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MECHANICAL AND DURABILITY PROPERTIES OF CONCRETE BY USING POTTERY POWDER (PP), METAKAOLIN (MK), BRICK POWDER (BP), QUARRY DUST (QD)

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ABSTRACT: *Concrete is the considerable man made material in the global. It is maximum broadly used introduction material because of its actual compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are jumbled collectively in precise proportions to provide plain concrete. Plain concrete wants congenial atmosphere by manner of providing wetness for a minimum period of 28days for precise association and to achieve most popular strength. Stream sand is most typically used fine aggregate within the production of concrete poses the matter of acute shortage in several areas. Secondary cementing materials like Brick Powder may be wont to part replace cement owing to pozzolanic nature. Materials like quarry mud best suites to sand attributable to its physical and chemical properties, fineness etc. conjointly these materials square measure notable to extend sturdiness, resistance to sulfate attack. The strength activity of developed Metakaolin is set with 17.5% a replacement of cement with Metakaolin as per ASTM it's determined that the activated Metakaolin has Associate in Nursing considerable influence on the rise in compressive strength of the mortars. Pottery powder is replaced in cement 7.5% the strength is augmented by adding the pottery powder scrutiny traditional mortar cubes. The assorted proportions 7.5%P.P, 17.5%M.K, % 12.5B.P%and 22.5%Q.D in M25 grade of concrete. The Mechanical homes like Compressive strength, split lastingness, Flexural strength and Rebound Hammer check and therefore the sturdy properties {acid check} and fast Chloride porosity test may be accomplished. And therefore the comparative study of traditional solidification concrete and blend proposition concrete of M25 grade. Our main aim is study the materials Pottery Powder, Brick powder, Quarry mud, Metakaolin square measure best appropriate for making ready mechanical and sturdy concrete for M25 Grade.*

Keywords: *Pottery powder, Metakaolin,, Brick powder, and Quarry dust, acid attack, chloride permeability.*

I. INTRODUCTION

Concrete is a manmade building material that looks like stone. The phrase "concrete" is derived from the Latin concrete meaning "to grow collectively." Concrete may be a composite material composed of coarse granular material (the combination or filler) embedded during a powerful matrix of fabric (the cement or binder) that fills the gap some of the mixture particles and glues them along. Instead, we will say that concrete may be a material that consists primarily of a binding medium during which is embedded particles or fragments of aggregates. The most effective definition of concrete can be written as

Concrete = filler + binder

Curing is the manner of keeping the right moisture content to promote only cement hydration immediately after placement. Right moisture situations are essential due to the fact water is essential for the hydration of cementations materials. **Brick** mud may be a waste material obtained from completely different brick kilns and tile factories. Plenty of waste merchandise like brick mud or broken items or flakes of bricks (brickbat) set out from these kilns and factories. So far, such materials are used only for filling low lying square measures or are drop as waste product.**Metakaolin** is a pozzolan, probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC. Its quality is controlled during manufacture, resulting in a much less variable material than industrial pozzolans that are by-products. First used in the 1960s for the construction of a number of large dams in Brazil, metakaolin was successfully incorporated into the concrete with the original intention of suppressing any damage due to alkali-silica reaction. **The pottery** square measure createdwith regionally offered fine unsmooth clay. The clay mould square measure ready in several shapes and square measure backed in oven. Later these clay wares square measure washed with pulverizedsubstance and square measure rubbed with mustard oil. They are adorned with floral and geometric mottled grooves victimisation sharp twigs.

They're smoke unemployed with rice husk in b oven which supplies its distinctive shiny black surface. They're once more rubbed with oil and baked in oven. **Quarry dust**It is a byproduct of the crushing method that could be a focused material to use as aggregates for concreting purpose, particularly as fine aggregates. In production activities, the rock has been crushed into varied sizes; throughout the method the mud generated is termed quarry mud and it's shaped as waste

II. LITERATURE REVIEW

In the literature the use of Pottery Powder, Metakaolin, Brick powder, Quarry dust are defined, the effect of admixtures inside the fresh concrete and the harden concrete are explained with the aid of the authors who're studied within the past.

N. J. COLEMAN(2000) The incorporation of 20% metakaolin into OPC pasteof moderate alkali content (0.63% equivalent Na2O)has been seen to result in changes in the chemical composition of the solid state phases of the hydrated material. The pozzolanic reaction has been demonstrated by DTA. Very little calcium hydroxide remained after acuring period of 100 days. Calcium hydroxide content is considered to be relevant to the stability of the passive Fe2O3 film that provides corrosion protection for embedded steel reinforcement. It has been suggested that the increase in chloride binding capacity observed for metakaolin-blended cement paste samples could be attributed to the participation of calcium aluminate species in the formationofFriedel's salt which would otherwise be engaged in the formation of hydrated gehlenite and tetracalcium aluminate hydrate.

