

**EXPERIMENTAL INVESTIGATION OF LIGHT WEIGHT CONCRETE
BY PARTIAL REPLACEMENT OF FINE AGGREGATE FOUNDRY
SAND**

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in
Civil Engineering
By

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Ajay Kumar. s (39200003), Anandha Krishnan. A (39200006) who carried out the project entitled "EXPERIMENTAL INVESTIGATION OF LIGHT WEIGHT CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE BY FOUNDRY SAND" under our supervision from Decemberr 2022 to April 2023.

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ABSTRACT

The objective of this paper is to review recent research on the usage of spent foundry sand in civil engineering practises. Since there are a limited number of non-renewable energy sources, recycling them once they have served their purpose is crucial. Sand may be recycled and utilised numerous times, and metal foundries frequently employ it in the process of casting metal. However, it becomes critical to supply sand in construction projects when sand supplies are depleted. In this study, we investigate the effect examines the compressive strength and split tensile strength of concrete mixes made with M-25 grade at various curing times when fine aggregate is substituted with leftover foundry sand. (7 days, 14 days, and 28 days).leftover foundry sand makes up 15%, 25%, and 35% of the weight of the fine aggregate, respectively. The test findings demonstrate how foundry sand left over may be utilised to make concrete. as a component to increase strength and create excellent results. An environment that is safe, sustainable, and affluent is produced by recycling resources in eco-friendly concrete.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE NO
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	TABLE OF CONTENT	vi
	LIST OF FIGURES	ix
	LIST OF TABLES	x
	LIST OF SYMBOLS & ABBREVIATION	
1	INTRODUCTION	1
	1.1 General	1
	1.2 Concrete	2
	1.3 Use of foundry sand in concrete	3
2	LITERATURE REVIEW	4
3	AIM, SCOPE AND OBJECTIVE	9
	3.1 Aim	9
	3.2 Scope	9
	3.3 Objective	11
4	METHODOLOGY	13
	4.1 General	13
	4.2 Flow diagram for Methodology	14
	4.3 Material properties and Tests	15
	4.3.1 General	15
	4.3.2 Cement	16
	4.3.2.i) Determination of Fineness of Cement	17

4.3.2.ii) Specific Gravity of Cement	18
4.3.2.iii) Initial setting time test	19
4.3.2iv) Final setting time test	20
4.4 Fine aggregate	21
4.4.1 Specific Gravity of Fine aggregate	21
4.4.2 Determination of Water absorption of Fine aggregate	22
4.5 foundry sand	23
4.5.1 Properties of Foundry sand	24
4.5.2 Specific Gravity of Foundry sand	29
4.5.3 Water absorption for Foundry sand	30
4.6 Coarse aggregate	30
4.6.1 Specific Gravity of Coarse aggregate	31
4.6.2 Grading of Coarse aggregate	33
4.6.3 Determination of water absorption for Coarse aggregate	34
4.6.4 Determination of Impact value of Coarse aggregate	34
4.7 Water	35
4.8 Concrete mix design	36
4.8.1 General	36
4.8.2 Objective	37
4.8.3 Mix design	38
4.8.3.(i) Design stipulation	38
4.8.3.(ii) Test data for material	38
4.9 Mix proportion	39

5	RESULT AND DISCUSSION	42
	5.2 Compression test	42
6	CONCLUSION	48
	REFERENCES	49

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
4.1	COLLECTION OF FOUNDRY SAND	24
4.2	MIXING OF CONCRETE	39
4.3	CONCRETE CUBE BLOCKS	40
4.4	REMOVING MOULDS	40
4.5	CURING CONCRETE CUBES	41
4.6	MEASURING FOUNDRY SAND	41
5.1	COMPRESSION TEST FOR CONCRETE CUBE	43
5.2	COMPRESSION TEST FO CONCRETE CUBES	43
5.3	COMPARISON OF COMPRESSIVE STRENGTH OF 7 TH DAY	44
5.4	COMPRESSIVE STRENGTH FOR 7 TH DAY	44
5.5	COMPARISON OF COMPRESSIVE STRENGTH FOR 14 TH DAY	45
5.6	COMPRESSIVE STRENGTH FOR 14 TH DAY	45
5.7	COMPARISON OF COMPRESSIVE STRENGTH FOR 28 TH DAY	46
5.8	COMPRESSIVE STRENGTH FOR 28 TH DAY	46

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
4.1	DETERMINATION OF FINESS OF CEMENT	18
4.2	SPECIFIC GRAVITY OF CEMENT	19
4.3	INITIAL SETTING TIME TEST	20
4.4	SPECIFIC GRAVITY OF THE AGGREGATE	21
4.5	DETERMINATION OF WATER ABSORBTION FOR FINE AGGREGATE	23
4.6	SPECIFIC GRAVITY OF FOUNDRY SAND	29
4.7	DETERMINATION OF WATER ABSORBTION FOR FOUNDRY SAND	30
4.8	SPECIFIC GRAVITY OF COARSE AGGREGATE	32
4.9	GRADING OF COARSE AGGREGATE	33
4.10	PROPORTIONS OF CONCRETE MATERIAL AT DIFFERENT PERCENTAGE	39

LIST OF SYMBOLS AND ABBREVIATIONS

ACRONYMS

EXPANSIONS

Psi	PER SQUARE INCH
ml	MILE LITER
Kg	KILO GRAMS
mm	MILE METER
N	NEWTON
Mpa	MEGA PASCAL
gm.	GRAMS
%	PERCENTAGE

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The construction sector is quickly growing, and new methods are being used to enable quicker and more effective work in the field. In this industry, concrete is a key building material, but producing it consumes a lot of natural resources, which can be expensive and unsustainable in the long run. It is crucial to either recover these natural resources or discover different solutions that can lessen the issue in order to handle these difficulties. Currently, waste foundry sand—a by-product of the metal casting industry—is contributing to several environmental issues. However, utilising this trash in the construction of buildings may help to lessen the environmental impact. We can lessen the construction industry's negative environmental effects and advance sustainability by figuring out how to integrate leftover foundry sand into building materials. It is crucial to investigate the possibilities of used foundry sand as a useful substitute material for building construction.

A high-quality silica sand by-product of the metal casting industry is called foundry sand. foundry's physical and chemical qualities Finding solutions to reuse or recycle the garbage that industries produce is essential since it can lead to serious environmental issues. Sand quality and industry sector of origin depend on the type of casting technique used. Moulding sands are used repeatedly in the casting process, but eventually they lose their usability due to deterioration. The leftover foundry sand is then regarded as garbage. Many studies on the mechanical, chemical, and physical properties of foundry sand have been done in the recent years. The strength and durability characteristics of foundry sand concrete, which are a crucial field of exploration, have, however, received scant attention in the literature. One benefit of using foundry sand in concrete is that it improves the characteristics of the material while requiring fewer natural resources and less waste. Therefore, the purpose of this report is to emphasise the importance of conducting more research on the strength and longevity of foundry sand concrete. Testing the concrete's longevity, tensile strength, compressive strength, and resistance to chemical and freeze-thaw cycles are all possible components of this study. Such studies will support the use of foundry

sand as a sustainable building material in concrete and contribute to decreasing environmental issues brought on by industrial waste.

Concrete, a widely used building material, is made up of cement, admixtures, water, and coarse and fine particles. Each of these components enhances the durability and qualities of concrete. However, the characteristics of concrete can be dramatically impacted by the partial or percentage replacement of any of these elements. The experimental investigation involves varying the percentage of fine aggregate replaced with used foundry sand to determine the optimum percentage of replacement that produces concrete with the desired properties. The study includes testing the compressive strength, tensile strength, and durability of the concrete. The results of this study will contribute to the development of low-cost and eco-friendly concrete using waste materials such as foundry sand. The use of such waste materials in concrete production will not only reduce environmental pollution but also reduce the cost of construction materials. The findings of this study will be beneficial to the construction industry and researchers working on sustainable building materials.

Research suggests that waste foundry sand can be a suitable material for use as a fine aggregate in concrete production. The smooth surface of the sand particles results in better workability for concrete walls. However, replacing 50% of the fine aggregate with waste foundry sand can result in a reduction of flexural strength by 10-15% compared to traditional fine aggregate concrete. The objective of this research is to promote the use of waste products as construction materials in the lightweight application of concrete. The aim is to encourage housing developers to explore the use of these materials in their construction projects. The study focuses on the replacement of fine aggregate with waste foundry sand while considering the strength properties. The research also examines the potential benefits of using commercially produced coconut shell concrete in terms of reducing the weight of the concrete.

1.2 CONCRETE

Due to its simplicity in shaping and sizing, as well as the accessibility of locally sourced resources, concrete is the second most used material in the world. In fact, more concrete is produced each year than any other man-made substance combined, amounting to one tonne for each person on the earth.

Concrete's adaptability is particularly remarkable because it is utilised in practically all significant construction projects. Usually utilised for specialised reasons, aggregate, a crucial component of concrete, accounts for between 60 and 75 percent of the mixture's volume. Aggregate has a big economic impact because it is the least expensive component of concrete. It's interesting to note that during the course of a building's existence, its electric utilities produce 80% of the CO₂ emissions that are associated with construction. Despite this, compared to other building materials on the market, concrete is still more economical. Fresh concrete testing is essential for monitoring and confirming the calibre of cement work. It is crucial to keep in mind that typical compression tests on specimens only assess the strength of concrete's potential, not the strength of the concrete in the actual construction. Therefore, tests on separately manufactured specimens cannot be used to directly determine the strength of concrete in the structure.

1.3 USE OF WASTE IN CONCRETE

Research efforts have been made to examine the potential of utilising waste materials in construction practises in response to society's growing concern for safe and affordable waste disposal. This strategy not only promotes a cleaner and more sustainable environment, but also helps save natural resources and lessen garbage in landfills. The production of two billion tonnes of Portland cement annually, which emits greenhouse gases and contributes to global warming, as well as the high demand for natural resources like stone, sand, and water make the current conventional method of using concrete in construction unsustainable. Because they provide a low-cost volume filler and account for 66 to 78% of the material, aggregates are essential to the creation of concrete.

The purpose of this study was to determine whether using coconut shell as an aggregate in concrete was feasible. Additionally, it was investigated whether using leftover foundry sand as a fine aggregate in concrete production could be a feasible solution to the issue of disposing of solid waste while simultaneously promoting resource conservation. In this study, the physical characteristics of waste foundry sand aggregate were examined. The study also assessed the qualities of lightweight concrete made with leftover foundry sand as a fine aggregate, such as density, slump, and 28-day compressive strength.

CHAPTER 2

LITERATURE REVIEW

There is a dearth of data on how adding discarded foundry sand to concrete affects its mechanical qualities, according to an examination of the literature. In this article, we give a quick summary of a few chosen experimental research that looked into the characteristics of concrete that contained these pollutants.

