Criteria 1 Curricular Aspects

Key Indicator: 1.3 Curriculum Enrichment

1.3.3: Percentage of programmes that have components of field projects / research projects / internships during the last five years.

Contents

1.	Sample Internship completion letter provided by host institution.	Open
2.	Sample Project Report submitted by the student	Open
3.	Program and course contents having element of field projects / research projects / internships	Open
4.	No. of Programs that have components of field projects / research projects / internships during the last five years	Open

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AIRPORTS AUTHORITY OF INDIA

Ref:AAI/CB/E-1(Student Project)/2022/1151 Date: 02.08.2022

TO WHOM SO EVER IT MAY CONCERN

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This is to certify that Ms. ANISHA.K, B.E.(CIVIL ENGINEERING) (Roll.No.2001002) student of M/s COIMBATORE INSTITUTE OF TECHNOLOGY, Civil Aerodrome Post, Coimbatore-641014 has successfully completed Internship Training in the field of CIVIL Department at Coimbatore International Airport during the period from(11.07.2022 to 25.07.2022).

Her conduct, behavior and interest shown by the student were exemplary.

We wish here all the best for her future endeavors.

सहायक प्रबंधक (सा.से) / Asst.Manager (SEC)
कोयंबत्तूर अंतरराष्ट्रीय हवाईअड्डा / Coimbatore Intl. Airport
कोयंबत्तूर / Coimbatore - 641 014

To
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B.E (CIVIL ENGINEERING)
Coimbatore Institute of Technology,
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18.7.22

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No.140/CMRL/HR/IPT/2022

Date: 25/07/2022

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During the Internship her conduct was good.

We wish him all the best for her better future.

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Assistant Manager (Admin)

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GROUP MANAGER - HR

GOVERNMENT OF TAMILNADU

PUBLIC WORKS DEPARTMENT

BUILDING CONSTRUCTION AND MAINTANANCE DIVISION, TRICHY-17

C ñ k T I £1 C ?t T E

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20/08/22

TO V'HOM SO EVER IT MAY CONCERN

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24/08/22

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INVESTIGATION ON ACID RESISTANCE OF PARTIAL REPLACEMENT OF CEMENT BY GROUND GRANULAR BLAST FURNACE SLAG IN RECYCLED FINE AGGREGATES CONCRETE.

A PROJECT REPORT

Submitted by

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in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

CIVIL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University and Accredited by National Board of Accreditation council)

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APRIL 2024

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DEPARTMENT OF CIVIL ENGINEERINC

BONAFIDE CERTIFICATE

Certified that this project report "INVESTIGATION ON ACID RESISTANCE OF PARTIAL REPLACEMENT OF CEMENT BY GROUND GRANULAR BLAST FURNACE SLAG IN RECYCLED FINE AGGREGATES CONCRETE" is the bonafide work of "GOKULAVASAN \' (2001061), ISHA VARSHfNI K (2001063), SATHISH R (2001078), and SWETHA F4 (2001087)" who carried out the project work under my supervision.

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26/04/2024

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ABSTRACT

This comprehensive study not only meticulously examined the effects of varied percentages of Ground Granular Blast Furnace Slag (GGBFS) and Recycled Fine Aggregates (RFA) on concrete properties but also sought to establish a nuanced understanding of their interplay. The systematic investigation encompassed a wide range of cement replacement with GGBFS, ranging from 10% to 40%, and NFA substitution with RFA at percentages of 10%, 20%, and 30%. Through rigorous testing methodologies, including compressive strength and split tensile strength tests, this research aimed to provide actionable insights into optimizing concrete formulations for enhanced durability and sustainability.

The immersion of concrete cubes in water and sulfuric acid facilitated a comprehensive evaluation of their performance under different environmental conditions, allowing for the identification of optimal GGBFS and RFA combinations that enhance concrete acid resistance. Notably, certain combinations, particularly at specific percentages, exhibited remarkable improvements over traditional concrete mixes, signifying their potential for mitigating environmental degradation in acidic environments. By corroborating these findings with existing literature and identifying the best-performing combination, this research contributes significantly to the advancement of infrastructure construction practices and environmental conservation efforts.

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1.0. Introduction

1.1. Origin of the Problem

The proposal for the effective management of sewage and wastewater is a critical concern for modern urban environments. As cities continue to grow, so does the demand for durable and sustainable sewage infrastructure. Traditional concrete, commonly used in sewage construction, faces challenges in terms of environmental impact and long-term resilience. In response to these challenges, innovative approaches are being explored to enhance the sustainability and performance of sewage infrastructure (Tanwar et al., 2021). One such approach involves the utilization of Ground Granulated Blast Furnace Slag (GGBFS) as a partial replacement for Ordinary Portland Cement (OPC). Utilization of GGBFS blended concrete had lot of advantages associated with fresh and hardened properties. In order to achieve the sustainability in the concrete technology, the usage of Recycled Fine Aggregate (RFA) in the concrete production is recommended now-a-days. Few countries, are started using the recycled aggregates (RFA & Recycled Coarse Aggregate [RCA]), as 100% replacement for the Natural Fine Aggregate (NFA) in the concrete production.

The potential of combining GGBFS and RFA to improve the quality and sustainability of concrete used in sewage applications. GGBFS is a byproduct of the iron and steel industry, known for its pozzolanic properties, which can enhance concrete durability and reduce its carbon footprint. RFA, on the other hand, divert waste from landfills and conserve natural resources. This synergy between sustainable materials and sewage infrastructure holds great promise for a greener and more resilient future. In this study, the examination of GGBFS as partial replacement for OPC and also RFA as partial replacement for NFA. By incorporating these sustainable practices into sewage infrastructure, not only contribute to reduced environmental impact but also enhance the

structural integrity of the concrete. The resulting infrastructure is better equipped to withstand the harsh and corrosive conditions found in sewage systems, ensuring longevity and minimal maintenance requirements. Moreover, these sustainable solutions align with global efforts to conflict the climate change and promote economy principles (Batikha et al., 2021).

1.2. Definition of the problem

This study aims to provide valuable insights into the practical application of GGBFS and RFAin exposed concrete for sewage infrastructure. Through a comprehensive examination of their benefitsand challenges, we can better understand how these innovations can be leveraged to create more sustainable and resilient sewage systems, ultimately benefiting both the environment and the communities they serve. Sewage water that transports for a long time in sewage pipe leads to conversion of sewage water to acid. This acid which is present for the long time, results in various concentration exposed to sewage pipe concrete. Exposing concrete to concentrated sulfuric acid in sewage environments can lead to a range of significant problems and challenges, primarily due to thehighly corrosive nature of sulfuric acid. These problems can compromise the structural integrity and longevity of sewage infrastructure. When sulphuric acid reacts chemically with the calcium hydroxide in cementitious matrix, leading to the formation of calcium sulphate (gypsum). This reaction causes the breakdown of the cementitious matrix, weakening the concrete's structural properties (Xie et al., 2021).

The acid can attack the surface of the concrete, causing it to erode gradually leads to surface erosion can induce a loss of protective coatings and surface finishes, making the concrete more susceptible to further corrosion. As the chemical reactions progress, the concrete may develop cracks and spalling. Exposure to sulfuric acid accelerates the

deterioration of concrete, reducing its overall durability. It can increase the porosity of concrete by leaching out calcium ions, leading to a more porous and permeable material. This increased porosity can make the concrete more susceptible to further chemical attacks and moisture infiltration. Choosing the right concrete mix and protective coatings becomes crucial when designing sewage infrastructure exposed to sulfuric acid (Sushma et al., 2021). Specialized acid-resistant concrete mixes which is partial replacement of OPC by GGBFS and partial replacement of NFA by RFA in exposed concrete is minimize the corrosion. In conclusion,the exposure of concrete to concentrated sulfuric acid in sewage environments poses significant challenges related to chemical corrosion, surface erosion, cracking, reduced durability, and increased maintenance requirements.

1.3. International status of the problem

This study inspects the role of waste beverage glass in altering the performance of GGBFS mixes. In order to obtain the best suited performance of the mixes, replacement of river sand with waste beverage glass at different substitution levels was done. Performance of the composites was judged by conducting fresh concrete in various aspects. Apart from this, mechanical properties show positive effect for the formed composites. This increase in the strength with pozzolanic nature of waste glasses (Tanwar et al., 2021).

Batikha et al., 2021, conducted the experimental work to validate the efficiency of Ceramic Waste Powder (CWP), Ceramic Fine Aggregate (CFA) and RCA as a partial replacement for OPC, NFA and Natural Coarse Aggregate (NCA) respectively. In this study, the utilization of ceramic waste and RCA together in the concrete mix in order to decrease usage of natural resources in production of concrete, and also to reduce carbon emissions from cement production and dependency on landfills for Construction & Demolition (C&D) materials. Concrete mixes samples were prepared in this study, and the

mechanical properties, shrinkage, cost and (Carbon di Oxide) CO2 emissions were obtained for each mix. It was found that a concrete mix with 100% replacement of NCA by RCA, 20% OPC replacement by CWP and 20% NFA replacement by CFA was 26% more advantageous than the control mix in terms of being sustainable and economic. This product proved to be a promising mix, 47% of whose conventional concrete components could be replaced by recycled materials.

Xie et al., 2021, produced a blended concrete by incorporating sludge ceramist, RCA and GGBFS as a partial replacement for NCA and OPC. In this experimental study was conducted to evaluate the surface characteristics, and microstructure of the Sludge Ceramist Recycled Concrete (SCRC) after exposure to elevated temperatures In addition, a new hollow block was manufactured with this SCRC, and the thermal resistance of the SCRC hollow block was examined. The results showed that the SCRC displayed a good resistance to high temperatures, and its strength retention rate was good. The incorporation of GGBFS improved the resistance of SCRC at elevated temperatures. With increasing GGBFS content, the residual compressive strength of the SCRC increased first and then decreased, and the suggested optimal GGBFS content is 30%. The prepared SCRC hollow block showed excellent thermal insulation performance and exhibited good application prospects in lightweight insulation walls.

1.4. National status of the problem

Kumar et al., 2021, conducted by completely replacing NCA with coconut shell (CS) an agricultural waste. Though it achieves the target strength the decrease in quality of CS concrete (CSC) is enhanced by utilizing a pozzolanic material GGBFS and its optimum percentage of replacement with OPC is found as 10% by conducting compressive strength for varying percentage. For the optimum mix, the durability study and microstructural

investigation was examined. The result revealed that incorporating GGBFS increases the strength of concrete to around 15%. The microstructural study has clearly exhibited that the hydration process has been improved to better formation of Calcium Silicate Hydrate and Calcium Aluminium Silicate Hydrate, when GGBFS is incorporated.

Tiwari et al., 2021 investigated the effect of replacing of OPC by Metakaolin (MK) and GGBFS, NCA was replaced by demolished waste materials crushed up to less than 20 mm size. Demolished waste material contains tiles, bricks, gravels and old paste with appropriate percentages. In this study, percentage of MK was fixed at 10 with varying percentages of GGBFS as 10, 15, 20 and 25%. Fresh and hardened concrete properties examined. Flow tests were performed with slump value. Compressive strength test was performed to evaluate the effect of MK and GGBFS with recycled aggregate. All specimens were cured at 7, 28 and 56 days. Significantly increment in strength was observed at 25% of replacement with RCA. Replacement of NCA with RCA lead an economical construction with satisfying requirements.

RP Singh et al., 2023 investigated the effect of Recycled coarse aggregates (RA) are sustainable alternatives to natural aggregate (NA) in concrete. The partial replacement of Ordinary Portland Cement (OPC) with the use of industrial by-products for preparation of geopolymer concrete (GPC),this study is to investigate the techno environmental feasibility of using fly ash (FA), ground granulated blast furnace slag (GGBS), and silica fume (SF) in GPC to support the use of 100 % RAs in concrete &this study aims to optimize the proportion of GGBS, FA, and SF in the design mix for the best mechanical performance and eco-efficiency of GPC concrete as compared to conventional OPC concrete.

2. Review of literature

2.1. Literatures based on GGBFS

2.1.1. Literature – 1

Kumar et al., 2021, conducted by completely replacing NCA with coconut shell (CS) an agricultural waste. Though it achieves the target strength the decrease in quality of CS concrete (CSC) is enhanced by utilizing a pozzolanic material GGBFS and its optimum percentage of replacement with OPC is found as 10% by conducting compressive strength for varying percentage. For the optimum mix, the durability study and microstructural investigation was examined. The result revealed that incorporating GGBFS increases the strength of concrete to around 15%. The microstructural study has clearly exhibited that the hydration process has been improved to better formation of Calcium Silicate Hydrate and Calcium Aluminium Silicate Hydrate, when GGBFS is incorporated.

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Tiwari et al., 2021 investigated the effect of replacing of OPC by Metakaolin (MK) and GGBFS, NCA was replaced by demolished waste materials crushed up to less than 20 mm size. Demolished waste material contains tiles, bricks, gravels and old paste with appropriate percentages. In this study, percentage of MK was fixed at 10 with varying percentages of GGBFS as 10, 15, 20 and 25%. Fresh and hardened concrete properties examined. Flow tests were performed with slump value. Compressive strength test was performed to evaluate the effect of MK and GGBFS

with recycled aggregate. All specimens were cured at 7, 28 and 56 days. Significantly increment in strength was observed at 25% of replacement with RCA. Replacement of NCA with RCA lead an economical construction with satisfying requirements.

2.1.3. Literature – 3

Xie et al., 2021, produced a blended concrete by incorporating sludge ceramist, RCA and GGBFS as a partial replacement for NCA and OPC. In this experimental study was conducted to evaluate the surface characteristics, and microstructure of the Sludge Ceramist Recycled Concrete (SCRC) after exposure to elevated temperatures In addition, a new hollow block was manufactured with this SCRC, and the thermal resistance of the SCRC hollow block was examined. The results showed that the SCRC displayed a good resistance to high temperatures, and its strength retention rate was good. The incorporation of GGBFS improved the resistance of SCRC at elevated temperatures. With increasing GGBFS content, the residual compressive strength of the SCRC increased first and then decreased, and the suggested optimal GGBFS content is 30%. The prepared SCRC hollow block showed excellent thermal insulation performance and exhibited good application prospects in lightweight insulation walls.

2.2. Literatures based on RFA

2.2.1. Literature – 4

S.K. Kirthika et al, investigates recycled fine aggregate (RFA) concrete against conventional river sand (RS) concrete, revealing key differences. RFA exhibits significantly higher water absorption and alkalinity compared to RS. Increasing RFA content diminishes fresh and hardened properties, but RFA30 shows strength improvements at 56 days. RFA30 displays less shrinkage than RS at 90 days,

while RFA100 exhibits more shrinkage due to fines. RFA concrete allows deeper water penetration and experiences heightened deterioration in acid-alkali immersion. RFA30 demonstrates higher resistivity and chlorine resistance than RS, but RFA100's porous structure exacerbates adverse effects. RFA's greater water absorption leads to increased CO2 ingress, resulting in significantly deeper carbonation depth compared to RS concrete.

2.2.2. Literature – 5

Maio et al, investigated concretes with recycled fine aggregate (RFA), replacing 0%, 20%, and 30% of natural river sand, adhering to Argentinean Regulation's resistance and durability requirements. It was found that compressive strengths of RC concretes with 20% and 30% RFA were comparable to 100% natural fine aggregate concrete due to a lower effective water/cement ratio. Drying shrinkage at 180 days was similar for conventional concrete (CC) and RC20, with slightly lower strain in RC30 due to its lower w/c ratio. The durable behavior of RC concretes matched conventional concrete, showing lower sorptivity and water penetration values, attributed to the lower w/c ratio and potentially superior interface transition zone (ITZ) of RFA. Carbonation depths at 310 and 620 days were similar for RC and CC due to the lower w/c ratio, with all concretes exhibiting low values (~2 mm) related to medium-level environmental aggression and low w/c ratio. Overall, concretes with up to 30% RFA demonstrated adequate mechanical and durable behavior, meeting structural concrete requirements, with similar performance achieved by reducing w/c ratio using plasticizer admixture.

2.2.3. Literature – 6

Marija et al, presents a comprehensive review of using recycled concrete aggregates (fRCA) in structural applications, focusing on their characteristics and limitations. Physico-chemical properties of fRCA influence concrete performance, yet guidelines for optimal use are lacking. Experimental optimization rather than theoretical analysis hinders fRCA reuse and cement reduction efforts. Challenges include achieving desired engineering properties and addressing limitations such as high water absorption and agglomeration. Moisture states of fRCA and characterization techniques need standardized guidelines for quality control. Research priorities include understanding fRCA treatments, cement interaction, and long-term behavior. Structural performance evaluation should consider deformability and corrosion resistance. Modifying existing models and conducting large-scale lab tests are suggested for accurate assessment. Clarity in designing concrete mixtures with fRCA requires integrating micromechanical properties and practical optimization approaches.

2.3. Literatures based on acid immersion

2.3.1. Literature – 7

Patro et al., 2016, produced an Acid resistance concrete by incorporating ferrochrome ash (FA) and lime, Workability decreased slightly while fresh density increased due to the inclusion of FA and lime. Strength properties, including compressive, flexural, and bond strength, improved with the addition of FA and lime, showing continuous enhancement with age. Sorptivity reduced with the inclusion of lime and FA. Concrete containing FA and lime exhibited increased resistance to acid and sulphate attacks. Rebound hammer values indicated improved

properties in concrete with FA and lime. Examination of hydration degree at 28 days revealed enhanced bonding between aggregates and cement paste, with reduced micro gap width upon inclusion of FA and lime.Optimal properties were observed in concrete mixes containing 10% FA and 7% lime. While property values decreased with increasing FA dosage, concrete containing 40% FA and 7% lime, replacing 47% of cement, demonstrated properties comparable to or exceeding those of normal concrete.The study affirmed the suitability of FA with lime as a partial cement replacement in concrete production.

2.3.2. Literature – 8

YC Choi et al., 2020, produced an Acid resistance concrete ,RP1.5 exhibited the highest compressive strength at 55.3 MPa, but further increases in resin powder dosage led to a 6–9% decrease due to polymer film formation, which doesn't contribute to strength. NF0.01 displayed the lowest strength at 35.8 MPa, while NF0.03 showed an 18% increase due to enhanced transverse tensile strength delaying the compression yield point. In accelerated watertightness tests, RC and RP1.5 revealed insufficient watertightness, posing risks of exfoliation and redamage to repaired parts. Thus, they are deemed unsuitable for repair mortars. After immersion in sulfuric acid, NF0.03 exhibited a significant decrease in chloride ion penetration index compared to base mortar, indicating low risk of redamage or degradation during partial concrete pipe repairs. Following freeze–thaw cycles, NF0.03 showed a remarkable reduction in chloride ion penetration index, signifying effective prevention of specimen cracking. Thus, NF0.03 emerges as the most suitable repair mortar for concrete repairs subjected to environmental conditions with repeated freeze–thaw cycles.

2.3.3. Literature – 9

The study immersed concrete samples in 1% sulphuric acid, yielding significant observations and conclusions. Firstly, limestone concrete (C2 and C4) demonstrated higher residual crushing loads compared to siliceous aggregate concrete (C1 and C5) after various durations of immersion, suggesting limestone's potential as a sacrificial medium to diminish acid concentration near the surface, thus slowing deterioration. Secondly, SEM examinations highlighted continuous paste-aggregate interfacial zones in limestone concrete, contrasting with cracked interfaces in siliceous aggregate concrete, potentially contributing to limestone concrete's superior performance under sulphuric acid attack. Additionally, concrete (C6) incorporating limestone aggregates and a ternary cement containing silica fume and fly ash exhibited excellent acid resistance, outperforming other tested concretes. Conversely, concretes incorporating slag cement or ternary cement with slag and silica fume (C3, C4, and C5) displayed reduced durability compared to Portland cement concrete (C1 and C2) in the acid environment, necessitating further research to understand deterioration mechanisms. Finally, the crushing load test emerged as a more reliable method than mass change measurement for assessing concrete deterioration in acid environments, providing direct insight into load-bearing capacity post-acid attack.

2.4. Observations from literatures

- GGBFS enhances concrete strength through improved hydration processes.
- Optimal replacement of OPC with GGBFS is found to be 10%.
- Combination of Metakaolin and GGBFS improves fresh and hardened concrete properties.
- Blended concrete with sludge ceramist, RCA, and GGBFS shows resistance to high temperatures.
- Optimal GGBFS content for blended concrete is suggested to be 30%.
- RFA concrete displays higher water absorption and alkalinity compared to RS concrete.
- RFA concrete exhibits deeper carbonation depths due to greater water absorption.
- Concrete containing FA and lime exhibits increased resistance to acid and sulphate attacks.
- Incorporating limestone aggregates and ternary cement enhances acid resistance of concrete.
- Crushing load test provides a reliable method for assessing concrete deterioration in acid environments.

2.5. Research gap

- Explore the specific replacement levels of GGBFS for OPC in various concrete applications and environmental conditions to ascertain the most effective ratios for enhancing concrete properties while maintaining cost-effectiveness and sustainability.
- Investigate the performance of RFA concrete over extended service life periods to understand its durability, structural integrity, and environmental impact, addressing gaps in long-term studies to ensure reliable and sustainable concrete solutions.
- Examine the prolonged impact of acid exposure on the durability, structural integrity, and performance of blended concrete mixes incorporating additives like GGBFS and recycled aggregates, considering diverse environmental conditions and exposure scenarios.
- Standardize testing methods and protocols for assessing the acid resistance of concrete, particularly focusing on comparing different concrete mixes with additives like GGBFS and recycled aggregates, ensuring consistency and reliability in evaluating concrete performance in acidic environments.
- Develop holistic optimization strategies for sustainable concrete mixes, considering factors such as material compatibility, performance trade-offs, and environmental impacts, to create optimized concrete formulations that balance sustainability with structural integrity and performance requirements.

