2023-2024

INSIGHT

Technical Magazine

CIVIL ENGINEERING STUDENTS ASSOCIATION

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VISION OF INSTITUTION

- Moulding technically competent and socially responsible professionals

MISSION OF INSTITUTION

- To create an excellent academic ambience with the state-of-the-art infrastructure in harmony with sustainable development

- To equip the students with social and employable skills and inculcate the habit of life long learning

VISION OF DEPARTMENT

• To be a center of excellence in Civil Engineering that moulds eminent professionals with due care of societal responsibilities and sense of ethics

MISSION OF DEPARTMENT

- To provide a compatible learning environment with ample resources and Infrastructure in tune with sustainable development.
- To encourage life long learning by empowering students with domain specific knowledge, technical skills, industrial exposure and social consciousness

PROGRAMME EDUCATIONAL OBJECTIVES

- **Build professionally competent Civil Engineers capable of solving the broad-based problems in the field of Civil Engineering**
- **Acquire effective communication skills and exhibit high levels of professionalism with ethical attitude while working in diverse team**
- **Foster life long learning with the spirit of acquiring new knowledge and skills to remain contemporary in civil engineering practices**

PROGRAMME SPECIFIC OUTCOME

- **Apply domain specific knowledge and technical skills in planning, designing and execution of civil engineering projects.**

- **Apply standard practices and strategies in identifying quality of materials, workmanship and methods in constructions.**

BABURAJAN T.S.
(Principal SRGPTC,Triprayar)

PRINCIPAL'S MESSAGE

We are excited to introduce INSIGHT, a publication dedicated to the innovators and visionaries shaping the future of civil engineering. Our magazine will serve as a platform for professionals, students, and enthusiasts alike, offering insights into groundbreaking projects, emerging technologies, and the challenges that define our ever-evolving landscape. Together, let's build a stronger, more sustainable world.

C.T.Jayalekshmi
(HOD Civil Engineering)

HOD'S MESSAGE

As we unveil this edition of our technical magazine, I am filled with pride in the collective efforts of our students and faculty. This magazine represents more than just pages of text; it is a testament to our relentless pursuit of innovation, creativity, and excellence. Our students have delved deep into the realms of technology, exploring emerging trends and offering insightful perspectives that reflect the dynamic nature of our field. The articles and features within are a reflection of their hard work, intellectual curiosity, and passion for pushing the boundaries of knowledge. I extend my heartfelt congratulations to the editorial team, contributors, and every individual who has played a role in bringing this magazine to life. Your dedication ensures that our department remains at the forefront of academic and technological advancements. May this magazine inspire, inform, and ignite the spark of innovation in every reader.

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Lecturer in Civil Engineering

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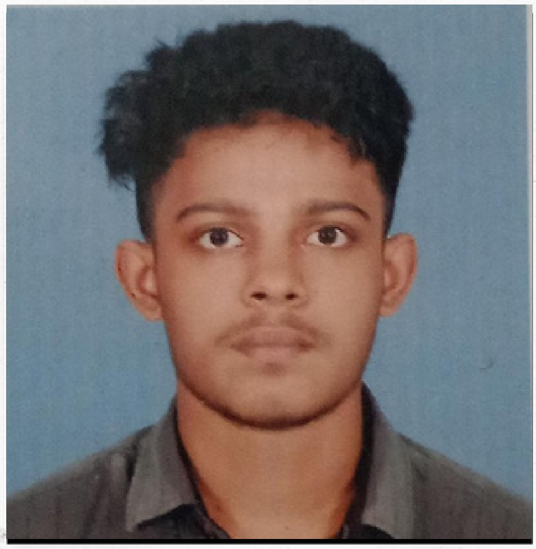

NOEL FRANCIS
S6 CE

TECHNICAL ARTICLES

EFFECT OF POLYPROPYLENE FIBER ON GEOPOLYMER CONCRETE

BY
NOEL FRANCIS

INTRODUCTION

The introduction sets the stage for the project on the transformative potential of polypropylene fibers in enhancing the strength and durability properties of cured geopolymer concrete. Geopolymer concrete, renowned for its eco-friendly composition and superior performance compared to traditional Portland cement-based concrete, holds immense promise for sustainable construction practices. However, despite its numerous advantages, geopolymer concrete still faces challenges related to tensile strength, crack resistance, and long-term durability. Recognizing the need for innovative solutions, this project explores the incorporation of polypropylene fibers as a means to address these limitations. Polypropylene fibers, known for their high tensile strength, impact resistance, and crack control capabilities, present an exciting opportunity to augment the mechanical and durability characteristics of geopolymer concrete. By delving into the synergistic effects between polypropylene fibers and the geopolymer matrix, this project aims to elucidate the mechanisms underlying improved performance and to provide practical insights for optimizing fiber content and distribution. Through a comprehensive examination encompassing experimental testing, microstructural analysis, and economic feasibility considerations, this project endeavors to pave the way for the widespread adoption of polypropylene fiber-reinforced geopolymer concrete in sustainable construction applications, heralding a new era of resilient and environmentally conscious infrastructure development.

GEOPOLYMER CONCRETE

Geopolymer concrete is a type of concrete that differs from traditional Portland cement- based concrete in its binder composition. Instead of using cement derived from limestone, geopolymer concrete relies on a geopolymer binder, which formed by the chemical reaction between alumina and silica-rich materials and an alkaline solution. The geopolymer binder is typically created by mixing industrial by-products, such as fly ash (a waste product from coal-fired power plants) or ground granulated blast furnace slag (a by-product of iron production), with an alkaline activator solution. Alternatively, natural materials like metakaolin (calcined kaolin clay) can also be used as a source of alumina and silica. Geopolymer concrete offers several advantages over conventional concrete. It has a significantly lower carbon footprints because it reduces the reliance on cement production, which is a major source of carbon dioxide emission. Additionally, geopolymer concrete generally exhibits higher compressive and tensile strength, improves resistance to fire and chemicals, and enhanced durability, making it a promising material for various construction applications.

APPLICATION AND DEVELOPMENTS

Geopolymer concrete can be used for a wide range of construction projects, including pavements, buildings, bridges, and even precast elements. Research is ongoing to optimize geopolymer mix designs, improve its workability, and understand its long-term behavior. Innovations are being explored to enhance its commercial viability.

