

EXPERIMENTAL STUDY ON CONCRETE USING BOTTOM-ASH AS PARTIAL REPLACEMENT OF CEMENT

Submitted in partial fulfillment of the requirement of 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 | 12B Status by UGC | Approved by AICTE JEPPIAAR
NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

May - 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **GOVARDHAN.G (38200010)** and **PRABHU.EA (38200026)** who carried out the project entitled "**EXPERIMENTAL STUDY ON CONCRETE USING BOTTOM-ASH AS PARTIAL REPLACEMENT OF CEMENT**" under our supervision from December 2021 to May 2022.


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DECLARATION

We **GOVARDHAN.G (38200010)** and **PRABHU.EA (38200026)** hereby declare that the project report entitled **""EXPERIMENTAL STUDY ON CONCRETE USING BOTTOM-ASH AS PARTIAL REPLACEMENT OF CEMENT""** done by us under the guidance of **MS. ESHANTHINI.P M.E.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

DATE: 28.04.2022

PLACE: CHENNAI

1.



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SIGNATURE OF CANDIDATE

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LIST OF SYMBOL AND ABRIVATIONS

Kg	Kilo-gram
Ft	Feet
Min.	Minimum
Max.	Maximum
BA	Bottom-ash
SEM	Scanning Electron Microscope
%	Percentage
Km	Kilometer

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ABSTRACT

The consumption of concrete is increased worldwide. The commonly used cementitious material the concrete are cement and flyash. The usage of cement is decreased because of high energy consumption ,emission of greenhouse gasses during production and the supply of flyash is also reduced due to the closure of coal –fired from plants. This study aims to examine partial replacement of cement using bottom-ash. Bottom ash is the waste material from coal power plants. This waste material contains many particles like SiO_2 , FeO_3 , Al_2O_3 , CaO , TiO_2 etc. Which can be used in construction to enhance the performance of concrete in building. By leaving this elements in ground can be hazardous to our environment. The bottom –ash were collected from Neyveli Lignite Corporation, Neyveli, Tamil Nadu. The experimental investigation was carried out for replacing cement with 20 % and 25 % of bottom ash by weight. Test on concrete was conducted for 7,14 and 28 days. The results shows that Mechanical properties, Compressive strength and modulus of rupture and durability properties like water absorption; Test results indicated that concrete span, concrete strength etc have been increased significantly. However, no significant effect on mechanical properties was observed. Furthermore, the additions of wastes have increase concrete properties and it is used to reduce pollution and dust resistant too. Therefore, it can be concluded that cost of cement can be minimized and environmental burden leading towards more economical and stable construction. By this we can reduce the space acquired by unused bottom-ash. By using copper wire we can reduce e-waste which was one of the land pollution, and that can be reduced.

1. INTRODUCTION

1.1 GENERAL

Building material industry has witnessed an increased demand from the last decade due to an increased demand of housing for the growth urban population which has caused shortage of building materials. The crisis of raw material shortfalls is faced by the relevant industry to fulfill the increased demand of building materials. This situation has levied the need for searching other substitutes of raw materials. Consequently, as a result of this search for raw materials. By doing this not only the industrial waste will be recycled and used as building materials. By doing this not only the industrial waste will be recycled and used as building materials but there will be economic design of buildings.

Control and restructuring using nanometers and to create new property and functions. This project fully based on bottom ash which contains lot of nano particles and its use in cement. Mostly all cement and concrete already deals some different nano or micro size particles. This section reviews recent survey in nano and concrete technology.

We all know that plain concrete is a brittle material and addition of nano particles has chance to make it strong and well worth in use. Copper wire in concrete can be used to increase tensile, static, flexural and impact strength. Use of this can make reduce in reinforcement thickness. Chance of micro cracks can be reduced. This type of concrete mix are called Fiber Reinforced Concrete (FRC).

2. LITERATURE STUDY AND METHODOLOGY

2.1 LITERATURE REVIEW

First of all, various books and journals were collected for reference and were studied before starting the project work for having an idea about how the project should be. In this project a partial replacement of cement an alternative building are introduced. So, first the basic and essential characteristics of cements were studied.

Xian et al., (2021) studied the effect of chemically non-anatase TiO_2 , SiO_2 and FeO_3 on early age hydration of cement-based materials, and to understand durability of nano-particals containing cementitious materials undergoing photocatalysis.

Marcin Janczarek, Luka Sz, Klapiszewski, Patryk Jedrzejczak, Izabela Klapiszewski et al., (2021)– TiO_2 which is mostly used in paints, paste and cosmetics can also used in construction as a concrete mix. By mixing it concrete life span and strength increase. Its possible that titanium dioxide reduce pollutions. Which may make earth eco-friendly.

1.Hao Zhang, Yingliana Zhao, Duanxu Hou, Haiqing Hao et al., (2020)- FeO_3 which is Ferric tri-oxide Ferric is an chemical property of iron-reinforcement, by mixing this in our concrete can increase strength and there will be reduction of reinforcement is possible. So it will be cost efficient.

2.M.Devasena, V.Sangeetha et al., (2020)- The nano particle SiO_2 in concrete increase compressive strength, flexural property, fracture properties etc. Key advantages of this nano-

particles resist high temperature and microstructure of HPC. SiO₂ significantly improves mechanical properties and durability.

3. Deepika Jamwal, Aashima Sharma, Rohini Kanwar, Surinder Kumar Mehta et al., (2019) - The Nano-tube Titanium dioxide, usage can increase strength of concrete and it has self cleaning property also has ability to absorb UV rays which is more harmful to human skins and life. It also has low relative humidity

4. Geethu Benny, Gayathri Krishna Kumar et al., (2019)- This is to investigate that compressive strength and workability of concrete is possible by partial replacement of cement. As 0.5, 1, 1.5 and 2 percentage weight. As result use of TiO₂ at 2% produces concrete in improved strength. Anyways 1% replacement itself shows ultimate strength of concrete than to nominal.

5. Bharat Jindal, Sanjay Sharma et al., (2019)- Compensating shrinkage with expansion produced by magnesium oxide proves effectively prevent thermal cracking and reduces the temperature control measure and speed up process of construction process.

8. V.V. Tvukavkina, L.G. Gerasimova, V.V. Semushin et al., (2019)- Result of Al₂O₃ by partial replacement for cement in different percentage like 0.5%, 1.0%, 1.5% and 2.0%. The ultimate strength achieved in 1% but 2% shows great changes than nominal. This concrete improves compressive strength but decrease the workability.

