

FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAM BY UTILIZING TANNERY SLUDGE AS A FINE AGGREGATE

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

By

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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 JOSHUA SAM JOSEPH.S (Reg.No.38200014) and SARAVANA KUMAR.R (Reg.No.38200031) who carried out the project entitled **"FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAM BY UTILIZING TANNERY SLUDGE AS A FINE AGGREGATE"** under my supervision from November 2021 to May 2022.

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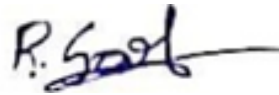
DECLARATION

We of **JOSHUA SAM JOSEPH.S (Reg.No.38200014)** and **SARAVANA KUMAR (Reg.No.38200031)** hereby declare that the Project Report entitled "**FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAM BY UTILIZING TANNERY SLUDGE AS A FINE AGGREGATE**" done by us under the guidance of **Dr.R.PADMA PRIYA** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

1.



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ABSTRACT

Concrete is a most common material which is commonly used in all types of civil engineering works. The demand for aggregates is more in current situation and on the other side the industries are producing a large number of tanning wastes from the leather industries cause of this dumping and contamination of these tannery wastes it affects the environment and causes some disposal problems. So, the experimental studies carried on the tannery solid wastes to introduce it with concrete and make it as a partial replacement in reinforced concrete. In this study, by partially replacing of fine aggregate with tannery sludge with some limited percentage 0%, 10% ,20%, 30% in volume. Two grades have been selected M20 and M25 specimens are casted and tested for both grades. The size of concrete cube is 150mm by 150mm by 150mm, the size of concrete cylinder is 300mm height ,150mm diameter, the size of concrete prism is 100mm by 100mm by 500mm, the size of Reinforced concrete beam is 230mm by 230mm by 1000mm. So, these specimens are been casted and cured for 28 days and these specimens are tested to found the mechanical properties by compressive strength test for cube is done on 7th day, 14th day and 28th day respectively, split tensile test for cylinder is done on 28th day, flexural strength test for prism is done on 28th day, flexural strength test for RC Beam is done on 28th day respectively. And to compare the results with the normal conventional concrete with tannery sludge replaced concrete where the specimens undergo heavy loading conditions. So as a result, the compressive strength and tensile strength of 30% replacement of tannery sludge is a bit higher than the normal conventional concrete.

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CHAPTER-1

INTRODUCTION

1.1 GENERAL

Concrete is weak in tension. Micro-cracks begin to generate in the matrix of a structural element at about 10 to 15% of the ultimate load, propagating into macro-cracks at 25 to 30% of the ultimate load. Consequently, plain concrete members cannot be expected to sustain large transverse loading without the addition of continuous bar reinforcing elements in the tensile zone of supported members such as beams or slabs.

They have proven that they can improve the mechanical properties of the concrete, both as a structure and a material, not as a replacement for continuous reinforcement when it is needed but in addition to it. Such a weakness is partially overcome by the addition of reinforcing bars, which can be either steel or fiberglass, as main continuous reinforcement in beams and one-way and two-way structural slabs or slabs on grade (Nawy and Neuw-erth, 1977; Nawy et al., 1971). They are able to add to the stiffness and crack-control performance by preventing the micro crack.

1.2 CONCRETE

Concrete is one of the most versatile building materials. It can be cast to fit any structural shape. It is readily available in urban areas at a relatively low cost. Concrete is strong under compression yet weak under tension and a relatively brittle material. As such, a form of reinforcement is needed. The most common type of concrete reinforcement uses steel bars. The advantages to using concrete include high compressive strength, good fire resistance, high water resistance, low maintenance, and long service life. The disadvantages to using concrete include poor tensile strength, and form work requirement.

1.3 REINFORCED CONCRETE

Reinforced concrete (RC) may be a versatile composite and one of the foremost broadly utilized materials in present day development. Concrete may be a generally delicate material that's solid beneath compression but less so in pressure. Plain, unreinforced concrete is unacceptable for numerous structures because it is moderately destitute at withstanding stresses initiated by vibrations, wind stacking, and so on. The longitudinal rebar in a beam stands up to flexural (tensile stress) while the stirrups, wrapped around the longitudinal bar, stand up to shear stresses. In a column, vertical bars stand up to compression and buckling stresses whereas ties stand up to shear and give imprisonment to vertical bars. Use of reinforced concrete makes for a great composite material with broad applications. Splits in reinforced concrete individuals extend freely until experiencing a rebar. The require for multidirectional and closely divided support for concrete arises.

1.4 TANNERY SLUDGE

Tannery wastes generated in leather industries contribute mainly skin trimmings, Keratin wastes, fleshing wastes, chrome shaving wastes and buffing wastes. It constitutes protein as the main component. If these protein and other chemicals, which are present in the chemical treated protein, are not utilized properly it will pose hazardous pollution problem to the environment.

The tannery waste generation is ever expanding due to setting up of modern industries to meet out the national demand and based on the government send out & trade policy to make work opportunity and revenue generation. As a part of waste to wealth concept the common resources utilized for manufacturing of building construction material can be reused by in tannery waste materials after ascertaining their chemical and physical characteristics. Volumes of tannery sludge are expanding all over the world. The sludge from leather handling comprises of natural and inorganic substances. The chemical composition of inorganic substances commonly displayed in tannery sludge.

CHAPTER-2

LITERATURE REVIEW

2.1 GENERAL

The literature review gives the necessary background data on concrete technology in common, together with materials utilized for concrete fabricating with a strong center on concrete. The fine and coarse concrete totals are reviewed in terms of their properties, and the testing procedures utilized in the characterization of reinforced concrete total are also surveyed.

The main purpose of literature review is to give an idea about the research work conducted in the world. This forms the basis on which one can carry out the work and techniques that can be used for conducting experiments. The following literature review elaborates the research studies made on partial replacement of tannery waste as a fine aggregate concrete.

2.2 LITERATURE REVIEW

R.N. Swamy, G.H. Lambert (1984),

These Tests are reported for the flexible behavior of reinforced concrete beams made of fly ash aggregates and sands. It turned out to be better a short-term deviation rate can be obtained if the contribution of concrete in stress is ignored. Some of the bars may not be fully satisfied for a long time-Deviation deviations from the term and this aspect should be considered in the design. It is shown that fly aggregate concrete beams can provide a satisfactory structure performance.

Md. Abdul Mannan, John V.Kurian (2006),

This paper introduces an investigation into the flexural behavior of reinforced concrete beams produced in oil palm shell (OPS) aggregates. Using OPS in concrete production not only solves the problem of disposing of this solid waste and also helps conserve natural resources. The study revealed that the flexibility of the reinforced concrete OPS beams was comparable to that of other lightweight concrete and the test results are well compared to current codes IS 2006: 13608 which is used.

M.R. Esfahani, M.R. Kianoush (2007),

This paper investigates the flexible behavior of reinforced concrete beams reinforced using sheets of Carbon Fiber Reinforced Polymers (CFRP). The effect of tightening the bar ratio on the flexible strength of the reinforced beams is tested. 12 (Twelve) examples of concrete beams of large size were made and tested. Beam sections with three different degrees of reinforcement are calculated.

Uma Shankar, G. Narayana (2008),

The main objectives of the research of this work are to recycle the used foundry sand produced in the Foundry industries as part of a good replacement for a good percentage. Although, the main research to be done is about the flexible behavior of reinforced sand beams, in order to facilitate the measurement of Foundry sand concrete, compressive strength studies are also being conducted. The beams will be provided with sufficient shear reinforcement so that the beams failure is flexible.

AlbertoMeda, Fausto Minelli Giovanni (2012),

In this Research studies have demonstrated the effectiveness of Fibre Reinforced Concrete (FRC) in improving the structural response of with rather tough Fiber Reinforced Concrete and so this is having a low strain-hardening ratio of the longitudinal rebars, the rotation capacity can substantially decrease localization at ultimate limit state. Experimental results evidence that fibres, when

provided in sufficient amount, are able to move the beam failure from concrete crushing to steel rupture. Under certain circumstances, the overall ductility, measured in terms of displacements, may decrease.

Sonia Hassan (2014),

The result showed that up to 5% mud / cement met the requirement for both physical and chemical properties. The recurrence test also confirmed the first test results obtained in 5% of the addition of cement mortar to the concrete. In both cases 15% of the energy was created compared to sludge-free concrete. The main objective of this study was to assess the feasibility of heavy metals in tannery mortar with a mixture of concrete and to test the usefulness of mixed concrete mortar. in the construction work.

A. Jayaprithikaa, K. Sekar (2016),

In this study the stress behavior of the coconut shell concrete consisting of granulated blast furnace slag and manufactured sand was found and was consistent with the popovics model. M20 coconut shell concrete was obtained using 401 kg / m³ of cement for medical concealment. The flexible behavior of a lightweight and hardened coconut shell shell designed in the form of a border using real stress behavior is similar to the test values. The deviation and fracture of the coconut shell crack compared to the permissible values given by IS 456: 2000, ACI-318.

M.P.RAJ, Dr.N. Vasudevan (2016),

The current study was to evaluate the use of fabric mud and tannery mud in the production of concrete blocks. The experimental study was designed to detect the compressive strength of blocks at intervals of 7 days and 28 days depending on the level of testing. The results of the study will not only be useful for the recycling of waste as a resource but also for reducing the impact due to the disposal of mud and cloth. Accordingly, the design combination is made of M15 level concrete and the test is performed with a pressure test machine. It was found that the best results were obtained with a 15% change in fabric and leather and a 20% change in the textile sludge.

Faizal Ahmad Zaid, M. Ibrahim (2017),

In this study, a study to assess the suitability of tanned waste as a substitute for a fraction of the total fine for concrete works was performed. Mechanical structures such as Compressive power and Split tensile power were made. Percentage change of part of the fined compound with tannery mortar respectively 0%, 10%, 20%, 30%, 40% and 50%. It was found that the best results were obtained by 30% instead of tannery mud of less aggregate.

Shayani Mendis, SafatAl-deen (2017),

This paper investigates the dynamic behavior of reinforced beams made of Crumbed Rubber Concrete (CRC) compounds of the same compressive strength. For this purpose, twelve beams of the same reinforcement systems and support conditions were prepared using six different CRC compounds. These beams were tested for failure under a two-point bending load, and their variable responses were measured during the test. An examination of the corresponding assets of the content is also performed. These test results were used to compare the beam response between beams made with the same strength of CRC mixes. The effectiveness of the available guidelines for designing concrete concrete, in predicting the flexibility of CRC beams is also investigated.