NECESSITY OF POLYPROPYLENE FIBERS WERE USED IN GEOPOLYMER CONCRETE

Enhanced Toughness: The inclusion of polypropylene fibers can significantly improve the toughness and ductility of geopolymer concrete. This toughness helps the concrete resist cracking and with stand stresses, including those induced by loadings and temperature fluctuations.

- Crack Control: The fibers help control and limit the propagation of cracks within the concrete matrix. This is particularly important in geopolymer concrete, which can be more brittle compared to traditional concrete. The fibers bridge across cracks, preventing them from widening and reducing the risk of structural failure.
- Increased Flexural Strength: Polypropylene fibers contribute to the flexural strength of the concrete, allowing it to handle bending and tension loads more effectively. This is valuable in applications such as pavements and slabs as we reffered from the previous study of our journal.
- Enhanced Durability: Polypropylene fibers can contribute to the durability of geopolymer concrete by reducing the ingress of water, aggressive chemicals, and other environmental factors that might lead to deterioration.
- Fire Resistance: Polypropylene fibers can improve the fire resistance of geopolymer concrete by preventing the rapid propagation of cracks and maintaining the structural integrity of the material at high temperatures as we reffered from the previous study of our journal.
- Reduced Construction Time: In certain applications, using polypropylene fibers can lead to faster construction due to the reduced need for conventional steel reinforcement or mesh
- Design Flexibility: Polypropylene fibers offer designers more flexibility in creating thinner sections and unique shapes without compromising structural integrity.

DIFFERENCE BETWEEN THE INCORPORATION OF POLYPROPYLENE FIBERS INTO GPC & NORMAL CONCRETE

- Binder Chemistry: Geopolymer concrete relies on geopolymerization, where aluminosilicate materials react with alkaline activators to form a cementitious binder. In contrast, traditional Portland cement-based concrete utilizes calcium-based binders derived from Portland cement.
- Mechanical Properties: Geopolymer concrete with polypropylene fibers tends to exhibit higher compressive strength, flexural strength, and tensile strength compared to polypropylene fiberreinforced Portland cement-based concrete. The unique chemical composition and curing process of geopolymer concrete contribute to its superior mechanical properties. 5
- Durability: Geopolymer concrete generally offers better resistance to chemical attack, abrasion, and environmental factors compared to Portland cement-based concrete. When polypropylene fibers are added to geopolymer concrete, they further enhance durability by reducing crack formation and propagation, thus improving resistance to freeze-thaw cycles and enhancing long-term performance.
- Sustainability: Geopolymer concrete is considered more environmentally friendly than traditional Portland cement-based concrete due to its ability to utilize industrial byproducts such as fly ash or slag, reducing the carbon footprint associated with concreteproduction. Incorporating polypropylene fibers into geopolymer concrete aligns with sustainable construction practices by improving material efficiency and reducing the need for additional reinforcement. .
- Workability and Mixing: Polypropylene fibers can affect the workability and mixing characteristics of both geopolymer and Portland cement-based concretes. However, adjustments in mix design and mixing procedures may be required to ensure uniform distribution of fibers and maintain desired workability.

MATERIALS AND METHODS

The binders used in this project were fly ash and GGBS. To activate the solid binder a combination of alkaline solutions was used. Sodium hydroxide solution with 98 % purity and sodium silicate solution consisting of 14.7 % Na_2O, 29.3 % SiO_2, and 55.9 % H_2O with SiO_2 to Na_2O ratio of 1.99. The polypropylene fibers used in the study were acquired from the Fiber region, Chennai. Manufactured sand was used as fine aggregate. While coarse aggregates were procured from a local vendor. Both fine and coarse aggregates were of desired quality and confirmed to IS 383–2016 requirements. To achieve good workability CONPLAST SP 430 from Fosroc Chemicals was used as a water reducer. Fig.3.1 shows the raw materials and Fig.3.2 shows the polypropylene fibers used in this project. Table 3.1 shows the chemical composition of fly ash and GGBFS. Table.3.3 shows the test certificate of GGBS. Fig.3.3 shows the SEM (Scanning Electronic Microscope) images of fly ash and GGBS (Ground Granulated Blast furnace Slag). The shape of fly ash particles is spherical with smooth surface. While the GGBS particles are angular with comparatively rough surface texture. The properties of polypropylene fibers are shown in Table 3.3. Polypropylene fibers are commonly used to produce composite materials due to their availability, cost, high tensile strength, and density. The size of polypropylene fibers is defined by a parameter called aspect ratio and previous journal studies have recommended the range of 850–1375 [6]. Therefore, in this project the aspect ratio of 480 was considered. Further, polypropylene fibers are considered as againstthe other shapes such as triangular, since it affects the post-cracking behavior by bridging action

MIX PROPORTION

The experimental research was conducted with a total of four different mixes. One control Geopolymer Concrete (GPC) mix and four other mixes with polypropylene Fiber Reinforced Geopolymer Concrete (PPFRGPC) were proportioned as presented in Table 3.3. The PPFRGPC mixes are followed by a numerical value that represents the volume fraction of polypropylene fibers. The mix proportion was based on achieving medium slump of 50–100 mm and a target compressive strength of 30 MPa at 28 days. This design parameter was adopted since such mixes are widely used in normal concrete works. To achieve this target properties with a fly ash to GGBS proportion of 70:30, and alkaline liquid to binder ratio of 0.45. The mix design parameter was finalized based on the findings of the previous journal study[7]. Further, the NaOH molarity was fixed at 8 M since it improves the practical feasibility of geopolymer concrete.

Fig. 3.1 Raw materials used for PPFRGPC preparation, (a) fly ash, (b) GGBS, (c) NaOH pellets (d) fine aggregate, (e) Coarse Aggregate, (f) Na_2SiO_3Solution.

Fig.3.2 Polypropylene Fiber

TEST RESULTS

The results of compressive strength are shown in Fig.4.2. The average compressive strength at 28 days curing ranged from 11.40 MPa to 32.14 MPa, and the obtained results are in agreement with previous journal studies.