2.6. Objectives of the present investigation

- To optimize the mix proportion of concrete with GGBS and RFA
- To study the performance of concrete exposed to different concentration of sulphuric acid for different curing periods.
- To develop the statistical model between the percentage of GGBS and the compressive strength of concrete exposed to acids.

2.7. Scope of the present investigation

The scope of study is to conduct experimental investigation on the recycled fine aggregate concrete with GGBS exposed to different sulphuric acid concentrations and at different curing periods. The scope of study is further extended to the development of statistical models with help of software.

3. Materials

3.1. Introduction

The integration of Ground Granulated Blast Furnace Slag (GGBFS) as a partial replacement for Portland cement in concrete offers a pathway to sustainable construction practices. With replacement proportions ranging from 10% to over 70%, GGBFS provides versatility to tailor concrete properties to specific project needs. Lower replacement levels enhance workability and durability, while higher levels prioritize sustainability, significantly reducing the carbon footprint of concrete. Paired with Recycled Fine Aggregates (RFA), which minimizes waste and reduces reliance on natural resources, our concrete formulation blends structural integrity with environmental responsibility. Let's delve further into the benefits and considerations of incorporating GGBFS and RFA in concrete construction.

3.2. Materials used

3.2.1. OPC 53 Cement - Dalmia

- Selected for its high-grade quality, OPC 53 Cement from Dalmia serves as the foundational component, providing strength and durability to our concrete mix.

3.2.2. GGBFS (Ground Granulated Blast Furnace Slag)

- Ground Granulated Blast Furnace Slag (GGBFS) is strategically integrated, partially replacing traditional cement. This environmentally friendly choice enhances resistance to harsh conditions and aligns with sustainable construction practices.

3.2.3. M Sand (Manufactured Sand)

- ❖ M Sand, chosen for its uniform particle size distribution, ensures consistency, enhancing the workability and strength characteristics of our concrete.

3.2.4. Recycled Fine Aggregates (from Crushing Demolition Waste)

- ❖ Recycled fine aggregates, derived from the crushing of demolition waste, play a pivotal role in reducing environmental impact and promoting responsible waste management.

3.2.5. Coarse Aggregates

- ❖ Carefully selected coarse aggregates of size 12 and 20 mm to contribute structural support, providing stability and strength to the overall concrete mixture.

3.2.6. Conplast (Concrete Plasticizer)

- ❖ Conplast, a concrete plasticizer, is incorporated to improve workability without compromising strength, enhancing the fluidity of the concrete during construction.

3.2.7. Water

- ❖ Clean and potable water, a fundamental component, ensures proper hydration of cement and successful setting of the concrete.

3.3. Replacement materials

3.3.1. GGBFS – Replacement for cement

GGBFS can be used as a partial replacement for Portland cement in various proportions, depending on the desired concrete properties and the specific project requirements. Common replacement proportions for GGBFS in concrete:

10-30% Replacement

- In many cases, a 10-30% replacement of cement by GGBFS is a typical starting point. This proportion provides benefits such as improved workability, reduced heat of hydration, and enhanced durability without significantly affecting the initial and long-term strength of the concrete.

40-50% Replacement:

- For projects where sustainability and reduced environmental impact are a primary concern, a higher replacement percentage of 40-50% can be considered. This level of substitution can still maintain acceptable strength while further reducing the carbon footprint of concrete.

60-70% Replacement

- In specialized applications, such as mass concrete structures or projects with stringent sustainability goals, GGBFS can be used at higher replacement percentages, often between 60% and 70%. However, it's essential to conduct thorough testing to ensure that the concrete meets the required performance criteria.

High-Volume Replacement (Above 70%)

- In some cases, especially in projects focused on sustainability and environmental considerations, very high replacement percentages of over 70% have been used successfully. However, this typically requires extensive testing, optimization of mix proportions, and specialized construction practices.

3.3.2. Recycled Aggregate – Replacement for Normal Aggregate.

Using RFA as a replacement for NFA in concrete is an eco-friendly and sustainable practice that can help reduce the demand for natural resources and minimize construction waste. However, it's essential to follow certain guidelines and considerations when incorporating recycled aggregates into concrete mixes. Material characterization tests are crucial for determining the properties of recycled aggregates and assessing their suitability for use in concrete or other construction applications. Here are some common material characterization tests to consider:

1. Particle Size Distribution
2. Aggregate Quality and Contaminant Assessment
3. Physical Properties
4. Mechanical Properties
5. Environmental and Health Considerations

It's essential to conduct these tests following relevant industry standards and guidelines, and the specific tests you perform may vary depending on the intended use of the RFA and local regulations.

3.4. Material properties

3.4.1. Cement

3.4.1.1. Cement consistency test

- Consistency value : 34 %
- Fluidity level : moderate

Fig. 1. Vicat Apparatus

Fig. 2. Test setup – cement consistency

3.4.1.2. Setting time test

- Initial setting time : 43 min
- Final setting time : 5 hrs 19 min

Fig. 3. Test setup - setting time of cement

3.4.1.3. Specific gravity test

weight of bottle	W1	342	g
weight of bottle + cement	W2	542	g
weight of bottle + cement + water	W3	1474	g
weight of bottle + water	W4	1338	g
specific gravity	G=(W2-W1)/ ((W4-W1)-(W3-W2))	**3.13**	

Fig. 4. Specific gravity test setup

3.4.2. M-sand

3.4.2.1. Gradation test

Weight of dry soil sample taken 0.5 kg

S.NO	APERTURE SIZE (mm)	EMPTY WEIGHT OF SIEVE (kg)	WEIGHT OF SIEVE + SOIL (kg)	WEIGHT OF SOIL RETAINED (kg)	PERCENTAGE RETAINED (%)	CUMM. PER. RETAINED (%)	PERCENTAGE FINER (%)
1	4.75	0.42	0.422	0.002	0.4	0.4	99.6
2	2.36	0.372	0.404	0.032	6.4	6.8	93.2
3	1.18	0.322	0.426	0.104	20.8	27.6	72.4
4	0.6	0.308	0.39	0.082	16.4	44	56
5	0.3	0.37	0.554	0.184	36.8	80.8	19.2
6	0.15	0.358	0.436	0.078	15.6	96.4	3.6
7	0.075	0.32	0.334	0.014	2.8	99.2	0.8
8	pan	0.256	0.26	0.004	0.8	100	0

Table. 1. Gradation test - M-sand

Fig. 5. Test setup - gradation test

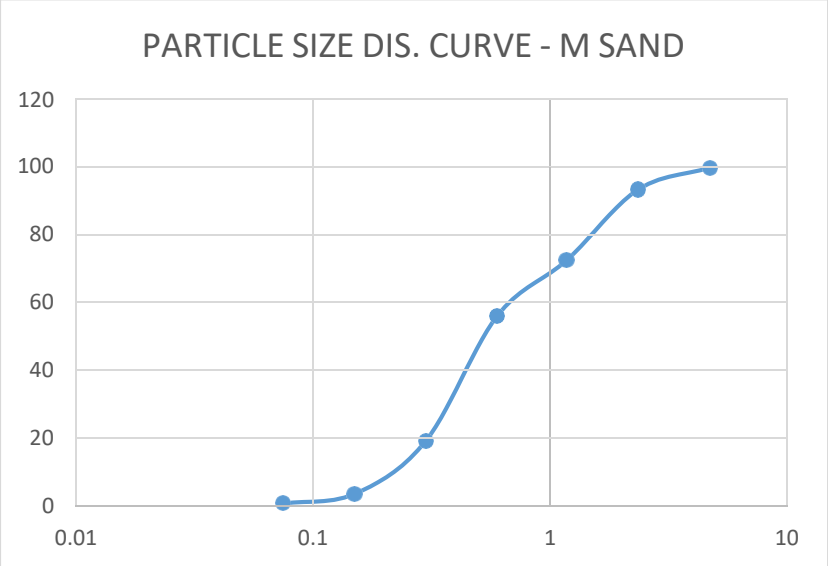

Fig. 6. Gradation curve - M-sand

3.4.2.2. Specific gravity test

weight of bottle	W1	342	g
weight of bottle + soil	W2	542	g
weight of bottle + soil + water	W3	1466	g
weight of bottle + water	W4	1338	g
specific gravity	G = (W2-W1)/((W4-W1)-(W3-W2))	2.78	

3.4.3. RFA

3.4.3.1. Gradation test

Weight of dry soil sample taken 0.5 kg

S.NO	APERTURE SIZE (mm)	EMPTY WEIGHT OF SIEVE (kg)	WEIGHT OF SIEVE + SOIL (kg)	WEIGHT OF SOIL RETAINED (kg)	PERCENTAGE RETAINED (%)	CUMM. PER. RETAINED (%)	PERCENTAGE FINER (%)
1	4.75	0.42	0.42	0	0	0	100
2	2.36	0.372	0.378	0.006	1.2	1.2	98.8
3	1.18	0.322	0.466	0.144	28.8	30	70
4	0.6	0.308	0.434	0.126	25.2	55.2	44.8
5	0.3	0.37	0.504	0.134	26.8	82	18
6	0.15	0.358	0.432	0.074	14.8	96.8	3.2
7	0.075	0.32	0.332	0.012	2.4	99.2	0.8
8	pan	0.256	0.26	0.004	0.8	100	0

Table. 2. Gradation test – RFA

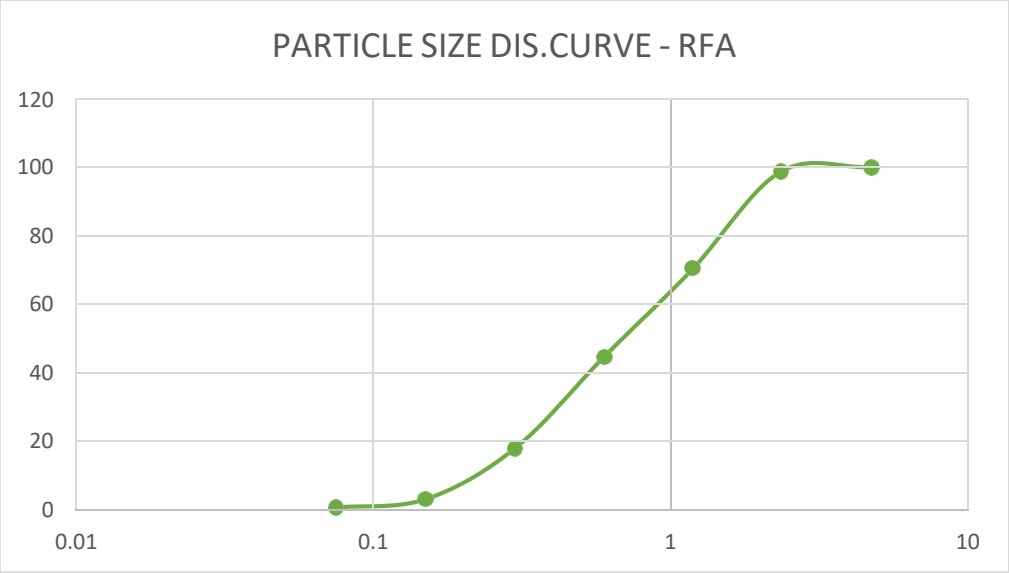

Fig. 7. Gradation curve – RFA

3.4.3.2. Specific gravity test

weight of bottle	W1	342	g
weight of bottle + soil	W2	542	g
weight of bottle + soil + water	W3	1456	g
weight of bottle + water	W4	1338	g
specific gravity	G = (W2-W1)/ ((W4-W1)-(W3-W2))	2.44	

3.4.4. Comparison b/w M-sand & RFA

3.4.4.1. Gradation curve

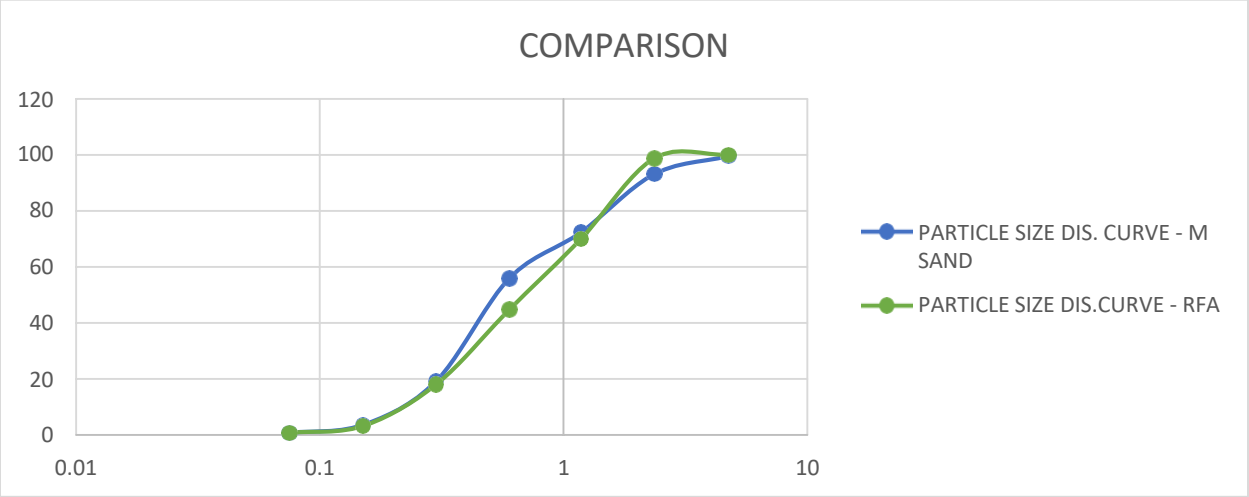

Fig. 8. Comparison - gradation curve

3.4.4.2. Specific gravity

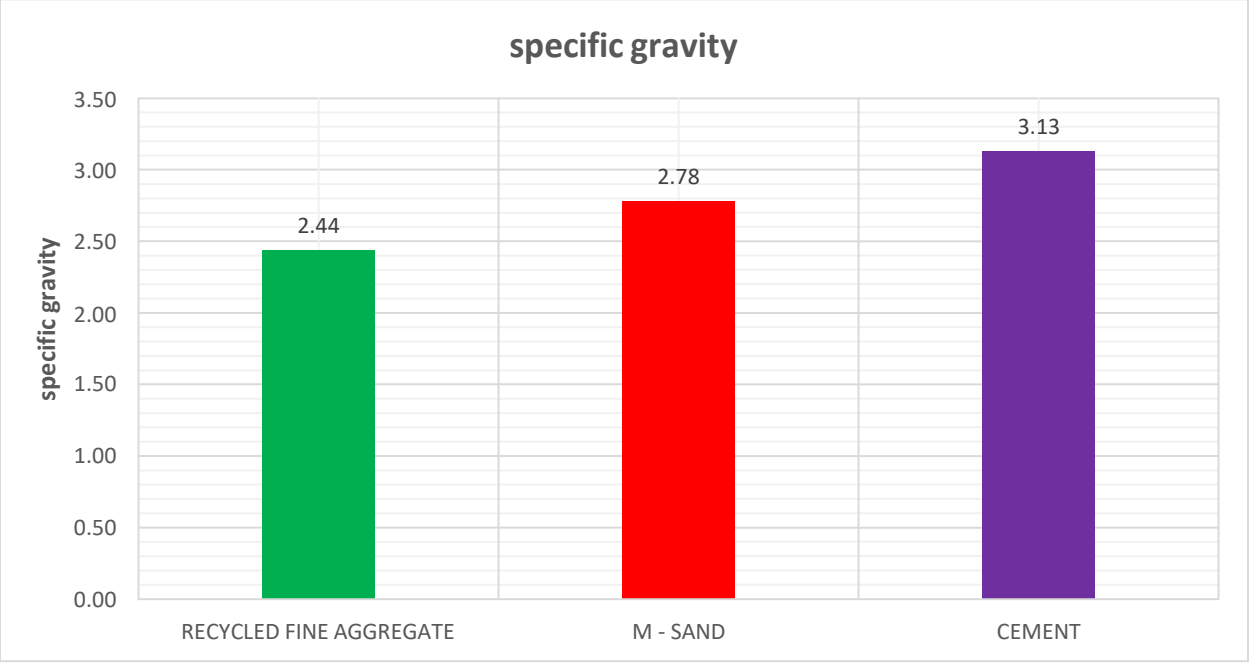

Fig. 9. Comparison - specific gravity

3.4.5. Coarse aggregate

3.4.5.1. Gradation test

Weight of dry soil sample taken 10 kg

S.NO	APERTURE SIZE (mm)	WEIGHT OF SOIL RETAINED (kg)	PERCENTAGE RETAINED (%)	CUMM. PER. RETAINED (%)	PERCENTAGE FINER (%)
1	50	0	0	0	100
2	40	0	0	0	100
3	25	0.102	1.02	1.02	98.98
4	20	0.524	5.24	6.26	93.74
5	16	3.592	35.92	42.18	57.82
6	12.5	4.812	48.12	90.3	9.7
7	10	0.831	8.31	98.61	1.39
8	6.3	0.138	1.38	99.99	0.01
9	5.6	0	0	99.99	0.01
10	4.75	0	0	99.99	0.01

Table. 3. Gradation test - CA

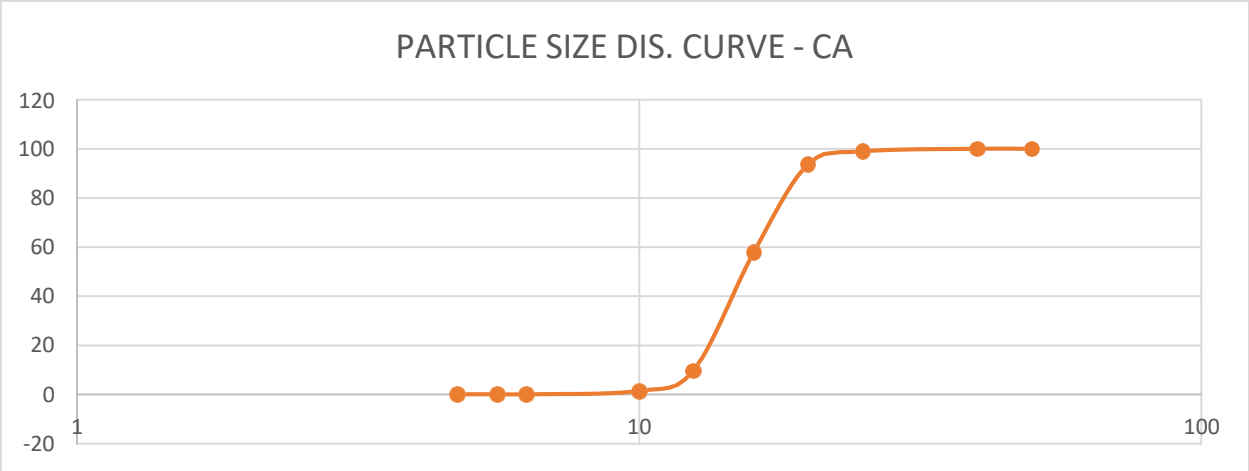

Fig. 10. Gradation curve – CA

Fig. 11. Test setup - gradation test – CA

3.4.5.2. Specific gravity test

OBSERVATION

Weight of saturated aggregates and basket in water	W1	2791
Weight of basket in water	W2	1474.5
Weight of saturated aggregates in water	W1-W2	1316.5
weight of saturated surface dry aggregates in air	W3	2008
Weight of oven raid aggregates in air	W4	2002

CALCULATION

Specific gravity of course aggregates	W4/(W3-(W1-W2))	2.896
Apparent specific gravity of course aggregates	W4/(W4-(W1-W2))	2.93

Fig. 12. Specific gravity test apparatus – CA

3.4.5.3. Water absorption test

OBSERVATION

Weight of saturated surface dried sample	W1	1	kg
Weight of the oven dried aggregate sample	W2	0.998	kg

CALCULATION

Percentage of water absorption	(W1-W2)/W2*100	0.21	%

Fig. 13. Water absorption test apparatus

3.4.5.4. Bulk density test

OBSERVATION

Diameter of metal measure in metre		0.25	m
Height of the metal in metre		0.205	m
Volume of metal measure in cumecs	V	0.01	cumecs
Weight of empty measure in kg	W1	8.278	Kg
Weight of cylinder measure with compacted aggregates in kg	W2	24.715	Kg
Weight of cylindrical measure with loosely packed aggregates in kg	W3	23.655	Kg

CALCULATION

Bulk density of compacted aggregates	(W2-W1)/V	1643.7	Kg/m3
Bulk density of loosely packed aggregates	(W3-W1)/V	1537.7	Kg/m3

3.5. Conclusion

A thorough series of material tests was carried out, involving detailed examination and analysis of their respective properties. Each test was conducted meticulously to ensure a comprehensive understanding of the materials' characteristics and behaviors.

4. Methodology

4.1. Introduction

Protecting concrete sewers from sulfuric acid attack is imperative for ensuring their longevity and operational efficiency. The corrosive nature of sulfuric acid poses a significant threat to concrete structures, potentially resulting in deterioration and subsequent costly repairs, along with environmental risks. In response to this challenge, the development of a methodology aimed at enhancing the resistance of concrete sewers to sulfuric acid attack becomes essential.