V. Tamil Thendral, K. Sachin Anand (2018),

This experimental study was performed to test the compressive strength of the concrete. Attempts have been made to evaluate the use of tannery mud in an appropriate mud stabilization system to reduce the accumulation of heavy metal in the skin mud. The sludge of the tannery is slightly modified to form a 20mm solid aggregate in the M35 level of concrete and the mixing rate is 5%, 10% and 15% respectively. A large number of 150x150x150 mm concrete cubes discarded with tannery sludge as coarse aggregates and cube pressure values are determined for 7 days, 14 days and 28 days with a different percentage of sludge in concrete.

Samuel Ehikhuenmen, Efe Ewaen Ikponmwosa's (2018),

The paper presents results of the investigation conducted to evaluate the types of the flexural performance of reinforced and reinforced concrete beams with ceramic waste as replacement of coarse aggregate. A total of forty-five (45) nonreinforced beams (150x150x750mm) and ten (10) reinforced beams (150x250x2150mm) were used to investigate the flexural behavior of the specimens. The flexural parameters investigated are crack formation and pattern, failure mode, ultimate load, theoretical and experimental ultimate moments, and deflection. From the results of the investigation, the increase in ceramic waste content led to substantial decrease in the failure load which produced higher experimental moments when compared to theoretical moments.

B. Parthiban, S. Thirugnanasambanda (2019),

The glass is recycled permanently without losing quality. This paper offers a variety Concrete range such as M 20, M 40 and M 60 is a properly recycled glass assembling as another method of making concrete. The paper covers various stages of concrete in the correct form of recycled glass as another method concrete test results are compared with the modeling of the object being used ANSYS software.

M. Jothilingam, Pratheeba Paul (2020),

Modern methods of disposal of mud such as Composting, landfill, anaerobic digestive systems do not give a satisfactory result. Tannery sludge about 150000 TPA generation creates chromium pollution and contaminates water bodies and the earth and the dangers to the eco-system. so that contributes to agricultural production therefore, Tannery is classified under the red category. Industrial waste is promoted worldwide and internationally as a remedy to reduce heavy metals from industrial waste. In this review the effect of diversity architectural research natural clay, ceramic and cement-based reinforcement skin mud was discussed and research gap was identified.

CHAPTER-3

SCOPE AND OBJECTIVE

3.1 OBJECTIVE

- ❖ To Find out the chemical properties of Tannery sludge.
- ❖ To find out the mechanical properties of Concrete (Compressive strength, Split tensile strength, Flexural strength, Acid Attack, Alkali Attack).
- ❖ To Determine flexural behaviour of reinforced concrete beam.

3.2 SCOPE OF THE STUDY

In this study, by partially replacing of fine aggregate with tannery sludge with some limited percentage 0%, 10% ,20%, 30% in volume. Two grades have been selected M20 and M25 specimens are casted and tested for both grades. The size of concrete cube is 150mm by 150mm by 150mm, the size of concrete cylinder is 300mm height ,150mm diameter, the size of concrete prism is 100mm by 100mm by 500mm, the size of Reinforced concrete beam is 230mm by 230mm by 1000mm. So, these specimens are been casted and cured for 28 days and these specimens are tested to found the mechanical properties by compressive strength test for cube is done on 7th day, 14th day and 28th day respectively.

CHAPTER-4

MATERIALS AND METHODOLOGY

4.1 MATERIALS

4.1.1 CEMENT

Cement has different properties and characteristics which depend upon their chemical compositions. It is regularly utilized for the reinforced concrete buildings, bridges, pavements, and where soil conditions are ordinary. It is additionally used for most of concrete masonry units. The most commonly used cement these days could be a hydraulic cement known as Portland cement. These are ordinarily the fundamental in making concrete, which could be a development material utilized as a load-bearing element. Cement used in the experimental work is Ordinary Portland Cement of 53 grades.

Table 4.1: Properties of Cement

S.NO	TEST	RESULT	IS LIMIT
1.	Specific gravity	3.12	3.15
2.	Setting time (min)	287	600(Max)
3.	Fineness of cement	1.88	10(Max)

4.1.2 AGGREGATES

Aggregate materials are utilized in building and development for blending with cement, bitumen, lime and gravel to form concrete or mortar. Aggregates, which account of 70 to 75 percent of the whole volume of concrete, are separated into two particular categories which are fine and coarse. Normal aggregates are for the most part used in normal state having rock parts, or are used after mechanical handling such as crushing, washing, and measuring.

4.1.2.1 Fine Aggregate

Fine aggregates are essentially normal sand particles from the arrive through the mining procedure. Aggregates less than 4.75 mm in measure are called fine aggregates. Natural sand has a perfect shape for utilize as fine aggregate in concrete. Well-shaped natural sand is perfect for workability of mix. Natural sand does not require more water to enhance the workability. Manufactured sand or manufactured fine aggregate is created by diminishing bigger pieces of aggregate into sand-sized aggregate particles. Manufactured sands tend to be flakier and more angular due to the smashing process.

Table 4.2: Properties of Fine Aggregate

S.NO	TEST	RESULT	IS LIMIT
1.	Specific gravity	2.672	-
2.	Water absorption (%)	1.61	-



Fig: 4.1: Fine Aggregate (M-Sand)

4.1.2.2 Coarse Aggregate

Coarse aggregate is stone which are broken into little sizes and irregular in shape. In construction work the aggregate are utilized such as limestone and rock or river total. Gravels constitute the larger part of coarse aggregate utilized in concrete with crushed stone making up most of the remaining portion. Coarse aggregate possesses 75% of the space in concrete. Concrete Mix is created by numerous ingredients or components but is for the most part made up of a material called Coarse Aggregates and they are one of the fundamental components of concrete and involve large volumes within the concrete mix. Materials that are larger to be held on 4.75 mm sieve measure in coarse aggregate.

Table 4.3: Properties of Coarse Aggregate

S.NO	TEST	RESULT	IS LIMIT
1.	Specific gravity	2.73	-
2.	Water absorption (%)	0.60	-
3.	Impact value (%)	14.24	30(Max)

4.1.3 Tannery Sludge

Tannery Sludge is a solid waste material obtained from tannery industries; Volumes of tannery sludge are expanding all over the world. The sludge from leather preparing comprises of natural and inorganic

substances. The chemical composition of inorganic substances commonly presented in tannery waste Normal sludge from tanneries includes a exceptionally high concentration of natural stack most of it being biodegradable, and high nitrogen substance, since the skin is made up of proteins, keratins, In expansion, natural compounds are connected within the tanning process. moreover, sludge contains inorganic compounds and a really high salt substance which also contains chromium and comes about in high levels of alkalinity.



Fig: 4.2: Tannery Sludge

Table 4.4: Physical Characteristic of Tannery Sludge

S.NO	TEST	RESULT
1.	Appearance	Fine powder
2.	Colour	Grey
3.	Odour	Yes
4.	Fineness Modulus	6.25%
5.	Water Absorption	1.25%
6.	Specific Gravity	1.70

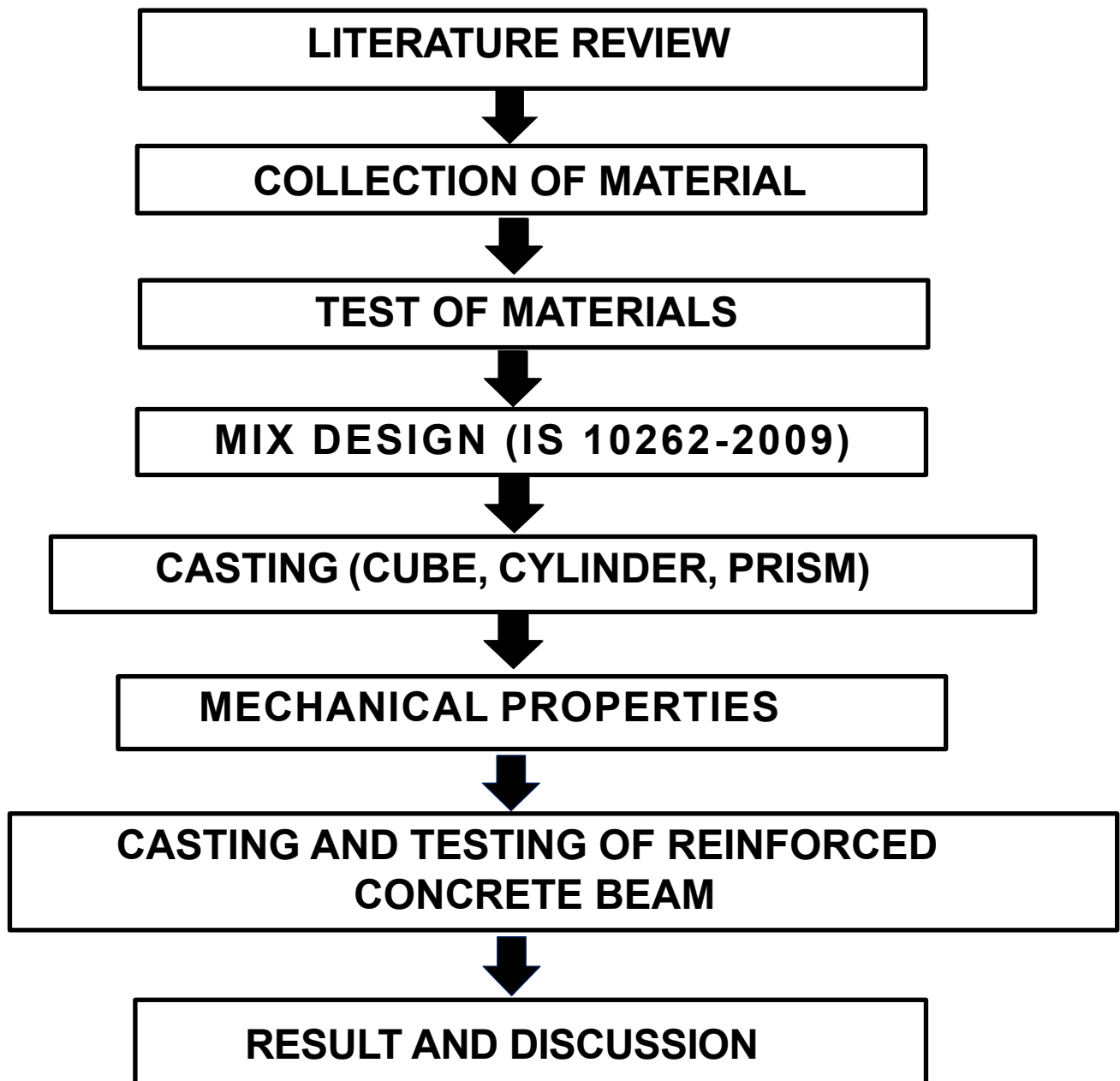
Table 4.5: Chemical Characteristic of Tannery Sludge

