REPLACEMENT OF CEMENT AND COARSE AGGREGATE BY USING METAKAOLIN AND TILES WASTE

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Abstract - *Concrete a widely used construction material consume natural resource cement, aggregates, water. In this content an interest was made by civil engineer to replace the composite concrete material with tiles waste. In this content metakaolin was pozzolanic material used in wide range in replacement of cement in concrete which was treated as economical and also due to its pozzolanic action increases strength and durability properties of concrete. Use of recycle concrete aggregate for tile waste aggregate in lean concrete production helps in solving vital environmental issue apart from being a solution to inadequate concrete aggregates in concrete.*

Key Words: Metakaolin, Tiles Waste, Coarse Aggregate, Fine Aggregate, M20 Grade, Compressive Strength, Environmental Waste.

1. INTRODUCTION

1.1 GENERAL

In construction industry, consumption of cement is increasing day by day as well as cost is also increasing so to reduce the consumption of cement, replacement with metakaolin and tile waste was done. Metakaolin is a calcined clay and easily available in Gujarat Maharashtra and Chennai.

The demand for Portland cement is increasing dramatically in developing countries. Portland cement production is one of the major reasons for CO_2 emissions into atmosphere. It is due to the use of fossil fuels, including the fuels required to generate electricity during cement manufacturing process. The use of pozzolana for making concrete is considered efficient, as it allows the reduction of the cement consumption while improving the strength and durability properties of the concrete.

Metakaolin when used as a partial replacement substance for cement in concrete, it reacts with $Ca(OH)_2$ one of the by-products of hydration reaction of cement and results in additional C-S-H gel which results in increased strength. Metakaolin is obtained by thermal activation of kaolin clay. This activation will cause a substantial loss of water in its constitution causing a rearrangement of its structure. To obtain an adequate thermal activation, the temperature range should be established between 600 to 750ºC.

Metakaolin is used in to improve the compressive and flexural strength of the hardened cement. Metakaolin also reduces the hardened cement permeability to liquids and gases. Hence by partially replacing Portland cement with Metakaolin not only reduces carbon dioxide emissions but also increases the service life of buildings.

Tile waste are hard having considerable value of specific gravity, rough surface on one side and smooth on other side, having less thickness and are lighter in weight than normal stone aggregates. Using tile waste in concrete not only it will be cost effective, but also provide considerable strength to the concrete. The tiles will also show more in the following mix design of M_{20} grade concrete, normal weight aggregate has been replaced by tile waste and their respective calculation has been done.

Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Rocks that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume .The quality and reactivity of metakaolin is strongly dependent of the characteristics of the raw material used. Metakaolin can be produced from a variety of primary and secondary sources containing kaolinite. Metakaolin is refined calcined kaolin clay under carefully controlled conditions to create an amorphous alumino silicate w h i c h i s reactive in concrete. Natural pozzolano like fly ash and silica, metakaolin a l s o reacts with the calcium hydroxide (lime) byproducts produced during cement hydration. Between 100-200°C, clay minerals lose most of their adsorbed water. Between 500-800°C kaolinite becomes calcined by losing water through dehydroxilization. The dehydroxilization of kaolin to metakaolin is an endothermic process due to the large amount of energy required to remove the chemically bonded hydroxyl ions. Above this temperature range, kaolinite becomes metakaolin, with a two-dimensional order in crystal structure. This material is ground to a required fineness of 700-900m2 /kg. In order to produce a pozzolan (supplementary cementing material) nearly complete dehydroxilization must be reached without overheating, i.e., thoroughly roasted but not burnt. This produces an amorphous, highly pozzolanic state, whereas overheating can cause sintering, to form the dead burnt, nonreactive refractory, called mullite.

1.2 OBJECTIVES

- To find the optimum replacement of cement by metakaolin.
- To find compression strength, split tensile strength and flexural strength of metakaolin concrete and conventional concrete.
- To reduce the water content of concrete.
- Tile waste utilization from production and construction sites.
- Impact of mining is minimized.
- Minimization in power consumption used for quarrying.
- Natural resources are conserved.
- The energy consumption is increased.
- Both of the metakaolin and tile waste are a lower heat of hydration.

By keeping the above objective in mind the aims of present work is to check the stability and utilization of metakaolin as replacement of Portland cement in concrete.