4.2. Methodology

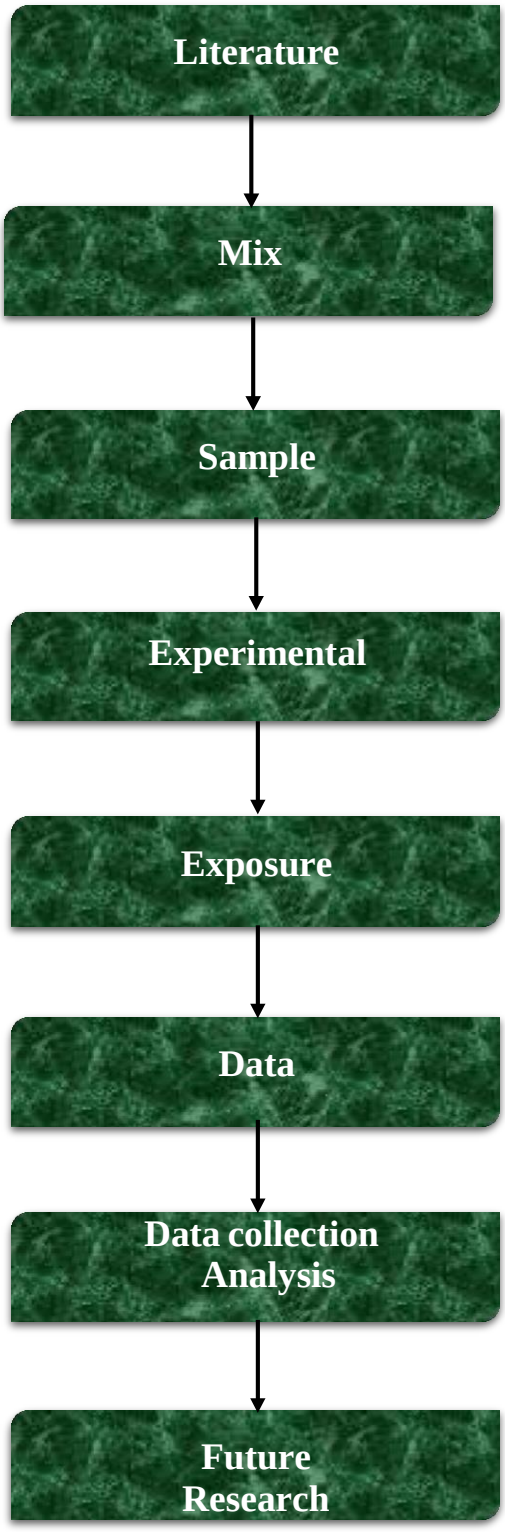

Fig. 14. Methodology

Fig. 15. Methodology

4.2. Mix design

Grade Designation	M	30.00	
Type of Cement		OPC 53 grade	
Maximum nominal size of aggregate		20.00	mm
Minimum Cement Content		320.00	kg/m^3
Maximum water cement Ratio		0.45	
Workability		100.00	mm
Exposure Condition		Severe	
Maximum cement content		450.00	kg/m^3
Chemical admixture type		Superplasticizer	

Test Data

Specific gravity of Cement	3.15	
Specific Gravity of CA	2.74	
Specific gravity of FA	2.65	
Specific gravity of Superplasticizer	1.15	
Water Absorption :		
1) Coarse Aggregate	0.50	%
2) Fine Aggregate	1.00	%

1. Target Strength for Mix proportioning

f'ck = fck +1.65s

			38.25	N/mm2

2. Selection of Water cement Ratio

From Table 5 of IS456,Maximum water - cement ratio			0.45	
Adopt water cement ratio as			0.40	
	0.4		<	0.45
			Hence OK	

3. Selection of Water content

From Table 2, Maximum water content	186.00	litre
Estimated water content for 100mm slump	197.16	
Superplasticizer is used,Water content Reduction of	23.00	%
Arrived water content	151.81	kg

4. Calculation of Cement content

Water -cement ratio			0.40	
Cement content			379.53	kg/m^3
From Table 5 of IS456 ,minimum cement			320.00	kg/m^3
	379.533		>	320
			Hence OK	

5. Proportion of CA and FA

	0.4	<	0.5	
			0.02	
Volume of CA for W/C of	0.4		0.64	

Volume of FA content	0.36	

6. Mix Calculation

Volume of Concrete	1.00	m^3
Volume of cement	0.12	m^3
Volume of water	0.15	m^3
Volume of Chemical Admixture	0.00	m^3
Volume of Entrapped Air	0.01	m^3
Volume of all in Aggregate	0.72	m^3
Mass of CA	1255.23	kg
Mass of FA	682.88	kg

7. Mix proportion

Cement	379.53	kg/m^3
Water	151.81	kg/m^3
FA	682.88	kg/m^3
CA	1255.23	kg/m^3
Admixture	1.90	kg/m^3
W/C ratio	0.40	

8. Adjustment on water

1) FA	676.11	kg/m^3
2) CA	1248.99	kg/m^3

Water content	164.82	
Water content	165.00	kg/m^3

9. Mix proportion

Cement	380.00	kg/m^3
Water	165.00	kg/m^3
FA	677.00	kg/m^3
CA	1248.99	kg/m^3
Admixture	1.90	kg/m^3
W/C ratio	0.40	kg/m^3

10. Mix Ratio

380.00	:	677.00	:	1248.99
1	:	1.78	:	3.28

4.3. Casting of specimens

Casting of specimens in concrete testing, particularly for cubes and cylinders, follows stringent procedures outlined in Indian Standard codes, ensuring accuracy and reliability of test results. As per IS 516:1959 (Method of Tests for Strength of Concrete), IS 10086:1982 (Specification for Moulds for Use in Tests of Cement and Concrete), and IS 5816:1999 (Method of Test Splitting Tensile Strength of Concrete), the casting process involves meticulous preparation and molding under controlled conditions. IS 10086:1982 specifies the dimensions and material requirements for molds, ensuring consistency in sample preparation. Additionally, IS 516:1959 details the procedures for mixing concrete constituents, compacting within molds using appropriate methods like vibration or rodding, and curing under specified conditions. Furthermore, IS 5816:1999 provides guidelines for casting cylindrical specimens for split tensile strength testing, ensuring uniformity and accuracy in sample preparation. Adhering to these Indian Standard codes guarantees the quality and reliability of concrete testing, facilitating accurate assessment of its strength and durability characteristics.

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4.3.1. Combinations

S.NO	COMBINATION	W/C
1	Nominal Mix - Trail -1 (Cement + FA + CA + Water)	0.45
2	Nominal Mix - Trail -2 (Cement + FA + CA + Water)	0.4
3	Cement 90% + GGBS 10 % + FA + CA + Water	0.4
4	Cement 80% + GGBS 20 % + FA + CA + Water	0.4
5	Cement 70% + GGBS 30 % + FA + CA + Water	0.4
6	Cement 60% + GGBS 40 % + FA + CA + Water	0.4
7	Cement 70% + GGBS 30 % + FA 90%+ RFA 10 % + CA + Water	0.4
8	Cement 70% + GGBS 30 % + FA 80% + RFA 20 % + CA + Water	0.4
9	Cement 70% + GGBS 30 % + FA 70%+ RFA 30 % + CA + Water	0.4

Table. 4. Casting combinations

Fig. 16. casting - 1

Fig. 17. casting - 2

Fig. 18. casting - 3

Fig. 19. casting - 4

Fig. 20. casting - 5

Fig. 21. casting - 6

4.4. Fresh concrete tests

4.4.1. Slump cone test

S.NO	COMBINATION	SLUMP VALUES(cm)
1	Nominal Mix - Trail -1 (Cement + FA + CA + Water)	3
2	Nominal Mix - Trail -2 (Cement + FA + CA + Water)	5
3	Cement 90% + GGBS 10 % + FA + CA + Water	7
4	Cement 80% + GGBS 20 % + FA + CA + Water	9
5	Cement 70% + GGBS 30 % + FA + CA + Water	11
6	Cement 60% + GGBS 40 % + FA + CA + Water	8
7	Cement 70% + GGBS 30 % + FA 90%+ RFA 10 % + CA + Water	7
8	Cement 70% + GGBS 30 % + FA 80% + RFA 20 % + CA + Water	9
9	Cement 70% + GGBS 30 % + FA 70%+ RFA 30 % + CA + Water	10

Table. 5. Slump cone test values

Fig. 22. Slump cone apparatus

4.4.2. Kelly ball test

S.NO	COMBINATION	VALUES (cm)
1	Nominal Mix - Trail -1 (Cement + FA + CA + Water)	1.5
2	Nominal Mix - Trail -2 (Cement + FA + CA + Water)	2.5
3	Cement 90% + GGBS 10 % + FA + CA + Water	3.5
4	Cement 80% + GGBS 20 % + FA + CA + Water	4.5
5	Cement 70% + GGBS 30 % + FA + CA + Water	5
6	Cement 60% + GGBS 40 % + FA + CA + Water	4
7	Cement 70% + GGBS 30 % + FA 90%+ RFA 10 % + CA + Water	3.5
8	Cement 70% + GGBS 30 % + FA 80% + RFA 20 % + CA + Water	4
9	Cement 70% + GGBS 30 % + FA 70%+ RFA 30 % + CA + Water	5

Table. 6. Kelly ball test values

Fig. 23. Kelly ball apparatus

4.5. Acid immersion

To replicate the corrosive conditions found in sewage environments, we're submerging our concrete samples in a solution of sulfuric acid within a controlled environment. This setup aims to simulate the harsh chemical exposure that concrete structures face in sewage systems. By subjecting the samples to this acidic immersion within a closed system, we're able to closely monitor and study the degradation processes, helping us develop more resilient concrete formulations for such demanding applications.

Acid Used	: Sulphuric Acid (H_2SO_4)
Molarity	: 0.25 M (Molar)
Normality	: 0.05 N (Normal)
Dilution Ratio	: 18.4 ml/Litre of Water

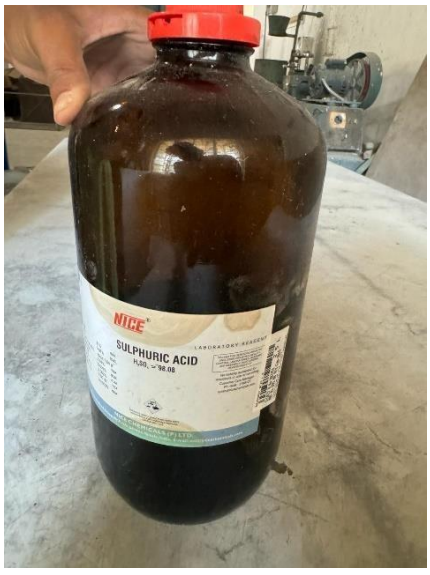

Fig. 24. sulphuric acid

Fig. 25. acid immersion

4.6. Testing

4.6.1. Compressive strength - IS 516:1959

Testing concrete cubes in a compressive testing machine is essential for evaluating structural integrity, ensuring quality control, verifying design assumptions, assessing durability, ensuring safety, and optimizing concrete mix designs. By subjecting concrete specimens to compressive forces, construction professionals can determine their ability to withstand loads and predict their performance in real-world conditions. This testing process is critical for ensuring that concrete structures meet design requirements, adhere to quality standards, and maintain safety for occupants and the public. Additionally, it provides valuable insights for refining mix designs and improving the overall performance and longevity of concrete elements in construction projects.

Fig. 26. CTM

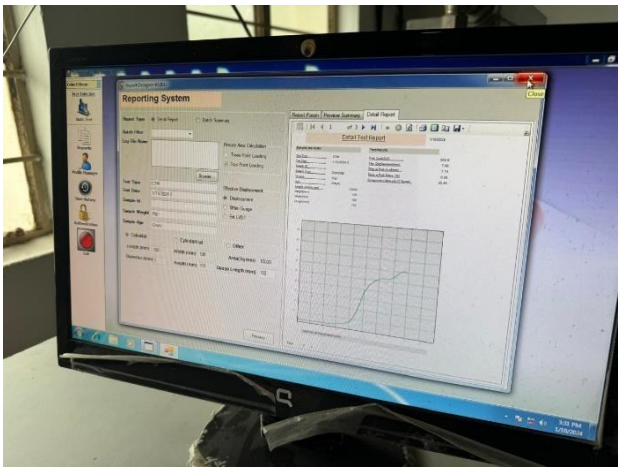

Fig. 27. CTM report

4.6.2. Split tensile strength - IS 5816:1999

Examining the split tensile strength of concrete cylinders offers additional insights into the material's performance. By subjecting cylindrical specimens to tensile forces perpendicular to their longitudinal axis, engineers can assess the material's resistance to cracking and deformation under tension. This testing process provides valuable data for evaluating concrete's ability to withstand bending and shear forces, which are crucial in structural applications such as beams and slabs. Understanding split tensile strength helps ensure the durability and safety of concrete structures, guiding design decisions and construction practices to enhance performance and longevity.

Fig. 28. split tensile strength apparatus

Fig. 29. split tensile strength report

4.7. Conclusion

In conclusion, adhering to the stringent procedures outlined in Indian Standard codes for concrete testing and casting of specimens ensures the accuracy, reliability, and integrity of test results. The utilization of IS 516:1959 for compressive strength testing of concrete cubes and IS 5816:1999 for split tensile strength testing of cylindrical specimens provides standardized methodologies for assessing concrete properties. Additionally, following IS 10086:1982 specifications for molds guarantees uniformity and consistency in sample preparation, essential for obtaining representative results. By adhering to these Indian Standard codes, construction professionals and researchers can confidently evaluate the strength and durability characteristics of concrete, facilitating informed decision-making and ensuring the long-term performance of concrete structures.

5. Mechanical studies on conventional and acid immersing concrete

5.1. Introduction

Mechanical studies play a pivotal role in assessing the structural integrity and durability of concrete under various environmental conditions. Concrete, a widely used construction material, undergoes rigorous testing to evaluate its compressive strength, split tensile strength, and resilience against adverse factors like acid immersion. These studies involve the meticulous casting of specimens such as cubes and cylinders, following standardized procedures outlined in Indian Standard codes. The compressive strength of concrete cubes is determined using IS 516:1959, while the split tensile strength of cylindrical specimens is evaluated according to IS 5816:1999. These mechanical tests provide crucial insights into the performance of concrete in real-world applications, guiding engineers and researchers in optimizing concrete mixtures and designing resilient structures.

5.2. Samples appearance

5.2.1. Plain mix

5.2.1.1. Before testing

Water immersion

Fig. 30. water immersion

Acid immersion

Fig. 31. acid immersion

5.2.1.2. after testing

Water immersion

Fig. 32. water immersion

Acid immersion

Fig. 33. acid immersion

5.2.2. GGBFS – 30%

5.2.2.1. before testing

Water immersion

Fig. 34. water immersion

Acid immersion

Fig. 35. acid immersion

5.2.2.2. after testing

Water immersion

Fig. 36. water immersion

Acid immersion

Fig. 37. acid immersion

5.2.3. GGBFS – 30% + RFA – 20%

5.2.3.1. before testing

Water immersion

Fig. 38. water immersion

Acid immersion

Fig. 39. acid immersion

5.2.3.2. after testing

Water immersion

Fig. 40. water immersion

Acid immersion

Fig. 41. acid immersion

5.2.3.3. Changes in weight for optimized combinations

For 100 mm cube at 28 days,

combination	weight (kg)		% weight increased
	water immersion	acid immersion	
plain mix	2.45	2.51	2.45
GGBFS - 30%	2.41	2.47	2.49
GGBFS - 30% + RFA - 20%	2.37	2.44	2.95

Table. 7. Changes in weight

5.3. Cube test results

5.3.1. Compressive strength

Target mean strength for M30			38.25	MPa						
S.NO	**SPECIMEN DETAILS**	**DATE OF CASTING**	**TYPE OF TESTING**	**DATE OF TESTING**	**INITIAL CRACKING LOAD (kN)**	**PEAK LOAD(kN)**	**SURFACE AREA OF THE SPECIMEN (mm^2)**	**COMPRESSIVE STRESS (MPa)**	**TARGET MEAN STRENGTH FOR M30 (MPa)**	**% ATTAINED**
WITHOUT ACID IMMERSION										
1	standard mix (trial - 1)	2-Jan	7th day	9-Jan	143.2	274.6	10000	27.46	38.25	71.79
			14th day	16-Jan	199.5	321.4	10000	32.14	38.25	84.03
			28th day	30-Jan	202.3	396.5	10000	39.65	38.25	103.66
2	standard mix (trial - 2)	3-Jan	7th day	10-Jan	159.2	305.2	10000	30.52	38.25	79.79
			14th day	17-Jan	201.5	334.8	10000	33.48	38.25	87.53
			28th day	31-Jan	228.2	405.2	10000	40.52	38.25	105.93
3	GGBFS - 10%	22-Jan	7th day	29-Jan	162.3	254.3	10000	25.43	38.25	66.48
			14th day	5-Feb	197.3	303.5	10000	30.35	38.25	79.35
			28th day	19-Feb	297.3	385.6	10000	38.56	38.25	100.81
4	GGBFS - 20%	23-Jan	7th day	30-Jan	151.3	261.8	10000	26.18	38.25	68.44
			14th day	6-Feb	178.5	313.6	10000	31.36	38.25	81.99
			28th day	20-Feb	278.6	390.2	10000	39.02	38.25	102.01
5	GGBFS - 30%	30-Jan	7th day	6-Feb	169.5	273.2	10000	27.32	38.25	71.42
			14th day	13-Feb	184.2	339.5	10000	33.95	38.25	88.76
			28th day	27-Feb	192.4	402.7	10000	40.27	38.25	105.28
6	GGBFS - 40%	31-Jan	7th day	7-Feb	175.6	232.1	10000	23.21	38.25	60.68
			14th day	14-Feb	206.8	326.4	10000	32.64	38.25	85.33
			28th day	28-Feb	215.7	360.3	10000	36.03	38.25	94.20
7	GGBFS - 30% + RFA - 10%	8-Feb	7th day	15-Feb	125.6	287.6	10000	28.76	38.25	75.19
			14th day	22-Feb	149.9	306.75	10000	30.675	38.25	80.20
			28th day	7-Mar	195.9	345.7	10000	34.57	38.25	90.38
8	GGBFS - 30% + RFA - 20%	12-Feb	7th day	19-Feb	130.4	294.1	10000	29.41	38.25	76.89
			14th day	26-Feb	150	309	10000	30.9	38.25	80.78
			28th day	11-Mar	199.6	371.7	10000	37.17	38.25	97.18
9	GGBFS - 30% + RFA - 30%	13-Feb	7th day	20-Feb	102.8	189.6	10000	18.96	38.25	49.57
			14th day	27-Feb	111.2	280.1	10000	28.01	38.25	73.23
			28th day	12-Mar	182.1	331.3	10000	33.13	38.25	86.61

Table. 8. Cube test results

5.3.1.1. GGBFS optimization

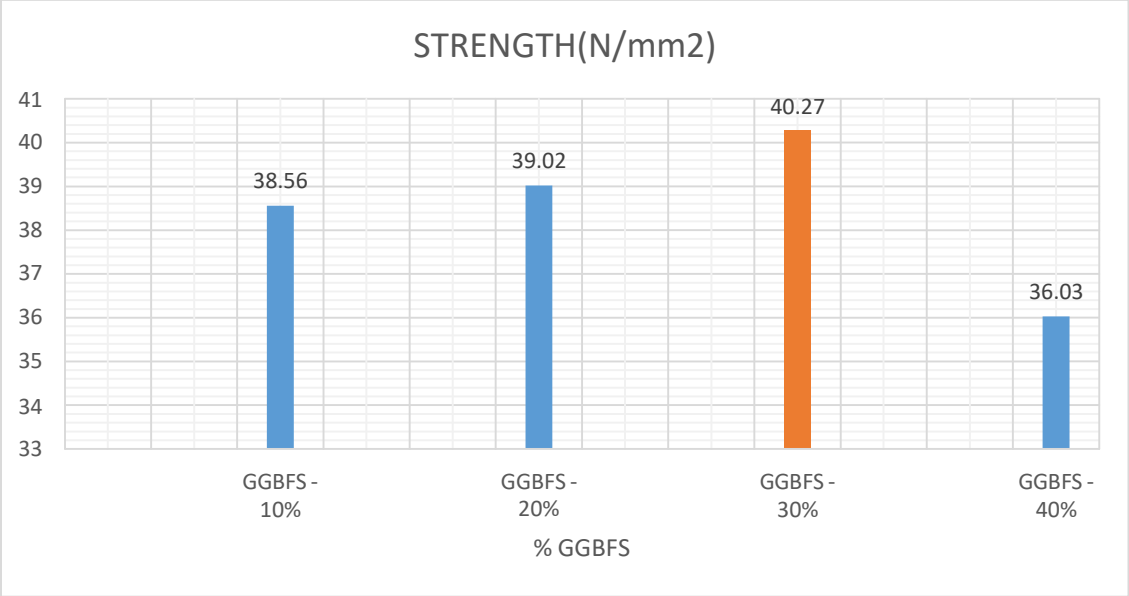

Fig. 42. GGBFS optimization

5.3.1.2. RFA optimization

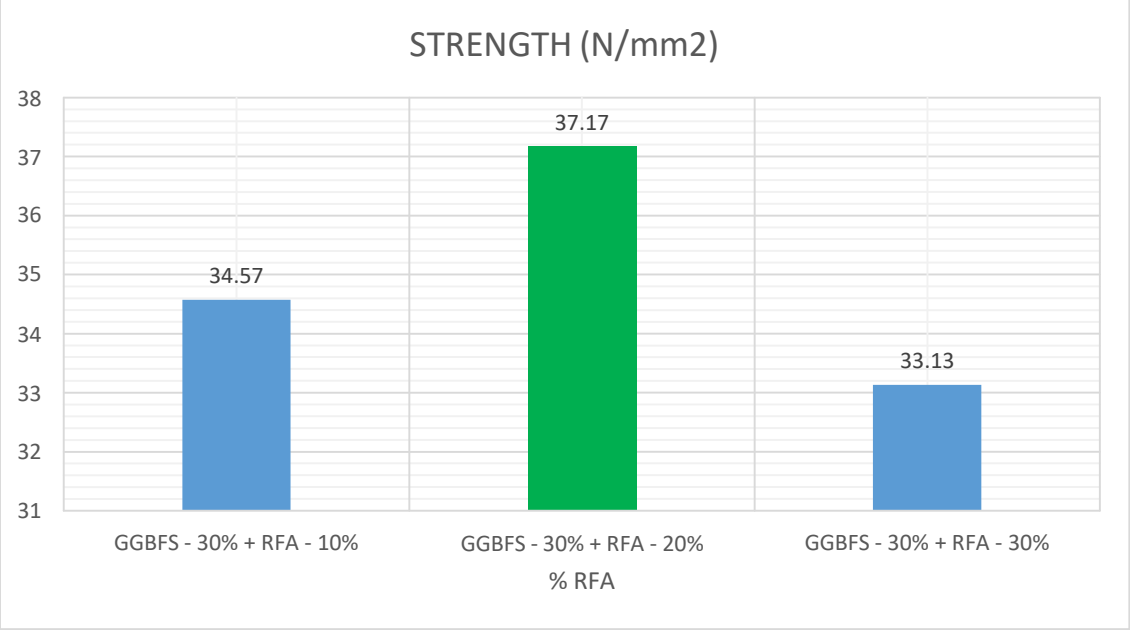

Fig. 43. RFA optimization

5.3.1.3. Cube test results – optimized combinations

combination	days	compressive strength (N/mm2)	
		water immersion	acid immersion
plain mix	7th day	30.52	22.12
	14th day	33.48	22.12
	28th day	40.52	30.35
GGBFS - 30%	7th day	27.32	26.52
	14th day	33.95	27.62
	28th day	40.27	28.71
GGBFS - 30% + RFA - 20%	7th day	29.41	25.43
	14th day	30.9	26.54
	28th day	37.17	27.54