9. Ning Xiw, Michekke Akin, Xianming Shi et al., (2018) - The goal of TiO₂ as possible at surface of material without risk of losing abrasion or weathering. Most efficient way is apply TiO₂ in thin layer cementitious material used in surface.

10. R.Gopalakrishnan, Bala Vignesh, R.Jeyalakshmi et al., (2018) - In this paper durability of concrete character which includes the chloride ion penetration, resist in electric, water penetration etc. Also the effects in microstructure of concrete and mortar than previous paper.
11. Zhen Li, Siqi Ding, Xun Yu, Baoguo Han, Jinping Ou et al., (2018) - The results showed that the use of nano-TiO₂ shows increase in flexural and compressive strength which the setting time of concrete is reduce by use of TiO₂. That is increase in concrete structure but decrease in setting time.
12. Q.L.Yu et al., (2018) - Application of nanomaterials in Alkali- activated materials- Use of bottom-ash reduce enomous vol. of hazardous waste into recycling waste. The BA can be viable solution by using it in concrete. By this landfillings and cement conctent may be reduced.
13. Lei Gao, Ke-yi Ren, Zhen Ren, Xiang-Juan Yu et al., (2017) - Hydration progresssed at lower rate than in cement, this can be effectively compensate for concrete shrinkage. Many studies have been conducted to investigate the hydration and expansion properties of MgO. The result after examine shows the durability of concrete containing MgO.
14. L.Y.Yang, Z.J.Jia, Y.M.Zhang, J.G. Dai et al., (2016) - A high-quality concrete is one which has acceptable workability in fresh condition and develops sufficient strength. Basically the bigger the measured height of slump. As result workability increases while adding TiO₂
15. Aiqin Zhao, Jinglei Yang, En-Hua Yang et al., (2016)- Addition of BA makes reduction of cement, fine aggregate and coarse aggregate. The nano-particles present in BA increase strength of concrete than nominal.

16. Ryo Kurihara, Ippei Maruyama et al., (2016)- Calcium oxide which gives the strength of RCC. So there is a chance of reducing reinforcement using CaO. This reduces crack in concrete. Using this in concrete structure can increase bending moment in beam.
17. Sharanendra Maneeth.P.D, Brijbhushan.S et al., (2016)- Compressive strength increase, Paver interlock with demolished waste gave greater compressive strength. Gave optimum flexural strength and little water absorption.
18. B.Shobana, B.N.Brinila Bright et al., (2016)- The electrical resistance increase almost 300% as water acting as electrolyte was lost. So smart concrete is sensitive to moisture change and using at construction may exposed to harmful by water.
19. K.Malli Kharjuna Rao, P.Srinivasa Rao et al., (2016)- Seaside structures whgich was attacked by chloride may decrease life span of concrete structure. This paper shows using copper wire decrease rusting and increase the span of structure
20. F.Hamidi, F.Aslani et al., (2016)- TiO_2 with cement develops photocatalytic products which is considerable attention on global scale. So TiO_2 works as an great photocatalytic as this harmful substance present in air like NO, NO_2 gases can be reduced with this TiO_2

2.2 METHODOLOGY AND ANALYSIS:

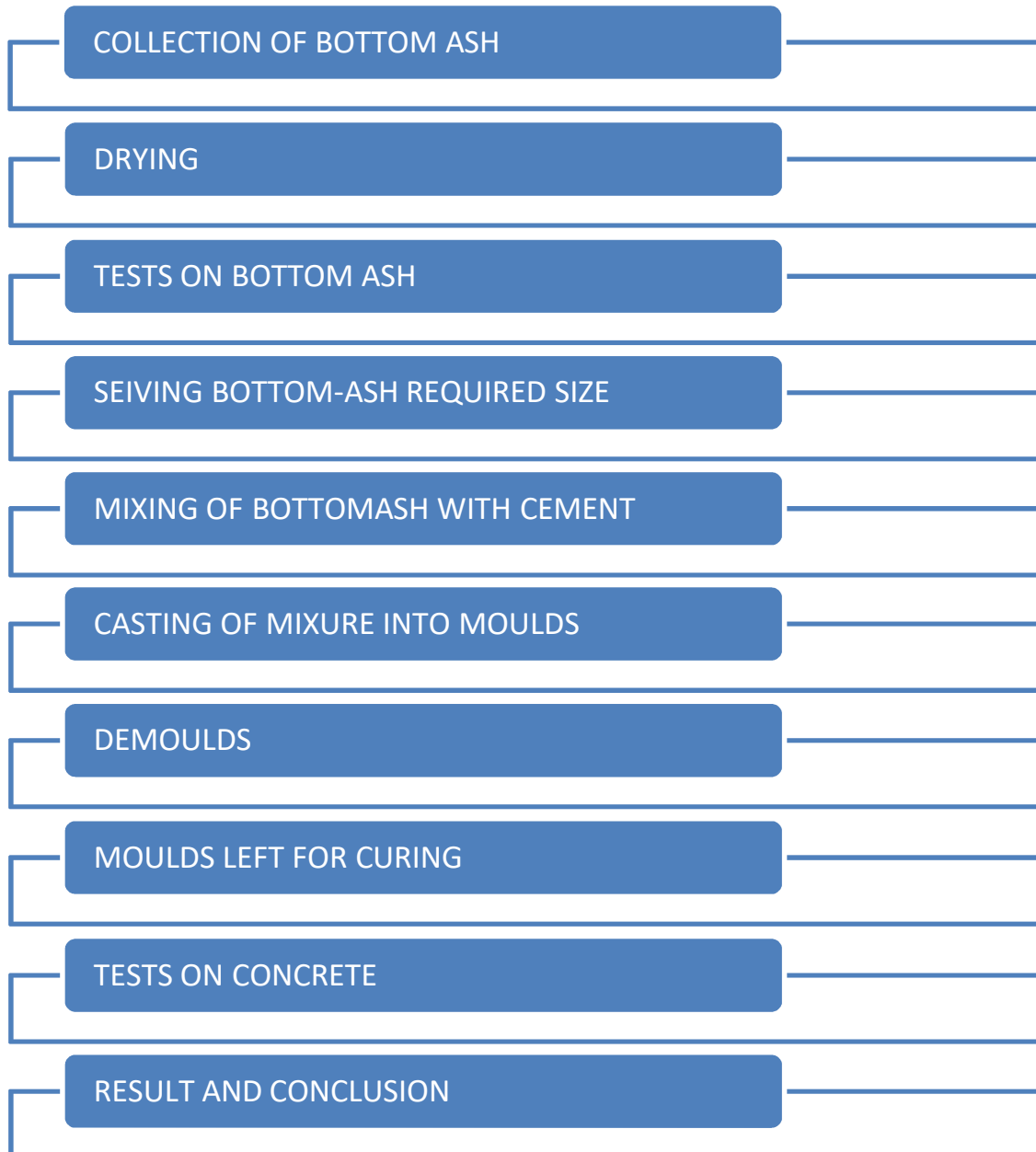


Fig. 2.1 Flow chart of method and analysis

3. AIM AND SCOPE

3.1 Objective:

1. To use bottom-ash combustion a waste from lignite coal as replacement of cement in concrete mix.
2. To determine the physical and chemical properties of bottom-ash.
3. To determine strength of concrete using bottom-ash.
4. To reduce pollution.
5. To prevent from UV rays.
6. To reduce cost and material.