2. MATERIALS AND TESTING

2.1 MATERIALS

2.1.1 CEMENT

Cement is used right from ancient periods in construction industry. In the most general sense of word, cement is binder, a substance which sets and hardens independently and can bind other materials together.IS mark 53 grade cement was used for all concrete mixes. The cement used was fresh and without any lumps. Testing of cement was done as per IS: 8112-1989. The various tests results conducted on the cement are reported in Table-1 Properties of cement

Fig -1: Cement

Table -1: Properties of cement

S.No	CHARACTERISTICS	VALUES
1	Normal consistency	34%
2	Initial setting time (minutes)	48 min.
3	Final setting time (minutes)	240 min.
4	Fineness (%)	3.5 %
5	Specific gravity	3.07

Table -2: Ingredient of Ordinary Portland cement

S.No	PROPERTY	VALUE %
1	Lime	62%
2	Silica	22%
3	Alumina	5%
4	Calcium Sulphate	4%
5	Iron Oxide	3%

2.1.2 AGGREGATE

2.1.2.1 FINE AGGREGATE

The sand used for the experimental programmed was locally procured and conformed to grading zone III as per IS: 383-1970.

The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. Properties of the fine aggregate used in the experimental work are tabulated in Table 3

Fig -2: Fine Aggregate

Table -3: Properties of fine aggregates

S. No	CHARACTERISTICS	VALUE
1.	Type	Uncrushed (natural)
2.	Specific gravity	2.68
3.	Total water absorption	1.02 %
4.	Moisture content	0.16 %
5.	Net water absorption	0.86 %
6.	Fineness modulus	2.507
7.	Grading zone	III

2.1.2.2 COARSE AGGREGATE

Aggregate are the major and important constituents of concrete. They form the whole body of concrete as it occupies 70 to 80% of the volume of concrete. Although aggregate were considered as inert material earlier which have been found recently to be chemically active to some extent.

Fig -3: Coarse Aggregate

Table -4: Properties of Coarse aggregates

S. No	CHARACTERISTICS	VALUE
1.	Type	Crushed
2.	Maximum size	20 mm
3.	Specific gravity (10 mm)	2.704
4.	Specific gravity (20 mm)	2.825
5.	Total water absorption (10 mm)	1.6432 %
6.	Total water absorption (20 mm)	3.645 %
7.	Moisture content (10 mm)	0.806 %
8.	Moisture content (20 mm)	0.7049 %
9.	Fineness modulus (10 mm)	6.46
10.	Fineness modulus (20 mm)	7.68

2.1.3 METAKAOLIN

The raw material in the manufacture of metakaolin is kaolin clay. Kaolin is a fine, Clay mineral that has been traditionally used in the manufacture of porcelain. Kaolin's are classifications of clay minerals, which like all clays are phyllosilicates.

Metakaolin is not a by-product of on industrial process nor is it entirely nature. It is derived from naturally occurring mineral and is manufactured specially for cementing applications. Metakaolin is produced under carefully controlled conditions to refine its color, remove inert, and tailor particle size such, a much high degree of purity and pozzolanic reactivity can be obtained.

Table -5: Physical properties of metakaolin

S.NO	PROPERTY	VALUE
1.	Specific gravity	2.5
2.	Mean grain size(µm)	2.54
3.	Specific area(cm^2/g)	150×10^3
4.	Colour	White and grey

Table -6: Chemical properties of metakaolin

S.No	CHEMICAL COMPOSITION	VALUE (%)
1	Silicon dioxide (SiO_2)	60-65
2	Aluminum oxide(Al_2O_3)	30-34
3	Iron oxide (Fe_2O_3)	1.00
4	Calcium oxide(CaO)	0.2-0.8
5	Magnesium oxide (MgO)	0.2-0.8
6	Sodium oxide (Na_2O)	0.5-1.2
7	Loss of ignition	<1.4

2.1.4 TILE WASTE

The production of tiles normally starts from raw material, grinding and mixing, granulated by spray, drying and pressing. The amount of tile waste on earth is enough for use as on aggregate in concrete.

Tile waste can be transformed into useful coarse aggregate. The properties of tile waste coarse aggregate are well within the range of the value of concrete making aggregate.

