyd, C.E. (1976), "Accumulation of dry matter, nitrogen and phosphorus by cultivated water hyacinths", Econ. Botany (30) 51-56.

[20] Brooker, M.P. (1984), "The behaviour of phosphate, nitrate, chloride and hardness in 12 Welsh rivers (UK)". J. Water Res. 18(9):1152-1164.

[21] Brown, R.D. (1971), "The use of biological analysis as indicators of water quality". J. Environ. Hlth. 34: 62-66.

[22] Cairns, J. Jr. (1968), "Suspended solids standards for the protection of aquatic organisms". Purde Univ. Engineer Bull. 129:16-27.

[23] Ellis, M.M. (1937), "Detection and measurement of stream pollution". Bull. Bur. Fish. Washington, 48(2):365-437.

[24] Falkenmark, M. (1993), "Water Scarcity: Time for realism". Populi. 20(6):11-12

[25] Fauvet, G., Claret, C. and Marmonier, P. (2001), "Influence of benthic and interstitial processes on nutrient changes along regulated reach of a large river (Rhone River, France)". Hydrobiol. 445(1-3):121-132.

[26] Findlay, D.L. (1984), "Effects on phytoplankton Biomass, succession and composition in Lake 223 as a result of lowering pH levels from 5.6 to 5.2. Data from 1980-1982, Can. M/s Report of Fish", Aquat. Sci. No. 1761. p.10.

[27] Gajghate, D.G. and Reddy P.J. (1989), "COD-BOD relationships for Industrial Wastes", Indian J. Env. Prot. 9(11):805-807.

[28] Galiulin, R.V., Bashkin, V.N., and Galiulina, R.R. (2001), "Behaviour of 2,4-D herbicide in coastal area of Oka River, Russia". Wat. Air, and Soil Poll. 129 (1-4): 1-12.

[29] Galtsoff, P.S. (1981), "Limnological observations in the upper Mississippi", U.S. Dep. Commerce, Bull. Bur. Fish. 39:347-438.

[30] Ganpati, S.N. and Chacko, P.I. (1951), "An investigation of the river Godavari and the effects of the paper mill pollution at Rajahmundry". Proc. Indo-Pac. Fish Counc.

Performance Study on Calotropis Fibre on Shear Reinforcement by Partial Replacement in Concrete Beams

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Abstract

This research evaluates the performance study on topic Calotropis gigantea fibre as a shear reinforcement in concrete beams. The aim of our project to investigate the effects of adding of Calotropis fibre with varying lengths and diameters to determine their mechanical properties and performance. Experimental tests were conducted on casting and testing fibre stirrups coating with epoxy resin aspect ratio. Reinforced concrete beams containing of Calotropis gigantea fibre (12×10-3g) partial replacements for traditional steel shear reinforcement have been casted and tested by Ansys software. The results shows that the use of Calotropis fibre as a partial replacement for shear reinforcement improved the load- carrying capacity, crack resistance, and ductility of the reinforced concrete beams. The study concludes that Calotropis gigantea fibre can be considered a viable alternative to traditional steel shear reinforcement in concrete beams. However, further studies are required to determine the optimal length, and diameter of Calotropis gigantea fibre to achieve maximum performance benefits.

Keywords: Calotropis gigantea fibre; Epoxy resin; Natural fibre stirrups; Ansys software; Partial replacement.

Introduction

Steel used in construction has significant drawbacks, including the release of greenhouse gases such as CO2, N2O, and methane. Due to the increased emissions caused by utilising this steel in the field, it is not recommended going forward because this would contribute to global warming. As opposed to this steel to address these environmental problems while maintaining strength, several fibre reinforcements have been introduced. A composite

material made using a polymer matrix and fibre reinforcement is known as a Fibre Reinforced Polymer (FRP). A variety of natural cellulose fibre materials have recently been discovered to be appropriate for a variety of uses and its alternative for man-made synthetic fibres such as carbon, glass, and aramid, in polymer matrix composites because the synthetic fibres are causing environmental pollution duet to the non-degradability and absorbing more energy for their preparation. Due to their light weight, high specific properties, renewability, biodegradability, and non-toxicity, natural cellulose fibres are therefore attracting the attention of material engineers, scientists, and researchers. Using natural fibre instead of synthetic fibre is a cost-effective method of building.

One of the natural fibres Calotropis Gigantea, a family of Asclepiadaceae, is a traditional medicinal plant with special mechanical properties and qualities that produces a high tensile strong fibre (Bowstring of India), excellent for ropes, carpets, fishing nets, and sewing thread. These plants are incredibly effective in keeping track of the pollutants in the area. The various fibre materials, that are utilised to make major reinforcements and stirrup bars. This study shows that Calotropis gigantea fibre reinforced polymer (CGFRP) was casted as stirrups bar might be suggested for shear reinforcement by partial replacement in concrete beams to enhancing the reduction in shear failure and durability of corroded and damaged beams. These CGFRP stirrups bars are added to the beams for comparison with the conventional steel shear reinforcements' stiffness, ductility, and crack pattern. Some of the test carried out for making the replacement of longitudinal steel bars with fibre reinforced bars. But here the replacement is made in stirrups with CGFRP materials. By using ANSYS software to analysis the deflection of the beams in shear failure location by partial replacement of CGFRP Bar.

Materials and Methods

- **Cement**

OPC 53 Grade delivers exceptional strength and durability to structures. Because of its optimal particle size distribution and outstanding crystallised structure. Being high strength cement, it offers several advantages whenever special high strength concrete is required, such as in the construction of skyscrapers, bridges, flyovers, chimneys, runways, concrete roadways, and other large load bearing structures. For checking workability of concrete Some of the tests for cement should be done. Table 1 shows the tests for cement.

Table 1 Tests for cement

S. No	Test	Results values
1	Fineness Test	9.8%
2	Initial and final setting time Test	27 min & 10 hrs
3	Consistency test	31%
4	Specific Gravity Test	3.18

- **Fine Aggregate**

In concrete, fine aggregate was utilised as a void filler. In general, fine aggregate was employed in all construction activities. The average fine aggregate size ranges from 4.75 mm to 75 mm. The fine aggregate used in concrete was free of dirt, dust, and organic matter, and its specific gravity ranged from 2.6 to 2.7. Table 2 shows the test for fine aggregate. According to IS 2386 (part 3) grade zone -II aggregate used.

Table 2 Tests for fine aggregate

S. No	Test	Results values
1	Sieve analysis test	3.2%
2	Specific gravity test	2.65

- **Coarse Aggregate**

The coarse aggregate was the main ingredient in the permeable concrete. On the sieve with a mesh size of 4.75 mm, coarse particles were retained. Their maximum size was usually around 7.5 mm. Table 3 shows that the test for coarse aggregate. The specific gravity of coarse aggregate is typically between 2.6 and 2.9.

Table 3 Tests for Coarse aggregate

S. No	Test	Results values
1	Impact strength	23.45 %
2	Specific gravity	2.7
3	Bulk density	1.287 kg/m^3

- **Concrete Mix Design**

Concrete is a building material composed of cement, water, and aggregates. Concrete has excellent compressive strength, but it is relatively weak in tension, which is why it is often reinforced with steel to increase its tensile strength. The tests required for concrete mix design, such as sand and aggregate fineness and specific gravity, were performed, and a detailed mix was developed. The cement grade considered was OPC53, while the concrete grade considered was M20 which is 1:1.5:3 and water cement ratio is 0.48. IS 10262 (2019) was used to design the mix. Six cubes of concrete were casted as per mix proportion to determine the targeted strength of concrete. The cube mould was 150mm× 150mm× 150mm in size. In the curing tank, potable water was used for curing. Table 4 shows that compressive strength of concrete and the tests were carried out after 7, 14, and 28 days.

- **Extraction of Gigantea Fibre**

CGFs were derived from the CG plant's bark or stem. The stems were wrapped into bundles with bags and retted in water tanks for 2 days to facilitate easy removal of fibres without causing damage to the stem. The fibres were manually extracted from the stems and cleaned and dried in the sun for one day. Figure 1 represents the fibre extraction process of the CG plant. Table 4 shows the chemical composition and table 5 shows the physical properties and characteristic features of the CGF. CGFs are light grey in colour, have a length of 0.5 m, and their shape varies from fibre to fibre, so the value finds from the mean value as well as being non-uniform. The fibre thickness ranged from 0.11 mm to 0.83 mm, as measured with a Digital microscope. According to ASTM D3822 the tensile strength the CG fibre is observed.

Table 4 Chemical Composition of CGF

Chemical composition	Results
Holocellulose	76 %
Cellulose	57 %
Lignin	18 %
Alkali soluble substance	17 %

Table 5 Physical Properties of CGF

Physical properties	Results
Mean average diameter	16 µm
Tensile strength	381 MPa
Appearance	Dim yellow
Strain at break	2.1%
Young's modulus	9.7 GPa
Density	0.56 g/cm^3

Figure 1 Fibre extraction process

- **Epoxy Polymer**

Epoxy polymers are often used for fiber-reinforced materials due to their excellent mechanical properties, chemical resistance, and adhesion. The fibers in a composite material provide strength and stiffness, while the epoxy matrix transfers the load between the fibers and protects them from external damage. These composite materials are commonly used in aerospace, automotive, marine, and construction industries, among others, where lightweight and high-performance materials are essential. Here epoxy resin (LY 556) is taken because of its high tensile strength and adhesion properties. Epoxy resins are typically used in conjunction with a hardener to create a thermosetting polymer that provides exceptional strength, durability, and chemical resistance. Here hardener (Hy 956) is used with epoxy resin. Because of its Cross-Linking: Epoxy resins (Ly556) are made up of linear chains of molecules that are held together by weak forces. When a hardener (Hy 956) is added to the resin, it causes the chains to cross-link and form a three- dimensional network of strong covalent bonds. This process is called curing and transforms the liquid resin into a solid, rigid material. Fig 2 shows the epoxy resin and hardener and table 6 shows the physical properties.

Figure 2 Epoxy resin (Ly556) and hardener (Hy956)

Table 6 Properties of Epoxy Resin and Hardener

Properties	Epoxy LY556	Hardener HY956
Visual appearance	Medium viscosity, colourless clear liquid	Brownish yellow colour liquid
Viscosity at room temperature	9000-1200 MPa	500-1000 MPa
Density at room temperature	1.13- 1.16 gm/cc	0.946 gm/cc

- **Mould for CGFRP Stirrups**

For getting the perfection of results in casting, surely to design the mould. Here to prefer the dual mould that means two halves. The mould having the rings surfaces in it for making CGFRP stirrups. Here the 8mm diameter of CGFRP stirrup is casted by making it into two

halves and then it is bonded together as shown in the Figure 3. And then table 7 shows the typical properties and dimensions of the mould.

Figure 3 Mould for CGFRP Stirrups

Table 7 Typical Properties and Dimensions of The Mould.

Typical Properties and Dimensions	Results
Mould type	Dualism (one box with 4mm Ø & another box with 4mm Ø - totally 8mm diameter)
Appearance	Dim yellow or green
Mould made up of	MDF water resistant wood
Dimension	23cm×15cm×1cm

- **Preparation of CGFRP**

A hand lay-up technique with a mould box with the size of 23 × 15 × 1 cm was used to prepare the CGFRP Stirrups. First, the mould box was coated with a releasing agent or using plastic tape for the easy removal of the cured CGFRPS. The Hardener were mixed with epoxy resin in the ratio of 1:10 using mechanical stirrer. After stirring for 10 minutes, the resin mixture was poured into the mould containing the CGFR, where the (12×10-3g) fibres are randomly distributed. Then, the mould was closed under pressure by tightening the screws and bolts and allowed to cure at room temperature for 24 hours. Preparation of composites of CGFRP stirrups shows in figure 4.

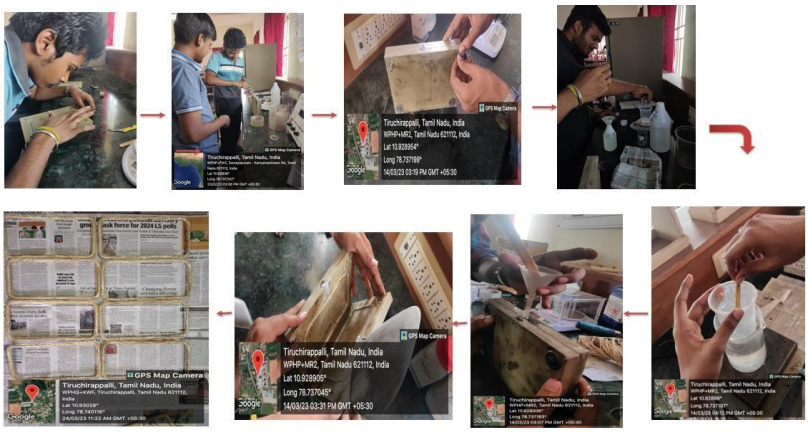


Figure 4 Preparation of CGFRP stirrups

- **Mechanical Testing**

Specimens for mechanical tests were cut from the manufactured CRFRP composite in accordance with ASTM specifications. Tensile tests were carried out in accordance with ASTM D3822 on a FIE universal testing machine with a crosshead speed of 5 mm/min. The hardness test for CGFRP composites was carried out on a Rockwell hardness machine accordance with ISO 6508 the impact test for composite specimens was carried out on an Izod and Charpy impact machine in accordance with ASTM D256 and ASTM A370 to determine the average value were evaluated for each combination. Figure 5(a) shows the test conducted on steel and fibre and figure 5(b) shows the images of CGFRP stirrups(8mmø) and steel stirrups (8mmø). Table 8 shows the comparisons of test values.

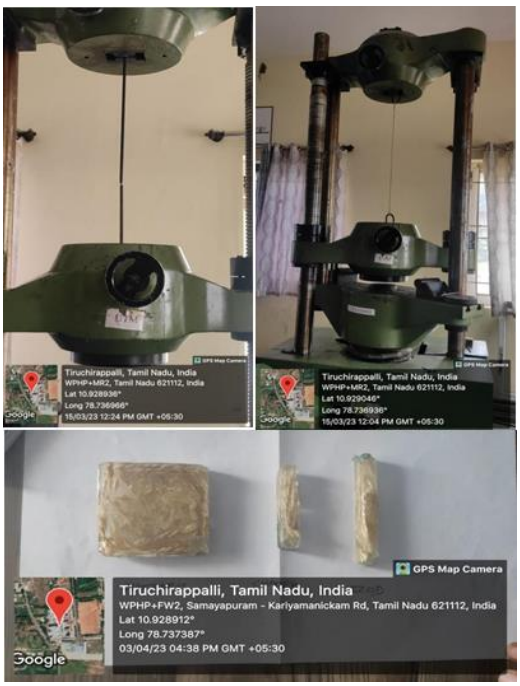


Figure 5 (a) Specimen and Test Conducted

Figure 5 (b) CGFRP Stirrups 8 mm and steel stirrups 8 mm

Table 8 Comparisons of Test Values

Test	Fe415 steel	8mm ø conventional rod	8mm ø CGFRP rod
Yield strength	415 N/mm^2	250 N/mm^2	600 N/mm^2
Ultimate tensile strength	485 N/mm^2	410 N/mm^2	1030 N/mm^2
Elongation	14.5 %	23 %	12.5 %
Impact test	15 KJ/m^2	8 KJ/m^2	81.21 KJ/m^2
Modulus of elasticity	200 GPa	200 GPa	25.7 GPa

- **Partial Replacement of CGFRP Stirrups**

By using solid works to design a singly reinforcement beam with dimension of 1.2 × 0.23× 0.15 m and CGFRP property figure 6 shows the dimension of beam and CGFRP stirrups which is implemented into the ANSYS software with the reinforcement placed inside with five cases of partial replacement of CGFRP stirrups compare to the conventional stirrups used in it. first case is casted with conventional steel stirrups tied in the longitudinal bars shows in figure 7(a), second case is partially replacing the steel stirrup with the one CGFRP stirrup at the two end of the beam which is shows in figure 7(b), third case is partially replacing the steel stirrup with the two CGFRP stirrup at the two end of the beam which is shows in figure 7(c), case is partially replacing the steel stirrup with the three CGFRP stirrup at the two end of the beam which is shows in figure 7(d), fifth case is partially replacing the steel stirrup with the four CGFRP stirrup at the two end of the beam which is shows in figure 7(e), The main reinforcement used in for RC beam is 12mm diameter bars with 8mm diameter bars.

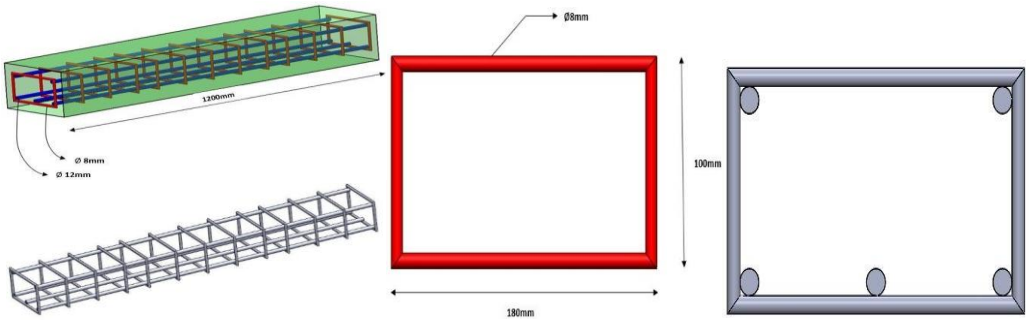
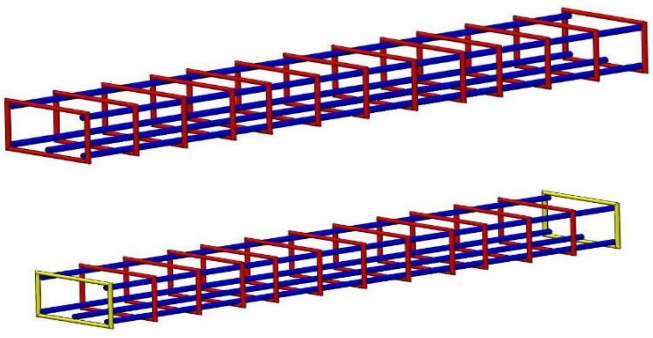


Figure 6 The dimension of beam and CGFRP stirrups



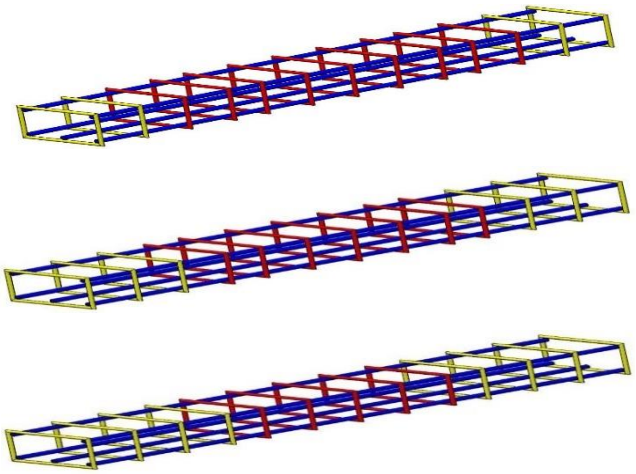


Figure 7 Beam

Results

Using Ansys software to find the maximum load and maximum deflection in shear failure location by partial replacement of CGFRP stirrups in concrete beams. Figure 8 shows the beam set up with reinforcement and Figure 9 - (a), (b), (c), (d), (e) shows the maximum deflection on conventional steel compared to the partial replacement of the other four cases.

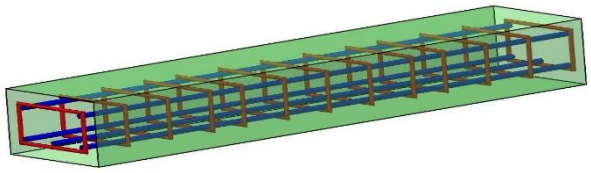


Figure 8 Beam setup with reinforcement

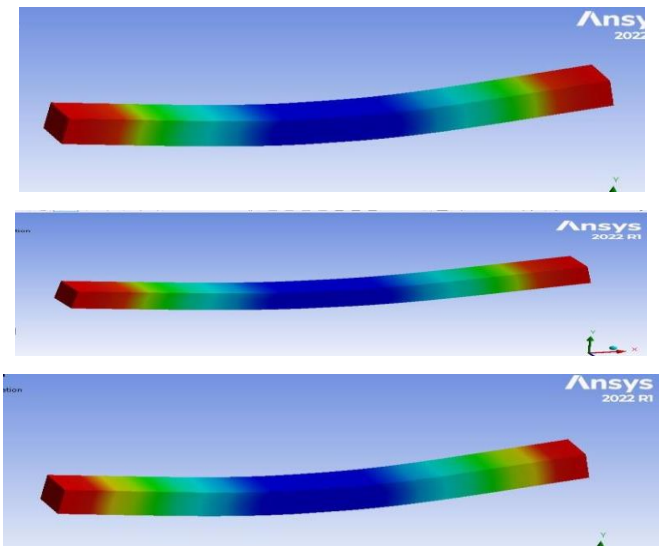


Figure 9 FEM Analysis

Discussions

Here we are comparing the maximum load and maximum deflection shows in table 9 with separate as starting, initial, final stages. Initial crack and load distribution setup is shown in figure 10.

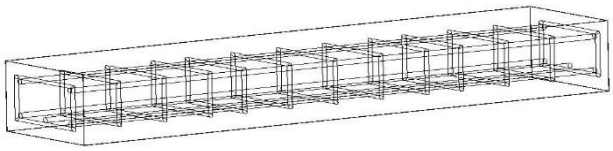


Figure 10 Initial Crack and load distribution setup

Table 9 The Maximum Load And Maximum Deflection with Stages

Sample	Load (KN)	Stages	Deflection (mm)
Conventional steel stirrups	05	Starting	0.75
	35	Initial	5.28
	120	Final	18.15
Partial replacement of one CGFRP stirrup at the two ends of the beam	05	Starting	0.62
	30	Initial	4.02
	100	Final	15.5
Partial replacement of two CGFRP stirrup at the two ends of the beam	05	Starting	0.60
	35	Initial	5.25
	120	Final	15.56
Partial replacement of three CGFRP stirrup at the two ends of the beam	05	Starting	0.75
	35	Initial	6.08
	145	Final	20.68
Partial replacement of four CGFRP stirrup at the two ends of the beam	05	Starting	0.70
	50	Initial	7.55
	150	Final	19.7

Conclusions

The study has provided many valuable insights about the fibre reinforced polymers, mainly the CGFRP (Calotropis gigantea fibre reinforced polymer) stirrups possess high strength to weight ratio, less weight, high anti corrosion resistance. The CGFRP stirrups gives same strength as steel stirrups and CGFRP stirrups has an advantage of anti-corrosion resistance. Due to the presence of anti-corrosion resistance in natural fibres, maintenance cost of the structure will be reduced. The weight of CGFRP stirrup and steel stirrups are 32 gm & 245 gm respectively. Dead load of a structure will decrease by using of CGFRP stirrups. Cost per CGFRP stirrups is also reduced compared to conventional steel stirrups.

References

[1] Wei Song, Aijuan Gu, Guzheng Liang, (2011), "Effect of the surface roughness on interfacial properties of carbon fibers reinforced epoxy resin composites", vol. 257, no. 9.

[2] P. Ganesan. Raja, (2018) "Calotropis gigantea fibre – A potential reinforcement for polymer matrices" vol. 19, no. 10–11.

[3] Hassan Ahmad, (2018), "Interfacial Properties And Structural Performance Of Resin-Coated", Natural Fibre Rebars Within Cementitious Matrices, vol. 87.

[4] Rashid, M. A. Mansur and P. Paramasivam, (2018), "Behavior of Aramid Fiber-Reinforced Polymer Reinforced High Strength Concrete Beams under Bending", vol. 171.

[5] Jayaprakash R, V. Srinivasan, (2019), "Mechanical properties of natural fibre reinforced epoxy composited", vol. 40, no. 1-2, pp. 41-69.

[6] P.Karthik, P.K Devan, (2020), "Optimization of surface treatment in Calotropis Gigantea (CG)- fiber yarn by simple techniques and characterization of CG fiber yarn reinforced laminate", vol. 12, no. 4138176.

[7] K. Subramanian, (2022), "Calotropis Gigantea Fibre-epoxy Composites: Influence of Fibre Orientation on Mechanical Properties and Thermal Behaviour", vol. 19, no. 10.

An Evaluation on the Effects of Anthropogenic Activities on Surface and Ground Water Quality

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Abstract

The present study has been made to evaluate the quality of underground water in Ariyalur district of Tamil Nadu. A total of 15 representative open well water samples were collected from different localities of Ariyalur district. The water quality parameters selected for physico-chemical analysis are pH, EC, Taste, Colour, Acidity, Hardness, Nitrate, Alkalinity, Chloride, Temperature, Turbidity. The data was statistically analyzed and correlation has been observed. Overall, the results describe the analysis of various water sample at a different location with a geo tag can identify the location with the latitude and longitude coordination. The results indicate that the waters have grossly high values of hardness and alkalinity. Which reduces the quality of water for drinking.

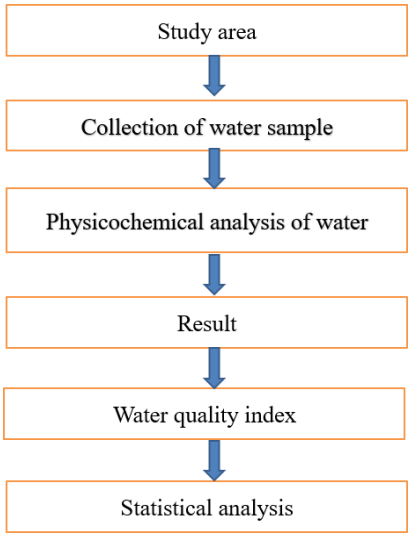
Keywords: Open well water samples, Physico-chemical parameters.

Introduction

One of the resources that nature has in great abundance is water. It also makes up around 75% of the total material that makes up the earth's crust and is a necessary component of both animal and plant life. As water is a solvent, it disperses minerals from the rocks it comes into contact with. It's possible for dissolved minerals and gases to give groundwater its distinctively sour flavour. Our land and water resources are under more stress now than they have ever been before because of the expansion of industry, technology, population, and water use. The quality of the groundwater in the area has declined. Chemical fertilizers, pesticides, herbicides, and industrial waste have seeped into the soil, contaminated some aquifers, and lowered the quality of groundwater.

Additional pollution issues include improper septic tank operation, landfill leachates, and sewer leaks. As a result, managing and protecting the quality of groundwater is always

important. The requirement for a groundwater quality assessment is mostly influenced by the diversity of contamination sources.



Materials and Methods

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you. Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

Physical water quality parameters

(i) Turbidity

(ii) Temperature

(iii) Colour

(iv) Taste

(v) Electrical Conductivity

Chemical Parameter of water quality

(i) pH

(ii) Acidity

(iii) Alkalinity

(iv) Chloride

(v) Hardness

Collection of water samples

Fifteen water samples from different sites were collected from Ariyalur area. The water samples were extensively used for drinking and other domestic proposes. The location of sampling is given in Table 1.

Table 1 Locations of sampling stations

S.NO	LOCATION	LONGITUDE	LATITUDE
1.	MELAPALLUR	79.037728 °	11.037959 °
2.	KEZHAPALUR	79.070847 °	11.051187 °
3.	SAMATHUVAPURAM	79.071899 °	11.071237 °
4.	VARANASI	79.77352 °	11.083820°
5.	THUVATHAIKULAM	79.078697 °	11.101501 °
6.	PAPANACHERI	79.065807 °	11.092674 °
7.	MARAVAMER	79.065080 °	11.093097 °
8.	JEMINADHUR	79.081421 °	11.108425 °
9.	SUBHANIYANAGAR	79.083990 °	11.141017 °
10.	AMINABAD	79.090697 °	11.164231 °
11.	GOVINDAPURAM	79.095956 °	11.172549 °
12.	SENTHUR	79.083206 °	11.151633 °
13.	BERGAMOT ARIYALUR	79.080007 °	11.122092 °
14.	PALUR	79.071457 °	11.055579 °
15.	PAPANGUDI	79.071450 °	11.04643 °

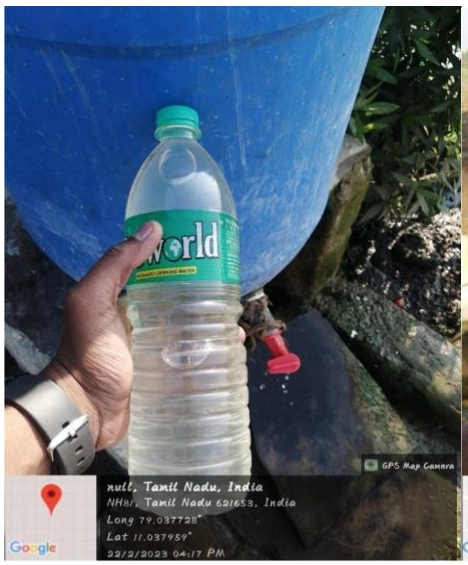


Figure 1 Collected water sample

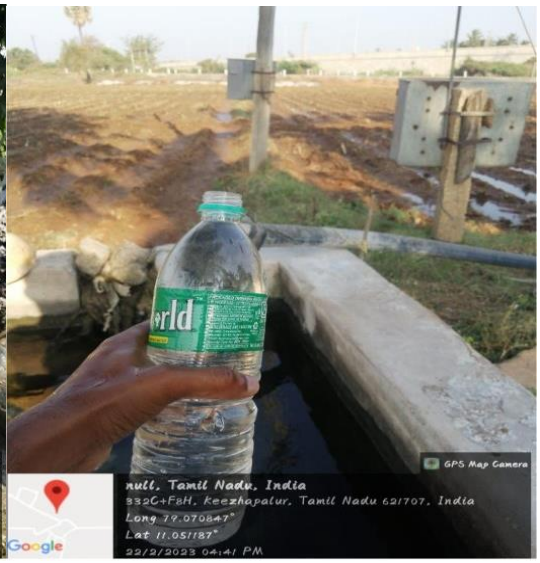


Figure 2 Collected water sample

Results and Discussion

The physicochemical characteristics of groundwaters are given along with the standard values in Table 2. Hydrogen ion concentration (pH): The present investigation of the Ariyalur area water source indicates that the water is alkaline in nature. Though, it has no direct effect on human health, the recommended value for drinking purpose is 6.81-9.42. Hence, the pH value is within the limit. The usual range of pH in BIS is 6.5-8.5.

Electrical conductivity: Conductance of water is due to the presence of soluble salts and other ionic species which act as conducting substances. The conductance values for the samples range from 1.003-1.269µ siemens 1cm. Which are within the limit prescribed by Bureau of Indian Standards (BIS).

Nitrate: The major contribution to nitrate concentration is from biological oxidation of organic nitrogenous substances which come from sewage and industrial waste. The samples were found to have nitrate content between 20 to 38 mg/L. Though it exceeds USPHS limit, but lies within WHO limit. When nitrate concentration is above 45 mg/L it leads to methemoglobinemia, also called blue baby disease.

Hardness: The total hardness ranges from 1275 to 2300 mg/L. It is correlated largely with the sources of high solid contents. The high hardness may render the waters less useful for domestic and industrial purposes, but for human use it has been used for long time without any health problems.

Alkalinity: The total alkalinity has varied from 290-486 mg/L in all the places of sampling. Alkalinity seems to be due to bicarbonates present in water. The standard range of alkalinity is 35 to 350 prescribed by Bureau of Indian Standards (BIS).

Chloride: The chloride values for the samples range from 88 to 446.75 mmol/L in all the places of sampling. The range of chloride is 250 by BIS.

Acidity: The samples were found to have acidity content between 46.25 to 430 mg/L.

Temperature: The temperature of water sample is tested by thermometer. The value of the sample from 25.2 to 29.8° C.

Turbidity: The samples were found to have turbidity content between 7.4 to 23.4 NTU.

Table 2 Ground water properties

Parameter	S1	S2	S3	S4	S5	S6
pH	8.68	9.06	7.06	7.15	6.69	7.31
EC	1.248	1.267	1.27	1.237	1.269	1.266
Taste	Salty	normal	normal	normal	normal	salty
Colour	colour	colourless	colourless	colourless	colourless	colourless
Acidity	222.5	340	62.5	85	72.5	213.75
Hardness	1275	1300	1375	1400	1400	1425
Nitrate	32	28	24	26	20	32
Alkalinity	312	366	434	338	470	426
Chloride	446.7	226.25	168.5	147.5	133.5	261.25
Temperature	28.7	28.6	28.5	28.8	28.6	28.7
Turbidity	15.9	13.6	7.4	7.5	8.2	11.9

Parameter	S8	S9	S10	S11	S12	S13
pH	7.09	9.39	9.12	9.02	9.09	9.11
EC	1.267	1.264	1.143	1.059	1.098	1.009
Taste	normal	salty	Normal	normal	normal	normal
Colour	Colourless	colourless	Colourless	colourless	colourless	colourless
Acidity	157.5	430	111	145	118.75	157.5
Hardness	1550	1600	1700	1775	1850	1550
Nitrate	35	29	34	23	27	35
Alkalinity	454	348	290	418	486	426
Chloride	173.75	203.5	95	88	109	173.75
Temperature	28	28.3	27.8	28.3	27.3	28
Turbidity	11.2	8.3	11.2	23.4	18.4	11.2

Parameter	S14	S15	USPHS	WHO	BIS
pH	9.42	9.8	7-8.5	6.5-9.2	6.5-8.5
EC	1.003	1.069	-	-	1-6
Taste	salty	normal	-	-	-
Colour	colourless	colourless	-	-	-
Acidity	215	46.25	-	-	-
Hardness	1925	2300	200	100-500	300
Nitrate	24	21	<10	45	-
Alkalinity	374	408	-	-	50-200
Chloride	116	152.25	0-250	-	250-550
Temperature	29.8	25.2	-	-	-
Turbidity	16.1	13.8	-	5	5-10

Conclusions

The analysis of groundwaters shows higher values of alkalinity and hardness in the drinking water of some places such as S14, S15 and S8. In these areas, the treatment technologies must be implemented to ensure good health of the community.

References

[1] APHA, (1989), "Standard Methods for the Examination of Water and Wastewater", 17 edn., American Public Health Associa tion, Washington DC.

[2] Palanisamy, S. and M. Manoharan, (1994), "Statistical methods for biologists" (Biostatistics). Palani Paramount Publications,

[3] Vatchala, K. (2007), "Unlization of fenugreek for the effective treatment of drinking water samples", M.Sc. Dissertation, Bharathidasan University. Trichy.

[4] Zafar. A.R. (1964), "On the ecology of algae in certain fish ponds on Hyderabad, India: Physico-chemical complexes", Hydrobiologia, vol. 23, pp. 179-195.

Experimental Investigation of Mortar with Ladle Slag and Citric acid

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Abstract

This project report discusses on the experimental investigation of mortar with ladle slag on a partial replacement in cement. In this project the research undertaken on waste material from steel industry to reuse that waste and keep environment safe. Ladle slag usage also gives greater advantage in reduction in cost. In this research work 60% to 70% of replacement of cement by using ladle slag and 2% citric acid added for control of setting time. There is increase in compressive strength, split tensile strength and adhesion test of mortar partially replaced with cement. Addition of higher percentage ladle slag leads to bleeding and segregation. Silica fume eliminates soundness problem.

Keywords: material testing, specific gravity, water absorption, sieve test, Compression test, Split tensile test, Adhesion test

Introduction

Mortar has played a major role in construction since ancient times with the oldest example having been found in Israel and thought to date back 10,000 years. Much of the ancient mortar still in existence remains durable today, a testament to the long-lasting nature of the material. In practice, mortar joint acts as a sealant, a bearing pad, the glue that sticks the units together yet keeps them apart and, in this sense, performs as a gap-filling adhesive. Today, mortar in the UK is produced to the specification BS EN 998-2: Specification for mortar for masonry - Part 2: Masonry mortar. It can made either by mixing on site in a concrete mixer or manufactured under factory-controlled conditions off site by specialist suppliers. In both instances, high quality cement, sand and sometimes lime are used in its production.

The quality of today's mortars is due to the commercial development of Portland cement in the 1920s, which made the potential for masonry construction much greater. New

mortar materials provided far more reliable strength development and much increased rate of strength gain than previously achieved using various forms of lime. This enabled construction to be planned and executed far more rapidly. The limes previously used in mortar produced acceptable working properties but the rate of strength gain was low, especially in cold weather. This meant that even a high-quality lime, with a good ultimate strength, could prove very problematic during winter usage. Indeed, it is probable that the majority of masonry construction proceeded little, if at all, during winter months. Availability of the new Portland cements changed this and enabled construction to carry on throughout the year, with the obvious exception of periods of very severe winter weather with heavy precipitation or freezing temperatures.

Need for Alternative material

High cost is the dominating factor of conventional construction material which is affecting the housing system. As an alternative method to overcome this drawback which is decreasing the strength of building, it is necessary to make research on any alternating materials which will decrease the cost and increase the strength of mortar Cement and fine aggregate are the important ingredients in mortar. Due to demand of cement, there is a need of alternative materials.

Need for the study

Ladle slag is a by-product from further refining molten steel after coming out of a basic oxygen furnace (BOF) or an electric arc furnace (EAF). Air-cooled ladle slag has a very large portion of fine particles due to the conversion of β-C2S to γ-C2S during the cooling process. X-ray diffraction (XRD) analysis of three ladle slag fine samples passing 100, 200 and 325 mesh indicates that the major mineral in ladle slag fines is γC2S, which does not show Cementitious property in water. Experimental results have indicated that ladle slag fines show significant Cementitious property in the presence of an alkaline activator. The finer the ladle slag is, the better the Cementitious property of the slag.

The usage of alternative material in mortar is an important study of worldwide interest. Many researchers have investigated the possible use of ladle slag as replacement of cement. For this investigation, some of the important literatures were reviewed and presented briefly

This paper presents an experimental investigation carried out to study the effects of Ground Granulated Blast Furnace Slag (GGBFS) on strength development of mortar and the optimum

use of slag in mortar. Cement was partially replaced with seven percentages (10%, 20%, 30%, 40%, 50%, 60% and 70%) of slag by weight. Ordinary Portland cement (OPC) mortar was also prepared as reference mortar. A total of 400 cube and briquette mortar specimens were cast and compressive as well as tensile strength of the mortar specimens were determined at curing age of 3, 7, 14, 28, 60, 90 and 180 days. Test results show that strength increases with the increase of slag up to an optimum value, beyond which, strength values start decreasing with further addition of slag.

Methodology

In this chapter, the brief description of the methodology and the sequence of the works to be carried out in this complete duration of project are presented.