3.2 Scope:

1. To promote the unused bottom-ash as a useful product.
2. To manage the disposal of waste product into construction raw material.
3. To dispose the waste safely.
4. To encourage the waste products as eco-friendly material.
5. To make concrete which are energy efficient and good to environment.
6. Conservation for future generations.

4. EXPERIMENTAL TESTING

4.1 Material used

4.1.1 Cement:

We all know that main element in structure is cement. This is because it is a binder to glue other elements. All of concrete strength depends on cement ratios. This cement with fine aggregate is called as mortar used for plastering and mix with fine and coarse and some admixtures called concrete used in beam, columns etc.

4.1.2 Fine aggregate:

Fine aggregate in concrete used to provide dimensional stability. The elastic modulus and abrasion resistance of concrete can be influenced with fine aggregate. Its quality also important in mixture proportions and harden it. The property in it have impact on shrinkage of concrete.

4.1.3 Coarse aggregate:

Coarse aggregate is another important element used to increase volume of concrete. It is used in increase strength.

4.1.4 Bottom-ash:

This is our main element in our project. Bottom ash we use has some nano-particles. Each particles contains each specific uses

4.1.4.1 : TiO_2 (Titanium dioxide):

Used to increase span and strength of concrete. Scientists shows that TiO_2 reduce pollution, absorbs UV rays. It's a photocatalytic sterilizing properties.

4.1.4.2 : MgO(Magnesium mono-oxide)

Used as Sound-proof, It can also be used as heat-insulating. Reduce setting time, Improve compressive strength etc

4.1.4.3 :Al₂O₃(Alumina tri-oxide)

It also improves the compressive strength of concrete but it shows that it decrease workability.

4.1.4.4 :FeO(Ferric mono-oxide)

Used to increase strength of concrete. Because of this there is a chance of reduce use in reinforcement.

4.1.4.5 :SiO₂(Silicon dioxide)

Nano-Silicon dioxide is present and which is used for improving workability and strength to give high performance.

S.No	Chemical present	Code	%
1	Loss of Ignition	IS:1721-1967(R-2004)	4.43
2	Silica dioxide as SiO ₂	IS:1721-1967(R-2004)	65.06
3	Iron trioxide as FeO ₃	IS:1721-1967(R-2004)	17.42
4	Aluminum trioxide as Al ₂ O ₃	IS:1721-1967(R-2004)	4.82
5	Calcium Oxide as CaO	IS:1721-1967(R-2004)	3.34
6	Magnesium Oxide as MgO	IS:1721-1967(R-2004)	1.54
7	Sulphur dioxide as SO ₂	IS:1721-1967(R-2004)	2.63
8	Titanium dioxide as TiO ₂	IS:1721-1967(R-2004)	0.76

Table 4.1 Chemical properties present in bottom-ash



Fig 4.1 Picture of bottom-ash

4.2 Experimental Procedure:

4.2.1 Preparation of mould:

Standard size of 150*150*150mm of cube in 6 numbers for each mix, 150mm dia and 300mm of height for cylinder 6 numbers for each mix and 100*100*500mm of size prism 4 numbers for each mix.

4.2.2 Mix preparation:

M30 grade concrete was made, Then 20% bottom-ash replacement with cement and Bottom- ash with 25% replacement with cement. Each mix was moulded in cube, cylinder and prism.

4.2.3 Demoulding:

Each moulds were demoulded so that it can be dried in air and ready for curing.

4.2.4 Curing:

These moulds were set for curing and the moulds were separated for 7days, 14days and 28days.



Fig 4.2 Picture of concrete in cubic mould



Fig 4.3 Picture of concrete in cylindrical mould



Fig 4.4 Picture of concrete in prism mould

4.3 Bottom-ash Concrete:

The mix obtained by moulding, these moulds were made and unmoulded set for tests. We took fresh mix tests and dry mix tests with nominal mix and both 20% and 25% replacement of cement. Each tests results and its uses discussed later. Here we cansee its physical and chemical properties.

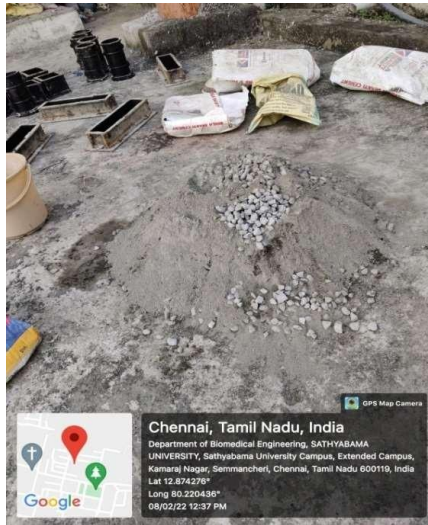


Fig 4.5 Picture of mixing concrete(Nominal Mix)



Fig 4.6 Picture of concrete mix(Bottom-ash 20%)

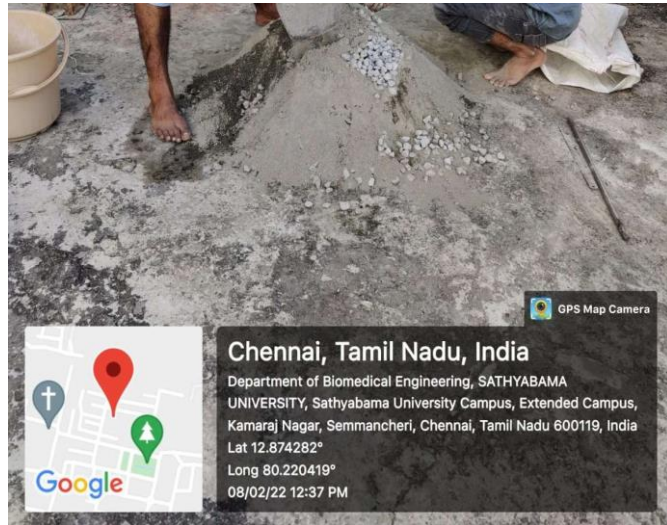


Fig 4.7 Picture of concrete mix(Bottom-ash 25%)

4.3.1 Absorption:

The mould which was under curing absorbed that Bottom-ash mix absorbs more water than nominal mix and so feel little heavy. We totally made 48 moulds which are cube-18, cylinder- 18 and prisms-12.