Table -7: Properties of tile waste

S.No	PROPERTY	VALUE(%)
1	Specific gravity	2.30
2	Fineness modulus	7.95
3	Crushing value	12.5
4	Impact value	27
5	Abrasion value	20
6	Maximum size (mm)	24

Table -8: Chemical properties of tile waste

S.No	COMPOSITION	VALUE (%)
1.	SiO_2	68.85
2.	Al_2O_3	18.53
3.	Fe_2O_3	4.81
4.	CaO	1.57
5.	Na_2O	2.01
6.	K_2O	1.63
7.	MgO	0.72
8.	TiO_2	0.737
9.	MnO	0.078
10.	P_2O_5	0.034
11.	SO_3	0.06
12.	Loss of ignition	0.48

2.2 TESTS

2.2.1 FINENESS TEST FOR CEMENT

This test could be performed in standard balance with100gm.weighing capacity. Accordance with IS:90 micron sieve confirming to IS:460-1962 and a Brush.

Break down air-set lumps in the cement sample with fingers. weigh accurately 100gms of the cement and place it on a standard 90micron IS sieve. continuously sieve the sample for 15minutes.weigh the residue left after 15 minutes of sieving. this completes the test.

Calculation

The percentage weight of residue over the total sample is reported.

$$\%\text{Weight of Residue} = \frac{(\text{Wt.of.sample Retained on the Sieve})}{(\text{Total Weight of the sample})}$$

The percentage residue should not exceed 10%

2.2.2 SOUNDNESS TEST FOR CEMENT

Cement concrete should not undergo large change in volume after setting. Such expansion takes place due to slow or delayed hydration of free lime, magnesia and calcium sulphate. The change in volume is called "unsoundness" which produces cracks, distortion and disintegration in the structure, thereby allowing water and atmospheric gases that may have injurious effect on concrete or the steel reinforcement. If expansion occurs after concrete has set, the structure will get damaged.

A cement paste with 78 % of the water required to make a paste of normal consistency is prepared with about 100 g of cement and is placed in the mould of Le Chatelier's apparatus which rests on a glass plate. Another glass plate is placed on the top and weighed. The whole apparatus is then immediately placed in a water bath whose temperature is between 27 _+ 2 OC. The distance between the tips Of pointers is measured after an interval of 24 hrs. The mould is then immersed in a beaker of water which is heated to boiling point in 25 to 30 minutes and kept boiling for one hour. After cooling, the distance between the tips of the pointers is again measured.

Calculation

Quantity of water for preparing cement paste of standard consistency

= % the cement specimen is sound/unsound.

2.2.3 CONSISTENCY TEST FOR CEMENT

The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the vicat mould.

Unless otherwise specified this test shall be conducted at a temperature 27 + 20C and the relative humidity of laboratory should be 65 + 5%. Prepare a paste of weighed quantity of cement (300gms) with weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3minutes or more than 5minutes and the gauging is completed before any sign of setting occurs. The gauging is counted from the time of adding water to the dry cement until commencing to fill the mould. Fill the vicat mould with this paste resting upon a non-porous plate. Smoothen the surface of the paste, making it level with the top of the mould. Slightly shake the mould to expel the air. In filling the mould operators hands and the blade of the gauging trowel shall only be used. Immediately place the test block with the non-porous resting plate, under the rod bearing the plunger. Lower the plunger gently to touch the surface of the test block and quickly release, allowing it sink into the paste. Record the depth of penetration Prepare trial pastes with varying percentages of water and test as described above until the plunger is 5mm to 7mm from the bottom of the vicat mould.

Calculation

$$\text{Standard consistency (\%)} = \frac{\text{Weight of water added}}{\text{Weight of cement}} \times 100$$

2.2.4 FINENESS MODULUS TEST FOR FINE AGGREGATE

To determine the fineness modulus, we need standard sieves, mechanical sieve shaker (optional), dry oven and digital weight scale. Take the sieves and arrange them in descending order with the largest sieve on top. If mechanical shaker is using then put the ordered sieves in position and pour the sample in the top sieve and then close it with sieve plate. Then switch on the machine and shaking of sieves should be done at least 5 minutes. If shaking is done by the hands then pour the sample in the top sieve and close it then hold the top two sieves and shake it inwards and outwards, vertically and horizontally. After some time shake the 3rd and 4th sieves and finally last sieves. After sieving, record the sample weights retained on each sieve. Then find the cumulative weight retained. Finally determine the cumulative percentage retained on each sieves. Add the all cumulative percentage values and divide with 100 then we will get the value of fineness modulus.

Calculation

Fineness modulus of fine aggregate= cumulative /100%

2.2.5 FINENESS MODULUS OF COARSE AGGREGATE

Take the sieves and arrange them in descending order with the largest sieve on top. If mechanical shaker is using then put the ordered sieves in position and pour the sample in the top sieve and then close it with sieve plate. Then switch on the machine and shaking of sieves should be done at least 5 minutes. After sieving, record the sample weights retained on each sieve. Then find the cumulative weight retained. Finally determine the cumulative percentage retained on each sieves. Add the all cumulative percentage values and divide with 100 then we will get the value of fineness modulus.