S. N. Raman (2005) based on the results and discussion mentioned above, the following conclusions can be derived. The quarry dust used in this study was a relatively weaker fine aggregate when compared to the river sand used in this study. The aggregate crushing value, flakiness index soundness and pH value of the quarry dust used in this study could contribute significant effects to the strength and durability of concrete. The incorporation of quarry dust as partial replacement material to sand in concrete resulted in a reduction in the compressive strength, and this was more evident when the replacement proportion was increased. The reduction in the compressive strength of the
Quarry dust concrete was compensated by the inclusion of mineral admixtures into the concrete mix. In the presence of silica fume or fly ash, quarry dust can be a suitable partial replacement material to sand to produce concretes with fair ranges of compressive strength.

III. MATERIALS

The materials used within the present examine are:

1. Cement: Cement is used as a binding fabric in concrete. The Cement used inside the present have a look at is manufactured through Zuari Cement business enterprise of 53 grade OPC (ordinary Portland Cement) confirming to IS 12269-1987 is used in this observe. The properties of cement are given underneath.

Table 1: Properties of Cement

S.NO	PARTICULARS	RESULTS
1	Specific Gravity	3.0
2	Initial Setting Time	70min
3	Final Setting Time	450min
4	Fineness	225m^2/kg

2. Aggregates: Aggregates represent a skeleton of concrete. More or less three-quarters of the amount of conventional concrete is occupied by aggregate. It's inevitable that a constituent occupying one of these large percentages of the mass have to make a contribution of essential properties to both the fresh and hardened product.

A. Fine aggregates: Aggregates passing through 4.75 mm sieve and predominately retained on 75 µm sieve are classified as fine aggregate. River sand is the most commonly used fine aggregate. In addition, crushed rock fines can be used as fine aggregate. However, the finish of concrete with crushed rock fines is not as good as that with river sand. In the present study we are using River sand for the good finishing and to fill the voids between the coarse aggregate. River sand is taken from Cheyyeru River near Nandalur. The properties of sand are given in below.

Table 2: Properties of Fine Aggregate

S.No	Particulars	Results
1	Type	River Sand
2	Specific gravity	2.64
3	Size	4.75 mm
4	Water absorption	1%
5	Grade of sand	Zone II
6	Fineness modulus	2.88

B. Coarse Aggregates: Aggregates predominately retained on 4.75 mm sieve are categorized as coarse aggregate. Usually, the size of coarse aggregate is from 5 to 150 mm. For normal concrete used for structural members including beams and columns, the maximum size of coarse aggregate is about 25 mm. For mass concrete used for dams or deep foundations, the maximum size may be as large as 150 mm. In this study the size of the aggregate is 20 mm and it is taken from the quarry Akepadu village near Rajampet. The physical properties of coarse aggregate are listed in below table.

Table 3: Properties of Coarse Aggregate

S.No.	Particulars	Results
1	Type	Crushed stone
2	Specific Gravity	2.72
3	Size	20mm
4	Water absorption	0.8%
5	Bulk density	1688kg/m^3

3. POTTERY POWDER Pottery powder is a range of refractory clays used in the manufacture of ceramics, especially fire brick and pots. The United States Environmental Protection Agency defines fire clay very generally as a "mineral aggregate composed of hydrous silicates of aluminium ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) with or without free silica. Fire clay is resistant to high temperatures, having fusion points higher than 1,600 °C (2,910 °F), therefore it is suitable for lining furnaces, as fire brick, and for manufacture of tools used in the metal working industries, such as crucibles, saggars, retorts and glassware. Because of its stability during firing in the kiln, it can be used to make composite items of pottery such as pipes and sanitary ware.The Specific Gravity is 2.8

Fig no: 1.Pottery powder

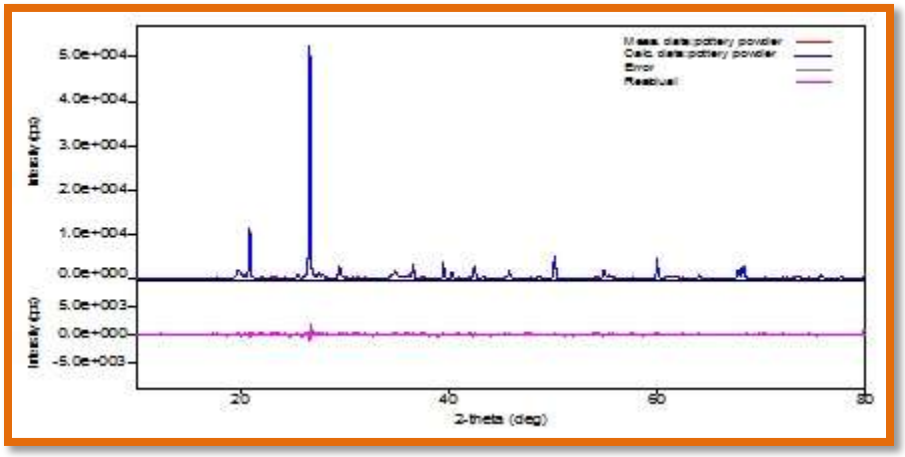
Table no: 4 Chemical composition of pottery powder