S.NO	TEST	RESULT(%)
1.	Silica Dioxide	6.1
2.	Aluminum oxide	66.12
3.	Chloride Content	1.43
4.	Chromium Oxide	0.85
5.	Phosphorous Pent Oxide	0.06
6.	Sodium Oxide	0.18
7.	Calcium Oxide	23.52
8.	Potassium Oxide	0.07

4.1.4 WATER

Clean potable water was utilized for blending and curing of concrete. Water has been tested and affirms the necessity. Consumable water is reasonable as mixing water for cement concrete, plain cement concrete, reinforced cement concrete for road development and other applications, since its chemical composition is also known and well controlled. The amount of water in concrete controls numerous fresh and strengthened properties in concrete as it contains workability and compressive qualities, penetrability and solidness and weathering, drying shrinkage and potential for splitting. For these reasons, restricting and controlling the sum of water in concrete is vital for both constructability.

4.2 METHODOLOGY



4.3 CONCRETE MIX DESIGN

4.3.1 MIXING PROCEDURE

Mixing Proportion is known as the method of selecting appropriate ingredients of concrete and deciding their relative amounts with the objective of producing a concrete of the desired, quality, strength, and workability as financially as conceivable, is named the concrete mix design. The proportioning of ingredient of concrete is represented by the specified performance of concrete in specifically the solidified states. In case the concrete isn't workable, it cannot be appropriately set and compacted. The property of workability, subsequently, gets to be of vital significance. cement is essentially one of the ingredients of concrete. It is a great binding substance that permits concrete to set, strengthen, harden and follow to other materials. Concrete mixes are classified as conventional mix and design mix. Nominal mix is adopted for little scale developments whereas design mix concrete is received for vital or large-scale construction work. Concrete mix plan could be a specialized strategy to choose the suitable extents of ingredients to attain the specified quality. The mix proportion includes a process of planning in which a mix of ingredients makes the desired quality and strength for the concrete structure. Since each ingredient within the mix consists of distinctive properties, it's not a simple task to form a great concrete mix. It is basic that all ingredients be tried to decide their physical properties and the bearing capacity of the venture location.

Table 4.6: Design Parameters

Grade Designation	M20 and M25
Type of Cement	OPC 53
Maximum nominal size if aggregate	20mm
Maximum Water Cement Ratio	0.50

4.3.2 MIX DESIGN CALCULATION

4.3.2.1 Mix Calculation for PCC of M20 Grade of Concrete

a. Cubes

Volume of 3 cubes = $3 \times 0.153 \times 1.2 = 0.0122\text{m}^3$

Cement = $394 \times 0.0122 = 4.78 \text{ Kg}$

Fine Aggregate = $4.78 \times 1.56 = 7.47 \text{ Kg}$

Coarse Aggregate = $4.78 \times 2.88 = 13.78 \text{ Kg}$

Water = $197 \times 0.0122 = 2.4\text{Liter}$

b. Cylinder

Volume of 3 cylinder = $3 \times 0.785 \times 0.152 \times 0.3 \times 1.2 = 0.02\text{m}^3$

Cement = $394 \times 0.02 = 7.56 \text{ Kg}$

Fine Aggregate = $7.56 \times 1.56 = 11.73 \text{ Kg}$

Coarse Aggregate = $7.56 \times 2.88 = 21.65 \text{ Kg}$

Water = $197 \times 0.02 = 3.76\text{Liters}$

c. Prism

Volume of 3 prisms = $3 \times 0.1 \times 0.1 \times 0.5 \times 1.2 = 0.018\text{m}^3$

Cement = $394 \times 0.018 = 7.10 \text{ Kg}$

Fine Aggregate = $7.10 \times 1.56 = 11.10 \text{ Kg}$

Coarse Aggregate = $7.10 \times 2.88 = 20.43 \text{ Kg}$

Water = $197 \times 0.018 = 3.546 \text{ Liters}$

Table 4.7: Mix Proportion of PCC for M20 Grade

Materials Mix	Cement	Fine Aggregate		Coarse Aggregate
		Tannery waste	Fine Aggregate	
Nominal mix	16.5kg	0kg	27kg	53.5kg
Mix 1	16.5kg	2.7kg	24.3kg	53.5kg
Mix 2	16.5kg	5.4kg	21.6kg	53.5kg
Mix 3	16.5kg	8.1kg	18.9kg	53.5kg
Total	66kg	16.2kg	91.2kg	214kg

4.3.2.2 Mix Calculation for RC Beam M20 Grade of Concrete

Mix Ratio: 1(Cement): 1.5 (Sand): 3 (Gravel)

W/C Ratio: 0.5

Beam size: 230 by 230mm

Beam length: 1000mm

Volume of Beam = 0.0529 m^3

For 2 Beams = 0.1058 m^3

Quantity of concrete = volume of beam – quantity/ area of steel = **0.05268 m^3**

a) Volume of cement for 1 m^3 concrete for,

M20 grade concrete = 403.2kg for $0.05268 \text{ m}^3 = 0.05268 \times 403.2 = \mathbf{21.24 \text{ kg}}$

b) Volume of Fine Aggregate for 1 m^3 concrete for,

M20 grade concrete = 672kg for $0.05268 \text{ m}^3 = 0.05268 \times 672 = \mathbf{35.40 \text{ kg}}$

c) Volume of Coarse Aggregate for 1 m^3 concrete for,

M20 grade concrete = 1326kg for $0.05268 \text{ m}^3 = 0.05268 \times 1326 = \mathbf{69.85 \text{ kg}}$

d) Water/cement ratio = 0.5 = 0.5×41.77

Water = **10.44 litre** .

Optimum Strength Occurs At 30% Replacement

Table 4.8: Mix Proportion for RC beam of M20 Grade

Materials Mix	Cement	Fine Aggregate		Coarse Aggregate
		Tannery waste	Fine Aggregate	
Nominal mix	21.24kg	0kg	35.40kg	69.85kg
Mix 3	21.24kg	10.65kg	24.81kg	69.85kg
Total	42.48kg	10.65kg	60.21kg	139.7kg

4.3.2.3 Mix Calculation for PCC of M25 Grade of Concrete

Cube size: 150 by 150 by 150 mm

Volume of cube = 0.003375 m³

For 8 cubes = 0.027 m³

Beam / prism size = 100 by 100 by 500 mm

Volume of beam = 0.005 m³

For 2 prisms = 0.01m³

Cylinder size: 150mm dia, 300mm height.

Volume of cylinder= 0.005m³

For 2 cylinders=0.01m³

Total volume = 0.047m³

Volume of cement for 1m³ concrete for M25 grade concrete = 380 kg

For 0.04025m³=0.047×380 =**17.86kg**

Volume of FA for 1m³ concrete for M25 grade concrete = 717kg

For 0.04025m³=0.047×717 =**33.7kg**

Volume of CA for 1m³ concrete for M25 grade concrete = 1170kg

For 0.04025m³=0.047×1170 =**55kg**

Water/cement ratio =0.5 =0.5×17.86

Water= **8.93 liter**

Table 4.9: Mix Proportion of PCC for M25 Grade

Materials Mix	Cement	Fine Aggregate		Coarse Aggregate
		Tannery waste	Fine Aggregate	
Nominal mix	17.86kg	0kg	33.7 kg	55kg
Mix 1	17.86kg	3.37kg	30.33kg	55kg
Mix 2	17.86kg	6.74kg	26.96kg	55kg
Mix 3	17.86kg	10.10kg	23.6kg	55kg
Total	71.5kg	20.21kg	114.6kg	220kg

4.3.2.4 Mix Calculation for RC Beam M25 Grade of Concrete

Mix Ratio: 1(Cement): 1.9 (Sand): 3.1 (Gravel)

W/C Ratio:0.5

Beam size: 230 by 230mm

Beam length: 1000mm

Volume of Beam = 0.0529 m^3

For 2 Beams = 0.1058 m^3

Quantity of concrete = volume of beam – quantity/ area of steel = **0.05268m³**

a) Volume of cement for 1m³ concrete for,

M25 grade concrete = 380kg for 0.05268m³ = $0.05268 \times 380 = \mathbf{20.01kg}$

b) Volume of Fine Aggregate for 1m³ concrete for,

M25 grade concrete = 717kg for 0.05268m³ = $0.05268 \times 717 = \mathbf{37.77kg}$

c) Volume of Coarse Aggregate for 1m³ concrete for,

M25 grade concrete = 1170kg for 0.05268m³ = $0.05268 \times 1170 = \mathbf{61.6kg}$

d) Water/cement ratio -0.5 = 0.5×39.3

Water = **10.44 Litres.**

Table 4.10: Mix Proportion of M25 Grade of Concrete

Materials Mix	Cement	Fine Aggregate		Coarse Aggregate
		Tannery waste	Fine Aggregate	
Nominal mix	20.01kg	0kg	37.77kg	61.60kg
Mix 3	20.01kg	11.37kg	26.50kg	61.60kg
Total	40.02kg	11.37kg	64.27kg	123.20kg

4.4 CASTING

Casting of concrete means the poured in place, is the concreting technique which is attempted in situ or within the concrete component's wrapped up position. Casting of concrete is the favored choice for concrete slabs and foundations and reinforcement as well as components such as pillars, columns, walls, roofing, and so on. The essential advantage of casting of concrete is its high level of quality. Casting of concrete is suitable for basement walls and home establishments.

Casting is a building constructing process by and large utilized for large production in which materials in a liquid state are poured into a mould where they set and hardened. The concrete might be strong as shortly as conceivable. Benefits of this technology are quality of the building, separator, and versatility for diverse sorts of buildings. Casting of concrete in the place includes some particular steps: setting formwork, setting reinforcement, and pouring concrete. The casting and testing procedure to be followed as Indian standard code IS 10262-2009.