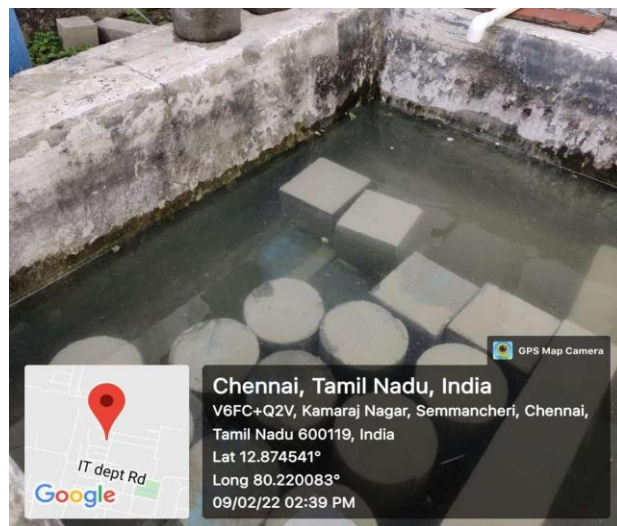


Fig 4.8 Picture of concrete set for curing

4.3.2 Structure:

Bottom ash's broken particle which was examined in lab under SEM (Scanning Electron Microscope). Their components were read and their images were given below. This will give us great idea of concrete structure. By this we can understand bond of chemical properties with our cement concrete. Here below we took image of 5000, 10000 and 40000 magnification as shown below. Our test was taken in Annamalai University, Chidabaram.

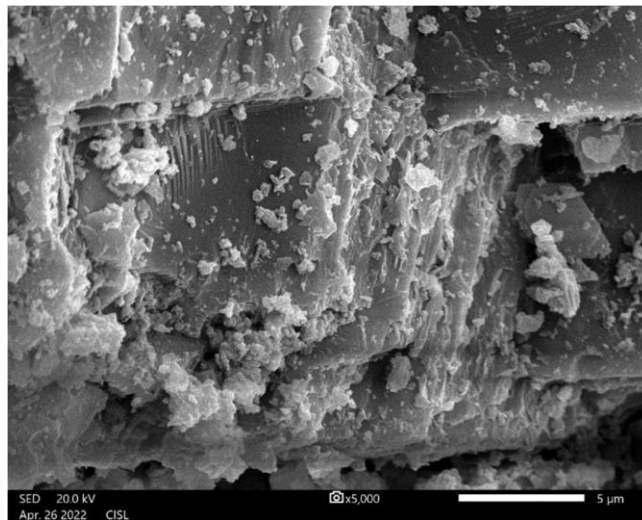


Fig 4.9 SEM image of Bottom-ash in 5K view

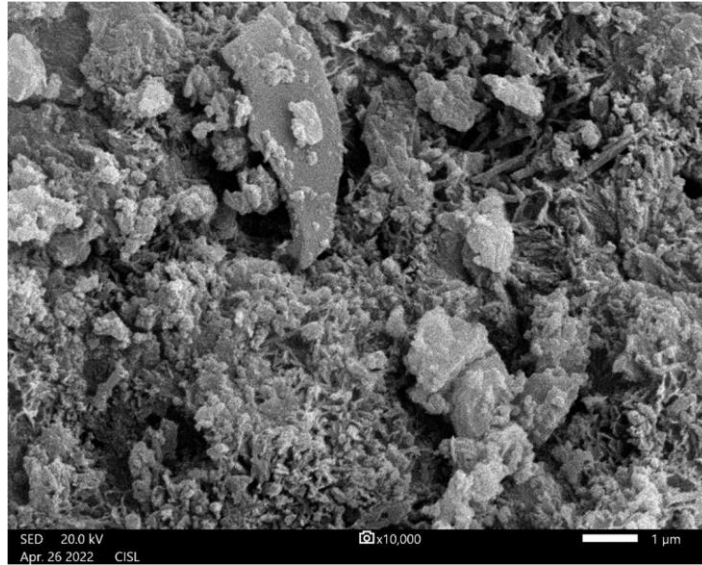


Fig 4.10 SEM image of Bottom-ash in 10K view

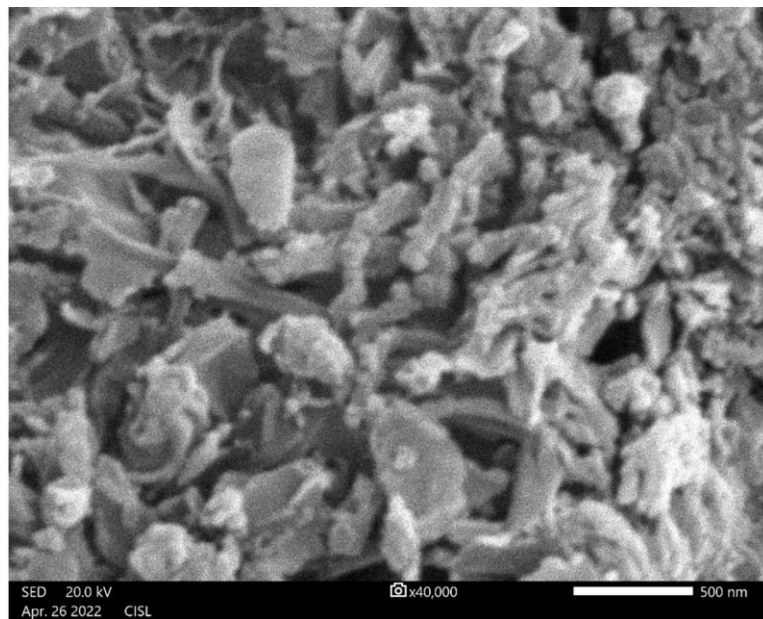


Fig 4.11 SEM image of Bottom-ash in 40K view

5. RESULT AND DISCUSSION

5.1 Calculations:

For mixing concrete it's very important to calculate to know its ratio of cement, aggregates, water and admixtures if any. Below here we calculate the ratio with the help of IS456-2000, IS10262-2009 & IS269-2013 Indian Standard code book. As per basis we assume the location is at severe condition.