Oxide Content	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	N_2O	K_2O	TiO_2
Pottery Powder	45.50	11.55	5.82	21.45	2.10	0.10	1.40	3.43	1.21

XRD test results for Pottery powder:

It contains silicon dioxide, cadmium copper dichromate. By using Williamson-Hall method crystallite size and lattice strain is obtained for Pottery powder crystallite size is 456A^o and -0.03 % of strain. Quantitative analysis results for Brick

powder, it contains silicon dioxide, and cadmium copper dichromate contains 100.0%. By using Debye – Scherer equation, K=0.9, λ= 1.54 A^o, A°=10^{-10} m, $\beta = \frac{\pi}{180} \times$ FWHM = $\frac{\pi}{180} \times$ 0.123 = 2.146×10^{-3} 2Θ= 26.658°,Θ= 13.329^o Particle size, $D=\frac{K\lambda}{\beta \cos\Theta} = \frac{0.9\times1.54\times10-10}{2.146\times10-3\times\cos(13.329)}$ = 6.637×10= 66.37×10^{-9} m=66.37 nm



1. Pottery Powder XRD Test

4. METAKAOLIN

Metakaolin is a pozzolan, probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a by-product and is formed when china clay, the mineral kaolin, is heated to a temperature between 600 and 800ºC. Its quality is controlled during manufacture, resulting in a much less variable material than industrial pozzolans that are by-products. Metakaolin was with success incorporated into the concrete with the first intention of suppressing any harm attributable to alkali-silica reaction. once accustomed replace cement at levels of 5% to 10% by weight, the concrete created is usually a lot of cohesive and fewer probably to bleed. As a result pumping and finishing processes need less effort. The compressive strength of hardened concrete is additionally hyperbolic at this level of replacement. Slightly higher replacement levels (up to 20%) manufacture a cement matrix that has low porousness and porousness. This leads to enhancements to resistance of the hardened concrete to attack by sulfates, chloride ions and alternative aggressive substances, like mineral and organic acids. Freeze/ thaw resistance is improved and also the risk of harm ensuing from the results of impact or abrasion is reduced for Metakaolin concrete that has been finished and cured properly. The Specific Gravity is "2".

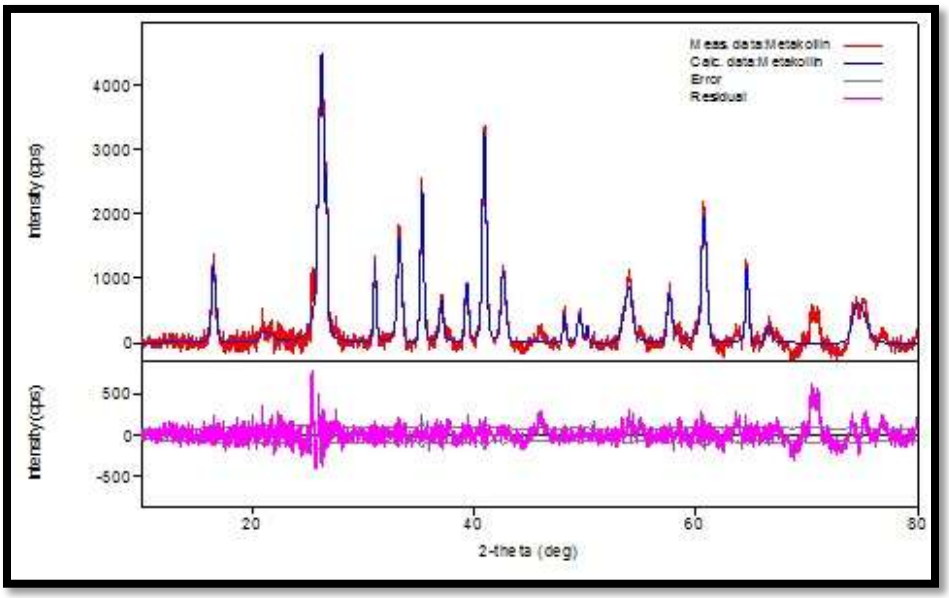
Table no : 5 CHEMICAL COMPOSITION

compound	CaO	SiO_2	Al_2O_3	Fe_2O_3	SO_3	MgO	K_2O
OPC	65.3	20.6	5.3	2.6	3.0	1.2	0.8
Metakaolin	0.4	54.2	40.8	0.6	0.3	0.2	2.1

Fig :2. Metakaolin

XRD test results for Metakaolin:

By using Williamson-Hall method crystallite size and lattice strain is obtained for Pottery powder crystallite size is 257A^{o} and 0.22 % of strain.Quantitative analysis results for Brick powder, it contains Mullite, syn, alpha-sio2 contains 100.0%. K=0.9, λ= 1.54 A^{o}, A°=10^{-10} m, $\beta = \frac{\pi}{180} \times$ FWHM = $\frac{\pi}{180} \times$ 0.63 = 0.0109955, 2Θ= 26.217°,Θ= 13.1085^{o}, The Particle Size of Metakaolin is D=$\frac{K\lambda}{\beta \cos\Theta} = \frac{0.9\times1.54\times10-10}{0.0109955\times\cos(13.1085)}$ = 1.2942×10^{-8} = 12.942×10^{-9} =12.942nm



2. Metakaolin XRD Test

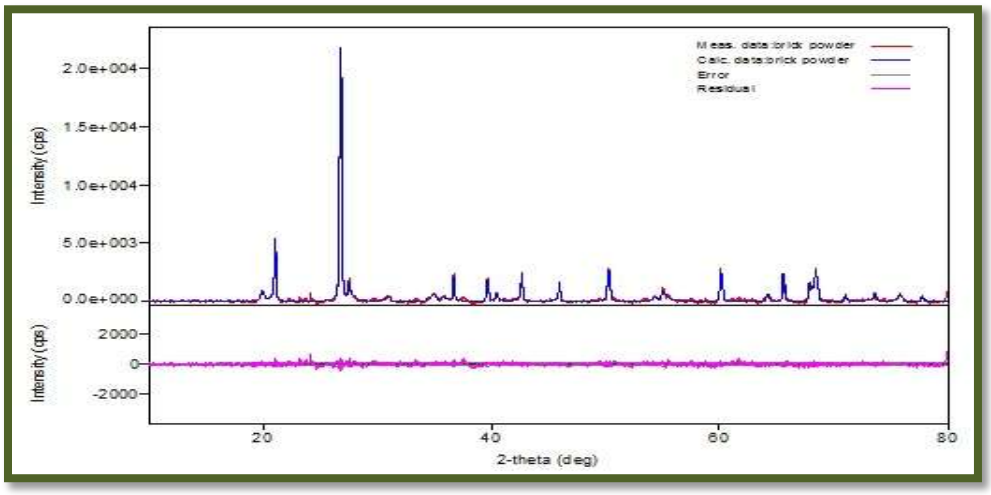
5. BRICK POWDER

Brick dirt may be a waste matter obtained from completely different brick kilns and tile factories.. Loads of waste product like brick dirt or broken items or flakes of bricks (brickbat) initiate from these kilns and factories. So far, such materials are used only for filling low lying area unit as are drop as waste product.Discharged bricks area unit burned in a very oven that makes them sturdy. Modern, fired, clay bricks area unit shaped in one in every of 3processes – soft mud, dry press, or extruded. Counting on the country, either the extruded or soft mud technique is that the most typical, since they're the foremost economical. The Specific Gravity is 2.07.

Fig 3: Brick Powder

XRD test results for Brick powder:
By using Williamson-Hall method crystallite size and lattice strain is obtained for Brick powder crystallite size is 578A^{o} and 0.09 % of strain.Quantitative analysis results for Brick powder, it contains Quartz, syn, Zin selenide and carbon contains 100.0%.K=0.9, λ= 1.54 A^{o}, A°=10^{-10} m, $\beta = \frac{\pi}{180} \times$ FWHM = $\frac{\pi}{180} \times$ 0.099 = 1.727×10^{-3}, 2Θ= 26.849°,Θ= 13.4245^{o},

The Particle Size of Brick Powder is $D=\frac{K\lambda}{\beta \cos\Theta}=\frac{0.9\times1.54\times10-10}{1.727\times10-3\times\cos(13.4245)}$ = 8.2509×10^{-8}= 82.509×10^{-9}m =82.504nm



3. Brick Powder XRD Test

6. QUARRY DUST

Quarry mud could be a byproduct of the crushing method that could be a focused material to use as aggregates for concreting purpose, particularly as fine aggregates. In production activities, the rock has been crushed into variedsizes; throughout the method the mud generated is termed quarry mud and it's shaped as waste. Therefore it becomes as a useless material and additionally leads to pollution. Therefore quarry mud ought to be utilized in construction works, which is able to cut back the value of construction and also the construction material would be saved and also the natural resources Is used properly. Most of the developing countries are harassed to exchange fine mixture in concrete by an alternate material additionally to some extent or altogether while not compromising the standard of concrete. This sort of mud is obtaining in style in construction comes like building, building homes and creating bricks and tiles.