Table. 9. Optimized test results

5.3.2. Results comparison

5.3.2.1. Plain mix

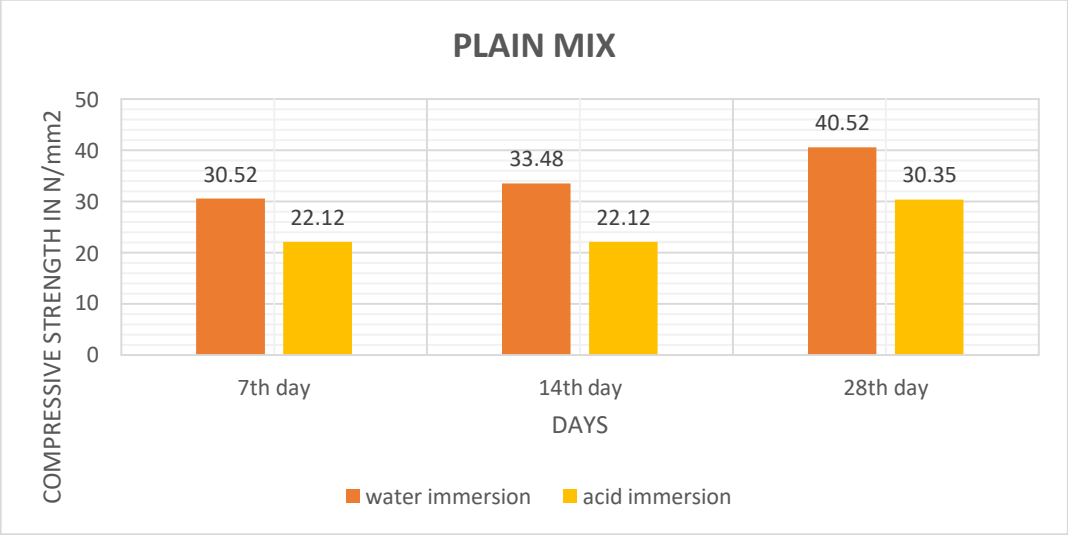

Fig. 44. Comparison - plain mix

5.3.2.2. GGBFS – 30%

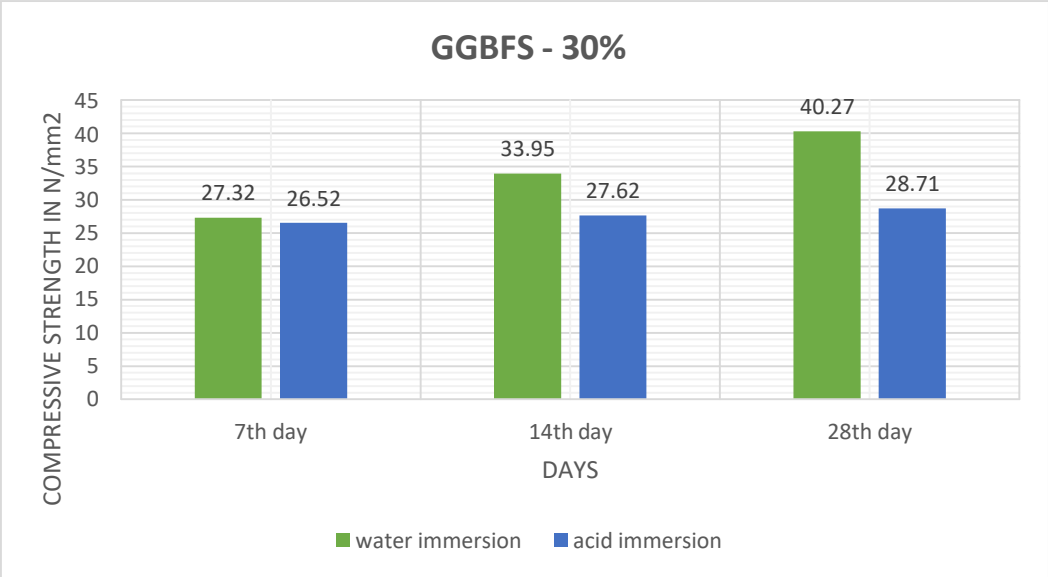

Fig. 45. Comparison - GGBFS - 30%

5.3.2.3. GGBFS – 30% + RFA – 20%

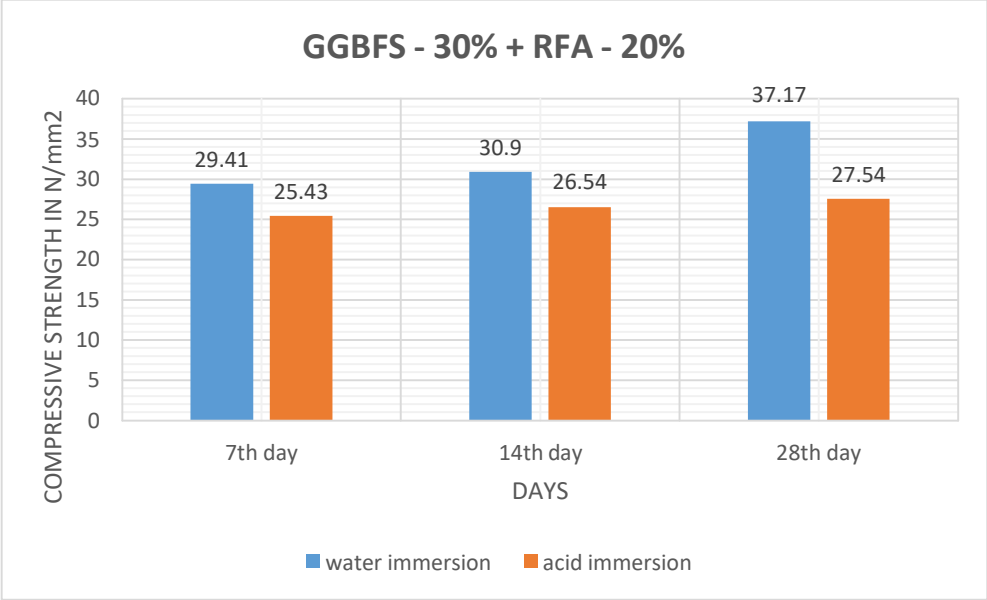

Fig. 46. Comparison for GGBFS + RFA

5.3.2.4. Comparison among all combinations

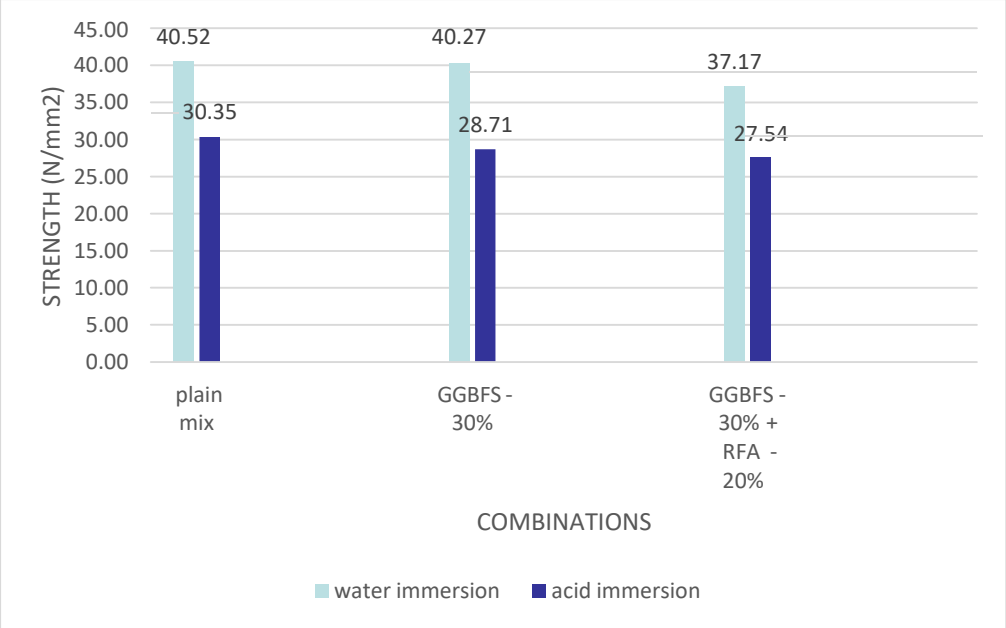

Fig. 47. Comparison among all combinations

5.3.2.5. Changes in compressive strength

combination	compressive strength (N/mm2)		% compressive strength reduced
	water immersion	acid immersion	
plain mix	40.52	30.35	25.10
GGBFS - 30%	40.27	28.71	28.71
GGBFS - 30% + RFA - 20%	37.17	27.54	25.91

Table. 10. Changes in comp. strength

5.3.3. Split tensile strength

5.3.3.1. Samples

Fig. 48. Split tensile strength sample - 1

Fig. 49.split tensile strength sample - 2

5.3.3.2. Plain mix

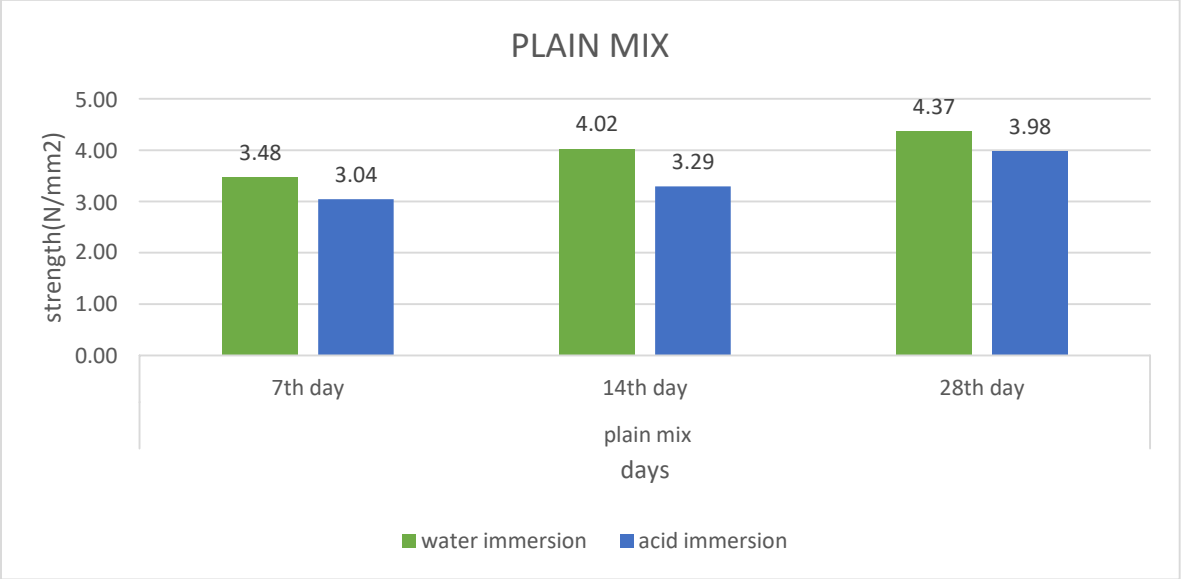

Fig. 50. Plain mix

5.3.3.3. GGBFS – 30%

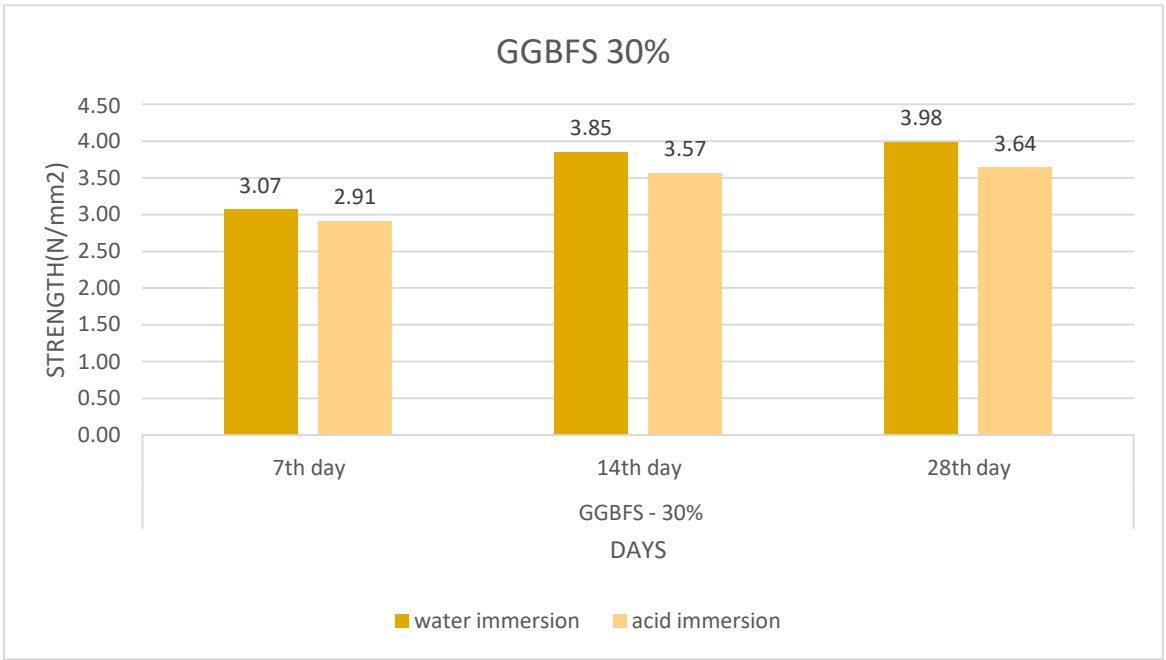

Fig. 51. GGBFS - 30 %

5.3.3.4. GGBFS – 30% + RFA – 20%

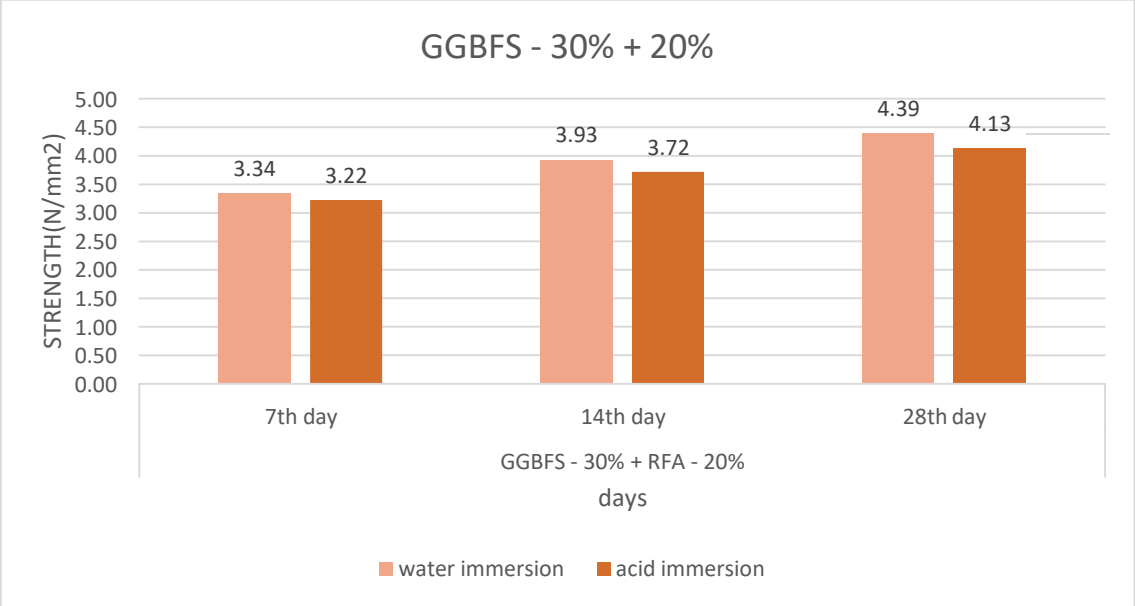

Fig. 52. GGBFS + RFA

5.3.3.5. Comparison among all combinations

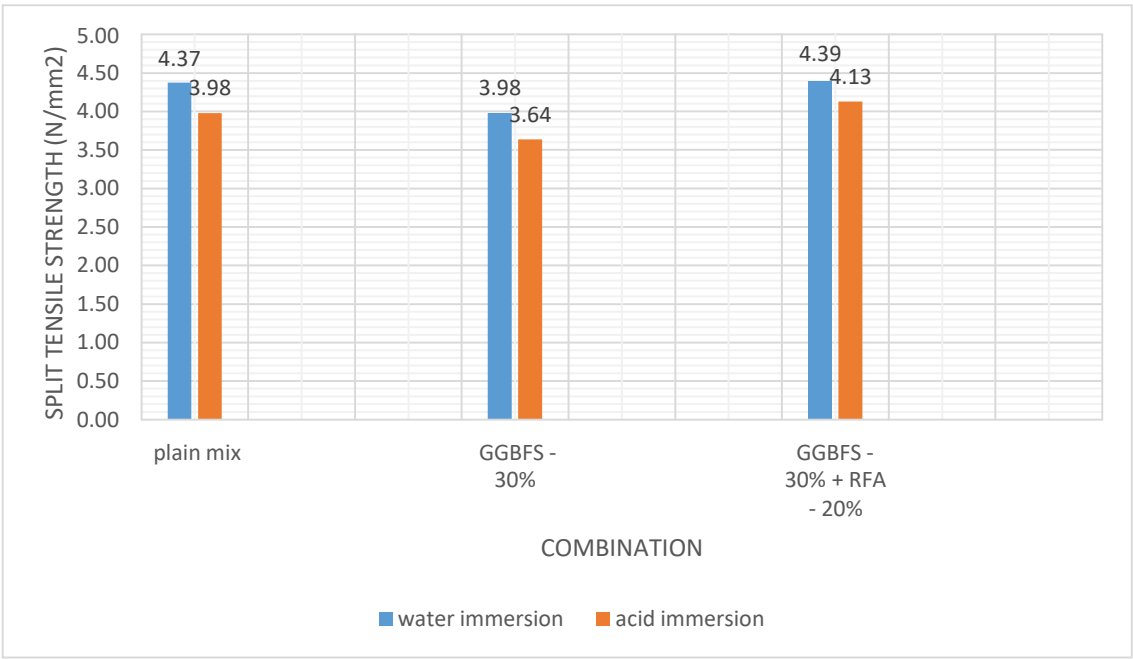

Fig. 53. Comparison among all combinations

5.3.3.6. Changes in split tensile strength

combination	split tensile strength (N/mm2)		% split tensile strength reduced
	water immersion	acid immersion	
plain mix	4.37	3.98	9.04
GGBFS - 30%	3.98	3.64	8.52
GGBFS - 30% + RFA - 20%	4.39	4.13	6.06

Table. 11. Changes in split tensile strength

5.4. Observations during and after testing

- ❖ Crack patterns
- ❖ Core dimensions
- ❖ Uniformity of distribution of particles
- ❖ Color and texture
- ❖ Porosity
- ❖ Weight and density

5.4.1. Core dimension - significance

- ❖ To Ensure Quality Control Assessment
- ❖ To Correlate with Compressive Strength
- ❖ To Evaluate Test Results
- ❖ To Gain Performance Insights
- ❖ To Conduct Root Cause Analysis