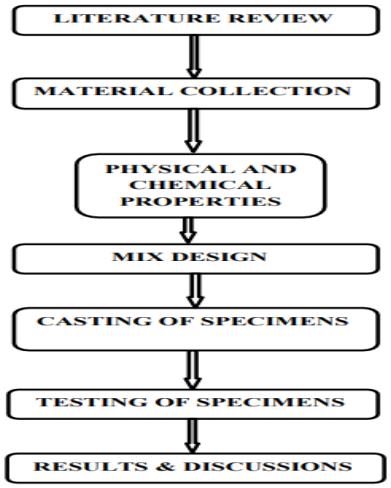

Figure 1 Flow Chart

Materials collection: The second process is to collect the various materials that are used. Materials such cement, fine aggregate, ladle slag and the important material such as citric acid and silica fume are collected

Physical properties: Physical properties such as specific gravity, water absorption, and sieve analysis for various materials are conducted.

Mix design: The mix design is carried out.

Casting of specimen: After completing mix design cube, briquettes are casted

Curing and Testing of Specimens: Curing and testing of specimens are carried out.

Results and discussions: The results that are obtained from the various test are compared and discussed.

Material Details

Cement: Ordinary Portland Cement (OPC) 53 grade is used for concrete production work. When compare to other grades OPC 53 gives higher strength, therefore it is used for concrete production work.

Aggregate: Aggregate in building and construction material used for mixing with cement, lime, gypsum or other adhesive to form concrete or mortar. The aggregates give volume, stability, resistance to wear or erosion and other desired physical properties to the finished product.

Fine aggregate: Fine aggregate used in this concrete preparation work is collected by using the sieve 4.75mm

Ladle slag: Ladle slag is a by-product from further refining molten steel after coming out of a basic oxygen furnace (BOF) or an electric arc furnace (EAF) ladle slag is, the better the Cementitious property of the slag

Figure 2 Cement

Figure 3 Ladle Slag

Silica Fume: Silica fume, also known as micro silica, (CAS number 69012-64-2, and EINECS number (273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high performance concrete.

Sand: Sand is a granular material composed of divided rock finely and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand sized particles by mass.

Citric Acid: Citric acid can be used to retard the hydration of cement. Experiments were carried out to investigate the influence of citric acid on the composition of solid and liquid phases during cement hydration. Analyses of the solid phases showed that dissolution of elite and

aluminate slowed down while analyses of the pore solution showed that citric acid was removed almost completely from the pore solution within the first hours of hydration. The complexion of the ions by citrate was weak, which could also be confirmed by thermodynamic calculations. Only 2% of the dissolved Ca and 0.001% of the dissolved K formed complexes with citrate during the first hours.

Water: Portable water from tap is used for concrete casting and curing process as per IS456:2000 specifications. Good water is essential for quality concrete

Physical Chemical Properties

Fine aggregate

Specific gravity

Specific gravity test is important test of fine aggregate. This test is conducted by pycnometer. Take the empty weight of the pycnometer. Fine Aggregate is taken upto2/3 level of the pycnometer and takes weight. Add the water up to cap of the pycnometer and also take weight. Take weight of pycnometer with water only.

Figure 4 Specific gravity test

Calculate the average specific value of the fine aggregate.,

Empty weight of pycnometer, W1=688.5gm.

Weight of pycnometer with fine aggregate, W2= 1154gm.

Weight of pycnometer with fine aggregate and full of water, W3=1895.5gm

Weight of pycnometer with full of water alone, W4= 1603gm.

Specific Gravity, G= (W2–W1) (W2–W1)–(W3–W4)

G= (1154–688.5) (1154–688.5) – (1895.5–1603)

Therefore, G =2.69

Water absorption

Take 600g of Fine aggregate and place it in tray covered with distilled water. The water shall be carefully drained and decanted through a filter paper and uniform drying shall be ensured until no free surface moisture can be seen. The saturated and surface dry samples shall be weighed (A) Dry specimen in a ventilated oven at a temperature of 100c to110c for a period of 24 hours. Cool the specimen to room temperature and obtain its weight (B). Weight of dry sample, W1 = 590g Weight of sample after immersing it in water for 24 hours, W2= 600 g % increase in weight = (W2–W1) x100 W1 = [(600-590)/590] x 100 Water absorption = 1.69%

Sieve Analysis

The sample shall be brought to an air-dry condition by either drying at room temperature or heating at a temperature of 100℃ to 110℃. Sample for sieving shall be prepared by either quartering or by means of sample divider.

Take proper weight of dries fine aggregate of 1000g. assemble IS sieves in following order 4.75mm, 2.36mm, 1.16mm, 600µ,300µ,150µand pan place the 15 aggregates in the top of the sieves and cover with the lid properly secure the sieves in the mechanical shaker and turn on the shaker or shake manually for five minutes.

Weight the materials that are retained on each of the sieve, including the weight retained on the pan and record on the value.

Table 1 Sieve analysis results

IS SIEVE SIZE	WEIGHT RETAINED Kg	PERCENTAGE WEIGHT RETAINED Kg	CUMILATIVE PERCENTAGE RETAINED Kg
4.75 mm	10	1	1
2.36 mm	40	4	5
1.18 mm	220	22	27
600micron	195	19.5	46.5
300micron	320	32	78.5
150micron	165	16.5	95
Pan	50	5	100
Total	1000	-	253

Fineness modulus =253/100 =2.53

Cement

Specific Gravity of cement

This is done by using standard Le-chatelier flask apparatus. Dry the flask and fill with kerosene or naphtha to a point between zero or 1ml. Put a weighted quantity of cement into the

flask so that level of kerosene rises to about 22 ml mark. The cement does not adhere to the sides of the flask. After putting all the cement to the flask, roll the flask gently in an inclined position to expel air until no further air bubble rises to the surface of the liquid. Note down the liquid level as final reading

Figure 5 Specific gravity test

Empty weight of bottle (W1) = 5 2g

Weight of bottle + water (W2) = 161 g

Weight of bottle + kerosene (W3) = 138 g

Weight of bottle + kerosene + cement (W4) = 212.2 g Weight of cement (W5) = 100 g

Specific gravity of kerosene

GK = (W3–W1) (W2–W1) = (138–52) (161–52) = 0.788 Specific gravity of kerosene (GK) = 0.788

Specific gravity of cement

Gc = W5 x GK (W5+W3–W4) = (100x0.788) (100+138–212.2) = 3.052

Specific gravity of cement (Gc) =3.05

Normal Consistency Test for cement

Normal consistency test is used to find out the consistency of cement. Take 400 grams of cement by weighing balance. Add 20% of weight of water. Then make a paste by mixing. There should not be any air bubbles. Place the paste into the mould. Attach the plunger with a needle having diameter of 1mm. Release the needle quickly without any jerk. This should be done within 3-5 mints after adding water to cement.

Figure 6 Consistency test

Table 2 Consistency results

SL No	Percentage of water to be used	Time taken for placing cement (minutes)	Penetration of needle (mm)
1	26	5	5
2	29	5	6
3	30	5	7
Normal consistency value of cement = 6mm			

Initial and Final Setting Time of cement

Fill the vi-cat mould completely with the paste prepared as for normal consistency. Fix the specified needle with the rod. Place the mould with the test specimen and release rod quickly. Note the depth of needle penetrate into paste once again for every 5 minutes. The reading is maintained up to 5 minutes. The penetrated depth can be found out.

Initial settling time- 30 minutes

Final settling time- 600 minutes

Ladle Slag

Specific Gravity of ladle slag

Empty weight of bottle (W1) = 52 g, Weight of bottle + water (W2) = 161 g, Weight of bottle + kerosene (W3) = 138 g

Weight of bottle + kerosene + Ladle slag (W4) = 217g Weight of cement (W5) = 100g

Specific gravity of kerosene

Gk = (W3–W1) (W2–W1) = (138-52) (161–52) = 0.788

Specific gravity of kerosene (Gk) = 0.788

Specific gravity of Ladle slag G = W5 x Gk M (W5+W3–W4) = (100x0.788) (100+138–217) = 3.752 Specific gravity of Ladles lag(GM) = 3.752

Mix Design

Design of Mortar mix

The mix design for mortar is taken as 1:4 in ratio. Materials such as sand, cement, water-citric acid remains constant. Only cement is replaced by ladle slag from 10% to100%.

Constituents of Materials:

Table 3 Mix ratios

TRIAL	REPLACEMENT PERCENTAGE OF CEMENT	REPLACEMENT PERCENTAGE OF LADLESLAG	QUANTITY OF CEMENT	QUANTITY OF LADLE SLAG	WATER IN ml
1	90%	10%	491.4 g	54.6 g	273 ml
2	80%	20%	436.8 g	109.2 g	273 ml
3	70%	30%	382.2 g	163.8 g	273 ml
4	60%	40%	327.6 g	218.4 g	273 ml
5	50%	50%	273 g	273 g	273 ml
6	40%	60%	218.4 g	327.6 g	273 ml
7	30%	70%	163.8 g	382.2 g	273 ml
8	20%	80%	109.2 g	436.8 g	273 ml
9	10%	90%	54.6 g	491.4 g	273 ml
10	0	100%	0 g	546 g	273 ml

Test and Results

Test Methods

The test methods should be simple, direct, and convenient to apply

- Compression test
- Split tensile test
- Adhesion test

Compression Test

Compression test is the most common test conducted on mortar, partly because it is an easy to perform, and partly because most of the desirable characteristic properties of mortar are qualitatively related to its compressive strength. The compression test is carried out on

specimen's cubical specimens. Cubes 75 mm ×75 mm × 75 mm in size were used. The cube moulds were cleaned thoroughly and properly oiled along their faces.

Table 4 Compression Test results

Curing Period[days	100:0	90:10	80:20	70:30	60:40	50:50	40:60	30:70
7	24.3	22.8	21.9	21.1	20.6	17.3	1.5	12.3
14	27.6	26.8	25.9	25.4	24.9	22.9	20.5	19.6
28	33.0	32.5	33.4	34.4	36.0	33.1	28.2	24.8

Split Tensile Strength test

Split tensile strength test is carried by using briquette specimen. Briquette had 25.4 mm x 25.4 mm. The briquette moulds were cleaned thoroughly and properly oiled along their faces. The mould was then filled with mortar in three layers and compacted using a tamping rod. Further, the moulds were placed on the vibrating table for 60 seconds to achieve proper compaction and subsequently maintained on a plane and level surface in the laboratory for 24 hours. The briquette was de-moulded and set aside for curing.

Table 5 Split Tensile Strength Results

Curing Period[days]	100:0	90:10	80:20	70:30	60:40	50:50	40:60	30:70
7	3.6	3.3	3.3	3.2	3.1	2.5	2.0	1.8
14	3.8	3.7	3.6	3.5	3.5	3.3	2.8	2.7
28	4.2	4.3	4.3	4.5	4.6	4.5	3.6	3.2

Adhesion Strength Test

This test is typically performed in a laboratory and is limited to testing on smooth, flat panel surfaces. Adhesion is rounded stylus or loop that determined by pushing the coated panels beneath a is loaded in increasing amounts until the coating is removed from the substrate surface

Adhesion Strength results

The test will work reliably over an adhesion strength range between 0.2 and 50 N/ Sq m

Conclusions

It has been concluded that based on the test results, the utilization of ladle slag and citric acid has considerably increased the strength properties of mortar. The specimens were casted for various proportions of ladle slag (10 to 100%) and citric acid (2%), the test results indicated ladle slag 80% and citric acid 2% addition gives improved result when compared to other combinations. Then the specimen casted with optimum percentage ladle slag & optimum percentage citric acid in the mortar and the test results compared with conventional mortar aggregate: Fine aggregate

Reference

[1] IS 383-1970: Specification for coarse and fine aggregate from natural resources of concrete.

[2] IS 5816-1999: Indian Standard splitting tensile strength of mortar - method of test.

[3] IS 9399-1979: specification for apparatus for adhesion testing of concrete.

[4] IS 10262-1982: Indian standard recommended method of mortar mix design.

[5] IS 12269-1987: Specification for 53 grade ordinary Portland cement.

[6] Tanpreet Singh and Anil Kumar, (2011), "Influence of ladle slag Mortar and Concrete Mix", vol. 2.

[7] Caijunshi &Shunfu Hu. (2003), "Cementitious properties of ladle slag fines using autoclave curing conditions" Construction and building materials, vol. 12.

[8] Waste Management – U.Arena, M.Barlaz, (2015), "Cement and concrete research".

Evaluation of Dairy Wastewater Treatment Process in an Aerobic Bio-Reactor with the Support of Nano-sorbent

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Abstract

The Performance of an Aerobic Bio-Reactor (ABR) for the behaviour of synthetic dairy processing wastewater was investigated. The system with 13.3 liters of working volume was accomplished by attached as well as suspended growth process. The experimental analysis was carried out with the influent Chemical Oxygen Demand of 2920 mg/l, 3488 mg/l and 4000 mg/l with an Organic Loading Rate (OLR) from 0.497 to 9.094 Kg COD/m3.day at Hydraulic Retention Times (HRT) of 11, 14, 17, 21, 28, 42, 84 and 141 hours. During the experiment, pH plays an important role and the Dissolved Oxygen was maintained within the permissible limit continuously. In an ABR, the maximum COD removal efficiency was attained 93.20% with an Organic Loading Rate (OLR) of 3.410 Kg COD/m3.day. To achieve the goal of reusing the wastewater, again the treated effluent was analyzed by the technology of adsorption process using zinc-oxide nano powder as a chemisorbent and the maximum COD removal efficiency of 100% was observed with 0.75 g of dosage content at the pH of 6 at the contact time of 180 minutes.

Keywords: Adsorption, Nanotechnology, Organic Loading rate, waste water treatment

Introduction

Water is our most valuable resource, and because we are more concerned about future water supplies, we are required to use new, changed technology to protect these water bodies from contamination. Industrial effluents that include large amounts of solids, COD, and have a high unstable pH are difficult to treat. As a result, sewage is frequently discharged into nearby bodies of water without even a basic treatment. In order to treat wastewater, a number of traditional procedures have been used. However, they are not efficient in their effectiveness. The biggest challenge of dairy sector is getting rid of effluent that doesn't match the standards. Due to constraints in present water and wastewater treatment technologies, it is no longer viable

to provide a sufficient amount of high-quality water that fulfils human and environmental demands [18], [15], [16], [7],[13], [17], [21]. As the effluent from the dairy business restrains significant amounts of whole materials, proper treatment before discharge is crucial [8]. Dairy synthetic wastewater has been generated in response to the problems, and an effort has been made to break down the greater quantities of organic debris. With the awareness of the affordable technologies of aerobic therapy, attention in the aerobic reactors has quickly improved [24].

In this situation, technologies that filter water without endangering people or the environment are required to produce clean, affordable water. Technological breakthroughs in nanotechnology provide up new possibilities for the creation of devices that might help ease water-related challenges. In order to create a sustainable water supply, it is crucial to repurpose treated wastewater effluents. In the current study, an Aerobic Bio-Reactor (ABR) investigational model was created to conduct experiments on replicated, man-made waste streams of dairy to evaluate the behaviour of treatment efficacy under changing experimental settings. Sorbents are frequently used in batch processes to remove excess organic and inorganic impurities.

Although nanoparticle water treatment has the potential to be used, its cost should be managed to withstand the market's current competitiveness. They convey size-dependent features such as strong reactivity, increased adsorption capability, and elevated dissolving action and can be employed in wastewater treatment because of their larger surface to volume ratio. Additionally, several distinctive qualities like super paramagnetic, semi conductivity, and the quantum confinement effect have added benefits to treatment methods. The effectiveness of common sorbents used in adsorption practice, such as activated carbon, ion-exchange resins, and others endure from a lack of active sites or high accessible face area, as well as from a be deficient in selectivity and specificity and adsorption kinetics. Due to the much better surface area of nanoparticles, their higher specificity and selectivity, as well as their tenable pore size and surface chemistry on a mass source the use of nanomaterials (also known as "Nano sorbents") may have advantages over conventional materials (also known as "Sorbents") in order to overcome difficulties. A few nanoparticles can also be very effective adsorbents due to their distinct structure and electrical characteristics. The intention of this study is to assess the performance of ABR at different HRT and the treated effluent was again treated with the support of nanotechnology in the ambient condition with a goal of reusing the effluent.

Materials and Methods

Reactor Configuration

In regulate to test the treatment effectiveness of synthetic wastewater from the dairy processing under a variety of experimental settings, an Aerobic Bio-Reactor model was constructed. Plexi glass made up the experimental lab model. The reactor had an operating capacity of 13 litres. Both the attached growth process and the suspended growth process are included in this model. The flow rate was managed using a peristaltic pump (PP-10EX) with variable speed. Fig.1. depicts the experimental setup's design. Characterization of wastewater was analyzed as per the APHA 2017 [4].

Figure 1 Photographic outlook of the Aerobic Bio-Reactor

Preparation of ZnO nano powder and characterization

To make zinc oxide nano powder, 0.01% PVA solution was first made. Then, 2 ml of PVA was added to 1 ml of zinc sulphate heptahydrate solution, and 2 ml of sodium hydroxide was slowly and drop wise supplementary to it. The ensuing solution was then agitated for almost 18 hours. One thing to maintain is that if there is a high concentration of PVA, a lot of fluff will form instead of precipitate. Huge amounts of white hasty were produced after 18 hours, which were filtered, rinsed with distilled water, dried for 2 hours in a muffle furnace at 100°C, crushed into fine powders, and then calcined at 450°C [3]. The powder was exemplified by the Scanning Electron Microscopy (SEM) and the element size analysis was drawn for the intensity and the diameter of the nanoparticle. The product specification is as offered in the Table 1. The characterization of synthesized ZnO nanoparticle as Particle size analysis graphical representation is shown in Fig. 2. and the SEM image is presented in Fig.3.

Table 1 Specification of Zinc nanoparticles

Purity	99.9%
Molecular Formula	Zn
Form	Powder
Density	7.14 g/cm³
Boiling Point	907 °C
APS	60-80 nm
Molecular Weight	65.37 g/mol
Colour	Grey to black
Melting Point	419.53 °C
Solubility	Insoluble in water

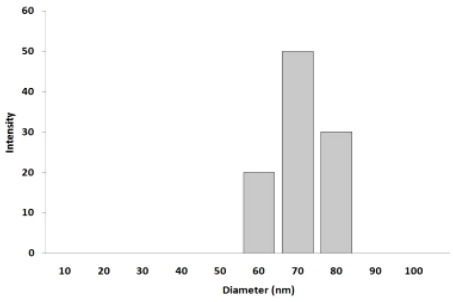

Figure 2 Particle Size Analysis

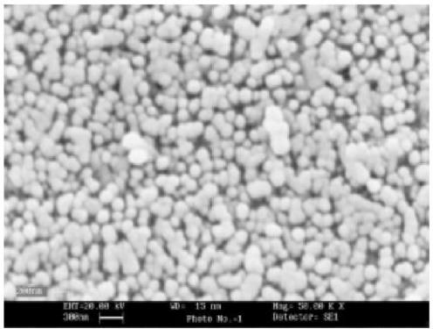

Figure 3 SEM image of Zinc-oxide nano-powder

Results and Discussions

Stabilization process

The activate stage is considered as the phase taken for steady function to be attained. This is a decisive step for the constant process of the ABR and other aerobic reactors at a planned organic loading rate (OLR). In adding up, operational temperature is high up throughout start-up [26]. In this work, the ABR was operated at a temperature between 25°C and 35°C (Mesophilic range). The start-up stage of the process was instigated by incessant feeding of the reactor with an average influent COD concentration of 856 mg/l. The COD elimination rate in first two days was low down in the series of 7% to 13%. The low efficiency in removal at the launch of the process is due to the biomass version to the new environment. During the start-up period the pH and DO plays an important role. The COD diminution was attained 7% in the initial stage and it was incremental up to 12th day and decline from 12th to 14th day and then attains a steady state from 15th day to 18th day with a COD deduction efficiency of 96.45%. (Fig. 5).

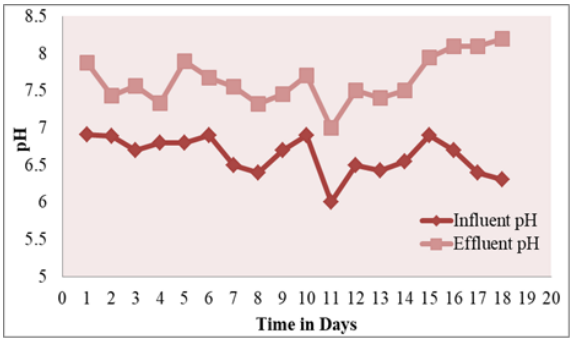

Figure 4 No. of days' vs. pH during Start-up process

The effluent pH throughout the start-up phase is shown in Fig. 4. The effluent pH rate was from 6.8 to 8.2. These results designated a good system of buffering and non-inhibition of micro-organism at the commencement of the adaptation process.

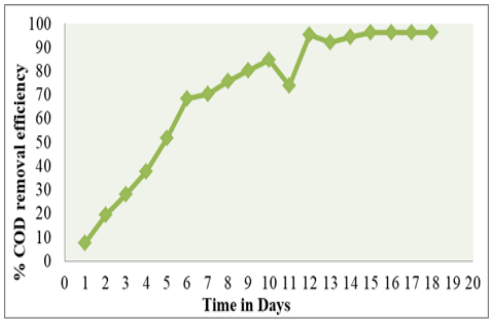

Figure 5 No. of days' vs. % COD removal efficiency

After achieving the steady state, the reactor was slowly fed with the dairy wastewater by 20%, 40%, 60%, 80% and 100% for the experimental analysis. Figure 6 shows the effectiveness of HRT in terms of the percentage of COD elimination efficiency [23]. Due to the large amount of biomass in the model at the beginning of the progression, the deduction efficiency was not as low as it may have been, but it is challenging to keep an adequate number of beneficial microorganisms in the system [31]. In aerobic reactors, pH continues to play a key role in regulating the digestive process [22]. Although it is true that stability may be reached when the pH range of 6.0 to 8.0, it is advised to evade the pH values less than 6.0 and more than 8.3 as in these ranges, the microbes may be suppressed [10]. Aerobic bacteria can live in settings with pH values in the range of 6.6 and 7.6. The pH of the reactor was kept steady, though, and ranged between 6.8 and 8.3, which is a good range for digesting activities [19]. Due to the amalgamation of attached growth processes and suspended growth processes in a single reactor, the reactor reached a steady state condition as early as expected.

COD Removal Efficiency of ABR

The average influent COD concentration was around 2920, 3488 and 4000 mg/l respectively, in Aerobic Bio-Reactor. It can be seen that maximum COD removal obtained were 78.83%, 87.84% and 93.20% with an OLR of 0.497 to 6.639, 0.594 to 7.930 and 0.682 to 9.094 Kg COD/ m3.day respectively. A huge amount of COD in the form of organic matter is consumed by the microorganisms during the simultaneous removal of nutrients in the aerobic reactors. The dairy wastewater with the average influent COD concentration of 4000 mg/l gives the higher efficiency of 93.20%. The lower OLR is known to favour the multiplication of bacteria population inside the reactor thus increasing the nutrient removal efficiency. However, at higher OLR, the degradation rate increases decreasing the doubling rate of bacterium.

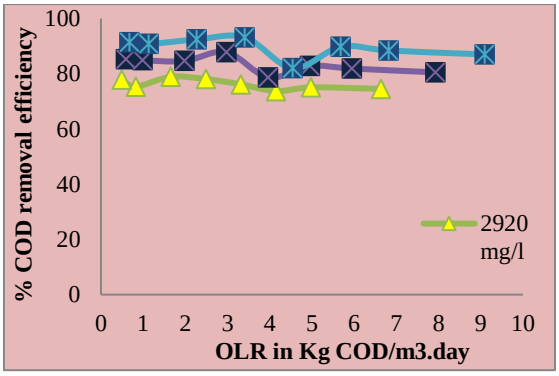

Figure 6 OLR in Kg COD/m3 day with respect to % COD removal efficiency of synthetic dairy wastewater with an average influent COD of 2920, 3488 and 4000 mg/l

Batch study as adsorption

Wastewater adsorption treatment is done right away using the batch procedure. The batch procedure is carried out in a clogged system with the ideal quantity of adsorbent in contact with the preset amount of adsorbate solution. Rotating stirrers are used to agitate the contents of a closed vessel, ensuring that all adsorbent components are well mixed with the contaminated solution. A high-quality recyclable effluent is produced following treatment by well-designed batch procedures since they are so effective. Additionally, if affordable adsorbents are utilized or regeneration is possible, a batch adsorption procedure may be cost-effective [25]. The batch adsorption method may also be applied to the quality enhancement of industrial and other wastewater as well as the source reduction of contaminants [6]. Adsorbent is combined with wastewater in the batch tank for a given amount of time and pH, after which the final adsorbate attentiveness is calculated. Depending on the needs, the batch process in industry can simply scaled up or scaled down [1]. Adsorption takes place in the batch tank

when contaminants in the solution come into contact with the adsorbent [30]. Physical and chemical adsorption are both possible forms of adsorption. Van der Waals forces serve as an attractive force during physical adsorption, and the ensuing adsorption is reversible. Strong chemical bonds operate as an attraction force in chemisorption, and this adsorption is irreversible.

For the experimental investigation, chemisorbent doses as zinc oxide of 0.25g, 0.5g, 0.75g, and 1.0g were utilized. The percentage removal effectiveness of COD at a dose of 0.25g of chemisorbent changes in relation to various effluent pH values. The experiment was examined using different zinc dose levels and a pH range of 1 to 14 presented in Table-II. The elimination efficiency was minimal and poor between pH 1 and 5.

Effect of pH on percentage removal efficiency of COD

The impact of adjusting the dose of Zinc oxide chemisorbent from 0.25 g to 1.0 g on the elimination of COD while maintaining the contact time of 60 minutes to 360 minutes was examined. It is one of the crucial variables in the sorption process because it has the ability to attack the chemical form and active sites of species in wastewater solution [12]. It was discovered that the pH decreased with the reduction of physicochemical factors. In general, the clearance effectiveness was poor and insignificant in the pH range of 1 to 3. The percentage removal efficiency was likewise high when the dose of the sorbent was increased at higher pH values [29].

Experiments were conducted to analyse the percentage COD removal efficiency of treated dairy wastewater with a COD concentration of 272 mg/l in various pH levels by varying the dosage of Zinc Oxide nano powder from 0.25 to 1.0g by keeping the contact time 60 minutes as constant. For pH level of 1, with 0.25g of Zinc Oxide nano powder, the percentage COD removal efficiency was 28.25. With the pH level of 2, the percentage COD removal efficiency was 36.44; for pH level of 7, the percentage COD removal efficiency was 71.56 and for pH 8, the percentage COD removal efficiency was 81.05. By increasing the dosage level of Zinc oxide nano-powder from 0.25 to 0.5g, the percentage COD removal efficiency was 72.67 at pH level of 7 and at pH 8, the percentage COD removal efficiency was 82.17. By increasing the dosage level to 0.75g the maximum percentage removal efficiency was attained at the pH level of 8 was 84.90. By increasing the dosage level to 1.0g with the same pH level, the percentage COD removal efficiency was constant and reached at equilibrium.

Table 2 Effect of pH on percentage COD removal efficiency by Zinc oxide nanopowder (chemi-sorbent) in treated synthetic dairy wastewater with a COD concentration of 272 mg/l

pH	Percentage removal efficiency of COD			
	0.25 g	0.5 g	0.75 g	1.0 g
1	28.25	29.05	30.14	30.14
2	36.44	37.41	38.76	38.76
3	45.76	46.30	47.05	47.05
4	50.42	51.00	51.32	51.32
5	58.37	59.85	60.21	60.21
6	67.09	68.37	69.40	69.40
7	71.56	72.67	73.89	73.89
8	81.05	82.17	84.90	84.90
9	78.21	79.11	80.51	80.51
10	74.56	75.45	76.32	76.32
11	59.24	60.32	61.87	61.87
12	54.47	55.31	56.63	56.63
13	46.56	47.49	48.39	48.39
14	38.25	39.01	40.10	40.10

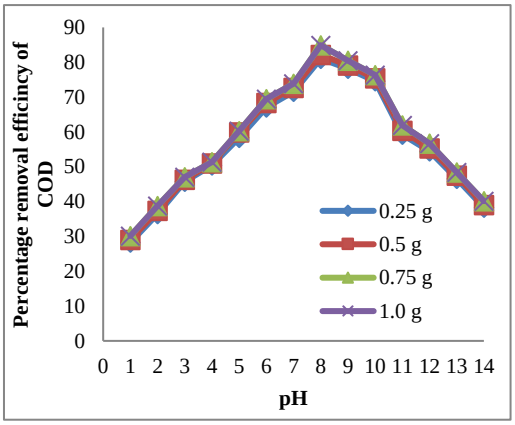

Figure 7 Effect of pH on percentage COD removal efficiency by Zinc oxide nano-powder (chemi-sorbent) in treated synthetic dairy wastewater with a COD concentration of 272 mg/l.

The results of the experimental investigation, which included pH ranges of 1 to 14, are presented in Fig. 7. The effectiveness of percentage removal for pH 1 was 15.81. In this instance, the greatest % removal efficiency was obtained at 100% at the same dose of 0.75g of chemisorbent with a pH level of 7. The clearance efficiency began to decline for the same dose (0.75g) with rising pH levels. Due to ion competition in the sorption sites, the removal effectiveness at lower pH was poor [32].

Percentage removal efficiency of COD with respect to the pH level of effluent (6 and 7) and dosage level of Zinc. The percentage COD removal efficiency was increased sharply from 71.56 at dosage of 0.25g at the pH of 7 and increased to 81.05 at the same dosage of 0.25g

with the pH of 8. Also, there was increment in the percentage COD removal efficiency with the dosage from 0.25 to 0.5g and also there is an increment in the percentage COD removal efficiency with the pH (Figure 8). The percentage COD removal efficiency was increased to 72.67 at dosage of 0.5g at the pH of 7 and increased to 82.17 at the same dosage of 0.5g at the pH of 8. By further increasing the dosage level from 0.5 to 0.75g, the maximum percentage COD removal efficiency was 84.90 at the pH of 8. After 0.75g dosage content of Zincoxide nanopowder at pH level of 8 the percentage removal efficiency was attained in equilibrium conditions.

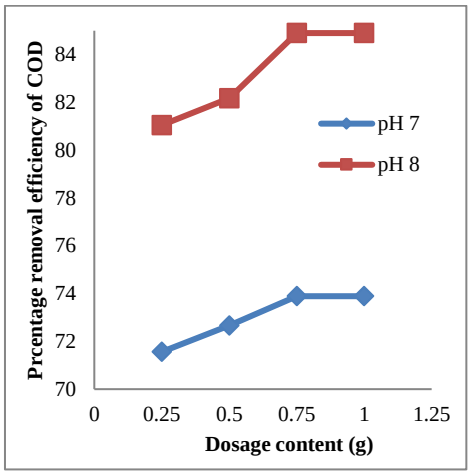

Figure 8 Effect of Dosage content on percentage COD removal efficiency by Zinc Oxide nanopowder (Chemi-sorbent) in treated synthetic dairy wastewater with a COD concentration of 272 mg/l pH 7& 8.

Effect of contact time on percentage removal efficiency of COD in treated synthetic sago wastewater by Zinc oxide nano powder (chemi-sorbent)

The rate of chemisorption was rapid in the initial stages because of the adequate surface area of the chemisorbent was available. After increased contact time, more extent of pollutants got adsorbed onto the surface of the chemisorbent due to Vander Waal's force attraction and the results were decreased in the available surface area. At pH level of 7 with the dosage of 0.5g of Zinc oxide nano powder for the contact time 60 minutes, the percentage COD removal efficiency was 73.89 and 84.90 at pH 8. As the contact time was increased to 120 minutes the percentage COD removal efficiency was also increased to 75.43 at pH 7 and 85.21 at pH 8. By increasing the contact time from 120 to 180 minutes the percentage removal efficiency of COD was increased and by further increasing 180 to 240 minutes the percentage COD removal

efficiency was increased as 80.11 at pH 7 and 88.23 at pH 8 as a maximum. After further increasing the contact time, the percentage removal efficiency did not show significant change in the equilibrium concentration, i.e., the chemisorption phase reached equilibrium conditions.

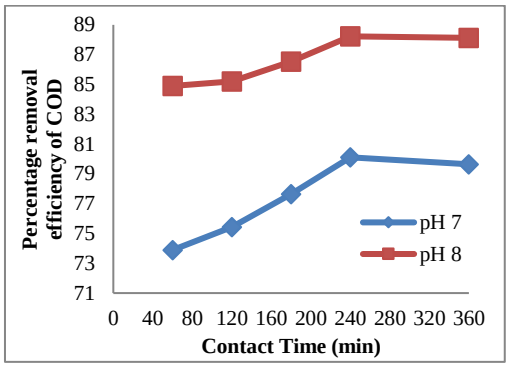

Figure 9 Effect of variation in contact time on percentage COD removal efficiency by Zinc oxide nanopowder (Chemi-sorbent) in treated synthetic dairy wastewater with a COD concentration of 272 mg/l at pH 7 and 8

Conclusions

From the above consequences, it could be concluded that by treating the dairy wastewater aerobically (ABR) could reduce the organic pollutants present in it. However, the COD removal efficiency was 93.20% with an Organic Loading Rate (OLR) of 3.410 Kg COD/m3.day but it was not satisfied for the purpose of reuse. Hence, an attempt of batch study was made as a tertiary treatment with chemisorbent of zinc oxide nano powder and observed the maximum COD removal efficiency of 88.23% with 0.75 g of dosage content at the pH of 8 at the contact time of 240 minutes. Therefore, it is suggested that dairy wastewater can be treated efficiently by Aerobic Bio-Reactor rather than by chemisorption of zinc oxide nano sorbent.

References

[1] Arafat, S.A. Samad, (2015), “Textile dye removal from wastewater effluents using chitosan-ZnO nanocomposite”, J. Text. Sci. Eng. Vol. 5, pp.5–8.

[2] Ahmed Hassan Alamin and Lupong Kaewsichan, (2015), “Adsorption of Zn (II) and Cd (II) ions from aqueous solutions by Bamboo biochar cooperation with Hydroxyapatite and Calcium Sulphate”, International Journal of ChemTech Research, vol. 7, no. 5, pp. 2159-2170.

[3] Ananthu C Mohan, Renjanadevi B (2016), "Preparation of Zinc Oxide Nanoparticles and its Characterization Using Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD)", Procedia Technology, vol. 24, pp. 761 – 766.

[4] APHA, (2017), 23rd Edition. Standard Methods for the examination of water and wastewater. American Public Health Association, Washington D.C., USA.

[5] Awwad, AM, & Salem, NM, (2012), "Green synthesis of silver nanoparticles by Mulberry Leaves Extract", Nanoscience and Nanotechnology, vol. 2, no. 4, pp. 125-128.

[6] Cheng, Y. Le,W. Cai, J. Yu, (2011), "Synthesis of hierarchical Ni(OH)2 and NiO nanosheets and their adsorption kinetics and isotherms to Congo red in water", J. Hazard. Mater. vol. 185, pp. 889–897.

[7] Ballinger, S. J., Head, I. M., Curtis, T. P., & Godley, A. R., (1998), "Molecular microbial ecology of nitrification in an activated sludge process treating refinery wastewater", Water Science and Technology, vol. 37, no. 4–5, pp 105–108.

[8] Banu, JR, Kaliappan, S & Beck, D, (2006), "Treatment of sago wastewater using hybrid anaerobic reactor", Water Quality Research Journal, vol. 41, no. 1, pp. 56-62.

[9] Bhakya, S, Muthukrishnan, S, Sukumaran, M, Muthukumar, M, Kumar, ST & Rao, MV. (2015), "Catalytic degradation of organic dyes using synthesized silver nanoparticles: a green approach", Journal of Bioremediation & Biodegredation, vol. 6, no. 5, pp. 1-6.

[10] Bindhu, M. R., & Umadevi, M. (2013), "Synthesis of monodispersed silver nanoparticles using Hibiscus cannabinus leaf extract and its antimicrobial activity", Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, vol. 101, pp. 184-190.

[11] Chakravarty S., Bhattacharjee S., Gupta K.K., Singh M., Hema T. Chaturvedi, Maity S., (2007). "Adsorption of Zinc from aqueous solution using chemically treated newspaper pulp", Bioresource Technology, pp. 1-6.

[12] Fan H., Yi J., Yang Y., Kho K., Tan H., Shen Z., Ding J., Sun X., Olivo M. and Feng Y. (2011), "Single crystalline MFe2O4 nanotubes/nano-rings synthesized by thermal transformation process for biological applications", Acs Nano, vol. 3, no. 9, pp. 2798–2808.

[13] Fang, H. Y., Chou, M. S., & Huang, C.W., (1993), "Nitrification of ammonia–nitrogen in refinery wastewater", Water Research, vol. 27, pp 1761–1765.

[14] Garima Singhal, Bhavesh, R., Kasariya, K., Sharma, A. R., & Singh, R. P. (2011), "Biosynthesis of silver nanoparticles using Ocimum sanctum (Tulsi) leaf extract and

screening its antimicrobial activity", J. of Nanoparticle Res. vol. 13, no. 7, pp. 2981-2988.

[15] Gonzalez, G., Herrera, G., Garcia, M. T., & Pena, M., (2001a), "Biodegradation of phenolic industrial wastewater in a fluidized bed reactor with immobilized cells of Pseudomonas putida", Bioresource Technology, vol. 80, pp. 137–142.

[16] Gonzalez, G., Herrera, G., Garcia, M. T., and Pena, M., (2001b), "Biodegradation of phenol in a continuous process: comparative study of stirred tank and fluidized bed bioreactors", Bioresource Technology, vol. 76, pp. 245–251.

An Experimental Investigation of Concrete by using Glass Powder and Fly Ash as Partial Replacement of Cement

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Abstract

The effect of adding glass powder to concrete to improve the properties of concrete and also the addition of glass powder and fly ash is to minimize the risk of the environmental pollution. The effect of adding glass powder as an admixture on the durability and the thermal insulation. To understand the effectiveness of glass powder and fly ash in strength. In general, first we are going to collect all the materials such as cement, sand, aggregate, glass powder and fly ash. We conduct fineness test, initial test, final setting time test, consistency test for cement impact test. The compressive strength test is spilt one test, compaction factor test and test for the hardened concrete.M30 mix design can be done by this project. We are going to replace the cement up to 10%, 20%. The compressive strength can be compared by normal concrete to fly ash and glass powder mixed concrete in 7, 14, 28 days. Design work are carried out by IS 456-2000, recommended guidelines for concrete mix design. The use of fly ash concrete admixture not only extents technical advantages to the properties of concrete but also contributes to the environmental pollution control. In India the total production of fly ash is more than 100 million tons. The project details can be used to construct with aesthetic appearance of the building without distributing the environment. This project mainly focuses on reduction cost of construction material and it will give high strength when comparing to ordinary concrete.