Particulars	Type	Specific Gravity	Grading size	Density
Results	Crushed Stone Powder	3.06	4.75mm	1.63gm/cc

Table no 6 – Physical properties of Quarry dust `

Fig 4: Quarry Dust

7. WATER:

Water is used for mixing and curing of concrete. In the present investigation, tap water available in the campus was used for both mixing and curing of concrete

IV. EXPERIMENTAL PROGRAM

A. Mix Proportions: In the present investigation M25 concrete is prepared with the water cement ratio 0.5. Concrete mixes are prepared by different proportions of cement replacing with Pottery Powder, Metakaolin, Brick powder, Quarry dust can be replaced in water with different proportions i.e. 7.5%P.P, 17.5% M.K, 12.5% B.P and 22.5%Q.D.
The mix designations are follows:

1. A1 refers to the conventional OPC concrete
2. A2 7.5%P.P, 17.5%M.K, in cement and 12.5B.P% and 22.5%Q.D in Fine aggregate

B. Casting of Specimens: The casting IS a standard size of mortar cubes 75mm ×75mm× 75mm dimensions The specimens are casted in the present study are cubes of size 150X150X150 mm, Cylinders of size 150 mm diameter and 300 mm height, Beam specimens of size 150X150X700 mm for 7 days, 14 days and 28 days,60days. RCPT of size 10 cmdiameter and 5 cm height used for 28 days and 60 days.

C. Mix Proportions: Mix Proportions for M25 concrete are:

Table 7: Mix Proportions of Concrete

Material	Quantity
Cement	351.5 Kg/m^3
Fine Aggregate	718.43 Kg/m^3
Coarse Aggregate	1163.6 Kg/m^3
Water	187 lit/m^3

V. EXPERIMENTAL RESULTS

A. COMPRESSIVE STRENGTH CEMENT MORTAR CUBES RESULTS OF POTTERY POWDER AND METAKAOLIN:

Table 8.compressive strength for mortar cubes

% of replacement of cement		Strength(N/MM^2)	
P.P	M.K	P.P	M.K
0	0	33.3	33.3
5	10	33.3	32.8
10	15	17.6	33.8
15	20	14.6	19.5

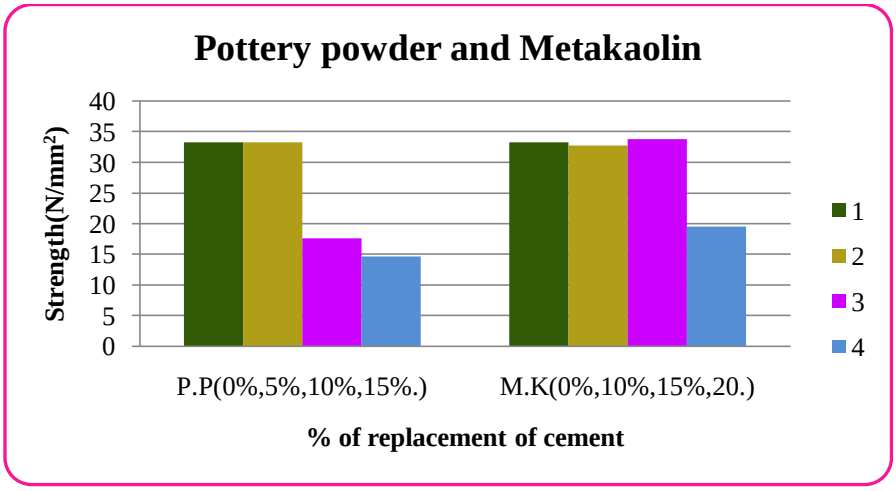
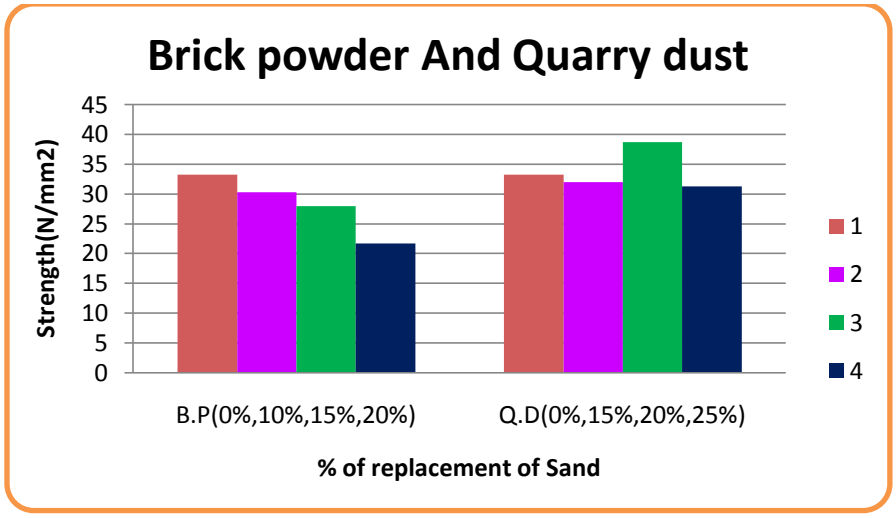