Fig. 54. core dimension - 1

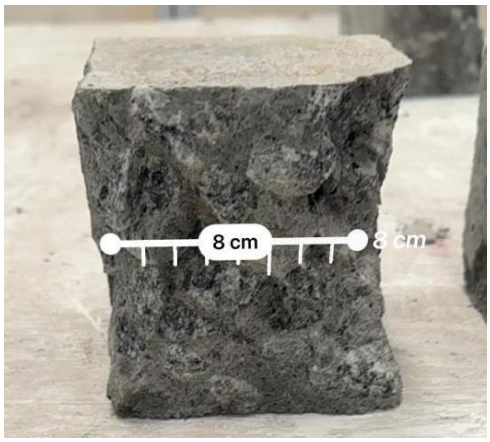

Fig. 55. core dimension -2

5.5. Modulus of elasticity

Fig. 56. Modulus of elasticity

5.5.1. Significance

- ❖ Elasticity Assessment
- ❖ Material Flexibility Analysis
- ❖ Deformation Prediction
- ❖ Quality Control Check
- ❖ Comparative Material Evaluation
- ❖ Long-Term Durability Evaluation
- ❖ Innovation in Concrete Technology

5.5.2. Values

elastic modulus 5000(fck)^0.5 27386 Mpa

STRESS (MPa)	LONGITUDINAL STRAIN	E (Mpa)
0	0	0
0.19	3.33333E-07	570000
0.5	2.33333E-06	214285.7
1.1	8.33333E-06	132000
1.3	1.4E-05	92857.14
1.5	3.23333E-05	46391.75
2.01	5.2E-05	38653.85
2.5	7.06667E-05	35377.36
3.1	9.06667E-05	34191.18
3.9	0.000110667	35240.96
4.1	0.000129333	31701.03
4.3	0.000146	29452.05
4.79	0.000160667	29813.28
5.02	0.000177333	28308.27
5.5	0.000195333	28157
6.2	0.000215667	28748.07

Table. 12. Modulus of elasticity values

5.5.3. Graph

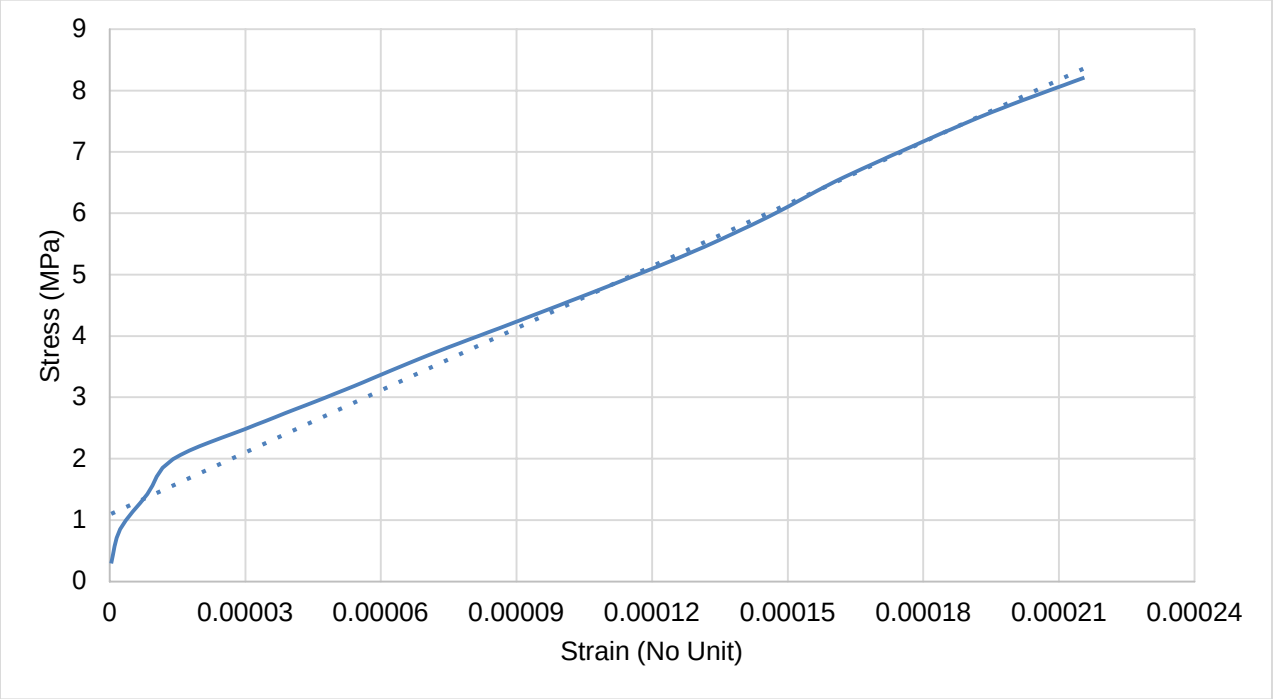

Fig. 57. Modulus of elasticity graph

5.6. Poisson’s ratio

In the realm of concrete engineering, Poisson's ratio plays a crucial role in understanding how concrete cylinders respond to loading. Poisson's ratio denotes the ratio of transverse strain to axial strain when concrete is subjected to compression or tension. Typically ranging from 0.1 to 0.2 for concrete materials, it signifies that when a concrete cylinder undergoes compression along its length, it will slightly expand laterally, and vice versa under tension. This property influences the distribution of stresses and strains within concrete elements, guiding engineers in the design and analysis of structures to ensure their stability and performance under diverse loading conditions. By considering Poisson's ratio, engineers can optimize designs for durability and safety, enhancing the reliability of concrete structures in construction projects.

5.6.1. Significance

- To Understand Concrete Deformation and Ensure Quality: Poisson's Ratio Insights in Concrete Testing
- To Optimize Structural Design and Enhance Material Understanding: Utilizing Poisson's Ratio Analysis in Concrete
- To Improve Compressive Strength Projects: Integrating Poisson's Ratio Assessment for Structural Integrity
- To Gauge Concrete Behaviour and Ensure Consistency: Significance of Poisson's Ratio in Quality Control
- To Assess Material Properties and Lay a Strong Foundation: Role of Poisson's Ratio in Compressive Strength Investigations.

5.6.2. Values

LATERAL STRAIN	LONGITUDINAL STRAIN	POISSON RATIO
0	0	0
6.66667E-07	3.33333E-07	2
2E-06	2.33333E-06	0.857143
3.33333E-06	8.33333E-06	0.4
4E-06	1.4E-05	0.285714
5.33333E-06	3.23333E-05	0.164948
6.66667E-06	5.2E-05	0.128205
8E-06	7.06667E-05	0.113208
8.66667E-06	9.06667E-05	0.095588
1E-05	0.000110667	0.090361
1.06667E-05	0.000129333	0.082474
1.13333E-05	0.000146	0.077626
1.2E-05	0.000160667	0.074689
1.26667E-05	0.000177333	0.071429
1.33333E-05	0.000195333	0.068259
1.46667E-05	0.000215667	0.068006
	AVERAGE	0.1855

5.7. Comparison between literature and test results

5.7.1. Based on compressive strength

5.7.1.1. Literature

- The compressive strength of recycled aggregate concrete (RAC) is crucial for its durability and performance.
- Generally, increasing the amount of recycled aggregate (RA) lowers compressive strength, typically by up to 10% compared to regular concrete.
- Some studies show even higher reductions, with RAC being 20% weaker than natural aggregate concrete (NAC) in some cases. However, there are instances where the compressive strength remains unaffected or slightly increases with up to 25% replacement of NA by RA.

5.7.1.2. Test results

Combination	Compressive strength (N/mm2)	% compressive strength reduced
Plain Mix	40.52	8.26
GGBFS - 30% + RFA - 20%	37.17	

- Mitigated by controlling factors like **water-binder ratio** and **RA grading**.
- The quality of RA, including water absorption, plays a significant role, and RAC may not be suitable for high-performance concrete due to reliability issues.

5.7.2. Based on GGBFS addition and water absorption

5.7.2.1. Literature

- GGBFS can replace 35–70% of OPC in concrete and offers benefits such as improved fresh workability and comparable or higher strength properties.
- GGBFS reduces thermal shrinkage but increases autogenously shrinkage, potentially leading to through cracks.
- Experimental results suggest that while GGBFS can delay cracking compared to OPC, it may increase EAC risk, especially with higher GGBFS content and give best results at 30%.

5.7.2.2. Test results

- Based on the compressive test results, the optimized percentage of Ground Granulated Blast Furnace Slag (GGBFS) is determined to be 30% for the concrete mix. At this percentage, the 30% GGBFS blend consistently exhibited significant improvements in compressive strength.
- Specifically, it achieved 27.32 MPa, 33.95 MPa, and 40.27 MPa at the 7th, 14th, and 28th days respectively.
- These values not only surpassed the target mean strength for M30 concrete but also showed consistent and substantial enhancement over time. Comparatively, other GGBFS percentages did not consistently achieve the same level of improvement.

5.8. Conclusion

In conclusion, mechanical studies on conventional and acid-immersed concrete serve as indispensable tools for assessing the structural properties and durability of concrete. Through standardized testing procedures outlined in Indian Standard codes, such as IS 516:1959 for compressive strength and IS 5816:1999 for split tensile strength, the behavior of concrete under various loading conditions and environmental exposures can be accurately evaluated. These studies enable engineers to make informed decisions regarding material selection, mix design, and construction practices, ultimately contributing to the development of robust and sustainable infrastructure. By embracing rigorous mechanical testing methodologies, we can ensure the longevity and performance of concrete structures in diverse applications, even in challenging environments subjected to acid immersion.

6. Conclusion

In conclusion, our investigation revealed a puzzling phenomenon of strength loss accompanied by unexpected weight gain in acid-exposed concrete. This underscores the need for further research. Moving forward, we recommend developing stronger acid-resistant concrete mixes, employing advanced microscopic analysis, implementing protective measures like coatings, prioritizing sustainability, and fostering collaboration among experts. Addressing these areas can significantly enhance concrete's performance in acidic environments, promoting durable and sustainable construction practices.

6.1. Results and discussion

- The test results indicate a loss of compressive strength in all concrete mixes – plain, GGBFS - 30% [Ground Granulated Blast-Furnace Slag], GGBFS - 30% + RFA - 20% [Recycled Fine Aggregate], – upon exposure to acid. Paradoxically, the weight of the concrete specimens appears to increase.
- The plain mix exhibits a 25% decrease in compressive strength after acid immersion. Similarly, the GGBS-30% mix shows a 28% decrease compared to normally cured cubes
- The weight of the cubes increased around 2-3% in all the following mixes.
- The underlying mechanisms for the observed strength loss and weight gain can only be definitively determined through a microstructure analysis employing various test methods.

6.2. Recommendations for further work

- Figure out the right mix of materials to make concrete stronger in acid.
- Use advanced tests like Raman spectroscopy, FTIR (Fourier Transform Infrared Spectroscopy), EDS (Energy-Dispersive X-ray Spectroscopy), and XRD (X-ray Diffraction) to understand how GGBFS and RFA interact with acid at a molecular level, helping concrete resist damage.
- Look into ways to protect concrete better from acid with coatings or treatments.
- Analyse the environmental impact of supplementary materials and promote sustainable practices in concrete production.
- Collaborate with different experts to share ideas and make progress in improving concrete for lasting construction.
- Infusing titanium dioxide into acid-resisting concrete boosts durability against chemical corrosion and offers self-cleaning properties, enhancing longevity and reducing maintenance needs.

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COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University)

DEPARTMENT OF CIVIL ENGINEERING

B.E. CIVIL ENGINEERING-FULL TIME

(III TO VIII SEMESTER)

Curriculum from the Academic Year 2019 - 2020 and onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19CEM31	Differential Equations and Boundary Value Problems	3	1	0	4	BSC
19CE31	Mechanics of Solids	3	1	0	4	ES
19CE32	Engineering Geology	3	0	0	3	PC
19CE33	Mechanics of Fluids	3	0	0	3	PC
19CE34	Surveying	3	0	0	3	PC
19CE35	Water Supply Engineering	3	0	0	3	PC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HSC
19CEL36	Strength of Materials Laboratory	0	0	2	1	PC
19CEL37	Survey Laboratory	0	0	2	1	PC
	One Credit Course	1	0	0	1	EEC
19HOC31	**Communication Skills for Engineers I***	**0**	**0**	**2**	**1**	**EEC**
	TOTAL CREDITS				**25**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19CE41	Construction Technology	3	0	0	3	PC
19CE42	Strength of Materials	3	1	0	4	PC
19CE43	Transportation Engineering	3	0	0	3	PC
19CE44	Applied Hydraulics and Hydraulic Machinery	3	0	0	3	PC
19CE45	Waste Water Engineering	3	0	0	3	PC
19CE46	Professional Practices and Ethics	3	0	0	3	BSC
19CEL47	Hydraulics Laboratory	0	0	2	1	PC
19CEL48	Environmental Engineering Laboratory	0	0	2	1	PC
	One Credit Course	1	0	0	1	EEC
19HOC41	**Communication Skills for Engineers II***	**0**	**0**	**2**	**1**	**EEC**
	TOTAL CREDITS				**23**	
	* Not to be counted for GPA. Pass is required					

Semester V

Course Code	Course Name	L	T	P	C	Category
19CE51	Structural Analysis - I	3	0	0	3	PC
19CE52	Design of Reinforced Concrete Structural Elements	3	0	0	3	PC
19CE53	Mechanics of Soils	3	0	0	3	PC
19CE54	Concrete Technology	3	0	0	3	PC
	Elective- I	3	0	0	3	EC
	Elective - II	3	0	0	3	EC
19CEL55	Computer Aided Civil Engineering Drawing	0	0	2	1	ES
19CEL56	Highway Engineering Laboratory	0	0	2	1	PC
	One Credit Course	1	0	0	1	EEC
	Mini Project	-	-	-	-	EEC
19INT51	Internship*	0	0	2	1	EEC
19HOC51	**Employability and Personality Development Skills I #**	**0**	**0**	**2**	**1**	**EEC**
	TOTAL CREDITS				**23**	

***2 weeks of Internship to be completed during 4th semester vacation**

Semester VI

Course Code	Course Name	L	T	P	C	Category
19CE61	Structural Analysis - II	3	0	0	3	PC
19CE62	Design of Steel Structures	3	0	0	3	PC
19CE63	Foundation Engineering	3	0	0	3	PC
	Elective- III	3	0	0	3	EC
	Elective- IV	3	0	0	3	EC
19CEL64	Soil Mechanics Laboratory	0	0	2	1	PC
19CEL65	Quantity Surveying and Project Planning Laboratory	0	0	2	1	PC
	One Credit Course	1	0	0	1	EEC
19CE66	Mini Project	0	0	6	3	EEC
19INT61	Internship*	0	0	2	1	EEC
19HOC61	**Employability and Personality Development Skills II #**	**0**	**0**	**2**	**1**	**EEC**
	TOTAL CREDITS				**23**	

***2 weeks of Internship to be completed during 5th semester vacation**

Not to be counted for GPA. Pass is required

Semester VII

Course Code	Course Name	L	T	P	C	Category
19CE71	Irrigation Engineering	3	0	0	3	PC
19CE72	Earthquake Resistant Design of Structures	3	0	0	3	PC
19CE73	Construction Management	3	0	0	3	PC
	Elective- V	3	0	0	3	EC
	Elective- VI	3	0	0	3	EC
19CEL74	Computer Applications Laboratory	0	0	2	1	PC
19CEL75	Concrete Laboratory	0	0	2	1	PC
19CE76	Project Work Phase I	0	0	6	3	EEC
	TOTAL CREDITS				**20**	

Semester VIII

Course Code	Course Name	L	T	P	C	Category
	Elective- VII	3	0	0	3	EC
	Elective-VIII	3	0	0	3	EC
19CE81	Project Work Phase II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

* Including first year credits **TOTAL CREDITS = 164***

BSC - Basic Sciences

HSC - Humanities and Social Sciences

ES - Engineering Sciences

PC - Professional Core

PE - Professional Elective

OE - Open Elective

EEC - Employability Enhancement Course

EC - Elective Course - PE / OE

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University)

DEPARTMENT OF MECHANICAL ENGINEERINGBACHELOR

OF MECHANICAL ENGINEERING CHOICE BASED CREDIT

SYSTEM

Curriculum from the Academic Year 2019 - 2020 and onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19MEM31	Ordinary and Partial Differential Equations	3	1	0	4	BSC
19ME31	Engineering Thermodynamics	3	1	0	4	PCC
19ME32	Engineering Mechanics for Mechanical Engineers	3	1	0	4	PCC
19ME33	Fluid Mechanics and Machinery	3	0	0	3	PCC
19ME34	Embedded Processor Architecture and Programming	3	0	0	3	ESC
19HSS01	Science of Creativity and Professional Ethics	1	1	0	1	HS
19MEL35	Computer Aided Machine Drawing - I	0	0	2	1	PCC
19MEL36A / 19MEL36B	Fluid Mechanics & Machinery Laboratory / Electrical Machines & Drives and Embedded Systems Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective I	1	0	0	1	EEC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**22.5**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19ME41	Applied Thermodynamics	3	1	0	4	PCC
19ME42	Strength of Materials	3	1	0	4	PCC
19ME43	Mechanics of Machines	3	1	0	4	PCC
19ME44	Materials Engineering	3	0	0	3	PCC
19ME45	Manufacturing Processes - I	3	0	0	3	PCC
19MEL46	Computer Aided Machine Drawing - II	0	0	2	1	PCC
19MEL36A / 19MEL36B	Fluid Mechanics & Machinery Laboratory / Electrical Machines & Drives and Embedded Systems Laboratory	0	0	2	0.5	PCC

19MEL47A / 19MEL47B	Material Characterization and Testing Laboratory / Manufacturing Processes Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective II	1	0	0	1	EEC
19HOC41	Communication Skills for Engineers - II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	L	T	P	C	Category
19ME51	Heat and Mass Transfer	3	1	0	4	PCC
19ME52	Design of Machine Elements	3	1	0	4	PCC
19ME53	Manufacturing Processes - II	3	0	0	3	PCC
19ME54	Metrology and Quality Control	3	0	0	3	PCC
19ME55	Operations Research	3	1	0	4	HS
	Elective 1	3	0	0	3	PEC
19MEL47A / 19MEL47B	Material Characterization and Testing Laboratory / Manufacturing Processes Laboratory	0	0	2	0.5	PCC
19MEL56A / 19MEL56B	Applied Thermal Sciences Laboratory / Dynamics and Metrology Laboratory	0	0	2	0.5	PCC
	One Credit Course - Elective III	1	0	0	1	EEC
19INT51	Internship - I	0	0	0	1	EEC
19ME67	Mini Project	0	0	3	0	EEC
19HOC51	Employability and Personality Development Skills - I*	0	0	2	1	
	TOTAL CREDITS				**25**	

Semester VI

Course Code	Course Name	L	T	P	C	Category
19ME61	Refrigeration and Air-conditioning	3	0	0	3	PCC
19ME62	Finite Element Analysis	3	1	0	4	PCC
19ME63	Design of Transmission Systems	3	1	0	4	PCC
19ME64	Computer Aided Engineering	3	1	0	4	PCC
	Elective 2	3	0	0	3	PEC
19MEL56A / 19MEL56B	Applied Thermal Sciences Laboratory / Dynamics and Metrology Laboratory	0	0	2	0.5	PCC
19MEL65	CAD / CAM Laboratory	0	0	2	1	PCC
	One Credit Course - Elective IV	1	0	0	1	PCC
19INT61	Internship - II	0	0	0	1	EEC
19ME67	Mini Project	0	0	3	3	EEC
19HOC61	Employability and Personality Development Skills - II*	0	0	2	1	
	TOTAL CREDITS				**25.5**	

Semester VII

Course Code	Course Name	L	T	P	C	Category
19ME71	Control Theory and Mechatronics	2	0	2	3	PCC
19ME72	Quality Engineering and Management	3	0	0	3	PCC
	Elective 3	3	0	0	3	PEC
	Elective 4	3	0	0	3	PEC
	Elective 5	3	0	0	3	OEC
	Elective 6	3	0	0	3	OEC
19ME73	Project Work Phase - I	0	0	6	3	EEC
	TOTAL CREDITS				**21**	

Semester VIII

Course Code	Course Name	L	T	P	C	Category
	Elective 7	3	0	0	3	PEC
	Elective 8	3	0	0	3	PEC
19ME81	Project Work Phase - II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

Semester 1	20
Semester 2	19
Semester 3	22.5
Semester 4	22
Semester 5	25
Semester 6	25.5
Semester 7	21
Semester 8	11
Total Credits	**166**

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM

Curriculum from the academic year 2019-2020 onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19ECM31	Matrices, Linear Algebra and Numerical Methods	3	1	0	4	BSC
19EC31	Digital Electronics	3	1	0	4	PCC
19EC32	Analog Electronics	3	0	0	3	PCC
19EC33	Signals and Systems	3	1	0	4	PCC
19EC34	Computer Architecture and Organization	3	0	0	3	PCC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HSC
19ECL35	Digital Electronics Laboratory	0	0	2	1	PCC
19ECL36	Analog Electronics Laboratory	0	0	2	1	PCC
	One Credit Course - Elective I				1	EEC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

*Pass is required not accounted for GPA

Semester IV

Course Code	Course Name	L	T	P	C	Category
19EC41	Probability and Stochastic Process	3	1	0	4	PCC
19EC42	Principles of Communication	3	1	0	4	PCC
19EC43	Microcontroller Based Systems	3	1	0	4	PCC
19EC44	Linear Integrated Circuits	3	0	0	3	PCC
19EC45	Electromagnetic Fields and Waveguides	3	0	0	3	PCC
19ECL46	Microcontrollers Laboratory	0	0	2	1	PCC
19ECL47	Linear Integrated Circuits Laboratory	0	0	2	1	PCC
	One Credit Course - Elective II				1	EEC
19HOC41	Communication Skills for Engineers -II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