Keywords: Glass powder, fly ash, fine aggregate, coarse aggregate, water, compressive strength.

Introduction

In olden days solid wastes were used as landfills in low-lying areas. Industrial wastes like fly ash, silica fume, blast furnace slag etc., And other wastes of plastics, glass, tiles, and agriculture are causing environmental pollution. Glass is an amorphous solid that has been around in various forms for thousands of years and has been manufactured for human use.

Glass is one the most versatile substances on Earth, used in many applications and in a wide variety. Glass occurs naturally when rocks high in silicates melt at high temperatures and cool before they can form a crystalline structure there were large amount wastes glasses present in our world so we planned to replace the glass powder instead of cement. This project mainly focuses on reduction cost of construction material and it will give high strength when comparing to ordinary concrete. A glass powder (GLP) is also used as a binder with partial replacement of cement which takes some part of reaction at the time of hydration; also, it is act as a filler material. A denser (less porous) and more homogeneous structure is produced when milled waste glass is used as partial replacement for cement, which benefits the resistance to moisture sorption and thus the long-term durability of cementations materials. Replacement for about 20% of cement, improves the moisture barrier qualities, durability, and mechanical performance of concrete Replacing cement by pozzolanic material like waste glass powder in concrete, not only increases the strength and introduces economy but also enhances the durability The main concerns for the use of crushed glass as aggregate for Portland cement concrete are the experiment and cracking caused by the glass aggregate due to alkali silica reaction.

Literature Review

Engineer Imad Qasim (2009) doing a study on the impact of glass powder on concrete and he was made some tests these tests include compressive strength, flexural strength, and flow table test (workability test). Twenty kilograms of glass powder was used as a partial replacement for cement and sand (silica and limestone) by 0%, 10%, 15%, and 20%. Concrete mixtures were tested at room temperature, four mixtures were cured by water and three mixtures were cured by high pressure steam curing (autoclaving).

Samtur.H.R, 1974, Seung Bum Park and Bong-Chum Lee, (2004): The use of recycled glass as aggregate greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled glass aggregate have shown better long term strength and better thermal insulation due to its better thermal properties of the glass aggregates (When tested for the Compressive strength values at the 10 %, 40%, and 60 % aggregate replacement by waste glass with 0 – 10mm particle size were 3%, 8% and 5% above the value of Conventional concrete.

Better results are achieved when the waste glass powder replaced either 30 % or 70% of the sand with particles sizes ranging between 50 µm and 100µm. Used glass waste, which is cylindrical in shape, prevents crack propagation in concrete structures. From the research carried out on glass powder by the authors, it was found that glass of particle size 1.18 to 2.36 mm produced the highest expansion where as low expansion was observed at smaller particle sizes.

Idir.R, Cyr.M and Tagnit Hamou. A, 2009 it was observed that with a 30% replacement of cement by amber waste glass content of particle size 75µm along with fly ash, the compressive strength of concrete increase 25% at 7 days and 35% when tested for 28 days strength (Pereira de Oliveira. L.A, J.P. Castro – Gomes, P. Santos, 2008). This effect provides ample evidence that both fly ash and waste glass sand can be used together to produce concretes with relative high strength without any adverse reaction. Particle sizes under that threshold had no effect on length variations. Glass was ground to a particle size of 300 or smaller, the alkali reaction (ASR) induced expansion could be reduced.

Scope and Objective

Objective

The objective of the project is to investigate the development of concrete strength using the investigation is also aimed at finding out the optimum grade of concrete for superior strength while using silica fume, fly ash and M sand, foundry sand.

- To evaluate the utility of Glass powder & fly ash as a partial replacement of cement in concrete.
- The effect of adding Glass Powder to concrete to improve the properties of concrete.
- The benefits of addition Glass Powder and fly ash is to minimize the risk of the Environmental Pollution.
- The effect of adding Glass Powder as an admixture on the durability and the thermal insulation.
- To study and compare the performance of conventional concrete and Glass powder & fly ash concrete.
- To understand the effectiveness of glass powder in strength.

Scope

- To evaluate the recyclability of glass powder and flash as a pozzolana as partial replacement of cement as partial replacement of fine aggregate in the concrete.
- To achieve 28 days characteristic compressive strength
- To study the compressive strength of glass powder and flash concrete and conventional concrete.
- To carry out the comparative study of compressive strength glass powder and flash and conventional concrete.
- To find out optimum grade of concrete at which the concrete yields superior mechanical properties.
- To achieve better concrete composite and to encourage the use of glass powder and granite powder to overcome the environmental impact caused due to waste disposal and over depletion of river sand.

Materials

This chapter presents the details of materials for concrete and the mix designs for performing the experimental study. The materials to be used for the experimental study are detailed as follows

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Glass powder
- Fly ash

Cement

Ordinary Portland cement (OPC) 53grades in one lot was produced and stored in air tight container. The cement used was fresh, used within three months of manufacture. It should satisfy the requirements of IS10262. The property of cement is determined as per IS4031:1968.

Table 1 Typical composition of OPC

S.No	Chemical properties	% by mass
1	Lime	62
2	Silica	22
3	Alumina	5
4	Calcium Sulphate	4
5	Iron Oxide	3
6	Magnesium Oxide	1
7	Sulphur Trioxide	1
8	Alkalis	1

Fine Aggregate

Fine aggregate used in this investigation was medium sand properties of the fine aggregate used in the experimental work. Advantage of natural sand is that the particles are cubical or rounded with smooth surface texture. The grading of natural fine aggregate is not always ideal. It depends on place to place. Being cubical, rounded and smooth textured it gives good workability. Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, lower shrinkage and greater durability.

Table 2 properties of fine aggregate

Properties	Fine Aggregate
Shape	Angular
Gradation zone	Zone II
Specific gravity	2.50
Fineness modulus	2.95

Coarse Aggregate

Locally available in coarse aggregates having the maximum size of 10 mm and 20 mm were used in the present work. Coarse aggregate is chemically stable material in concrete.

Table 3 properties of coarse aggregate

S No.	Properties	Values
1	Specific gravity	2.60
2	Total water absorption	0.8%
3	Fineness modulus	10%
4	Impact value	29.2%
5	Crushing value	18.39%
6	Flakiness index	12.84%
7	Elongation index	16.43%

Glass Powder

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and calcium carbonate at high temperature followed by cooling during which solidification occurs without crystallization. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The amount of waste glass is gradually increased over the recent years due to an ever-growing use of glass

products. Most waste glasses have been dumped into landfill sites. The Land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. So, we use the waste glass in concrete to become the construction economical as well as eco-friendly.

Figure 1 Glass powder

Figure 2 Fly ash

Fly Ash

Fly ash is the most widely used pozzolanic material all over the world. In the recent time, the importance and use of the fly ash in concrete has grown so much that it has almost become a common ingredient in concrete, particularly for making high strength and high-performance concrete. High volume of fly ash concrete is a subjected of current interest all over the world. The use of fly ash as concrete admixture not only extents technical advantages to the properties of concrete but also contributes to the environmental pollution control.

Table 4 Chemical Composition of fly ash

S.No.	Chemical Constituents of Fly ash	% by mass
1	Silica	50.41
2	Alumina	30.66
3	Potassium oxide	0.31
4	Iron oxide	3.34
5	Magnesium oxide	0.93
6	Sulphur Trioxide	1.71
7	Sodium oxide	3.07
8	Lime	3.04
9	Tio2	0.84

Manufactured sand as a construction raw material neither imposes risks to the human kind nor to the environment. Specific gravity of M-Sand is 2.75 and fineness modulus is 2.74.

Water

The potable water available in college campus was used for mixing and curing of concrete. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients. It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact properties. The quality of water was found to satisfy the requirement of IS456-2000.

Mix Design

The mix shall be designed to produce the grade of concrete having the required workability and the characteristic strength. The properties are either by volume or by mass. The water-cement ratio is usually expressed in mass.

Factor to be considered

The grade designation giving the characteristic strength requirement of concrete.
The type of cement influences the rate of development of compressive strength of concrete.
Maximum nominal size of aggregates.
The cement content is to be limited from shrinkage, cracking and creep.
The workability of concrete and maximum temperature of concrete at the time of placing.

Casting and Curing

The main objective of the test program is to study the strength characteristic of concrete with replacement of Silica Fume and Fly ash. The main parameters were studies the compressive, Split tensile and Flexural strength.

Casting of cubes

Initially the constituent materials were weighed and dry mixing was carried out for Cement, Fine aggregate, Coarse aggregate, Silica Fume and Fly ash, M sand. The was thoroughly mixed manually to get uniform colour of mix. The mixing was carried out for 3-5 minutes duration. Then the mix poured in to the cube moulds of size 150x150x150mm and then compacted manually using taming rods. Cubes are prepared by using the mixes of M30 Grade namely conventional concrete and concrete made by replacing 10%, 20%, 30%, 40%, 50% of Silica Fume, Fly ash, M sand and Foundry sand

Casting of cylinders

Initially the constituent materials were weighed and dry mixing was carried out for Cement, Fine aggregate, Coarse aggregate, Silica Fume, Fly ash, M sand, Foundry sand. This was thoroughly mixed manually to get uniform colour of mix. The mixing was carried out for 3-5 minutes duration. Then the mix poured in to the cylinder mould by layer by layer and each layer effectively compacted by the cylinder of 150mm dia and 300mm height were casted for each design mixes.

Casting of RCC Beams

The concrete mixes were filled in the Beam moulds after laying the reinforcements with the required cover and compacted effectively by using damping rod. The beams dimensions 700x100x100mm were casted for each design mixes.

Curing

The Cubes, Cylinders and Beams are de-moulded after 1 day of casting and then kept in water for curing at normal temperature. The concrete specimens are taken out from curing tank after 7days, 14days and 28days for testing. Curing is a procedure that is adopted to promote the hardening of concrete under condition of humidity and temperature which are conducive to the progressive and proper setting of the constituent cement. They should be sent to the testing laboratory well packed in damp sand, damp sacks, or other suitable material so as to arrive there in a damp condition not less than 24 hours before the time of test Concrete that has been specified, batched, mixed, placed, and finished can still be a failure if improperly or inadequately cured.

Testing of Specimens

The following tests are conducted to the casted concrete specimens.

Compressive Strength Test: The tests were carried out on 150x150x150mm size cube, The compression test is the most common test conducted on the hardened concrete, partly because it is an easy test conducted on the and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compressive test is carried out on specimens cubical or cylindrical in the shape. The specimen was placed between the steel plates of the compression-testing machine. The load is applied and the failure load in KN is observed from the dial gauge of the Compression Testing Machine. The

compression test on cubes was conducted according to Indian Standard specifications. The compressive strength of the cube specimen is calculated using the following formula:

Compressive Strength, fc=P/A N/mm^2.

Split Tensile Strength Test: A direct measurement of ensuring tensile strength of concrete is difficult. This is an indirect tensile test. The split tensile strength test was carried out on the universal testing machine. The split tensile strength of the cylinder specimen is calculated using the following formula:

Split Tensile Strength, f =2p/ΠDL N/mm^2 Where, P = Load at failure in N

L = Length of the Specimen in mm

D = Diameter of the Specimen in mm

Flexural Strength Test: Flexural strength, also known as modulus of rupture, bending strength or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The value of modulus of rupture depends on the dimension of the beam and type of loading. The loading is central or third –point loading. In the third –point the critical crack may appear at any section, where the bending moment is maximum or the resistance is weak. The flexural strength represents the highest stress experienced with in material at terms of stress, here given the symbol calculated using the following formula:

The flexural strength when a >133 mm for 100 mm specimen, f fb = Pa/bD2

The flexural strength when a < 133 mm for 100 mm specimen, f fb = 3Pa/bD2

b = measured width of specimen in mm

D = measured depth in mm of the specimen at the point of failure.

a = distance of the crack from the nearer support in mm

P = maximum load in N applied to the specimen.

Results and Discussions

Compressive Strength

Compressive strength of concrete is the one of most important property of the hardened concrete. The concrete cubes were casted and tested accordance with the IS standard and 7, 14 and 28 days. Compressive strength results of concrete. The highest compressive strength value is 39.18 Mpa which is obtained at 28 days for M 30 grade by replacement of 10% ,20% ,30%. Curing periods for the various mixes. The compressive strength is gradually increased when the grade of concrete is increased.

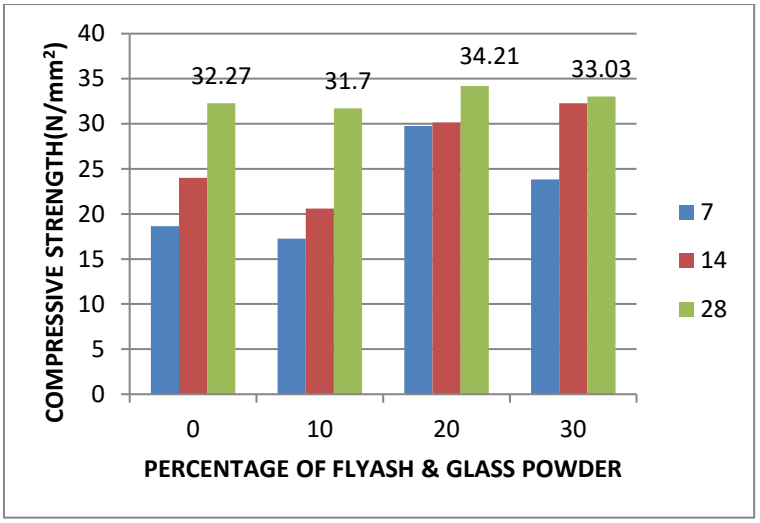

Figure 3 Comparison graph for Compressive strength on M30 grade concrete with 10%, 20%, 30% replacement of GLP & FLYASH

Split Tensile Strength

After curing of Cylinder specimen, they are placed in testing machine. The load is applied on the cylinder specimens. The cylinder specimen is failed at ultimate load which is noted from dial gauge reading. From the result.

Split tensile strength is most important property of the hardened concrete. The concrete cylinders were cast, cured and tested accordance with the IS standard and 7 ,14 and 28 days split tensile strength results of concrete. Based on the result, the highest split tensile strength value is 7.0 Mpa (for M 30) which is obtained at 28 days by replacement of 10%, 20%, 30% fly ash and glass powder the split tensile strength of concrete for various mixes. Strength is increased 16.2% than the conventional concrete.

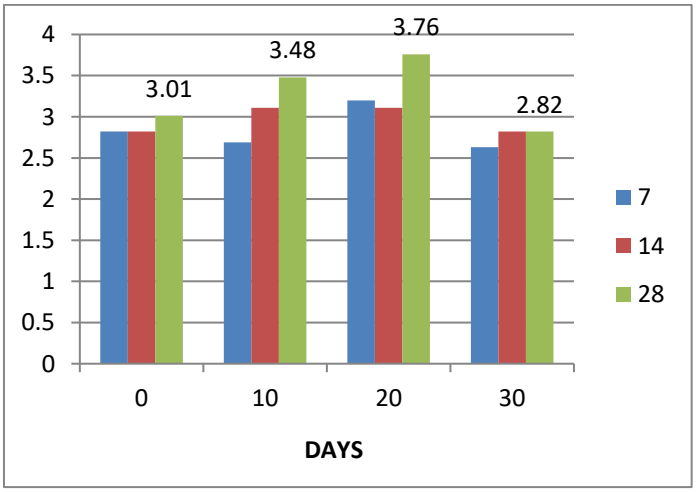

Figure 4 Comparison graph for split tensile strength on M30 grade concrete with 10%,20%,30% replacement of GLP & FLYASH

Flexural Strength

After curing of beam specimen, they are placed in testing machine having a maximum capacity of 40 tonne. The load is applied on the beam specimens. The specimen is failed at ultimate load which is noted from dial gauge reading. From the result flexural strength is increased with respect to the grade of concrete when adding 10%, 20%, 30% of fly ash and glass powder when compared to the conventional concrete.

Summary and Conclusions

At the level of 20% replacement of cement by glass powder meets maximum strength as compare to that of normal concrete and other percentage of replacement of cement.

Conventional concrete shows at 28 days compressive strength as 32.27 N/mm^2 split tensile strength of 3.01N/mm^2.

1. Replacement of glass powder and fly ash in cement by 10%, 20% and 30% increases the compressive strength by 31.70 N/mm^2, 34.21 N/mm^2, and 33.03 N/mm^2, respectively.
2. Replacement of glass powder and fly ash in cement by 10%, 20% and 30% increases by 3.48 N/mm2, 3.70 N/mm2, and 2.82 N/mm^2 respectively.
3. Glass powder concrete increases the compressive and tensile strength effectively, when compared with conventional concrete.
4. Very finely ground glass has been shown to be excellent filler and may have sufficient pozzolonic properties to serve as partial cement replacement, the effect of ASR appear to be reduced with finer glass particles, with replacement level.

References

[1] Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, (2012) “Soil Mechanics and Foundations”, Laxmi Publications (P) Ltd.

[2] N. Krishnaraju (2012), “Reinforced Concrete Structures”, Laxmi Publications (P) Ltd.

[3] M.S Shetty (2013) “Concrete Technology Theory and Practice”, S.Chand & Company pvt.ltd.

[4] Dr. P. Jayarani Reddy (2011), “Concrete and its Structures”, Laxmi Publications (P) Ltd.

[5] P. Purshothama Raj (2013), “Construction Techniques Equipment and Practices”, Laxmi Publications (P) Ltd.

[6] IS 12269-1995, Specifications for 53 grade Ordinary Portland Cement, Bureau of Indian Standard, New Delhi.

[7] IS 650-1991, Standard sand for testing cement specification, Bureau of Indian Standard, New Delhi.

[8] IS: 383-1970, Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi, India.

[9] IS 10262-1982, Recommended guidelines for concrete mix design, Bureau of Indian Standards, New Delhi, India.

Geopolymerised Industrial by Product of Soil Subgrade for Pavement as Experimental Study

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Abstract

Pavement subgrade is the original ground underneath a road pavement which is made up of native soil compacted to withstand the repetitive dynamic loads above it. The scarcity of raw materials and the rising prices results in a number of obstacles in the field of highway constructions. Incorporating industrial wastes in pavement construction not only provides a source of raw materials, but it also gives waste management a bright future. Iron ore tailing is a by-product of mining industry which is usually piled up in the form of tailing ponds. The tailing ponds tend to collapse when accumulated in large amounts and can destruct the nearby areas. The disposal of iron ore tailing is a cost intensive process and its accumulation results in wastage of useful land. Fly ash is also a waste product produced from the combustion of coal in thermal power plants. It can also cause serious environmental and health hazards if unattended. Different combination of fly ash and iron ore tailings are made by replacing IOT with fly ash at replacement rates of 10%, 20% and 30% by weight and tests are conducted to know the index and engineering properties. UCS and CBR results of iron ore tailing blended with 30% fly ash satisfies IRC guidelines and it shows improvement in other properties also. This project provides a promising future for the valorisation of industrial waste, as well as a reserve for raw material supply.

Keywords: Geopolymer, Compressive strength, Industrial waste, UCS, CBR.

Introduction

Industrial waste is one category of waste, which is generated predominantly with the globalization and industrialization in developing countries, such as India. Recently, major solid waste has been industrial waste and construction or demolished waste. Industrial wastes such as IOT and FA can be used in pavement construction as subgrade material. India is one of the major iron ore producers and exporters in the world. In mining industries, the extraction of the targeted resource results in the production of a significant volume of waste material called mine

tailings. It consists of crushed rock and processing fluids from mills, washers or concentrators that remain after the extraction of metals, minerals or coal. The volume of tailings is normally far in excess of the liberated resource, and the tailing often contain potentially hazardous contaminants which can harm the environment. These tailings are piled up in tailing ponds. As the tailings are in slurry form, it exhibits fluidity and can collapse which leads to the destruction of the surrounding area. So, the importance of management of iron ore tailing cannot be overstated.

Fly ash is another industrial waste which is produced in thermal power plants as. Fly ash contains micro-sized particles which can create both environmental and health hazards. It causes cancer and other respiratory diseases. In addition to deposition problem, this can result in environmental threats like pollution of waterways, ground water, drinking water, air etc. Using this waste in construction industry will reduce the problem in great extent. This practice gives an insight to the disposal of materials in a sustainable and economic manner by reusing and recycling them. It also functions as a raw material reserve and helps to conserve natural resources.

Pavement subgrade soil is the base of road bed which is important for structural and pavement life. Under dynamic loading, it should be strong enough to prevent excessive deflection.

Iron ore tailings along with a suitable binder can be used as a pavement construction material due to its strength and hydraulic properties. Fly ash proves to be an efficient binder in various industries due to its pozzolan city. Measurable cohesion can be achieved in fly ash under moist condition which made it a good construction material. Iron ore tailing blended with fly ash can be used as a pavement subgrade material. It also has other sustainable benefits and contributes to circular economy. In a nutshell, this project will allow for the efficient utilization of industrial waste in construction industry. Same way the project uses geopolymer instead of water. The geopolymer is sodium silicate and sodium hydroxide. As this is used for activating fly ash which can be used for increasing strength and durability.

The management of wastes piled up in various industries is one of the major challenges in today's world. Studies on valorisation of waste have gained a lot of interest in recent years. Iron ore tailing improves soil properties due to its strength and index properties. Fly ash can be used as a suitable binder in pavement construction industry due to its pozzolan city. Incorporation of fly ash and iron ore tailings in construction sector not only provides a

sustainable pavement material but also a cost-effective waste management technique. Moreover, it acts as a raw material reserve for construction industry.

Materials

Iron Ore Tailing

Iron ore tailings (IOTs) are a form of solid waste produced during the beneficiation process of iron ore concentrate. In this paper, iron recovery from IOTs was studied at different points during a process involving pre-concentration followed by direct reduction and magnetic separation. Then, slag-tailing concrete composite admixtures were prepared from high-silica residues. Based on the analyses of the chemical composition and crystalline phases, a pre-concentration test was developed, and a pre-concentrated concentrate (PC) with an iron grade of 36.58 wt. % and a total iron recovery of 83.86 wt % was obtained from a feed iron grade of 12.61 wt. %. Furthermore, the influences of various parameters on iron recovery from PC through direct reduction and magnetic separation were investigated. The optimal parameters were found to be as follows: A roasting temperature of 1250 °C, a roasting time of 50 min, and a 17.5:7.5:12.5:100 ratio of bit mite/sodium carbonate/lime/PC.

Table 1 Physical properties of iron ore tailings

Physical Properties	Value
Specific gravity of solids	2.916
Uniformity coefficient	10.7
Coefficient of curvature	3.9
Mean particle diameter (mm)	0.085
Medium sand (0.425mm < d < 0.200mm)	4
Fine sand (0.075 mm < d < 0.425mm) (%)	49
Silt (0.002mm < d < 0.075mm) (%)	42
Clay (d < 0.002mm) (%)	5
Optimum moisture content at standard energy compaction (%)	11.6

Table 2 Chemical composition of iron ore tailings

Chemical Component	Composition
Silica (SiO2)	9.02
Ferric Oxide (Fe2O3)	66.56
Alumina (Al2O3)	9.56
Calcium Oxide (CaO)	1.96
Magnesium Oxide (MgO)	2.12
Titanium Oxide (TiO2)	0.66

Fly ash

Fly ash is also an industrial waste which is produced in thermal power plants as a result of coal combustion. Fly ash contains micro-sized particles which can create both environmental and health hazards. Fly ash can be used as a suitable binder in pavement construction industry due to its pozzolan city. Iron ore tailing is replaced with fly ash in different replacement rates to get an efficient pavement subgrade material. Tests on iron ore tailing with 10%, 20%, 30% fly ash to know the strength characteristics and based on which the suitability of IOT-fly ash as pavement subgrade material can be suggested.

Figure 1 Iron ore tailing

Figure 2 Fly ash sample

Table 3 Physical properties of fly ash

Physical Properties	Value
Bulk Density (gm/cc)	0.9-1.3
Specific Gravity	1.6-2.6
Plasticity	Lower or non-plastic
Shrinkage Limit (Volume Stability)	Higher
Grain size	Major fine sand
Clay (%)	Negligible
Free swell index	Very low
Classification (Texture)	Sandy silt to silty loam
Water holding capacity (%)	40-60
Porosity (%)	30-65
Surface area (m2/kg)	500-5000

Table 4 Chemical Composition of fly ash

Chemical Properties	Composition
Silica (SiO2)	64.58
Ferric Oxide (Fe2O3)	5.27
Alumina (Al2O3)	25.89
Calcium Oxide (CaO)	0.59
Magnesium Oxide (MgO)	0.26
Sodium Oxide (Na2O)	0.027

Sodium Hydroxide

Sodium hydroxide, also known as lye and caustic soda is an inorganic compound with the formula NaOH. It is a white solid ionic compound consisting of sodium cations Na+ and hydroxide anions OH−.

Sodium hydroxide is a highly corrosive base and alkali that decomposes proteins at ordinary ambient temperatures and may cause severe chemical burns. It is highly soluble in water, and readily absorbs moisture and carbon dioxide from the air. It forms a series of hydrates. The monohydrate NaOH·H2O crystallizes from water solutions between 12.3 and 61.8 °C. The commercially available "sodium hydroxide" is often this monohydrate, and published data may refer to it instead of the anhydrous compound.

Figure 3 Sample of sodium hydroxide

Figure 4 Sample of sodium silicate

Sodium Silicate

Sodium silicate is a generic name for chemical compounds with the formula. The anions are often polymeric. These compounds are generally colourless transparent solids or white powders, and soluble in water in various amounts. Sodium silicate is also the technical and common name for a mixture of such compounds, chiefly the met silicate, also called water glass, water glass, or liquid glass. The product has a wide variety of uses, including the formulation of cements, passive fire protection, textile and lumber processing, manufacture of refractory ceramics, as adhesives, and in the production of silica gel. The commercial product, available in water solution or in solid form, is often greenish or blue owing to the presence of iron-containing impurities.

In industry, the various grades of sodium silicate are characterized by their SiO2:Na2O weight ratio (which can be converted to molar ratio by multiplication with 1.032). The ratio

can vary between 1:2 and 3.75:1. Grades with ratio below 2.85:1 are termed alkaline. Those with a higher SiO2:Na2O ratio are described as neutral.

Table 5 Physical properties of sodium silicate

Density	40.4 – 42.0
Dry matter	37.50 – 39.50%
Molar Ratio	3.30 – 3.50
Weight Ratio	3.20 -3.40
SiO2	29.50%
Na2O	9.00%

Methodology

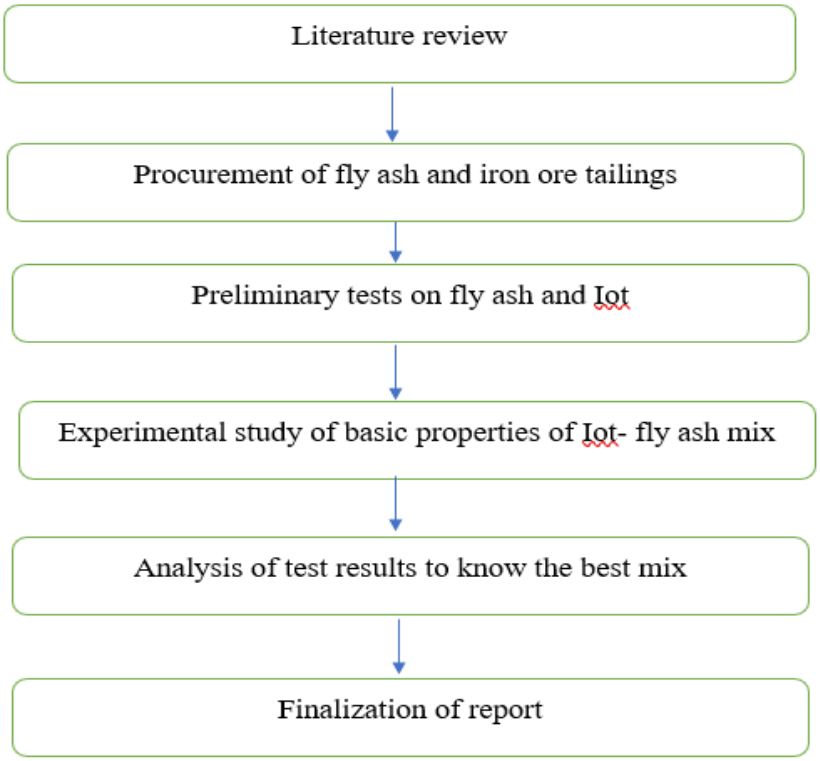

Figure 5 Flow chart

Results and Discussions

Variation of Specific gravity

Specific gravity is an important property as far as geotechnical properties are concerned. Upon addition of fly ash, specific gravity of fly ash decreases due to the low density of fly ash.

Specific gravity of iron ore tailing. The readings obtained from pycnometer test is given in the table. Specific gravity of iron ore tailings using pycnometer.

Table 6 Specific Gravity test results of IOT

Determination number	1	2	3
Weight of pycnometer, W1 (kg)	0.509	0.509	0.509
Weight of pycnometer+ IOT, W2 (kg)	0.945	0.96	0.95
Weight of pycnometer+ IOT + water, W3 (kg)	1.85	1.84	1.84
Weight of pycnometer + full of water, W4 (kg)	1.542	1.542	1.542
Specific gravity, G = (W2-W1)/((W2-W1)-(W3-W4))	3.406	2.948	3.084

Particle size analysis

Particle Size Distribution of grains of different sizes in each soil is an important property of soil. In general, a combined analysis is carried out as most soils contain both coarse and fine particles. The readings are depicted in the following tables. Particle size analysis of iron ore tailings.

Table 7 Particle size analysis

Sieve No	Sieve opening	Weight of soil retained, kg	Percent retained	Cumulative percent retained	Percent finer
4.75	4.75	0.23	7.667	7.667	92.333
2.36 mm	2.36	0.086	2.867	10.533	89.467
1.18 mm	1.18	0.695	23.167	33.700	66.300
600 microns	0.6	0.269	8.967	42.667	57.333
300 microns	0.3	0.478	15.933	58.600	41.400
150 microns	0.15	0.597	19.900	78.500	21.500
75 microns	0.075	0.32	10.667	89.167	10.833
Pan		0.312	10.400	99.567	0.433

CBR

CBR (California Bearing Ratio) test is conducted on iron ore tailings. It is the ratio expressed in percentage of force per unit area required to penetrate a soil mass with a standard circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. The ratio is usually determined for penetration of 2.5 and 5 mm. The California Bearing Ratio is a measure of the strength of the subgrade of a road or other paved area, and of the materials used in its construction.

In this method the combination of load penetration test performed in the laboratory or in-situ along with empirical design charts are analysed to determine the thickness of pavement and its constituent layers.

For designing the flexible pavement this is one of the most commonly used method. The thickness of the various elements comprising a pavement is determined by CBR values. The CBR test is a small-scale penetration test in which a cylindrical plunger of 5 cm in diameter is used. Cross-section is penetrated into sub-grade material, at the rate of 0.05 in per minute i.e.

The penetration resistance of the plunger into a standard sample of crushed stone for the corresponding penetration is called the standard load. Standard loads adopted for different penetrations for the standard material with a CBR value of 100% is given below in the table. From the experimental results of soaked California Bearing Ratio test on expansive soil treated with increasing percentage of ceramic dust from 0% to 30%, there is an increase in CBR values from 2 % to 3.5%. The MDD increases with increase in the percentage of ceramic dust, it results in increase in both the UCS and CBR values of the soil.

Based on the experimental study the thickness of the pavement has found by using IRC 37:2001. The thickness of the sub-base course pavement for 10 msa of untreated soil is 850 mm and treated soil with ceramic dust; it attains maximum strength at 10% of ceramic dust with soil. The sub-base pavement thickness for treated soil is 796mm. The CBR value goes on increasing with increasing the percentage of ceramic dust. The optimum content of soil with ceramic dust was arrived at 10%

Conclusions

The Liquid limit, Plastic limit and Plasticity index goes on decreasing with the increasing percentage of in-addition of Iot-fly ash mix. The UCS, MDD and soaked CBR goes on increasing and OMC goes on decreasing, with the increase in percentage of Iot-fly ash mix. The pavement design was made for the flexible pavement construction initially the pavement sub-base course thickness was obtained as 850mm, after adding Iot-fly ash mix the sub-base course thickness was reduced as 760mm. In addition of Iot-fly ash the total cost of the pavement construction is reduces and economical

References

[1] Baser, O, (2009), “Stabilization of Expansive Soils Using Waste Marble Dust,” Master of Science thesis submitted to Civil Engineering Department, Middle East, Technical University.

[2] Binici, H. (2007), “Effect of Crushed Ceramic and Basaltic Pumice as Fine Aggregates on Concrete Mortars Properties,” Construction and Building Materials, vol. 21, pp. 1191-1197.

[3] Chen, F.H. (1988), “Foundations on Expansive Soils”, Elsevier Science Publication, Newyork.

[4] Koyuncu, H., Guney, Y., Yilmaz, G., Koyuncu, S., and Bakis, R. (2004), "Utilization of Ceramic Wastes in the Construction Sector." Key Engineering Materials, vol. 264-268, pp. 2509-2512.

[5] Nelson, D.J., and Miller, D.J. (1992), "Expansive Soils, Problems and Practice in Foundation and Pavement Engineering", John Wiley and Sons, Newyork.

[6] Palaniappan, K.A. and Stalin, V.K. (2009), "Utility effect of Solid Wastes in Problematic Soils", International J. of Emerging Trends in Engineering and Development, vol. 1, no. 2, pp. 42-49.

[7] Sabat, A.K., and Nandha, R.P. (2011), "Effect of Marble dust on Strength and durability of Rice Husk Ash Stabilised Expansive Soil, "International Journal of Civil and Structural Engineering, vol. 1, no. 4, pp. 939-948.

[8] R Saravanan, K R Sowmiya, R. Ramya, (2013), "The effect of waste ceramic dust on strength properties of clay soil in pavement construction", International J. of Research in Civil Engineering. Architecture, & Design, vol. 1, no. 2, pp. 68-74.

[9] IRC: 37-2001, "Guidelines for the Design of Flexible Pavements".

Experimental Research on the Performance of Extraordinary Composition of Bricks Over Conventional Bricks

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Abstract

This paper provides to experimentally investigate and achieved to study the performance of different composition of clay bricks over convectional clay bricks. Four types of bricks with different raw materials were cast and their characteristic properties were tested. The four types of bricks were Type 1: RSS (Red Soil + Sand), Type 2: RSC (Red Soil + Cement), Type 3: Cement Brick, Type 4: CPC (Coir Pith + Cement). The various tests conducted for this project were Compressive strength, Water absorption test, Soundness test, Size and Shape test and Efflorescence test. Comparative studies also to find the behaviour of different composition of clay bricks over conventional clay bricks by Compressive strength, Water absorption test, Soundness test, Size and Shape test and Efflorescence test. The 7, 14, 21, 28 days compressive strength of four types of bricks and conventional clay bricks was observed and tabulated. The comparative study was interpolated graphically. A realistic approach was adopted by utilizing the locally available natural resources for obtaining raw materials in the making of bricks, cleaning of raw materials included removal of dried vegetation, small stones decayed material, organic substance from the clay soil. Blending of various raw materials in required ratios, kneading of ingredients, burning process of bricks was carried out as codal recommendations. Thus, this reviewed approach on bricks from waste as well as useful materials like coconut fibre provided potential and sustainable solutions.

Keywords: Red soil, Cement, Clay and Coir Pith.

Introduction

An adequate shelter is a basic human need, yet about 80% of the rural populations in developing countries still live in spontaneous low-quality settlements, as they cannot afford the high cost of building materials. One alternative for the expensive materials is to use natural soil stabilized bricks because they have been identified as low-cost material with the potential of reducing the problem of living in sub-standard houses. An upcoming and worldwide spoken

concept is the development of green environment, where the use of natural building materials is encouraged in order to reduce the environmental heat evolved from the man-made building materials. The above said technology uses the available soil on site, which is stabilized with a small amount of cement or/and lime depending on the characteristics of the soil so as to improve the engineering properties of the produced blocks.

Table 1 Collection of materials

S. No	Materials used
1	Red soil
2	Fine Aggregate
3	Cement
4	Coir Pith
5	Water

Materials used

Clay- Clay is the chief ingredient and should contain of 20-30%. It imparts plasticity to brick earth for easy moulding. It becomes very hard on burning. Clay is a fine-grained natural rock or soil that combines one or more clay minerals with traces of metal oxides and organic matter. Clay soil consist soil particles having size between 0.001-0.01mm.

Fine Aggregate - Sand is a naturally occurring granular material, composed of finely divided rock and mineral particles. The major composition of sand is silica. Natural river sand was used as a fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-1). The results are shown in test data of materials. The results obtained from sieve analysis are furnished. The results indicate that the sand conforms to zone 11 of IS: 383-1970.

Cement - Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement is made up of four main compounds: tricalcium silicate (3CaO SiO2), dicalcium silicate (2CaO· SiO2), tricalcium aluminate (3CaO Al2O3), and a tetra-calcium aluminoferrite (4CaO Al2O3Fe2O3).

Coir Pith - A spongy material that binds the coconut fibre in the husk. Coir pith is finding new applications. It is an excellent soil conditioner and is being extensively used as a soil-less medium for Agri-horticultural purposes. The coir pith is washed, heat-treated, sieved to remove large particles, and graded. Very often it is compressed into blocks or bricks, which need to be soaked before using. You may also find bags or bales of coir.

Water - Water is a transparent, odourless, and nearly colourless chemical substance that is the main constituent of earth's streams, lakes, and the fluids of most living organisms. The water used for mixing of brick and should be potable drinking water having pH 6 to 8.

Experimental Investigation

Testing of Materials

The specific gravity test is done on all materials to determine its specific gravity values, which are used to find the calculation of mix ratio by using their density value. Where the specific gravity test is used for cement, FA and Clay is done by using specific gravity bottle.

Specific Gravity Test Result

Cement: The specific gravity of the cement is found out using specific gravity bottle apparatus. 10 grams of cement, kerosene is taken to conduct this experiment. Then the average specific gravity of cement is 3.09

Fine Aggregate: The specific gravity of the Fine aggregate is found out using specific gravity bottle apparatus. 10 grams of sand, water is taken to conduct this experiment. Then the specific gravity of river sand is 2.8.

Red Soil: The specific gravity of the red soil is found out using specific gravity bottle apparatus. 10 grams of soil, water is taken to conduct this experiment. The specific gravity of soil is 2.70.

Preliminary Investigation of Specimens

Preparation of Mould

Mould dimension of brick is (190X90X90) mm. For every mix of sample three trials are conducted. These bricks are dried naturally in sun-light for 14 days and then placed for oven heating for 2 days. After oven heating then it is cooled at room temperature for 2 days.