Table: 9 .Compressive strength Cement mortar cubes results of Brick powder And Quarry dust

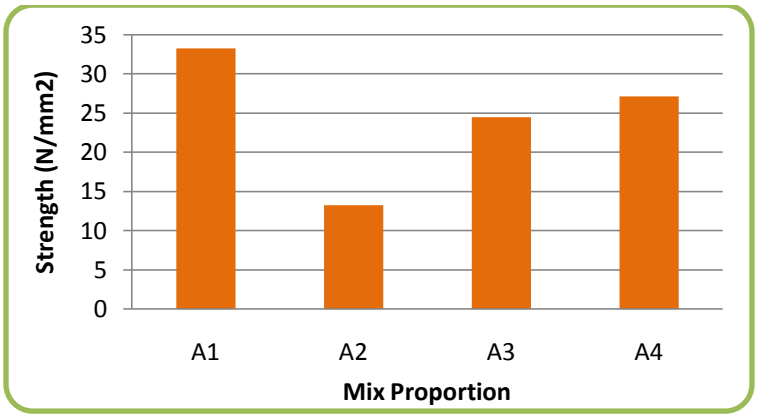
Replacement of B.P	Strength(N/MM^2)	Replacement of Q.D	Strength(N/MM^2)
0	33.3	0	33.3
10%	30.3	15%	32.0
15%	28.0	20%	38.7
20%	21.7	25%	31.3



Mix Proportion	Proportions of Supplementary Material
A1	100% Cement & fine aggregate
A2	2.5%P.P& 12.5% M.K in Cement AND 7.5%B.P & 17.5%Q.D in Fine aggregate
A3	5%P.P& 15% M.K in Cement AND 10%B.P & 20%Q.D in Fine aggregate
A4	7.5%P.P& 17.5% M.K in Cement AND 12.5%B.P & 22.5%Q.D in Fine aggregate

Table no: 11 The Mortar Cubes compressive strength in 7 days

Material	Strength (N/mm$^{2)}$
A1	33.3
A2	13.3
A3	24.5
A4	27.02



The above compressive mortar test they calculate the optimum percentage for using this materials. That is A4 is the optimum strength is came. The strength is 29.89 N/MM^2

4.1. Mix Proportions of Concrete cubes

Table no- 12. Mechanical Properties of Mix Proportions

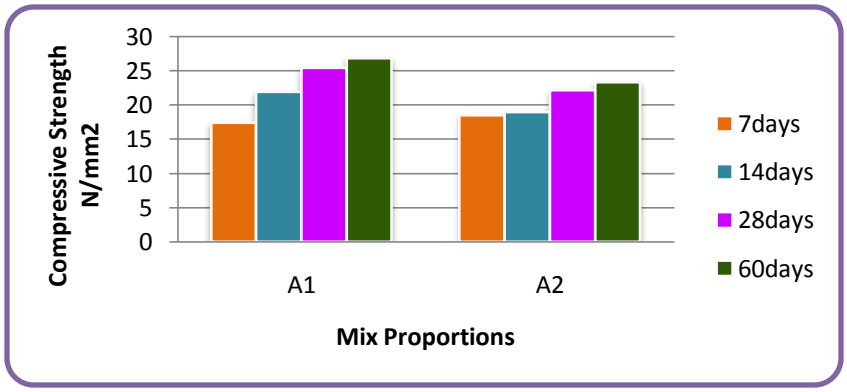
Mix Proportion	Proportions of Supplementary Material
A1	100% Cement & fine aggregate
A2	7.5%P.P& 17.5% M.K in Cement AND 12.5%B.P & 22.5%Q.D in Fine aggregate

4.2. Compressive Strength:

The Compressive strength of M_{25} grade of concrete by replaces in ordinary Portland cement with Pottery powder &Metakaolin. And replaces in sand Brick powder & Quarry dust with different percentage its show in above table. The results of compressive strength of A1, A2 concrete mixtures tested at 7days, 14days, 28days, and h60days the data are presented in the given below table and graphical presentation compressive strength.