5.1.1 Grade adopted:

We took M30 as our grade which is used for standard constructions. As we mostly look over economic stuff it is used for a residential and also for apartment construction. Code book ref. IS456-2000 pg16 Table 2 for grade of concrete.

Table 2 Grades of Concrete
(Clause 6.1, 9.2.2, 15.1.1 and 36.1)

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 Days in N/mm ²
(1)	(2)	(3)
Ordinary Concrete	M 10	10
	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60
	M 65	65
	M 70	70
	M 75	75
	M 80	80

Fig.5.1 Picture from IS:456 representing table of concrete grade

5.1.2 Environmental exposure:

It is very important to note our environmental exposure. This exposure is used to understand our nature of site like its climatic condition, soil type, temperature etc.,

Table 3 Environmental Exposure Conditions*(Clauses 8.2.2.1 and 35.3.2)*

Sl No. (1)	Environment (2)	Exposure Conditions (3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water Concrete surfaces sheltered from saturated salt air in coastal area
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water Concrete exposed to coastal environment
iv)	Very severe	Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet Concrete in contact with or buried under aggressive sub-soil/ground water
v)	Extreme	Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals

Fig.5.2 Picture from IS:456 representing table of environmental exposure

5.1.3 Minimum Ratio:

Code book gives us a basic idea for the grade of concrete according to our grade and environment exposure.

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size

(Clauses 6.1.2, 8.2.4.1 and 9.1.2)

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m ³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m ³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	–	300	0.55	M 20
iii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES:

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

Fig.5.3 Picture from IS:456 representing table of min. ratio of grade and environment exposure

5.1.4 Standard Deviation:

Std. Deviation is used to know the variation in concrete. Those concrete std. deviation we calculated according to our IS:456-2000 code book.

Table 8 Assumed Standard Deviation
(Clause 9.2.4.2 and Table 11)

Grade of Concrete	Assumed Standard Deviation N/mm ²
M 10 M 15	3.5
M 20 M 25	4.0
M 30 M 35 M 40 M 45 M 50	5.0

NOTE—The above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials, aggregate gradings and moisture content; and periodical checking of workability and strength. Where there is deviation from the above the values given in the above table shall be increased by 1N/mm².

Fig.5.4 Picture from IS:456 representing table of standard deviation

5.1.5 Water/Cement ratio:

Used to calculate cement and water mix ratio.

Table 4 Water Content per Cubic Metre of Concrete For Nominal Maximum Size of Aggregate
(Clause 5.3)

Sl No.	Nominal Maximum Size of Aggregate mm	Water Content ¹⁾ kg
(1)	(2)	(3)
i)	10	208
ii)	20	186
iii)	40	165

¹⁾Water content corresponding to saturated surface dry aggregate

Fig.5.5 Picture from IS:1062 representing table of W/C

5.1.6: Volume of Aggregates:

Calculation of aggregates a hard support of concrete used to increase the strength and compact power.

Table 5 Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate for Water-Cement/Water-Cementitious Materials Ratio of 0.50
(Clause 5.5)

Sl No.	Nominal Maximum Size of Aggregate mm	Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate			
		Zone IV	Zone III	Zone II	Zone I
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	0.54	0.52	0.50	0.48
ii)	20	0.66	0.64	0.62	0.60
iii)	40	0.73	0.72	0.71	0.69

Fig.5.6 Picture from IS:10262 representing table of Aggregates

5.2 Concrete calculations:

5.2.1 M30 Concrete

calculations:a)Targeted

strength:

$$F'_{ck}=f_{ck}+(1.65*s)$$

$$S=5N/mm^2$$

$$F'_{ck}=30+(1.65*5)$$

$$=38.25 \text{ N/mm}^2$$

b)Selection of w/c ratio:

For severe exposure condition (RCC)

Min. water cement ratio=0.45

Min. grade – M30

W/C ratio=0.45

c) Calculation of water content:

max. water content for 186kg for 50mm slump

3% of water for every 25mm slump change

100mm slump we use so add 6% with it

$$=186+[(6/100)*186] = 197\text{kg}$$

d) Calculate cement content:

W/c ratio= water content/ cement content

$$=230.5/0.45 = 512.22$$

e) Aggregate proportion between coarse and fine

aggregate:20mm aggregate=0.6

But our w/c ratio=0.45

If ± 0.05 change in w/c ratio change proportion to ± 0.01

$$0.5-0.45=0.05 \text{ so add } 0.01 \Rightarrow 0.6+0.01=0.61$$

Pump able concrete reduce 10% vol. of coarse

$$\text{aggregate Vol. of coarse} = 0.9*0.61=0.55$$

$$\text{Vol. of fine} = 1 - 0.55 = 0.45$$

f) Mix design calculation:

$$\text{i) Vol. of cement} = 1 \text{ m}^3$$

$$\text{ii) Vol. of cement} = \text{mass/specific gravity} \times 1/100$$

$$= 0.14 \text{ m}^3$$

$$\text{iii) Vol. of water} = m/\text{sp.g} \times 1/1000$$

$$= 0.2 \text{ m}^3$$

$$\text{iv) Vol. of all in aggregate} = [i - (ii + iii)]$$

$$= 0.66 \text{ m}^3$$

$$\text{v) m of coarse aggregate} = \text{iv} \times \text{vol. of proportion of coarse aggregate} \times \text{sp.g} \times 1000$$

$$= 994.62 \text{ kg}$$

$$\text{vi) m of fine aggregate} = \text{iv} \times \text{vol. of proportion of fine aggregate} \times \text{sp.g} \times 1000$$

$$= 814 \text{ kg}$$

g) FINAL

OUTPUT:

$$\text{Cement} = 438 \text{ kg/m}^3$$

$$\text{Water} = 197 \text{ kg/m}^3$$

Coarse

$$\text{Aggregate} = 994.62 \text{ kg/m}^3 \quad \text{Fine}$$

$$\text{aggregate} = 814 \text{ kg/m}^3$$

W/c ratio=0.45

5.2.2 Mix-1 (Bottom-ash 20%)

Replacement)a)Targeted strength:

$$F'_{ck}=f_{ck}+(1.65*s)$$

$$S=5\text{N/mm}^2$$

$$F'_{ck}=30+(1.65*5)$$

$$=38.25 \text{ N/mm}^2$$

b) Selection of w/c ratio:

For severe exposure condition (RCC)

Min. water cement ratio-0.45

Min. grade – M30

W/C raio=0.45

c) Calculation of water content:

max. water content for 186kg for 50mm slump

3% of water for every 25mm slump change

100mm slump we use so add 6% with it

$$=186+[(6/100)*186] = 197\text{kg}$$

Bottom ash absorbs water which is 17% so..,

$$=197(17/100*197)= 230.5\text{kg}$$

d) Calculate cement content:

W/c ratio= water content/ cement content

$$=230.5/0.45 = 512.22 \text{ kg/m}^3$$

$$20\% \text{ bottomash mix with cement} = 512.22 - 102.45 = 410\text{kg/m}^3$$

$$\text{Cement}=410\text{kg/m}^3$$

$$\text{Bottom-ash}= 102.5\text{kg/m}^3$$

e) Aggregate proportion between coarse and fine

aggregate:20mm aggregate=0.6

But our w/c ratio=0.45

If ± 0.05 change in w/c ratio change proportion to ± 0.01

$$0.5 - 0.45 = 0.05 \text{ so add } 0.01 \Rightarrow 0.6 + 0.01 = 0.61$$

Pump able concrete reduce 10% vol. of coarse

$$\text{aggregate Vol. of coarse} = 0.9 * 0.61 = 0.55$$

$$\text{Vol. of fine} = 1 - 0.55 = 0.45$$

f) Mix design calculation:

i) Vol. of cement=1m³

ii) Vol. of cement= mass/specific gravity*1/100

$$=0.13\text{m}^3$$

$$\text{iii) Vol. of water} = m/\text{sp.g} \times 1/1000$$

$$=0.231\text{m}^3$$

$$\text{iv) Vol. of bottom-ash} = m/\text{sp.g} \times 1/1000$$

$$=0.041\text{m}^3$$

$$\text{v) Vol. of all in aggregate} = [i - (\text{ii} + \text{iii} + \text{iv})]$$

$$=0.598\text{m}^3$$

$$\text{vi) m of coarse aggregate} = v \times \text{vol. of proportion of coarse aggregate} \times \text{sp.g} \times 1000$$

$$=904.2\text{kg}$$

$$\text{vii) m of fine aggregate} = v \times \text{vol. of proportion of fine aggregate} \times \text{sp.g} \times 1000 = 740\text{kg}$$

g) FINAL OUTPUT:

Cement=410kg/m³

Water=230.5kg/m³

Coarse aggregate=904.2kg/m³

Fine aggregate=740kg/m³

Bottom-ash= 102.5kg/m³

W/c ratio=0.45

5.2.3 Mix-2 (Bottom-ash 25% Replacement)

5.2.4 a) Targeted strength:

$$F'_{ck} = f_{ck} + (1.65 \cdot s)$$

$$S = 5 \text{ N/mm}^2$$

$$F'_{ck} = 30 + (1.65 \cdot 5)$$

$$= 38.25 \text{ N/mm}^2$$

b) Selection of w/c ratio:

For severe exposure condition (RCC)

Min. water cement ratio-0.45

Min. grade – M30

W/C ratio=0.45

c) Calculation of water content:

max. water content for 186kg for 50mm slump

3% of water for every 25mm slump change

100mm slump we use so add 6% with it

$$= 186 + [(6/100) \cdot 186] = 197 \text{ kg}$$

Bottom ash absorbs water which is 17% so...

$$=197(17/100*197)= 230.5\text{kg}$$

d) Calculate cement content:

W/c ratio= water content/ cement content

$$=230.5/0.45 = 512.22 \text{ kg/m}^3$$

$$25\% \text{ bottomash mix with cement} = 512.22 - 128.06 = 384.16 \text{ kg/m}^3$$

$$\text{Cement} = 384.16 \text{ g/m}^3$$

$$\text{Bottom-ash} = 128.06 \text{ kg/m}^3$$

e) Aggregate proportion between coarse and fine

aggregate:20mm aggregate=0.6

But our w/c ratio=0.45

If ± 0.05 change in w/c ratio change proportion to ± 0.01

$$0.5 - 0.45 = 0.05 \text{ so add } 0.01 \Rightarrow 0.6 + 0.01 = 0.61$$

Pumpable concrete reduce 10% vol. of coarse

$$\text{aggregate Vol. of coarse} = 0.9 * 0.61 = 0.55$$

$$\text{Vol. of fine} = 1 - 0.55 = 0.45$$

f) Mix design calculation:

i) Vol. of cement=1m³

ii) Vol. of cement= mass/specific gravity*1/100

$$=0.122\text{m}^3$$

$$\text{iii) Vol. of water} = m/\text{sp.g} \times 1/1000$$

$$=0.231\text{m}^3$$

$$\text{iv) Vol. of bottom-ash} = m/\text{sp.g} \times 1/1000$$

$$=0.051\text{m}^3$$

$$\text{v) Vol. of all in aggregate} = [i - (\text{ii} + \text{iii} + \text{iv})]$$

$$=0.596\text{m}^3$$

$$\text{vi) m of coarse aggregate} = v \times \text{vol. of proportion of coarse aggregate} \times \text{sp.g} \times 1000$$

$$=898.172\text{kg}$$

$$\text{vii) m of fine aggregate} = v \times \text{vol. of proportion of fine aggregate} \times \text{sp.g} \times 1000 = 734.868\text{kg}$$

g) FINAL OUTPUT:

$$\text{Cement} = 384.16\text{kg/m}^3$$

$$\text{Water} = 230.5\text{kg/m}^3$$

Coarse

$$\text{Aggregate} = 898.17\text{kg/m}^3$$

$$\text{Fine aggregate} = 734.87\text{kg/m}^3$$

$$\text{Bottom-ash} = 128.06\text{kg/m}^3$$

$$\text{W/c ratio} = 0.45$$

5.3 Tests on Concretes:

There are four different tests needs to be undergone for their strength testing and for their performance. As each tests we absorbs different results.

They are

1. Fresh concrete test
2. Compressive test
3. Split-Tensile test
4. Flexural test

5.3.1 Fresh concrete test:

It's based on slump value. As per this slump test a good concrete should be shear slump which is half of cone at least. Other type of slumps are true which is in the shape of mould and other is collapse here slump is fully collapsed.