A. Amitkumar D. Ravaletal. (2015)

The purpose of the study was to determine whether it was possible to make M-25 grade concrete using waste foundry sand in place of ordinary Portland cement (OPC). The replacement percentages by cement weight ranged from 0% to 50%. The study discovered that by replacing up to 30% of the cement in M-25 grade concrete with ceramic waste, the concrete's compressive strength rose. However, the compressive strength decreased as more cement was substituted with foundry sand. In particular, a 30% substitution of foundry sand for cement resulted in a compressive strength of 26.77N/mm². When compared to normal concrete, the cost of M-25 grade concrete was reduced by up to 13.27%, making it more affordable without sacrificing strength.

B. Dr. B. Kameshwari et al. (2014)

When waste foundry sand was used in concrete, it was discovered that at specific amounts of addition, the strength consistently decreased. However, after 7 days, concrete reached its full strength when sand replacement levels of 30% and 40% waste foundry sand were used. This shows that foundry sand can be used to produce concrete with a strength that is acceptable. It is advised to recycle used foundry sand for use in construction projects since it not only lowers disposal costs but also contributes to resource conservation and offers both technical and financial advantages. In this experiment, spent foundry sand was substituted for natural sand at varying percentages (from 10% to 100%), in order to assess the strength of concrete. For M-25 grade concrete, compression strength tests were performed for all levels of foundry sand substitution.

C. Sohail Md et al.(2013)

To obtain various qualities of concrete, the use of foundry sand as a partial or even complete replacement for cement or fine aggregates has been researched. This study looked at the impact of replacing fine aggregate with foundry sand on the compressive strength, split tensile strength, and flexural strength of M-30 grade concrete. From 0% to 100% by weight of fine aggregate, foundry sand was substituted for fine aggregates in the concrete mix in eleven different percentages. All replacement levels of foundry sand underwent compression strength, split tensile strength, and flexural strength testing at various curing times. (7 days, 28 days, and 56 days).

D. Dr. Pradeep kumar et al.(2014)

In both the architectural and civil engineering professions, recycling materials has gained importance, particularly with the rise of the idea of "green concrete," which places an emphasis on environmental compatibility. In this study, the potential for using foundry sand, a widely dumped waste product from the casting industry, in concrete has been assessed. The study looked at the compressive strength and split tensile strength of concrete with a mix ratio of 1:1.28:2.56:0.45, focusing on the influence of foundry sand as a replacement for fine aggregate. (7 days and 28 days). Between 10% and 100% of the weight of the fine aggregate was replaced with foundry sand. The findings demonstrated that as fine aggregate replacement by foundry sand grew, so did the compressive strength and split tensile strength of concrete specimens, reaching their maximum strength at 50% replacement. The strength parameters thereafter displayed a drop in their corresponding levels. Therefore, it is desired, economical, minimises the need for fine aggregate, eases landfill issues, and protects nature to replace natural sand with old foundry sand up to 50%.

E. Gurpreet Singh and Rafat Siddique (2011)

In this study, waste foundry sand was used in place of some of the natural sand to perform an experimental examination to assess the strength and durability of concrete mixtures. Foundry sand was substituted for natural sand at weight replacement rates of 0%, 5%, 10%, 15%, and 20%. To assess the durability of concrete at various ages, compression tests and splitting tensile strength tests were conducted. (7 days, 28 days, and 91 days).

F. Shyam Mak wana and prof. Yashwantsinh Zala (2015)

Studied the physical and chemical properties of ceramic waste and foundry sand. They made a review on utilization of ceramic waste and foundry sand in civil engineering practice. In the world, there are large amounts of calcined-clay wastes and waste foundry sand produce from the industry each year. So, these wastes are use in landfills. Reusing these wastes in concrete can be very beneficial situation for society. Therefore, at one side, we can solve the problems of industries and at the other side, they can make more sustainable concrete by reducing non-renewable resources like cement, aggregates and also solve the environmental problems related to land fill wastes. They determine the proportion of SiO₂ is about 60-70% and in foundry sand is 80-90% which is responsible to improve the strength and durability of concrete. So, it can be used in concrete to improve the properties of concrete and reduce disposal problems on land and environmental problem.

G. Eknath P.Salokhe and D.B.Desai (2014)

The qualities of fresh and cured concrete containing ferrous and nonferrous foundry waste sand substituted with four different percentages of fine aggregate (0%, 10%, 20%, and 30%) by weight were compared, and tests were conducted for M20 grade concrete. The results showed that (i) the presence of very fine binders causes both foundry sand additions to give low slump; (ii) both ferrous and nonferrous mixtures' compressive strengths increase after seven days, with 20% of both types of foundry sand causing the greatest increase; at 28 days, 30% of ferrous foundry sand and 10% of nonferrous foundry sand additions produce concrete with the same strength as regular concrete; and so on..

H. Smt. M. Kacha, Abhay V. Nakum, Ankur C. Bhogayata (2014)

Examined the advancement in the usage of recycled foundry sand in cementation concrete. The use of foundry sand as a component of concrete is discussed in the paper along with some noteworthy results from other researchers' experimental work. The addition or substitution of fine sand with used foundry sand in various amounts was shown to have a favourable effect on the traditional cementitious concrete's strength and durability attributes. This study indicated that using spent foundry sand has significant promise for the creation of environmentally friendly and long-lasting cementitious concretes. It is possible to draw the conclusion that all

researchers found that when foundry sand is used to replace 30–40% of the fine aggregate in concrete, compressive and tensile strength increases by up to 20% while the modulus of elasticity does not change significantly. However, very few researchers went up to 100% replacement, where strength and durability criteria needed to be studied more thoroughly in the future.

I. Pathariya Saraswati, Rana Jaykrushna K, Shah Palas, Mehta Jay G (2013)

Suggested a low-cost, environmentally friendly concrete and showed how leftover foundry sand may be used to partially replace fine aggregate in concrete. For M-25 grade concrete (PPC), an experimental examination is conducted on a concrete that contains waste foundry sand in the range of 0%, 20%, 40%, and 60% by weight. Material was created, put through testing, and its strength and workability were compared to those of regular concrete. The mechanical characteristics of concrete were tested over 7, 14, and 28 days using a standard cube of 150*150*150 mm. Through the findings of their experiments, they came to the conclusion that split tensile strength and partial replacement of waste foundry sand both improve compressive strength. strength declines as the proportion of leftover foundry sand rises. Maximum compressive strength in this investigation is attained when waste foundry sand replaces fine aggregate to the extent of 60%. As the percentage of discarded foundry sand increases, split tensile strength decreases. When waste foundry sand is replaced by 60%, the percentage cost change results in a reduction of up to 3.5. This demonstrates how economically the concrete was created.

J. KEWAL, SANJAY K. SHARMA AND HIMMI GUPTA

Concluded that Paver Block has a high compressive strength of 66 MPa at a relatively young age. With the substitution of foundry sand, it was discovered that the compressive strength of geopolymer paver blocks was diminishing. It has been discovered that replacing fine sand by foundry sand up to 60% results in slightly higher compressive strength. Complete replacement with foundry sand reduces compressive strength somewhat; the lower value is 41 MPa, which may be utilised to produce paver blocks at a 40 MPa strength. Paver blocks have a very high maximum strength of 78 MPa at 0% replacement, which makes them suitable for use in extremely heavy traffic. Geopolymer paver blocks' 4-5% water absorption is within the allowable limits of IS:15658-2006..

K. Mr.S.S.Jadhav Dr.S.N.Tande Mr.A.C.Dubal

Observed that it is possible to make concrete blocks using foundry sand up to 30% instead of cement..

L. Saif ali, Rajat Saxena, Sumit yadav, Satyam Bhati, Nitin Kumar

It has been discovered that the usage of foundry sand could be very typically employed in producing high-quality concrete and building materials since it has been seen that the compressive strength of concrete mixture improves when the amount of foundry sand is increased. Compressive strength was increased when foundry sand replenishment was between 10 and 20 percent. We may state that the amount of fine aggregate required to produce 1 m³ of concrete of grade M20 is 538.45 kg. So, we can conclude that up to 30% of foundry sand is used in the production of concrete in an efficient and ecological manner. Concrete made using foundry sand may reduce construction waste and reduce disposal expenses for the metal sector. Through this investigation, an original additional construction material is created.

CHAPTER 3

3.1 AIM

The purpose of testing foundry sand's effect on the strength and durability of the resulting concrete is to replace some of the fine aggregate in concrete cubes. We can potentially lessen the negative environmental effects connected with the production of concrete while simultaneously preserving or improving its performance by investigating the effects of this substitution. The major objective of this study is to ascertain the ideal quantity of foundry sand that can be utilised in place of fine aggregate without reducing the concrete's compressive and tensile strengths. To do this, a series of tests will be performed to assess the strength characteristics of concrete cubes containing various amounts of replacement foundry sand, and the outcomes will be compared to those of plain concrete. The overarching goal of this research is to create a technology for making concrete that is both ecologically responsible and sustainable while maintaining crucial structural properties. We can produce concrete in a more sustainable manner and lessen the environmental impact of this business by striking the ideal balance between adding leftover foundry sand and preserving concrete strength. In the end, this research may help the construction sector adopt more sustainable practises, which is crucial for fostering a future that is ecologically mindful.

3.2 SCOPE

The purpose of this study is to look at how waste foundry sand affects the properties of mortars and concretes. To identify the ideal Foundry sand content that can be added to the mixture without impairing workability, mechanical qualities like compressive strength and dynamic elastic modulus, or drying shrinkage, the performance of these materials will be assessed at various water/cement (w/c) ratios. The main goal of this study is to evaluate the performance of freshly mixed, cured concrete that uses Foundry sand as a fine aggregate replacement. After 28 days, the control concrete mix's compressive strength was 25 MPa. This study focuses on the effects of different Foundry sand replacement amounts on the final concrete's mechanical characteristics and drying shrinkage. The overall goal of this study is to provide information about how Foundry sand is used in the manufacture of concrete and how it affects the end product's characteristics. This research can aid in the

advancement of sustainable and ecologically responsible practises in the construction sector by identifying the ideal amount of Foundry sand that can be added to concrete mixtures without noticeably impairing its performance. In the end, this research can point to a more environmentally friendly method of producing concrete that strikes a compromise between the requirement for efficiency and the desire to lessen the environmental impact of the sector.

A) The main goal of this project is to evaluate students' knowledge of environmentally friendly construction methods and procedures that are appropriate for various climatic situations. The project's scope includes a review of construction techniques that can be used in a variety of settings while also taking the effects of the materials and techniques on the environment into account. The goal of the study is to find and promote environmentally friendly, robust construction techniques that may be modified for use in various environments. This project can help to build a more ecologically responsible approach to construction by assessing students' knowledge and understanding of eco-friendly construction techniques and procedures. The overarching objective of this research is to promote understanding of sustainable building practises and their application in the construction sector. This project can aid in fostering a more sustainable and resilient approach to construction that considers the influence on the environment and diverse climatic situations by finding and promoting environmentally conscious construction techniques and practises. In the end, this research may help create a future where the construction sector and the ecosystem are more sustainable.