Table no: 13. Compressive strength

Mix Proportions	Compressive strength N/mm^2			
	7-Days	14-Days	28-Days	60 –Days
A1	17.4	21.9	25.41	26.86
A2	18.53	18.96	22.16	23.33

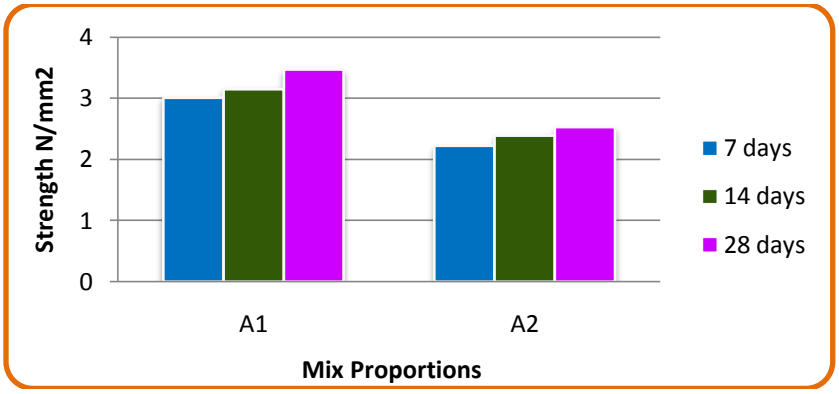


4.3. Split Tensile Strength

The Split Tensile strength of M_{25} grade of concrete by replaces in ordinary Portland cementwith Pottery powder &Metakaolin. And replaces in sand Brick powder & Quarry dust with different percentage its show in above table. The results of compressive strength of A1, A2 concrete mixtures tested at 7days, 14days,and 28days. The data are presented in the given below table and graphical presentation Split Tensile strength.

Table no: 14. Split Tensile Strength

Mix Proportions	Split Tensile strength N/mm^2		
	7-Days	14-Days	28-Days
A1	3.01	3.15	3.47
A2	2.22	2.39	2.53

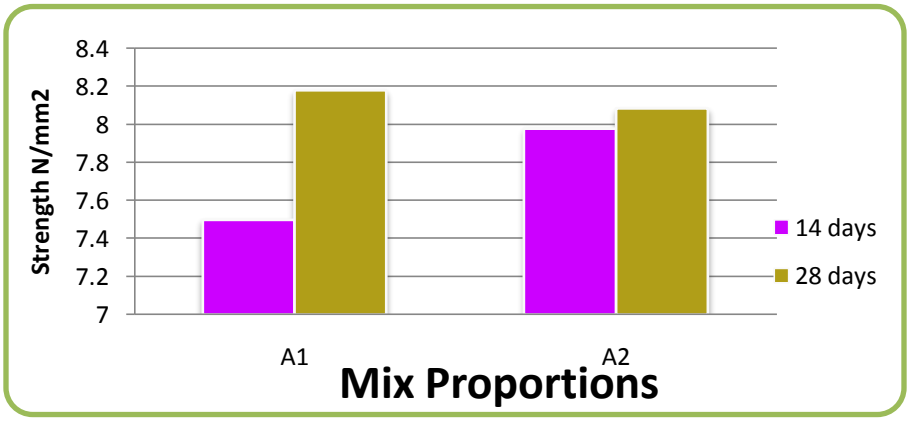


4.4. Flexure Strength

TheFlexure Strength strength of M_{25} grade of concrete by replaces in ordinary Portland cement with Pottery powder &Metakaolin. And replaces in sand Brick powder & Quarry dust with different percentage its show in above table. The results of compressive strength of A1, A2 concrete mixtures tested at 14days,and 28days. The data are presented in the given below table and graphical presentation Flexure Strength strength.

Table no : 15. Flexure Strength

Mix Proportions	Flexural strength (Mpa)	
	14 dys	28 days
A1	7.5	8.18
A2	7.98	8.085

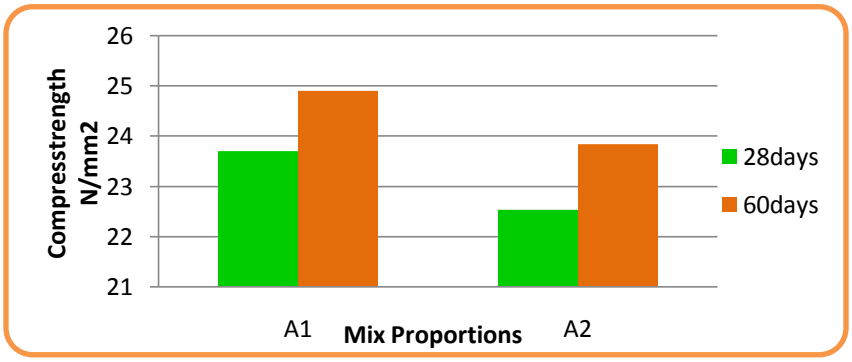


4.7 Rebound Hammer Test

The Rebound Hammer test strength results for various replacement levels ordinary Portland cement with Pottery powder &Metakaolin. And replaces in sand Brick powder & Quarry dust with different percentage its show in below the table. The results of Rebound Hammer Test of A1, A2 concrete mixtures tested at 28days, and 60days. The data are presented in the given below