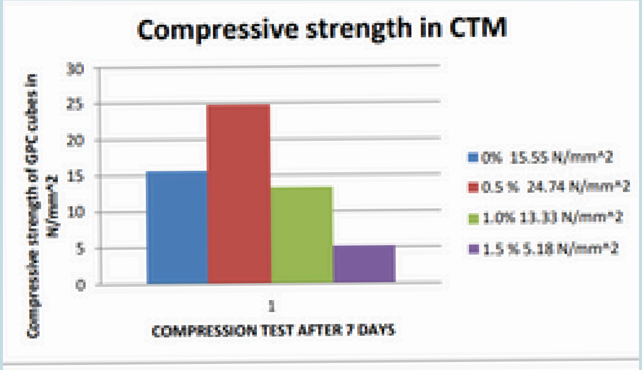

Fig. 4.1 Compressive strength of GPC and PPFRGPC after 7 days.

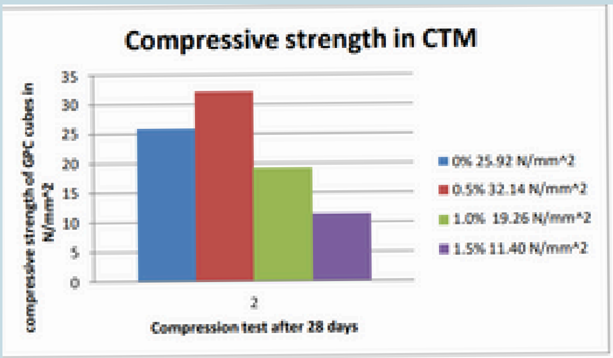

Fig. 4.2 Compressive strength of GPC and PPFRGPC after 28 days.

WATER ABSORPTION

Water absorption (W.A) was calculated for the following sample using the Archimedes principle. The weights of the sintered products were taken dry weight, (D) and then this was followed by soaking the samples in water . The soaked weight (W) of the sample was measured. Using the equation the water absorption percentage can be calculated.

Water absorption = (W-D) /D *100

W = Soaked weight

D = Dry weight

Sl no	GPC cubes description	Wt of GPC dry cubes W1 (kg)	Wt of GPC cube after immersion W2 (kg)	% water absorbed	Average % water absorbed
1	0% GPC cube	8.335	8.713	4.53	3.06
2	0.5% GPC cube	8.465	8.735	3.19	3.06
3	1% GPC cube	8.045	8.218	2.15	3.06
4	1.5 % GPC cube	7.145	7.315	2.38	3.06

CONCLUSION

In conclusion, the incorporation of polypropylene fibers in cured geopolymer concrete significantly enhances both its strength and durability properties. Through comprehensive experimentation and analysis, it has been demonstrated that polypropylene fibers effectively reinforce the concrete matrix, resulting in improved mechanical performance. This reinforcement leads to higher compressive & increased crack resistance. Additionally, polypropylene fiber geopolymer concrete exhibits reduced water absorption, contributing to enhanced durability and resistance to environmental factors such as chemical attack. The synergistic effect of polypropylene fibers on the geopolymer matrix ensures structural integrity and longevity, making it a promising solution for sustainable construction applications. Further research and development in this area hold great potential for advancing the use of geopolymer concrete with polypropylene fibers as a reliable and durable building material. Further previous journal studies on the flexural strength and tensile strength of polypropylene fiber geopolymer concrete hold significant promise for advancing sustainable construction materials and infrastructure development. Investigating these properties in greater detail can provide valuable insights into the mechanical behavior and performance of geopolymer concrete reinforced with polypropylene fibers. Exploring the flexural strength of polypropylene fiber geopolymer concrete can offer crucial information on its ability to resist bending and withstand applied loads, which is essential for structural applications.

SEMI-FLOWABLE SELF-CONSOLIDATING CONCRETE USING INDUSTRIAL WASTES FOR CONSTRUCTION OF RIGID PAVEMENTS

BY
MIYA ROSE OXAN T G

INTRODUCTION

There are mainly two types of pavement, one is flexible pavement and another one is rigid pavements. Nowadays, rigid pavements are preferred to flexible pavements owing to various advantages like more life span, durability, and requirement of lesser maintenance. Sustainability is the new concern in all aspects of technology nowadays. Sustainability in pavement construction is also the need of the hour as the construction of transportation facilities like roadways, flyovers, bridges, etc. requires a huge amount of funds, materials from different sources, and manpower. Sustainability can be achieved by using different techniques like self-consolidating concrete (SCC), slip-form paving, utilization of by products of industries, or agricultural wastes in the construction industry Conventionally, pavement quality concrete (PQC) is used in the construction of rigid pavements. However, it requires rigorous vibrations to achieve full compaction thereby proving energy-consuming. The use of slip form paving technique enables one to place, compact, and finish the concrete easily. Nevertheless, the slip-form paving machine leaves trails on the surface due to vibrations involved and this further, renders the inferior pavement surface finish. To overcome this, the use of self-consolidating concrete (SCC) would be an ideal solution as it requires lesser or no vibrations for compaction. But, the problem with the SCC is that it will not have sufficient shape stability in the fresh state and as such after the forward movement of the slip form machine, the SCC slab extruded will not retain the required camber when used in the construction of rigid pavements at grades. This necessitates the development of concrete with both flowability and shaperetaining ability, i.e., green strength. This necessitated the evolution of an innovative kind of SCC called semi-flowable self-consolidating concrete (SFSCC). Here we discuss the need, evolution, properties, design, and testing methods of fresh and hardenedproperties of SFSCC for the slip form paving. Further, the utilization of different industrialwastes in road construction And then, the possibility of using the industrial wastes in the production of the SFSCC as a material for construction in the rigid pavement are discussed. Further, the scope for future work on various aspects of SFSCC using industrial wastes as pavement construction material are also discussed.