B) We haven't yet looked into the possibility of using waste foundry sand as an aggregate in structural concrete. This highlights the need for additional research in this area and reveals a gap in the existing research on concrete production methods. With a focus on the ensuing mechanical qualities and environmental impact, the main goal of this study is to evaluate the viability and effectiveness of using Foundry sand as an aggregate in structural concrete. This study aims to further the creation of more economical and ecologically friendly production methods by assessing the potential of Foundry sand as an aggregate in structural concrete. The findings of this study can offer important insights into the usage of waste materials in construction, which can assist lessen the industry's negative environmental effects while also promoting sustainable and practical practises. This study's overall objective is to advance our

understanding of concrete manufacturing methods by investigating the potential of Foundry sand as a workable replacement for conventional aggregate materials. This study can assist future efforts to create more sustainable and ecologically responsible construction practises by emphasising the advantages and disadvantages of employing Foundry sand in structural concrete. In the end, our research may help to create a future where both the environment and the construction industry are more robust and sustainable.

C) The main goal of this study is to assess the viability and efficiency of using waste foundry sand in place of natural aggregate as a fine aggregate in concrete. The purpose of the study is to determine whether this method is practical and to evaluate the mechanical characteristics and potential environmental effects of the produced concrete. With the goal of revealing useful information about the potential uses of this waste material in the production of concrete, the study focuses on evaluating the viability of using Foundry sand as a substitute for natural aggregate in various applications. The goal of the study is to provide guidance for future attempts to create more efficient and environmentally friendly concrete production methods by examining the mechanical qualities and potential environmental impact of the produced concrete. By investigating the potential of Foundry sand as a workable substitute for natural aggregate, the study ultimately aims to contribute to the development of more environmentally friendly and economically advantageous concrete production techniques. The study can offer useful insights into the prospects of using waste materials in construction by examining the viability of using Foundry sand as a fine aggregate in concrete and evaluating its impact on the resulting concrete's mechanical qualities and potential environmental implications. The results of this study may ultimately help to create a future where both the environment and the construction industry are more robust and sustainable.

3.3 OBJECTIVE

1. To lower building costs while maintaining high standards of quality
2. The goal of this project is to address the problem of disposing of foundry waste by identifying alternative remedies
3. The purpose of this study is to show that foundry sand can be used in building instead of fine aggregate.
4. The purpose of this study is to determine the effects of replacing fine aggregate in M25 grade concrete with foundry waste at different ratios (15%, 25%, and 35%).
5. This study's goal is to compare the strength of ordinary concrete to the compressive strength of a concrete mix that contains foundry sand.

CHAPTER 4

METHODOLOGY

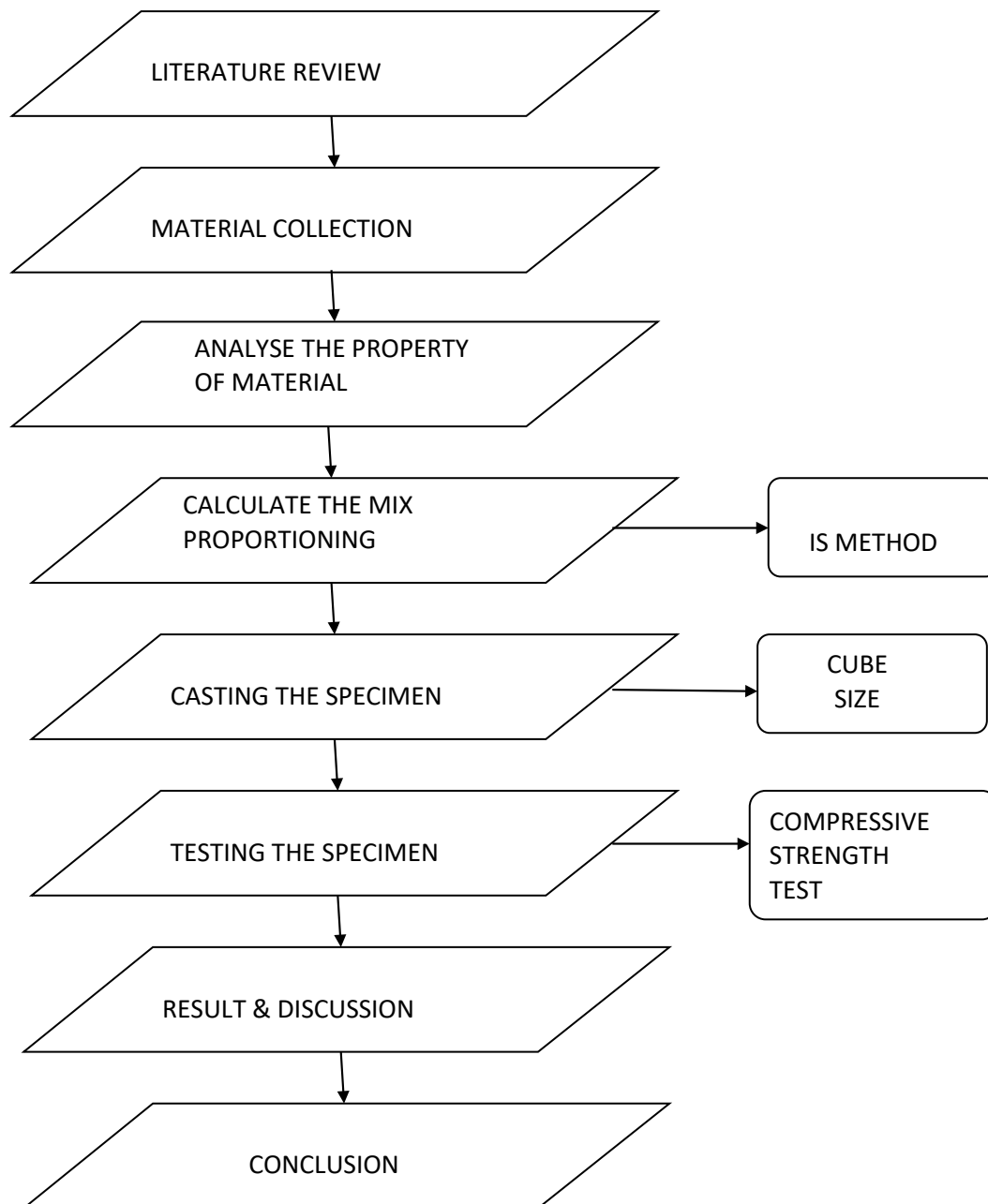
4.1 GENERAL

With an emphasis on the compressive strength of cubes and the split tensile strength of cylinders, the methodology used for this study involved assessing the mechanical properties of concrete. The right testing procedures were used to evaluate these qualities. The objective of the study was to evaluate the effects of using waste foundry sand in place of natural aggregate in concrete and to determine the optimum Foundry sand addition that could be made without significantly affecting the mechanical qualities of the concrete. To accomplish this, numerous concrete mixtures with various amounts of Foundry sand were made, and the compressive and split tensile strengths of each were assessed using accepted testing methods. The testing procedure used in this study made sure that the results were precise and trustworthy, giving important insights into how employing Foundry sand affected the mechanical characteristics of concrete. The study was able to determine the ideal fraction of Foundry sand that may be utilised without affecting the concrete's mechanical properties by evaluating the compressive and split tensile strengths of concrete cubes and cylinders. Overall, the methodology of the study was created to make it possible to accurately examine the mechanical characteristics of concrete in various combinations, enabling a thorough assessment of the possibilities for employing waste foundry sand as a substitute for natural aggregate. The study was able to produce accurate data by using suitable testing methodologies and procedures, which may be utilised to guide the creation of more ecologically friendly and sustainable concrete production methods.

- a. Choosing an acceptable grade of concrete mix, constructing the mix with the right technique, creating test mixes, and figuring out the final mix's qualities, such as the split tensile strength of cylinders and the compressive strength of cubes.]
- b. Calculating the total amount of concrete needed to complete the job.
- c. Calculating the necessary amount of waste foundry sand, fine aggregate, coarse aggregate, and cement for the project work.

- d. Conducting necessary standards-compliant tests on the qualities of waste foundry sand, cement, fine aggregate, and coarse aggregate
- e. Making concrete cubes out of leftover foundry sand and the other mix ingredients.

4.2 Flow diagram of methodology



4.3 MATERIAL PROPERTIES & TESTS

4.3.1 GENERAL

In this study, we examine the durability and strength properties of concrete cubes using used foundry sand. To ascertain the material qualities, laboratory tests were conducted in compliance with the applicable Indian Standard regulations. Basic tests were performed on the cement and fine aggregate to determine whether they were suitable for making concrete. The results of these tests are presented in the chapter that follows.

The original round of experiments was primarily concerned with examining the physical and chemical properties of the employed foundry sand. In order to determine the batch quantities, these tests included calculating the particle size distribution in accordance with the IS: 1970 standard and the specific gravity (IS 2386, Part III, 1963). In order to enable the conversion of material quantities from weight to volume for concrete production, the bulk density (IS 2386, Part III, 1963) was also measured. The results of these tests are described in detail in the section that follows.

The purpose of this study was to look into the strength and durability of concrete cubes made with foundry sand waste. To ascertain the material qualities, laboratory tests were conducted in compliance with Indian Standard norms. The first set of tests analysed the employed foundry sand's physical and chemical characteristics. The tests involved measuring the specific gravity (IS 2386, Part III, 1963), the bulk density (IS 2386, Part III, 1963), and the particle size distribution in line with the IS: 1970 standard. For the manufacturing of concrete, these tests were required to determine batch sizes and convert material quantities from weight to volume. In the section that follows, the outcomes of these tests are covered in great depth. Basic tests were also carried out on the cement and fine aggregate to determine their suitability for making concrete, and the results are also shown in the following chapter. Using the batching by volume approach required multiple processes to create a concrete mix. First, the amount of cement needed was calculated based on the final product's desired strength and durability. The spent foundry sand served as an additional component and helped to raise the mix's overall quality after being added to the cement. The required amount of fine aggregate was then added to the mixture after the cement and sand had been properly combined. This was carried out gradually while the mixer was operated at a

moderate speed to guarantee that the ingredients were well combined and a homogeneous consistency was reached. It was crucial to keep an eye on the mix's moisture level during this procedure because an extremely wet or dry mix could produce subpar concrete. The components were fully mixed for long enough after the fine aggregate had been introduced to guarantee that a reliable and good mix was produced. In order to achieve this, the mixer needed to be operated at a higher speed for a number of minutes, until the mixture was homogenous and free of lumps or clumps. Overall, the batching by volume technique worked well for producing concrete that was of a good calibre. The final product was robust, long-lasting, and well-suited to its intended application thanks to meticulous measurement, mixing, and blending of the various components.