*Pass is required not accounted for GPA

Semester V

Course Code	Course Name	L	T	P	C	Category
19EC51	Control Systems	3	0	0	3	PCC
19EC52	Digital Signal Processing	3	0	0	3	PCC
19EC53	Embedded Systems and IoT	3	0	0	3	PCC
19EC54	Antennas and Wave Propagation	3	0	0	3	PCC
	Elective - I	3	0	0	3	PEC
	Elective - II	3	0	0	3	PEC/OEC
19ECL55	Signal Processing Laboratory	0	0	2	1	PCC
19ECL56	Embedded Systems and IoT Laboratory	0	0	2	1	PCC
	One Credit Course - Elective III	0	0	2	1	EEC
19EC66	Mini Project				-	EEC
19INT51	Internship - I*				1	EEC
19HOC51	Employability and Personality Development Skills- I**	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

* Internship / Project to be completed during 4th semester vacation

** Pass is required not accounted for GPA

Semester VI

Course Code	Course Name	L	T	P	C	Category
19EC61	VLSI Design	4	0	0	4	PCC
19EC62	Digital Communication	3	0	0	3	PCC
19EC63	Data Communication Networks	3	0	0	3	PCC
	Elective - III	3	0	0	3	PEC
	Elective - IV	3	0	0	3	PEC/OEC
19ECL64	VLSI Design Laboratory	0	0	2	1	PCC
19ECL65	Analog and Digital Communication Laboratory	0	0	2	1	PCC
	One Credit Course - Elective IV	1	0	0	1	EEC
19EC66	Mini Project	0	0	6	3	EEC
19INT61	Internship - II*				1	EEC
19HOC61	Employability And Personality Development Skills - II**	0	0	2	1	EEC
	TOTAL CREDITS				**24**	

* Internship to be completed during 5th semester vacation

** Pass is required not accounted for GPA

Semester VII

Course Code	Course Name	L	T	P	C	Category
19EC71	Digital Image Processing	4	0	0	4	PCC
19EC72	Microwave Engineering and Optical Communication	4	0	0	4	PCC
19EC73	Wireless Communication and Networks	3	0	0	3	PCC
	Elective - V	3	0	0	3	PEC
	Elective - VI	3	0	0	3	PEC
19ECL74	Wireless Communication and Networking Laboratory	0	0	2	1	PCC
19ECL75	High Frequency Laboratory	0	0	2	1	PCC
19EC76	Project Phase I	0	0	6	3	EEC
	TOTAL CREDITS				**22**	

SEMESTER VIII

Course Code	Course Name	L	T	P	C	Category
	Elective -VII	3	0	0	3	PEC
	Elective -VIII	3	0	0	3	PEC
19EC81	Project Phase II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

TOTAL CREDITS : 165 (4 year B.E ECE)

TOTAL CREDITS : 129* (Lateral-B.E ECE)

*125 credits-from 3rd to 8th semester,

4 credits-Bridge Courses (Engineering Mathematics-2 Credits & Physical Sciences -2 Credits)

Category; BSC - Basic Sciences Course, HSC- Humanities and Social Sciences Course, ESC-Engineering Sciences Course, PCC -Professional Core Course, PEC- Professional Elective Course, OEC-Open Elective Course, EEC -Employability Enhancement Course

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University)

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING (FULL TIME)

CHOICE BASED CREDIT SYSTEM

Curriculum from the Academic Year 2019 - 2020 and onwards

SUBJECTS OF STUDY

Semester III

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEM31	Transforms, Probability and Random Variables	3	0	0	3	BS
2	19EE31	Electric Circuit Analysis	2	1	0	3	PCC
3	19EE32	Electromagnetic Fields	2	1	0	3	PCC
4	19EE33	DC Machines and Transformers	3	0	0	3	PCC
5	19EE34	Analog Electronics	3	0	0	3	PCC
6	19EE35	Digital Electronics	3	0	0	3	PCC
7	19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HS
8	19EEL36	DC Machines and Transformers Laboratory	0	0	2	1	PCC
9	19EEL37	Analog and Digital Electronics Laboratory	0	0	2	1	PCC
10		One Credit Course 1				1	OCC
11	19HOC31	Communication Skills For Engineers I*	0	0	2	1	EEC
(BS - 3, HS - 1, PCC - 17, OCC - 1, EEC - 1) TOTAL CREDITS						**23**	
* Not to be counted for GPA. Pass is required							

Semester IV

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE41	AC Rotating Machines	3	0	0	3	PCC
2	19EE42	Networks and Systems	3	0	0	3	PCC
3	19EE43	Measurements and Instrumentation	3	0	0	3	PCC
4	19EE44	Linear Integrated Circuits	3	0	0	3	PCC
5	19EE45	Transmission and Distribution	3	0	0	3	PCC
6	19EE46	OOPS and C++ for Electrical Engineers	3	0	0	3	PCC
7	19EEL47	AC Rotating Machines Laboratory	0	0	2	1	PCC
8	19EEL48	Linear Integrated Circuits Laboratory	0	0	2	1	PCC
9		One Credit Course 2				1	OCC
10	19HOC41	Communication Skills For Engineers II*	0	0	2	1	EEC
(PCC - 20, OCC - 1, EEC - 1) TOTAL CREDITS						**22**	
* Not to be counted for GPA. Pass is required							

Semester V

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE51	Control Systems	3	0	0	3	PCC
2	19EE52	Power System Analysis	3	0	0	3	PCC
3	19EE53	Data Structures and Algorithms	3	0	0	3	PCC
4	19EE54	Embedded System Design	3	0	0	3	PCC
5		Elective Course 1	3	0	0	3	EC
6		Elective Course 2	3	0	0	3	EC
7	19EEL55	Control systems Laboratory	0	0	2	1	PCC
8	19EEL56	Embedded System Design Laboratory	0	0	2	1	PCC
9		One Credit Course 3				1	OCC
10	19EEL66	Mini Project	-	-	2	-	EEC
11	19INT51	Internship - I	-	-	-	1	EEC
12	19HOC51	Employability and Personality Development Skills - I *	0	0	2	1	EEC
(PCC - 14, EC - 6, OCC - 1, EEC - 2)		**TOTAL CREDITS**				**23**	
* Not to be counted for GPA. Pass is required							

Semester VI

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE61	Power Electronics	3	0	0	3	PCC
2	19EE62	Digital Protection of Power Systems	3	0	0	3	PCC
3	19EE63	Digital Signal Processing	3	1	0	4	PCC
4		Elective Course 3	3	0	0	3	EC
5		Elective Course 4	3	0	0	3	EC
6	19EEL64	Power Electronics Laboratory	0	0	2	1	PCC
7	19EEL65	Power Systems Laboratory	0	0	2	1	PCC
8		One Credit Course 4				1	OCC
9	19EEL66	Mini Project	0	0	6	3	EEC
10	19INT61	Internship - II	-	-	-	1	EEC
11	19HOC61	Employability and Personality Development Skills - II*	0	0	2	1	EEC
(PCC - 12, EC - 6, OCC - 1, EEC - 5)		**TOTAL CREDITS**				**24**	
* Not to be counted for GPA. Pass is required							

Semester VII

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE71	Solid State Drives and Control	3	0	0	3	PCC
2	19EE72	Generation of Electrical Energy	3	1	0	4	PCC
3	19EE73	Smart Grid	3	0	0	3	PCC
4		Elective Course 5	3	0	0	3	EC
5		Elective Course 6	3	0	0	3	EC
6	19EEL74	Electrical Drives Laboratory	0	0	2	1	PCC
7	19EEL75	Professional Competency	0	0	4	2	PCC
8	19EE76	Project Work Phase - I	0	0	6	3	EEC
(PCC - 13, EC - 6, EEC - 3)		**TOTAL CREDITS**				**22**	

Semester VIII

S. No.	Course Code	Course Name	L	T	P	C	Category
1		Elective Course 7	3	0	0	3	EC
2		Elective Course 8	3	0	0	3	EC
3	19EE81	Project Work Phase - II	0	0	10	5	EEC
(EC - 6, EEC - 5)		**TOTAL CREDITS**				**11**	

TOTAL CREDITS : 164 *

* Including First Year Credits

Category : **BS** - Basic Sciences, **HS** - Humanities and Social Sciences, **ES** - Engineering Sciences, **PCC** - Professional Core Course, **EC** - Elective Course, **EEC** - Employability Enhancement Course, **OCC** - One Credit Course.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

B.E. COMPUTER SCIENCE AND ENGINEERING

CHOICE BASED CREDIT SYSTEM

Curriculum from the academic year 2019 - 2020 onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
19CIM31	Linear Algebra, Complex Variables and Transform Techniques	3	1	0	4	BSC
19CI31	Data Structures and Algorithms - I	3	1	0	4	PCC
19CI32	Digital Design	3	0	0	3	ESC
19CS31	Discrete Mathematics	2	0	0	2	PCC
19CI33	Object Oriented Programming and Java	3	0	0	3	PCC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HSC
19CIL34	Digital Design Laboratory	0	0	3	1.5	ESC
19CIL35	Object Oriented Programming Laboratory	0	0	3	1.5	PCC
	One Credit Course	0	0	2	1	OCC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	Total Credits				**22**	

Semester IV

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
19CI41	Data Structures and Algorithms- II	3	0	0	3	PCC
19CI42	Database Management Systems	3	0	0	3	PCC
19CI43	Computer Architecture	3	0	0	3	PCC
19CI44	Operating Systems	3	0	0	3	PCC
19CI45	Software Engineering	2	1	0	3	PCC
19CS41	Formal Languages and Automata Theory	2	0	0	2	PCC
19CIL46	Database Management Systems Laboratory	0	0	3	1.5	PCC
19CIL47	Data Structures and Algorithms Laboratory	0	0	3	1.5	PCC
	One Credit Course	0	0	2	1	OCC
19HOC41	Communication Skills for Engineers - II*	0	0	2	1	EEC
	Total Credits				**22**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
19CI51	Computer Networks	3	0	0	3	PCC
19CS51	Unix Internals	3	0	0	3	PCC
19CI52	Data Warehousing and Data Mining	3	0	0	3	PCC
19CS52	Statistical Data Analysis	2	1	0	3	PCC
	Elective - I	3	0	0	3	PEC/OEC
	Elective - II	3	0	0	3	PEC/OEC
19CIL54	Computer Networks Laboratory	0	0	2	1	PCC
19CIL48	Operating Systems Laboratory	0	0	2	1	PCC
	One Credit Course	0	0	2	1	OCC
19HOC51	Employability and Personality Development Skills - I*	0	0	2	1	EEC
19CS65	Mini Project	0	0	3	-	EEC
19INT51	Internship-I*	-	-	-	1	EEC
	Total Credits				**23**	

Semester VI

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
19CI53	Embedded Systems	3	0	0	3	PCC
19CS61	Internet of Things and Its Applications	3	0	0	3	PCC
19CS62	Machine Learning	3	0	0	3	PCC
	Elective - III	3	0	0	3	PEC/OEC
	Elective - IV	3	0	0	3	PEC/OEC
19CSL63	Embedded Systems & IOT Laboratory	0	0	2	1	PCC
19CSL64	Machine Learning Laboratory	0	0	2	1	PCC
19HOC61	Employability and Personality Development Skills-II*	0	0	2	1	EEC
	One Credit Course	0	0	2	1	OCC
19CS65	Mini Project	0	0	3	3	EEC
19INT61	Internship-II*	-	-	-	1	EEC
	Total Credits				**23**	

***Internship to be completed during 4th semester and 5th semester vacation**

* Not to be counted for GPA. Pass is required.

Semester VII

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
19CS71	Principles of Compiler Design	3	1	0	4	PCC
19CI61	Artificial Intelligence	3	0	0	3	PCC
19CI71	Cryptography and Network Security	3	1	0	4	PCC
	Elective - V	3	0	0	3	PEC/OEC
	Elective - VI	3	0	0	3	PEC/OEC
19CSL72	Compiler Design Laboratory	0	0	3	1.5	PCC
19CSL73	Artificial Intelligence Laboratory	0	0	3	1.5	PCC
19CS74	Project Phase-I	0	0	6	3	EEC
	Total Credits				**23**	

Semester VIII

Course Code	Course Name	Periods			Credits	Category
		L	T	P		
	Elective - VII	3	0	0	3	PEC/OEC
	Elective - VIII	3	0	0	3	PEC/OEC
19CS81	Project Phase-II	0	0	10	5	EEC
	Total Credits				**11**	

Note :

- Open Electives (Maximum 2) can be opted from other departments as approved by CSE department.
- NPTEL 3 credit courses can be opted instead of electives with approval of department.

TOTAL CREDITS

CREDITS (First and Second semester) : 40

CREDITS (Third to Eight semester) : 124

TOTAL : 164 Credits

SCC-Subject Category Code:

HSC - Humanities and Social Sciences, BSC - Basic Science Courses, ESC - Engineering Science Courses, PCC- Professional Core Courses, PEC - Professional Elective Courses, OEC - Open Elective Courses, EEC - Project Work, Entrepreneurship, Seminar, Soft skills, Internship, Comprehensive Test, MCC - Mandatory Courses, OCC - One Credit Courses

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

B.Tech. INFORMATION TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

Curriculum from the academic year 2019-2020 onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19CIM31	Linear Algebra, Complex Variables and Transform Techniques	3	1	0	4	BS
19CI31	Data Structures and Algorithms - I	3	1	0	4	PC
19CI32	Digital Design	3	0	0	3	ES
19IT31	Discrete Mathematics And Automata Theory	3	0	0	3	PC
19CI33	Object Oriented Programming and Java	3	0	0	3	PC
19HSS01	Science Of Creativity and Professional Ethics	1	0	0	1	HS
19CIL34	Digital Design Laboratory	0	0	3	1.5	ES
19CIL35	Object Oriented Programming Laboratory	0	0	3	1.5	PC
	One Credit Course	0	0	2	1	OCC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19CI41	Data Structures and Algorithms II	3	0	0	3	PC
19CI42	Database Management Systems	3	0	0	3	PC
19CI43	Computer Architecture	3	0	0	3	PC
19CI44	Operating Systems	3	0	0	3	PC
19CI45	Software Engineering	2	1	0	3	PC
19CIL46	Database Management Systems Laboratory	0	0	3	1.5	PC
19CIL47	Data Structures and Algorithms Laboratory	0	0	3	1.5	PC
19CIL48	Operating Systems Laboratory	0	0	2	1	PC
	One Credit Course	0	0	2	1	OCC
19HOC41	Communication Skills for Engineers -II*	0	0	2	1	EEC
	TOTAL CREDITS				**21**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	L	T	P	C	Category
19CI51	Computer Networks	3	0	0	3	PC
19CI52	Data Warehousing and Data Mining	3	0	0	3	PC
19CI53	Embedded Systems	3	0	0	3	PC
19IT51	Economics for Engineers	2	0	0	2	HS
	Elective-I	3	0	0	3	PE/OE
	Elective-II	3	0	0	3	PE/OE
19ITL52	Embedded Systems Laboratory	0	0	2	1	PC
19CIL54	Computer Networks Laboratory	0	0	2	1	PC
	One Credit Course	0	0	2	1	OCC
19HOC51	Employability and Personality Development Skills - I*	0	0	2	1	EEC
19IT65	Mini Project	0	0	3	-	EEC
19INT51	Internship-I	0	0	0	1	EEC
	TOTAL CREDITS				**22**	

Semester VI

Course Code	Course Name	L	T	P	C	Category
19CI61	Artificial Intelligence	3	0	0	3	PC
19IT61	Mobile Computing	3	0	0	3	PC
19IT62	Internet Technology	3	0	0	3	PC
	Elective-III	3	0	0	3	PE/OE
	Elective-IV	3	0	0	3	PE/OE
19ITL63	Data Analytics and Artificial Intelligence Laboratory	0	0	3	1.5	PC
19ITL64	Internet Technology & Software Engineering Laboratory	0	0	3	1.5	PC
	One Credit Course	0	0	2	1	OCC
19HOC61	Employability and Personality Development Skills - II*	0	0	2	1	EEC
19IT65	Mini Project	0	0	3	3	EEC
19INT61	Internship -II	0	0	0	1	EEC
	TOTAL CREDITS				**24**	

• Internship/Project to be completed during 4th and 5th semester vacation

* Not to be counted for GPA. Pass is required.

Semester VII

Course Code	Course Name	L	T	P	C	Category
19CI71	Cryptography and Network Security	3	1	0	4	PC
19IT71	Distributed Systems	3	0	0	3	PC
19IT72	Internet of Things	3	1	0	4	PC
	Elective-V	3	0	0	3	PE/OE
	Elective-VI	3	0	0	3	PE/OE
19ITL73	Internet of Things Laboratory	0	0	3	1.5	PC
19ITL74	Mobile Application Development Laboratory	0	0	3	1.5	PC
19IT75	Project Phase-I	0	0	6	3	EEC
	TOTAL CREDITS				**23**	

Semester VIII

Course Code	Course Name	L	T	P	C	Category
	Elective-VII	3	0	0	3	PE/OE
	Elective-VIII	3	0	0	3	PE/OE
19IT81	Project Phase-II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

Total Credits : 164 (4 years B.Tech (IT))

Total Credits : 126 (Lateral B.Tech (IT))

122* Credits for Laterals + 4 Credits - Bridge

Course (Engineering Mathematics - 2 Credits & Physical - Sciences - 2 Credits)

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University)

B.Tech. CHEMICAL ENGINEERING

Curriculum from the Academic Year - 2019

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	CAT
19CEM31	Differential Equations and Boundary Value Problems	2	1	0	3	BS
19CH31	Mechanics of Solids	3	0	0	3	ES
19CH32	Fluid Mechanics	2	1	0	3	PCC
19CH33	Chemical Engineering Thermodynamics	2	1	0	3	PCC
19CH34	Environmental Science	3	0	0	3	PCC
19CH35	Chemical Process Calculations	2	1	0	3	PCC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HS
19CHL36	Computer Laboratory (Programming for problem solving)	0	0	2	1	ES
19CHL37	Electrical and Electronics Engineering Laboratory	0	0	2	1	ES
	One Credit Course	1	0	0	1	
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

Semester IV

Course Code	Course Name	L	T	P	C	CAT
19CH41	Biology for Chemical Engineers	3	0	0	3	ES
19CH42	Mechanical Operations	2	1	0	3	PCC
19CH43	Chemical Reaction Engineering - I	2	1	0	3	PCC
19CH44	Heat Transfer	2	1	0	3	PCC
19CH45	Mass Transfer - I	2	1	0	3	PCC
19CH46	Instrumental Methods of Analysis	3	0	0	3	PCC
19CHL47	Fluid Mechanics Laboratory	0	0	2	1	PCC
19CHL48	Technical Analysis Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	
19HOC41	Communication Skills for Engineers - II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	L	T	P	C	CAT
19CH51	Numerical Methods in Chemical Engineering	2	1	0	3	PCC
19CH52	Chemical Reaction Engineering- II	2	1	0	3	PCC
19CH53	Mass Transfer-II	2	1	0	3	PCC
	Elective - I	3	0	0	3	PEC
	Elective - II	3	0	0	3	PEC
19CHL56	Entrepreneurship Development	0	0	2	1	HS
19CHL57	Mechanical Operations Laboratory	0	0	2	1	PCC
19CHL58	Heat Transfer Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	-
19CH68	Mini Project*	0	0	2	No Credit	EEC
19INT51	Internship-I#	0	0	2	1	EEC
19HOC51	Employability and Personality Development Skills-I*	0	0	2	1	EEC
	TOTAL CREDITS				**21**	

Internship - I to be completed during 4th semester vacation

* Mini Project will be evaluated in 6th Semester

Semester VI

Course Code	Course Name	L	T	P	C	CAT
19CH61	Process Dynamics and Control	2	1	0	3	PCC
19CH62	Chemical Process Industries	3	0	0	3	PCC
19CH63	Chemical Process Safety	3	0	0	3	PCC
	Elective - III	3	0	0	3	PEC
	Elective - IV	3	0	0	3	PEC
19CHL66	Chemical Reaction Engineering Laboratory	0	0	2	1	PCC
19CHL67	Mass Transfer Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	-
19CH68	Mini Project	0	0	4	2	EEC
19INT61	Internship-II#	0	0	2	1	EEC
19HOC61	Employability and Personality Development Skills-II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Internship-II to be completed during 5th semester vacation

* Not to be counted for GPA. Pass is required.

Semester VII

Course Code	Course Name	L	T	P	C	CAT
19CH71	Transport Phenomena	2	1	0	3	PCC
19CH72	Process Economics and Technology Management	3	0	0	3	PCC
19CH73	Process Modeling and Simulation	2	1	0	3	PCC
19CH74	Electrochemical Engineering	3	0	0	3	PEC
	Elective - V	3	0	0	3	PEC/OEC
19CHL76	Process Equipment Design and Drawing	0	0	4	2	PCC
19CHL77	Process Control and Simulation Laboratory	0	0	2	1	PCC
19CH78	Project Work Phase - I	0	0	6	3	EEC
	TOTAL CREDITS				**21**	

Semester VIII

Course Code	Course Name	L	T	P	C	CAT
	Elective -VI	3	0	0	3	PEC
	Elective-VII	3	0	0	3	PEC
	Elective-VIII	3	0	0	3	PEC/OEC
19CH84	Project Work Phase - II	0	0	10	5	EEC
	TOTAL CREDITS				**14**	

Category : BS - Basic Science, HS - Humanities and Social Science, ES - Engineering Science, PCC - Professional Core Course, PEC - Professional Elective Course, OEC - Open Elective Course, EEC - Employability Enhancement Courses.