Table no 16- Rebound Hammer results

MixProportions	28days	60days
A1	23.75	24.9
A2	22.53	23.84



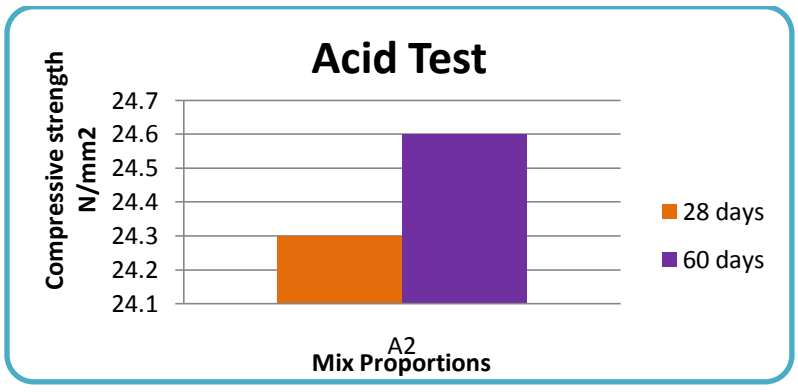
DURABILITY PROPERTIES

A. Acid TestCompressive Strength:

The Compressive strength of M_{25} grade of concrete by replaces in ordinary Portland cement with Pottery powder &Metakaolin. And replaces in sand Brick powder & Quarry dust with different percentage its show in above table. The results of compressive strength of A1, A2 concrete mixtures tested at normal currying 28 days after the cubs curringinacid 28days, 60 days. the data are presented in the given below table and graphical presentation compressive strength.

Table no :17Compressive strength of Acid test Results

Mix Proportions	Compressive strength N/mm^2	
	28days	60days
A2	24.3	24.6

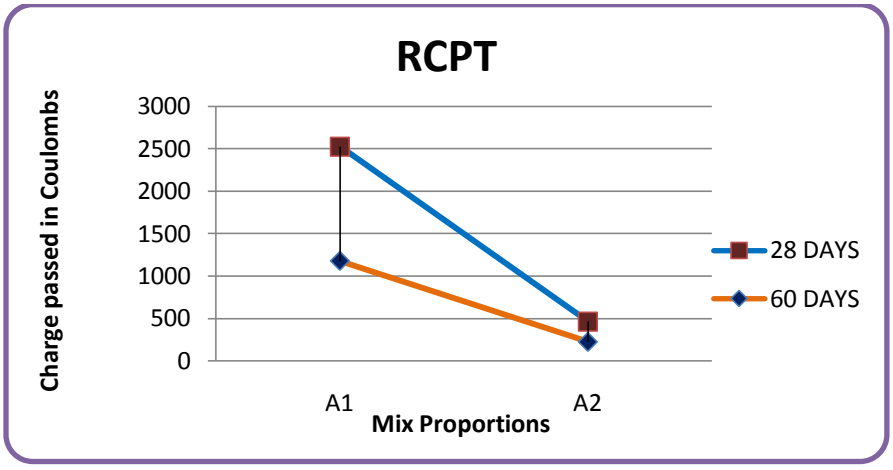


4.6. Rapid Chloride Penetration Test

`The test results conducted for 28 days and 60 days of rapid chloride permeability test with various percentages replacement of cement with fly ash as well as cow dung ash are presented in tables and then discussed. From the results it may be observed that decreasing the values by replacing various percentages of materials with cement.

Table no-18 Rapid Chloride Permeability Results

MixProportions	28 days	60days
A1	1348.2	1178.5
A2	237.6	227.25



IV. CONCLUSION

- The compressive strength of cement mortar cubes having 5% Pottery powder is more strength than while adding the pottery powder of 10% and 15%. and 15% Metakaolin is more strength than while adding the Metakaolin 10% and 20% this both material replacement in cement
- The compressive strength of cement mortar cubes having and 20% of Quarry dust is more strength than while comparing normal concrete and while adding the Quarry dust 15% and 25%. And 10% Brick powder is more strength than while adding the Brick powder 15% and 20% this both replacement in fine aggregate
- Finding the optimum strength by mixing the four materials in the compressive strength of cement mortar cubes 7.5% P.P,17.5%M.K, replacement in cement. And 12.5%B.P, and 22.5% Q.D replacement in fine aggregate
- The compressive strength of concrete cubes is only 7 days strength is more strength and remaining 14,28 and 56 days is equal to normal concrete
- The Tensile strength of normal concrete is more strength comparing the mix proposition concrete cubes
- Flexural strength of mix proposition concrete is more strength in normal concrete
- Rebound hammer test is equal strength to the normal concrete
- The Durability of acid test is 90 days strength is more comparing the 56 days of cubes
- The RCPT test From the results it may be observed that decreasing the values by replacing various percentages of materials with cement and aggregate. So the concrete resistance to chloride permeability is very low.
- It is Economical cheep and this material is wasted materials and easily available
- Finally they can't used this much of material .Because the strength is decrees comparing to normal concrete.

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