Indian road infrastructure

The development of the country depends on an adequate road network connecting various places. The major part of goods and passenger traffic is carried by road transportation mode. Thus, it is very important to construct and maintain a high quality road network. In India, the flexible pavement construction has been widely used and the share of rigid pavements is very small. However, Ministry of Road Transport and Highways has laid a thrust on the concrete roads as a general mode of road construction on national highways by considering benefits related to life span, saving in fuel cost, better resistance to weather conditions, and lesser maintenance cost

Sustainability Construction

Construction of the large span of rigid pavements requires a huge quantity of concrete to be produced. But, the problem is with the production of Portland cement which affects the environment due to the emission of greenhouse gases (GHG) like CO2. Thus, it is important to reduce cement contents in the making of concrete mix to reduce the emission of GHGs and energy consumption. Sustainability in the production of concrete often involves reducing cement content, increasingly replacing the Portland cement with supplementary cementitious materials (SCMs) of about 30% or more, and incorporating the durable aggregates "Sustainable pavements" is a new trend, which means the pavements satisfy the engineering needs for serving the purpose of construction; ecosystem preservation; the economical use of financial and environmental resources along with satisfying health, happiness, safety, employment, equity and comfort

Slip form paving

In the construction industry, the most widely used material is concrete and the production of which essentially requires Portland cement, the manufacturing of which releases a huge amount of greenhouse gas CO2. Thus, the evolution of concrete technology is needed to meet its demand in the construction field.Nowadays, the concrete pavements are being constructed worldwide by adopting the slip-form paving technique SEMINAR REPORT 2023-2024 SFSCC FOR HIGHWAY Department of Civil Engineering. 3 SRGPC Thriprayar Slip-form paver was invented in the 1940s which was effective since the concrete can be placed continuously and more efficiently than before and the concrete pavements have the advantages of a higher life span and ease of maintenance. A slip-form paver and the typical process involved in slip-form paving are indicated in Fig. 1. Moreover, the slip form paver requires no formwork, either steel or wooden, as in the case of fixed-form construction. However, in the slip-form paving, the concrete being used is of the low slump which needs rigorous vibrations internally as well as externally to attain full compaction. These vibrations leave vibratory trails and cause a poor surface finish as shown in Fig. 2. It also causes internal bleeding, segregation and loss of air content along the vibrator line and because of this, the concrete is more vulnerable to deterioration processes such as freezing and thawing damage. These problems with the low slump concrete necessitated the modification in the concrete technology which renders the high workability to the concrete with lesser or no vibrations for compaction and holds its shape effectively once the paver moves forward

The importance being given to the construction of new roads and upgradation of the existing road network in the country, the need for sustainable road building techniques and the problems in using SCC in slip form paving has led to the evolution of SFSCC.

Fig. 1 On-site slip form paving technology

Fig. 2 Vibrator trails on the concrete pavement

SEMI-FLOWABLE SELF-CONSOLIDATING CONCRETE

SFSCC is basically a self-consolidating type of concrete with the benefit of not only self flowing but also shape-holding as well as ease in surface finish advantage. There was studies carried out on the feasibility of using the SFSCC in the construction of concrete roads with the slip-form paver and these studies emphasized the fresh properties of SFSCC and ensured the feasibility of using the same in the construction of concrete pavements using slip-form paving technology and there were also other studies focussed on the design of concrete in such a way that it attains maximum compaction with lesser compaction energy by vibration along with shape-retaining ability. Initially, a basic SCC mix with high flowability was chosen and then to achieve shape stability, the mix proportion was modified with the addition of different admixtures and/or additives. The mixes containing fly ash (FA) were improved by adding clay, MgO and the fibers to obtain high compactability close to that of SCC and high green strength as close to that of SFSCC.

Materials requirements for SFSCC

- Cement
- Cementitious
- Materials
- Aggregates
- Admixtures such as

Properties and testing methods of SFSCC

Property	Test
Flowability	Flow table test for SFSCC mortar(to check the balance between both flow and shape stabilty) Modified slump test for concrete Rheometer(IBB rheometer)
Compactability	Compaction factor test Visual inspection Shape holding ability(Green strength test)
Overall performance	Mini-paver test
Strength Durability	Compressive strength Freeze-thaw Rapid chloride penetration test Porosity Resistance against scaling and deicing chemicals

Two basic properties of the SFSCC are self-consolidation and shape-holding ability. The mix should achieve self consolidation with required flowability and compatibility; and should be resistant to segregation. The shape-holding ability is the property of concrete to retain its shape in the fresh state as soon as the slip-form paver moves forward. The compatibility can be tested by using the compaction factor test, visual inspection, and the shape holding ability by green strength test. The compaction factor is the ratio of un-rodded weight to the fully compacted weight of the concrete either by rodding or vibrating. A compaction factor close to 1 is preferred for SFSCC. The green strength can be tested by un-rodded slump test either by Method A in which the concrete is dropped from a height of 360 mm to attain the required compaction or by Method B in which the concrete is loosely filled and consolidated by 15 drops. Both methods are presented in Fig. 3(a) and (b)

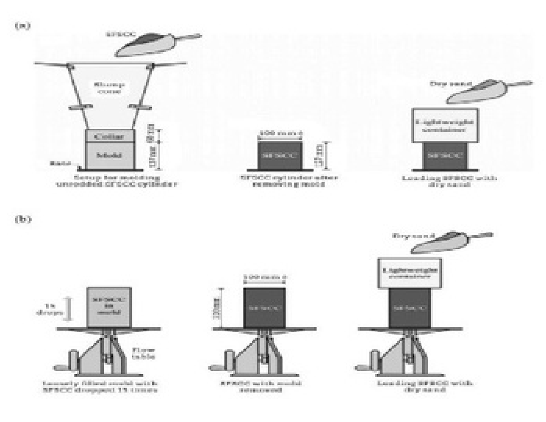

Fig.3 Test methods for green strength of SFSCC. (a) Method A. (b) Method B

A mini paver as shown in Fig. 4 is used for the overall performance check of SFSCC. The slab after the mini paver dragged forward should have a filled shape and vertical faced sides and visual inspection reveals the aggregate segregation resistance. The cores from the hardened slab extracted from the mini paver can be used for different tests like compressive strength.