Fig 5.7 Fresh concrete test on nominal, Mix1and Mix2 respectively

MIX DESIGN	RESULT
Nominal mix	7cm
20% replacement	5cm
25% replacement	4cm

Table 5.1 Result of slump test

5.3.2 Compressive test:

This shows the strength of concrete. Here there was a slight change of strength observed. From nominal mix, mix1 and mix2. Increase in strength from 7, 14 and 28 days of these concrete. On table 1 below shows the value noted. This test based on cube mould using Universal Test Machine (UTM).

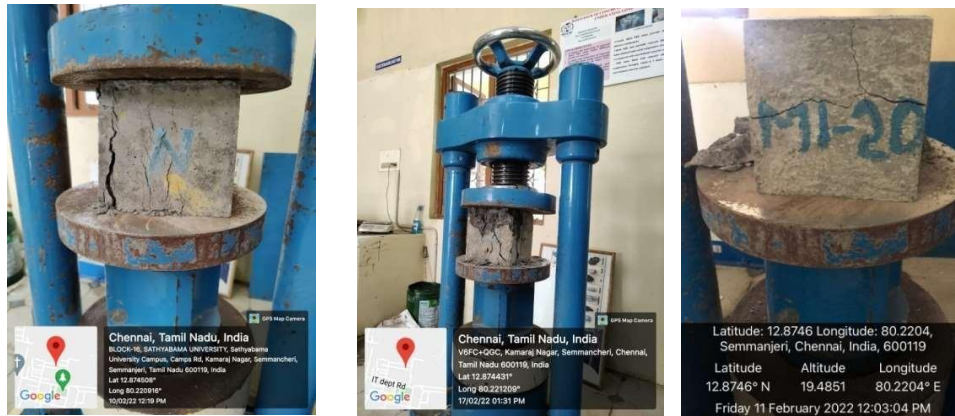


Fig 5.8 Picture of compression test on concrete moulds

Concrete type	7days	14days	28days
Nominal mix	16.44	21.4	23.52
BA 20% replacement with copper wire	16.97	22.06	24.2
BA 25% replacement with copper wire	17.68	22.98	25.28
BA 20% replacement without copper wire	16.58	21.41	23.68
BA 25% replacement without copper wire	17.46	21.96	24.44

Table 5.2 Result of compression test

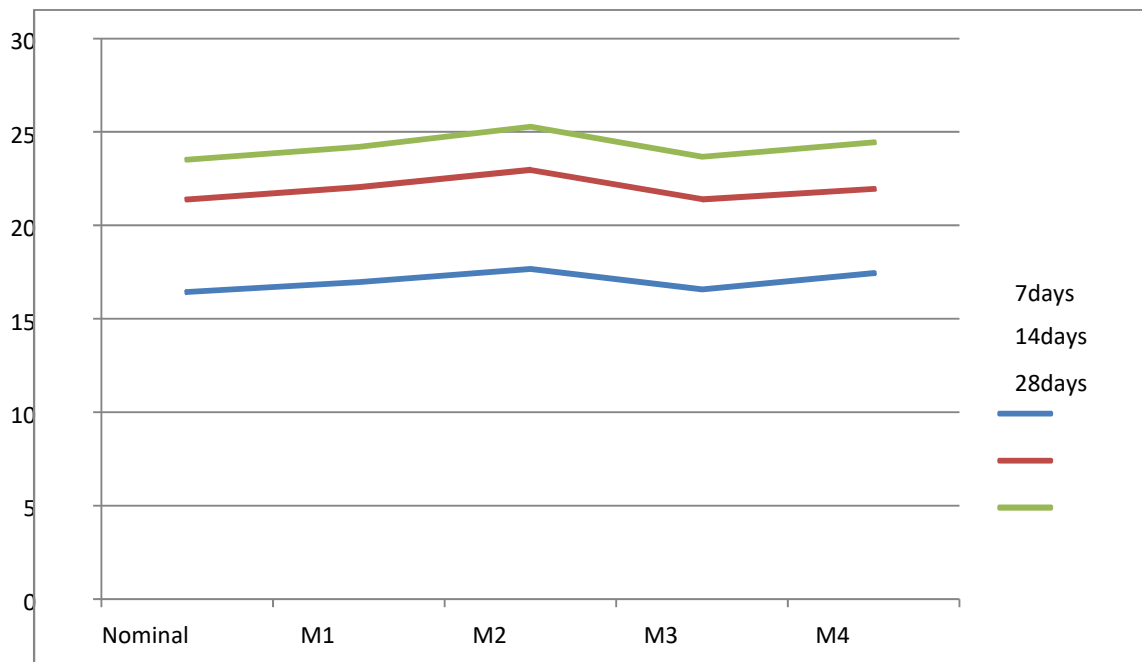


Fig.5.9 Graph Chart representing result of compression test

5.3.3 Split tensile test:

It was done using the cylindrical moulds which was test in same UTM but position was made horizontally. Here also we noted a slight different in load resisting. Value was taken and noted below the table.

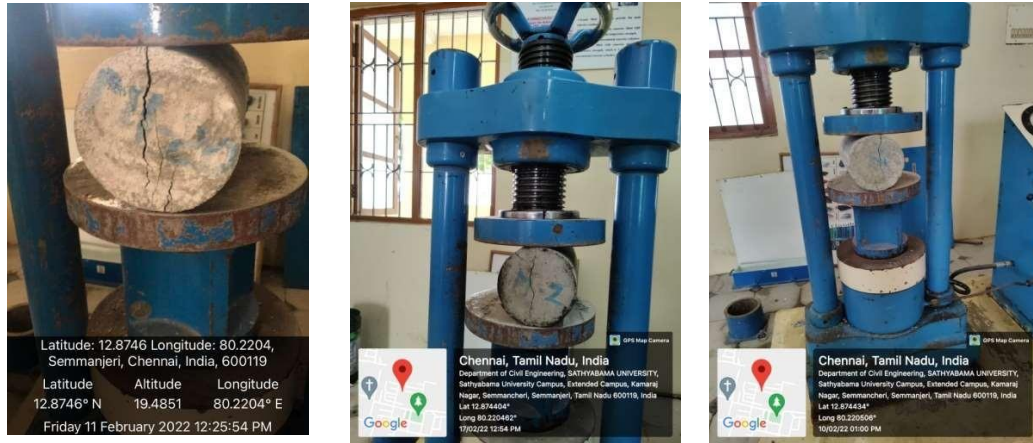


Fig.5.10 Picture of Split tensile test

Concrete type	7days	14days	28days
Nominal mix	7.92	10.3	11.33
BA 20% replacement with copper wire	8.35	10.85	11.93
BA 25% replacement with copper wire	8.62	11.21	12.33
BA 20% replacement without copper wire	8.23	10.7	11.76
BA 25% replacement without copper wire	8.57	11.14	12.25