Table 4.11: No. of Specimen to be Casted for M20 Grade Of Concrete

TYPE OF SPECIMEN	NO. OF SPECIMEN
Cube	24 (7 th ,14 th ,28 th day test)
Cylinder	8 (28 th day test)
Prism	8 (28 th day test)
RC Beam	2 (28 th day test)
Total	42

Table 4.12: No. of Specimen to be Casted for M25 Grade of Concrete

TYPE OF SPECIMEN	NO. OF SPECIMEN
Cube	32 (7th,14th ,28th day test)
Cylinder	8 (28 th day test)
Prism	8 (28th day test)
RC Beam	2 (28th day test)
Total	50

4.4.1 CUBE CASTING

Cube Molds of required size a 150mm x 150mm x 150 mm linear unit for nominal size of aggregate not exceptional 38 mm. Cube Molds should be provided with a base plate and they should be as per IS:10262-2009.

The cube Mould plates need to be removed, properly clean assembled and each one the bolts need to be completely tight. a thin layer of oil then should be applied on all the faces of the Mould. it's essential that cube angle faces ought to be parallel. After taking concrete samples and combination them, the cubes should be strong as soon as possible. The concrete sample might be packed into the cube Molds in layers roughly 5 cm deep. In embeddings each scoop of concrete.

The cube might be affected circular the prime edge of the Mould since the concrete slides from it, so as to create a symmetrical distribution of the concrete with inside the Shape. each layer might be compacted by hand. Each layer of the concrete stuffed within the Mould shall be compacted by not but 35 strokes by tampering rod.

4.4.2 CYLINDER CASTING

Cylinder mould are metal 150 x 300 mm cylinder moulds are used for casting concrete test specimens in the field. Before filling, they should be placed on a smooth, firm, level surface. each layer to be tampered with a uniformly twenty-five times with a sixteen-millimeter diameter x 450 – 600-millimeter long hemi spherically tipped steel rod.

The strokes should be distributed evenly over the cross-sectional of the Mould. The foot layer should be tampered all through its depth. for each higher layer, the bar might enter regarding 25 mm into the underlying layer. In case voids are left by the bar, the edges of the Form need to be tapped to shut the voids before including the Ext layer of material.

4.4.3 PRISM CASTING

The Mould standard measure will be 100mm x 100mm x500mm made up of metal. The tamping rod might be a steel bar weighing 2kg, 40 cm long and should have a slamming confront 25 mm square. The test specimen should be made as soon as practicable after blending and in such way as to create full compaction of concrete whereas neither isolation nor excessive laitance.

The compaction should be distributed consistently over the area of the Mould. The bottom layer should be rodded all through its depth. For each upper layer, the bar might enter approximately 25 mm into the fundamental layer. On the off chance that voids are cleared out by the bar, the sides of the Shape ought to be tapped to shut voids before adding the following layer of material.

4.4.4 Reinforced Concrete Beam

The casting and testing of Reinforced Concrete Beam is followed by the Indian standard code IS 10262-2009. Reinforced concrete gives additional strength. With more prominent comprehensive quality than normal concrete the beam mold is utilized to do a concrete products and samples for flexural testing of reinforced concrete beams. The longitudinal rebar in a beam stands up to flexural (tensile strength) while the stirrups, wrapped around the longitudinal bar, stand up to shear stresses. In a column, vertical bars resist compression and buckling stresses whereas ties to restrict shear and provide restriction to vertical rebar. Strengthening and reinforcing the ductile quality or tensile stress of concrete. When totally encompassed by the solidified concrete mass it shapes a fundamentally part of the two materials so reinforcement is done.

The Beam Mould size is 230mm x 230mm x 1000mm made out of wood. The tamping bar shall be a steel bar weighing 2kg, 40 cm long and shall have a ramming face 25 mm square. Which should be tampered for 25 times continuously through the parts in the mould where concrete poured.

4.4.4.3 Reinforcement Details

Indian Standard 10262-2009

Beam Size: 230mm(weight) x 230mm(depth) x 1000mm(length)

4 Number of 16mm dia main bars at 170mm spacing is used.

7 Number of 8mm dia used with equal spacing.

Area of Reinforcement: $0.04 \text{ bd} = 0.04 \times 0.23 \times 0.23 = 0.0002116$

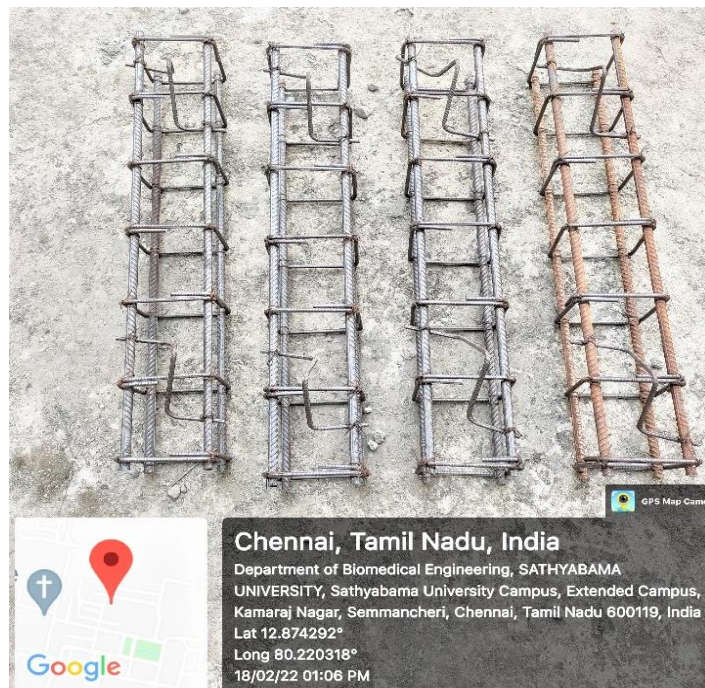


Fig: 4.3: Reinforcement Details

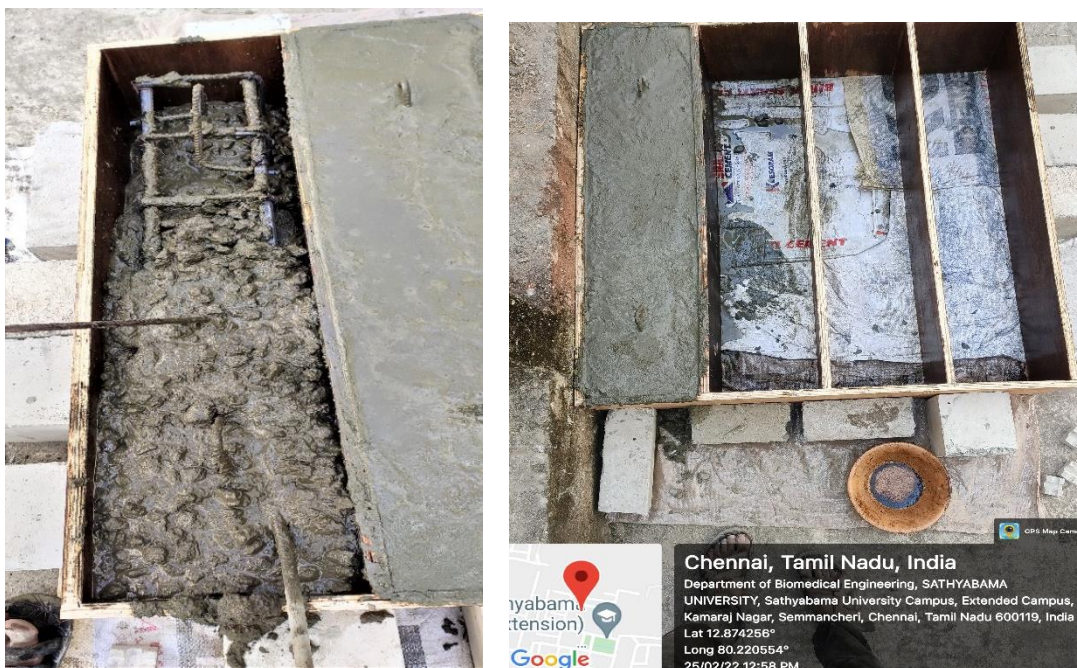


Fig: 4.4: Reinforced Concrete Beam Casting

4.5 DEMOLDING AND CURING

4.5.1 DEMOLDING

Demolding is to see the specimens got to be demoulded between sixteen to twenty-four hours when they have been made. In case of when this range of your time the concrete has not accomplished sufficient quality to adjust demoulding whereas not damaging the specimens and then demoulding ought to be done in 48 hours. And once removal of the concrete samples from the Mould, take the Mould separate fully. beware to not hurt the specimens since, in case any cracking is caused, the all-strength parameters might also be decreased.

When demolding, each take a look at the concrete specimens need to be checked with a reasonable identification on the high or bottom utilizing a water ink. The Mould should be thoroughly clean when demoulding. make sure that oil or dirt doesn't collect between the faces of the spines, other than the 2 halves won't coordinate along appropriately.



Fig: 4.5: Demoulded RC Beam

4.5.2 CURING

Curing plays an important role regarding concrete strength development and sturdiness. Curing of Concrete may be a technique by that the concrete is protected against loss of moisture needed for association and unbroken inside the suggested temperature vary. Curing can increase the strength and reduce the Permeable of hardened concrete. Curing is additionally helping in mitigating thermal and plastic cracks, which may severely impact durability of structures.

Curing follow includes keeping the concrete moist or wet till the affiliation of concrete is complete and quality is gained. normal process of concrete got to start directly after introductory setting time of concrete. As per IS 456 – 2000 concrete shouldn't be cured but seven days for standard Portland Cement, and it ought to be a least of ten days for concrete with mineral admixtures or integrated cement are utilized. fair in case of climatic condition and extremely dry temperature conditions, the common handle shouldn't be but ten Days for OPC and fourteen days for concrete with coordinates cement & mineral admixtures.



Fig: 4.6: Curing of concrete

4.6 TESTING OF CONCRETE

4.6.1 COMPRESSIVE STRENGTH TEST (CUBE)

The Compressive strength of a material or specimens is determined by the capacity of the material to stand up to failure within the form cracks. In this test, the push constraints applied on the both faces of concrete example and the maximum compression that concrete bears without failure is noted to be the results. The cube compressive strength test is carried out on cube specimens of measure 150mm x 150mm x 150mm. All specimens are tried in immersed surface dry conditions, after wiping out the surface moisture. For each blend combination, three similar specimens are tested at the span of 7,14- & 28-days. Using compression strength testing machine. Loading was produced till the specimen had failed or break into pieces. The reading at that moment of reversal gives the ultimate stress or load.