Total Credits

Semester	Credits
I	21
II	21
III	23
IV	22
V	21
VI	22
VII	21
VIII	14
TOTAL	**165**

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

B.TECH. ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Curriculum and Syllabi

(R2021)

Under Choice Based Credit System

(For the students admitted during the academic year 2021 - 2022 and onwards)

SUBJECTS OF STUDY
SEMESTER I

Subject Code	Subject	SCC[#]	Periods			Credits
			L	T	P	
21FYM14	Matrices and Calculus	BS	3	1	0	4
21FYE11	Technical English	HS	2	0	1	2
21FYP13	Engineering Physics	BS	3	0	0	3
21FYC11	Engineering Chemistry	BS	3	0	0	3
21CS11	C Programming	ES	3	0	0	3
21CSL11	C Programming Laboratory	ES	0	0	4	2
21PL11	Physics Laboratory I	BS	0	0	2	0.5
21CL11	Chemistry Laboratory I	BS	0	0	2	0.5
21MEL12	Engineering Practices Laboratory	BS	0	0	2	1
21FYEL11	Employability Skills	EEC	0	0	2	1
Total Credits						**20**

SEMESTER II

Subject Code	Subject	SCC#	Periods			Credits
			L	T	P	
21FYM21	Linear Algebra and Gradient Calculus	BS	3	1	0	4
21AD21	Fundamentals of Industry Revolution 4.0	PC	3	0	0	3
21FYC21	Environmental Science and Engineering	ES	3	0	0	1
21CS21	Digital Design	ES	3	0	0	3
21CSL22	Python Programming	ES	1	0	4	3
21MEL11	Engineering Graphics	ES	1	0	4	3
21PL21	Physics Laboratory II	BS	0	0	2	0.5
21CL21	Chemistry Laboratory II	BS	0	0	2	0.5
21CSL21	Digital Design Laboratory	ES	0	0	2	1
21FYEL21	English for Employability	EEC	0	0	2	1
21CC01	Co-curricular Activities	-	-	-	-	1
	Total Credits					**21**

SEMESTER III

Subject Code	Subject	SCC[#]	Periods			Credits
			L	T	P	
21AD31	Probability and Statistics	BS	3	1	0	4
21AD32	Data Structures and Algorithms	PC	3	1	0	4
21AD33	Principles of Artificial Intelligence	PC	3	0	0	3
21AD34	Software Engineering Principles and Practices	PC	3	0	0	3
21AD35	Web Development Technologies	PC	3	0	0	3
21AD36	Science of Creativity and Professional Ethics	HS	1	1	0	1
21ADL37	Data Structures and Algorithms Laboratory	PC	0	0	3	1.5
21ADL38	Web Development Laboratory	PC	0	0	3	1.5
21ADOC01	One Credit Course – Elective I	OCC	-	-	-	1
21HOC01	Communication Skills for Engineers – I	EEC	0	0	2	1
Total Credits						**23**

SEMESTER IV

Subject Code	Subject	SCC#	Periods			Credits
			L	T	P	
21AD41	Discrete Mathematics and Automata Theory	BS	3	1	0	4
21AD42	Machine learning techniques	PC	3	0	0	3
21AD43	Database Management Systems	PC	3	0	0	3
21AD44	Principles of Computer Systems	PC	3	0	0	3
21AD45	Data communication and Networking	PC	3	0	0	3
21AD46	Foundation in Data Science	PC	3	0	0	3
21ADL47	Machine Learning Laboratory	PC	0	0	3	1.5
21ADL48	Database Management Systems Laboratory	PC	0	0	3	1.5
21ADOC02	One Credit Course-Elective II	OCC	-	-	-	1
21HOC02	Communication Skills for Engineers – II	EEC	0	0	2	1
Total Credits						**24**

SEMESTER V

Subject Code	Subject	SCC#	Periods			Credits
			L	T	P	
21AD51	Cloud Architecture	PC	3	0	0	3
21AD52	Mobile Application Development	PC	3	0	0	3
21AD53	Data Mining and Analysis	PC	3	0	0	3
21AD54	Big Data Architecture: Tools and Techniques	PC	3	0	0	3
	Professional Elective I	PE	3	0	0	3
	Open Elective I	OE	3	0	0	3
21ADL55	Mobile Application Development Laboratory	PC	0	0	2	1
21ADL56	Data Mining and Analysis Laboratory	PC	0	0	2	1
21ADOC03	Comprehensive Exam Training (One Credit Course)	EEC	-	-	-	1
21AD66	Mini Project *(** Evaluated at Sem VI)*	EEC	0	0	6	-
21ADI57	Internship I * *(To be completed during third/fourth semester vacation)*	EEC	0	0	0	1
	Total Credits					**22**

SEMESTER VI

Subject Code	Subject	SCC#	Periods			Credits
			L	T	P	
21AD61	Deep Learning Techniques	PC	3	0	0	3
21AD62	Computer Vision and Pattern Recognition	PC	3	0	0	3
21AD63	Data Visualization	PC	3	0	0	3
	Professional Elective II	PE	3	0	0	3
	Open Elective II	OE	3	0	0	3
21ADL64	Deep Learning Laboratory	PC	0	0	4	2
21ADL65	Data Visualization Laboratory	PC	0	0	2	1
21AD66	Mini Project	EEC	0	0	6	3
21ADI67	Internship II* *(To be completed during fourth/fifth semester vacation)*	EEC	0	0	0	1
Total Credits						**22**

SEMESTER VII

Subject Code	Subject	SCC[#]	Periods			Credits
			L	T	P	
21AD71	Data Security	PC	3	0	0	3
21AD72	IoT and its Applications	PC	3	0	0	3
21AD73	Applied Natural Language Processing	PC	3	0	0	3
	Professional Elective III	PE	3	0	0	3
	Professional Elective IV	PE	3	0	0	3
21ADL74	Applied Natural Language Processing Laboratory	PC	0	0	2	1
21ADL75	Internet of Things Laboratory	PC	0	0	2	1
21AD76	Project Phase-I	EEC	0	0	6	3
	Total Credits					**20**

SEMESTER VIII

Subject Code	Subject	SCC#	Periods			Credits
			L	T	P	
	Professional Elective – V	PE	3	0	0	3
	Professional Elective – VI	PE	3	0	0	3
21AD81	Project Phase-II	EEC	0	0	10	5
	Total Credits					**11**

Note:

- **Open Electives can be opted from other departments too**
- **NPTEL 12-week courses, CISCO certifications, AWS certifications, PM certifications can be opted instead of electives with approval of department**

TOTAL CREDITS:

Semester I and Semester II : 41

Semester III to Semester VIII : 122

Total : 163

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF CIVIL ENGINEERING

COURSES OF STUDY

For the students admitted during 2019 - 2020 and onwards

Under Choice Based Credit System

Name of the degree : M.E. (Full-Time)

Specialization : M.E. Structural Engineering

Semester I

Course Code	Course Name	L	T	P	C	CY
19MCE11	Applied Mathematics	4	0	0	4	FC
19MCE12	Applied Elasticity and Plasticity	3	0	0	3	PC
19MCE13	Matrix Methods of Structural Analysis	3	0	0	3	PC
19MCE14	Advanced Reinforced Concrete Structures	3	0	0	3	PC
19MCE15	Advanced Steel Structures	3	0	0	3	PC
	Program Elective - I	3	0	0	3	PE
19MCE16	Computer Applications Laboratory	0	0	4	2	PC
	TOTAL CREDITS				**21**	

Semester II

Course Code	Course Name	L	T	P	C	CY
19MCE21	Structural Dynamics	3	0	0	3	PC
19MCE22	Finite Element Method	3	0	0	3	PC
19MCE23	Design of Foundation Structures	3	0	0	3	PC
	Program Elective - II	3	0	0	3	PE
	Program Elective - III	3	0	0	3	PE
	Program Elective - IV	3	0	0	3	PE
19MCE24	Advanced Structural Engineering Laboratory	0	0	4	2	PC
	TOTAL CREDITS				**20**	

Semester III

Course Code	Course Name	L	T	P	C	CY
	Program Elective - V	3	0	0	3	PE
	Program Elective - VI	3	0	0	3	PE
	Open Elective / Professional Elective - VII	3	0	0	3	OE
	One Credit Course	1	0	0	1	EEC
19MCE31	Practical Training	0	0	0	2	EEC
	TOTAL CREDITS				**12**	

Semester IV

Course Code	Course Name	L	T	P	C	CY
19MCE41	Project Work and Viva Voce	0	0	36	18	EEC
	TOTAL CREDITS				**18**	

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

M.E. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

(Curriculum from the Academic Year 2019-2020 onwards)

SUBJECTS OF STUDY

Semester I

Course Code	Course Name	Category	L	T	P	C
19MEN11	Applied Statistics and Probability	FC	3	0	0	3
19MEN12	Environmental Chemistry	PC	3	0	0	3
19MEN13	Environmental Microbiology	PC	3	0	0	3
19MEN14	Separation Process In Environmental Engineering	PC	3	0	0	3
19MEN15	Industrial Wastewater Treatment and Management	PC	3	0	0	3
	Program Elective - I	PE	3	0	0	3
19MEN16	Process Engineering Laboratory - I	PC	0	0	4	2
	TOTAL		**18**	**0**	**4**	**20**

Semester II

Course Code	Course Name	Category	L	T	P	C
19MEN21	Design of Water and wastewater treatment Plant	PC	3	0	0	3
19MEN22	Air Pollution and Control	PC	3	0	0	3
19MEN23	Solid and Hazardous Waste Management	PC	3	0	0	3
	Program Elective - 2	PE	3	0	0	3
	Program Elective - 3	PE	3	0	0	3
	Program Elective - 4	PE	3	0	0	3
19MEN24	Process Engineering Laboratory - II	PC	0	0	4	2
	TOTAL		**18**	**0**	**4**	**20**

Semester III

Course Code	Course Name	Category	L	T	P	C
	Program Elective - 5	PE	3	0	0	3
	Program Elective - 6	PE	3	0	0	3
	Open Elective / Professional Elective - VII	OE	3	0	0	3
19MEN31	Practical Training	EEC	-	-	-	2
	One credit course	EEC	0	-	2	1
	TOTAL		**10**	**0**	**2**	**12**

Semester IV

Course Code	Course Name	Category	L	T	P	C
19MEN41	Project	EEC	0	0	36	18
	TOTAL		**0**	**0**	**36**	**18**

Total Credits : 70

L - Lecture, T - Tutorial, P - Practical, C - Credit, FC - Foundation Course, PC - Professional Core, PE - Professional Elective, EEC - Employment Enhancement Course

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

M.E. CONSTRUCTION MANAGEMENT

(Curriculum from the Academic Year 2019 - 2020 onwards)

Semester I

Course Code	Course Name	Category	L	T	P	C
19MCM11	Statistical Methods and Research Methodology for Construction Management	FC	3	-	-	3
19MCM12	Construction Project Management	PC	3	-	-	3
19MCM13	Construction Project Formulation and Appraisal	PC	3	-	-	3
19MCM14	Construction Resource Planning and Management	PC	3	-	-	3
19MCM15	Construction Economics and Financial Management	PC	3	-	-	3
	Program Elective - 1	PE	3	-	-	3
19MCM16	Data Analysis Laboratory for Construction Management	PC	-	-	4	2
	Total		**18**	**0**	**2**	**20**

Semester II

Course Code	Course Name	Category	L	T	P	C
19MCM21	Construction Planning, Scheduling and Control	PC	3	-	-	3
19MCM22	Contract Management and Dispute Resolution	PC	3	-	-	3
19MCM23	Quantitative Techniques in Construction Management	PC	3	-	-	3
	Program Elective - 2	PE	3	-	-	3
	Program Elective - 3	PE	3	-	-	3
	Program Elective - 4	PE	3	-	-	3
19MCM24	Project Planning Laboratory for Construction Management	PC	-	-	4	2
	Total		**18**	**0**	**2**	**20**

Semester III

Course Code	Course Name	Category	L	T	P	C
	Program Elective - 5	PE	3	-	-	3
	Program Elective - 6	PE	3	-	-	3
	Open Elective / Program Elective - 7	PE	3	-	-	3
19MCM31	Practical Training	EEC	-	-	-	2
	One Credit course	EEC			-	1
	Total		**9**	**-**	**-**	**12**

Semester IV

Course Code	Course Name	Category	L	T	P	C
19MCM41	Project Work	EEC	-	-	-	18
	Total		**-**	**-**	**-**	**18**

Total Credits to be Earned for the Award of the Degree = 70

FC - Foundation Courses
PC - Professional Core
PE - Professional Electives
EEC - Employment Enhancement Courses

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Curriculum from the Academic Year 2019 - 2020 onwards

Under Choice Based Credit System

Specialization : Embedded And Real Time Systems

Semester I

Course Code	Course Name	L	T	P	C	Category
19MA11	Linear Algebra and Stochastic Processes	4	0	0	4	FC
19MER11	Real Time Operating Systems	3	1	0	4	PC
19MER12	Embedded Processors	3	0	0	3	PC
19MER13	Wireless Communication Sensors	3	0	0	3	PC
19MA14	Electromagnetic Interference and Compatibility	3	0	0	3	PC
	ELECTIVE I	3	0	0	3	PE
19MER14	Embedded Processors Laboratory	0	0	4	2	PC
	Total				**22**	

Semester II

Course Code	Course Name	L	T	P	C	Category
19MA21	Automation and Industrial Internet of Things	3	0	0	3	PC
19MA22	Robotics Technology and Intelligence	3	0	0	3	PC
19MER21	Embedded System Design using FPGA	3	0	0	3	PC
	ELECTIVE II	3	0	0	3	PE
	ELECTIVE III	3	0	0	3	PE
	ELECTIVE IV	3	0	0	3	PE
19MER22	FPGA based Embedded System Design Laboratory	0	0	4	2	PC
19MAEE01	Feasibility Report Preparation	0	0	4	2	EEC 1
	One Credit Course				1	OCC1
	TOTAL				**23**	

Semester III

Course Code	Course Name	L	T	P	C	Category
	ELECTIVE V	3	0	0	3	PE
	ELECTIVE VI	3	0	0	3	PE
	OPEN ELECTIVE I	3	0	0	3	OE
	One Credit Course				1	OCC 2
	TOTAL				**10**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19MER41	PROJECT - DISSERTATION	0	0	36	18	EEC2
	TOTAL				**18**	

TOTAL CREDITS: 73

(**Note :** FC - Foundation Course; PC - Professional Core; PE - Professional Elective; OC - Open Elective; EEC - Employability Enhancement Course; OCC - One Credit Course)

CURRICULUM

M.E- ADVANCED MANUFACTURING TECHNOLOGY

SEMESTER – I						
S.No	**COURSE CODE**	**COURSE NAME**	**TEACHING SCHEME**			**CREDITS**
			L	**T**	**P**	
1.	19MMA11	Applied Numerical Analysis	3	0	0	3
2.	19MMA12	Mechatronics in Manufacturing Systems	3	0	0	3
3.	19MMA13	Computer Integrated Manufacturing	3	0	0	3
4.	19MMA14	Optimization for Engineering Applications	3	0	0	3
5.	19MMA15	Advanced Material Engineering	3	0	0	3
6.		Professional Elective – I	3	0	0	3
7.	19MMA17	CIM Laboratory & Mechatronics Laboratory	0	0	4	2
		Total Credits:	**18**		**4**	**20**

SEMESTER – II						
S.No	**COURSE CODE**	**COURSE NAME**	**TEACHING SCHEME**			**CREDITS**
			L	**T**	**P**	
1	19MMA21	Design for Manufacture and Assembly	3	0	0	3
2	19MMA22	Advanced Metal Joining Technology	3	0	0	3
	19MMA23	Finite Element Analysis in Manufacturing Engineering	3	0	0	3
3		Professional Elective – II	3	0	0	3
4		Professional Elective – III	3	0	0	3
		Professional Elective – IV	3	0	0	3
5	19MMA27	Simulation Laboratory & Welding Laboratory	0	0	4	2
8		Mini project / Industrial Training / Employability Enhancement Courses	0	0	4	2
		Total Credits:	**18**		**8**	**22**

M.E- ADVANCED MANUFACTURING TECHNOLOGY

SEMESTER – III						
S.No	COURSE CODE	COURSE NAME	TEACHING SCHEME			CREDITS
			L	T	P	
1		Professional Elective - IV	3	0	0	3
2		Professional Elective -V	3	0	0	3
		Open Elective / Professional Elective	3	0	0	3
3	19MMA41	Project Work and Viva Voce	0	0	0	0
		Total Credits:	**9**			**9**

SEMESTER – IV						
S.No	COURSE CODE	COURSE NAME	TEACHING SCHEME			CREDITS
			L	T	P	
1	19MMA41	Project Work and Viva Voce	0	0	0	18
		Total Credits:				**18**

TOTAL CREDITS FOR THE PROGRAMME = 20 + 22 + 9 + 18 = 69

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

MASTER OF COMPUTER APPLICATIONS

UNDER CHOICE BASED CREDIT SYSTEM

Curriculum from the Academic Year 2018 - 2019 onwards

Semester I

Course Code	Course Name	L	T	P	C	Category
	THEORY					
18MCA11	Theory of Computing	3	0	0	3	FC
18MCA12	Data Structures	3	0	0	3	FC
18MCA13	Programming in C	3	0	0	3	PC
18MCA14	Computer Organization	3	0	0	3	FC
18MCA15	Probability and Statistics	3	0	0	3	PC
	PRACTICALS					
18MCA16	C Programming Laboratory	0	0	4	2	PC
18MCA17	User Experience Laboratory	0	0	4	2	FC
18MCA18	Statistics Laboratory	0	0	4	2	FC
18MCA19	Communication Skills	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Semester II

Course Code	Course Name	L	T	P	C	Category
	THEORY					
18MCA21	Design and Analysis of Algorithms	3	0	0	3	FC
18MCA22	Object Oriented Principles and Programming in JAVA	3	0	0	3	PC
18MCA23	Principles of Operating System	3	0	0	3	PC
18MCA24	Database Management Systems	3	0	0	3	PC
18MCA25	Software Engineering	3	0	0	3	PC
	PRACTICAL					
18MCA26	Algorithms and Operating Systems Laboratory	0	0	4	2	PC
18MCA27	Object Oriented Programming Laboratory	0	0	4	2	PC
18MCA28	RDBMS Laboratory	0	0	4	2	PC
18MCA29	Professional English	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Semester III

Course Code	Course Name	L	T	P	C	Category
	THEORY					
18MCA31	Numerical Methods and Applied Statistics	4	0	0	4	FC
18MCA32	Computer Networks	3	0	0	3	PC
18MCA33	Artificial Intelligence	3	0	0	3	PC
18MCA34	SOA and Web Services	3	0	0	3	PC
	Elective I	3	0	0	3	PE
	PRACTICAL					
18MCA35	Advanced Programming Laboratory	0	0	4	2	PC
18MCA36	Artificial Intelligence Laboratory	0	0	4	2	PC
18MCA37	Network Programming Laboratory	0	0	4	2	PC
18MCA38*	Personality Development					EEC
	TOTAL CREDITS				**22**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
	THEORY					
18MCA41	Operations Research	4	0	0	4	FC
18MCA42	Data Mining and Warehousing	3	0	0	3	PC
18MCA43	Accounting and Financial Management	4	0	0	4	PC
	Elective II	3	0	0	3	PE
	Elective III	3	0	0	3	PE
	PRACTICAL					
18MCA44	Data Mining Laboratory	0	0	4	2	PC
	Elective Laboratory	0	0	4	2	PE
18MCA45	Mini Project	0	0	4	2	EEC
	TOTAL CREDITS				**23**	

Semester V

Course Code	Course Name	L	T	P	C	Category
	THEORY					
18MCA51	Software Testing and Quality Assurance	3	0	0	3	PC
18MCA52	Cryptography and Network Security	3	0	0	3	PC
	Elective IV	3	0	0	3	PE
	Elective V	3	0	0	3	PE
	Elective VI	3	0	0	3	PE
	PRACTICAL					
18MCA53	Software Testing Laboratory	0	0	4	2	PC
18MCA54	Information Security Laboratory	0	0	4	2	PC
18MCA55*	Professional Ethics					EEC
	TOTAL CREDITS				**19**	

Semester VI

Course Code	Course Name	L	T	P	C	Category
18MCA61	Project work and Viva voce				18	EEC
	TOTAL CREDITS				**18**	

TOTAL = 126

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF MANAGEMENT STUDIES (MBA)

MASTER OF BUSINESS ADMINISTRATION REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

MBA programme curriculum is designed to prepare the post graduate students

I. To have a thorough understanding of the core aspects of the business.

II. To provide the learners with the management tools to identify, analyze and create business opportunities as well as solve business problems.