4.3.2 CEMENT

When making concrete, cement is a crucial ingredient because it fills in any spaces or gaps in the mixture and binds the coarse aggregate with water to form a sturdy, cohesive structure. Compressive strength and rheological characteristics of the final concrete, which are crucial elements in determining its general durability and performance, can be strongly impacted by the kind and calibre of cement employed. Two essential needs for cement in the concrete mix design are the acquisition of adequate rheological characteristics and the growth of compressive strength over time. Concrete's flow qualities, workability, and capacity to be pumped or poured into different shapes and forms are referred to as its rheological properties. For concrete to be able to endure the loads and stresses it will be subjected to throughout the course of its lifespan, the growth of compressive strength over time is essential.

The parameters governing the strength of the concrete can be significantly affected by changes in the chemical make-up or physical characteristics of cement. For instance, differences in the cement's content of calcium silicates or alumina can have an impact on the concrete's strength development and hydration rate. Similar to this, changes in the cement's fineness or particle size distribution can affect the concrete's water need, workability, and strength parameters. Therefore, when designing the concrete mix, it is crucial to carefully evaluate the type and production of cement. In order to do this, choose a cement that is suitable for the intended use and satisfies the necessary rheological and strength requirements. By doing this, high-

quality concrete will be produced that is resilient and able to endure the pressures and stresses it will be subjected to.

Type of cement used: Ordinary Portland Cement (OPC)

OPC 43 Grade sample was tested to obtain the following characteristic:

- Specific gravity (determined by Le-chartelier flask) (IS:1727-1967)
- Standard consistently (IS:4031-1968 part 4)
- Initial setting time (IS 4031-1968 part 4)
- Final setting time (IS 4031-1968 part 4)

4.3.2 i) DETERMINATION OF FINENESS OF CEMENT

A common sieve test was carried out to determine the cement's fineness in the concrete mix. For the test, a 100-gram sample of cement was taken, and any lumps that had developed as a result of oil setting were broken apart. After that, the material was continually sieved for 15 minutes in a circular and vertical motion. The amount of residue that was still on the sieve after the sieving procedure was finished was calculated based on its weight. With a higher proportion of residue suggesting a coarser material and a smaller proportion of residue indicating a finer material, this supplied a measure of the cement's fineness. The standard sieve test is a crucial technique for assessing cement quality and making sure it adheres to the standards needed for use in concrete mixtures. Because it offers more surface area for the chemical processes that take place during the hydration process, a finer cement often produces concrete that is stronger and more durable. The outcomes of the sieve test offered important details about the calibre of the cement used in the concrete mix. It was feasible to gauge the cement's degree of fineness and judge its fitness for use in the intended application based on the percentage of residue that remained on the sieve. You can create high-quality, long-lasting concrete that can handle the pressures and loads it will be subjected to over time by carefully checking the cement's fineness and making sure it satisfies the necessary criteria.

SI.NO	DESCRIPTION	VALUES
1	Type of cement	OPC
2	Weight of cement taken(W1)	100g
3	Weight of residue(W2)	9.3g
4	% of weight of fineness $W_2 \times 100 / W_1$	3.1%

Table 4.1: Determination of Finess of cement

4.3.2 ii) SPECIFIC GRAVITY OF CEMENT

A specific gravity bottle test was performed to ascertain the specific gravity of the cement used in the concrete mix. In order to determine the substance's specific gravity, a dry bottle was used in the test and its weight was recorded as W1. The bottle was then weighed after being filled with distilled water, and the filled mass was noted as W2. The bottle was subsequently filled with kerosene, dried off, and its mass was recorded as W3. The bottle was then filled with roughly 50 grammes of weighed cement. The bottle was gently rolled in an inclined position and filled to the brim with kerosene after the cement had been allowed to settle until no more air bubbles showed on the surface. The filled bottle was weighed and marked as W4 after filling. The mass of the specific gravity bottle filled with cement, as measured and noted in W4, was used to calculate the cement's specific gravity. This gave a measurement of the cement's mass in relation to the mass of water of the same volume and temperature. The specific gravity bottle test is a crucial technique for assessing cement quality and making sure it adheres to the standards needed for use in concrete mixtures. The density, strength, and appropriateness of the cement for use in particular applications can all be evaluated by calculating its specific gravity. The specific gravity bottle test findings revealed important details about the calibre of the cement used in the concrete mix. It was feasible to ascertain the density and strength of the cement and judge its acceptability for use in the intended application using the specific gravity value that was obtained. It is feasible to create high-quality and resilient concrete that can endure the strains and loads to which it will be exposed over time by carefully monitoring the specific gravity of the cement and making sure that it satisfies the necessary criteria.

SI. NO	NATURE OF SPECIMEN	WEIGHT
1	Mass of empty bottle (W1)	30 grams
2	Mass of empty bottle +cement, (W2)	80 grams
3	Mass of bottle + Cement +Water, (W3)	118 grams
4	Mass of bottle + Kerosene (W4)	83 grams
5	Specific gravity of cement $S = (W2 - W1) / [(W4 - W1) - (W3 - W2)]$	3.15

Table 4.2: Specific gravity of cement

4.3.2 iii) INITIAL SETTING TIME TEST

A common consistency test was performed on a 300-gram cement sample to ascertain the initial setting time. The cement sample was mixed with 0.85 times as much water as was required for a standard consistency, and the resultant paste was ready in 3 to 5 minutes. A timer was started as soon as the water was introduced to the cement after the paste had been placed to a mould. The test block's surface was then lightly touched with a needle and gently lifted. The first setting time was determined as the interval between adding water to the cement and the moment the needle pierced the test block at a depth of 3-5 mm below the top. The standard consistency test is a valuable tool for estimating the cement's setting time, which is a key element in establishing the effectiveness and quality of concrete. The amount of time it takes for the paste to harden and become strong enough to sustain loads and strains is referred to as the setting time of cement. The usual consistency test's findings provide crucial details about how long the cement sample first took to set. By using this information, one may make sure that the cement is of the right kind and adequate quality for use in concrete mixtures that call for particular setting durations. It is feasible to create high-quality and resilient concrete that can survive the stresses and loads to which it will be exposed over time by carefully monitoring the initial setting time of cement and making sure that it complies with the necessary requirements. To do this and ensure the best performance of concrete structures, the standard consistency test is a crucial tool.

SI. NO	TIME OF PENETRATION OF THE NEEDLE (min)	DEPTH OF PENETRATION OF THE NEEDLE (min)
1	5	0
2	10	0
3	15	0
4	20	3
5	30	5

Table 4.3: Initial setting time test

4.3.2 iv) FINAL SETTING TIME TEST

The amount of time that cement holds its plasticity after being combined with water is known as the setting time of cement. A typical setting time for concrete activities is 30 minutes, during which the concrete can be moulded and formed into the appropriate shape. By varying the cement's composition and fineness, the setting time of cement can be precisely regulated. After being compacted and placed in its final location, concrete must lose its elasticity and set as rapidly as possible to lessen its vulnerability to outside factors that could harm it. For various types of cement, the final setting period normally lasts 20 hours. This time restriction should not be exceeded since if the cement takes longer to set, its properties may be impaired. In order to guarantee that concrete constructions have the appropriate strength and longevity, cement setting time must be carefully managed. The water-cement ratio, ambient temperature, and the usage of additives are a few more variables that can influence how quickly concrete sets in addition to regulating the composition and fineness of the cement. It is feasible to create high-quality concrete that is resistant to the negative effects of the environment and has the requisite strength and durability to handle the stresses and loads it will be subjected to over time by carefully monitoring and adjusting the cement's setting time. Therefore, when designing and building concrete mixes, it's necessary to take the cement's setting time into account. The final setting time of cement = 550 minutes

4.4 FINE AGGREGATE

The cement utilised in the study had a final setting time of 550 minutes. However, this outcome can be considerably impacted by the calibre of the fine aggregate utilised. For the best concrete qualities, fine aggregate a crucial ingredient in the manufacturing of concrete must be free of contaminants, dangerous compounds, and fungal development. It should also have angular and sharp edges, be sufficiently strong, and encourage high workability in the mixture. River sand from the Mimisal area was utilised as the fine aggregate in this investigation. Several experiments were conducted to determine its appropriateness for usage, and the results are provided in the next portion of the study.

4.4.1 SPECIFIC GRAVITY OF FINE AGGREGATE

Every experiment needs precise measurements to be successful, and the research of the fine aggregate used in the concrete mix was no exception. The weight of the container and its contents were measured four times. First, the empty container's weight (W1) was measured and recorded. The fine aggregate was then added to the container, and its weight was recorded as W2. Thirdly, after adding water, the container's weight was calculated and recorded as W3. The container was then filled with water after being emptied, and its weight, W4, was estimated and noted

SI NO	DESCRIPTION	VALUES
1	Weight of container(W1)	0.560
2	Weight of container +Aggregate(W2)	1.390
3	Weight of container + aggregate+ water(W3)	1.895
4	Weight of container + water(W4)	1.383

Table 4.4: Specific gravity of the aggregate

Specific gravity of fine aggregate $= (W2 - W1) / (W2 - W1) - (W3 - W4)$

Specific gravity = 2.61

4.4.2 DETERMINATION OF WATER ABSORPTION OF FINE AGGEREGATE

To determine the water absorption of the fine aggregate, the weight of the empty container was measured as W1. Then, the container was filled with dry fine aggregate and weighed as W2. Water was added to the container and mixed with the fine aggregate, and the mixture was allowed to sit for 30 minutes.

After 30 minutes, the container was removed from the water and allowed to drain for a few minutes. The weight of the container and wet aggregate was measured as W3.

After 30 minutes, the container was removed from the water and allowed to drain for a few minutes. The weight of the container and wet aggregate was measured as W3.

The following formula was used to determine the fine aggregate's water absorption capacity:

Water absorption is equal to $[(W3 - W2) / (W2 - W1)] \times 100\%$

where W1 is the weight of the full container, W2 is the weight of the dry fine aggregate, and W3 is the weight of the container and wet aggregate. The water absorption value, which is represented as a percentage of the aggregate's dry weight, reveals how much water the fine aggregate has absorbed.

CALCULATIONS:

Weight of dry aggregate, W1 = 3000g

Weight of wet aggregate, W2 = 3150g

% of water absorption $= (W2 - W1) / (W2) \times 100$

$$= 3150 - 3000 / 3.15 \times 100$$

$$= 1.64\%$$

SI .NO	MATERIAL	VALUE
1	Fine Aggregate	1.64 %

Table 4.5: Determination of water absorption for fine aggregate

4.5 FOUNDRY SAND

After 30 minutes, the container was removed from the water and allowed to drain for a few minutes. The weight of the container and wet aggregate was measured as W3. A high-quality silica sand by-product created during the manufacture of ferrous and non-ferrous metal castings is known as waste foundry sand . Silica sands with sizes are used in foundries for moulding and pricing. In recent years, foundry sand has been employed as a workable alternative to fine aggregate in flowable fill applications and asphalt paving mixtures. After 30 minutes, the container was removed from the water and allowed to drain for a few minutes. The weight of the container and wet aggregate was measured as W3.