Fig: 4.7 Compressive strength test (cube)

4.6.2 TENSILE STRENGTH TEST (CYLINDER)

This can be an indirect test to decide the tensile strength of cylindrical examples. Splitting tensile strength test is carried out at the span of 28 days for the concrete cylinder specimen of size 150mm diameter and 300mm length utilizing universal testing machine. The load is produced continuously till the specimen split and the readings are noted. The part tensile strength has been evaluated utilizing this method of testing.

The concrete tensile strength is the capacity of concrete to resist tensile constrain or stress applied to it. The tensile quality of concrete is measured by the part cylinder test of concrete method. The tensile quality of concrete is measured by the Units of Force per Cross-Sectional area (N/Sq.mm. or MPa).

$$f = 2P/\pi dl$$

4.6.3 FLEXURAL TEST (PRISM)

This test method covers the assuring of the flexural quality of concrete by the utilize of a simple prism with third-point loading. A simply supported concrete prism is loaded by two-point loads set at third points along the span. The load is monotonically expanded until flexural failure happens.

In order to determine the horizontal load resistance, the prisms are tested for flexure. The prism (100mm x 100mm x500mm) were set evenly and tested for flexural quality concurring to third point loading. The starting failure area was observed and found that the failure area of all prism was within the middle third. The third point loading was utilized to determining the stress at failure.

4.6.4 FLEXURAL STRENGTH TEST FOR REINFORCED CONCRETE BEAM

Flexural test evaluates the ductile strength of concrete indirectly. It tests the capacity of reinforced concrete beam or column to withstand failure in twisting. The results in flexural test on concrete expressed as a modulus of crack which indicated in psi. The flexural test on concrete can be conducted utilizing either three-point load test or center point load test.

A beam with an effective span of 1000 mm length is tested under two-point loading by using hydraulic jack with the distance between the loading points are 500 mm from the center points with fixed support at one end and roller support at one end which is been tested after 28 days of curing using wet gunny bags at ambient temperature.



Fig: 4.8: Experimental Set up for M20 Grade Conventional Beam



Fig: 4.9: Experimental set up for M20 Grade Mix-3



Fig: 4.10: Experimental set up for M25 grade Mix-3

CHAPTER-5

RESULT AND DISCUSSION

5.1 EXPERIMENTAL RESULTS FOR M20 GRADE OF CONCRETE

The experimental results of this compressive strength test (cube), Tensile strength test (cylinder), Flexural strength test (prism) and flexural strength test (Reinforced Concrete Beam) is the experimental result and calculation are for **M20 Grade of concrete.**

5.1.1 COMPRESSIVE STRENGTH TEST FOR CUBE (M20 GRADE)

To find the capability of concrete to counterattack by crushing force, compression strength test was carried out for casted cube specimens. The cubes are made in M20 Grade of Concrete. The test specimen of cube of size (150mm×150mm×150mm) are casted and tested 7th, 14th, 28th day. To carry out the compressive strength test.

Table 5.1: Compressive Strength Test (Cube) For M20 Grade of Concrete

S. No	Samples	Percentage (%) Tannery Sludge	7 Days (N/mm ²)	14 Days (N/mm ²)	28 Days (N/mm ²)
1	Conventional mix	0%	14.63	18.11	23.15
2	Mix 1	10%	17.25	23.75	30
3	Mix 2	20%	19	26	35
4	Mix 3	30%	19.5	32	44.5

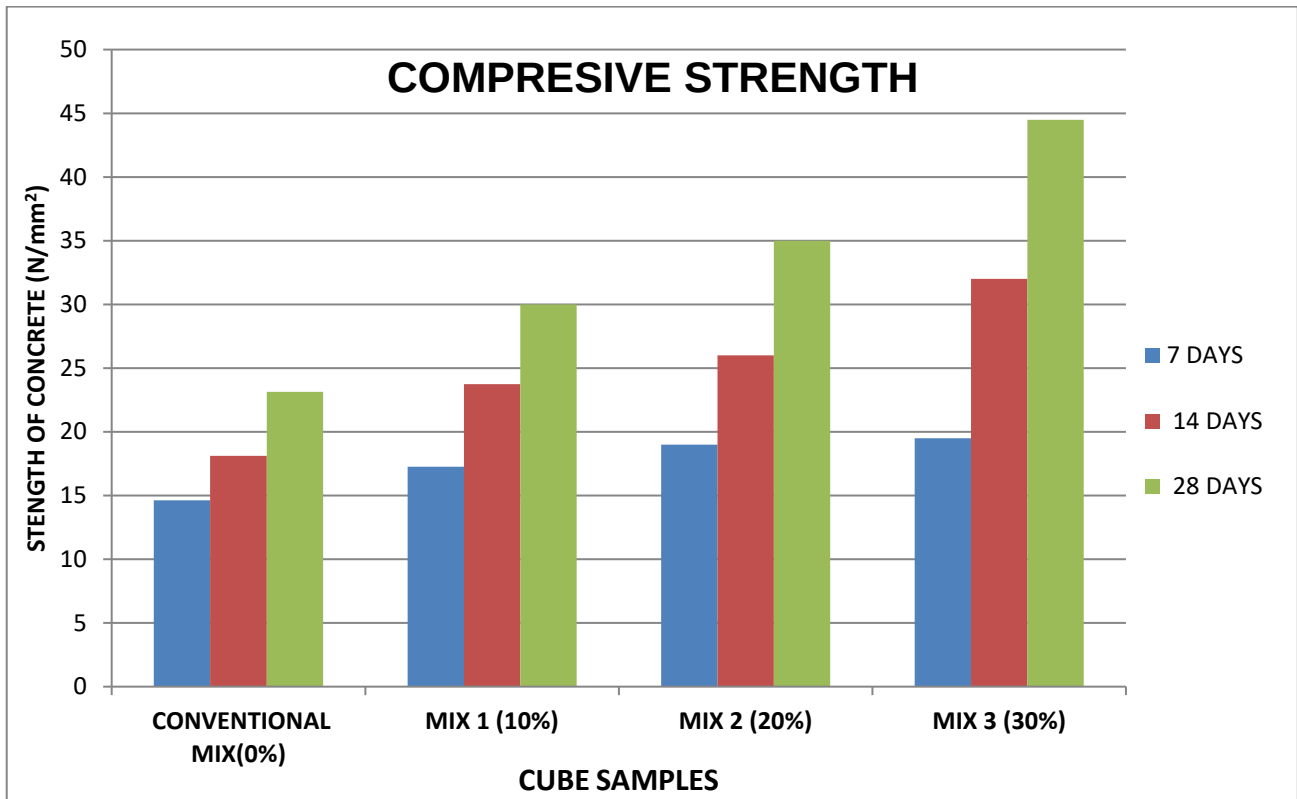


Fig: 5.1: Comparison of compressive strength cube for M20 grade of concrete

5.1.2 SPLIT TENSILE STRENGTH TEST FOR CYLINDER (M20 GRADE)

Split tensile strength of concrete is the basic property of concrete to find its tensile force. The test was carried out on specimen cylinder of 150mm diameter and 300mm height are casted, cured and tested after 28 days. The cylinders are made in M20 Grade of Concrete. The tensile strength of concrete (cylinder) is founded.

Table 5.2: Split Tensile Strength Test (Cylinder) For M20 Grade

Samples	28 th day in (N/mm ²)
Conventional mix (0%)	2.09
Mix (10%)	3.47
Mix (20%)	3.69
Mix (30%)	4.35

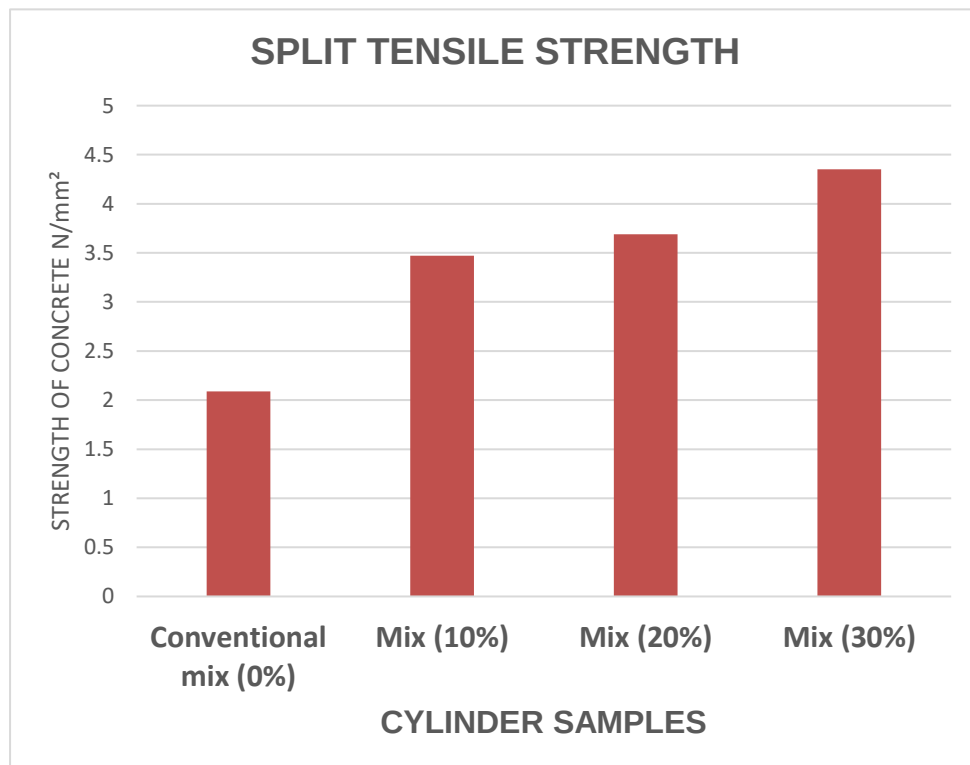


Fig: 5.2: Optimum Strength Of Tensile Strength (Cylinder) For M20 Grade

5.1.3 FLEXURAL STRENGTH TEST FOR PRISM (M20 GRADE)

Flexural strength test of concrete is tested to find the capability of concrete to counterattack flexural force. The test was carried out on specimen prism of size (100mm×100mm×500mm) are casted, cured and tested after 28 days. The prisms are made in M20 Grade of Concrete. Flexural strength test by three-point loading method is applied to find flexural strength.