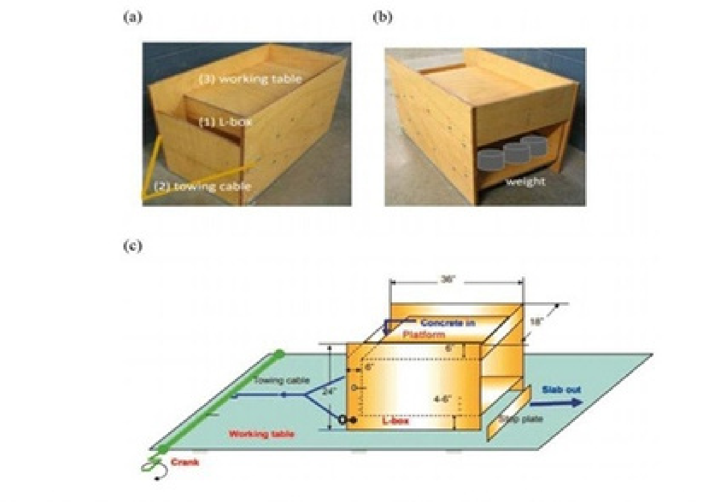

Fig. 4 Details of Mini-paver. (a) Front view. (b) Back view. (c) Dimensions and arrangement

Different properties of SFSCC

- Rheology
- Compressive strength.
- Elastic modulus
- Shrinkage

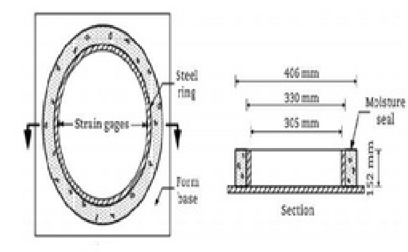

Fig. 5 Restrained ring apparatus for the shrinkage test of SFSCC

USE OF INDUSTRIAL WASTES IN THE CONSTRUCTION INDUSTRY

Possible Usage	Industrial Waste
Bulk Fill	FA, colliery spoil, spent oil shale, nonferrous slag, China clay, and mill tailings
Filler in bituminous mix	FA, marble dust
Artificial aggregates	FA, waste tires
Base/sub-base material, binder in soil stabilization	Blast furnace slag, construction, demolition waste, mill tailings, cement kiln dust
Aggregate in bituminous mix	Mill tailings, nonferrous slags, China clay

CONCLUSION

The advantages of rigid pavements as compared to flexible pavements necessitate innovation in the concrete industry. To minimize the energy consumption in slip form paving, an easy, quick and efficient technology in rigid pavement construction is preferred. It is required to minimize or avoid the mechanical vibrations which lead to performance and durability issues. The solution is the innovative type of concrete called SCC. As the SCC suffers from the problem of lesser shape-holding ability, a new type of SCC, named SFSCC is being recently developed.

The SFSCC can be an economical, efficient and sustainable pavement construction material. Its production enables one to use industrial waste materials which solve the problem of waste disposal and also proves to be economical by saving the virgin materials. The SFSCC can be a solution to complicated slip-form construction practices with required flowability and shape-holding capacity along with strength, durability and textural aesthetics.

The guidelines for the selection of different ingredient materials, mix design approaches, and testing methods for fresh, strength, and durability properties of SFSCC are discussed. Further, the viability of using different industrial wastes in road construction and production of SCC is reviewed. The advantages of using SFSCC in road construction are briefly explained.

The studies on the rheology, strength, elastic modulus, and shrinkage of SFSCC are discussed. It can be seen that the SFSCC can be effectively used in the construction of pavement by using continuous slip-form paving technique without any internal vibrators or devices for compaction. This saves the time, cost, and energy consumption involved in the construction of concrete pavements. Further, the reduction in cement contents by using industrial wastes also reduces the shrinkage of SFSCC which is high. . The studies show the efficiency of different industrial wastes in the production of materials for different layers of road pavements. There are many studies depicting the efficient use of industrial waste products in the construction industry and also in the production of SCC.

ROBOTIES IN CONSTRUCTION INDUSTRY

BY
RABEEA M R

INTRODUCTION

Robotics in construction involves the use of robotic systems to automate tasks that were traditionally performed manually. This integration covers a wide range of applications, from automated bricklaying and 3D printing of building components to advanced inspection techniques and material handling. As construction projects become increasingly complex and the demand for higher quality and faster completion times grows, robotics offers innovative solutions to meet these needs.Robotics in the construction industry represents a groundbreaking shift in how building projects are designed, managed, and executed. Traditionally, construction has been a labor-intensive field with high risks and variable quality. The integration of robotics into this sector aims to address these challenges by leveraging advanced technologies to enhance precision, efficiency, and safety.

Key Drivers of Robotics Adoption

- Efficiency and Speed: Robotics can significantly accelerate construction processes. Automated systems perform repetitive tasks more quickly and with greater consistency than human workers, leading to faster project completion and reduced labor costs.
- Safety: Construction sites are inherently hazardous, with risks ranging from falls to exposure to dangerous materials. Robots can handle dangerous tasks, reducing the risk of injuries and improving overall site safety.
- Precision and Quality: Robots offer high precision and repeatability, which enhances the quality of construction work. This precision is particularly beneficial in tasks that require exact measurements and consistent results.
- Labor Shortages: The construction industry often faces shortages of skilled labor. Robotics can help fill this gap by performing tasks that are difficult to staff, thereby addressing labor shortages and enhancing productivity.

Applications of Robotics in Construction

- Automated Bricklaying: Robots like the Semi-Automated Mason (SAM) lay bricks with high speed and accuracy, reducing manual labor and construction time.
- 3D Printing: Large-scale 3D printers can create building components or entire structures, allowing for complex designs and reducing material waste.
- Drones for Inspection: Drones equipped with cameras and sensors inspect construction sites and gather data for analysis, enhancing site monitoring and quality control.
- Material Handling: Autonomous vehicles and robotic arms streamline the movement and placement of materials on construction sites, improving logistics and safety.
- Inspection and Maintenance: Robots equipped with advanced sensors perform detailed inspections of structures, such as bridges and pipelines, identifying issues that may be missed through traditional methods.