Waste foundry sand is a silica sand of superior quality and uniform size that is frequently utilised in foundry casting procedures. The type of casting technique used has a significant impact on the characteristics of foundry sand. Due to its high heat conductivity, foundry sand has been used as a mould casting material for millennia. Green sand and Silica sand are the two main categories of foundry sands. Bentonite clay, which has a silica concentration ranging from 85% to 95%, is used as the binder in green sand. On the other hand, silica sand, which has a silica percentage of 93% to 99%, employs core oil as a binder. Silica foundry sand can often take the place of sand in the majority of applications due to its likeness to natural sand. This study's goal is to examine the results of replacing a portion of fine aggregate with silica waste foundry sand in concrete at different percentages of 0%, 15%, 25%, and 35%.



Figure 4.1: Collection of foundry sand

4.5.1 PROPERTIES OF FOUNDRY SAND

STRENGTH

The ability of a material to sustain external mechanical stress without deforming or changing its original shape is considered a material's strength in the field of materials science. Being a particulate material, sand shares this strength attribute, which is important in deciding its viability for usage in a variety of industries including manufacturing, engineering, and building. Therefore, any inquiry or analysis relevant to sand's qualities and applications must have a thorough understanding of the strength characteristics of sand. In this way, sand's strength significantly affects how well it performs and functions generally in a variety of circumstances.

PERMEABILITY

Due to its capacity to permit gases and steam to escape during the casting process, foundry sand is a crucial component of the metal casting industry. This

characteristic is crucial for good metal casting because it allows gases and steam to escape while molten metal is being poured into a mould. The final casting's quality depends heavily on the foundry sand's permeability since trapped gases or steam can cause flaws or abnormalities in the final product. For metal casting operations to be effective, it is crucial to comprehend the permeability of foundry sand. This can lessen the possibility of flaws or irregularities, increase the final casting's quality, and eliminate the need for pricy rework or repairs. The size and shape of the sand particles, the degree of compaction of the sand in the mould, and the moisture content of the sand can all have an impact on the permeability of foundry sand. To maximise the permeability of the foundry sand and assure the success of the casting process, it is necessary to carefully control these variables. This can lessen the possibility of flaws or irregularities, increase the final casting's quality, and eliminate the need for pricy rework or repairs. In conclusion, foundry sand permeability is an important consideration in the metal casting business since it affects the finished casting's integrity and quality. The efficiency and effectiveness of metal casting operations can be increased by comprehending and managing the permeability of foundry sand, which will also aid to minimise flaws and inconsistencies in the finished product and lessen the need for expensive rework or repairs.

MOISTURE CONTENT

In order to guarantee the quality of a final casting, a mould's strength and permeability are essential. These elements, in turn, may have an impact on the casting's integrity depending on the moisture level of the mould. The quality of the final casting may be harmed if the mould is too dry since it will become brittle and more likely to break or crack. On the other hand, if the mould has too much moisture in it, the pouring procedure may cause steam bubbles to become trapped inside the casting. This may result in the end object expanding and deforming, which could result in flaws and eventual failure. To ensure the optimum results, it is crucial to regulate the mould's moisture level during the casting process. In addition to employing the proper binders and additives to modify the moisture content of the sand mixture, this may entail carefully controlling the temperature and humidity of the casting environment.

Furthermore, ensuring that the mould is correctly prepared before use might aid in improving its permeability and strength. To increase the mould's resistance to moisture and boost the quality of the casting, this may entail preheating it or coating it. In conclusion, the strength, permeability, and general quality of a metal casting are significantly influenced by the moisture content of the mould. It is feasible to create high-quality castings that fulfil the required standards and function well in their intended applications by carefully controlling the mould's moisture content and taking the necessary steps to maximise its strength and permeability.

FLOWABILITY

Making precise and intricate moulds for castings depends in large part on sand's capacity to fill microscopic gaps in patterns. A more exact and detailed mould is produced when the sand has a high degree of flowability because it can efficiently fill even the smallest gaps in the pattern. This is particularly advantageous for castings that need complicated and complex shapes because even the smallest deviation or mould flaw could have a big impact on the finished product. Because it can assure the production of moulds that can create accurate and detailed castings of high quality and precision, high flowability of sand is very desirable in the casting process.

GRAIN SHAPE

One crucial aspect of foundry sand evaluation is the morphology of individual sand grains. The grains are often divided into three varieties based on how rounded they are: rounded, angular, and sub-angular. Although they have an excellent surface polish and flowability, rounded grains have a weaker bonding capacity. On the other hand, angular grains have less flowability and permeability than rounded grain sands but a stronger bonding force due to interlocking. Sub-angular grains, which are better than rounded grains in strength and permeability but weaker than angular grains, lie in the middle of the two and provide a balance between strength and permeability. These grain categories are important for choosing foundry sand and affect the casted product's quality.

COLLAPSIBILITY

A highly collapsible sand mixture has many advantages, one of which is that it permits the metal casting to shrink more freely during solidification without running the

risk of hot tearing or breaking. By ensuring that the casting maintains its shape and dimensions during the cooling process, this quality helps to maintain the integrity and quality of the finished product. The ability of the mould to collapse is an important consideration when designing and producing metal castings since it helps to ensure the quality of the finished product. To do this, the right sand combination and binder must be chosen, and the mould must be built to endure the strains and pressures of casting. It is possible to create metal castings of exceptional quality and integrity, ensuring that they fulfil the required requirements and function well in their intended applications, by carefully taking the mould's ability to collapse and other important elements into consideration. In conclusion, the ability of a mould to collapse is a crucial element in metal casting and has a substantial impact on the integrity and quality of the finished product. Metal castings of high quality and performance can be created by giving the mould's capacity to endure strain and stress throughout the casting process first priority

REFRACTORY STRENGTH

It is essential that the mould does not melt, burn, or split when molten metal is poured into it. The moulding sand's capacity to tolerate high heat, which is commonly gauged by its refractory strength, must be considered in order to ensure this. For the mould to be able to survive the high temperatures needed for metal casting without losing structural integrity, this strength is crucial. To create high-quality metal castings, it is crucial to evaluate the refractory strength of moulding sand.

REUSABILITY

Reusing moulding sand after sand conditioning to create further sand castings in later manufacturing operations is crucial in the context of sand casting. Sand's capacity to be reused is crucial for cutting down on production costs and material waste while increasing manufacturing productivity. As a result, being able to reuse moulding sand is important when conducting sand casting operations since it has a big impact on the production process' sustainability and profitability,

APPLICATIONS

Using waste foundry sand in place of fine aggregate in the manufacturing of concrete can lead to concrete that is lightweight, strong, and economically viable.

Metal industries frequently employ sand casting techniques, and silica sand moulds that are clean and of the highest quality are sought. Due to the lower material costs, the reuse of waste foundry sand in the production of concrete presents an alluring option for environmentally friendly waste disposal.

Waste foundry sand can be used to produce concrete with a lighter finished product, making it ideal for situations where structural weight is less of an issue. This can apply to a variety of uses, such as the construction of high-rise buildings with lighter building materials that ease the burden on the base and other structural components. Furthermore, by lowering the quantity of trash produced by metal casting processes, the use of waste foundry sand in concrete production helps increase the sustainability of the building sector. This can lessen the negative effects these operations have on the environment and lessen the demand for pricey trash disposal techniques. To sum up, using leftover foundry sand in the manufacturing of concrete has a number of advantages, including lower material prices, lightweight concrete appropriate for a variety of uses, and increased sustainability. This waste material can be used to encourage ecologically responsible and financially feasible practises in the building sector, making it a promising option for resource utilisation and waste management.

Given the widespread usage of sand-casting systems in the metal industry, having access to a dependable source of uniformly sized, high-quality sand is crucial for ensuring both the quality of the finished product and the effectiveness of the manufacturing process. Waste foundry sand can be effectively repurposed by using it as a partial or full substitute for fine aggregate in the creation of concrete, helping to create a more sustainable and affordable manufacturing process.

WORKABILITY

A crucial factor that gauges how simple it is to compact and mould concrete is called workability. Fresh concrete's workability determines how easily it can be moved from the mixing stage to its final compacted form. While lightweight and heavy aggregates are both used to create new concrete, workability is still a critical aspect to take into account. This is due to the fact that porous lightweight aggregates can be challenging to finish well due to their low density and rough texture, especially when crushed. High slump and excessive vibration are two issues that come with employing

lightweight particles in concrete that could cause the heavier mortar to be dragged away from the surface. As a result, extra consideration must be paid to the workability of lightweight aggregate concrete mixtures.

4.5.2 SPECIFIC GRAVITY OF FOUNDRY SAND

A unitless number that indicates a substance's density in relation to water's density at a specified temperature and pressure is known as "specific gravity" or "relative gravity." To determine this value, divide the substance's density by the density of water under the given conditions. This measurement is frequently employed in a variety of sectors, as well as in scientific investigation and experimentation, to establish the purity or concentration of a product.

Specific gravity=Density of the object /Density of water

A weighing process was used to calculate the weight of the foundry sand and the container's volume. The container's weight (W1) was initially determined. The container was then reweighed after being filled with foundry sand and levelled off. (W2). The container was then filled with water till the top surface level, and it was then weighed once again. (W3). The container was then weighed once again after being filled with water and emptied. (W4). In order to accurately determine the weight and volume of the foundry sand and to enable suitable calculations to be performed in subsequent investigations, these measurements were made

SI NO	DESCRIPTION	VALUES
1	Weight of container(W1)	0.560
2	Weight of container +Aggregate(W2)	1.295
3	Weight of container + aggregate+ water(W3)	1.793
4	Weight of container+ water(W4)	1.280

Table 4.6: Specific gravity of foundry sand

4.5.3 WATER ABSORPTION FOR FOUNDRY SAND

The weights of the empty container (W_1) and the container containing the dry fine aggregate (W_2) were initially determined in order to determine the fine aggregate's water absorption capacity. The fine aggregate container was then filled with water, and it was allowed to soak for 30 minutes. After soaking, the aggregate container was taken out of the water and left to drain for a while. The container's weight containing the wet aggregate was then determined. (W_3).