Type 1 RSS Brick - In this Type 1 RSS (Red Soil + River Sand) brick, the red soil & Sand are used as raw materials. The ratio we have selected to casting is 3R:2FA. No chemicals were added.

Type 2 RSC Brick -In this Type 2 RSC (Red Soil + Cement) brick, the red soil & Cement are used as raw materials. The ratio we have used is 1:3 i.e.: 1 part of cement & 3 part of red soil. Additionally, no chemicals were added.

Type 3 – Cement Brick- In this Type 3 Cement brick, we have selected the raw materials are cement (OPC) & Fine Aggregate. The mix ratio we used 1:2 (i.e.) 1 part of cement & 2 part of sand.

Type 4 – CPC Brick- In this Type 4 CPC (Coir Pith + Clay) brick, we used Coconut fibre, Coir rope wastage & Clay as raw materials. The ratio we selected is (1:100) 10 g of coir for 1kg of clay.

Figure1 Type 1-Red Soil+Sand (3:2) 60% of Soil 40% of Fine Aggregate

Figure 2 Type 2-Red Soil + Cement (1:3) 25% of cement + 75% of soil

Figure 3 Type 3- Cement Brick (1:2) (1 Part cement 2 Part FA)

Figure 4 Type 4 -Coir Pith + Soil Bricks (1:100) 10g of coir for 1Kg of soil

Figure 5 Types of Bricks 1, 2, 3 and 4

Results and Discussion

Size & Shape Test: In this test should be of standard size and it should be truly rectangular with sharp edges. For this purpose, 20 bricks of standard size are selected at random and they are stacked lengthwise, along the width and along the height. Sizes of brick = 190mm × 90mm × 90mm

Soundness Test: Two bricks are taken one in each hand and they are struck with each other lightly. The bricks should not break and clear ringing sound be produced.

Efflorescence Test: The presence of alkalis in bricks is harmful and they form a grey or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks this test is performed. In this test a brick immersed in fresh water for 24 hours and then it taken out from water are allowed to dry state. If the whitish layer is not formed on surface, it proves the absence of alkalis in bricks. If the whitish layer is formed about 10% of brick surface, then the presence of alkalis in brick

Water Absorption Test: The water absorption of bricks is not related directly to the porosity of the bricks. Some of pores may be through pores which permit air to escape and allow free passage of water in absorption test. The test is done by immersing the brick in water for 24 hours. % of water absorption = (W2 –W1) / W1) × 100 W1 = Dry weight of brick in Kg W2 = Wet weight of brick in Kg.

Compression Strength: The compressive stress formula is: CS = F / A, where CS is the compressive strength, F is the force or load at point of failure and A is the initial cross-sectional surface area.

Minimum crushing strength of brick is 3.5 N/mm².

Table 1 Type 1: Compression Test for RSS Brick

Specimen No	Perfectional Area (m)	Load in KN	Compressive Strength (N/mm²)
1. (7 days)	0.19 x 0.09	81.6	4.77
2. (14 days)	0.19 x 0.09	83	4.85
3. (21days)	0.19 x 0.09	88	5.15
4. (28days)	0.19 x 0.09	90	5.26

Table 2 Type 2 Compression Test for RSC Brick

Specimen No	Perfectional Area (m)	Load in KN	Compressive Strength (N/mm²)
1. (7 days)	0.19 x 0.09	115	6.72
2. (14 days)	0.19 x 0.09	121	7.05
3. (21days)	0.19 x 0.09	130	7.60
4. (28days)	0.19 x 0.09	135	7.89

Table 3 Type 3 Compression Test for Cement Brick

Specimen No	Perfectional Area (m)	Load in KN	Compressive Strength (N/mm^2)
1. (7 days)	0.19 x 0.09	190.5	11.14
2. (14 days)	0.19 x 0.09	215	12.25
3. (21days)	0.19 x 0.09	223	13.04
4. (28days)	0.19 x 0.09	231	13.51

Table 4 Type 4 Compression Test for CPC Brick

Specimen No	Perfectional Area (m)	Load in KN	Compressive Strength (N/mm^2)
1. (7 days)	0.19 x 0.09	90.5	5.27
2. (14 days)	0.19 x 0.09	94	5.49
3. (21days)	0.19 x 0.09	104	6.08
4. (28days)	0.19 x 0.09	108	6.30

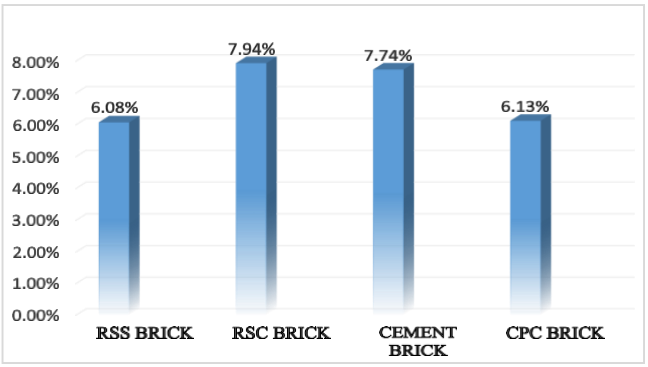

Figure 6 Compression Strength Test Results for Bricks

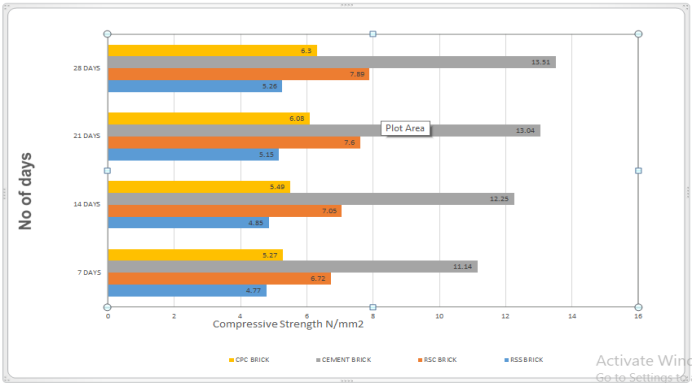

Figure 7 Graph of Compression strength Test Results for bricks

Conclusions

The results of experimental and analytical study of comparison of bricks were studied. The experimental setup models have the same structural conditions stipulated as per Indian

Standards. Based on the above experimental and analytical studies the following conclusions are drawn.

Type 1 RSS Brick – It attains the strength of 5.26 N/mm^2. It gives the result of low compression value which is not suitable for high load structure.

Type 2 RSC Brick - It attains the strength of 7.89 N/mm^2. It gives the result of high durability and average compression value.

Type 3 Cement Brick - It attains the strength of 13.51 N/mm^2. It gives the result of normal strength, durability etc.

Type 4 CPC Brick- It attains the strength of 6.30 N/mm^2. It gives an additional protective strength from cracks and also increase the durable.

Acknowledgment

We would like To thanks to Our Principal, Head of the Department and the entire teaching and non-teaching faculty, Department of Civil Engineering, for their constant encouragement during the project work.

References

[1] I.M. Attar, Prof. A.K. Gupta, "Application of Foundry Sand in Civil Construction" International J. of Mechanical and Civil Engineering, pp. 38-42.

[2] B.V.Venkatarama Reddy, (1994), "Pressed Soil Cement Blocks: An Alternative Building Material for Masonry" J. of materials in civil engineering, pp. 425-433.

[3] Eknath P. Salokhe, D.B. Desai, "Application of Foundry Sand in Manufacture of Concrete" International J. of Mechanical and Civil Engineering, pp. 43-48.

[4] Nithiya, R. (2016), "Experimental investigation on bricks by using various waste materials", International J. of Latest Trends in Engineering and Technology, vol. 6.

[5] Raut, S.P., R.V. Ralegaonkar, S.A. Mandavgane, (2011), "Development of sustainable construction material using industrial and agricultural solid waste: A review of waste create bricks", J. of Construction and Building Material, vol. 25, pp. 4037-4043.

[6] S. Soundharya, (2017), "Comparitive study of clay bricks and stabilized soil cement bricks with and without foundry sand as replacement", IJLT.

Experimental Investigation of Geopolymer Concrete with Nano Silica

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Abstract

Cement production became responsible for polluting the atmosphere through the emission of greenhouse gases. Nano silica produced from physically-processed white rice husk ash agricultural waste can be incorporated into geopolymer cement-based materials to improve the mechanical and micro performance. Geopolymer cement is eco-friendly. It increases the strength, durability, and resistance to attack in peaty/acidic environments. It is proposed to determine and compare the differences in properties of Ferro cement geopolymer concrete with Nano silica. The investigation is to be done by using several tests which include a workability test, sieve analysis, specific gravity test, compression test, and flexural strength. Nano silica was then added to the optimum geopolymer concrete sample by ratios 1, 2, and 3% of the total weight of cement materials. Samples tested for mechanical properties. The results showed that using a hot activator and oven-curing samples gives higher mechanical properties. Also using nano-silica up to 2% increases the compressive strength up to 24% at age 28 days.

Keywords: Geopolymer concrete, Mix proportion, Nano-silica, Compressive strength, Modelling.

Introduction

Concrete, after water, is the second most useful material for the construction industry. Every year, 25 billion tons of concrete are produced worldwide, acquiring 2.6 billion tons of cement, which will increase by 25% over the next ten years. Cement production has a negative impact on the environment because one ton of cement emits one ton of CO2 into the atmosphere, alarming the ecology. However, cement-based concrete remains the most widely used material in the global building industry. Therefore, all nations have become mandatory to consider CO2 emission regulations and reductions. As a result, extensive research has been conducted to develop a new material that can be used as an alternative to Portland cement; among them, geopolymer technology was developed in France by Professor Davidovits. Due

to the high consumption of waste materials in mixed proportions, GPC emits approximately 70% less green gas than conventional concrete. Geopolymers are an inorganic alumino-silicate polymer family produced through alkaline activation of various aluminosilicate virgin or waste materials rich in silicon and aluminium. The mixed proportions of the GPC consist of aluminosilicate source binder materials, fine and coarse aggregates, alkaline solutions, and water. The polymerization process consists of four main steps: dissolution, condensation, polycondensation, and crystallization of the gels, between the alkaline solutions and source binder materials, produced solid concrete, like traditional concrete composites. Sodium hydroxide and sodium silicate are commonly used alkaline activators to create geopolymer composites. These two activators were produced commercially, so they have adverse effects on environmental issues; therefore, it is essential to use activators that between the alkaline solutions and source binder materials, produced solid concrete, like traditional concrete composites. Sodium hydroxide and sodium silicate are commonly used alkaline activators to create geopolymer composites. These two activators were produced commercially, so they have adverse effects on environmental issues; therefore, it is essential to use activators that were made cleanly and environmentally friendly such as a mixture of NaOH and glass waste and a mixture of olive biomass ash and water.

Production of Portland cement is highly energy intensive and is also an obvious contributor to carbon dioxide emission in the environment.

- To increase the sustainability of concrete and step towards a clean environment, the replacement of cement with by-product materials is the most important.
- Nano silica which is produced from silica sand has been shown to be more effective in enhancing the strength of concrete by filling the minute pores in the concrete.

With the addition of sodium hydroxide-based alkaline solution, high-strength concrete can be developed using fly ash.

Methodology

This study is divided into three sections: review, modelling, and experimental work. To gather information about geopolymer concrete incorporated NPs, an extensive search of several databases, including Research Gate, Science Direct, Google Scholar, Scopus, and the Web of Science, was conducted. It was discovered that a wide variety of NPs, including NS were used to improve various properties of GPC composites, with NS being the most commonly used. As

a result, in this study, the authors use articles that used NS to improve various properties of GPC composites to create the models. However, all GPC papers containing NPs were taken into account for the review process. In the modelling process, eleven input parameters were used, limiting the authors' ability to utilize a more significant number of data in the created models. The gathered datasets were statistically analyzed and classified into three groups. The models were built using the larger group, including 135 dataset.

Mix Proportions

In this study M25 grade of concrete was selected and OPC 53 grade of cement was used. The Table 1 shows the properties of materials.

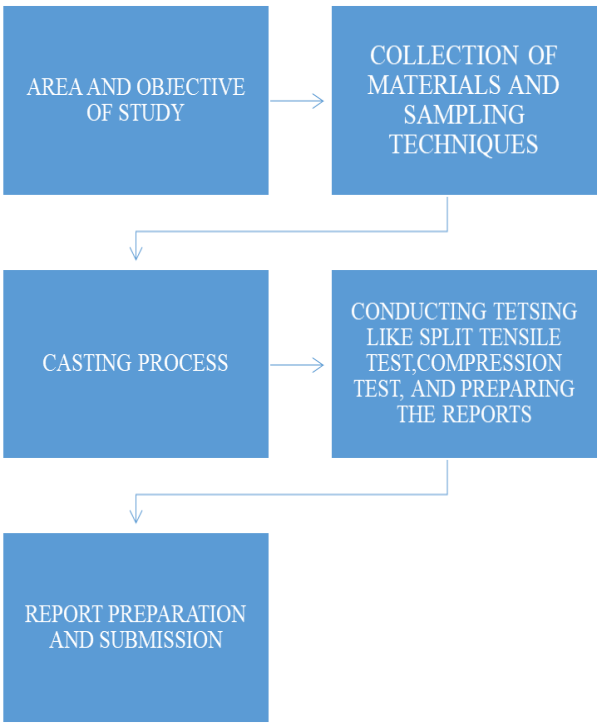

Figure 1 Methodology

Table 1 Materials Properties

Properties	Values
Max. Cement Content	325 kg
Coarse Aggregate (CA) size	20 mm
Specific gravity of cement	3.15
Specific gravity of CA	2.63
Specific gravity of fine aggregate (FA)	2.49
Mix ratios	1:1.69:3.02

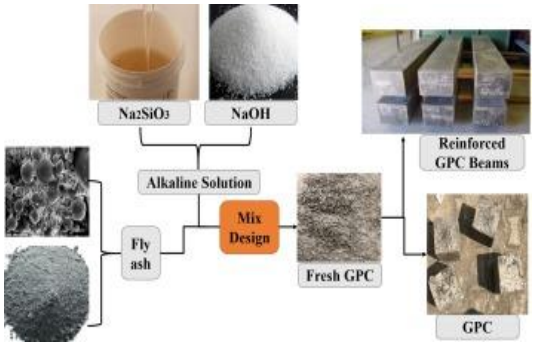

Figure 2 Materials used

Mix Proportions and Curing

From the various different trial mixes, this mix proportion has been adopted for the study.

Total aggregates percentage taken as 70%

Heat curing in the oven, at 60˚C

Nano-silica with 0%, 0.5%, 1%, 1.5% and 2%.

Nano-Silica

Nano silica, also called quartz dust or silica dust, is a material that, like SF, is characterized by its high SiO2 percentage, over 99%.

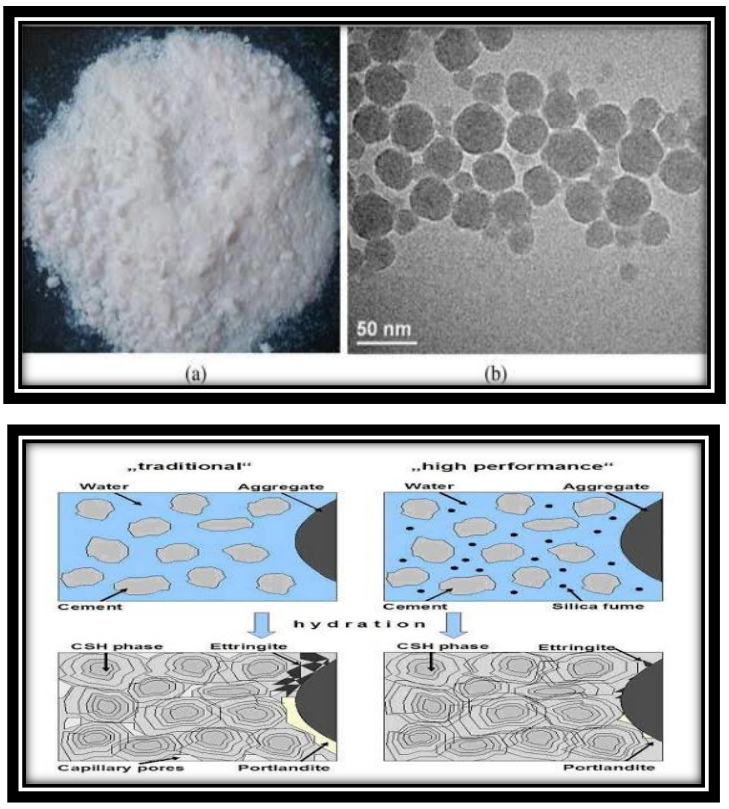

Figure 3 Nano-Silica and Silica Fume

Conclusions

It can be concluded that the addition of nano-silica did not increase the tensile strength of the cement paste but actually decreased it. However, the inclusion of 1, 2, and 3% of wt. of nano-silica made the geopolymer cement paste better in the face of failure, that the collapse did not occur suddenly. This is consistent with what was reported by where the inclusion of nano-silica in the geopolymer cement paste gave rise to a residual stress phrase after failure. The cause of the emergence of residual stress is because the nano-silica was able to fill the pores and form a good matrix with epoxy. However, the nano-silica could not withstand the tensile load after cracking, so that the maximum tensile strength dropped. Therefore, the addition of nano-silica is recommended because it can increase the residual strength.

References

[1] Paratibha Aggarwal, Rahul Pratap Singh & Yogesh Aggarwal (2015), "Use of nano-silica in cement-based materials—A review", Cogent Engineering, vol. 2, no. 1078018.

[2] R.D. Schuiling, (1986), "A method for neutralizing waste sulphuric acid by adding a silicate". Utrecht University, European Patent Application no 8590343.5.

[3] R.R. Zaky, M.M. Hessien, A.A. El-Midany, M.H. Khedr, E.A. Abdel-Aal and K.A. El-Barawy, (2008), "Preparation of silica nanoparticles from semi-burned rice straw ash", Powder Technology vol. 185, pp. 31–35.

[4] N. Thuadaij and A. Nuntiya, (2008), "Synthesis and Characterization of Nanosilica from Rice Husk Ash Prepared by Precipitation Method", J.Nat.Sci. Special Issue on Nanotechnology, vol. 7, no. 1, pp. 59-65.

[5] J.J. Gaitero, I. Campillo and A. Guerrero, (2008), "Reduction of the calcium leaching rate of cement paste by addition of silica nanoparticles", Cement and Concrete Research, vol. 38, pp. 1112–1118.

[6] G. Roddy, J. Chatterji and R. Cromwell, (2008), "Well treatment composition and methods utilizing nano-particles", Halliburton Enery Services, United States of America Patent Application no 20080277116 A1, pp. 1-12.

[7] L. Wen, I.D. Yu-he, Z. Mei, X. Ling and F. Qian, (2006), "Mechanical properties of nano SiO2 filled gypsum particleboard", Trans. Nonferrous Met. Soc. China, vol. 16, pp. 361-364.

[8] K. Sobolev and M. Ferrara, (2005), "How nanotechnology can change the concrete word-Part 2", American Ceramic Bulletin, vol. 84, no. 11, pp. 16-20.

[9] D.F. Lin, K.L. Lin, W.C. Chang, H.L. Luo and M.Q. Cai, (2008), "Improvements of nano-SiO2 on sludge/fly ash mortar", Waste Management, vol. 28, pp. 1081–1087.

[10] J. Bjornstrom, A. Martinelli, A. Matic, L. Borjesson, and I. Panas, (2004), "Accelerating effects of colloidal nano-silica for beneficial calcium–silicate–hydrate formation in cement," Chemical Physics Letters, vol. 392, pp. 242–248.

Investigation on Low- Cost Bricks by adding Suitable Additives

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Abstract

Bricks are a commonly used building material all over the world for constructing walls, pavement and other elements in masonry construction. Conventional bricks are manufactured by firing of clay in high temperature kilns. Extensive research is going on production of bricks from industrial wastes as there is a shortage of natural resources that are used as raw materials for the manufacturing of bricks. This paper presents an experimental study carried out on bricks made from fly ash and Manufactured Sand (M-sand). This investigation also aims to use waste materials effectively since fly ash is a waste obtained from thermal power plants and lime is a waste from water treatment plant. The properties of the fly ash bricks are investigated by conducting various tests like Compressive strength test, water absorption test. 10%,20%,30% fly ash and Plastic Waste have been added for testing and validation of new form of brick

Keywords: Brick, Compressive strength, water absorption strength, Mix design

Introduction

This template, Civil construction falls in the category of civil engineering which is all about designing, constructing and maintaining the physical and naturally built environment. Civil construction is the art of building bridges, dams, roads, airports, canals and buildings. Civil engineering is the oldest disciplines of engineering. Since the very beginning of the human existence, it has been the aspect of life. One of the main aspects of civil construction is structural engineering. It helps in designing the structure in a way that it is able to support itself successfully along with resisting loads. On olden days of civil fields all the construction are to be made with help of bricks only. On today world can be partial changed to RC structure. But, also brick can be used for many works.

In today's society, there are huge projects meant for civil construction and engineering. The infrastructure used in our daily lives all has been created because of civil construction and engineering. The roads, railways, stadiums, harbours, schools, and other buildings constructed all are a contribution of civil engineering. Classifying large projects into civil construction

stages has always been anticipated whether it is for independent or conjunction construction. To escalate the progress of the civil construction, every stage of the process is taken as individual contracts. All of the contracts are continued in special patterns and schedules. To maintain the quality of work in the construction process, the duration of every stage should be analyzed and evaluated before the process starts.

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand and lime or brick materials. Bricks are produced in numerous classes, types, materials and sizes which vary with region, time period and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks.

Block is a similar term referring to a rectangular building unit composed of similar materials, but is usually larger than a brick. Lightweight bricks (also called "lightweight blocks") are made from expanded clay aggregate. On the olden days of brick is fired bricks. Fired brick are one of the longest-lasting and strongest building materials, sometimes referred to as artificial stone and have been used since 5000 BC. Air-dried bricks also known as mudbricks, have a history older than fired bricks and have an additional ingredient of a mechanical binder such as straw.

Bricks are laid in courses and numerous patterns known as bonds, collectively known as brickwork and may be laid in various kinds of mortar to hold the bricks together to make a durable structure.

Methods of manufacture

Three basic types of brick are un-fired, fired and chemically set bricks. Each type is manufactured differently some of followings are:

Mud brick

Unfired bricks, also known as mudbricks are made from a wet, clay-containing soil mixed with straw or similar binders. They are air-dried until ready for use.

Fired brick

Raw bricks were sun dried before fired. Fired bricks are burned in a kiln which makes them durable. Modern fired clay bricks are formed in one of three processes soft mud, dry press or extruded.

Normally, brick contains the following ingredients:

- Silica (sand) – 50% to 60% by weight
- Alumina (clay) – 20% to 30% by weight
- Lime – 2 to 5% by weight
- Iron oxide – ≤ 7% by weight
- Magnesia – less than 1% by weight

The soft mud method is the most common, as it is the most economical. It starts with the raw clay, preferably in a mix with 25–30% sand to reduce shrinkage. The clay is first ground and mixed with water to the desired consistency. The clay is then pressed into steel moulds with a hydraulic press. The shaped clay is then fired ("burned") at 900–1000°C to achieve strength.

Dry pressed bricks

The dry press method is similar to the soft mud method, but starts with a much thicker clay mix. So, it forms more accurate, sharper-edged bricks. The greater force in pressing and the longer burn make this method more expensive.

Extruded bricks

For extruded bricks the clay is mixed with 10–15% water (stiff extrusion) or 20–25% water (soft extrusion) in a pug mill. This mixture is forced through a die to create a long cable of material of the desired width and depth. This mass is then cut into bricks of the desired length by a wall of wires. Most structural bricks are made by this method as it produces hard, dense bricks, and suitable dies can produce perforations as well. The introduction of such holes reduces the volume of clay needed, and hence the cost. Hollow bricks are lighter and easier to handle, and have different thermal properties from solid bricks. The cut bricks are hardened by drying for 20 to 40 hours at 50 to 150 °C before being fired. The heat for drying is often waste heat from the kiln.

Chemically set bricks

Chemically set bricks are not fired but may have the curing process accelerated by the application of heat and pressure in an autoclave.

Figure 1 Sand-lime cement brick

Calcium-silicate bricks are also called sand lime or flint lime bricks depending on their ingredients. Rather than being made with clay they are made with lime binding the silicate material. The raw materials for calcium-silicate bricks include lime mixed in a proportion of about 1 to 10 with sand, quartz, crushed flint or crushed siliceous rock together with mineral colorants. The materials are mixed and left until the lime is completely hydrated; the mixture is then pressed into moulds and cured in an autoclave for three to fourteen hours to speed the chemical hardening. The finished bricks are very accurate and uniform, although the sharp arises need careful handling to avoid damage to brick and bricklayer. The bricks can be made in a variety of colours white, black, buff and grey-blues are common and pastel shades can be achieved. This type of brick is common in Sweden, especially in houses built or renovated in the 1970s. In India these are known as fly ash bricks manufactured using the FaL-G (fly ash, lime and gypsum) process. Calcium-silicate bricks are also manufactured in Canada and the United States.

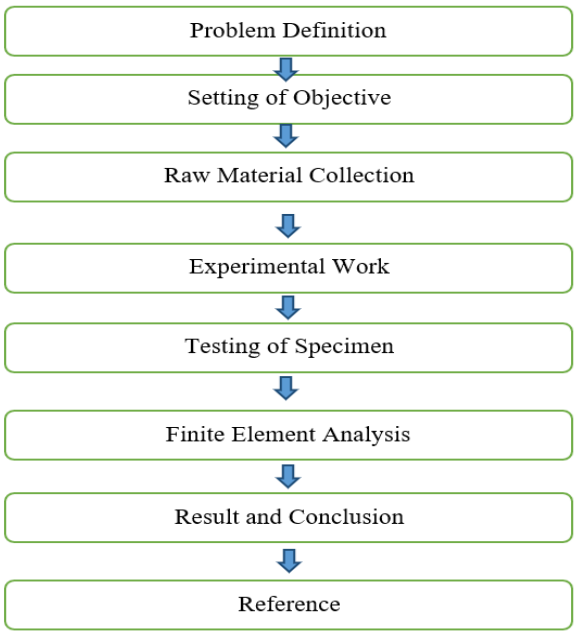
Literature Review

Brick Mix with Waste Paper –Ritzawaty binti Mohamad Shukeri and A. Naser Abdul Ghani, University Sains Malaysia, Pulau Pinang. Malaysia is facing a serious challenge in disposing of waste in the many Landfills throughout the country that are near or at capacity. The landfill situation is resulting in high disposal costs and potential environmental problems. If current trends continue, with waste production projected to grow by 5% each year, landfills would be at full capacity by 2020. Brick mixes containing various contents of the paper were prepared and basic strength characteristics such as compressive strength, splitting tensile, flexural, and water absorption were determined and compared with a control mix. Four brick mixes containing of the waste, which are control mix, 5%, 10%, 15% as an additional material to brick were prepared with ratios of 1:2:3 by weight of cement, sand, and aggregate respectively. The maximum size of aggregate was 20mm. In earlier work on the subject during trial mix, it was shown that the addition of wastepaper reduces the mechanical strength of brick. The test results also revealed that as the content of the paper increased the water to cement ratio for the mix was also increased. With the addition of 25% wastepaper in proportion to the amount of cement, the mechanical strength decreases significantly. Overall, a high correlation was observed between density and strength of brick containing paper.

Experimental Study on Behaviour of Steel and Glass Fiber Reinforced Brick Composites

Kavita S Kene, Vikrant S Vairagade and Satish Sathawane. Brick is most widely used construction material in the world. Fiber reinforced brick (FRC) is a brick in which small and discontinuous fibers are dispersed uniformly. FRC has found many applications in civil engineering field. Based on the laboratory experiment on fiber reinforced brick (FRC), cube and cylinders specimens have been designed with steel fiber reinforced brick (SFRC) containing fibers of 0% and 0.5% volume fraction of hook end Steel fibers of 53.85, 50 aspect ratio and alkali resistant glass fibers containing 0% and 0.25% by weight of cement of 12mm cut length were used without admixture. Comparing the result of FRC with plain M20 grade brick, this paper validated the positive effect of different fibers with percentage increase in compression and splitting improvement of specimen at 7 and 28 days, analyzed the sensitivity of addition of fibers to brick with different strength First, confirm that you have the correct template for your paper size.

Methodology



Collection of Materials

In this paper, the chosen material are weeds fly ash, Plastic material as to chosen because of easy availability on all place and reduce on the cost of manufacturing brick.

Micro debris

Micro debris is plastic pieces between 2 µm and 5 mm in size. Plastic debris that starts off as meson- or macro debris can become micro debris through degradation and collisions that break it down into smaller pieces. Micro debris is more commonly referred to as nurdles. Nurdles are recycled to make new plastic items, but they easily end up released into the environment during production because of their small size. They often end up in ocean waters through rivers and streams. Micro debris that come from cleaning and cosmetic products are also referred to as scrubbers. Because micro debris and scrubbers are so small in size, filter-feeding organisms often consume them. A 2004 study by Richard Thompson from the University of Plymouth, UK, found a great amount of micro debris on the beaches and waters in Europe, the Americas, Australia, Africa, and Antarctica. Thompson and his associates found that plastic pellets from both domestic and industrial sources were being broken down into much smaller plastic pieces, some having a diameter smaller than human hair. If not ingested, this micro debris floats instead of being absorbed into the marine environment. Thompson predicts there may be 300,000 plastic items/km2 of sea surface and 100,000 plastic particles/km2 of seabed.

Macro debris

Plastic debris is categorized as macro debris when it is larger than 20 mm. These include items such as plastic grocery bags. Macro debris are often found in ocean waters, and can have a serious impact on the native organisms. Fishing nets have been prime pollutants. Even after they have been abandoned, they continue to trap marine organisms and other plastic debris. Eventually, these abandoned nets become too difficult to remove from the water because they become too heavy, having grown in weight up to 6 tons.

Persistent organic pollutants

It is estimated that global production of plastics is approximately 225 mt yr−1. Their abundance has been found to transport persistent organic pollutants, also known as POPs. These pollutants have been linked to an increased distribution of algae associated with red tides.

Effects on the environment

The distribution of plastic debris is highly variable as a result of certain factors such as wind and ocean currents, coastline geography, urban areas, and trade routes. Human population in certain areas also plays a large role in this. Plastics are more likely to be found in enclosed

regions such as the Caribbean. Plastic pollution, more so in the forms of macro- and mega-plastics, potentially serves as a means of distribution of organisms to remote coasts that are not their native environments. This could potentially increase the variability and dispersal of organisms in specific areas that are less biologically diverse. Plastics can also be used as vectors for chemical contaminants such as persistent organic pollutants and heavy metals.

Land

Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem. This can cause serious harm to the species that drink the water. Landfill areas contain many different types of plastics. In these landfills, there are many microorganisms which speed up the biodegradation of plastics. The microorganisms include bacteria such as Pseudomonas, nylon-eating bacteria, and Flavobacteria. These bacteria break down nylon through the activity of the nylons enzyme. When biodegradable plastics are broken down, methane is released, which is a very powerful greenhouse gas that contributes significantly to global environment.

Ocean

In 2012, it was estimated that there was approximately 165 million tons of plastic pollution in the world's oceans. One type of plastic that is of concern in terms of ocean plastic pollution is nurdles. Nurdles are manufactured plastic pellets (a type of micro plastic) used in the creation of plastic products and are often shipped via cargo. A significant amount of nurdles is spilled into oceans, and it has been estimated that globally, around 10% of beach litter consists of nurdles. Plastics in oceans typically degrade within a year, but not entirely. In the process, toxic chemicals such as biphenyl and polystyrene can leach into waters from some plastics.

Ocean-based sources of ocean plastic pollution

Almost 90% of plastic debris that pollutes ocean water, which translates to 5.6 million tons, comes from ocean-based sources. Merchant ships expel cargo, sewage, used medical equipment, and other types of waste that contain plastic into the ocean. Naval and research vessels also eject waste and military equipment that are deemed unnecessary. Pleasure crafts also release fishing gear and other types of waste. These different ships do not have enough storage space to keep these pollutants on the ship, and thus they are discarded. These plastic items can also accidentally end up in the water through negligent handling. The largest ocean-based source of plastic pollution is discarded fishing gear, responsible for up to 90% of plastic debris in some areas. This equipment includes a variety of traps and nets.

M-sand

Manufactured sand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipment's including cone crushers, impact crushers; roll crushers, road rollers etc.

Material property of M-Sand

Table 1 M sand Properties

Constituent	Manufactured sand (%)	Natural sand	Test method
SiO_2	62.48	80.78	
AL_2O_3	18.72	10.52	IS : 4032-1968
FE_2O_3	6.54	1.75	
CaO	4.83	3.21	
MgO	2.56	0.77	
NNa_2O	Nil	1.37	
K_2O	3.18	1.23	
TiO_2	1.21	Nil	
Loss of ignition	0.48	0.37	

Specific gravity test

Determine the specific gravity of soil fraction passing 4.75 mm I.S sieve by density bottle. Specific gravity G is defined as the ratio of the weight of an equal volume of distilled water at that temperature both weights taken in air.

Figure 1 Specific Gravity

Consistency test

The consistency test has to take a sample of dried gypsum of about 400 g weight which must pass through the 90 micron IS Sieve. Then mix in it about 25% of water by weight a form a uniform paste within 2 minutes of time. Fill the Vicat's mould with this paste and make the

10 mm plunger fixed to the arrangement to just touch the top surface of the gypsum paste. Make it freely fall and note the amount of penetration.

Table 2 Consistency of cement

Trail Nos	Penetration	Plunging Reading
Trail 1	42.8	5.8
Trail 2	43.6	6.4
Trail 3	42.4	5.5
Trail 4	44.2	6.8

Cement

Cement of grade 53 can be used for bending of material. Portland pozzolana cement conforming to IS: 269-1976 and IS: 7031-1968 was used in this study.

Water

Water can be used for mixing of all raw material. And binding for making of the brick. Ordinary potable tap water available in laboratory was used for mixing and curing of brick.

Table 3 Water Properties

Property	Value
pH	7.1
Taste	Agreeable
Appearance	Clear
Turbidity (NT units)	1.75

Mix design procedure

In present study M15 grade brick was designed. The weight ratio of mix proportion is 1:2:4 keeping water cement ratio 0.4. It was proposed to investigate the properties of brick. In this experimental work, physical properties of materials used in the experimental work were determined. M15 grade of reference brick was mixed and cured in potable water.

Brick Mix Design

Step:-1 Target means compressive strength

$f'ck = fck + 1.65\ s$

Where,

$f'ck$=Target mean compressive strength in N/mm^2

fck= Compressive strength in N/mm^2

s = Standard deviation in N/mm^2

Assume $fck = 30\ N/mm^2$;

$s = 5.0\ N/mm^2$ in IS 10262:2009

f'ck= 30 + (1.65 * 5)

f'ck= 38.25 N/mm^2

Step:-2 Water Cement Ratio

Assume the exposure condition is severe condition. So, the water cement ratio is W/C = 0.45

Step:-3 Water Content

From Table-2 in IS 10262:2009

Maximum size of coarse aggregate = 20 mm

Water content = 186 kg/m^3 for the slump value is 25 to 50 mm. But we have slump value is 60mm, so increase 3% of water content.

= 186 + ((3/100) * 186)

= 191.58 kg/m^3

Water content = 191.58 kg/m^3

Step:-4 Cement Content

We know that water cement ratio is 0.45.

(W/C) = 0.45

C = (W/0.45) => (191.58/0.45)

= 425.73 kg/m3

Cement content = 425.73 kg/m3

Step: 5 volume of Coarse Aggregate

From Table-3 volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate For Water – cement ratio of 0.50 = 0.60

We have a water cement ratio is 0.45. Based on following condition volume of coarse aggregate is increased.

As the water cement ratio is lower by 0.10, the proportion of volume of coarse aggregate is increased 0.02.

Volume of Coarse aggregate = 0.61

Volume of Fine aggregate = 1 – 0.61

= 0.39

Volume of Fine aggregate = 0.39

Step:-6 Mix Calculation

Volume of brick = 1 m3 (a)

Volume of cement = (Mass of cement/Specific gravity of cement*1000)

= (425.73/3.15*1000)

Volume of cement = 0.135 m3 (b)

Volume of water = (Mass of water/Specific gravity of water*1000)

= (191.58/1*1000)

Volume of water = 0.192 m3 (c)

Volume of all aggregate = a – (b+c)

= 1 – (0.135+0.192)

Volume of all aggregate (e) = 0.673 m3

Mass of Fine aggregate = { (volume of Fine aggregate)*(specific gravity of Fine aggregate) * 1000 * e}

= {0.39 * 2.74 * 1000 * 0.673}

Mass of Fine aggregate = 719.17 kg

Mass of Coarse aggregate = { (volume of Coarse aggregate)*(specific gravity of Coarse aggregate) * 1000 * e}

= {0.61 * 2.74 * 1000 * 0.673}

Mass of Coarse aggregate = 1124.85 kg

Specimen Preparation

In this project, we can design for the 3 types of specimen by change in the admixture of bricks.

Proportions

Table 4 Mix ratios

Plastic & Fly Ash %	Cement (kg)	M Sand (kg)	Plastic Waste (kg)	Fly Ash (kg)
10	0.992	4.04	3.078	0.162
20	0.992	4.04	2.916	0.324
30	0.992	4.04	2.754	0.486

Collection of Materials

Plastic Waste

Plastic waste collected can be collected from the cool drink Shop which is located near the college.

Cement

Cement of grade 53 can be buy for the cement agent in Perambalur

Weed Fly ash

Fly taken from weed plants by burning them in electrical furnace

Testing of Specimen

The testing are to be made on the prepared partial on the compressive testing machine and water absorption test.

Compression Test

Compression strength is the total load observed by the brick. The strength of brick is usually defined and determined by the crushing strength of 230mm x 80mmx 110mm, at an age of 14days. It is most common test conducted on hardened brick as it is an easy test to perform and also most of the desirable characteristic properties of brick are qualitatively related to its compressive strength. Wooden mould made of Tee wood dimension 230mm x 80mmx 110mm used for casting of brick filled. The mould and its base rigidly damped together so as to reduce leakages during casting. The sides of the farm and base plates were oiled before casting to prevent bonding between the farm and brick. The brick was then stored for 5mins undisturbed at temperature of l8°C to 22°C and a relative humidity of not less than 90%. Then after 14 days curing the brick to be tested on compression machine.