Importants of robotics in civil engineering

1. Enhanced Precision and Quality
   - Accuracy: Robots provide high levels of precision in tasks such as surveying, material placement, and construction, which leads to higher quality outcomes. For example, robotic arms and automated systems can achieve exact measurements and consistent results that are challenging to maintain with manual methods.
   - Consistency: Repetitive tasks, such as bricklaying or concrete pouring, benefit from robotic consistency, reducing human error and ensuring uniformity throughout a project.
2. Increased Efficiency and Speed
   - Faster Construction: Robotics can significantly speed up various construction processes. Automated systems perform tasks more quickly than human laborers, which accelerates project timelines and allows for faster completion of complex projects.
   - 24/7 Operation: Robots can operate continuously, without the need for breaks or shifts, maximizing productivity and enabling round-the-clock construction activities.

3. Improved Safety
    - Hazardous Tasks: Robots can undertake dangerous tasks in hazardous environments, such as inspecting high structures or handling toxic materials, reducing the risk to human workers.
    - Risk Reduction: By automating risky operations like heavy lifting or working in confined spaces, robotics help minimize the chances of accidents and injuries on construction sites.
4. Addressing Labor Shortages
    - Skill Gaps: The civil engineering sector often faces shortages of skilled labor. Robotics can help bridge this gap by performing tasks that are hard to staff or that require high precision, thereby supporting ongoing projects despite a limited workforce.
    - Labor Efficiency: Robots can augment human workers, handling repetitive or strenuous tasks and allowing human resources to focus on more complex and supervisory roles.
5. Enhanced Data Collection and Analysis
    - Surveying and Inspection: Drones and robotic systems equipped with sensors and cameras can collect detailed data from construction sites. This data helps in precise surveying, monitoring structural health, and identifying potential issues early.
    - Real-Time Monitoring: Robotics enable real-time data collection and analysis, facilitating better decision-making and timely interventions during construction projects.
6. Innovative Design and Construction Methods
    - 3D Printing: Robotics and 3D printing technology allow for the creation of complex architectural designs and custom components, which can lead to innovative and unique structures.
    - Modular Construction: Robots can aid in prefabricating modular components off-site, which can then be assembled quickly on-site, leading to faster construction times and improved quality control.


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Advantages of robotics in construction industry

- Increased Efficiency : Robots can work continuously without breaks, leading to faster project completion and reduced labor costs.

- Enhanced Precision : Robotics ensures high accuracy in tasks such as bricklaying, welding, and 3D printing, reducing errors and material waste.

- Improved Safety : Robots can handle hazardous tasks like demolition or working at heights, reducing the risk of accidents and injuries for human workers.

- Cost Savings : Automation can lower labor costs and reduce the time required for construction, leading to overall project cost savings.

- Labor Shortage Solution : Robotics can address labor shortages by taking on repetitive or physically demanding tasks, freeing up human workers for more skilled activities.

- Data Collection and Analysis : Drones and robotic systems can gather real-time data on construction sites, improving project management and decision-making.

- Sustainability : Robots can be programmed to use materials more efficiently, contributing to more sustainable construction practices

SULPHUR CONCRETE AND ITS APPLICATION IN DEFENCE BUILDING

BY
HRISHI ABHIMANYU

INTRODUCTION

Sulphur concrete is a concrete including modified sulphur cement and aggregate, which is produced without water. Its binder property is obtained with molten modified sulphur. The first studies with SC were obtained in 1970. Sulphur concrete has a low porosity and is a poorly permeable material. Its low hydraulic conductivity slows down water ingress in its low porosity matrix and so decreases the transport of harmful chemical species. Its resistant to some compounds like acids which attack normal concrete. However, unlike ordinary concrete, cannot withstand prolonged high heat.

The construction of the watchtowers and defence lies from concrete enabled military personal to survive the attacks with minimum loss. In the past years, many painful events have been experienced in how insecure the outposts consisting of sheet roofs and brick walls are compared to the outpost made of HSC. With these experience, it was decided to build defence structures from customized concrete with high explosion resistance and these structure protected the life of soldiers in many area. It Provides security, and also defend the counter attack. Military shelters have been established by tents in many operations. But this shelter is insufficient for security causes.

Its aim to construct military and critical buildings and structures with sulphur concrete, to reduce the damage to reinforced concrete and to protect the shelters in a short time. It also helps in studying of making shelters from SC at the operation site in short time.

METHODOLOGY

COLLECTION OF MATERIALS

- **Sulphur** – 20% Sulphur is an element which it can be elementally revealed in nature. Besides, it can also be produced by oxidizing and precipitating H2S and SO2 gases in factories. As 0.06% of the world is made up of sulphur, too much sulphur stock in factories emerges as waste. Pure sulphur, whose density varies between 2.03and 2.06 g/cm3, is very low in thermal conductivity and it is a very good insulator since it has no electrical conductivity.
- **Sand** – 5% Size: 0-2 mm
- **Fine aggregate** – 32% Size: 2-4 mm
- **Coarse aggregate** – 48% Size: 4-8 mm

HEATING OF AGGREGATES

The steel mould was heated to 100℃. Then, the coarse aggregate is preheated slowly to a temperature of about 120°C and then this aggregate is fed into a tilting drum mixer

MELTING OF SULPHER

Then, the sulphur was heated up to 114℃ in the cooker and mixed and heated until it reached the rhombic phase.

MIXING OF MATERIALS

The mixed aggregate heated during this phase is poured into the cooker. It was mixed for a while and then it was mixed homogeneously.

MOULDING

After the mixing of materials in homogeneously then mixture poured in to the mold for required shape.

COOLING

After cooling the SC unmolding and take out from the mold.

EXPERIMENTAL STUDIES

Fig. 2 Mixing the aggregate mixture into homogeneous

Fig. 3 Heating of sulphur and providing binder feature

Fig. 4 Pouring sulphur aggregate composition into molds

Fig. 5 Sulphur concrete cube

PROPERTIES OF SULPHUR CONCRETE

- MECHANICAL PROPERTIES
- RECYCLABILITY
- SHORT SETTING TIME
- RECRUITMENT
- RADIATION
- REQUIREMENTS
- FIRE RESISTANCE AND AGGRESSIVE ENVIRONMENTS RESISTANCE

PROTECTION WALL OF PCC

HELIPAD SAMPLES

BOMB SHELTERS

ADVANTAGES

- Rapid curing, waste management
- Possibility of recycling
- High resistance to acids and radiation
- Possibility of concreting at negative ambient temperatures
- Quick setting time
- Low electrical and thermal conductivity
- Water tightness
- High frost resistance

DISADVANTAGES

- It is vulnerable to combustion and produces toxic gases.
- It creeps more than port-land cement concrete.
- It has poor resistance to freezing and thawing.
- Material Availability

CONCLUSION

In this report, SC is introduced and given some information about process of production. Sulphur concrete compared with PCC. In defense structures, it was mentioned why SC should be used in target structures against attacks. In experiments, it was observed in the studies and pressure test that SC was superior to PCC.