The following formula was used to calculate the fine aggregate's water absorption capacity:

$$\text{Water absorption} = ((W_3 - W_2) / (W_2 - W_1)) \times 100$$

Calculation:

Weight of dry aggregate, $W_1 = 3000$ g

Weight of wet aggregate, $W_2 = 3250$ g

% of water absorption

$$\begin{aligned} &= (W_2 - W_1) / (W_2 - W_1) \times 100 \\ &= 3250 - 3000 / 3.25 \times 100 \\ &= 1.64 \% \end{aligned}$$

SI .NO	MATERIAL	VALUE
1	Foundry sand	1.64 %

Table 4.7: Determination of water absorption for foundry sand

4.6 COARSE AGGREGATE

The body or bulk of concrete is provided by aggregates, which also help to minimise shrinkage and increase concrete's cost-effectiveness. Although it was often believed that aggregates lacked chemical activity, more recent studies have shown that some varieties of aggregates can in fact possess chemical activity and can even create chemical bonds when combined with paste. Since aggregates make up between 70 and 80 percent of concrete, it is crucial to research and comprehend their qualities and traits in order to manufacture concrete that is both high-quality and long-

lasting. For the concrete to have the appropriate strength, durability, and performance, it is therefore essential to investigate the aggregates used in the concrete.

- ❖ Several tests were conducted in accordance with the instructions provided by IS:2386-1986 (IV) to ensure the acceptability of the crushed blue stone as an aggregate for concrete. The physical characteristics of the aggregate, such as its particle size distribution, bulk density, specific gravity, and water absorption capacity, were examined during these tests. The aggregate's mechanical characteristics, including its crushing strength, impact resistance, and abrasion resistance, were also tested for. These experiments provided a thorough understanding of the characteristics of the crushed blue stone, enabling a well-informed choice to be made regarding its suitability for use as an aggregate in concrete.
- ❖ Specific Gravity
- ❖ Sieve Analysis and Fineness Modulus
- ❖ Water Absorption
- ❖ Impact Strength

The aggregate was put through a number of tests in order to learn crucial details about its characteristics, including density, particle size distribution, water absorption rate, and impact resistance. These tests are an essential tool for determining whether the aggregate is suitable for use in concrete and guaranteeing the calibre of the finished product. In order to assess the compatibility of the aggregate and its effect on the overall performance of the concrete, the results of these tests are crucial.

4.6.1 SPECIFIC GRAVITY OF COARSE AGGREGATE

The container's starting weight (W1) was measured in order to ascertain the container's weight. After that, the container was weighed after being filled with coarse aggregate, leaving a tiny gap at the top. (W2). The container was then filled with water until it reached the aggregate's top surface, and it was then weighed. (W3).

Following this, the container was weighed after being filled with water. (W4). Using these values, the following calculation was used to determine the coarse aggregate's apparent specific gravity:

$$\text{APPARENT SPECIFIC GRAVITY} = (W2 - W1) / (W3 - W4)$$

Calculating the coarse aggregate's specific gravity is a crucial stage in the construction industry to guarantee the strength and quality of concrete. Specific gravity is a measurement of a substance's density in relation to water's density, and it has a big impact on the yield and toughness of concrete created from that substance. The container, the container filled with coarse aggregate, the container filled with coarse aggregate and water, and the container filled with simply water are all weighed in order to determine the specific gravity of coarse aggregate. In this procedure, the weight of the coarse aggregate is compared to the weight of an equivalent volume of water to produce an exact measurement of the coarse aggregate's specific gravity. The following formula can be used to determine the specific gravity of coarse aggregate:

$$W_2 - W_1 / [(W_3 - W_1) - (W_4 - W_1)] = \text{Specific Gravity}$$

Where W₁ is the container's weight, W₂ is the weight of the container when filled with coarse aggregate, W₃ is the weight of the container when filled with both water and coarse aggregate, and W₄ is the weight of the container when filled with only water.

To guarantee the quality and strength of the concrete built from coarse aggregate, it is essential to determine its specific gravity. Concrete with a low specific gravity may yield less and be weaker, whereas concrete with a high specific gravity may be brittle and more likely to shatter. Therefore, determining specific gravity is a crucial step in making concrete of a high calibre that satisfies industrial standards..

SI. NO	DESCRIPTION	VALUES
1	Weight of container, (W ₁)	0.560
2	Weight of container + Aggregate, (W ₂)	1.385
3	Weight of container + Aggregate + Water, (W ₃)	1.895
4	Weight of container + Water, (W ₄)	1.391

Table 4.8: Specific gravity of coarse aggregate

$$\begin{aligned}
 \text{Specific gravity of Coarse Aggregate} &= (W_2 - W_1) / (W_2 - W_1) - (W_3 - W_4) \\
 &= (1.382 - 0.560) / \\
 &\quad (1.382 - 0.560) - (1.892 - 1.390) \\
 &= 2.66
 \end{aligned}$$

4.6.2 GRADING OF COARSE AGGREGATE

Using a receiver and a series of sieves, the particle size distribution of an aggregate sample was calculated. The receiver was positioned at the bottom to collect the material that made it through the sieves. The sieves were organised in descending sequence of size, starting with the 4.75 mm sieve at the top and moving down to smaller sieves. To guarantee thorough sifting, a 1 kilogramme air-dried sample was put on the top sieve and sieved for 15 minutes. For additional investigation, the residue on each sieve was precisely weighed. The findings of the experiment offer important knowledge on the distribution of particle sizes in the aggregate sample.

SI.NO	IS SIEVE SIZE	WEIGHT RETAINED	PERCENTAGE WEIGHT RETAINED	CUMULATIVE% RETAINED	% OF PASSING
1	80 mm	0	0	0	100 %
2	40 mm	0	0	0	100 %
3	20 mm	1.355	45.167	45.167	54.833%
4	10 mm	1.555	51.833	97.000	3.00 %
5	4.75 mm	0.090	3.000	100	0 %

Table 4.9: Grading of coarse aggregate.

$$\% \text{ of weight retained} = \text{Sum of cumulative retained} / 100$$

$$= 242.167 / 100$$

$$= 2.42 \%$$

$$\% \text{ of finer} = 100 - (\% \text{ of weight retained})$$

$$= 100 - 2.421$$

$$= 97.579 \%$$

Result:

% of weight retained = 2.421 %

% of finer = 97.579 %

4.6.3 DETERMINATION OF WATER ABSORPTION FOR COARSE AGGREGATE

The weight of the empty container (W_1) and the container containing the dry coarse aggregate (W_2) were both measured in order to calculate the coarse aggregate's water absorption. After that, water was added to the aggregate, and it was let to soak for 30 minutes. The basket with the wet aggregate was then taken out of the water and left to drain for a little while. The following formula was then used to determine the aggregate's water absorption capacity.

percentage of water absorption = $(W_2 - W_1) / W_2 \times 100\%$

Calculation

Weight of Dry aggregate, $W_1 = 3000$ g

Weight of Wet aggregate, $W_2 = 3080$ g

% of water absorption = $(W_2 - W_1) /$

$(W_2) \times 100 = (3080 - 3000) / (3080) \times 100$

= 2.59 %

4.6.4 DETERMINATION OF IMPACT VALUE OF COARSE AGGREGATE

Aggregate material with a size range of 10–12.5 mm was used in the experiment. The material was heated at a temperature between 100 and 1100 C for 4 hours to dry it. After cooling, the material was sieved through 12.5 mm and 10 mm IS sieves. For the experiment, the material that made it past the 12.5 mm sieve but was caught on the 10 mm sieve was employed. The aggregate was then compressed in three layers of equal thickness inside a mould. Following the weight of the aggregate being added to the mould, the weight of the empty mould (W_1) was recorded as W_2 .

This experiment was carried out to ascertain the aggregate material's crushing strength under the specified circumstances.

Impact value = (Weight of aggregate passing through 2.36mm sieve) x (100)/(Weight of aggregate)

4.7 WATER

Water plays a critical role in the chemical reaction taking place between cement and other components in concrete. Water actively contributes to the cement's binding, which ultimately decides the final product's strength. The production of unfavourable spaces or capillaries in the cured cement, however, might result from using too much water, which can considerably reduce the cement's overall quality and durability. The amount of water in concrete should be kept to a minimum essential for the chemical reaction of un-hydrated cement in order to ensure optimal strength and quality. voids and capillaries, which might jeopardise the concrete's structural integrity, will be less likely to form as a result. In order to achieve the appropriate strength and quality of the finished product, it is crucial to balance the amount of water used in concrete. The water-cement ratio during the mixing process can have a significant impact on the final qualities of the concrete if it is carefully considered and controlled. The compatibility of the chemical additive, water, and other elements used in concrete manufacture is essential for efficient mixing. Although it is frequently stated in concrete rules and literature that any water appropriate for drinking is also suitable for creating concrete, this may not always be the case. Water that is safe for drinking might not always be appropriate for use in cement concrete, even though it might be okay for consumption.

For instance, the hydration process and, consequently, the overall quality of the concrete, might be negatively impacted by the presence of sugar in water.

1. Due to the greater quantity of heat produced during the hydration process, concrete with a high cement content can quickly lose its workability. Therefore, it is critical to prevent any large changes in cement's early hydration rate.

2. The growth of concrete's strength over time is largely unaffected by the presence of salt in water.

3. After a predetermined curing interval, durability factors such porosity, resistance to CO₂ diffusion, resistance to CaSO₄ moisture, and air oxygen resistance should be carefully assessed in addition to strength considerations.

4. In the process of making concrete, water-to-cement ratios normally range from 0.40 to 0.55.

5. It is crucial to remember that a combination with a higher aggregate-to-cement ratio will produce better strength for a given water-to-cement ratio.

6. According to the study, utilising crushed granite as coarse aggregate in concrete mixtures with a water-cement ratio of less than 0.4 that has a maximum size of 10mm or 20mm results in greater compressive strength than using gravel.

7. On the other hand, utilising gravel as coarse aggregate resulted in greater workability and somewhat higher strength as compared to employing crushed granite for combinations with a water-cement ratio higher than 0.4.

The commonly used Abram's water-cement ratio law holds true for high strength concrete within the typical range of concrete compositions. It should be noted that additional elements can affect the strength of high strength concrete.

1. Aggregate cement ration
2. Type and maximum size of coarse aggregate used
3. The stiffness of the mix
4. The compaction method employed

4.8 CONCRETE MIX DESIGN

4.8.1 GENERAL

A crucial step in the production of concrete is mix design, which involves calculating the right proportions of different components to produce the desired attributes, such as strength, durability, and consistency, while keeping costs in mind. Finding the ideal mixture of elements that will generate concrete with the appropriate properties is the main goal of mix design. The mix proportions must be carefully chosen to guarantee that the finished product meets the necessary requirements. In order to get the desired workability of the fresh concrete, which makes it easier to handle, transport, and compact into the desired shape or form, it is necessary to calculate the perfect quantities of each component. Since mix design directly affects the overall quality of the finished product, any mistakes or omissions made at this stage could have serious repercussions. Therefore, it is crucial to use a systematic

approach and the right testing techniques to confirm the mix design and guarantee that the finished product complies with the necessary standards.

As a result, mix design is an essential step in the creation of concrete, and its success necessitates a thorough knowledge of the traits and tendencies of the individual components. It is feasible to create concrete that satisfies the necessary standards while maintaining its simplicity of handling and installation by selecting the proper mix proportions and using relevant testing methodologies.