Table 5.3: Flexural Strength test (Prism) for M20 Grade

Samples	28 th day in (N/mm ²)
Conventional mix (0%)	6
Mix (10%)	5.86
Mix (20%)	7.15
Mix (30%)	9

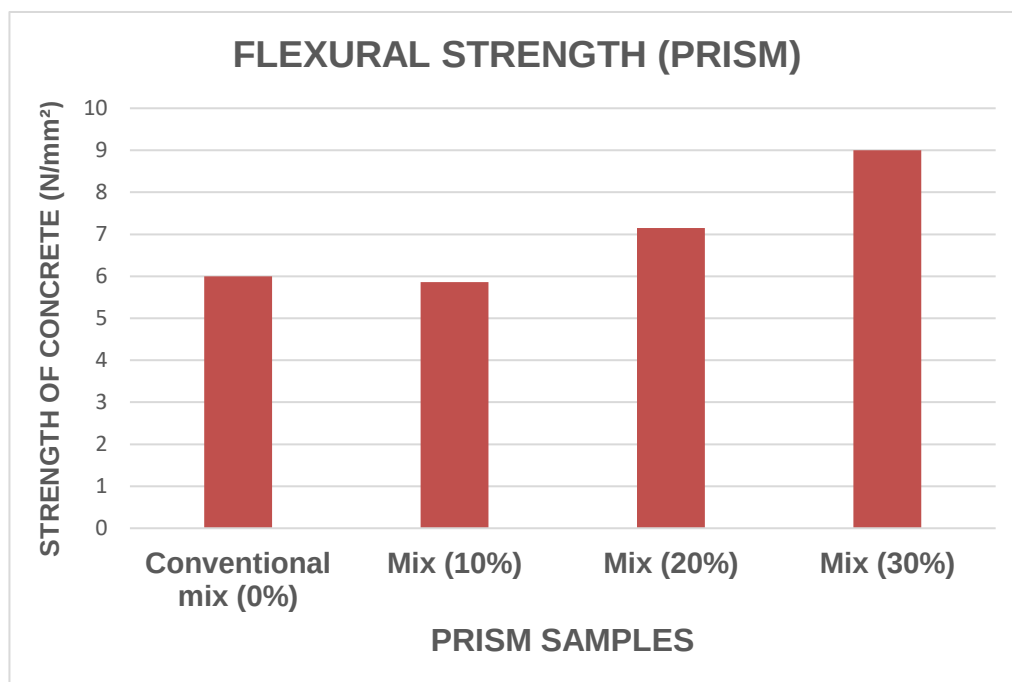


Fig. 5.3: Optimum Strength of Flexural Strength (Prism) For M20 Grade

5.1.4 Flexural Strength of Reinforced Concrete Beam for M20 grade

Flexural strength test of concrete is tested to find the capability of concrete to counterattack flexural force. The test was carried out on specimen reinforced concrete beam of size (230mm× 230mm× 1000mm) are casted, cured and tested after 28 days. The RC Beams are made in M20 Grade of Concrete. The beam was subjected to two-point loading after curing and for every 5 KN, three deflection values were noted. Two beams were casted for M20 Grade Nominal and Mix 3 respectively.

5.1.4.1 M20 Grade Concrete Nominal Mix

Table 5.4: Flexural Strength of RC Beam for M20 Grade Nominal Mix

Load (KN)	DEFLECTION (mm)		
	Left	Center	Right
5 KN	0.07	0.08	0.07
10 KN	0.15	0.17	0.10
15 KN	0.20	0.22	0.14
20 KN	0.22	0.26	0.16
25 KN	0.25	0.29	0.19
30 KN	0.28	0.31	0.22
35 KN	0.30	0.35	0.24
40 KN	0.33	0.37	0.27
45 KN	0.36	0.42	0.30
50 KN	0.38	0.45	0.36
55 KN	0.40	0.49	0.38
60 KN	0.44	0.53	0.40

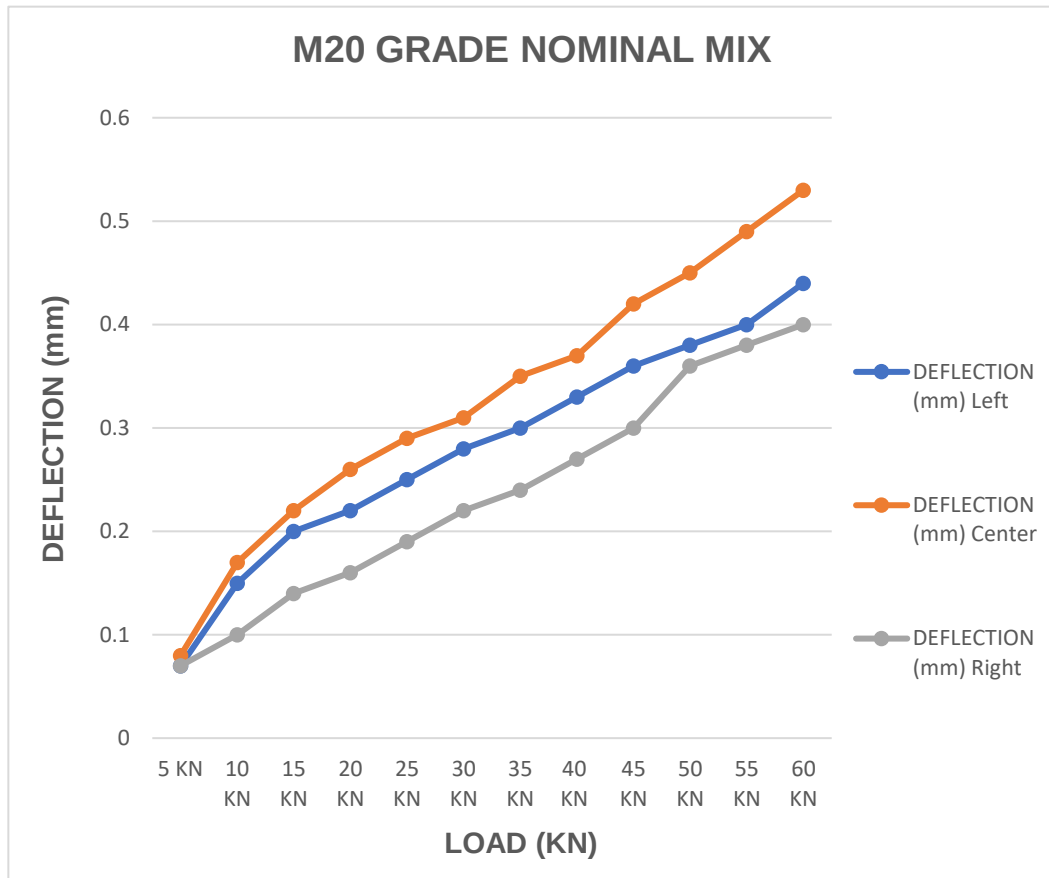


Fig: 5.4: Flexural Strength of RC Beam for M20 Grade Nominal Mix

5.1.4.2 M20 Grade Concrete Mix 3

Table 5.5: Flexural Strength of RC Beam for M20 Grade Mix-3

Load (KN)	DEFLECTION (mm)		
	Left	Center	Right
5 KN	0.15	0.21	0.19
10 KN	0.26	0.37	0.34
15 KN	0.39	0.47	0.44
20 KN	0.48	0.54	0.52
25 KN	0.59	0.65	0.61
30 KN	0.63	0.68	0.64
35 KN	0.66	0.73	0.69

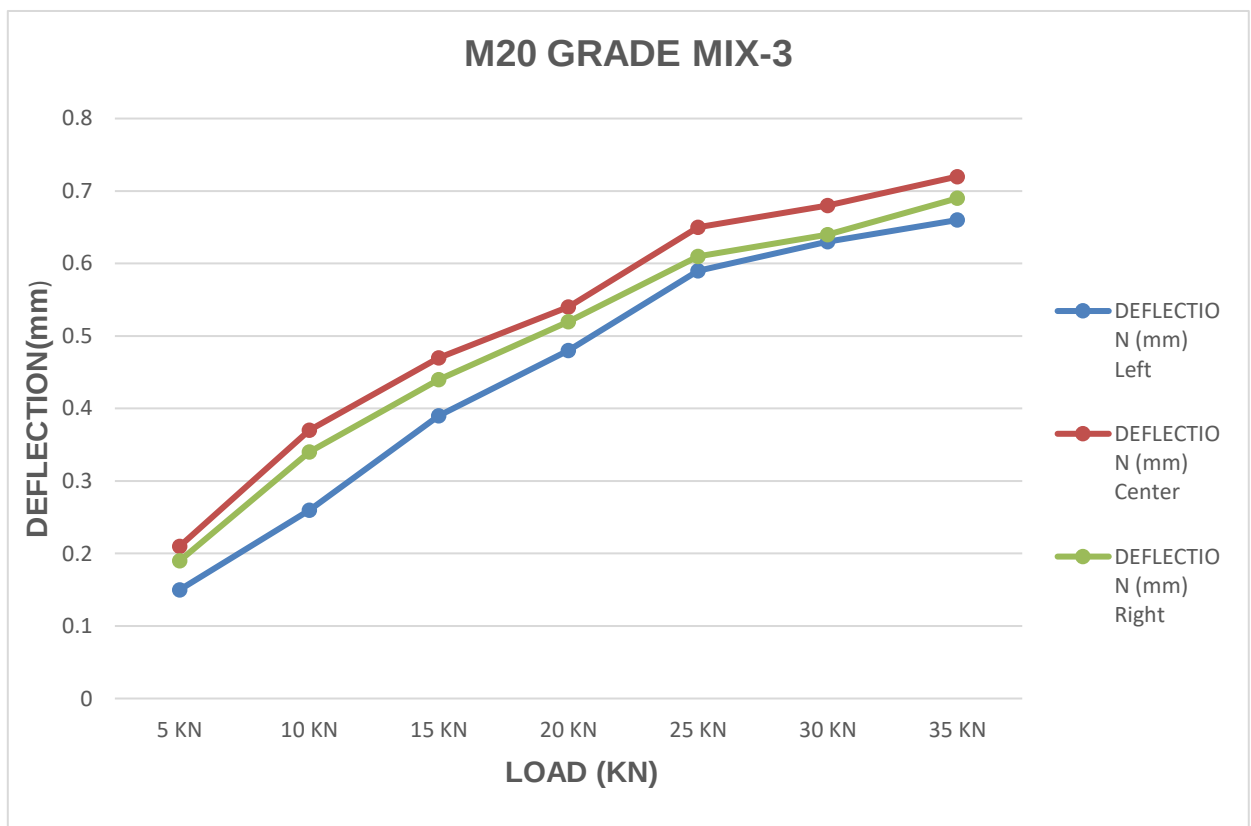


Fig: 5.5: Flexural Strength of RC Beam for M20 Grade Mix-3

5.2 EXPERIMENTAL RESULTS FOR M25 GRADE OF CONCRETE

The experimental results of this compressive strength test (cube), Tensile strength test (cylinder), Flexural strength test (prism) and flexural strength test (Reinforced Concrete Beam) is the experimental result and calculation are for **M25 Grade of concrete.**

5.2.1 COMPRESSIVE STRENGTH FOR CUBE (M25 GRADE)

To find the capability of concrete to counterattack by crushing force, compression strength test was carried out for casted cube specimens. The cubes are made in M25 Grade of Concrete. The test specimen of cube of size (150mm×150mm×150mm) are casted and tested 7th, 14th, 28th day. To carry out the compressive strength test.