III. To prepare them to have a holistic approach towards management functions.

IV. To motivate them for continuous learning.

V. To inspire and make them practice ethical standards in business.

PROGRAMME OUTCOMES (POs) :

On successful completion of the programme,

1. Ability to apply the business acumen gained in practice.
2. Ability to understand and solve managerial issues.
3. Ability to communicate and negotiate effectively, to achieve organizational and individual goals.
4. Ability to upgrade their professional and managerial skills in their workplace.
5. Ability to explore and reflect about managerial challenges, develop informed managerial decisions in a dynamically unstable environment.
6. Ability to take up challenging assignments.
7. Ability to understand one's own ability to set achievable targets and complete them.
8. Ability to pursue life long learning.
9. To have a fulfilling business career.
10. Ability to have financial literacy.
11. Ability to fulfill social out reach
12. Ability to understand business analytics

MAPPING OF PEOS WITH POS :

Programme Educational Objectives	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	3	3	2	1	3	3	1	2	1	1	1	3
II	1	3	1	2	3	1	3	2	1	3	1	3
III	3	3	2	3	3	2	3	3	3	1	2	3
IV	2	1	2	3	3	1	3	3	3	1	2	1
V	1	3	3	2	2	3	1	2	3	1	3	1

Year	Sem.	COURSE TITLE	Programme Outcomes								
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	SEM 1	Statistics for Management		-							
		Management Concepts and Organizational Behavior	-		-	-					
		Managerial Economics	-				-	-			
		Accounting for Decision Making		-							
		Legal Aspects of Business	-	-	-						
		Information Management	-		-	-				-	-
		Marketing Management	-			-					-
		Indian Ethos and Business Ethics Seminar				-	-				-
		Business Communication (Laboratory)			-	-				-	-
	SEM 2	Quantitative Techniques for Decision Making		-		-					
		Financial Management		-		-		-			-
		Human Resource Management	-		-	-		-		-	-
		Operations Management	-	-		-			-		
		Business Research Methods		-		-			-		
		Business Analytics		-		-					-
		Non-Functional Elective									
		Data Analysis and Business Modelling (Laboratory)		-				-	-		-
		Rural Community Engagement	-		-		-			-	-
YEAR 2	SEM 3	Strategic Management	-		-	-		-		-	-
		International Business	-		-		-				-
		Creativity and Innovation Laboratory	-	-		-		-			-
		Elective I									
		Elective II									
		Elective III									
		Elective IV									
		Elective V									
		Elective VI									
		Summer Internship	-	-	-	-	-	-	-	-	-
	SEM 4	Project work - 16 weeks Project Work + Maximum 4 weeks for report writing	-	-	-	-	-	-	-	-	-

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF COMPUTING

M.SC. (SOFTWARE SYSTEMS)

Curriculum - For the Students admitted during 2020 - 2021 and onwards

Semester I

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS11	Technical English	2	0	0	2	HS
20MSS12	Applied Algebra and Calculus	3	1	0	4	BS
20MSS13	Structured Systems Analysis and Design	3	0	0	3	PC
20MSS14	Digital Electronics	3	0	0	3	PC
20MSS15	Problem Solving using C Programming	3	1	0	4	PC
	PRACTICALS					
20MSS16	Computing Laboratory	0	0	4	2	PC
20MSS17	Programming Laboratory in C	0	0	4	2	PC
20MSS18	Digital Electronics Laboratory	0	0	2	1	PC
20MSS19	Employability Skills	0	0	2	1	EEC
	TOTAL CREDITS				22	

Semester II

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
	Language Elective	2	0	0	2	HS
20MSS21	Probability and Statistics - I	3	1	0	4	BS
20MSS22	Data Structures and Algorithms	3	1	0	4	PC
20MSS23	Fundamentals of Web Technology	3	0	0	3	PC
20MSS24	Object Oriented Programming	3	0	0	3	PC
	PRACTICALS					
20MSS25	Web Application Development Laboratory	0	0	4	2	PC
20MSS26	Data Structures and Algorithms Laboratory	0	0	4	2	PC
20MSS27	Object Oriented Programming Laboratory	0	0	4	2	PC
20MSS28	English for Employability	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

Semester III

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS31	Theoretical Computer Science	3	0	0	3	BS
20MSS32	Probability and Statistics - II	3	1	0	4	BS
20MSS33	Advanced Data Structures	3	0	0	3	PC
20MSS34	Computer Architecture	3	0	0	3	PC
20MSS35	Operating Systems	3	0	0	3	PC
	PRACTICALS					
20MSS36	Python Programming Laboratory	0	0	4	2	PC
20MSS37	Advanced Data Structures Laboratory	0	0	4	2	PC
20MSS38	Operating Systems Laboratory	0	0	4	2	PC
	TOTAL CREDITS				**22**	

Semester IV

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS41	Resource Management Techniques	3	0	0	3	BS
20MSS42	Microprocessors and Microcontrollers	3	0	0	3	PC
20MSS43	Software Engineering	3	0	0	3	PC
20MSS44	Database Management Systems	3	0	0	3	PC
20MSS45	Java Programming	3	0	0	3	PC
	PRACTICALS					
20MSS46	Microprocessors and Microcontrollers Laboratory	0	0	4	2	PC
20MSS47	Database Management Systems Laboratory	0	0	4	2	PC
20MSS48	Java Programming Laboratory	0	0	4	2	PC
20MSS49	Personality Development	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Semester V

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS51	Full Stack Application Development	3	0	0	3	PC
20MSS52	Computer Networks	3	0	0	3	PC
20MSS53	Design and Analysis of Algorithms	3	1	0	4	PC
20MSS54	Machine Learning	3	0	0	3	PC
	Elective I	3	0	0	3	PC
	PRACTICALS					
20MSS55	Full Stack Application Development Laboratory	0	0	4	2	PC
20MSS56	Network Programming Laboratory	0	0	4	2	PC
	Elective Laboratory I	0	0	4	2	PC
20MSS57	Communications Skills	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

Semester VI

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS61	Software Testing and Quality Assurance	3	0	0	3	PC
20MSS62	Mobile Computing	3	0	0	3	PC
20MSS63	Cloud Computing	3	0	0	3	PC
20MSS64	Software Architecture	3	0	0	3	PC
	Elective II	3	0	0	3	PC
	PRACTICALS					
20MSS65	Software Engineering Laboratory	0	0	4	2	PC
20MSS66	Cloud and Mobile Application Development Lab	0	0	4	2	PC
	Elective Laboratory II	0	0	4	2	PC
20MSS67	Hackathon	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Semester VII

Course Code	Course Name	L	T	P	C	CAT
20MSS71	Project Work and Viva Voce-I	0	0	0	18	EEC

Semester VIII

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS81	Software Project Management	3	0	0	3	PC
20MSS82	Smart Sensors and Internet of Things	3	0	0	3	PC
20MSS83	Artificial Intelligence	3	0	0	3	PC
	Elective III	3	0	0	3	PC
	Elective IV	3	0	0	3	PC
	PRACTICALS					
20MSS84	Internet of Things Laboratory	0	0	4	2	PC
20MSS85	Artificial Intelligence Laboratory	0	0	4	2	PC
	Elective Laboratory III	0	0	4	2	PC
	TOTAL CREDITS				**21**	

Semester IX

Course Code	Course Name	L	T	P	C	CAT
	THEORY					
20MSS91	Agile Methods for Software Development	3	0	0	3	PC
20MSS92	Information Security	3	0	0	3	PC
20MSS93	Professional Ethics	3	0	0	3	EEC
	Elective V	3	0	0	3	PC
	Elective VI	3	0	0	3	PC
	PRACTICALS					
20MSS94	Information Security Laboratory	0	0	4	2	PC
	Elective Laboratory IV	0	0	4	2	PC
	Elective Laboratory V	0	0	4	2	PC
	TOTAL CREDITS				**21**	

Semester X

Course Code	Course Name	L	T	P	C	CAT
20MSS10	Project Work and Viva Voce-II	0	0	0	18	EEC
	TOTAL CREDITS				**18**	
	GRAND TOTAL OF CREDITS				**212**	

Coimbatore Institute of Technology, Coimbatore - 14

Department of Computing

M. Sc. DECISION AND COMPUTING SCIENCES

(Five year Integrated Programme)

Curriculum from the Academic Year 2022 – 2023 onwards

Semester I

Course Code	Course Name	L	T	P	C	CAT
Theory						
22MDC11	Technical English	2	0	1	2	HS
22MDC12	Applied Algebra and Calculus	3	1	0	4	BS
22MDC13	Statistical Methods	3	0	0	3	BS
22MDC14	Principles of Management	3	0	0	3	PC
22MDC15	Problem Solving and Programming in C	3	0	0	3	PC
Practicals						
22MDC16	Mathematical and Statistical Computing Laboratory	0	0	4	2	PC
22MDC17	C Programming Laboratory	0	0	4	2	PC
22MDC18	Foundations of Computer Science Laboratory	0	0	4	2	PC
22MDC19	Employability Skills	0	0	2	1	EEC
	Total Credits				**22**	

Semester II

Course Code	Course Name	L	T	P	C	CAT
Theory						
	Language Elective	2	0	1	2	HS
22MDC21	Probability Distributions and Applications	3	0	0	3	BS
22MDC22	Organisational Behavior	4	0	0	4	PC
22MDC23	Data Structures and Algorithms	3	0	0	3	PC
22MDC24	Computer Organization and Operating Systems	3	0	0	3	PC
Practicals						
22MDC25	Applied Probability Laboratory	0	0	4	2	PC
22MDC26	Data Structures and Algorithms Laboratory	0	0	4	2	PC
22MDC27	Python Programming Laboratory	0	0	4	2	PC
22MDC28	English for Employability	0	0	2	1	EEC
	Total Credits				**22**	

Curriculum and Syllabi
Semesters III - X and Electives

Semester III

Course Code	Course Name	L	T	P	C	Category
	THEORY					
22MDC31	Applied Statistics for Business Decisions	3	1	0	4	BS
22MDC32	Financial Analysis and Reporting	3	1	0	4	PC
22MDC33	Digital Marketing	3	0	0	3	PC
22MDC34	Database Management Systems	3	0	0	3	PC
22MDC35	Object Oriented Programming	3	0	0	3	PC
	PRACTICALS					
22MDC36	Digital Marketing Laboratory	0	0	4	2	PC
22MDC37	Database Management Systems Laboratory	0	0	4	2	PC
22MDC38	Object Oriented Programming Laboratory	0	0	4	2	PC
	Total Credits				**23**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
	THEORY					
22MDC41	Predictive Analytics	3	0	0	3	BS
22MDC42	Operations Research for Business	3	1	0	4	PC
22MDC43	Financial Engineering	3	0	0	3	PC
22MDC44	Advanced Data Structures and Algorithms	3	0	0	3	PC

22MDC45	Artificial Intelligence	3	0	0	3	PC
	PRACTICALS					
22MDC46	Predictive Analytics Laboratory	0	0	4	2	PC
22MDC47	Financial Engineering Laboratory	0	0	4	2	PC
22MDC48	Advanced Data Structures and Algorithms Laboratory	0	0	4	2	PC
22MDC49	Personality Development	0	0	2	1	EEC
	Total Credits				**23**	

Semester V

Course Code	Course Name	L	T	P	C	Category
	THEORY					
22MDC51	Human Resource Management and Analytics	3	1	0	4	PC
22MDC52	Software Engineering	3	0	0	3	PC
22MDC53	Computer Networks	3	0	0	3	PC
22MDC54	Machine Learning	3	0	0	3	PC
	Elective - I	3	0	0	3	PE
	PRACTICALS					
22MDC55	Full Stack Application Development lab	0	0	4	2	PC
22MDC56	Machine Learning Laboratory	0	0	4	2	PC
	Elective Laboratory - I	0	0	4	2	PE
22MDC57	Managerial Communication Skills	0	0	2	1	EEC
	Total Credits				**23**	

Semester VI

Course Code	Course Name	L	T	P	C	Category
	THEORY					
22MDC61	Economic Foundations of Business	3	0	0	3	PC
22MDC62	Systems for Decision Support	3	0	0	3	PC
22MDC63	Cloud Computing	3	0	0	3	PC
22MDC64	Deep Learning	3	0	0	3	PC

Semester V

	Elective - II	3	0	0	3	PE
	PRACTICALS					
22MDC65	Cloud and Mobile Application Development Laboratory	0	0	4	2	PC
22MDC66	Deep Learning Laboratory	0	0	4	2	PC
	Elective Laboratory - II	0	0	4	2	PE
22MDC67	Hackathon	0	0	2	1	EEC
	Total Credits				**22**	

Semester VII

Course Code	Course Name	L	T	P	C	Category
22MDC71	Project Work and Viva Voce-I	0	0	0	18	EEC
	Total Credits				**18**	

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF COMPUTING - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

M.Sc. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(Five-Year Integrated Programme)

Curriculum from the Academic Year 2019 - 2020 and onwards

Semester VII

Course Code	Course Name	L	T	P	C	CAT
19MAM71	Project Work and Viva Voce - I	0	0	0	18	EEC
	TOTAL CREDITS				**18**	

Semester X

Course Code	Course Name	L	T	P	C	CAT
19MAM101	Project Work and Viva Voce - II	0	0	0	18	EEC
	Total Credits				**18**	
	Grand Total of Credits				**210**	

Coimbatore Institute of Technology, Coimbatore - 14.

(Government Aided Autonomous Institution Affiliated to Anna University)

Department of Computing

M. Sc. DATA SCIENCE

CHOICE BASED CREDIT SYSTEM

Five year Integrated Programme

Curriculum for the Academic Year 2021 – 2026

Semester 1

Subject code	Name of the Subject	L	T	P	C	CAT
	THEORY					
21MDS11	Technical English	2	0	0	2	HS
21MDS12	Algebra and Applications	3	1	0	4	BS
21MDS13	Statistical Methods	3	0	0	3	PC
21MDS14	Problem Solving and Programming in Python	3	0	0	3	PC
21MDS15	Principles of Digital Electronics	3	0	0	3	PC
	PRACTICALS					
21MDS16	Computing Laboratory I	0	0	4	2	PC
21MDS17	Programming Laboratory in Python	0	0	4	2	PC
21MDS18	Digital Electronics Laboratory	0	0	4	2	PC
21MDS19	English for Employability	0	0	2	1	EEC
	Total Credits				**22**	

Semester 2

Subject code	Name of the Subject	L	T	P	C	CAT
	THEORY					
	Language Elective	2	0	0	2	HS

21MDS21	Calculus and Applications	3	1	0	4	BS
21MDS22	Probability Distributions and Applications	3	0	0	3	PC
21MDS23	Data Structures and Algorithms I	3	0	0	3	PC
21MDS24	Object Oriented Programming	3	0	0	3	PC
	PRACTICALS					
21MDS25	Computing Laboratory II	0	0	4	2	PC
21MDS26	Data Structures and Algorithms Laboratory I	0	0	4	2	PC
21MDS27	Object Oriented Programming Laboratory	0	0	4	2	PC
21MDS28	Employability Skills	0	0	2	1	EEC
	Total Credits				**22**	

Semester 3

Subject code	**Subject Name**	**L**	**T**	**P**	**C**	**CAT**
	THEORY					
21MDS31	Business Statistics	3	0	0	3	PC
21MDS32	Discrete Structures and Automata Theory	3	0	0	3	PC
21MDS33	Operating Systems	3	0	0	3	PC
21MDS34	Database Systems	3	0	0	3	PC
21MDS35	Data Structures and Algorithms II	3	0	0	3	PC
	PRACTICALS					
21MDS36	Database Systems Laboratory	0	0	4	2	PC
21MDS37	Data Structures and Algorithms Laboratory II	0	0	4	2	PC
21MDS38	Web Technology Framework Laboratory	0	0	4	2	PC
	Total Credits				**21**	

Semester 4

Subject code	**Subject Name**	**L**	**T**	**P**	**C**	**CAT**
	THEORY					

21MDS41	Multivariate Data Analysis	3	0	0	3	PC
21MDS42	Graph Theory	3	0	0	3	PC
21MDS43	Design and Analysis of Algorithms	3	0	0	3	PC
21MDS44	Computer Networks	3	0	0	3	PC
21MDS45	Machine Learning	3	0	0	3	PC
	PRACTICALS					
21MDS46	Predictive Analytics Laboratory	0	0	4	2	PC
21MDS47	Design and Analysis of Algorithms Laboratory	0	0	4	2	PC
21MDS48	Machine Learning Laboratory	0	0	4	2	PC
21MDS49	Personality Development	0	0	2	1	EEC
	Total Credits				**22**	

Semester 5

Subject code	**Subject Name**	**L**	**T**	**P**	**C**	**CAT**
	THEORY					
21MDS51	Operations Research	3	0	0	3	PC
21MDS52	Deep Learning	3	0	0	3	PC
21MDS53	Big Data Computing	3	0	0	3	PC
21MDS54	Artificial Intelligence	3	0	0	3	PC
	Elective - I	3	0	0	3	PE
	PRACTICALS					
21MDS55	Deep Learning Laboratory	0	0	4	2	PC
21MDS56	Big Data Computing Laboratory	0	0	4	2	PC
	Elective Lab - I	0	0	4	2	PE
21MDS57	Communication Skills	0	0	2	1	EEC
	Total Credits				**22**	

Semester 6

Subject code	Subject Name	L	T	P	C	CAT
	THEORY					
21MDS61	Stochastic Models	3	0	0	3	PC
21MDS62	Cloud Computing	3	0	0	3	PC
21MDS63	Data Mining	3	0	0	3	PC
21MDS64	Software Engineering	3	0	0	3	PC
	Elective- II	3	0	0	3	PE
	PRACTICALS					
21MDS65	Cloud Computing Laboratory	0	0	4	2	PC
21MDS66	Data Mining and Visualization Laboratory	0	0	4	2	PC
	Elective Lab - II	0	0	4	2	PE
21MDS67	Hackathon	0	0	2	1	EEC
	Total Credits				**22**	

Semester 7

Subject code	Subject Name	L	T	P	C	CAT
21MDS71	Project Work and Viva Voce-I	0	0	0	18	EEC
	Total Credits				**18**	

Semester 8

Subject code	Subject Name	L	T	P	C	CAT
	THEORY					
21MDS81	Data Privacy and Security Analytics	3	0	0	3	PC
21MDS82	Quantum Machine Learning	3	0	0	3	PC
21MDS83	Ethics in Data Science	3	0	0	3	PC

	Elective - III	3	0	0	3	PE
	Elective - IV	3	0	0	3	PE
	PRACTICALS					
21MDS84	Data Privacy and Security Analytics Laboratory	0	0	4	2	PC
21MDS85	Quantum Machine Learning Laboratory	0	0	4	2	PC
	Elective Lab - III	0	0	4	2	PE
	Total Credits				**21**	

Semester 9

Subject code	Subject Name	L	T	P	C	CAT
	THEORY					
21MDS91	Econometric Analysis	3	1	0	4	PC
21MDS92	Web Analytics	3	0	0	3	PC
21MDS93	Healthcare Analytics	3	1	0	4	PC
	Elective - V	3	0	0	3	PE
	Elective - VI	3	0	0	3	PE
	PRACTICALS					
21MDS94	Econometric Analysis Laboratory	0	0	4	2	PE
21MDS95	Web Analytics Laboratory	0	0	4	2	PE
	Elective Lab - IV	0	0	4	2	PE
	Total Credits				**23**	

Semester 10

Subject code	Subject Name	L	T	P	C	CAT
21MDS101	Project Work and Viva Voce- II	0	0	0	18	EEC
	Total Credits				**18**	
Grand Total of Credits					**211**	

	1.3.3 No. of Programs that have components of field projects / research projects / internships during the last five years					
	Name of the Programmes offered by the HEI	**Programme Code**	**Whether the program has components of Field project / research project/ internship (Yes/ No)**	**If yes, name of the component (Field project / research project/ internship)**	**Course code of the component**	**Number of students undertaking the field projects / research projects/ internships**
1	B.E. Civil Engineering	1-1341759247	Yes	Internship / Mini Project	19INT51 / 19INT61 / 19CEL66 / 15CE66 /	1302
2	B.E. Mechanical Engineering	1-1341759425	Yes	Inplant Training / Field Project / Internship	15ME68 / 15ME81 / 19INT51 / 19INT61 / 19ME73 / 19ME81	705
3	B.E. Electrical and Electronics Engineering	1-1341759422	Yes	Inplant Training / Internship I / Internship II	19INT51 / 19INT61	1126
4	B.E. Electronics and Communication Engineering	1-1341759429/1-1341759431	Yes	Research Project / Internship	19EC76 / 19EC81 / 15EC81 / 19INT51 / 19INT61	1167
5	B.E. Computer Science and Engineering	1-1341759433	Yes	Internship	19INT51 / 19INT61	517
6	B.Tech Information Technology	1-1341759435	Yes	Internship-I / Internship-II / Mini Project / Project-Phase-I / Project-Phase-II	19INT51 / 19INT61 / 19IT65 / 19IT75 / 19IT81	390
7	B.Tech Artificial Intelligence and Data Science	1-9517843882	Yes	Research Project	21AD21 / 21AD66 / 21AD67 / 21ADI57 / 23AD211	299
8	B.Tech.Chemical Engineering	1-1341759437	Yes	Internship I / Internship II / Field Project	19INT51 / 19INT61 / 19CH84	298
9	M.E Structural Engineering	1-1341759439	Yes	Practical Training / Project Work and Viva Voce	15MCE31 / 19MCE31 / 19MCE41 / 23MSE331	61
10	M.E Environmental Engineering and Management	1-1341759451	Yes	Practical Training	15MEN31 / 19MEN31 /23MEN331	45
11	M.E Construction Management	1-1341759465	Yes	Practical Training	15MCM31 / 19MCM31 / 23MCM331	45
12	M.E. Advanced Manufacturing Technology	1-1341759455	Yes	Project Work and Viva Voce	19MMA41	1
13	MCA	1-1341759463	Yes	Mini Project / Project work and viva voce / Inplant Training /	15MCA45 / 15MCA61 / 18MCA45 / 18MCA61 / 20MCA28 / 20MCAIT01 / 20MCA41 / 23MCA241	605
14	M.Sc. Software Systems	31	Yes	Internship	15MSS71 / 15MSS101 / 20MSS71	572
15	M.Sc. Data Science	32	Yes	Internship	16MDS71 / 16MDS101	515
16	M.Sc. Decision and Computing Sciences	33	Yes	Internship	17MDC71 / 17MDC101 / 17MDC95	326
17	M.Sc. Artificial Intelligence and Machine Learning	34	Yes	Internship	19MAM71 / 19MAM101	167
18	MBA	1-9509558851	Yes	Summer Internship / Project Work	21MBAL34 / 21MBA41 / 23MBA222	262