4.8.2 OBJECTIVE

Two things are the main objectives of concrete mix design.

- The first goal is to achieve the concrete's minimum needed strength.
- The second objective is to produce the most economical concrete mix feasible.

For all varieties of concrete, the expenses of mixing, moving, and curing concrete are largely uniform.

With a focus on lowering the amount of cement required, the mix design process in the manufacturing of concrete strives to optimise material use and reduce costs. Finding the ideal material mix can help to maximise cement's efficiency and lower overall production costs because cement is one of the more expensive components of concrete. It is feasible to determine the most cost-effective method of achieving the desired concrete attributes, such as strength and durability, without losing quality by carefully choosing the appropriate mix proportions. This may entail replacing a portion of the cement with less expensive materials like fly ash or slag that have comparable characteristics. To determine the optimal mix proportions for the particular application, the mix design process often entails conducting laboratory tests on various material combinations. Once the best mix design has been found, it can be applied to make concrete with the desired properties while keeping the cost of materials to a minimum. In conclusion, the mix design process is an important part of producing concrete that aims to cut costs by maximising the use of ingredients, especially cement. It is feasible to obtain the desired qualities of the concrete while reducing production costs by selecting the optimal combination of components and altering the mix proportions accordingly.

4.8.3 MIX DESIGN

Concrete Mix Design of M25 by LS code Method (IS 10262-2009):

In order to produce concrete that meets minimum strength and durability criteria while still being as cost-effective as feasible, the mix design process entails selecting the right concrete materials and determining their relative proportions.

a. Making sure that the concrete reaches the required minimum strength and durability is the main goal of mix design.

b. Finding the most economical way to create concrete is the secondary goal.

4.8.3 i) Design stipulation

- 1) designation of grade: M25
- 2) Cement type: OPC 53 grade according to IS8112
- 3) aggregate nominal size at its maximum: 20 mm
- 4) smallest amount of cement: 340kg/m³
- 5) Maximum cement to water ratio:0.43
- 6) Workability :50 mm
- 7) Exposure circumstance: Extreme
- 8) Continuity of supervision: Very Good
- 9)Crushed angular aggregate is the type of aggregate.
- 10) highest level of cement: 450kg/m³
- 11) Chemical admixture type: Super plasticizer

4.8.3 ii) Test data for material:

- 12) Utilised cement: OPC 53 grade compliant to IS8112
- 13) Cement's specific gravity is 3.15.
- 14) Chemical admixture: Super plasticizer
- 15) A coarse aggregate's specific gravity is 2.89, whereas a fine aggregate's is 2.6.

16) Sieve analysis: Zone III for fine aggregate.

4.9 MIX PROPORTION

0% of Foundry sand	Cement (kg)	Fine Aggregate (kg)	Foundry Sand (kg)	Coarse Aggregate (kg)	Water (kg)
0	8.5	21	0	16.25	4.25
15	8.5	17.85	3.15	16.25	4.25
25	8.5	15.75	5.25	16.25	4.25
35	8.5	13.65	7.35	16.25	4.25

Table 4.10 : Proportions of concrete material at different percentage



Figure 4.2: Mixing of Concrete



Figure 4.3: cube blocks



Figure 4.4: removing mould



Figure 4.5: curing concrete cubes



Figure 4.6:measuring foundry sand

CHAPTER 5

RESULT AND DISCUSSION

5.1 COMPRESSION TEST

A compressive strength test was carried out on a set of 24 cubes with dimensions of 150 x 150 x 150mm. Prior to the testing, workability tests were performed on the cubes. The elastic modulus of the cubes was assessed after 7 days , 14 days, and 28 days after casting. The following table provides a summary of the test results:

Sl. No	Mix Designation	Aggregate Replacements%	Compressive strength of M25 grade in N/mm ²		
			7 th Day	14 th Day	28 th Day
1	A0	0	17.9	23.8	26.6
2	A1	15%	18.7	22.9	26.1
3	A2	25%	17.1	21.8	24.6
4	A3	35%	16.9	20.7	22.4