Calculation

Fineness modulus of coarse aggregate

= cumulative /100%

2.2.6 CRUSING STRENGTH TEST

The principal mechanical properties required in stones are (i) satisfactory resistance to crushing under the roller during construction and (ii) adequate resistance to surface abrasion under traffic.

Aggregate used in road construction, should be strong enough to resist crushing under traffic wheel loads . If the aggregates are weak, the stability of the pavement structure is likely to be adversely affected .the strength of coarse aggregates is assessed by aggregates crushing test. The aggregates crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load.to achieve a high quality of pavement ,aggregate possessing low aggregate crushing value should be preferred.

Calculation

The aggregate crushing value is defined, as a ratio of the weight of fines passing the specified IS sieve to the total weight of the sample expressed as a percentage.

Aggregate crushing value = 100 w2/w1

Where,
W1= Total weight of dry sample
W2= Weight of the portion of crushed material passing 2.36mm IS Sieve.

2.2.7 FRESH CONCRETE TEST

2.2.7.1 SLUMP CONE TEST

This method of test specifies the properties to be adopted, either in the laboratory or during the progress of work in the field , for determining by the slump test, the consistency of concrete.

The internal surface of the mould shall be thoroughly cleaned and freed from superfluous moisture and any set concrete before commencing the test. the mould shall be placed on a smooth ,horizontal, rigid and non –absorbent surface . such as a carefully leveled metal plate, the mould being firmly held in place while it is being filled. the mould shall be filled in four layers, each approximately one-quarter of the height of the mould each layer shall be tamped with 25 strocks of the rounded end of the damping road the strocks shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer .the bottom layer shall be damped throughout its depth after the top layer has been rodded. the concrete filled any mortar which may have leaked out between the mould and the base plate, shall be cleaned away.

The mould shall be removed from the concrete immediately by raising it slowly and carefully in a vertical direction .

This allows the concrete to subside and the slump shall be measured immediately by determined the difference between the height of the mould and that of the highest point of the specimen being tested.

The above operation shall be carried out a place free from vibration or shock and within a period of 2 minutes after sampling. The slump measured shall be recorded in terms of millimeters of subsidence of the specimen during the test.

Any slump specimen which collapses or shears off laterally gives incorrect result and if this occurs the test shall be repeated with another sample.

Fig -4: slump cone test

2.2.7.2 COMPACTION FACTOR TEST

Arrange the sieves in descending order and put the arrangement on mechanical shaker. It is suggested that, to know the exact value of fineness modulus for coarse aggregate, mechanical shaker will give better value than hand shaking because of more no. of sieves and heavy size particles.

After proper sieving, record the sample weights retained on each sieve and find out the cumulative weight of retained particles as well as cumulative % retained on each sieve.

Finally add all cumulative percentage values and divide the result with 100. Then we get the value of fineness modulus.

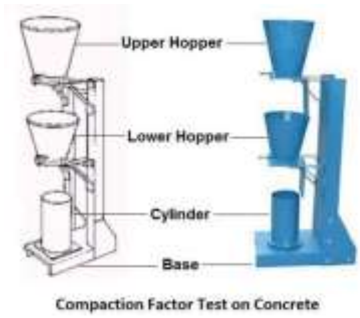

Fig -5: slump cone test

2.2.8 HARDENED CONCRETE TEST

2.2.8.1 COMPRESSION STRENGTH TEST

Out of many test applied to the concrete this is the at most important which gives an idea about all the characteristics of concrete. By this single test one judge that whether concreting has been done properly or not. For cube test Specimens cubes of 15cm × 15 cm × 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of specimen should be made smooth.

These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails.

Calculation

Compressive strength = P/A (N/mm^2)

Where,

P – Compressive load

A – Cross sectional area of specimen

Fig -6: Compression strength test setup

2.2.8.2 COMPRESSION STRENGTH TEST

It is the standard test to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS: 5816-1970.

A standard test cylinder of concrete specimen (300 mm × 150 mm diameter) is placed horizontally between the loading surfaces of compression testing machine. The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load near the points of application of this load strips of plywood are placed between the specimen and loading plants of the testing machine. Concrete cylinders split into two halves along this vertical plane due to indirect tensile stress generated by Poisson's effect.