Figure 2 Compression Test on Brick

Average Compressive strength = Avg. Load / Area of material

Table 5 Compressive strength

Material	Avg. Load on 7 days curing (KN)	Avg. Load on 14 days curing (KN)	Avg. Load on 28 days curing (KN)	Avg. Compressive Strength (N/mm^2)		
				7 days	14ays	28ays
Normal Brick	390	596	702	20.46	25.89	32.74
Specimen 1	488	612	816	21.63	27.45	33.65
Specimen 2	421	635	872	22.65	30.25	36.54
Specimen 3	462	675	817	22.96	31.26	34.87

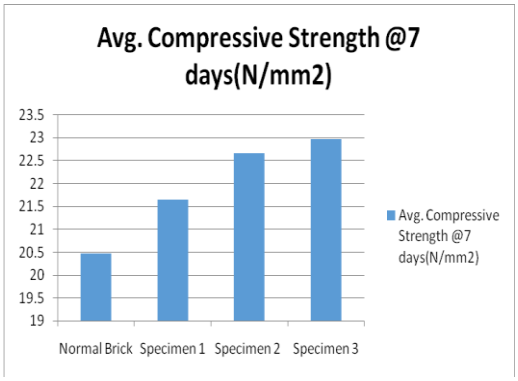


Figure 3 Compressive strength at 7 days

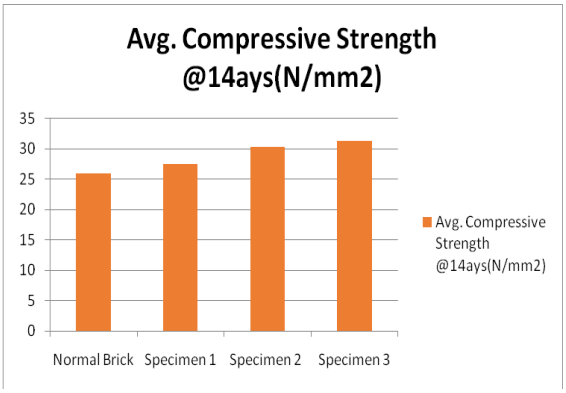


Figure 4 Compressive strength at 14 days

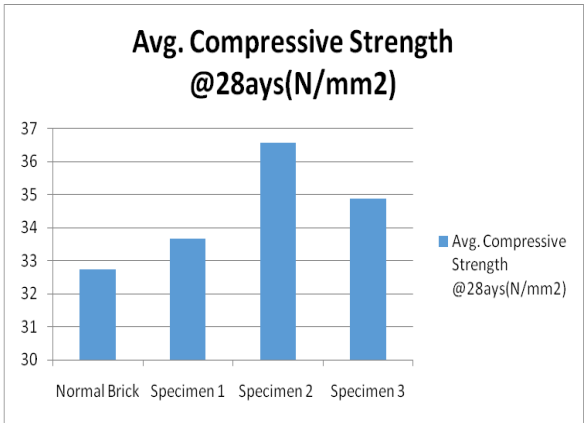


Figure 5 Compressive strength at 28 days

Water Absorption Test

The water absorption test can be used to denote the absorption value of the hybrid material. The average dry weight of brick specimens after removing from farm after 14 days can be measured. Then the average weight of brick specimens after submerging in water for 1 days of age. The percentage of water absorption was measured for each brick specimen and it gave indirect measure of durability.

Percentage of Water absorption = Wet Weight – Dry Weight

Figure 6 Compression Test on Brick

Table 6 Water Absorption

Material	Dry Weight (Kg)	Wet Water Weight (Kg)	Water Absorbed (gm)
Specimen 1	3.900	4.250	350
Specimen 2	3.800	4.125	325
Specimen 3	3.600	3.900	300

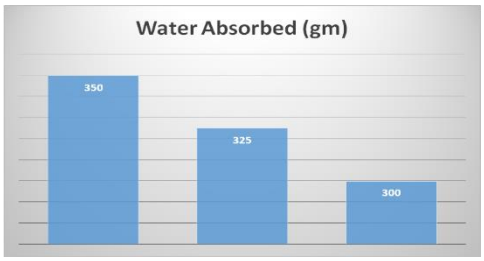


Figure 7 Water absorption test results

Efflorescence Test

The bricks are placed in the shallow flat bottom dish. The dish containing the distilled water. The depth of immersion of bricks should not less than 2.5cm. It should be kept in the warm room for the adequate ventilation. The water in the dishes gets reduced due the absorption of water and evaporation. Distilled water is added until the bricks appear having dried. After adding the distilled water at second time, the bricks are observed for efflorescence. The appearance of bricks is checked for any white patch of salt on the surface of the brick.

The efflorescence is reported only by qualitative words as follows:

Serious. Salt deposition is spread in round shape in heavy on the bricks.

Heavy. Salt deposits cover more than 50 percent of the surface area. The tendency to powder is absent.

Moderate. Salt deposits cover 10-50 percent surface area. The salt forms thin layers without showing any tendency to peel off in flakes or become powdery

Slight. Salt covers the surface area of less than 10 percent and forms only a very thin sticky layer.

Nil. There is seen no deposit of any salt even after repeated wetting.

Figure 8 Brick samples

Size and Shape Test

Twenty bricks are taken randomly. Remove the loose particles of clay and projecting blisters from bricks. The bricks are arranged in a straight series on the smooth level surface in which the adjoining surfaces are in contact with each other. The arrangement of the bricks are arranged in accordance with the dimensions of bricks. The bricks are measured in all directions and checked with the standard dimensions of bricks.

Soundness Test

In the soundness test, the two bricks are taken and struck each other. The brick should produce the ringing sound when struck with each other and should not break. This sound is carried out to find out that a clear ringing sound is produced or not when the two bricks are with each other without breaking any of the two bricks. If the two bricks are not broken after striking with each other and a clear ringing sound is produced, then it means that the bricks are sufficiently sound.

Hardness Test

In this test, the brick surface is scratched with the help of a finger nail. If there is no impression present on the surface of bricks, the brick is sufficiently hard.

Figure 9 Brick samples

Results and conclusions

From this study the effective utilization of lime, gypsum, fly ash has been developed and it made to use in the concrete mixture as fine aggregate.

- Various testing having been verified and concluded that fly ash brick cost comparison with other brick it is low and also its strength is high.
- Here by using this in this project various laboratory experiments were carried out on Hybrid bricks samples. Some of them are Compressive strength study, water absorption study has been done and verified. Also, Other test for brick have been done, where no other default issues seen to probe in the brick

Reference

[1] Kavita S Kene, Vikrant S Vairagade and Satish Sathawane, (2012), "Experimental study on behavior of steel and glass fiber reinforced brick composites".

[2] Gunalaan Vasudevan, Seri Ganis Kanapathy pillay, (2013), "Performance of using waste glass powder in brick as replacement of cement".

[3] Dr.A.D.Pofale, Syed Raziuddin Quadri, (2013), "Effective utilization of crusher dust in brick using portland pozzolana cement".

[4] Sajad Ahmad, M. Iqbal Malik, Muzaffar Bashir Wani, Rafiq Ahmad, (2013), "Study of brick involving use of waste paper sludge ash as partial replacement of cement".

[5] G.Balamurugan, Dr.P.Perumal, (2013), "Use of quarry dust to replace sand in brick".

[6] A.V.S.Sai. Kumar, Krishna Rao B, (2014), "A Study on strength of brick with partial replacement of cement with quarry dust and metakaolin".

[7] Ademola S, Buari T (2014) Behaviour of Bamboo Leaf Ash Blended Cement Brick in Sulphates Environment.

[8] P.Asha, A. Salman, R. Arun Kumar, (2014), "Experimental study on brick with bamboo leaf ash".

[9] Abdullah shahbaz khan, Ram panth, Gagan Krishna R, Suresh G. Patil, (2014), "Structural performance of brick by partial replacement of cement with hypo sludge".

[10] Chijioke Chiemela, Igwegbe E. Walter, Ibearugbulem H. Ogedi1, Okoye C. Peter & Oke Mong, (2015), "Comparing The compressive strengths of brick made with river sand and quarry dust as fine aggregates".

[11] Lodhi Ravindra Singh, Akhtar Saleem, Batham Geeta, (2015), "Application of Paper Waste In Cement Brick".

Structural Health Monitoring

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Abstract

In recent years, there has been a lot of interest in the new IoT concepts and technology. This technology attempts to increase production and quality across a range of industries. The Internet of Things (IoT) involves the use of smart devices, sensors, and actuators that are incorporated in them for automated purposes. The technique has demonstrated its value in numerous industries and is successfully applied in the various branches of civil engineering. Infrastructure that is smart and sustainable is being made possible by IoT applications. This essay aims to analyse the current state of IoT usage in civil engineering, as well as any associated problems.

Keywords: IOT, Security, Concrete

Introduction

IoT and sensing technology advancements are transforming civil infrastructure. By increasing the efficiency of the construction industry across the whole value chain, from the manufacture of building materials to the design, construction, operation, and maintenance phases, the use of smart devices and IoT is paving the path towards smart and sustainable infrastructure. IoT has various uses in the field of civil engineering, including for structures like buildings, roads, bridges, dams, trains, and sewage systems, among others.

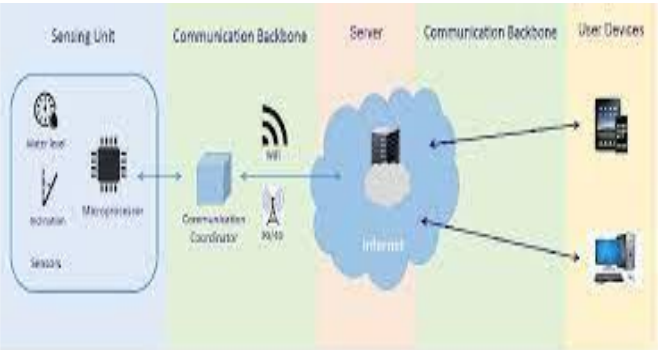

Figure 1 IoT and Sensing Technology

Architecture of IOT

IoT intends to promote occupant comfort, building system efficiency, energy consumption reduction, operating and maintenance cost reduction, increased security, remote access, and equipment and utility life cycle improvement. By adding a few smart devices, any old building may be transformed into a smart building.

Security

Two of the most difficult challenges to manage on a building site are security and safety. With IoT-enabled tags, any material or item theft can be easily stopped because these sensors will let you know where the materials or object are right now. Sending a human worker to undertake a comprehensive check is no longer necessary. IoT makes it possible to create a digital real-time job site map, replete with updated risks related to the activity, and notifies each worker when they are getting close to a risk or entering a hazardous area.

IoT technologies will not only shield workers from dangerous circumstances, but they will also be able to identify those circumstances either before or during their occurrence. Employees can take greater initiative on the job site.

Execution

The construction sector is governed by deadlines and goals. Because they force budget increases, backlogs must be prevented at all costs. IoT can increase readiness and efficiency, which will increase production. A sufficient supply of materials is required to guarantee the project's smooth operation. Unfortunately, materials are routinely delivered to the construction site late due to poor scheduling brought on by human error. It is possible to use IoT to automatically calculate the quantity, place automatic orders, or sound an alarm if the supply unit has the proper sensor. With more time at their disposal thanks to IoT, stakeholders may communicate with project owners and one another, creating fresh ideas that will improve project delivery and customer satisfaction.

Maintenance

Waste will occur if power and fuel usage are not carefully managed, raising the project's overall cost. Due to the availability of real-time data, it is now possible to plan maintenance breaks or refuelling stops and turn off idle equipment. Field sensors also assist in problem avoidance, which reduces warranty claims, boosts profitability, and maintains customer satisfaction.

In addition to getting stock-depletion alerts, sensors can be used to monitor the status of materials, including their appropriateness, temperature, environment, or humidity, handling problems, damage, and expiration. Equipment providers have had to evolve from being merely vendors to becoming partners who continuously monitor and maintain equipment so that customers can focus on their core businesses.

Budgeting and Resource Management

The majority of construction companies have trouble staying inside their budgets. The genuine value of the utilization of rented equipment is frequently miscalculated, workers are idle, and available resources are frequently not managed in accordance with their true worthier can help real-time business owners track expenses and produce a detailed budget plan in one step. assuring the prompt delivery of new resources and equipment while utilizing the most popular and efficient project cost reduction approaches. IoT helps with planning by monitoring the use of available resources and ensuring that they are utilized to their full potential without being wasted.

Curing Concrete

Another exciting technology that is revolutionizing the building industry is the usage of IoT in concrete curing. Construction management can confidently monitor and plan their schedules thanks to sensors that are put into the concrete during the casting process and track concrete curing in real-time. It is possible to optimize crucial construction procedures including formwork removal, bridge/road traffic opening, pre-stressed cable tensioning time, and concrete mix design with the help of an accurate in-situ assessment of concrete's compressive strength. One of the most challenging parts of construction is budgeting for labour and formwork. Understanding the concrete's maturity allows for the scheduling and cycle of the formwork as well as labour efficiency.

Structural health monitoring

In order to detect vibrations, cracks, and the condition of critical building members and civil structures, IoT is used in structural health monitoring.

Waste administration

Modern construction sites must consider waste management in great detail, especially in view of the growing concern over the carbon footprint of the industry. It's also crucial to clean waste as quickly as possible in order to create space and reduce risks on a construction site. There is a set amount of time in which trash levels must be monitored and removed. The

enforcement of correct rubbish disposal techniques is also essential. IoT trackers can now be used to efficiently monitor trucks or garbage cans. If rubbish is not managed correctly, authorities may fine the contractor.

Digital twins and BIM Optimization

In addition to being used to monitor current job sites, the continuous flow of real-time data from IoT sensors combined with historical data from other projects can be used to create a growing dataset that can be combined with machine learning to perform predictive analytics, making construction even smarter. The actual benefit comes from moving from a BIM model to a digital twin and making sure that real-time sensor data is incorporated into the model to produce a realistic simulation. Companies that don't adapt swiftly risk falling behind. IoT in the construction sector appears to have a promising future.

The future of IOT in construction

Although the construction industry is implementing new technology and communication techniques, it should be noted that this process is still a little slow. Many builders and contractors are unwilling to spend the money on such gadgets because they are unaware of their importance. However, if used appropriately and carefully, these technologies can be crucial in helping to establish a location where everything is organised into a single space and is recorded.

Applications for the Internet of Things might help you keep track of upcoming and new construction-related costs both on and off the job site. They offer detailed information that can be tracked and documented. The best method for construction companies to adopt technology is to base investment decisions on the potential impacts of IoT.

Conclusions

The advent of IOT provides better in-sights into the construction industry. The IOT can be applied to various domains of civil engineering in addition to that IOT can also be employed efficiently in construction industry in health and safety issues of workforce, structural health monitoring. The IOT works with minimum hum intervention but it requires human supervision for efficient decision making. The technology can also be employed in various fields of the civil engineering and there is a huge scope for improving the efficiency of IOT enabled smart technologies

References

[1] L. Atzori, A. Ieraa, & G. Morabito, (2010), “The Internet of Things”. A Survey Computer Networks, vol. 54, no. 15, pp. 2787-2805.

[2] Wikipedia Contributors (2018), “Internet of Things”, Wikipedia, The Free Encyclopedia.

[3] D. Bandyopadhyay & J. Sen. Internet of Thins, (2011), “Applications and Challenges in Technology and Standardization”, Wireless Personal Communications, vol. 58, no. 1, pp. 49-69.

[4] D.L. Yang, F.Liu And Y.D Liang, (2010), ”A survey of the internet of things: International Conference On E-Business Intelligence (Icebi)”.

An Experimental Investigation of Glass Powder and Coconut Fiber Ash in Soil Stabilisation

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Abstract

The main objective of this study is to investigate the use of waste fiber materials in geotechnical applications and to evaluate the effects of waste polypropylene fibers on shear strength of unsaturated soil by carrying out direct shear tests and unconfined compression tests. The results obtained are compared for various tests and inferences are drawn towards the usability and effectiveness of fiber reinforcement as a replacement for deep foundation or raft foundation, as a cost-effective approach. Randomly distributed fiber reinforcement technique has successfully been used in a variety of applications such as slope stabilization, road subgrade and sub base etc. This is a relatively simple technique for ground improvement and has tremendous potential as a cost-effective solution to many geotechnical problems. Keeping this in view the present study was taken up. In this study a series of compression tests under different confining pressures were conducted on soil sample without and with plastic reinforcement. Plastic fibers are similar to the roots of trees and vegetation which provide an excellent ingredient to improve the soils and the stability of natural slopes.

Keywords: Clay soil; Shear strength; CBE; Stabilization; Index properties

Introduction

The soil just below the ground surface is not good but a strong stratum exists at a great depth, deep foundations, such as piles, wells and caissons are required. Deep foundations are quite expensive and are cost effective only in the where the structure to be supported is quite heavy and huge. Sometimes the soil conditions are very poor even at greater depth and it is not practical to construct even deep foundation. In such cases various methods of soil stabilization and reinforcement technique is adopted. The objective is to improve the characteristics at site and make soil capable of carrying load and to increase the shear strength decrease the compressibility of the soil. The clayey soils with different plasticity indexes at five different

percentages of fiber content (0%, 1%,2%, 3%, 4%) by weight of raw soil CBR tests are conducted. The point of view of use of waste plastic fibers in soil reinforcement. the point of view of use of waste plastic fibers in soil reinforcement. Effects of Random Fiber Inclusion on Consolidation, Hydraulic Conductivity, Swelling, Shrinkage Limit and Desiccation Cracking of Clays. point to the strength and settlement characteristics of the reinforced soil and compared with unreinforced condition.

Objectives

The clayey soils with different plasticity indexes at five different percentages of fiber content (0%, 1%,2%, 3%, 4%) by weight of raw soil CBR tests are conducted.

The point of view of use of waste plastic fibers in soil reinforcement. Effects of Random Fiber Inclusion on Consolidation, Hydraulic Conductivity, Swelling, Shrinkage Limit and Desiccation Cracking of Clays. The strength and settlement characteristics of the reinforced soil and compared with unreinforced condition.

Literature review

Elango *et al*., (2023), studied the suitability of S-Glass/carbon fibre reinforced polymer composite for submarine hulls under to hydrostatic pressure. Polymer composites have been investigated to demonstrate their mechanical stability to handle transverse and impact loads because metallic materials have generated concerns due to their breakdown due to low resistance to salt. In order to achieve this, the mechanical characteristics of an S-Glass/carbon fibre reinforced polymer composite were experimentally studied. It was found that the composite had greater specific strength and stiffness than various metallic materials utilized for submarine hull.

Wu *et al*., (2022), conducted experiments based on the disturbed state concept (DSC), a uniaxial strain-softening constitutive model for fiber-reinforced soils is created. While the reaction in the fully adjusted condition satisfies the linear model produced by an extension of the residual strength, the response in the comparatively intact state is considered to satisfy the Duncan-Chang model acquired from the pre-peak stress-strain curve. The disturbance function, which serves as the weight, creates a weighted average response from the two aforementioned response curves to create the apparent stress-strain curve. The disturbance function gives the parameters in a plausible physical meaning by assuming that the disturbance begins and ends at the peak of the stress-strain curve and the post peak stable point, respectively.

Hu *et al*., (2022), conducted experiments on soil to study the improvement of strength through stabilized via microbially induced carbonate precipitation (MICP), an alternate technique. This work attempts to suggest a strategy by combining the MICP approach with pretreatment to better improve the reinforcement effect. The preparation parameters of pretreatment-mixing MICP reinforced soil (PMMRS), including the soil's moisture content and dry density, the concentration of urea and CaCl2 in the cementation solution, the engineering properties, the CaCO3 distribution, as well as the mineralogical and microstructural characteristics, were all investigated in a series of laboratory tests. The ideal preparation conditions for PMMRS were established using the findings of the orthogonal experiment. The moisture content and CaCl2 concentration had a stronger influence on the UCS of PMMRS than did the CaCl2 to urea concentration ratio.

Methodology

The following tests are being carried out well before the reinforcement is added to properly determine the properties of soil. These tests are used to find out the various characteristics of the soil. These tests help in determining properties such as size of soil, specific gravity, cohesiveness, Atterberg's limit etc.,

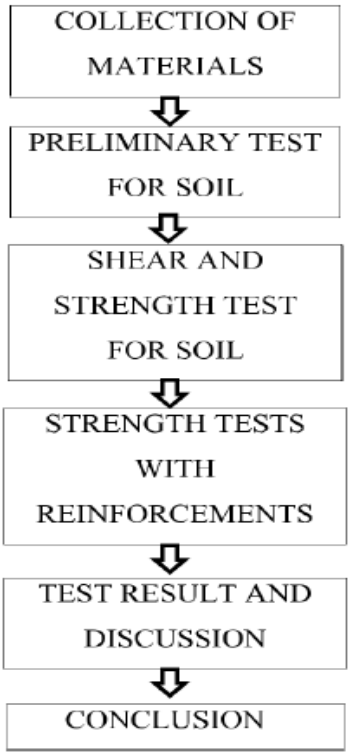

Figure 1 Methodology

Experimental Investigation

Materials

Soil sample: The soil sample was collected in front of New Production Block, Velammal Engineering College. Randomly oriented waste plastic fibres of random dimensions.

Figure 2 Preparation of plastic fibers from waste plastic

Table 1 Index properties

Sl. No.	Index properties	Values
1	Specific gravity	2.81
2	Liquid limit	27%
3	Plastic limit	23%
4	Plasticity Index	4%
5	Max. Dry unit weight	18.87 kN/m^3
6	Optimum Moisture content	8%
7	Cohesion	0.16 kg/cm^2
8	Angle of internal friction	19.9°

A. Liquid Limit

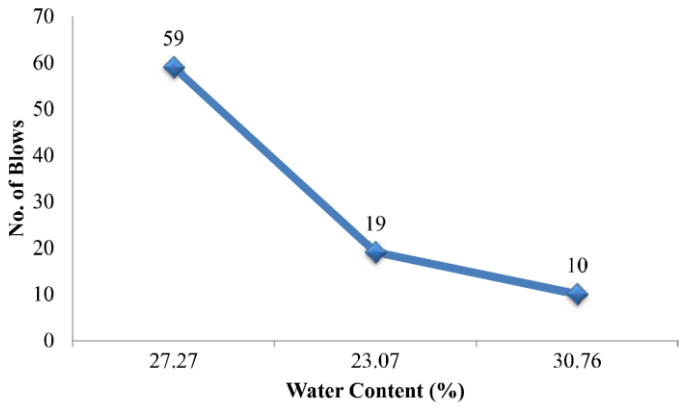

Figure 3 No. of blows vs. Water Content

B. Particle Size Distribution

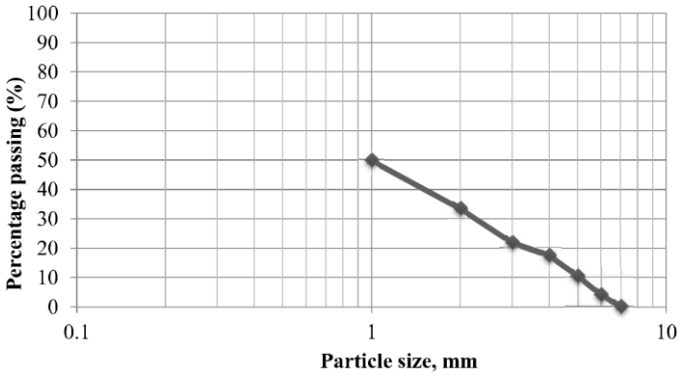

Figure 4 Particle size distribution curve

Results and Discussions

A. Direct Shear Test

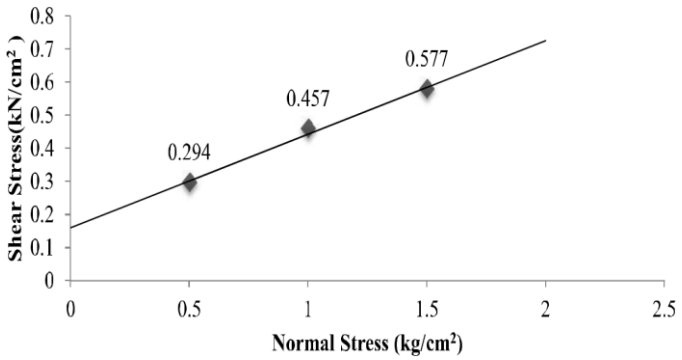

Figure 5 Stress strain curve for unreinforced curves

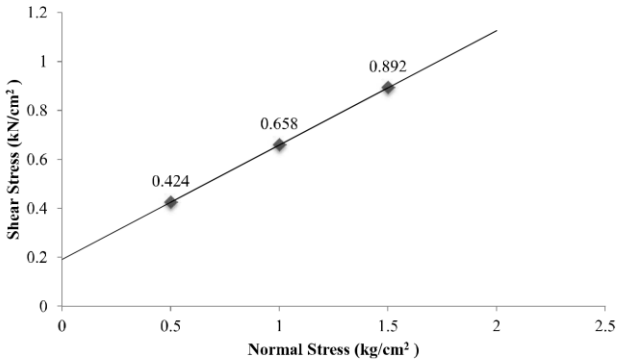

Figure 6 Stress strain curve for reinforced soil with 0.15% plastic fiber

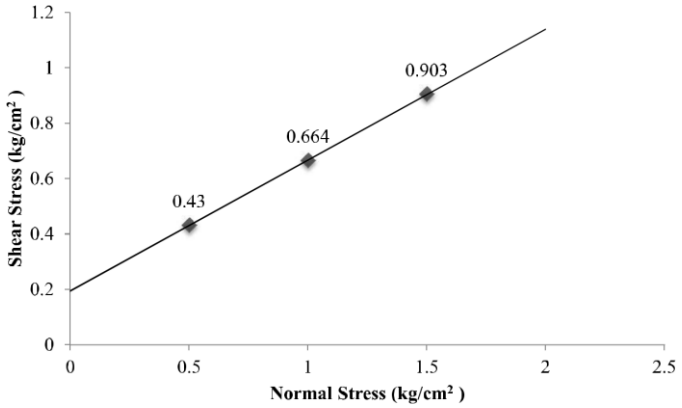

Figure 7 Stress strain curve for reinforced with 0.25% plastic fibers

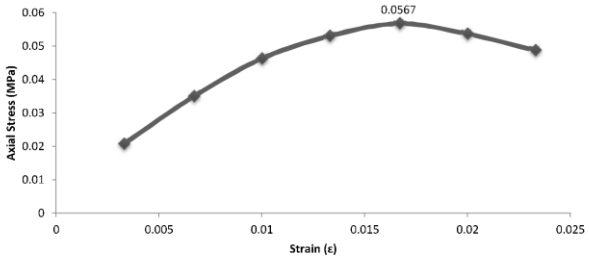

Fig 16: UCS - Axial Stress vs. Strain Graph for Unreinforced Soil

Figure 8 Unconfined compressive strength test for unreinforced soil

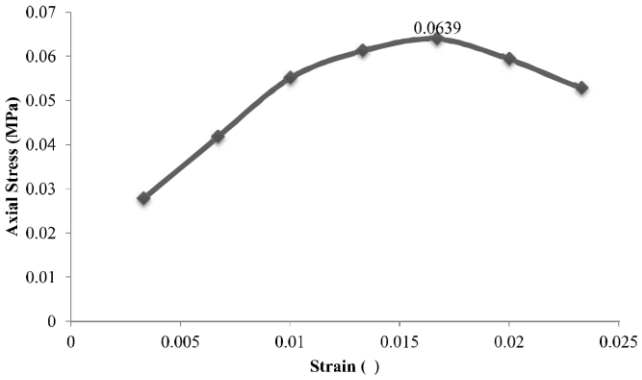

Figure 9 UCC for reinforced soil with 0.15% of plastic fiber

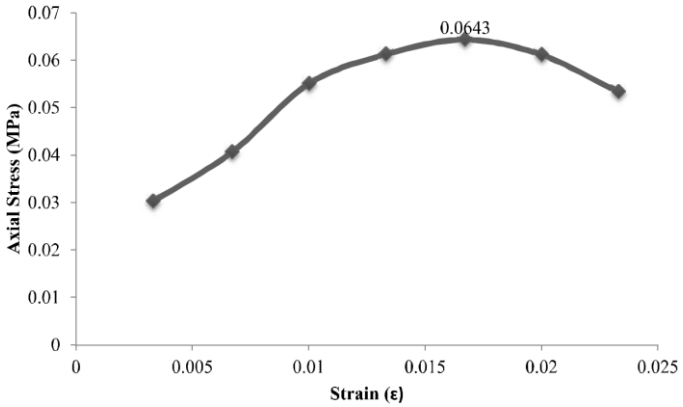

Figure 10 UCC for reinforced soil with 0.25% plastic fiber

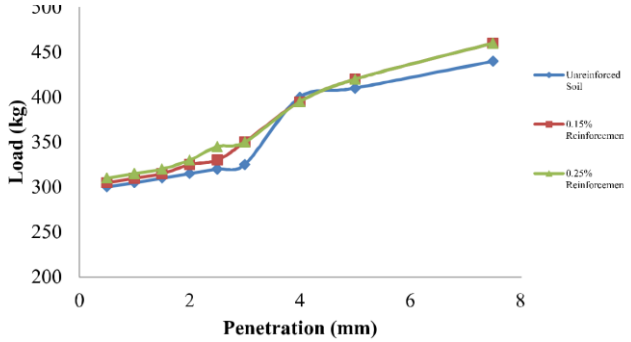

Figure 11 CBR – unsoaked

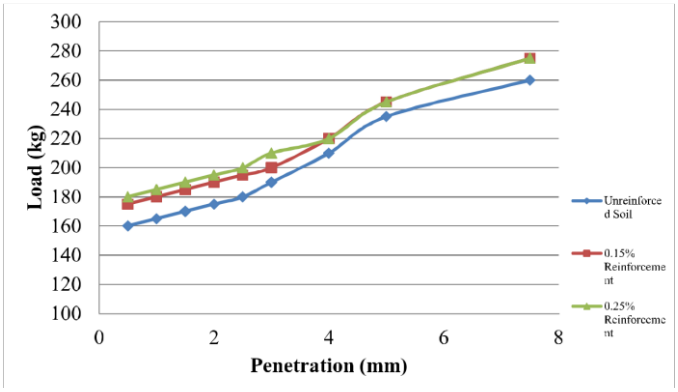

Figure 12 CBR for Soaked soil

Conclusions

The tests were conducted and the observed results are:

- The cohesion value of unreinforced soil is 0.16 kg/cm^2 while for soil with 0.15% reinforcement is 0.198 kg/cm^2 which is an increase of 19.19%.

- The cohesion value of unreinforced soil is 0.16 kg/cm^2 while for soil with 0.25% reinforcement is 0.199 kg/cm^2 which is an increase of 19.50%.
- The UCC of unreinforced soil is at a maximum of 0.0567 MPa, the sample which is made based on IS codes.
- The UCC, reinforced with 0.15% of waste plastic fibers is at a peak value of 0.0639 MPa which is an increase of 11.26% from 0.0567 MPa for unreinforced soil.
- The UCC, reinforced with 0.25% of waste plastic fibers is at a peak value of 0.0643 MPa which is an increase of 12.10% from 0.0567 MPa for unreinforced soil.
- There is improvement in CBR value when waste plastic fibers are mixed with soil samples.
- The addition of reclaimed plastic wastes materials was to increase the CBR value of the soil.

References

[1] Naeini and S. M. Sadjadi, (2008), "Effect of waste polymer materials on shear strength of unsaturated clays", EJGE J. vol. 13, pp. 1-12.

[2] Yetimoglu, T., Inanir, M., Inanir, O. E., (2005), "A study on bearing capacity of randomly disturbed fiber-reinforced sand fills overlying soft clay", Geotextiles and Geomembranes, vol. 23, pp. 174-183.

[3] Consoli, N.C., Pritto, P.D., and Ulbrich, L.A. (1999), "The beahviour of a fibre reinforced cemented soil", Ground Improvement, vol. 3, pp. 21-30.

[4] IS: 2720 (Part 2), 1973. Methods of tests for soils, determination of water content.

[5] IS 2720 (III/Sec-I) 1980. Methods of tests for soils, Determination of specific gravity.

[6] IS 2727 (VII) 1980. Methods of Tests for soils, Determination of water content dry density using light compaction.

Investigation on eco-friendly paver block using construction and demolition (C&D) waste

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Abstract

Construction and Demolition (C&D) waste, a major component of the solid waste is defined as a waste. resulting from the construction, renovation and demolition of structures. Till date a significant portion of C&D waste is disposed of in the landfills which not only consumes a considerable amount of landfill volume but also leads to environmental and health risks. As construction cost increases and land area gets scarcer, it becomes vital to take measures that incorporate a solution to the same. Developing a sustainable construction material (PAVER BLOCK) using construction and demolition (C&D) waste by diversion of C&D waste from the main waste stream can help in gaining a substantial area of land. The present study aims to develop C&D waste paver block of size 275 mm × 220 mm × 130 mm. Cement and fly ash were used as a binder along with C&D waste as replacement for natural coarse and fine aggregates.

Keywords: paver block, waste, ecofriendly

Introduction

The majority of concrete block pavement built in India has performed admirably, but there are two major issues are sporadic failure brought on by severe surface wear, and variation in block strength. The world's natural resources are running out at the same time that industrial and residential waste production is sharply rising. In order to make up for the lack of natural resources and to find alternative methods of preserving the environment, sustainable development for construction involves the use of non- conventional and innovative materials as well as the recycling of waste materials. The amount of waste plastic that has accumulated in the 21st century has created significant challenges for their management.

Materials used and its properties

Materials used for the experiment includes ordinary Portland cement of grade 43, fine aggregate of size less than 4.75 mm, coarse aggregate of size less than 4 mm.

Cement

The physical properties of the ordinary Portland cement of grade 43 is depicted in Table 1.

Coarse aggregate

Construction companies often mine sufficient rock deposits to create crushed stone, which is then crushed into different sizes using a crusher. The resulting crushed stone can subsequently be used to make concrete and asphalt, as well as a base material for roads, driveways and other construction projects. In order to make concrete, which is a strong and long- lasting substance, crushed stone is frequently utilised as an aggregate. Additionally, it serves as the base material for paver blocks, giving the pavers a solid base.

Fine aggregate

Manufactured sand (M- sand) is artificial sand produced from crushing hard stones into small sand sized angular shaped particles, washed and finely graded to be used as construction aggregate. It is a superior alternative to River sand for construction purpose.

C & D Waste

As per the construction and demolition (C&D) waste rule 2016, any waste comprising building materials, debris and rubble resulting from construction, remodeling, repair and demolition of any civil structure is classified as c and D waste. C&D waste are in several types. We particularly using brick types c & d waste using size c & d waste will sieve in 4.35mm.

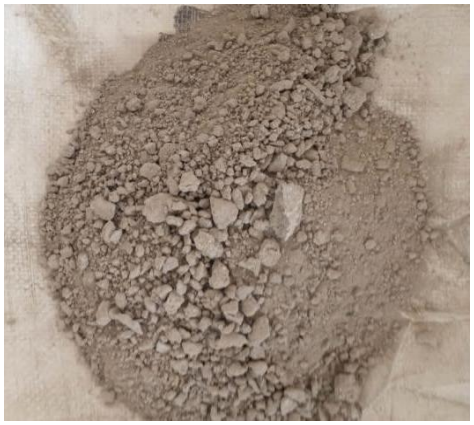

Figure 1 C & D waste

Table 1 Properties of cement

Properties	Measured values
Fineness	2.75%
Consistency	33%
Soundness	1.95%
Bulk density	0.87kg/m^3
Initial setting time of cement	30 min
Final setting time	600 min
Specific gravity	3.12

Table 2 Properties of fine aggregates

Properties	Measured values
Specific Gravity	3
Bulk density	13.27%
Soundness	3mm
Fineness modulus	2.49

Table 3 Properties of C & D Waste

C & D Waste	Measured values
Specific gravity	2.15
Fineness modulus	2.28
Soundness	3mm
Bulk density	0.798kg/m^3

Mixture proportion and test preparation

Mix design proportion

The details of the mixing proportions and identifications for grade 20 MPa concrete (M 20) are seen in Table 4.

Table 4 Mix design proportions

Materials	Percentage
Cement	12%
C & D Waste	27.5%
Coarse aggregate	45%
Chemical additives	0.3%
Water	15%

Test Results and Discussions

Properties of OPC

The Portland cement were quantified using the main reactive oxides CaO, SiO2, Al2O3, Fe2O3, MgO, and SO3 from the binders' chemical composition to represent their hydraulic and pozzolanic reactivity.

B. Compressive strength

The compressive strength test of paver block size is 275mm x 220mm x 130mm employed. The test was conducted as per the code of IS 15658-2006.

The tests were carried out at a uniform stress after the specimen has been cantered in the testing machine.

The Compressive strength of 9 N/mm^2 is achieved in 14 days.

Then after we proceed 28 days of the compressive strength, we get 14.7N/mm^2.

As per the required is above 10, so it is satisfied

Table 5 Compressive strength test

Block	C&D waste replacement	Result
TYPE 1	60%	50%
TYPE 2	70%	60%
TYPE 3	80%	90%

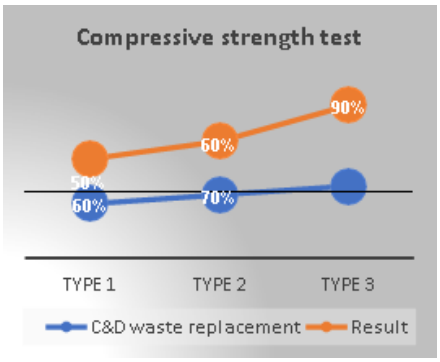

Figure 2 Compressive strength

Conclusions

The following conclusion were drawn from the experimental investigation

- The utilization of C&D waste in production of paver block has productive way of disposal of C&D waste.
- The cost of paver block is reduced when compared to that of concrete paver block.
- Paver block made using C&D waste, M sand, coarse aggregate and cement have shown better result.
- It also shows good heat resistance.
- Though the compressive strength is low when compared to the concrete paver block it can be used in gardens, pedestrian path and cycle way etc

References

[1] Daniel Hoornweg and PerinazBhada-Tata (2012), “A Global Review of Solid Waste Management", vol. 15.

[2] Minaxi rani and Alisha Gupta, (2016), “Construction waste management in India”, International J. of science technology and management, vol. 5, issue 6, pp. 63-70.

[3] Dhapekar & Mishra, (2017), “Effective utilization of construction and demolished waste concrete- review”, Res. J. Engineering Sci., vol. 6, no. 6, pp. 52-55.

[4] Bhagyashree S & Katkar (2012), “Utilization of recycled demolition waste aggregates in pervious concrete”, International J. of Innovative research in science and Engineering, vol 3, no. 5, pp. 84-88.