Table 4.11: Show result of compression strength cube test



Figure 5.1: Compression test of concrete cube



Figure 5.2 : compression test of concrete cubes

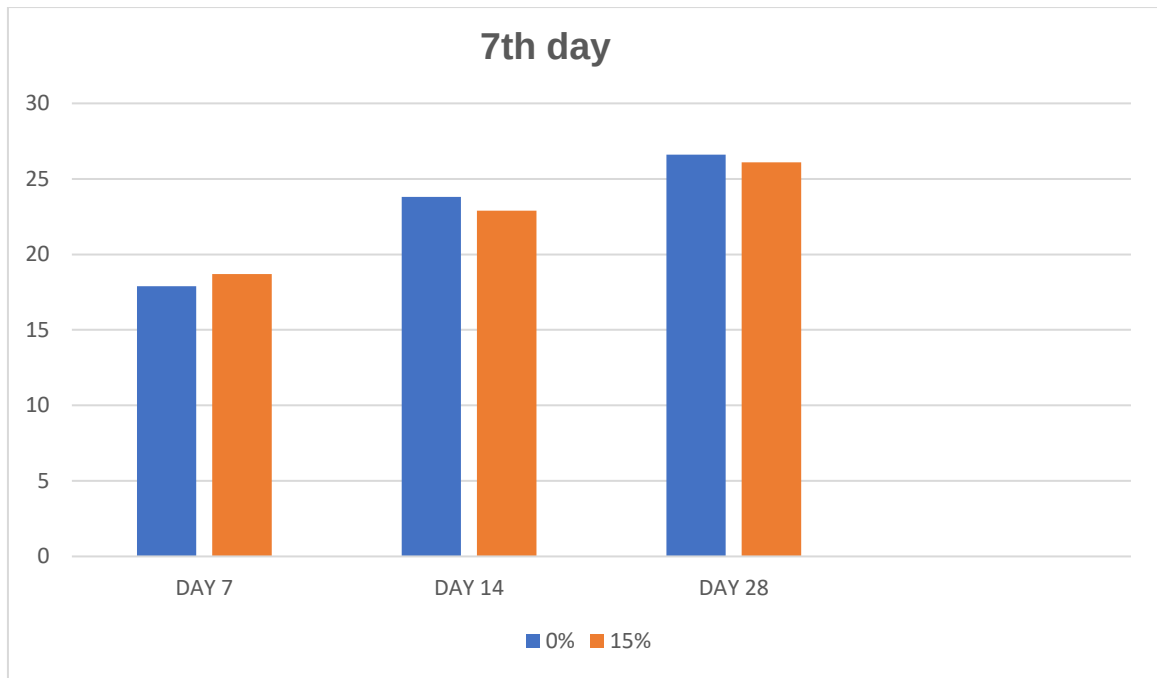


Figure 5.3:Comparison of compressive strength of 7th day

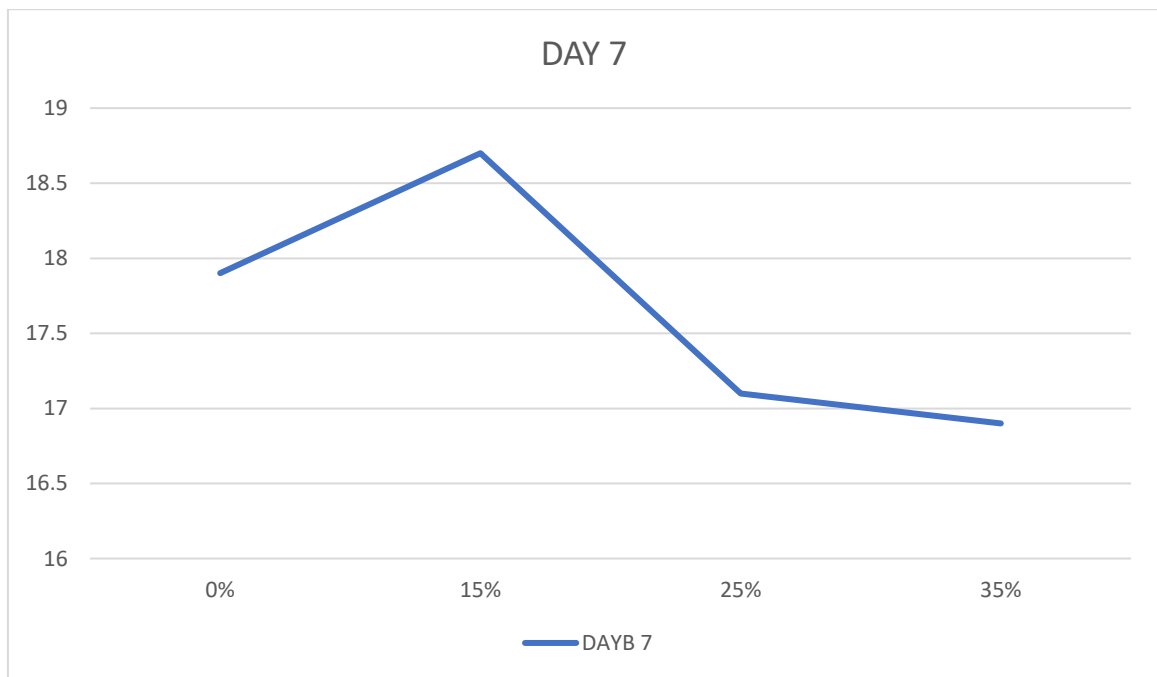


Figure 5.4:Compressive strength for 7th day

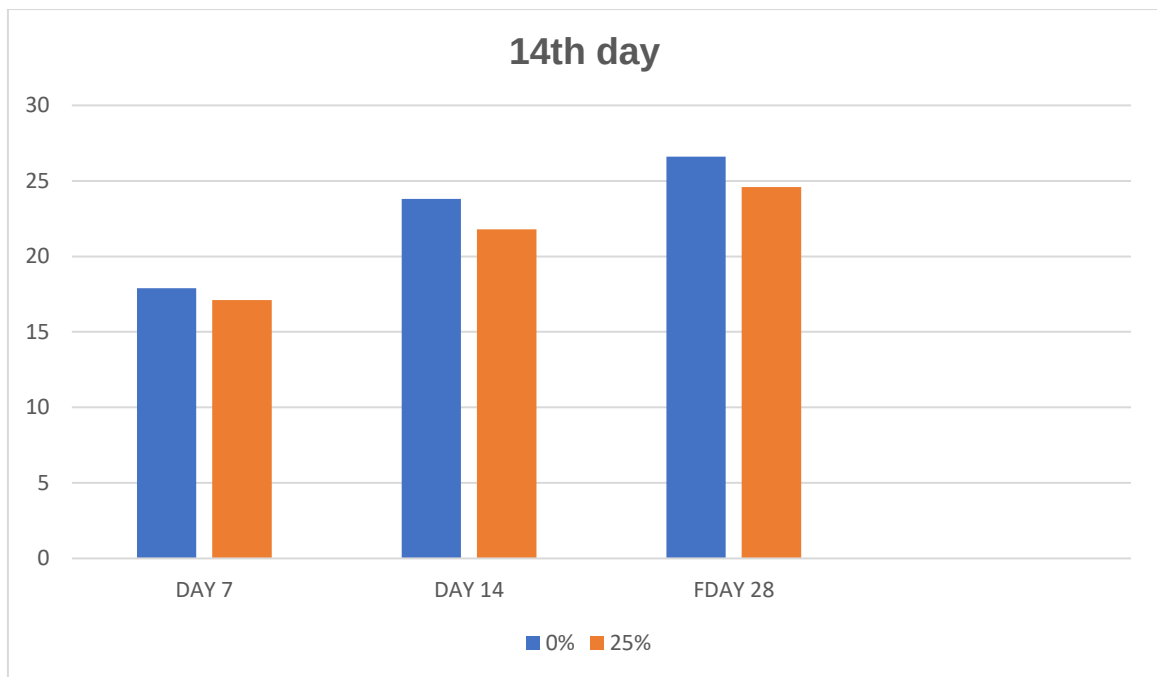


Figure 5.5: Comparison of compressive strength for 14th day

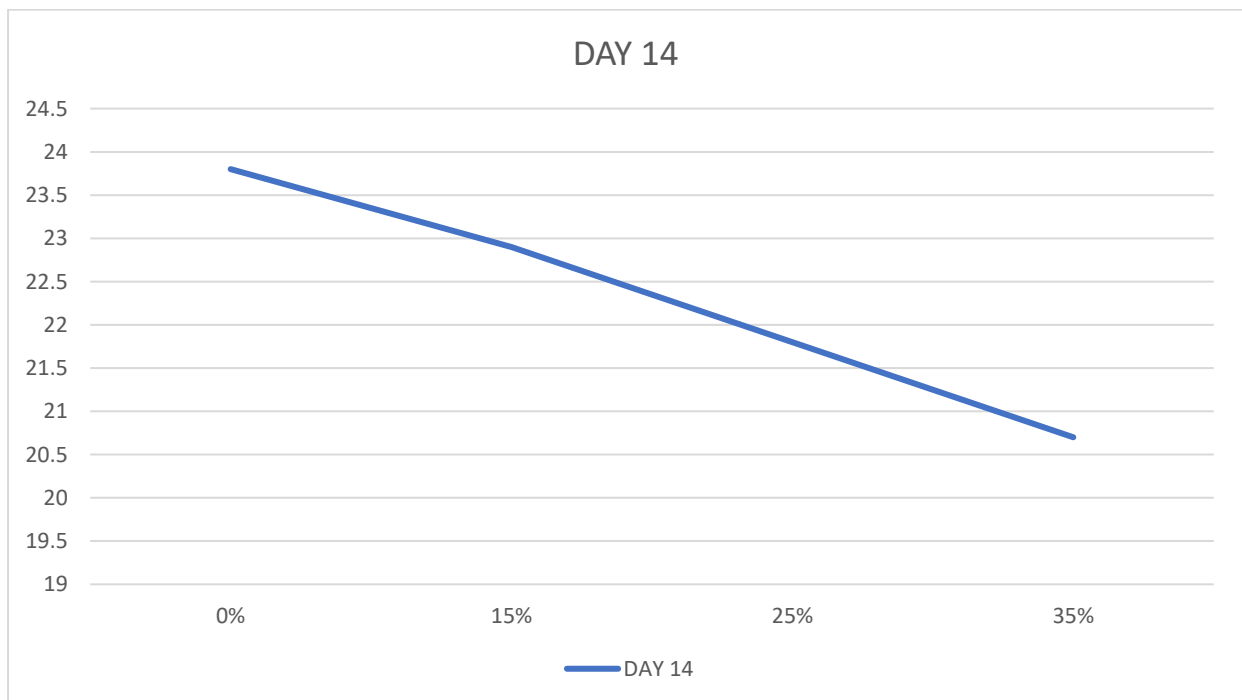


Figure 5.6: Compressive strength for 14th day

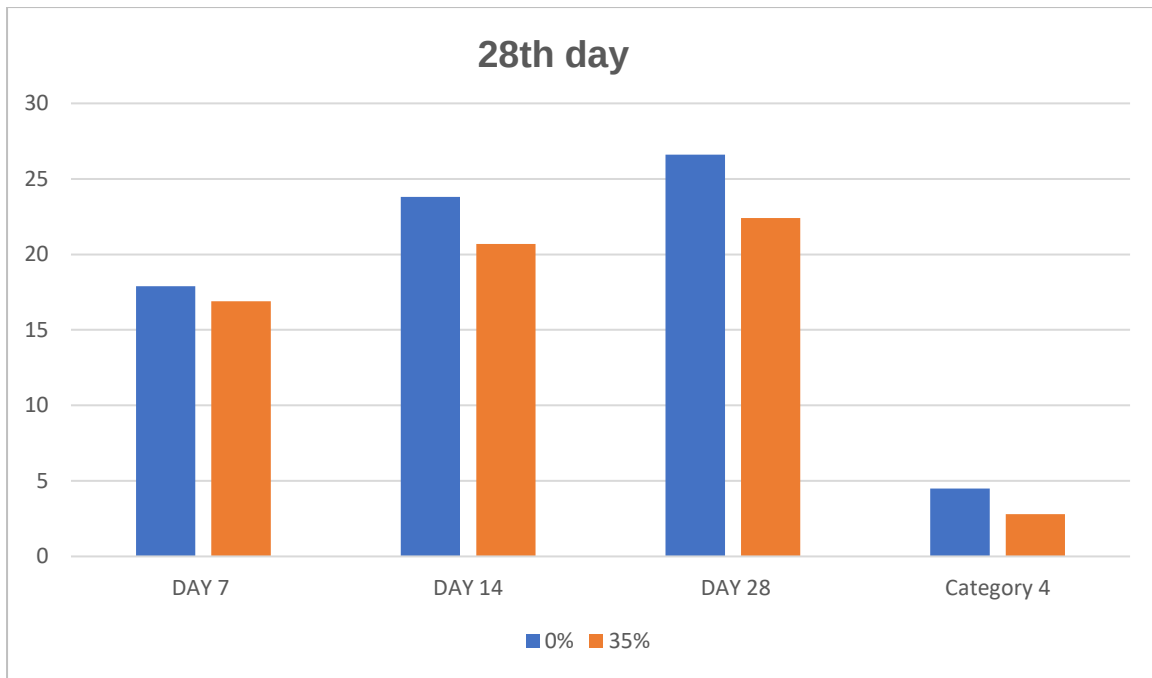


Figure 5.7: Comparison of compressive strength for 28th day

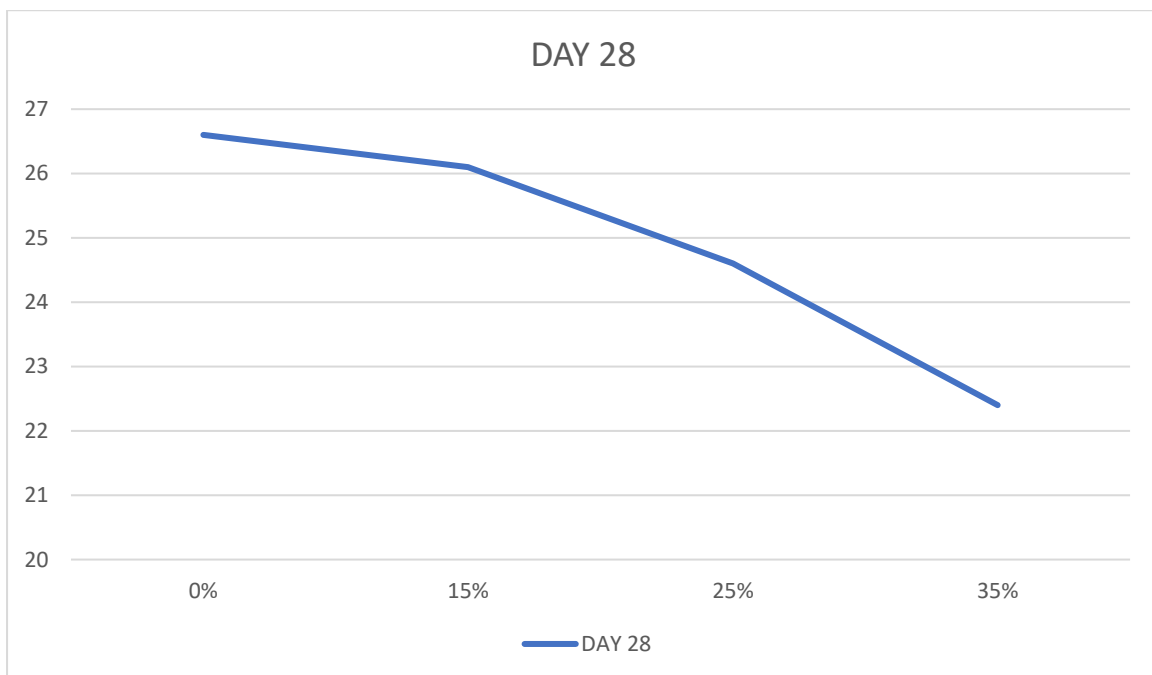


Figure 5.8: Compressive strength for 28th day

The test findings show that using Foundry sand aggregates in place of traditional aggregates can result in concrete with qualities similar to those of traditional concrete.

The concrete in mixtures' compressive strength A1, A2, and A3 differed from ordinary concrete (A0) by 4.3%, 4.5, and 5.7%, respectively, after 7 days of curing. After 14 days of curing, the compressive strength of concrete in mixes A1, A2, and A3 differed from ordinary concrete (A0) by 3.8%, 8.7%, and 13.9%, respectively. The concrete in mixtures' compressive strength A1, A2, and A3 differed from ordinary concrete (A0) by 1.8%, 7.8%, and 17.1%, respectively, after 28 days of curing.

A1 mix, which substituted 15% of its using foundry sand with fine aggregate aggregates, had the most significant compressive strength of all the mixtures in terms of strength performance.

CHAPTER 6

CONCLUSION

- In this project, waste foundry sand will be substituted for fine aggregate at varied ratios ranging from 0% to 60% to produce lightweight concrete. However, there is a problem when used foundry sand is used with concrete.
- To determine the optimal outcomes, an extensive analysis was done. According to the study, when compared to typical concrete's waste composition as a % foundry sand increased with an increase in compressive strength.
- The study discovered that a 40% substitution of fine aggregate with used foundry sand produced the best compressive strength. Concrete is a green building material because it uses discarded foundry sand, which lowers waste generation in the metal industry.
- Additionally, this lowers the expense of maintaining landfills and disposing of waste.

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