Calculation

Split tensile strength = 2P / πDL

Where,

P – Tensional load

D – Diameter of specimen

L – Length of the specimen

Fig -7: Split tensile strength test setup

2.2.8.3 FLEXURAL STRENGTH TEST

Flexural strength also known as modules of rupture bend strength or fracture strength a mechanical parameter for brittle material is defined as a materials ability to resist deformation under load the transverse bending test is most frequently employed in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress here given the symbol "σ".

Calculation

Flexural strength = PL / bd^2

Where,

P – Load

L – Length of the specimen

b – Breadth of the specimen

d – Depth of the specimen

Fig -8: Flexural strength test

3. TEST RESULTS

3.1 CEMENT

3.1.1 FINENESS TEST OF CEMENT

Table -9: Fineness Test of Cement

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	7 Days	13.45	13.80 N/mm^2
2	150×150		13.80	
3	150×150		14.10	

Calculation:

Fineness modulus of cement $= W_2/W_1$

$=(0.0073/0.1)\times 100$

$= 7.35$

3.1.2 SOUNDNESS TEST FOR CEMENT

Weight of cement sample (Wc) = 100 gm

Water required for standard consistency (ρ) = 32%

Water added to the cement sample = 0.8×P×Wc

= 0.8×0.32×100

= 25.6ml (or) cc

Table -10: Soundness Test of Cement

Sample	Distance b/w pointer ends		Difference	Average
	Before heating D_1(mm)	After heating D_2(mm)	D_2-D_1 (mm)	
A	9mm	15mm	6mm	6mm
B	10mm	15mm	5mm	
C	9mm	16mm	7mm	

3.1.3 CONSISTENCY TEST FOR CEMENT

Table -11: Consistency Test of Cement

S.No	Weight of cement (gm)	Quantity of water		Index reading		
		in %	in ml	Initial	Final	Different
1.	400	28	112	0	24	24
2.	400	30	120	0	15	15
3.	400	32	128	0	6	6

3.2 FINENESS MODULUS TEST FOR FINE AGGREGATE

Weight of dry fine aggregate = 1000gm

Table -12: Fineness Modulus of Fine Aggregate

S.No	IS sieve	weight retained in gm	% of weight retained	Cumulative % of weight retained	% of passing
1.	4.75mm	-	-	-	100%
	2.36mm	150 gm	5	5	95%
3.	1.18mm	117 gm	11.70	16.70	83.20%
4.	600µm	191 gm	19.10	35.80	64.20%
5.	300µm	289 gm	28.90	64.70	35.30%
6.	150µm	353gm	35.30	100	0%

Calculation:

Fineness modulus of coarse aggregate

= cumulative / 100%

= 222.20 / 100

= 2.22 %

3.3 FINENESS MODULES OF COARSE AGGREGATE

Table -13: Fineness Modules of Coarse Aggregate

S.No	Sieve size	Weight of retained (gm)	% of weight retained	Cumulative % of weight retained	% of passing
1.	80 mm	-	-	-	100%
2.	40 mm	-	-	-	100%
3.	20 mm	2710	54.20	54.20	45.80%
4.	16 mm	900	18	72.20	27.80%
5.	12.5 mm	670	13.56	85.76	14.26%
6.	10 mm	654	13.08	98.84	1.16%
7.	4.75mm	27	0.60	99.38	0.62%

Calculation:

Fineness modules of coarse aggregate

= Cumulative / 100%

= 410 / 100

= 4.10%

3.4 CRUSHING STRENGTH TEST

Empty weight of Mould (W) = 10.69 kg

Weight of sample Mould & base plate (W_1) = 13.51 kg

Weight of sample passing through 2.36mm IS sieve (W_2) = 1.42 kg

Aggregate crushing value = W_2/(W1-W) ×100

= 1.42/13.21-10.69×100

= 57%

3.5 FRESH CONCRETE TEST

3.5.1 SLUMP CONE TEST

Table -14: Slump Cone Test

S.No	Water cement ratio	Water added in "ml"	Initial height		Final height	Slump in "mm"
			h_1	h_2	h_1-h_2	
1.	0.50	1250	300	250	50	50
2.	0.55	1375	300	120	120	120
3.	0.60	1500	300	155	145	145