[5] Dinesh W. Gawatre, Rohit S. Chhajed, Prashik B. Panpatil, Shubham S. Desarda, Chetan S. Waghchaure, Nikhil S. Agrawal, (2016), “Manufacture of paver block using partial replacement of construction and demolition concrete waste”, IJPRET, vol. 4, no. 9, pp. 11-18.

Partial Replacement of Copper Slag in Cement and Rise Hush Ash for Fine Aggregate

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Abstract

Disposal of wastes is one of the issues confronting the world today. Scientists all over the world are making efforts to minimize the production and to effectively recycle the waste. Reducing the greenhouse gas emission and recycling of industrial wastes are the key areas of concern. Production of wealth will be a boon to the industries as the benefits are twofold: the pollution problem is addressed and the raw material shortage problem is also effectively tackled. Against this back-drop, in the present work, copper slag (CS) and Rice Husk Ash (RHA) are utilized as viable substitutes in concrete. M20 grade concrete with different mix proportion of sand replaced with copper slag from 0 to 70% and 0 to 25% cement replaced with Rice Husk Ash (RHA) and a combination of both (30% CS +10% RHA) is prepared. Tests for strength (compression and split tensile strength) and durability (acid resistance and SEM analysis) are carried out. The results of this work undertaken have revealed that maximum strength is obtained on 30% replacement of sand with copper slag (45.3 Mpa) and 10% of cement with RHA (38.8Mpa).

Keywords: Copper slag, Rice Husk Ash, Compression test, waste disposal

Introduction

Concrete is one of the prime materials for structures and it is widely used for various applications all over the world. Aggregates and cement play a major role in concrete. In India there is a great shortage of natural aggregates Recently Tamil Nadu government (in India) has imposed restrictions on removal of sand from the riverbeds due to unsafe impacts threatening many parts of the state [1]. Production of cement liberates similar amount of carbon dioxide which is the great cause of ozone depletion. In order to overcome these drawbacks and to make concrete sustainable copper slag and Rice husk Ash are used as suitable substitutes for sand and cement respectively.

Copper slag is an industrial by-product obtained during the matte smelting and refining of copper. Large quantities of slag are produced as a by-product of metallurgical operations, resulting in environmental concerns with disposal [2]. The applications utilize only about 15% to20% and the rest is dumped as a waste material and this cause environmental pollution [3]. Caijun Shi *et al* [4] reported that copper slag is glassy and granular in nature and has a similar particle size range to sand, indicating that it could be used as a replacement for the sand present in the cementitious mixes. Khalifa S *et al* [5] has investigated the performance of high strength concrete made with copper slag as a fine aggregate.

Rice husk is an agro-waste constitutes about one fifth of 300 million tons of rice production annually in the world. This Rice Husk is used only as a fuel in rice boiling process. By burning rice husk under a controlled temperature and atmosphere, a highly reactive RHA is obtained [6]. The most important property of RHA that determines pozzolanic activity is the amorphous phase content Recently, Nair *et al*. [7] reported an investigation on the pozzolanic activity of RHA by using various techniques in order to verify the effect of incineration temperature and burning duration. He stated that the samples burnt at 500 or 700 °C and burned for more than 12 hours produced ashes with high reactivity with no significant amount of crystalline material.

Although there are many studies has been carried out on CS and RHA not much researches have been investigated the combined effect of both and their durability. This paper evaluates not only the strength but also the durability of blended concrete.

Materials and Methods

Cement: Ordinary Portland cement from Ultratech Cement Company of grade 53 was used for this study. This cement is the most widely used one in the construction industry in India. The specific gravity and fineness modulus is 3.15 and 1.3 respectively

Fine aggregate: Fine aggregate of zone II is used with specific gravity 2.66.

Coarse Aggregate: Coarse aggregates of maximum size 20mm, specific gravity 2.815, fineness modulus 4.9 is used.

Copper Slag: Copper Slag used in this work has been brought from Sterlite Industries Ltd (SIL), Tuticorin, Tamil Nadu, India Its Specific gravity, water absorption and fineness are 2.66,0.7% and 4.8 respectively. Copper slag used has high iron oxide followed by silica.

Rice husk Ash: Rice Husk Ash is obtained by burning rice husk at 700oC to 800oC under uncontrolled combustion. The specific gravity and fineness of RHA used is 1.72 and 1.98 respectively. Its chemical properties are given in table II

Table 1 Chemical composition of RHA

Sl.No	Chemical composition	Content in %
1	Calcium oxide (CaO)	1.05
2	Silicon Oxide (SiO2)	77.4
3	Aluminium Trioxide (Al2O3)	0.28
4	Iron (Fe 2O3)	0.66
5	Magnesium (MgO)	1.96
6	Loss of Ignition	7.98

Water: Casting and curing of specimens were done with the potable water that is available in the university premises

Mix Design: The mix design chosen for grade M20, (i.e., 1: 1.48: 3.30 with water cement ratio as 0.5.) Concrete mixes with different proportions of copper slag and RHA are used. 0 to 70% sand replacement with copper slag and 0 to 25% RHA replacement for cement. 140 cubes, 45 cylinders were prepared for these tests. The slump tests were done on fresh concrete to determine its workability. Compression test, split tensile test, acid resistance test, corrosion test and SEM analysis were done on the specimens as per IS specifications.

Table 2 Concrete Mixtures with Different Mix Proportions

Mix Id	Cement (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)	C.S (Kg/m^3)	RHA (Kg/m^3)
CC	383.2	570	1267	0	0
CS10	383.2	513	1267	77.45	0
CS20	383.2	456	1267	154.9	0
CS30	383.2	399	1267	232.3	0
CS40	383.2	342	1267	309.8	0
CS50	383.2	285	1267	387.2	0
CS60	383.2	228	1267	464.7	0
CS70	383.2	171	1267	542.1	0
RHA 5	364	570	1267	0	19.16
RHA 10	344.88	570	1267	0	38.32
RHA 15	325.72	570	1267	0	57.5
RHA 20	306.56	570	1267	0	76.64
RHA 25	287.4	570	1267	0	95.8
CMB	344.8	399	1267	232.3	38.32

F.A-Fine Aggregate; C.A-Coarse Aggregate
CS 10-10% sand is replaced with copper slag.
RHA 5-5% of cement is replaced with RHA, CMB- 30%sand is replaced with copper slag and 10% of cement is replaced with RHA.

Test Results and Discussions

Slump test

Slump test is conducted on fresh concrete of different mix proportion. The slump value of all mix proportion shows good workability of concrete. The value ranges between 40 and 100.This implies that all concrete mixes show good workability.

Compressive Strength

Concrete cubes of size 150 mm X 150 mm X 150 mm were prepared as per IS 100861982.Once the specimen is cured, it is tested for compressive strength. The maximum load at failure reading was taken and their average compressive strength are given in figure1.

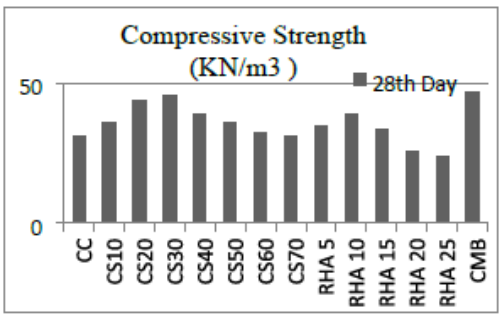

Figure 1 Compressive strength of various mixes

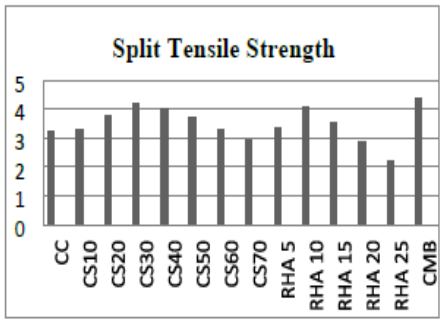

Figure 2 Split tensile strength of various mix

The compressive strength results reveal that maximum strength is obtained on 30% replacement of sand with CS and 10% cement with RHA. The obtained results of RHA mixes are almost nearer to the values of Maurice E. Ephraim *et al* [9] and CS mixes are similar to Brindha.D *et al* [8]. The combined mix gives % higher strength than control concrete.

Split Tensile Strength

Concrete cylinders of diameter 150 mm and height 300mm were casted as per IS 100861982. Once the specimen is cured, it is tested for split tensile on 28th day. The maximum load at failure reading was taken and their average compressive strength are given in figure.

Acid resistance test

The acid resistance tests are conducted for selected concrete mixes. In the present investigation immersion techniques was adopted. After 28 days 150mm cube specimens were immersed in 5% H2SO4 solution. The solution was kept at room temperature and the solution was stirred regularly, at least twice a day to maintain uniformity. The evaluations are conducted after14 days from the immersion.

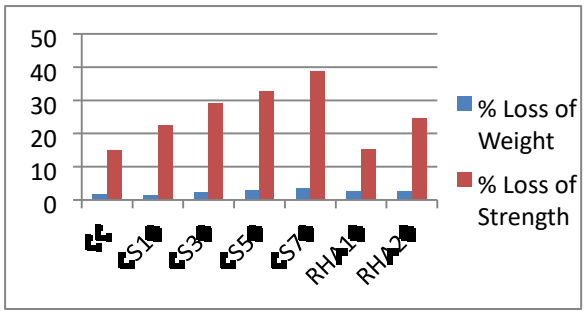

Figure 3 Results of acid resistance test

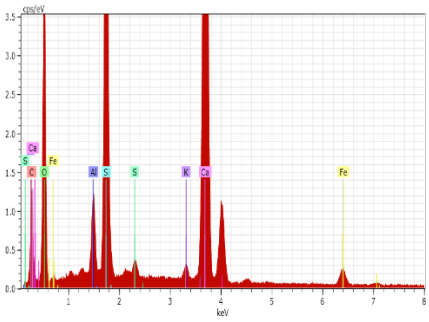

Figure 4 SEM analysis of Control concrete

The results shows that the concrete with higher percentage of copper slag possess less resistance to acid attack, whereas RHA possess good resistance

SEM analysis

SEM (Scanning electron microscopy) is an important technique in the study of cement and concrete. From the analysis it is found that control concrete contains more oxygen content followed by carbon. Whereas the mix contain 30% of copper slag contain carbon 3.7% less than control concrete. calcium content is 1.65% more in CS30 mix compared to control concrete. Al content is found to be very less in RHA 10.

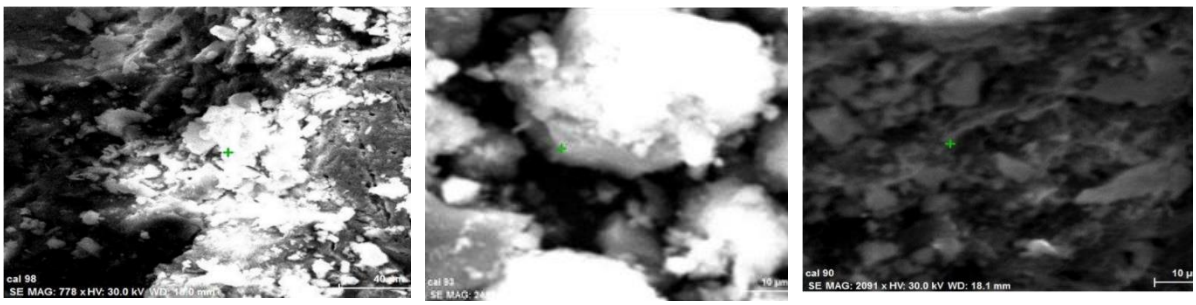

Figure 5 SEM Images

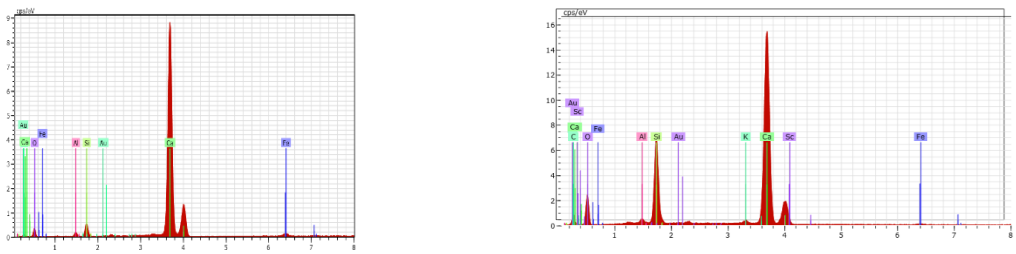

Figure 6 XRD Images

Conclusions

The physical and chemical properties of waste materials copper slag and RHA is studied.

- The performance of this blended replacement of cement up to 10% and sand up to 30% gives optimum compressive and tensile strength.
- From acid resistance test, it was observed that the concrete containing copper slag was found to be low resistant to the H2So4 solution than the control concrete.
- The cost of concrete reduces due to the partial replacement of wastes
- The partial replacement of fine aggregate with copper slag and cement with RHA provides additional environmental and technical benefits for all related industries.

References

[1] C. Kanmalai Williams, P. Partheeban and T.Felix Kala, (2008) "Mechanical Properties of High Performance Concrete Incorporating Granite Powder as Fine Aggregate", International J. on Design and Manufacturing Technologies, vol.2, no.1.

[2] ACI Committee 233, (1987), "Ground Granulated Blast-Furnace Slag as a Cementitious Constituent in Concrete" ACI Materials J. vol.84, no.4, pp.330.

[3] S.Meenakshi Sudarvizhi and R.Ilangovan, (2011), "Performance of Copper slag and Ferrous slag as partial replacement of sand in Concrete", International J. of Civil and Structural Engineering., vol.1. no. 4.

[4] Caijun Shi, Christian Meyer, Ali Behnood, (2008), "Utilization of copper slag in cement and concrete", Resources, Conservation, vol. 52, pp. 1115–1120.2008.

[5] Khalifa S. AlJabri, Makoto Hisada, (2009), "Copper slag as sand replacement for high performance concrete" Cement & Concrete Composites, vol. 31, pp 483–488.

[6] Zhang, M.H and Malhotra, V.M, (1996), "High performance concrete Incorporating Rice Husk Ash as a Supplementary Cementing Material" ACI Materials J. pp. 629-636.

Experimental Investigation of Light Weight Concrete using Thermocol Balls

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Abstract

In order to minimize the overall density of the mixture, light weight concrete is a form of concrete that uses thin thermocol balls. Due to its various advantages, such as better insulating qualities, increased fire resistance, better sound insulation qualities, better and lower weight, this form of concrete has grown in popularity in recent years. A practical and affordable approach that can enhance the efficiency and sustainability of buildings and other structures is the use of thermocol balls in light weight concrete. An overview of the advantages of employing thermocol balls in light weight concrete and the advantages of this form of concrete over conventional concrete are given in the experimental abstract.

Keywords: thermocol balls, concrete, experimental

Introduction

Concrete that is lighter in weight than regular concrete has a lower density. The concrete's weight and density are decreased by adding thermocol balls while retaining its strength and durability. The thermocol balls serve as a lightweight aggregate and take the place of some of the mix's conventional components. As a result, the concrete is simpler to handle, move, and install. Concrete built with thermocol balls is a great material to use in buildings and structures where energy efficiency is vital since it is lightweight and has strong thermal insulation qualities. In general, the incorporation of thermocol balls into lightweight concrete is a creative and economical technique to produce a strong, light-weight construction material with high thermal insulation qualities.

Materials used and its properties

Materials used for the experiment includes ordinary Portland cement of grade 53, thermocol 2mm or 4mm, fly ash, M sand, super plasticizer and air entrainment.

Cement: The physical properties of the ordinary Portland cement of grade 53. Table 1

Thermocol: Structures that need to be lightweight use thermocol. Concrete that has thermocol in it will float over water and maintain its temperature during transportation or storage.

Fly ash: Concrete's strength and durability are increased when fly ash is used in place of some of the cement.

M-Sand: To ensure that M-sand fulfils the necessary criteria, it should be made using the appropriate technology and quality control procedures. Concrete's strength and durability can be negatively impacted by improperly generated M-sand, and this could eventually result in structural problems.

Figure 1 Thermocol

Super plasticizer: Concrete mixtures can be made more workable without adding more water by adding superplasticizer admixture 0.5%, a sort of chemical additive.

Admixture Air entrainment: Concrete mixtures can contain a controlled number of microscopic air bubbles by using an air entrainment admixture 0.2%, a type of chemical additive. By enabling expansion and contraction without cracking, these air bubbles increase the concrete's longevity and resistance to freeze-thaw conditions.

Table 1 Properties of cement

Properties	Measured values
Fineness	5.1%
Consistency	38%
Initial setting time of cement	31 min
Final setting time	571 min
Specific gravity	3.24

Mixture Proportion and Test Preparation

Mix design proportion

Throughout the design mix process, the physical properties of the components, such as specific gravity, water absorption and moisture content, were taken into consideration to provide a

consistent mixing method for the chosen ratio. The manual method was used to do the mix design of concrete using Portland cement.

Table 2 Mix design

Materials	Quantity
Cement	300kg/m^3
Fly ash	150kg/m^3
Water	200kg/m^3
Retarder admixture	2.25kg/m^3
Air entrainment admixture	0.9kg/m^3
Beads	4kg/m^3
M sand	818kg/m^3
Density of concrete	1475.15kg/m^3

Test Results and Discussions

Properties of OPC

The Portland cement were quantified using the main reactive oxides CaO, SiO2, Al2O3, Fe2O3, MgO, and SO3 from the binders' chemical composition to represent their hydraulic and pozzolanic reactivity.

Compressive strength

The compressive strength obtained for sample of conventional CC cubes of 150x150x150 mm to their respective loading at day 7th and 14th respectively. The variations of compressive strength of concrete mix of M20 grade for 7th and 14th day.

Table 3 Compressive strength test

Average Compressive Strength at Day 7 (kN)	Average Compressive Strength at Day 14 (kN)
30	61
33	65
35	66.5

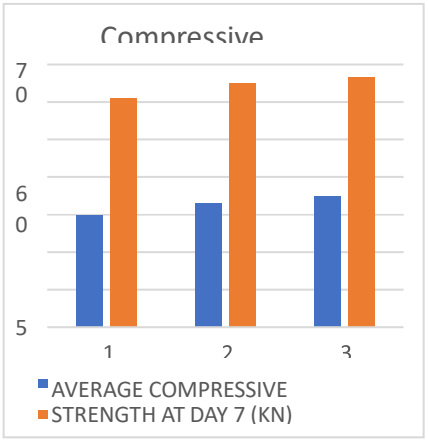

Figure2 Compressive strength

Conclusions

Finally, it can be said that using thermocol balls in lightweight concrete has shown to be a successful method. The concrete mixture can be made much lighter in weight while still keeping acceptable strength and durability by substituting thermocol balls for some of the aggregate.

- A low-density filler like the thermocol balls makes the concrete lighter and easier to handle and transport. Additionally, the thermocol balls' ability to insulate can help increase the energy efficiency of structures made with this kind of concrete.
- It's crucial to remember that there are some restrictions on the usage of thermocol balls in concrete. For instance, it might not be appropriate for specific structural applications that demand greater strength.

References

[1] Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade Sangran Naik, Amruta Kulkarni, (2015), "Lightweight Concrete Using EPS", International Journal of Science and Research, vol. 4, no. 3, pp. 2007-2010.

[2] Daneti Saradhi Babu, K. Ganesh Babu, Wee Tiong-Huan, (2006), "Effect of polystyrene aggregate size on strength and moisture migration characteristics of lightweight concrete", ELSEVIER, Cement & Concrete Composites, vol. 28, pp. 520-527.

[3] Hemant K. Sarje, Amol S. Autade, (2014), "Study of Performance of Lightweight Concrete", International Journal of Latest Trends in Engineering and Technology (IJLTET), vol. 4, no. 4.

[4] Jay Bankim Shah, Sagar Patel, (2015), "Light Weight Concrete using Expended Polystyrene Beads and Plastic Beads", International journal of pure and applied research in engineering and technology, vol. 3, no. 10, pp. 43-48.

[5] K. Ganesh Babu, D. SaradhiBabu, (2003), "Behaviour of lightweight expanded polystyrene concrete containing silica fume", Cement and Concrete Research, vol. 33, pp. 755–762.

[6] Lakshmi Kumar Minapu1, M K Ratnam, Dr. U Rangaraju, "Experimental Study on Light Weight Aggregate Concrete with Pumice Stone, Silica Fume and Fly Ash as a Partial Replacement of Coarse Aggregate", International Journal of Innovative Research in Science, Engineering and Technology, vol. 3, no. 12.

Experimental investigation on partial replacement of fine aggregate by halite in high performance concrete

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Abstract

Concrete is mixture of cement, fine Aggregate, coarse aggregate, and wet or Concrete, plays a vital role in the development of infrastructure viz, building industrial Structures, bridge and highway etc. Leading to utilization of large quantity of concrete, as cost of concrete is attributed to the cost if its ingredients, which is expensive, leads to usage of economically alternative materials in its production. This requirement is drawn the attention of investigation to explore new replacement of fine aggregate with Halite (sodium chloride) at a different proportion. Bore water contain high levels of minerals including Sodium, calcium, magnesium, potassium, chloride, bicarbonate and iron. Sodium and chloride occur naturally in groundwater, those sources Such as road salt, water softeners, underground Salt deposits, pollution from septic systems as well as salt water intrusion diet to proximity to ocean. The ground water with 200 to 1200 TDS per liter. Halite contains high level of total alkalinity and high level of calcium, silicates, iron, manganese, salt has allow pH and high temperature. Compressive strength 50% replacement of sand with Halite. In our experimental investigation, it is observed that, the compressive strength of concrete has been increased by 10% the concrete mix of M25 prepared was Tested at 7-, 14- and 21-days Halite being a byproduct serves as an eco-friendly material, our current investigation shows that the most economical way of using Halite (sodium chloride) in construction is to mixed with other building materials. It can be mixed in added of molds are dried and fixed on a wall surface.

Keywords: Concrete, halite, investigation

Introduction

Concrete can be defined as the composite material composed of the binding medium such as the mixture of cement, water, and different fine and coarse aggregates. Many people do consider cement as concrete, but cement is just a part of concrete. Concrete structures that have been built around the world are subject to a wide range of different conditions of use and

acquaintance to environmental conditions comprising erosion, weather, and pollution. Concrete consists of a solid and chemically inert particulate substance, called aggregate (usually sand and gravel), bonded together by cement and water. One of the commonly used salt crystals for salt finish concrete is Rock salt (Halite). The concrete which is prepared by using Rock salt crystals is known as a Rock Salt finish concrete. Rock salt is also known as Halite. Rock salt is formed by Sodium Chloride (NaCl). It is frequently used in food preservation methods across various cultures. Larger pieces can be ground in a salt mill or dusted over food from a shaker as finishing salt. Halite is also often used both residentially and municipally for managing ice. Rock salt is precipitated from sea water and may occur in the Earth as extensive salt beds or interstratified with, for example, sedimentary rocks. The mineralogical composition of natural rock salts varies from very homogeneous (99 % halite; NaCl) to heterogeneous mineral associations. In many areas, salt domes are found, such as beneath the Ekofisk field in the North Sea, where the underlying salt has a strong impact on the reservoir stresses (see Section 3.1). Salt may also be found above reservoirs, such as in the Gulf of Mexico area and offshore Brazil. Sometimes, salt is found to impose drilling problems. Salt has very low permeability and is therefore of interest for long-term storage of hazardous waste.

Salt grains (or crystals) can be between 1 and 50 mm in size. Virgin rock salt is usually characterised by very low porosity (< 0.5–1.0 %), which in some cases may be less than 0.1 %. A significant portion of the pore volume may occur as closed voids containing gas, brine, or both. Pore sizes are in the nanometre to micrometre range. Permeability of virgin rock salt in the Earth is probably in the nano. Darcy range or lower (Cosenza and Ghoreychi, 1993). Ultra-low permeability of natural intact rock salt enables us to hold this rock impermeable in many practical situations. The negligible permeability of rock salt is also attributed to healing processes and creep taking place under in situ conditions (Horseman, 1988). A practical problem of measuring porosity and permeability is the solubility of rock salt in the liquids usually used in laboratory routine work. Therefore, organic fluids or inert gas is often used for permeability tests. Laboratory measured permeabilities and porosities may be much larger than those representative for field conditions. The value of Young's modulus in rock salt as obtained in a conventional static test is rate-sensitive. To reduce the effect of rate sensitivity, Young's modulus is usually measured during unloading- reloading paths, yielding E-values of 10–30 GPA for various types of rock salt. Poisson's ratio ranges between 0.15 and 0.4 being 0.2–0.3 on the average (Hansen *et al*., 1984). Some rock salt types have tight cementation and are quite

competent, whereas others are loosely cemented and can be crushed by hand pressure. Uniaxial compressive strength typically ranges from about 15 MPa to 35 MPa. Tensile strength varies from less than 1 MPa to 2–3 MPa. Low resistance against tensile stresses is one of the characteristic features of rock salt. The ratio can be above 20 (Silberschmidt and Silberschmidt, 2000). The angle of internal friction ranges from 40° to 65°. Confining pressure remarkably increases the ductility of rock salt. Axial strain measured at failure in the confined regime can reach 10–25 % (Lux and Rokahr, 1984). The plastic behaviour of rock salt is linked to very significant creep behaviour. This phenomenon can be explained microscopically by a dislocation glide mechanism (Munson and Wawersik, 1991; Fokker and Kenter, 1994) and can be modelled macroscopically in analogy with time-dependent metal plasticity. The amount of creep strain increases with increasing deviatoric stress and increases strongly with increasing temperature.

Exposing concrete to salt isn't always a bad thing, especially in the case of a rock salt finish—a traditional and easy method for adding subtle texture and skid resistance to plain or coloured concrete. Considered a step above smooth or broom-finished concrete, a salt finish leaves a speckled pattern of shallow indentations on the concrete surface, similar to the appearance of slightly pitted, weathered rock. With the growing popularity of stamped concrete, however, the use of this finish has been waning, and many homeowners aren't even aware of it as an option. That's unfortunate because a salt finish still has a lot going for it and is far too attractive to be considered obsolete. While the pattern isn't elaborate, it has a distinctive look not achievable with any other method. Even better, the finish requires few additional tools and materials to produce, keeping the cost affordable for those who want decorative concrete on a budget.

Rock salt or sodium chloride is the most commonly used ice melter. It is inexpensive and melts ice. Compared to other materials, though, it has limited effectiveness in very cold temperatures. It will not melt ice at temperatures below 20° F, and it may be harmful to vegetation, but is considered safe for concrete.

Materials and methodology

Aggregates

As indicated by their size, totals are for the most part dormant and can be categorized as one of two classes: coarse or fine aggregates have a grain size of less than 4.75 mm, while

coarse aggregates have a grain size of more than 4.75 mm. Before using aggregate in concrete, a number of properties must be checked, including basic properties like sieve analysis, specific gravity, water absorption, and mechanical properties like fineness modulus and silt content. Concrete's design and behaviour are directly affected by these properties. All of the necessary primary tests are carried out in accordance with IS code 383, and the test results are compared to the properties of sodium chloride to determine whether NaCl can be used as an FA in concrete instead of sand. Table 1 illustrates the aggregate test results.

Table 1. Physical Properties of NaCl and Fine aggregates

Physical properties	Sodium chloride	Fine aggregates	Cement
Free Moisture Content (%)	-	0.13	-
Fineness Modulus	2.206	2.85	236
Bulk Density (kg/m3)	2120	1780	-
Specific Gravity	3.83	2.66	3.15
Consistency	-	-	26%
Water Absorption (%)	0.5	1.5	-

Water

Since no oils, acids, soluble bases, sugar, salts, or natural mixtures were available, the water utilized for restoring and blending agreed with IS 3025 - 1964 section 22, section 23, and IS:456 - 2000. The pH level needs to be at least 6. How much solids in the example were inside the reach allowed by IS: 456 - article 5.4 from 2000.

Experimental Investigation

The primary objective of this experiment is to substitute sodium chloride for natural sand in order to maintain the most stable properties of the concrete. In this examination, three unique blends were utilized, including M20, M40, and M60. These grades' concrete is produced in accordance with the IS10262-2009 guidelines. In each grade, the weight of the sand replaces the sodium chloride at a rate of 0 to 100 percent.

Testing methods

In accordance with BIS:1199-59, R. 2004, a slump flow test was performed to ascertain the workability of fresh concrete. As per BIS: 516- 1959 rules, chamber and 3D square molded substantial examples were tried in a 3000kN limit uniaxial pressure testing unit, separately, to decide the strength of concrete composites against pressure and split-pliable of solidified concrete composites.

Tests on concrete

The compressive strength test was done according to IS: 516-1959, and ten 150x150x150mm cubes of each mix were cast to determine the compressive strength. Three examples were checked at 7, and 28days in the wake of relieving. Cast cylindrical specimens measuring 300 mm in length and 150 mm in diameter, as well as beam specimens measuring 100 mm x 100 mm x 500 mm prism, were used for the indirect tensile strength test. The solid shapes according to IS:10086-1982 in Pressure Testing Machine (CTM) of 2000kN, pressure test, and spilt tractable test were led on blocks and chamber, separately. Conforming to IS 516-1959, the flexural testing is carried out in a UTM with a capacity of 40T.

Compression test

After the allotted amount of time for curing has passed, remove the specimen from the water and wipe off any moisture that is still on the surface. To the nearest 0.2 m, the specimen's size should be determined. The bearing surface of the testing gadget should be cleaned. Put the example inside the device with the rival sides of the 3D square uniformly bearing the heap. Place the specimen in the middle of the base plate of the machine. By gently rotating the movable part, you can get it to touch the specimen's top surface. Apply the load steadily until the specimen fails. Take note of any distinctive failure-type characteristic NaCl by observing the maximum load.

Split tensile test

To avoid surface drying, which reduces flexural strength, the specimen should be tested as soon as it is removed from the curing environment. Place the example near the stacking focuses. No loading points should come into contact with the specimen's hand-finished surface. This will guarantee that the specimen has sufficient contact with the loading points. The applied force ought to be centered on the loading system. At the loading locations, bring the block's applying force into contact with the specimen's surface. Conforming to IS 516- 1959, the flexural testing is carried out in a UTM with a capacity of 40T.

Results & Discussions

IS 2386 part III was utilized for the evaluation of the NaCl and river sand's S.G. (Specific Gravity) and density. sodium chloride, which was used in the study, has a fineness modulus of 2.20, a higher S.G. of 3.83, and a bulk density of 2120 kg/m3, making concrete with a higher density. Fine aggregate, on the other hand, has a lower density. In addition, 0.5%

water absorption is discovered. sodium chloride may require a lower water-to-binder ratio when used to prepare the concrete mix due to its lower surface porosity than sand. The sieve analysis performed on the NaCl and the FA in accordance with IS-383 is depicted in Fig. 1.

Physical properties of cement due to addition of NaCl

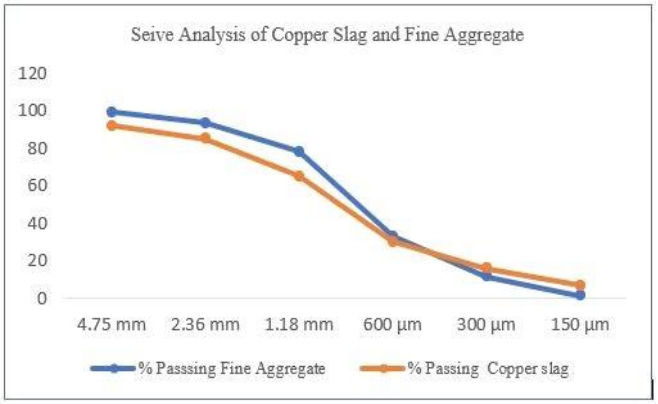

Fig. 1 Sieve analysis of sodium chloride and fine aggregates

Effects of fresh properties of concrete due to Halite

While utilizing total other than that which is exhorted for concrete, the effect on the usefulness of new cement might be a possible issue. The cement composite's workability was assessed by measuring its slump in fresh form. Fig. 2(a), Fig. Figure 2(b) 2(c) displays the slump tests performed on concrete containing NaCl at various percentages and mix proportions. When sodium chloride is added to concrete mixtures, it makes the concrete easier to work with, as shown in Fig. 2

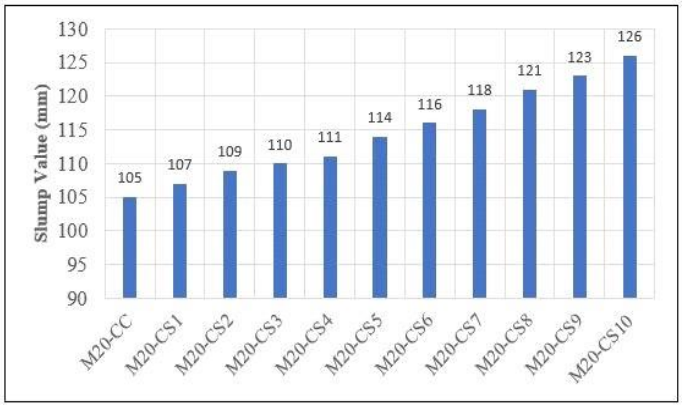

Figure 2 (a) Slump value of different sodium chloride M20 concrete

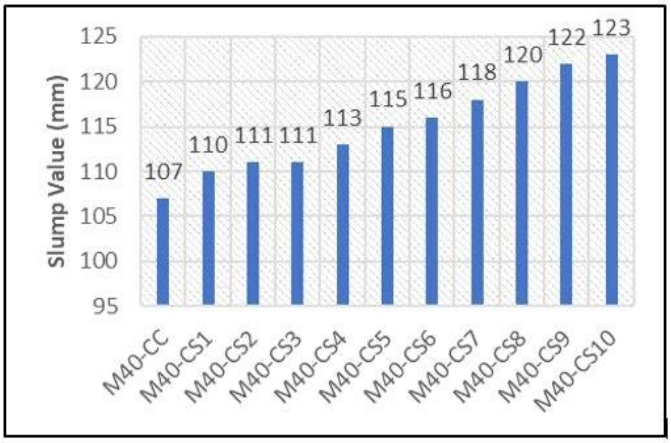

Figure 2 (b) Slump value different sodium chloride M40 concrete mixtures

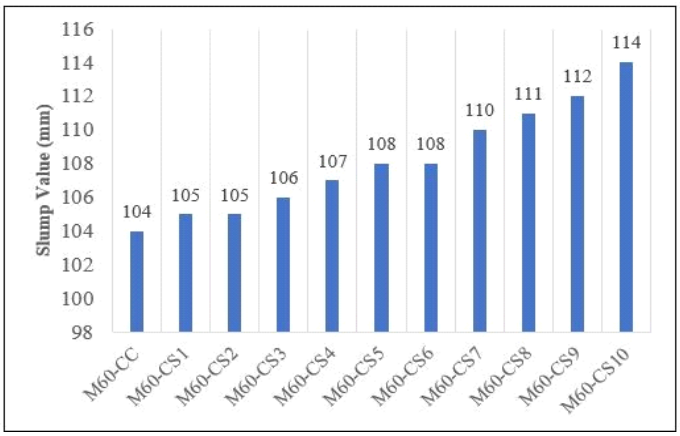

Figure 2 (c) Slump value of different sodium chloride M60 concrete mixtures.

Effects of hardened properties of concrete due to halite

Compressive strength

Conventional concrete has a compressive strength of 23.8 MPa at the M20 concrete grade, whereas 60 percent substitution results in a compressive strength of 36.8 MPa, which is 3.5 times greater than conventional concrete (Fig. 3a). When NaCl is substituted with FA, the compressive strength of M40 grade cement composite is 46.8 MPa and 61.8 MPa, respectively, in conventional concrete (Fig. 3b). Compared to standard concrete, this concrete has a compressive strength that is 41% higher and a strength that is 7% higher. The leftover example is in the two qualities. The compressive strength of the standard cement composite sample for M60 grade concrete is 66.5 MPa (Fig. 3c). The compressive strength of the cement composite gradually rises more than that of conventional cement composite when fine aggregate is used in place of sodium chloride in amounts ranging from 10% to 100%. It presently goes somewhere in the range of 72.8 and 69.6 MPa. The ability to bond and fill pores appears to

improve when FA is used in place of NaCl. Other researchers investigated the effects of NaCl as fine aggregates on the strength of regular cement composite as a follow-up to the aforementioned findings. sodium chloride concrete has significantly higher compressive strengths than control mixtures, as shown by the findings.

Figure 3 (a) Compressive strength of different sodium chloride M20 concrete mixtures

Figure 3 (b) Compressive strength of different sodium chloride M40 concrete mixtures

Tensile strength of concrete

fig. 4 (a) and 4(b). and Figure 4(c) shows how NaCl replacement affected the cement composite's tensile strength for M20, M40, and M60 grades of concrete, respectively. When sodium chloride is replaced with sand in various ratios, the lowest split tensile strength of 3.21 MPa is achieved at 100 percent. Conventional M20 grade concrete has a split tensile strength of 3.28 MPa. This value is two percent stronger than the strength of standard concrete. The split tensile strength reaches 3.58 MPa at 60 percent replacement. This worth is 9% more prominent than the worth of standard cement. M40 grade concrete has a parted elasticity of 3.14 MPa for conventional cement, and the most reduced and greatest split rigidity values subsequent to supplanting sodium chloride with sand are 3.12 MPa and 3.37 MPa, separately.

By replacing sodium chloride with sand, these values are increased by 100% and 50%, respectively. The above esteem is 1% lower than traditional concrete and 7% higher than customary cement. The strength against split-tensile of conventional concrete in the grade M60 is 3.14 MPa. With 100% replacement, the lowest strength is 3.11 MPa, which is 1% lower than the maximum split tensile strength of 3.35 MPa, which is 7% higher than standard concrete and is achieved with 50% replacement. The findings demonstrate that the average tensile strength was within acceptable limits, as required by the design. For the purposes of design, the tensile strength can be estimated to be 0.45 (13).