Table 5.6: Compressive Strength Test (Cube) For M25 Grade of Concrete

S. No	Samples	Percentage (%) Tannery Sludge	7 Days (N/mm ²)	14 Days (N/mm ²)	28 Days (N/mm ²)
1	Conventional mix	0%	4.3	2.4	2
2	Mix 1	10%	2.5	4.4	2
3	Mix 2	20%	3.5	1.8	3
4	Mix 3	30%	4.5	2.8	5

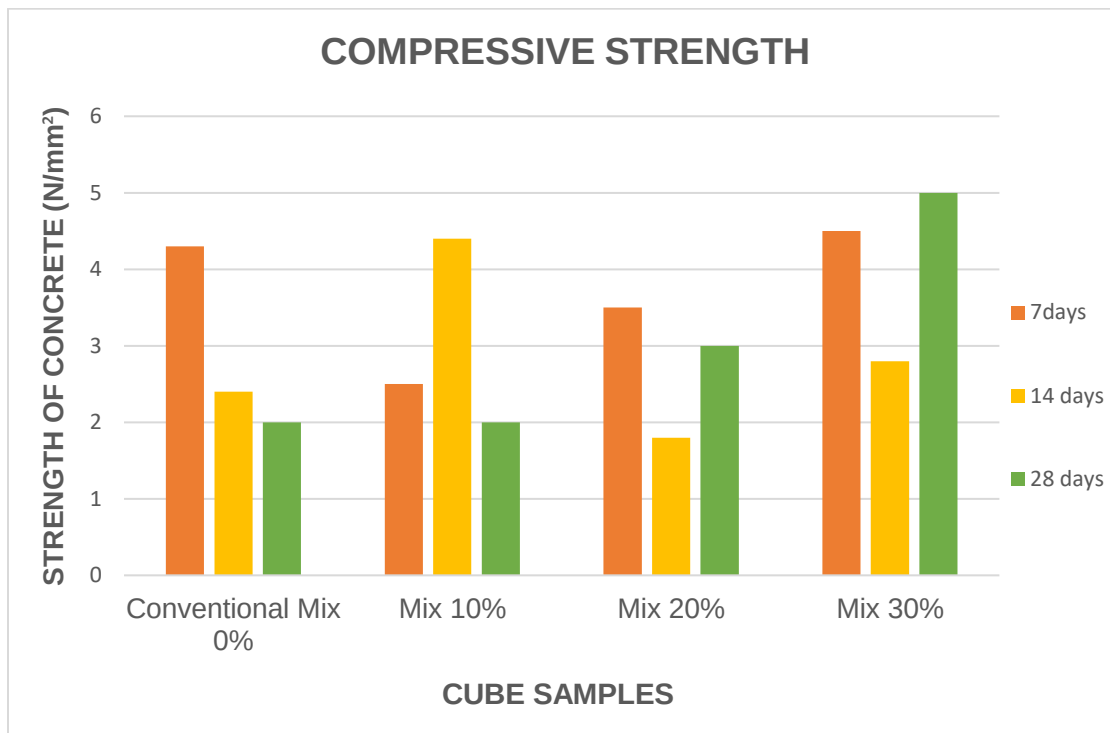


Fig: 5.6: Comparison of compressive strength cube for M25 grade of concrete

5.2.2 SPLIT TENSILE STRENGTH FOR CYLINDER (M25 GRADE)

Split tensile strength of concrete is the basic property of concrete to find its tensile force. The test was carried out on specimen cylinder of 150mm diameter and 300mm height are casted, cured and tested after 28 days. The cylinders are made in M25 Grade of Concrete. The tensile strength of concrete (cylinder) is founded.

Table 5.7: Split Tensile Strength Test (Cylinder) For M25 Grade

Samples	28 th day in (N/mm ²)
Conventional mix (0%)	2.67
Mix (10%)	2.69
Mix (20%)	3.03
Mix (30%)	3.57

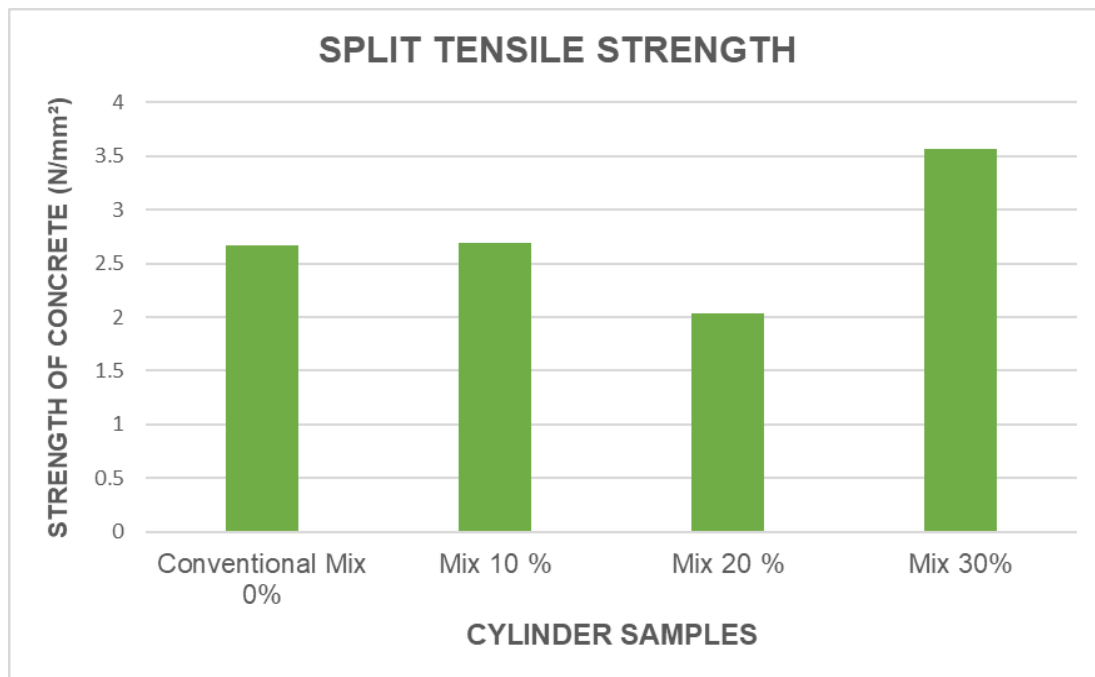


Fig: 5.7: Optimum Strength of Tensile Strength (Cylinder) For M25 Grade

5.2.3 FLEXURAL STRENGTH FOR PRISM (M25 GRADE)

Flexural strength test of concrete is tested to find the capability of concrete to counterattack flexural force. The test was carried out on specimen prism of size (100mm×100mm×500mm) are casted, cured and tested after 28 days. The prisms are made in M25 Grade of Concrete. Flexural strength test by three-point loading method is applied to find flexural strength.

Table 5.8: Flexural Strength test (Prism) for M25 Grade

Samples	28 th day in (N/mm ²)
Conventional mix (0%)	2.68
Mix (10%)	2.70
Mix (20%)	2.02
Mix (30%)	3.57