Sulphur concrete has superior strength values, physical and mechanical values compared to PCC. Despite the scientists' work on SC development, it is not as widespread as PCC. Known features have remarked the attention of scientists. It is hoped that it will be researched more widely in the globalizing world and applied in the field.

Sulphur concrete, whose compressive, bending and tensile values are at least twice as compared to PCC, has high resistance against aggressive environments, corrosion resistance and fire resistance. Sulphur, which has gained its binding properties by reaching high temperatures, has combined with aggregate to reach high compressive strength values and is intended to be used as a bearing element with high strength. In addition, it doesn’t need to water.

It is thought that there is no need to use the amount of potable water consumed worldwide. Sulphur concrete, which can use in police stations, important buildings, military operations in a short time like 24 hours; makes us advantageous to use in areas that need to be defended with its features such as mobilization, long lifetime, and higher resistance against attacks and easy to recycle.

PREFABRICATED VERTICAL DRAIN

BY
RIKSON P R

INTRODUCTION

In the construction of various structures on compressible, saturated soils like soft clay, excessive settlement is a common problem to be dealt with. Geotextile prefabricated vertical drains (PVD) is one of the most suitable methods to overcome this problem. The sole purpose of vertical drain system is to shorten the drainage path of the pore water from a low permeable layer to free water surface or to pre-installed drainage layer, there by accelerating the rate of primary consolidation or the process of settlement. The process of installation, depth of installation and the width of installation are dependent on soil properties and expected consolidation of soil. The PVD are used in the construction of road, railway, airport, industrial project and land reclamation projects.

PVD or wick drained are composed of a plastic core enhanced by a geotextile nonwoven or woven fabric. PVD have a channeled or studded plastic core wrapped with a geotextile. The plastic core functions as a support for the filter fabric and provides longitudinal flow paths along the drain length. The core also provides resistance to longitudinal stretching as well as buckling of the drain. The drain jacket acts as a filter to limit the passage of fine-grained soil into the core area and prevent the closure of the internal water flow paths under lateral soil pressure. The plastic core channeled structure and textile encasing are typically coupled with surcharging to accelerate preconstruction soil consolidation.The surcharge will increase pore water pressures with time and water will drain away from the soil. The vacuum created due to removal of water will compress and subsequently strengthen the soil. These prefabricated wick drains are used to accelerate the water travel distance and reduce the preloading time. Prefabricated wick drains also used to reduce potential down drag on mass or increase storage capacity for future landfills and waste containment places. An advanced application for PVD is the collection and removal of contaminated groundwater, which may be coupled with cut off walls to protect full withdrawal.

STEPS INVOLVED IN PVD INSTALLATION

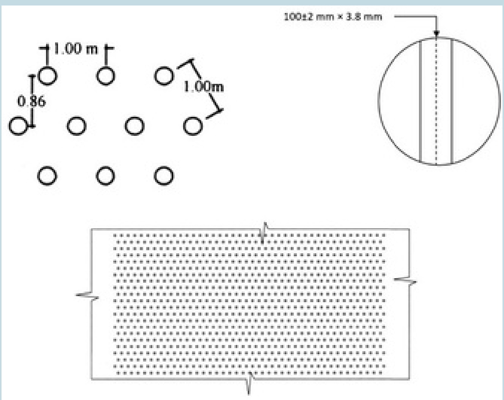
• Soil investigation

The field of study has to conduct where the protective barrier embankment to be constructed between the river and an economic zone with the support of geotechnical investigation, field investigation and laboratory investigation.

Casagrande's Apparatus

•Design and construction of vertical drains.

The construction of embankment requires careful planning and design to ensure the safety and stability of the structure. The use of ground improvement techniques, such as vertical drains, is a common approach to improve the soft soil layer's strength and reduce settlement. We have to examine the design and implementation of vertical drains for the project, based on geotechnical profiles and laboratory test results. Seven different vertical drain options were initially evaluated. Based on the consolidation time of 40 100 days and the drain's discharge capacity, strength, and apparent opening size (AOS), a PVD with a 100 mm width and 3.8 mm thickness at 1.0 m center to-center spacing in a triangular pattern was selected for implementation.



Cross section & Plan of PVD

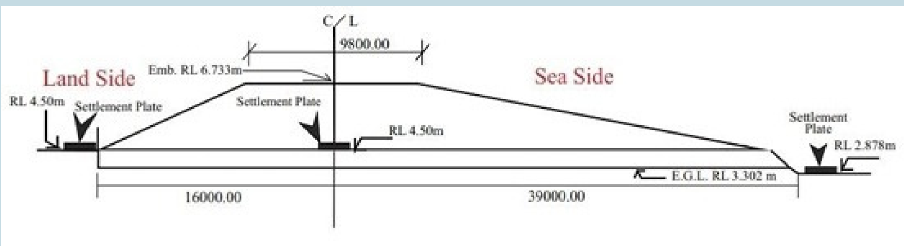
• PVD installation and factor of safety determination.

The PVD were installed using a mandrel with minimum sub soil disturbance. The hollow mandrel was driven through the subsoil using a constant vibratory load, and an anchor was utilized to stay in place at the bottom of the PVD when the mandrel was removed after installation. PVDs are installed with the help of a hollow steel mandrel encasing the wick drain material. The mandrel is inserted into the ground by a stitchery joined to an excavator carrier. This is a vibrating force, but static choices are also available for areas near underground utilities. Below the mandrel, the wick is looped through a steel anchor to fix the drain in place. Once the wanted depth is achieved, the drain is anchored and the mandrel is removed. The mandrel is removed 15- 20 cm above the surface for the wick drain to be cut. If the soil which the mandrel is driving into is mostly stiff, and the mandrel cannot be vibrated into the ground, and pre-drilling may be required.