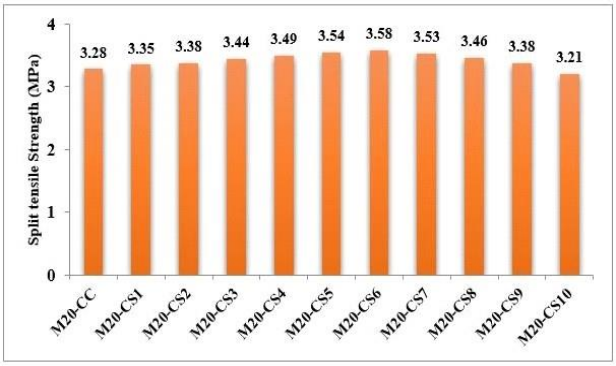

Figure 4 (a) Split tensile strength of different sodium chloride M20 concrete mixture

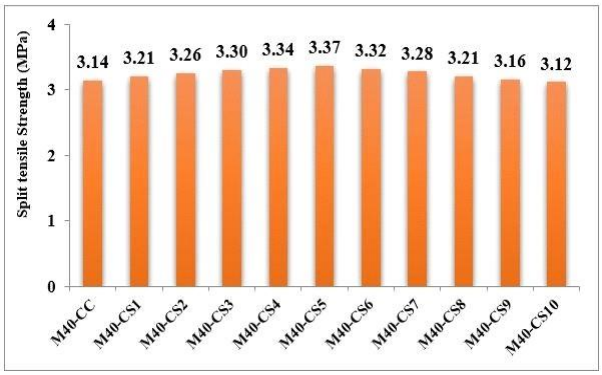

Figure 4 (b) Split tensile strength of different sodium chloride M40 concrete mixture

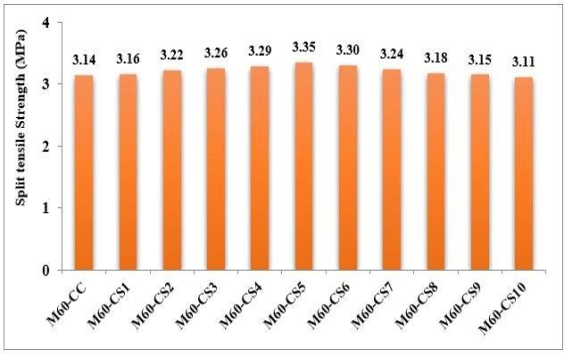

Figure 4 (b) Split tensile strength of different sodium chloride M60 concrete mixture

Flexural strength of concrete

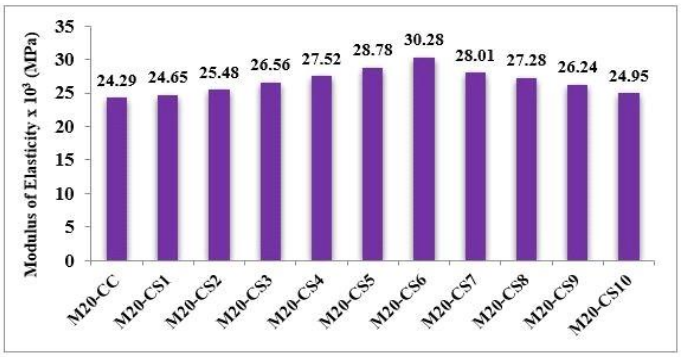

Figure 5 (a) Flexural strength of different sodium chloride M20 concrete

Fig. 5(a), Fig. 5(b), and Fig. 5(c) shows how different concrete mixes with different substitutions for sodium chloride perform in terms of flexural intensity. By supplanting 60% of sodium chloride with sand, the M20 substantial grade accomplishes a general modulus of flexibility of 30.28 x10^3 N/mm^2. The concrete with a young's modulus of 24.65 x10^3 N/mm^2 against the sand had the lowest modulus of elasticity, which is 25% higher than the conventional concrete strength value. At a 50% substitution of sand for sodium chloride, the M40 concrete grade attains its ideal young's modulus value. Their Young's modulus esteem relates to 39.48 x10^3 N/mm^2. The value of this is 19% higher than that of a typical concrete specimen. In M60 grade concrete, the maximum modulus of elasticity value of 46.62x10^3 N/mm^2 was achieved by replacing 40% of sodium chloride with sand. After the intensity has been gradually increased and then decreased when making a 100% replacement, the elasticity modulus value exceeds 41.20x103 N/mm^2.

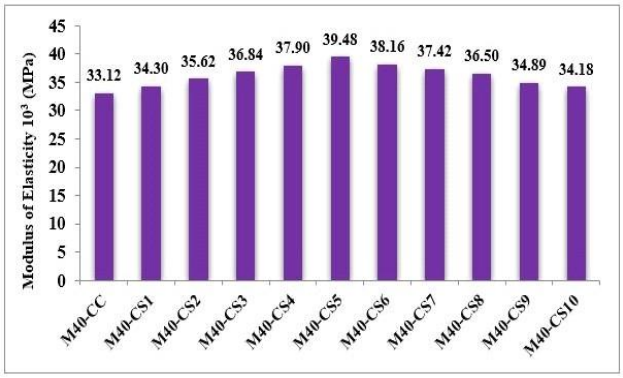

Figure 5 (b) Flexural strength of different sodium chloride M40 concrete

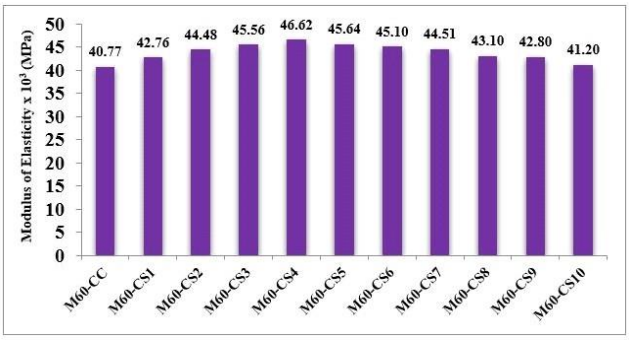

Figure 5 (c) Flexural strength of different sodium chloride M60 concrete

Conclusions

It appears that when used as a FA in mortar, NaCl behaves like river sand. However, a few minor adjustments or modifications may be required due to the sodium chloride's required quantity, the rough surface texture, and the higher specific gravity. Reduced waste generated during copper production is good for the environment when NaCl is used instead of FA.

The results of the workability test indicate that the concrete is simple to work in its fresh state when NaCl and sand are combined to serve as fine aggregate. Additionally, there is no change to the concrete's flow properties. Based on the results of various revisions and mechanical strength measurements, the optimal dosage level of sodium chloride for the M20, M40, and M60 grades of concrete is 60 percent, 50 percent, and 40 percent, respectively. At this percentage of the replacement stage, the concretes possess strong strength characteristic NaCl. sodium chloride's strong properties as a fine aggregate when combined with other materials are demonstrated by this result.

M60, M40, and M20 are three examples of concrete grades with maximum compressive strengths of 83.9, 61.8, and 36.8 MPa, respectively. When compared to conventional concrete specimens of the same grade, these values are 30 percent, 41%, and 55% higher, respectively. A significant increase in compressive strength can be observed when sodium chloride is used in quantities that are within permissible limits. Compressive strength has expanded thanks to sodium chloride's high sturdiness and polished surface.

At the optimal dose of sodium chloride, the split tensile strength test values for various M60, M40, and M20 concrete mixes are 8.62, 6.25, and 5.12 MPa, respectively. The values are 62%, 48%, and 55% higher than the conventional concrete specimen for their respective grades. The modulus of elasticity values at the optimal dose of sodium chloride for various mixes of M60, M40, and M20 concretes are, respectively, 46.62x103, 39.48x103, and 30.28x103

N/mm2. When compared to conventional concrete specimens of their respective grades, the prices are 14%, 13%, 14%, 13%, 23%, and 25% higher, respectively. With further mix optimization, it is possible to say that this kind of aggregate could be used as a suitable replacement for ordinary sand based on the aforementioned results.

References

[1] Palankar N., Shankar AR, Mithun BM, (2016), "Durability studies on eco- friendly concrete mixes incorporating steel slag as coarse aggregates", Journal of cleaner production, vol. 129, pp. 437-448.

[2] Maslehuddin M, Sharif AM, Shameem M, Ibrahim M, Barry MS, (2003), "Comparison of properties of steel slag and crushed limestone aggregate concretes", pp. 105-112.

[3] Mahieux PY, Aubert JE, Escadeillas G. (2009), "Utilization of weathered basic oxygen furnace slag in the production of hydraulic road binders", vol. 23, no. 2, pp. 742-747.

[4] Guo Y, Xie J, Zhao J, Zuo K. (2019), "Utilization of unprocessed steel slag as fine aggregate in normal and high strength concrete, vol. 204, pp. 41- 49.

[5] Zareei SA, Ameri F, Bahrami N, Shoaei P, Moosaei HR, Salemi, N. (2019), "Performance of sustainable high strength concrete with basic oxygen steel-making (BOS) slag and nano-silica", vol. 25, no. 100791.

[6] Dai S, Zhu H, Zhang D, Liu Z, Cheng S, Zhao J. (2022), "Insights to compressive strength, impermeability and microstructure of micro- expansion steel slag cement under constraint conditions", vol. 326, no. 126540.

[7] Hussain I, Ali B, Rashid MU, Amir MT, Riaz S, Ali A. (2021), "Engineering properties of factory manufactured paving blocks utilizing steel slag as cement replacement", vol. 15, no. 755.

[8] Qiang W, Mengxiao S, Jun Y. (2016), "Influence of classified steel slag with particle sizes smaller than 20 μm on the properties of cement and concrete", vol. 123, pp. 601-610.

[9] Wang Q, Yan P, Yang J, Zhang B. (2013), "Influence of steel slag on mechanical properties and durability of concrete, vol. 47, pp. 1414-1420.

[10] Ding YC, Cheng TW, Liu PC, Lee WH. (2017), "Study on the treatment of BOF slag to replace fine aggregate in concrete", vol. 46, pp. 644-651.

[11] Wang Q, Wang D, Zhuang S. (2017), "The soundness of steel slag with different free CaO and MgO contents", vol. 151, pp. 138-146.

[12] Wang G. (2010), "Determination of the expansion force of coarse steel slag aggregate, vol. 24, no. 10, pp. 1961-1966.

Interlinking of Local Water Bodies in the Villages of Thethakkudi, Mayiladuthurai District, Tamilnadu, India

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Abstract

Interlinking of water bodies involve the process of diverting surplus water through a network of canals. Through which the water bodies can holds water for a much longer period than in the past. This would cover additional areas for irrigation, remove the imbalance in availability of water and create the way for effective utilization of available water resources. Therefore, this project will offer interlinking of local water bodies through the link water channels at micro-level in the village of Thethakkudi. The Thethakkudi is a village in Mayiladuthurai district in Indian state of Tamil Nadu. The present population of the village is 358. Out of these 129 are men, 141 are women and 88 are children. The village is administered by the Kathiruppu Panchayat, which covers an area of 0.98km2. Thethakkudi has an average elevation of 4m and is located 11km from the coast of Bay of Bengal. The quality of Groundwater is poor compared to the villages around it. In this village, most of the income of the people derives from agriculture. Even this income they get from outstations because of the lack of quantity and quality of water resources. Therefore, the agriculture in this village is also being destroyed. Now farmers have a habit of selling their lands for soil excavation. So, the fertility of the soil is also sold. Currently there are more than 20 excavated ponds and puddles are available. Very few ponds are seasonal at best, and their water does not last beyond monsoons. Most of the ponds are get water from rainfall, also dry up as early as March. So, the process of diverting surplus pond water through a network of canals to relatively drier areas is more useful for agriculture development of the village. Therefore, the aim of this project is to improve the agricultural practices through interlinking of ponds depending upon the local topographical survey using Remote Sensing and GIS. The Remote Sensing and GIS with DEM Techniques are used to study topography of the ground and to analyze the morphologic characteristics easily, quickly and at low cost. The benefits accruing from this project are crop

diversification, better farm practices, improving food productivity, rejuvenation of groundwater and improving revenue of farmers.

Keywords: Water bodies, Interlinking, Remote Sensing, GIS, DEM, Topography

Introduction

Water is a unique natural resource and has a significant role in sustaining all forms of life, food production, and economic development and for general wellbeing. In the globe, about 97% of water resource is salt water, mainly in oceans and only 2.8% is available as fresh water at any time on the planet earth. Out of the 2.8% of freshwater, about 2.2% is available as surface water in which 2.5% in the form of glacier and ice caps and only of the order of 0.01% is available in lakes and streams, the remaining 0.04% being in other forms. However, it has fulfilled most of the requirements of the human being for various utilities. In recent decades, availability and utilizable of surface water is diminished due to contamination by natural and anthropogenic activities. In this scenario, the precious and invisible natural resource of groundwater has become a supplementary resource for the human needs. In this Connection, the Interlinking of water bodies involves the process of diverting surplus water through a network of canals. Through which the water bodies can holds water for a much longer period than in the past. This would cover additional areas for irrigation, remove the imbalance in availability of water and create the way for effective utilization of available water resources. Therefore, this paper will offer interlinking of local water bodies through the link water channels at micro-level in the village of Thethakkudi. The following are the objectives of this project.

- To Identify the location of the excavated water bodies of the village.
- To compute the slope and land use pattern of the village.
- To prepare the flow direction map of the village.
- To recommend the route for interlinking of water bodies through channels.

Study Area

Thethakkudi is located at 11.23°N 79.73°E, which runs along the Kollam River, in Sirkazhi District. Sirkazhi has an average elevation of 5.18m above sea level and is located at 13km west of Bay of Bengal. It is located 95km North-East of Thanjavur, 24km North of Mayiladuthurai and 20 kilometres South of Chidambaram. The town experiences long

summers and short winters and receives an average yearly rainfall of 1,250 mm mainly from the north-east monsoon between October and December. Its close proximity to the sea means that Sirkazhi receives more rainfall than neighbouring towns. Sirkazhi is part of the Cauvery delta region and has irrigation channels, called the Kollidam channels, which carry water from the rivers and provide a rich deposit of fertile silt before reaching the sea. The soil is black and contains fertile alluvial sediment. The area's main crop is rice and other crops grown in the area are coconut, tamarind and neem. The landscape mostly consists of plain lands with fields and small portions of scrub jungle. Antelope, spotted deer, wildhog, jackal and fox are present in the jungles and outlying areas of the town. Crow and ordinary game birds are found in large numbers in the town.

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The quality of Groundwater is poor compared to the villages around it. In this village, most of the income of the people derives from agriculture. Even this income they get from outstations because of the lack of quantity and quality of water resources. Therefore, the agriculture in this village is also being destroyed. Now farmers have a habit of selling their lands for soil excavation. So, the fertility of the soil is also sold. Currently there are more than 20 excavated ponds and puddles are available (fig 1). Very few ponds are seasonal at best, and their water does not last beyond monsoons.

The 2004 Indian Ocean earthquake was an undersea megathrust earthquake that occurred on 26 December 2004, with an epicentre off the west coast of Sumatra, Indonesia, triggering a series of devastating tsunamis along coastal fringes of the Indian Ocean. Nagapattinam district was the most affected part of Tamil Nadu, accounting for 6,064 off the 8,009 casualties in the state. Sirkazhi remained mostly unaffected by the tsunami, but the groundwater quality deteriorated where aquifers were close to the water bodies. There was heavy salt-water intrusion inland.

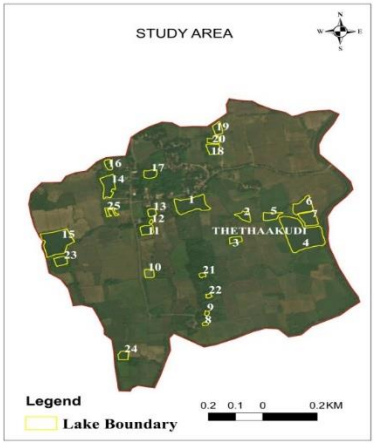

Figure 1 Study Area map

Methodology

Availability of information on depth of smaller water bodies is generally difficult as they vary based on local catchment conditions and their maintenance. As the study was aimed to develop tool for regional surface water storage, it was proposed to simulate average depth of the smaller water bodies with help of stream information which water body is existing and elevation values from digital elevation model. This was demonstrate through a sub basin as an example model considering all water bodies in Krishna Middle sub basin and a data frame work was set up which has been extended to other river sub basins. Sample analysis of digital elevation difference from bund to tail surrounding smaller water bodies of varying sizes has been carried out. These observations are taken as guidance for proposing the average depth of water int base water bodies. View of digital elevation model (ASTER DEM) over sub basin overlaid with water bodies. Determination of average depth for each of the water bodies was done by observing the surrounding elevation values of a water body from upstream to downstream. An assumption was made that this elevation difference was directly linked to depth of water body

GIS technology is widely used for land resource management and urban planning. In this study, QGIS open-source software is used for linking the lakes in the urban area. GIS is used to find out the suitable canal alignment by considering the shortest path to connect different lakes, the elevation of the lakes, water quality from the water sample analysis in the different lakes, and population in and around the lakes.

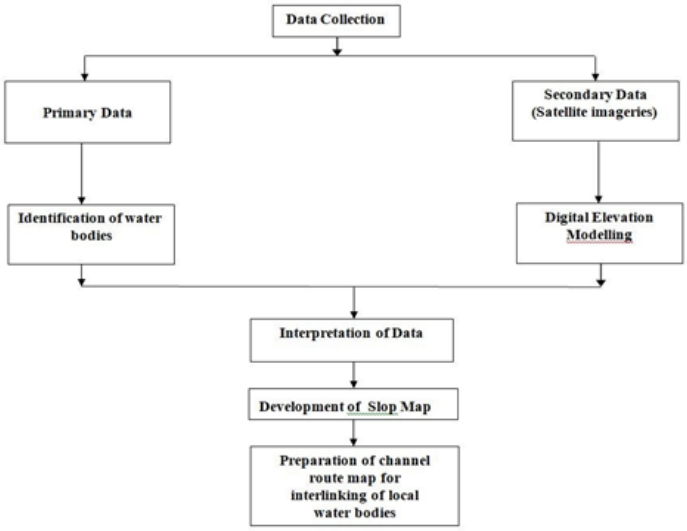

Figure 2 Methodology of the Study

Result and Discussion

The present study is carried out to interlink the water bodies in Theethakudi Village. The interlinking of lake is done with the help of many primary and secondary datasets. Lake polygons are generated with the help of Google Earth Pro software. Field checking has also done for ground truth. Elevation, slope and LULC maps are prepared using ArcGIS 9.8 software.

Total area of the water bodies in study area is around 2 Km2 and the total volume is about 2000 m3. The Digital elevation map is prepared using Aster GDEM. The elevation difference in study area is from 4 to 8 m with the sloping angle of 30-50 degree. The volume of the water body is calculated using Global mapper software. From the slope and elevation date the flow direction is identified and the major flow in south east direction.

Prediction of water volume

Water potential of the study area was determined using inflow and outflow data. Measured annual inflow data from 1978 to 1999 used to generate mass curve. Demand line was generated from total outflow that including for hydro-electric power, irrigation, domestic use of water natural life in stream. Maximum difference in mass curve and demand line gives the amount of water volume which can be stored based on inflow data of the study area. Water volume was calculated as 2000m3. Dam crest elevation was determined.

Table 4.1 Area and Volume of lake

Location	Volume (Cu. m)	Area (sq.km)
1	272.8156	0.003217
2	18.1904	0.000852
3	5.495256	0.0004105
4	913.4426	0.00961
5	77.9135	0.000878
6	67.87359	0.002051
7	113.5764	0.001728
8	2.177463	0.0001566
9	3.414105	0.0001564
10	19.78464	0.000603
11	2.353348	0.0001632
12	0.101209	0.0000251
13	12.15488	0.000681
14	175.598	0.002054
15	207.6919	0.004408
16	19.48923	0.000562
17	36.78776	0.000781
18	5.254492	0.0004812
19	5.527514	0.0003797
20	47.56852	0.000758
21	2.551475	0.00016
22	3.478408	0.0001962
23	31.60738	0.001044
24	53.81754	0.000952
25	20.07479	0.0004752

Digital elevation model

The contour map of scale 1:10000 of the study area was imported ArcGIS 9.8. This map was digitized. Digitized topographic map was used in preparation of Digital Elevation Map (DEM) with cell size 5m x 5m. DEM shows the maximum elevation value is 8 and minimum elevation value is 4 so that the study area is not sloppy and hence runoff is very less.

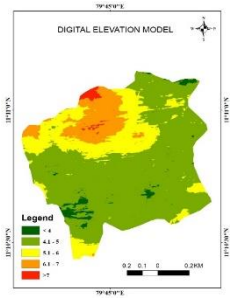

Figure 3 Digital Elevation Map of the study area

- **Slope**

Slope map is prepared using DEM data. The elevation of the study area shows that the area is not sloppy in nature and the water flow is verry low. Most of the regions are flat. Its because they are is fully of cultivation and its similar to step cultivation.

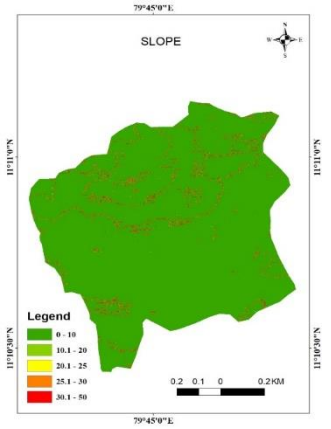

Figure 4 Slope Map of the study area

- **Flow direction**

The study area is near to river so the water level will be maintained based on groundwater level and recharge rate. The flow direction of the area is south east and south west due to the elevation. Stream order is also prepared to check the water recharge. In study area the streams are 6th, 1st and 2nd order.

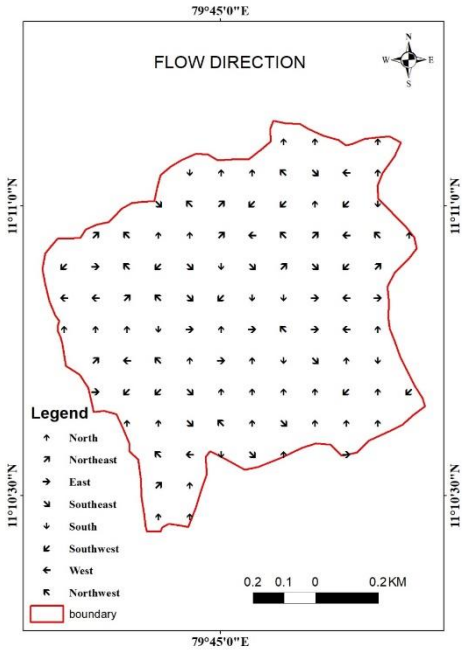

Figure 5 Flow Direction map of the study area

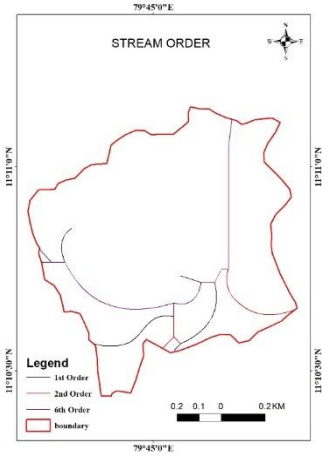

Figure 6 Stream order Map of the study area

E. LULC (Land Use Land Cover)

Land use land cover map is used to find the flow direction based on the density. In highly polluted cities due to over weightage of buildings in banks the water will seep out to the nearby area or it may change the shape of the water body. In our study are more than 80% of the area is cultivation. The urban area is only in the northern part. The water recharger will be more in this area due to cultivation activities.

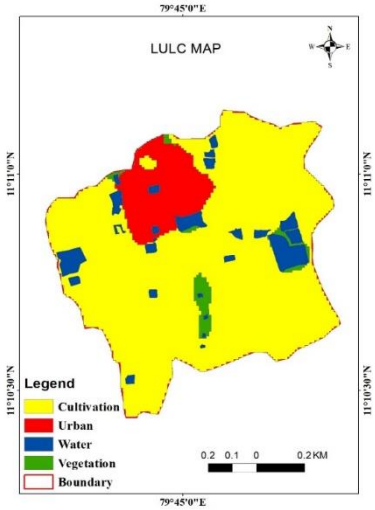

Figure 7 LULC map of the study area

Interlinking of Lakes using GIS

GIS is specifically useful for water quality management since its ability to capture, store, analyse, and view geographically referenced data. The growth of GIS applications for spatial data management and interpretation is increasing day by day. This study combined GIS

analysis features with water quality parameters to link the lakes and the elevation of lakes. It is designed to process a wide variety of lake data and geo-referenced datasets, providing the required input data for water quality assessment methods and system planning. The related findings from the Case Study of the lake were then shown on GIS maps. The data is obtained from the toposheet to develop GIS with a scale of 1m = 5km. As the open-source software is nowadays used for the application, in this research, QGIS is used to extract the region unit data at the level of point, line, and area, Lakes. This study's main parameter is the length of linking and elevation between two lakes and water quality values. The toposheet extracted the various lakes in the study area, roads, railway lines, residential area, and other land uses. Figure 4.2 shows the study area's elevation map, which varies from4 m to 8 m. Hence, linking the lakes required either cutting or filling of canals to the above slopes. The important point is small lakes will get filled early and drained the excess water to the main water supply lakes in the study area.

It is possible to reduce runoff waste in the research region thanks to these types of connectivity solutions. In addition, since geospatial technology is used to connect the lakes, an exact technique of determining the canal connection with the shortest and most efficient flood route may be applied. Once the link is created, the authorities may monitor and maintain the catchment areas of these lakes, which aids in the prevention of encroachment. Because the lakes are being connected by canals, the groundwater level can be maintained along the canal path and the canal due to the recharging of the water from these linking canals. During the summer seasons, it is noticed that the river supplies water to the study area; however, if these lakes are connected, water can be shared and delivered to the people for domestic use. The method of joining water with other lakes can be conducted without any additional investigation, thus this research is carried out with water quality examination in these lakes.

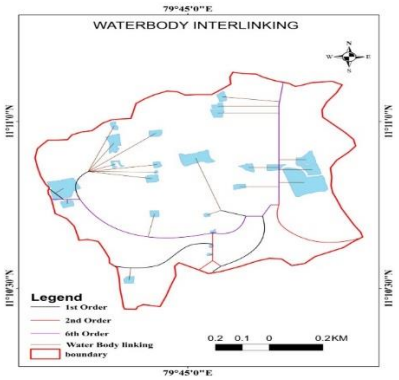

Fig. 8 Interlinking of water Bodies

Conclusions

In the present study, a DEM map has been used to determine watershed characteristics, stream network, storage reservoir volume, and reservoir surface area. Using GIS, these calculations can be performed effortlessly and quickly. Drainage network and surface area of storage space maps were created with ArcGIS, while build - up-volume and elevation-area graphics were created with Global mapper.

The water body's reservoir capacity was determined to be 2,000 m3. Given that the elevation values on the digital elevation map range from 4 to 8, it appears that the study area is relatively level with a gentle slope. The utmost slope of the area is 50 degrees, and that is only along the edges of agricultural land. The area is flat, and the direction of the inclination is to the south-east. The flow orientation of the study area is south-east, and the lake is interconnected according to the stream order. The area's stream order is 1st, 2nd, and 6th order. The alignment of the canal is proposed based on hydrology, geology, and land use perspectives, and one is chosen as the most appropriate for linking lakes. The alignment takes into account factors such as the minimum distances between lakes, populated roads, agricultural lands, etc. A field survey is conducted to determine the most reliable alignment and attain the lowest gradient possible.

Before determining the capacity of the canal or culvert, the water balance and overflow rate must be examined. Based on the land use map, Alignment 1 passes through agricultural lands, excluding built-up areas. The alignment must pass through agricultural land for a minimum distance. It has no gradient for gravitational flow. Currently, agricultural land has been converted to urban development.

Therefore, gravitation flow is possible. This alignment passes through the urban area, thereby increasing the cost. It follows the longest route. This alignment follows a zigzag route that traverses roads and avoids urban areas. Gravity flow is capable of attaining a minimum gradient. This alignment's advantage is that it follows the roadside; therefore, no building demolition is required, and the gradient necessary for gravity flow can be attained. The gradient and slope obtained are minimal, so a large cross-section is required.

Reference

[1] Eilander, D., Frank, O. Annor, Lorenzo Iannini and Nick van de Giesen, (2014), "Remotely sensed monitoring of small reservoir dynamics a bayesian approach", J. Remote Sens, vol. 6, pp. 1191-1210.

[2] Hao, J. and Tong, X. (2014), "An automated method for extracting rivers and lakes from Landsat imagery", J. Remote Sensing, vol. 6, pp. 5067-5089.

[3] Hui, F., Bing, Xu, Huabing, Huang, Qian, Yu and Peng, Gong, (2008), "Modelling spatial-temporal change of Poyang Lake using multitemporal landsat imagery", Internat. J. Remote Sensing, vol. 29, no. 20, pp. 5767–5784.

[4] Hanqiuxu (2006), "Modification of normalized difference water index (NDVI) to enhance open water features in remotely sensed imagery", Internat. J. Remote Sensing, vol. 27, no. 14, pp. 3025- 3033.

[5] McKee, T.B., Doeskin, N.J. and Kleist, J. (1993), "The relationship of drought frequency and duration to time scales", In: Proceedings of the eighth conference on applied climatology, Anaheim, CA, January 17–23, 1993. American Meteorological Society Boston MA.179–184.

[6] Subramaniam, A.V. Suresh Babu, E., Sivasankar, V. Venkateshwar Rao and Behera, G. (2011), "Snow cover estimation from resourcesat-1 AWiFS – Image Processing With an automated Approach", Internat. J. Image Processing (IJIP), vol. 5, no. 3, pp. 445-467.

An experimental study on Plastic Waste used in Bitumen Pavement

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Abstract

Use of plastic along with the bitumen in construction of roads is not only increases its life and smoothness but also makes it economically sound and environment friendly. Plastic waste is used as modifier of bitumen to improve some of bitumen properties roads that are constructed using plastic waste are known as plastic roads and is found to be perform better compared to conventional bitumen. Future it has been found that such roads where not subjected to stripping and come in conduct with water. In this paper the use of higher percentage of plastic waste reduces the need of bitumen by 10%. It also increases the strength and performance of the road. Plastic increases the melting point of the bitumen and hence mixing can be done in more better and easier way. Plastic wastes replace 8% of bitumen. Inclusion of plastic waste in road construction eliminates the plastic shrinkage cracking of road surface and reduces the drying shrinkage to some extent

Keywords: Plastic waste, Pavement, Bitumen, Drying shrinkage

Introduction

Plastic is durable and degrade very slowly the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Unfortunately, they are not easily degradable, and take pretty long time which is of the order of 100-500 years. This causes a heavy burden on the environment to degrade. It is well known that sources of good quality mineral aggregate including traditional fillers (lime, cement, etc.,) are depleting fast due to large scale develop of road infrastructure in India. Disposal of waste has become a great problem in cities.

The main problem with plastic is, it will be thrown on roads and dumped in dustbins and drains. Plastic is a non-biodegradable material and researchers found that the material can remain on earth 4500 years without degradation. Plastic is a very resourceful material. It is possible to improve the performance of bituminous mixes used in the surfacing course of roads.

Use of waste plastics in road construction is gaining importance these days because plastic roads perform better than normal roads.

Literature review

Laboratory investigation on use of fly ash plastic waste composite in bituminous concrete mixtures. This paper reports the benefits of composite of fly ash and plastic waste in bituminous concrete (BC) mixture for construction of flexible pavement. Fly Ash (FA) and plastic waste (PW) are two abundantly available waste materials, with several good characteristics, making them suitable for bituminous road construction. The plastic waste will improve some properties of the bituminous mix and also solve environmental problems. Fly ash is the finely in hot mix asphalt (HMA) paving applications.

Utilization of waste plastic materials as bitumen-blends for road construction in Oman

Studies are reported in the present work to focus on blending of waste plastic materials (in the form of shredded polyethylene bags) being used as a binding agent in asphalt for road construction. This study compared the results with the standards set by Oman as per MOTC (Ministry of Transportation & Communications) guidelines for asphalt as a road laying material. Polyethylene was used as a binding agent along with bitumen (60/70) grade and dolerite as the aggregate material. The studies showed that not only did the road become a receptacle for plastic waste, but it also had a better strength and durability which were verified by determining the bulk density, stability test, flow test and the density and voids analysis.

Methodology

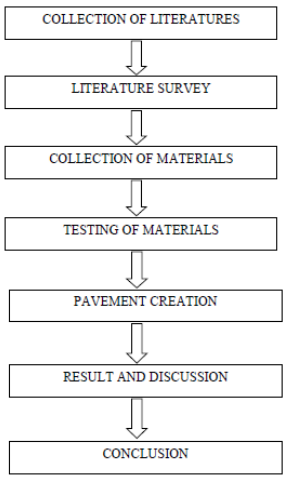

Chart 1 Collection of Materials and its properties

Collection of materials

We use following material for making bitumen pavement by using plastic waste.

- Plastic wastes
- Aggregate
- GSP (Ground Source Pavement)
- WMM (Wet Mix)
- Bitumen

Material Properties

Every material is having different type of properties, the following material properties are using for making plastic waste bitumen pavement

Plastic Waste

Aggregate

Bitumen

Testing Procedure

Tests on aggregate

- Abrasion test
- Impact test
- Shape test
- Flakiness Index
- Elongation Index
- Water absorption test

Tests on Bitumen

- Penetration test
- Ductility test
- Softening point test
- Viscosity test
- Marshall stability test

Table 1 Styles

Tests	Values
Abrasion	5.32%
Impact of aggregate	11.82%
Flakiness index	30.37%
Elongation index	18.51%
Water absorption	2.2%
Penetration of bitumen	136.667
Ductility	53.3 cm
Softening point	45°C
Viscosity	9 sec
Marshall stability – optimum binder content	16.05 kN

Results and discussions

We had to conducted the ductility test, penetration test, softening point test, viscosity test and marshal stability test. With the result of test Ductility test and penetration test values are reduced and softening point test, viscosity test and Marshall Stability test values are increased. Use of innovative technology not only strengthens the road construction but also increased the road life as well as helps to improve environment and it will also create source of income.

Table 2 Mix proportions

TEST	WITHOUT PLASTIC	WITH 8% OF PLASTIC	RANGE
Ductility	65cm	53.3cm	Min 40
Penetration	68mm	62mm	60 – 70mm
Viscosity	8 sec	12 sec	-
Softening point test	40°C	45°C	40 – 60°C
Marshall stability	12kN	16.50kN	-

Comparison between normal bitumen pavement and plastic waste bitumen pavement

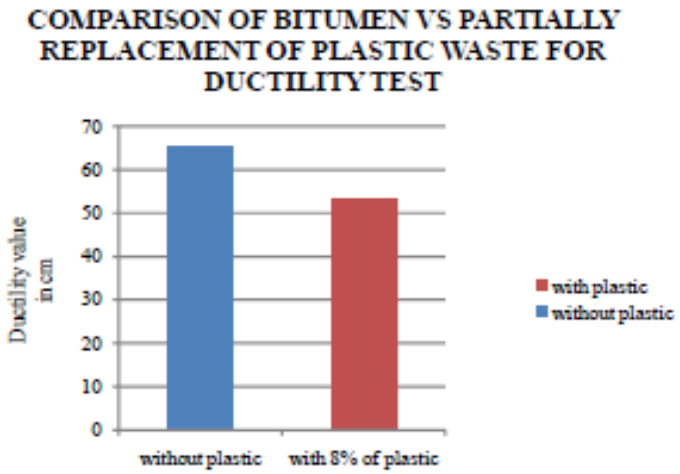

Figure 1 Bitumen vs partially replacement of plastic waste for ductility test

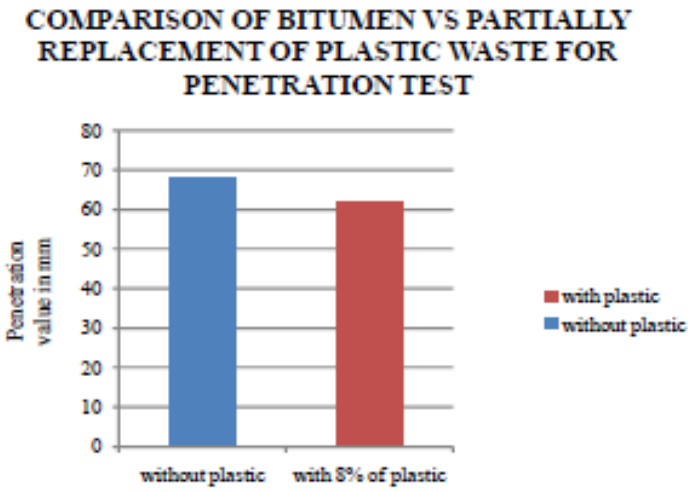

Figure 2 Bitumen vs partially replacement of plastic waste for penetration test

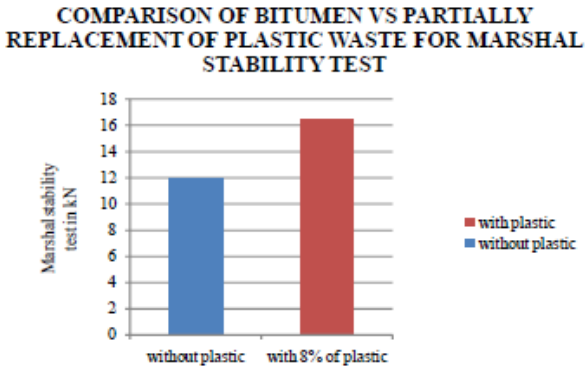

Figure 3 Bitumen vs partially replacement of plastic waste for stability test

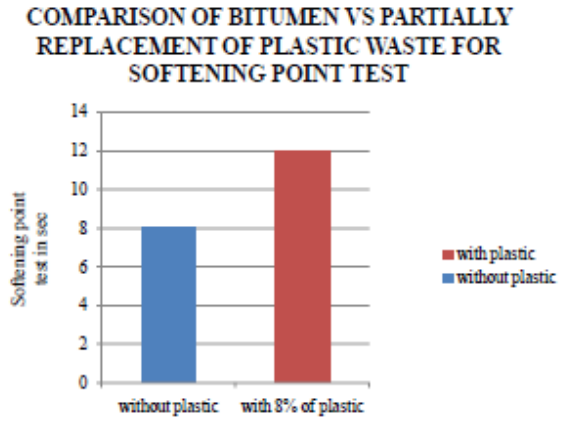

Figure 4 Bitumen vs partially replacement of plastic waste for softening point test

Conclusions

- Optimum plastic content was obtained as percent by weight of bitumen.
- Strength increased by 100% and withstand heavy load.
- This help to reduce the quality of bitumen needed for road laying and to save 10% of bitumen.
- Road strength is twice stronger than normal roads.
- Help to improve the environment.
- Increase the strength and performance of the roads, reduce the cost, in order to provide employment for rag picker.

References

[1] Afroz sultana. S. K, K.S.B. Prasad, (2012), "Utilization of waste plastic as a strength modifier in surface course of flexible and rigid pavements", International journal of engineering research and application (IJERA), vol. 2, no. 4, pp.1185-1191.

[2] AmitGawande, G. Zamare, V.C. Renge, SaurabhTayde, G. Bharsakale, (2012), "An overview on waste plastic utilization in asphalting of roads", Journal of Engineering Research and Studies, vol. 3, pp. 01-05.

[3] Apura J Chavan, "Use of plastic waste in flexible pavements", International journal of application or innovation in engineering & management, vol. 2, no. 4.

[4] Apurva J Chavan, (2013), "Use of plastic waste in flexible Pavements", vol. 2, no. 4.