Table.5.3 Table showing result of Split-tensile test

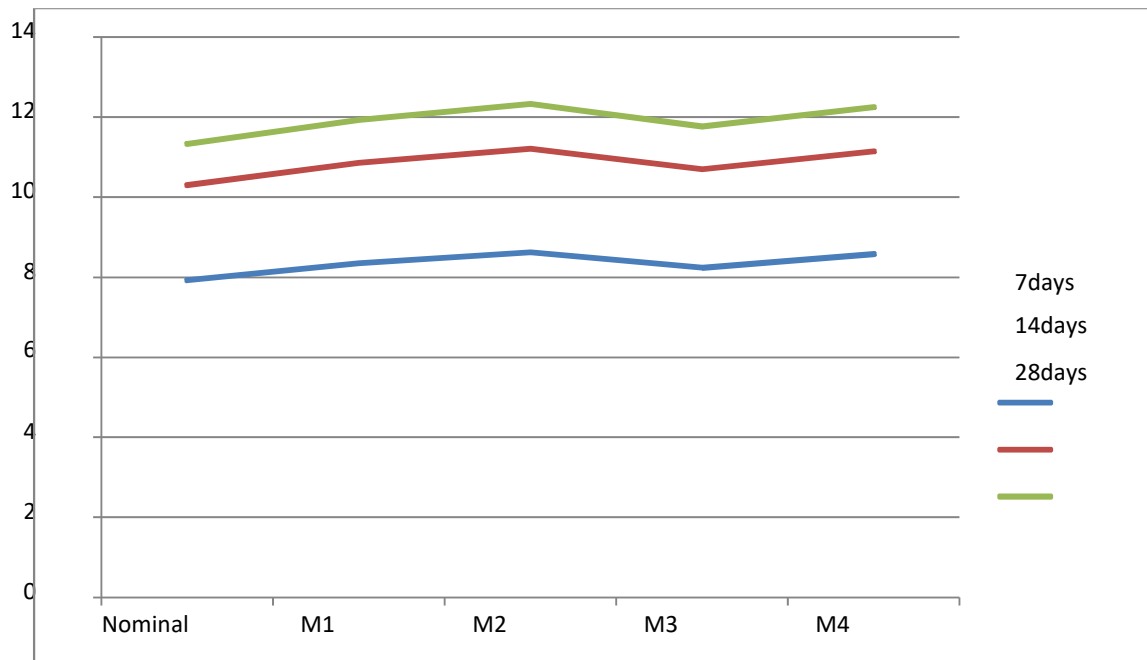


Fig.5.11 Graph Chart representing result of Split-tensile test

5.3.4 Flexural test:

It was done in prism using flexural testing machine. This prism is made up of plain cement concrete. It is used to measure force needed to bend a beam and to determine stiffness. As per the other tests here also slight increase in strength of concrete.



Fig.5.12 Picture of flexural test on concrete

	7days	14days	28days
Nominal mix		1.9	2.1
BA 20% replacement with copper wire		2.1	2.31
BA 25% replacement with copper wire		2.4	2.64
BA 20% replacement without copper wire		2.02	2.24
BA 25% replacement without copper wire		2.3	2.56

Table5.4 Represents result of flexural test

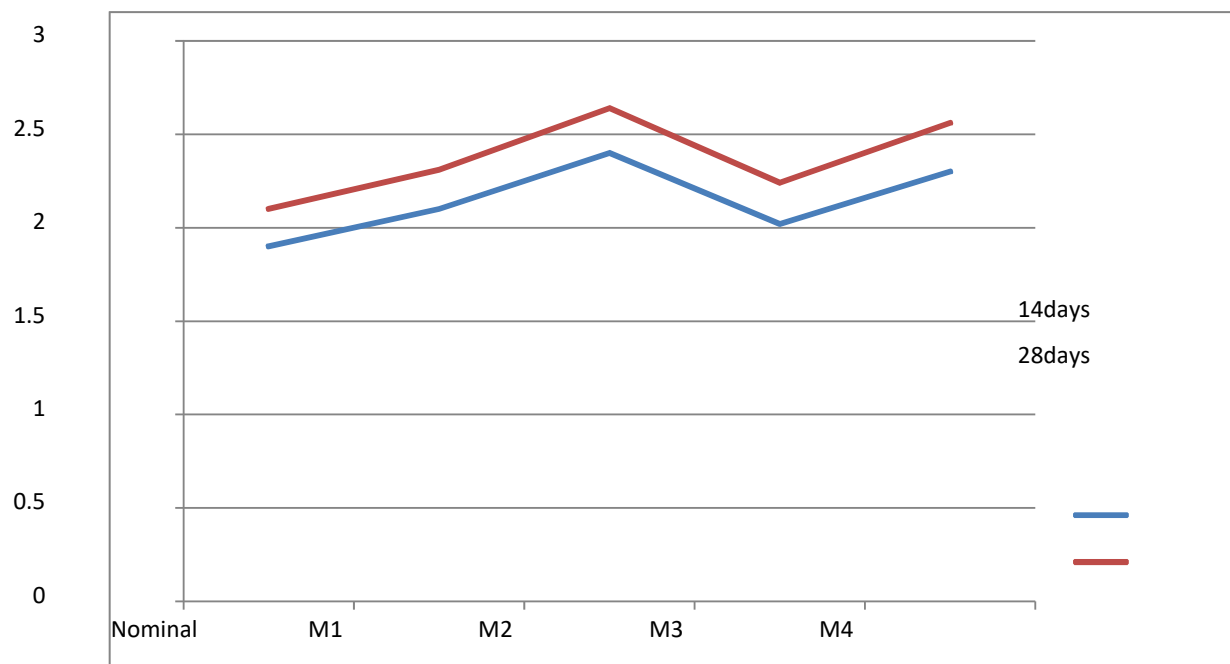


Fig.5.13 Graph Chart representing result of Flexural test

6. CONCLUSION

1. Lignite coal which was burned and that left waste which was sediment in land was disposed in environment was left unused.
2. These concretes are easy to set which means the setting time is too low.
3. The nano-tubes present in bottom-ash has natural properties like quick setting time,
4. Prevention of UV-rays, absorption of pollution, self-cleaning property etc.
5. Concrete strength increased than nominal
6. Usage of water is high
7. Cement, Fine aggregates, Coarse aggregates usage was reduced
8. Little technical mind is needed for calculating water quantity

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