PVD installation

• Settlement monitoring

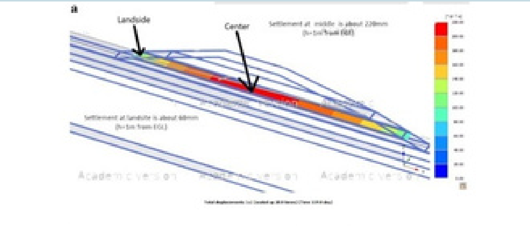
In order to measure the actual field settlements under embankment loading, settlement plates were installed at eight sections, with each section comprising three settlement plates placed at the centerline, land side toe, and seaside toe, before any fills was placed. The cumulative settlement at each location over time was obtained from the settlement gauges, and the results revealed that the estimated settlement at the centerline, land side, and sea sides of the embankment varied between 455–782 mm, 25–77 mm, and 31 57 mm, respectively. The required time for 95% consolidation was found to be between 25 and 78 days from the start of the increase in fill height.



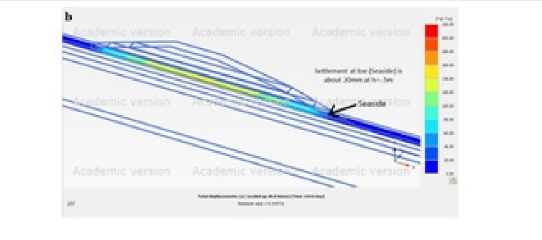
Settlement monitoring

Numerical modeling using PLAXIS software.

Traditional methods of estimating the settlement potential and factor of safety (Fs) of embankment sections are time-consuming and often cannot account for variations in subsoil profile along the layout of the embankment. As a result, numerical modeling techniques, such as the finite element method (FEM), are becoming increasingly popular for evaluating settlement potential and safety status quickly and accurately. In a recent study, FEM was used to investigate the behavior of soft subsoil that had undergone prefabricated vertical drain (PVD) improvement under staged loading of the embankment. The objective was to compare field-observed settlement with settlement values obtained from the numerical model. Two boreholes at different chainages, where field settlements were monitored, were selected for this comparison. The thickness of the soft soil layer varied in these two locations, with 12 m and 4.5 representing two marginal conditions.



a. Consolidation settlement of the embankment (K3+900) at the center and landside



b. Consolidation settlement of the embankment (K3+900) at the center and seaside

- **Result and analysis**

In this study, potential settlement and factor of safety of embankment sections were evaluated using a combination of theoretical calculations, finite element modeling, and field observations. Settlement gauges were used to monitor settlements at different levels of embankment sections, and the estimated possible settlement at different sections was determined. The results of field observed settlement at the center of the embankment, seaside, and landside for different locations of embankment are shown in settlement monitoring. To further analyze the settlement behavior of the embankment, finite element modeling was conducted using the PLAXIS program. Theoretical safety factor of the embankment at various sections was calculated by the well-recognized Low's method, which is particularly popular for the calculation of the safety status of earth embankment built on soft soil. A comparison of the factor of safety value for theoretical and model results is presented in the report. Among the preselected locations for field observation, embankment sections at K3+900 and K4+700 were modeled to compare the finite element analysis with field observation of settlement and theoretical calculation of factor of safety. The predicted settlement of embankment sections by the finite element method closely matches the field observed value, while in some cases, the model results predict better than theoretical estimations. Additionally, for the factor of safety estimation, finite element results closely match the theoretical Low's method.

ADVANTAGES

- Greater assurance of a permanent, continuous vertical drainage path or 20-30 m below the ground surface.
- PVD can withstand considerable lateral displacement or buckle under vertical or horizontal soil movements.
- The technology of PVD installation with corresponding to rapidly consolidated soil.
- PVDs can also be installed under water and in a non-vertical orientation conveniently.
- Decrease overall time required for completion of primary consolidation due to preloading.
- Decrease the amount of surcharge required to achieve the desired amount of pre compression in the given time.
- Increase the rate of strength gain due to consolidation of soft soils when stability is of concern.
- Comparison to sand drains: Economic competitiveness, less disturbance to the soil mass compared to displacement sand drains, and the speed and simplicity of Faster rate of installation possible.

DISADVANTAGES

- If the compression layer is overlain by dense fills or sands, very stiff clay or other obstructions, drain installation could require pre-drilling, jetting and use of a vibratory hammer.
- It may not even be feasible under such conditions and general pre-excavation can be performed if appropriate.
- Where sensitive soils are present or where stability is to concern, disturbance of the soil due to drain installation may not be tolerable.

CONCLUSION

Careful consideration required during foundation design to ensure stability due to the very soft and non cohesive inorganic silty clay soil. 100 mm wide and 38 mm thick PVD with 1.0 m center to center spacing in a triangular pattern has been selected due to its ability to provide consolidation time of 40-100 days. Appropriate discharge capacity, strength and AOS while also bring cost effective. SPT results before and after use of prefabricated vertical drains (PVD) for soil improvement shows an increase in SPT-N value, which indicates the effectiveness of PVD for soil improvement. Difference in estimated settlement and actual settlement values attributed to variation in soil properties, construction particle and duration of loading. The numerical results found from PLAXIS were compared to field measurements and theoretical calculations. It has demonstrated that the simplified method can produce satisfactory settlement results.

Prefabricated vertical drains are effective solutions for improving the stability and load-bearing capacity of soft, compressible soils. By providing a path for excess pore water to escape, PVDs significantly reduce the consolidation time of these soils, thereby speeding up construction schedules and minimizing ground settlement. Their use is particularly beneficial in large-scale infrastructure projects where rapid soil improvement is crucial. While PVDs offer considerable advantages, their successful implementation depends on proper design, installation, and monitoring to ensure desired outcomes. Overall, PVDs are a valuable technology in modern geotechnical engineering, contributing to more efficient and cost-effective construction practices..

INSIGHT

TECHNICAL MAGAZINE

2023-2024