[5] Indian Roads Congress IRC: 37-2012 - Guidelines for the design of flexible pavements-August 2012

[6] M. Wahlstrom. (Oct 1999), "Environmental quality assurance system for use of crushed mineral demolition waste in road constructions", Waste management, vol. 20, pp. 225-232.

[7] K. S. Roy (2009), "Effect of polyethylene on life of flexible pavements", Road congress, no. 573.

[8] S.S.Verma, (2008), "Roads from plastic waste", The Indian Concrete Journal.

[9] Vasudevan R., Nigam S. K., velkennedy R., A. Ramalinga Chandra sekar and B. Sundarakannan, Utilization of waste polymers for flexible pavement and easy disposal of waste polymers,

[10] Vinoth.N - Use of plastic wastes in road construction Central Institutes of Plastic Engineering and technology.

Automatic Irrigation System Using Soil Moisture Sensor

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Abstract

Now a day's water is becoming very precious due to scarcity in obtaining clean water for domestic purpose including irrigation. In order to optimize the use of water, mechanism to develop water conversation is the need of the hour. Also, automation in agricultural systems is a necessity to optimize water usage, reduce water wastage, and to implement modern technology in agriculture systems. Soil moisture sensor is a novel device which senses the moisture content in the soil, and with suitable mechanism allows water to be irrigated depending on the moisture content of the soil. This allows flow of water or stoppage of water to the plants by using an automated irrigation system. The device consists of an Arduino board, which is the micro controller which activates the water pump and supplies water to plants through Rotating Platform Sprinkler. A submersible motor pump is used for this purpose of pumping water. This system uses low power consumption and pumps water up to 100 litres/hour. Necessary tunings for pumping and supplying water is arranged depending on the consumption of water. This involves a power supply of 2.5 V to 6 V. Soil moisture sensor is inserted in the soil which contains a probe to measure the moisture content of the soil.

Keywords: Moisture sensor, Arduino, Microcontroller

Introduction

This is a microcontroller-based control system used for data processing. The activation of the pump to supply water through the tunings connected to the pump depends upon the signals received through the sensing mechanism. The purpose is to regulate water and optimize the water flow so that plants are not starved of water. This is particularly useful during summer seasons when water is scarce. During monsoon and winter seasons, the water flow can be optimized depending on the requirement, thus saving precious water. As the technology is improving day by day, the basic idea is to develop a new device to this project GSM, (Global

System for Mobile) controlled soil moisture sensor. GSM module is used to operate the soil moisture sensor. The device is very sensitive and care is taken to use a 5V microcontroller device and interfaced with 240 V energy meter, used for domestic power consumption [1].

Methodology

The major components used in this project are:

- Microcontroller based control system with regulated power supply
- Soil moisture sensor
- Electromagnetic relay to control the electrical motor (pump)
- Relay driver
- GSM modem attached to Microcontroller for remote communication

LED Indicators

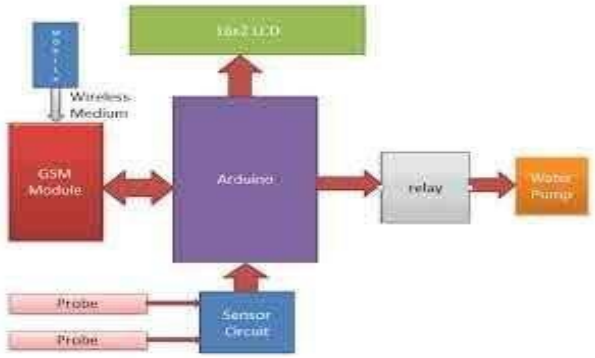

Figure 1 Basic Block Diagram

Power Supply

As this electronic device is power operated, the controller and other devices used are low power devices. The voltage has to be step down to obtain a constant DC output [2]. The block diagram of regulated power supply is as shown in Fig.2.

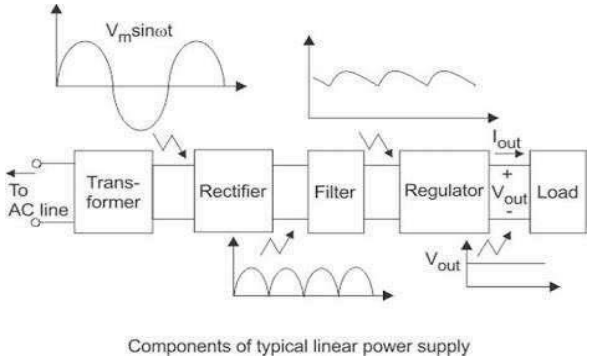

Figure 2 Power supply block diagram

The following components are used in the circuit.

The Arduino Uno

It is a microcontroller-based board connected to the power supply.

Figure 3 Arduino Uno

GSM Module

It is used to send and store messages. It also alerts the user of any specific data. It is handy and can be carried anywhere easily.

Figure 4 GSM module

Figure 5 Relay

Relay

A simple relay is used to open or close a circuit. It can energize and de-energize the system according to the inputs.

LED

It is a light emitting diode used as flash lights to emit light during operation and used as indicator.

Moisture sensor

It consists of a probe consisting of moisture sensors which can be inserted in the soil, in order to measure the moisture content of the soil. When the field is in dry condition, the sensor device senses the condition of the soil and the signal is transmitted to the microcontroller. which in response makes the motor ON. Now, the water is pumped and the irrigation is done at the dry places only. This is done by moisture sensor device. Where there is moisture present in the soil, irrigation process will stop and vice-versa. Soil moisture sensors measure the water content in soil.

Figure 6 Moisture Sensors

Submersible pump

This is a low cost, small size Submersible Pump Motor which is operated from a 2.5 V to 6 V power supply. It is used to deliver about 100 litres of water per hour. The pipe tubings are connected to the motor outlet and submerged in water. Power is activated when water is to be pumped. Care is taken to ensure the level of water is higher than the motor...

Conclusions

The 'Automatic Irrigation System using Soil Moisture Sensor' has been developed and tested successfully and found to function automatically.

References

[1] M-Nesa Sudha, (2011), "Energy efficient data transmission in automatic irrigation system using wireless sensor network", pp. 215-221.

[2] Joaquin Gutierrez, (2014), "Automated Irrigation System using a Wireless Sensor Network and GPRS Module", vol. 63.

[3] Purnima (2012), "Design of Remote Monitoring and Control System with Automatic Irrigation System using GSM -Bluetooth", vol. 42.

[4] Venkata Naga Rohit Gunturi, (2013), "Micro Controller Based Automatic Plant Irrigation System", vol. 2, no. 4.

[5] Nikhil Agrawal, (2015), "Smart Drip Irrigation System using Raspberry pi and Arduino".

[6] J. Clerk Maxwell, (1892), "A Treatise on Electricity and Magnetism", 3rd ed., vol. 2. Oxford: Clarendon, pp.68-73.

[7] S.G. Manoj Guru, (2017), "Smart Irrigation System using Arduino".

Effect on Properties of Concrete with Carbon Black and Robo Sand as a Partial Replacement to Cement and Natural Sand

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Abstract

The sustainability, strength, and durability of any of the constituent material of concrete play an important role in studying and determining the effects on the properties of concrete. Pores in concrete seem to be an immense problem ever since concrete was discovered. Pores attract water that leads to the ill effects such as acid intrusion, freezing and thawing, decrease in resistance to chloride ion, reduced compressive strength etc. Less permeability of concrete plays an important role in gaining the strength and reducing the corrosion of reinforcement in concrete. This paper reviews in studying the properties of concrete using quarry dust (Robo sand) as a partial replacement of natural fine aggregate and carbon black as a partial replacement of cement in concrete by using different percentages of both the materials. Experiments have been conducted by introducing carbon black in concrete which is a waste of rubber industry to act as filler and which imparts the enhanced properties of concrete. In this present experimental study, various properties of concrete have been studied using quarry dust (Robo sand, artificial sand, stone dust) as a replacement of natural fine aggregate and carbon black as a replacement of cement in concrete by using different percentages of both the materials. Eventually the experimental investigation conducted between various percentages of mixes and compressive strength, split tensile strength and flexural strength have been evaluated.

Keywords: Carbon black, Robo sand, Natural sand, Concrete, Compressive strength, Tensile strength

Introduction

Concrete is the most popular building material in the world. However, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the

depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for cement and river sand that are preferably by-products.

Robo Sand

Robo sand is sand manufactured in stone quarries and it is a substitute for the river sand which is used in construction. Certain manufacturers are openly claiming that robo sand is a better alternative when compared to river sand. Robo sand can be an economic alternative to the river sand.

Robo sand is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. Quarry dust, a by-product from the crushing process during quarrying activities is one of such materials. Granite fines or rock dust is a by-product obtained during crushing of granite rocks and is also called quarry dust. In recent days there were also been many attempts to use Fly Ash, an industrial by product as partial replacement for cement to have higher workability, long term strength and to make the concrete more economically available. The specific gravity of this natural sand was found to be 2.55. The water absorption and moisture content values obtained for the sand used was found to be 6% and 1.0% respectively. The bulk density of ROBO sand or crusher dust is 1768 kg/m^3.

Need for the Replacement of Sand

Large scale efforts are required for reducing the usage of the raw material that is present, so that large replacement is done using the various by-product materials that are available in the present day. Materials like fly ash especially Class F fly ash is especially useful as the fine aggregates. The fly ash is obtained from the thermal power plants which is a by-product formed during the burning of the coal. The other material that can be used is Robo sand which is made while in the processing of the Granite stone into aggregates, this is formed as a fine dust in the crushers that process the coarse aggregates, which is used a earthwork filling material in the road formations majorly. Many studies are made with several other materials which gave the concrete to be a material made of recycled material but the parameters that are primary for the material was not satisfied. The properties of concrete in fresh and hardened state are studied in the various papers that are used as a reference for this. Some of the properties are workability; compressive strength is the major one that are considered.

Advantages of Robo Sand

- No or near zero impurities.

- Controlled gradation of particles. Hence, no wastage.
- No oversized particles or shingles, stones and pebbles.
- Generally dry, so does not fiddle with the concrete mix proportions.
- Higher concrete compressive strength achieved.
- Zero silt content.
- Cheaper than marine sand or river sand.
- Easier to spot adulteration judging by oversized or undersized particles and colour (greyer the purer, browner the impure).
- Extraction of sand from river and sea beds is an environmental hazard.

Carbon Black

Carbon black is a substance that is an intense black substance, which belongs to the carbon family. The carbon black structure is of a high surface-area-to-volume ratio, making it light and durable. It is obtained through the unfinished combustion process of heavy petroleum's like coal tar, ethylene cracking tar, etc.

Advantages of Carbon Black in Concrete

Carbon black pigments used in cement compared to iron oxides, normally 4 to completely black shade. Depending on the type of product, a dose of between 1.5 and 2% is enough to create a black colour. In some cases, the dose can reach 4% or even 6%.

Scope of the Project

The scope of this project involves the following.

Chemical and physical properties of carbon black from rubber waste and robo sand from manufacturing sand quarry. Carry out the test on fresh and hardened concrete with carbon black and robo sand as per IS codal provisions. Strength assessment of concrete by the aid of modern equipment according to the procedure given in IS codes.

Objectives of the Project

The objective of this project work involves the following.

- To study the literature reviews related to the carbon black and robo sand.
- To study the physical and chemical properties of carbon black and robo sand.
- To prepare the required number of specimens with selected percentages of carbon black and robo sand of the concrete.
- To carry out the workability test, compression test, split tensile strength test and flexural strength test on prepared specimens.

- To evaluate and compare the exact test result with conventional concrete by following the test procedures given in IS codes.

Literature Review

Dr. G. Chitra *et al*. (2014) "Carbon Black as an Additive in Conventional Concrete" investigated the different tests regarding strength and durability. Carbon black was used as a filler to minimize the presence of pores. 18 cubes, 12 cylinders were cast at the percentage replacement of cement at 0%, 2%, 5%, 8%, 12% and 15%. Different tests like compressive strength test, water absorption and split tensile test were conducted during the research work. It was later found that at 5% replacement of cement with carbon black, there is 20.7% increase in compressive strength (for M25 grade, the compressive strength was found out to be 29.33 N/mm2). Moreover, the split tensile strength at 5% was found out to be effective.

M. Shahul Hameed *et al* (2009) investigated the feasibility of using quarry dust and marble dust in the concrete as a replacement of natural sand. The results indicated that the compressive strength, split tensile strength and flexural strength were 14% more than that of conventional concrete at 50% replacement.

Mr Shaik Mohammed Siraj *et al*. (2017) "Combined Concrete using Robo Sand" studied use of combiner as an admixture in varying proportion of 0%, 1%, 5%, 8%, 10% by weight of cement. The grade M25 was designed as per BIS 10262:2009-2009. It was found out that the compressive strength of the conventional M20 grade concrete was 28.36 N/mm2 and the highest strength attained using combiner increased significantly to about 37.61 N/mm2. The usage of combiner as an admixture in concrete only enhances the overall performance of concrete, but if it is used in excessive percentage, it has adverse effects.

B. Padma Priya *et al*. (2016) "Experimental Investigation on the Properties of Concrete with Carbon Black and PET" studied the effect of PET (Polyethylene Terephthalate) and Carbon Black in concrete. PET was kept constant and carbon black content was replaced at different percentages 0%, 10%, 20% and 30%. Then the strength properties were compared to the conventional concrete. They concluded that at 30% replacement of cement by carbon black, compressive strength is increased.

S. Rukmangadhara Rao *et al*. (2015) studied two grades of concrete M25 and M35 at different replacements of natural sand by robo sand. The results were quite satisfying indicating when the 50% of natural river sand was replaced by robo sand, the compressive strength was

found out to be maximum rather than 0%, 75% and 100% replacement. It was concluded that the compressive strength at 50% replacement was 36.15 N/mm2 for grade M25 and 49.33 N/mm2 grade M35.

S. Rukmangadhara Rao *et al*. (2015) "Study on Strength of Concrete Using Robo Sand as a Partial Replacement of Fine Aggregate" studied two grades of concrete M25 and M35 at different replacements of natural sand by robo sand. The results were quite satisfying indicating when the 50% of natural river sand was replaced by robo sand, the compressive strength was found out to be maximum rather than 0%, 75% and 100% replacement. It was concluded that the compressive strength at 50% replacement was 36.15 N/mm2 for grade M25 and 49.33 N/mm2 grade M35.

M.H. Kharita *et al*. (2011) concluded by their experimental investigation that when carbon black is used as an Additive in the hematite concrete (15% of weight of the cement), there is no significant effect on the shielding properties, But it enhances the mechanical properties of hematite concrete. It has been investigated that of 6% of carbon black powder in hematite concrete enhances the workability of fresh mix, and compressive strength of the concrete. Precautions should be taken when the carbon black powder is used as an additive at high temperatures, because it gets affected easily by heat.

Methodology

- General studies on carbon black and robo sand
- Literature reviews on carbon black and robo sand
- Collection of required sample of materials
- Basic material tests on cement, fine aggregate, course aggregate, carbon black and robo sand to find the properties
- Fixation of percentage of carbon black and robo sand as a partial replacement to cement and natural fine aggregate.
- Preparation of specimen for conventional concrete and carbon black, robo sand replaced concrete
- Test on specimen at 3,7 and 28 days
- Result and comparison on conventional concrete and carbon black, robo sand replaced concrete

Materials Used

The following materials were used in this project

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Carbon black
- Robo sand

Cement

Cement commonly used is Portland cement. Cement is obtained by burning at a very high temperature mixture of calcareous and argillaceous materials. For this experimental work, Chettinad cement 53 grade of ordinary Portland cement is used and its properties are listed. The cement samples were tested as per the procedure given in IS: 4031-1996 and IS: 4032-1999 and found to be confirming to various specifications IS: 12269-1987.

Table 1 Cement Properties

Properties	Value
Type of cement	OPC
Grade of cement used	G53
Specific gravity	3.14
Fineness	96%
Standard consistency	38%
Initial setting time	30 min
Final setting time	8 hours

Fine Aggregate

The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate also assists the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate, particularly when it is necessary to transport the concrete some distance from the mixing plant to point placement. The locally available clean, well graded and manufactured sand was collected for experimental work. Fine aggregate properties were evaluated as per the IS 383-1970 methods.

Table 2 Fine aggregate Properties

Properties	Value
Type of aggregate	Natural Sand
Size of fine aggregate	4.75 mm
Specific gravity	2.73
Fineness modulus	4.5
Water absorption test	1.31%

Coarse Aggregate

The coarse aggregate is the strongest and least porous component of concrete. It is chemically stable materials. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. Aggregates passing through 20 mm sieve and retained on 10 mm sieve are used as coarse aggregate. The crushed stone aggregate is collected from local quarry and their properties are shown in table. The coarse aggregate used in the experimentation were tested as per IS 383-1970 and 2386 -1963(I, II and III) specification.

Table 3 Coarse aggregate Properties

Properties	Value
Size of coarse aggregate	20 mm
Fineness modulus	2.16
Specific gravity	2.47
Impact value	39.62%

Water

Water is an important ingredient of concrete, as it actively participates in the chemical reactions with cement to form the hydration product, calcium silicate hydrate (C-S-H) gel. A higher water cement ratio (w/c) will decrease the strength, durability, water tightness and other related properties of concrete. Addition of excess water ends up in the formation of undesirable voids (capillary pores) in the hardened cement paste of concrete. The PH value of water lies between 6 to 8 and it should be free from organic matters, acids, suspended solids, alkalis and impurities. Locally available portable water confirming to standard specified in IS: 456-2000 is used.

Carbon Black

Carbon black (CB) is effectively pure carbon which is formed by incomplete burning/ thermolysis the compounds made up of hydrogen and carbon. The appearance of carbon black is black, fine powder. It is an unwanted material obtained from the rubber manufacturing industries and hence it is difficult to dispose. Normally these wastes from rubber manufacturing industries are decomposed in the soil thereby causing soil contamination and pollution in water. By utilizing carbon black as filler, this problem can be reduced to a high degree.

Table 4 Carbon black Properties

Properties	Value
Colour	Solid black
Form of nature	Powder
Specific gravity	2.5
Fineness modulus	98%

Robo Sand

Robo Sand (RB) is obtained from crushing stones in a quarry. The sand used in concrete must have a proper gradation of 150 microns to 4.75 mm. The fineness modulus of robo sand is 2.52. The uniformity coefficient is less than 6 and its specific gravity if 2.66. It has the following facets.

- The strength of concrete increases
- Reduction of permeability of water
- Eco-friendly
- Low cost

Specimen to be prepared

Cube

Cube mould of size 150x150x150 mm was used to prepare the concrete the specimens for determination of compressive strength of concrete.

Cylinder

Cylinder mould of size 300 mm height and 150 mm diameter was used to prepare the concrete specimen for determination of split tensile strength of concrete.

Prism

Prism mould of size 500 mm length, 100 mm width and 100 mm thick was used to prepare the concrete specimens for determination of flexural strength of concrete.

Slump Cone Test

Table 5 Slump values

% of replacement		Slump Value (mm)
Carbon black	Robo sand	
0		78
8	8	75
	16	73
16	16	70
	24	68

Workability of Concrete by Compaction Factor Test

Table 6 Compaction factor values

% of replacement		Compaction factor
Carbon black	Robo sand	
0		0.92
8	8	0.91
	16	0.90
16	16	0.86
	24	0.85

Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength.

Table 7 Compressive Strength

% replacement	Compressive strength (MPa)
0% (conventional)	13.26
8% CB+ 8% RB	9.16
8% CB+ 16% RB	9.44
16% CB+ 16% RB	10.56
16% CB+ 24% RB	13.94
24% CB+ 24% RB	12.46

Split Tensile Strength Test

The tensile strength is one of the basic and important properties of the concrete. The concrete in not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The test consists of applying a compressive strength line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive plates as shown in fig. the tensile strength of is calculated using the equation.

Table 8 Split Tensile strength

% Replacement	Split Tensile strength (MPa)
0% (conventional)	2.32
8% CB+ 8% RB	1.28
8% CB+ 16% RB	1.52
16% CB+ 16% RB	1.55
16% CB+ 24% RB	1.71
24% CB+ 24% RB	1.57

Conclusions

The following conclusions were observed

- The compressive strength of the concrete was increased by adding the CB and RB.
- The split tensile strength of the concrete was increased considerable with the addition of CB and RB.

References

[1] I.M. Attar, Prof. A.K. Gupta, "Application of Foundry Sand in Civil Construction", International J. of Mechanical and Civil Engineering, pp. 38-42.

[2] B.V.Venkatarama Reddy, (1994), "Pressed Soil Cement Blocks: An Alternative Building Material for Masonry", J. of materials in civil engineering, pp. 425-433.

[3] Eknath P. Salokhe, D.B. Desai, "Application of Foundry Sand in Manufacture of Concrete", International J. of Mechanical and Civil Engineering, pp. 43-48

[4] Nithiya.R. (2016), "Experimental investigation on bricks by using various waste materials", International J. of Latest Trends in Engineering and Technology, vol. 6.

[5] Raut, S.P., R.V. Ralegaonkar, S.A. Mandavgane, (2011), "Development of sustainable construction material using industrial and agricultural solid waste: A review of waste create bricks", J. of Construction and Building Material, vol. 25, pp. 4037-4043.

An Experimental Study of Clay Bricks by using Stainless Steel Slag

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Abstract

Clay bricks are one of the oldest and most commonly used building materials. They are made by shaping clay into blocks and firing them at high temperatures to harden them. However, in recent years, there has been growing interest in enhancing the properties of clay bricks by adding supplementary materials such as steel slag. Steel slag is a by-product of the steel industry and is rich in minerals and metals such as iron, calcium, and magnesium. When added to clay, it can improve the compression strength of the resulting bricks. Compression strength refers to the ability of a material to withstand forces pushing down on it, such as the weight of a building. Studies have shown that the addition of steel slag to clay bricks can increase their compression strength by up to 50%. This is because steel slag particles fill the gaps between clay particles and create a stronger, more compact structure. Additionally, steel slag can improve the durability and resistance of the bricks to weathering and erosion. Using steel slag in the production of clay bricks can lead to higher quality, stronger, and more durable building materials that are better suited to withstand the demands of modern construction.

Keywords: Clay, Brick, Hardening

Introduction

The industrial waste treatments that have been primarily used in recent times are solidification and thermal processes. While they are alternatives to land disposal, they still pose problems regarding waste disposal and secondary pollution. There is a need for more resource recovery options to be considered. Steel slag is a by-product of the conversion of iron ore or scrap iron to steel, and its mineralogical composition varies with its chemical composition. High temperatures in a cement kiln can sinter the waste slag and form cement clinkers, which can be used as a raw material for high compressive strength cementitious materials. However, high free CaO content in steel slag can lead to volume expansion problems. In Taiwan, most metallurgical slag is used as aggregate in various applications, and granulated blast furnace

slag is often used as a substitute for raw material in cement production. Burnt clay brick and calcium silicate brick are essential building materials, and waste alkali-activated slag can potentially be used to manufacture permeable blocks and pavement bricks. This study examines the feasibility of using combined clay and alkali- activated slag in brick production and investigates various properties such as water absorption, compressive strength, drying shrinkage, and firing shrinkage

Steel slag is a by-product produced during the conversion of iron ore or scrap iron to steel. The mineralogical composition of steel slag changes with its chemical composition. Olivine, merwinite.

In Taiwan, most metallurgical slag is used as aggregate in different applications. A great portion of granulated blast furnace slag is used as a substitute for raw material in cement production. This may increase the final strength and improve the microstructure and durability of the hardened cement and concrete. However, the replacement might also significantly retard strength development in the early stage, which makes a complicated cement application (Malhotra, 1987). Hence, alternate reuse strategies should be considered. Burnt clay brick is one of the basic materials used in building construction. Calcium silicate brick is considered an advanced building material and is made from siliceous materials and lime (Central Building Research Institute, 1994; Malhotra and Tehri, 1996). Waste alkali activated slag contains siliceous materials and lime that are produced from the steel industry. Nishigaki (1996, 2000) successfully used the slag to manufacture permeable blocks and pavement bricks but further investigation is needed. This study investigated the feasibility of combined clay and alkali-activated slag in the production of bricks. The properties measured in this study included brick water absorption, compressive strength, drying shrinkage, and firing shrinkage.

Using steel slag as a raw material in clay bricks has several advantages. Firstly, it is an effective method of utilizing industrial waste, which helps in reducing the environmental impact caused by the accumulation of steel slag. Secondly, it enhances the mechanical properties of clay bricks, such as compressive strength, flexural strength, and abrasion resistance. The addition of steel slag in clay bricks also increases the density of the bricks and reduces their water absorption capacity, making them more durable and resistant to weathering. Furthermore, steel slag is cost-effective and abundantly available, making it an attractive option for sustainable construction practices.

Steel slag is a by-product of steel production that has been used in the production of construction materials such as concrete, asphalt, and bricks. In recent years, there has been an increasing interest in the use of steel slag as a partial replacement for traditional materials in brick manufacturing. This is due to the fact that steel slag possesses properties such as high compressive strength, low porosity, and good chemical resistance, which make it a desirable material for producing durable and sustainable bricks.

Studies have shown that the incorporation of steel slag into clay bricks improves their physical and mechanical properties, resulting in enhanced durability and strength. This is due to the fact that steel slag has a high content of calcium and silicon, which react with the clay matrix during firing to form new mineral phases that enhance the strength and stability of the brick.

Moreover, the use of steel slag in brick manufacturing also has environmental benefits, as it reduces the amount of waste generated during steel production and diverts it from landfill. This helps to reduce the carbon footprint associated with the production of traditional construction materials, making it a more sustainable and eco-friendlier alternative.

Materials and Methodology

Raw material

The utilization of industrial waste has become increasingly important due to the growing concern for the environment. In this regard, slag, a by-product generated during the process of producing stainless steel, has been found to be a promising material for reuse. The slag is obtained from an electric arc furnace and converter before the full production of steel takes place. It consists of calcium, silicon, aluminum, magnesium and iron as the major species. The chemical composition of the slag was analyzed through microwave digestion followed by ICP-OES. The results showed that the slag contains calcium carbonate which causes significant weight loss in the temperature range of 600-800°C. Further investigation was conducted through thermogravimetric (TG) analysis, which indicated that parts of the calcium component in the slag are in the form of calcium carbonate. This weight loss may occur due to the fact that the calcium carbonate is in amorphous form, which prevents the typical diffraction peak of calcium carbonate from being revealed in the XRD pattern of the slag. Moreover, the iron content in the slag may be in reduced form, and therefore oxidized in elevated temperatures in an oxygen-rich atmosphere, leading to weight gain beyond 900°C. In order to achieve uniform

particle size, the slag and clay obtained from a brick manufacturing plant in Taiwan were crushed and ground below 0.074 mm and then dried for further applications. The chemical composition of the clay was also analyzed through microwave digestion followed by ICP-OES, and it was found to contain calcium, silicon, aluminum, magnesium and iron as the major species. X-ray diffraction analysis showed that the clay used in this research was mainly quartz and kaolin. The size distribution of the raw materials is listed in Table 1. The study aims to investigate the behaviour of these raw materials at elevated temperatures and their feasibility in producing bricks. To accomplish this, properties such as brick water absorption, compressive strength, drying shrinkage and firing shrinkage will be measured. The research aims to find more efficient and environmentally friendly alternatives for waste treatment and resource recovery.

Brick specimen manufacture process

In order to investigate the feasibility of slag reuse in brick making, the slag content in the clay-slag mixture varied from 5% to 10%, 20% or 30% by weight. The mixture was first homogenized in a blender. The mixture was blended at a water-to-solid ratio of 3:5 and then molded in a 50x50x50 mm mold. The molded specimens were air-dried at room temperature for 24 h, then oven dried at 80 °C for another 24 h for the removal of water content, and then the dried specimens were heated. At least three specimens were prepared for the future analysis of each clay-slag mixing ratio.

The heating process is designed according to the environment in a real brick manufacturing process. The samples are heated to 500 °C in 3 h. After the temperature has been maintained at 500 °C for 2 h, the samples are heated to a designated temperature (800, 950, 1000, 1050 and 1100 °C) in 6 h and the temperature is also maintained for 6 h for baking. Then the samples are cooled to 300 °C in 6 h and the furnace is cooled to room temperature.

Processing of Making Clay Brick

The process making of making clay brick to sieving the clay soil and red soil to remove the impurities of organic matter in the soil. Un-soiling of clay we need pure clay for the preparation of bricks. proved to be easy to produce, resistant, and durable. The sieving of both clay soil and red soil to prepare the brick

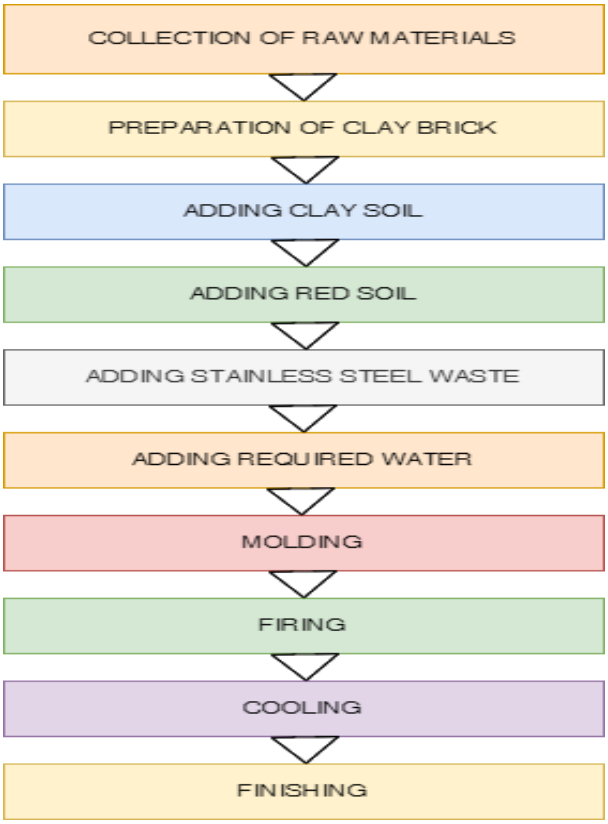

Figure 1 Methodology

Figure 2 Sieving the clay soil and red soil

Figure 3 Mixing of clay soil & red soil

To suitable clay and sand, water, fuel and manpower. The clay must be easily available, be plastic when mixed with small amounts of water, develop strength upon drying and develop hard and durable use-strength when burned.

Alumina is the main constituent of clay. It acts as a cementing material in raw brick. Brick clay is plastic due to the presence of alumina. Clay brick owes its unique properties such as strength, durability, dimensional stability, longevity, fire- and weather-resistance to the final

composition of raw materials as well as a time trusted process that is as rich in tradition as it is in performance. The manufacture of brick and structural clay products involves mining, grinding, screening and blending of the raw materials followed by forming, cutting or shaping, drying, firing, cooling, storage, and shipping of the final product.

Clay Bricks and Pavers can be used for a variety of applications. They can be used for walls, façades as well as Paving, terraces Driveways and open spaces. Clay Bricks and Pavers can be used almost anywhere and for all architectural styles. clays should be processed to meet expected physical characteristics, that is workability, drying shrinkage, firing behaviour and fired properties Good quality bricks should be well-burnt, as well as having a uniform colour. If bricks are under-burnt or over-burnt, they lose this uniformity.

Process of Making Clay Soil and Red Soil

We are adding the clay soil and red soil to mixing Clay consists between 30% Red soils contain large amounts of clay soils have the smallest particle size of the soils which is why they have such a fine texture and are so easily compacted. Clay soils remain wet and cold in winter and dry out in summer. These soils are made of over 25 percent clay, and because of the spaces found between clay particles, clay soils hold a high amount of water.

Process of Adding SS Waste

The process of making clay brick We are adding the main ingredients of waste stainless steel slag to mixing with the soil. It enhanced the mechanical properties of stainless-steel slag.

The mixing of steel slag to improve the strength and durability of bricks by using this kind of clay brick it increases the strength to compare the day brick. The elements of calcium and magnesium could be provided by steel slag to promote the formation of anorthite and clinopyroxene. Adding magnesium-rich materials,

Figure 4 Mixing of clay soil & red soil with Waste stainless steel slag

Figure 5 Preparation of making the brick on mould

Process of Making Brick

Clays are mixed to contain 20 to 30 percent water and then formed into brick in mold the Bricks are moulded depending on the quality of bricks to be made. Bricks are produced by mixing the clayey soil with the water, and then it is shaped in the desired shape. After moulding, the bricks it is dried, and then it is burnt at some specified temperature & Preparation and tempering of the mixture. Once we have all the required materials, then they should be added in a specified proportion.

Test Conducted on Bricks

- Compressive strength of brick
- Water Absorption test on brick
- Efflorescence test on bricks
- Soundness test on brick
- Hardness test on brick
- Dimension test on bricks

Compressive strength test

This test measures the maximum amount of force that a brick can withstand before it breaks under compression. The bricks are placed in a testing machine and gradually loaded until they fail. Compressive Strength/crushing strength of sundried brick is 15 to 25 kg/cm^2.Compressive Strength/crushing strength of common building brick is 35 kg/cm^2.

Table 1 Compressive Strength of Brick

Average Compressive Strength at Day 7 (kN)	Average Compressive Strength at Day 14 (kN)
20	41
23	43
26	45
28	47.5

From the result average compressive strength is 4.725 N/mm^2 (approx. 47.25 kg/cm^2). Relevant is Code Is Code 3495

Water absorption test

This test measures the amount of water that a brick can absorb when submerged in water for a specified period of time. The percentage of water absorbed is an indicator of the brick's porosity and can be used to assess its suitability for different applications. Determine water absorption of the specimen by 24 hours immersion in cold water.

Results and Discussion

Water absorption

Brick water absorption versus various slag additions is presented in Table 3. According to the criteria listed in CNS 382, a first-class brick must have less than 15% water; a second-class brick must have 15–19% water, and the third- class brick calls for less than 23% water. When the test specimen contained less than 10% slag and the firing temperature was higher than 1050 °C, the third-class water absorption standard was met.

When the slag content was from 0% to 30%, the water absorption was from 31.3% to 42.1%, 26.6% to 38.4%, 22.8% to 40.4%, 9.8% to 30.0%, and 2.6% to 9.8% with respect to firing temperatures of 800, 950, 1000, 1050 and 1100 °C. Results indicated that the water absorption of the bricks increased when the slag content increased. Additionally, as the firing temperature increased, the water absorption of the brick decreased. However, when the slag content was higher than 20%, the water absorption of the brick peaked at 1000 °C.

Weight loss on ignition

The weight loss on ignition. Results indicated that when the firing temperature was below 800°C, the carbonate in the mixture did not completely de- form. When the firing temperature was higher than 950°C, the carbonate deformed to CO2 and caused a weight loss in the brick. Additionally, when the temperature was higher than 1000 °C, oxygen was recaptured from the air due to the oxidation of iron and the weight loss in the brick was reduced. A normal clay brick weight loss on ignition is 15%. The bricks made from this study met all the criteria.

Brick firing shrinkage

The results of brick firing shrinkage. When the slag content in the mixture varied from 0% to 30%, the brick firing shrinkage changed from 0.4% to 6.4%, 3.3% to 7.3%, 6.1% to 12.1%, 14.8% to 25.6%, and 34.0% to 39.6% with respect to firing.

Slag content of specimen (%) varied from 0% to 30%, the compressive strength of the brick changed from 6.3 to 9.6, 16.1 to 64.9, 18.9 to 71.0, 64.2 to 95.3, and 95.0 to 110.0 kg/cm^2 with respect to firing temperatures of 800, 950, 1000, 1050 and 1100 °C, respectively. Nevertheless, as the slag is the product from the high temperature process, the slag is inert to the sintering process if the temperature is not high enough. Therefore, as the slag content increased, the com- pressive strength appeared to decrease when the sintering temperature is low (e.g., 950 and 1000°C). The effect becomes insignificant as the sintering temperature increases to 1100°C. The compressive strength of 40 the mixture bricks met the criteria for the

third-class brick when the firing temperature was higher than temperatures of 800, 950, 1000, 1050 and 1100°C, respectively. A good quality brick exhibits shrinkage less than 8%. Results indicated that when the firing temperature of a normal clay brick was less than 950°C, firing shrinkage met the criteria. The effect of the firing temperature on the clay brick was greater than on the mixture brick because the percentage of firing shrinkage in the mixture brick was smaller than the percentage in a normal clay brick.

Compressive strength of brick

The compression test is the most important test when assuring the engineering quality for a building material application. Table 5 shows the results of the compression test. Results indicated when the firing temperature was less than 800°C, the brick specimen could not be sintered to show the strength. As the firing temperature increased to 950°C and above, the compressive strength of the brick gradually increased. When the slag content 1050°C.

Conclusions

Clay makes a significant impact on the brick's strength; high compressive and flexural strength are achieved clay content is 15% to be a good brick the testing Compressive strength of brick units from 4.3 to 6.9 MPa. It with an average of 5.7 MPa. Average modulus of elasticity was found to be about 3878 MPa., and bricks found to be soft and weak compared to clay bricks. Based on the results for the experiments done clay brick Compressive strength is 47.25 kg/cm^2 and % Water absorption is 18.26 %.

References

[1] Central Building Research Institute, (1994), “Calcium silicate bricks”, Special Publication, Roorkee, India.

[2] Li, Y., Sun, Y., (2000), “Preliminary study on combined-alkali-slag paste materials. Cem. Concr. Res, vol. 30, pp. 963–966.

[3] Malhotra, S.K., Tehri, S.P., (1996), “Development of bricks from granulated blast furnace slag”, Construct. Build. Mater. vol. 10, pp. 191– 193.

[4] Malhotra, V.M., (1987), “Properties of fresh and hardened concrete incorporating ground granulated blast furnace slag”, In: Malhotra, V.M. (Ed.), Supplementary Cementing Materials for Concrete, Canada: Minister of Supply and Services, pp. 291–336.

[5] Nishigaki, M., (1996), "Reflecting surface-melt furnace and utilization of the slag", Waste Manag., vol. 16, no. 5/6, pp. 445–452.

[6] Nishigaki, M., (2000), "Producing permeable blocks and pavement bricks from molten slag", Waste Manag., vol. 20, no. 5/6, pp. 185–192.

[7] Shi, C., Day, R.L., (1999), "Early strength development and hydration of alkali- activated blast furnace slag/fly ash blends, Adv. Cem. Res., vol. 11, pp. 189–196.

[8] Shi, C., Qian, J., (2000), "High performance cementing materials from industrial slag- A review", Resour. Conserv. Recycl., vol. 29, pp. 195–207.

[9] Sun, S., (1983), "Investigations on steel slag cements", In: Collections of Achievements on the Treatment and Applications of Metallurgical Industrial Wastes. Chinese Metallurgical Industry Press, pp. 1–71.