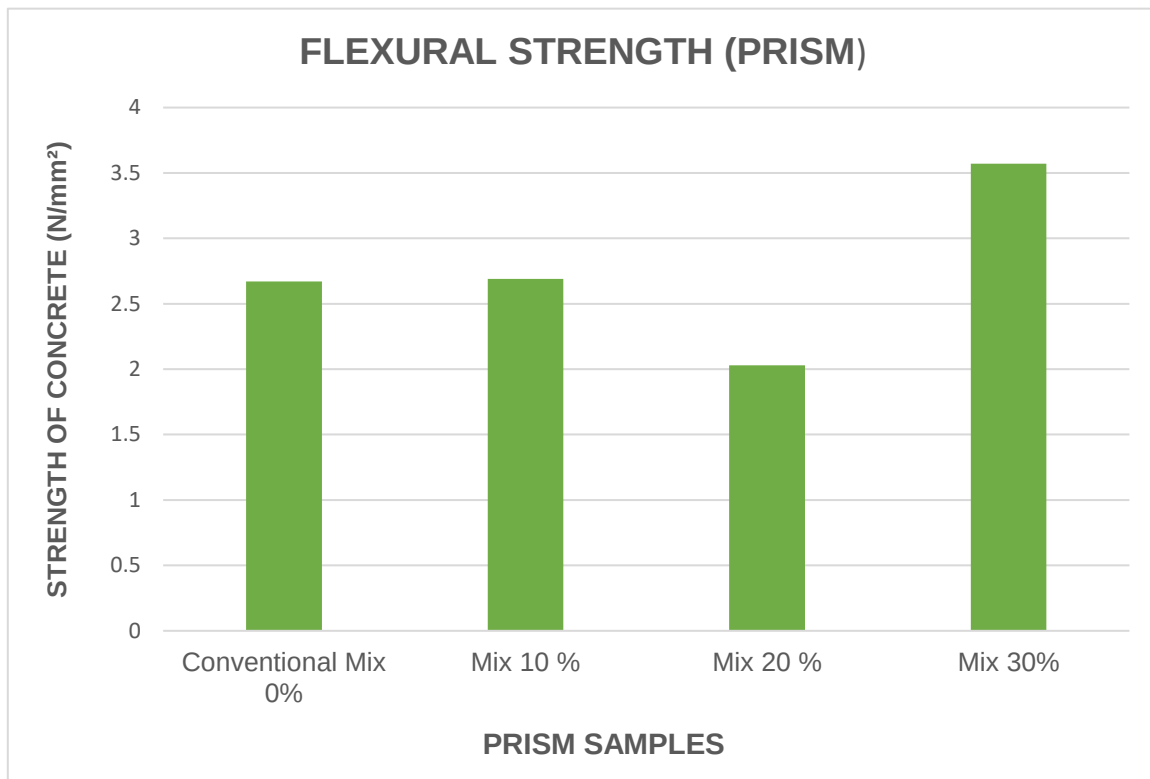


Fig: 5.8: Optimum Strength of Flexural Strength (Prism) For M25 Grade

5.2.4 Flexural Strength for Reinforced Concrete Beam of M25 grade

Flexural strength test of concrete is tested to find the capability of concrete to counterattack flexural force. The test was carried out on specimen reinforced concrete beam of size (230mm× 230mm× 1000mm) are casted, cured and tested after 28 days. The RC Beams are made in M25 Grade of Concrete. The beam was subjected to two-point loading after curing and for every 5 KN, three deflection values were noted. Two beams were casted for M25 Grade Nominal and Mix 3 respectively.

5.2.4.1 M25 Grade Concrete Nominal Mix

Table 5.9: Flexural Strength of RC Beam for M25 Grade Nominal Mix

Load (KN)	DEFLECTION (mm)		
	Left	Center	Right
5 KN	0.15	0.22	0.18
10 KN	0.17	0.24	0.22
15 KN	0.18	0.27	0.24
20 KN	0.20	0.33	0.27
25 KN	0.23	0.37	0.32
30 KN	0.27	0.39	0.36
35 KN	0.29	0.42	0.38

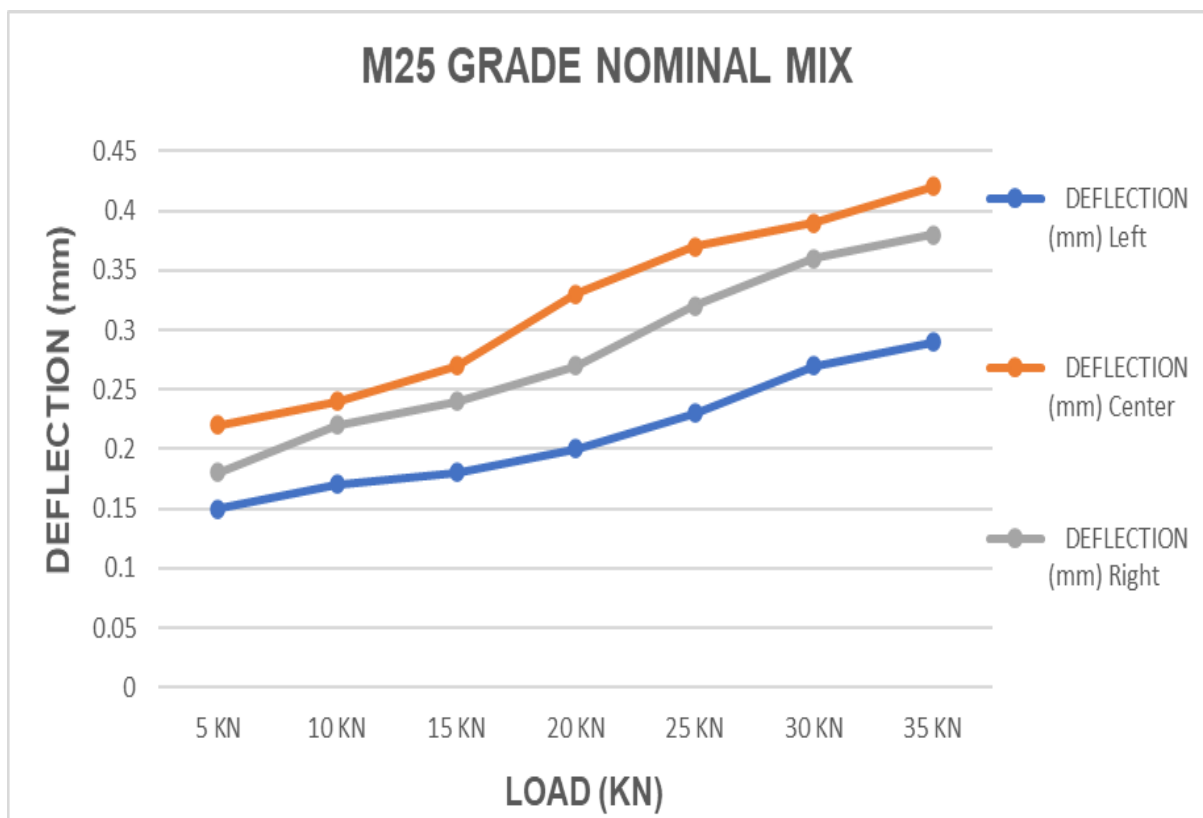


Fig: 5.9: Flexural Strength of RC Beam for M25 Grade Nominal Mix

5.2.4.2 M25 Grade Concrete Mix-3

Table 5.10: Flexural Strength of RC Beam for M25 Grade Mix-3

Load (KN)	DEFLECTION (mm)		
	Left	Center	Right
5 KN	0.09	0.12	0.10
10 KN	0.15	0.19	0.17
15 KN	0.26	0.39	0.32
20 KN	0.29	0.45	0.41
25 KN	0.33	0.57	0.52
30 KN	0.38	0.64	0.59
35 KN	0.49	0.68	0.65

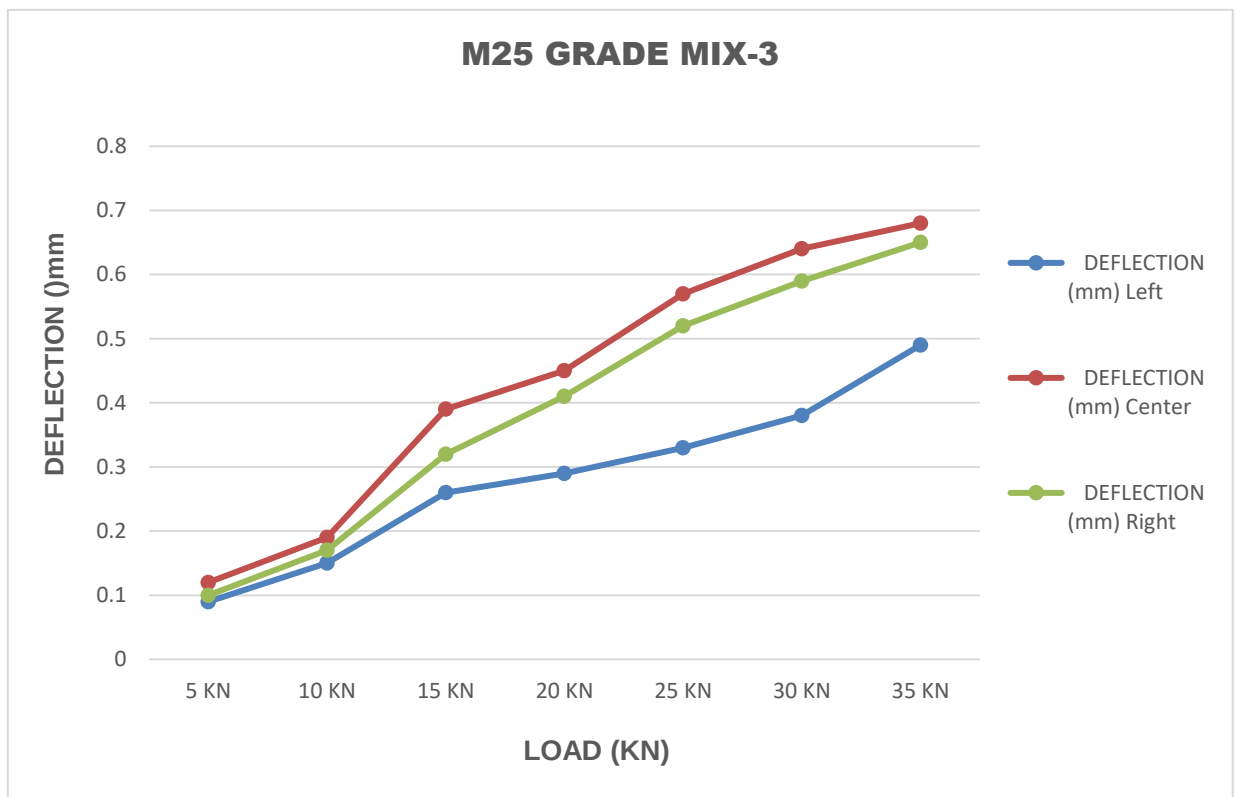


Fig: 5.10: Flexural Strength of RC Beam for M25 Grade Mix-3

CHAPTER-6

CONCLUSION

6.1 GENERAL

The following conclusions are given below:

- As a partially replacing of tannery sludge as a fine aggregate it gives some results which gives some good strength and workability.
- Mechanical properties of nominal and tannery sludge concrete cube, cylinder, prism and RC Beam was studied for compressive, split tensile strength and flexural strength with curing time of 7 ,14 and 28 days.
- Compressive strength and split tensile strength of tannery sludge mix is increases and become good strength at 30% of replacement. That is the maximum strength of tannery sludge mix in both grades of concrete M20 and M25.
- The flexural strength of RC Beam with tannery sludge replacement mix is results as a weak in flexural strength comparing to conventional concrete beam.

It can be concluded from the above result that 30% replacement of tannery sludge waste with fine aggregate is the best and correct proportion for the compressive strength and split tensile strength. But the flexural strength of Reinforced Concrete Beam of tannery sludge mix is less compared to conventional beam. Thus, our project states the tannery sludge replacement in concrete can give good compressive strength and tensile strength.

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