The slump value of concrete is,

1. 50mm for 0.5 w/c
2. 120mm for 0.55 w/c
3. 145mm for 0.60 w/c

3.5.2 COMPACTION FACTOR TEST

Mass of cylinder, W_1 = 7.75 kg

Weight of cement = 2 kg

Weight of fine aggregate = 3 kg

Weight of coarse aggregate = 6 kg

Table -15: Compaction Factor Test

S.No	w/c ratio	Mass with partially compacted concrete (w_2)	Mass with fully compacted concrete (w_3)	Mass with partially compacted (w_2-w_1)	Mass with fully compacted concrete (w_3-w_1)	(w_2-w_1)/(w_3-w_1)
1.	0.4	15.90kg	16.15 kg	8.15 kg	8.40 kg	0.97
2.	0.5	16kg	16.25 kg	8.25 kg	8.50 kg	0.97
3.	0.6	16.40kg	16.65 kg	8.65 kg	8.90 kg	0.97

3.6 COMPRESSIVE STRENGHT TEST ON CONCRETE CUBE (M20)

FORMULA USED

Compressive strength = (load/area) N/mm^2

3.6.1 FOR 5% OF METAKAOLIN AND 25% OF TILE WASTE

Table -16: Compression Strength Value for 7 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	7 Days	13.45	13.80
2	150×150		13.80	
3	150×150		14.10	

Table -17: Compression Strength Value for 14 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	14 Days	19.40	19.75
2	150×150		20.05	
3	150×150		19.85	

Table -18: Compression Strength Value for 28 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	28 Days	25.15	25.45 N/mm^2
2	150×150		25.80	
3	150×150		25.45	

3.6.2 FOR 10% OF METAKAOLIN AND 50% OF TILE WASTE

Table -19: Compression Strength Value for 7 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	7 Days	14.45	14.35 N/mm^2
2	150×150		14.12	
3	150×150		14.51	

Table -20: Compression Strength Value for 14 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	14 Days	19.28	19.47 N/mm^2
2	150×150		20.12	
3	150×150		19.02	

Table -21: Compression Strength Value for 28 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	28 Days	25.80	25.17 N/mm^2
2	150×150		24.49	
3	150×150		25.23	

3.6.3 FOR 20% OF METAKAOLIN AND 60% OF TILE WASTE

Table -22: Compression Strength Value for 7 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE (N/mm^2)
1	150×150	7 Days	13.88	14.38 N/mm^2
2	150×150		14.28	
3	150×150		14.99	

Table -23: Compression Strength Value for 14 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm²)	AVERAGE (N/mm²)
1	150×150	14 Days	19.01	19.47 N/mm²
2	150×150		19.94	
3	150×150		19.45	

Table -24: Compression Strength Value for 28 days

S.NO	SIZE (mm)	AGE OF LOADING IN DAYS	COMPRESSIVE STRENGTH (N/mm²)	AVERAGE (N/mm²)
1	150×150	28 Days	25.91	25.52 N/mm²
2	150×150		25.45	
3	150×150		25.22	

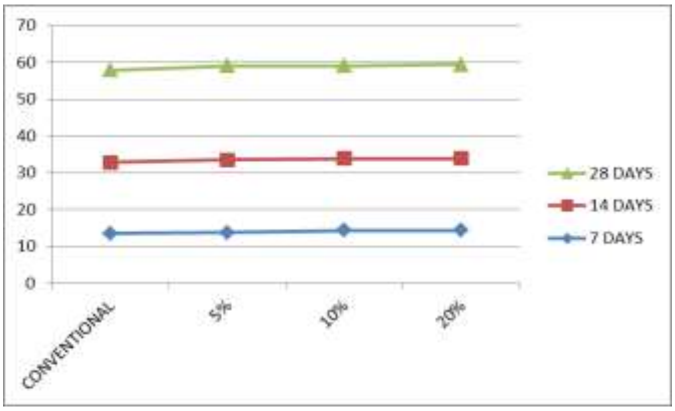

CHART-1: Comparison of compression strength in cube

4. CONCLUSION

Based on the test results obtained from the experimental program of this work the following major calculations are arrived from workability and Compressive strength.

- M_{20} grade mix design for conventional concrete is carried out using IS: 10262 – 2009 guide lines.
- The compressive strength of M_{20} grade conventional concrete cubes is obtained.
- The compressive strength of M_{20} grade metakaolin and tile waste concrete specimens will be done.
- The split tensile strength of M_{20} grade metakaolin and tile waste concrete specimens will be done.
- The Flexural strength of M_{20} grade metakaolin and tile waste concrete specimens will be done.
- For normal strength and high strength compared. Using as mineral admixtures get early strength in concrete.
- The harden properties like compression strength, tensile strength and flexural strength of concrete is obtained as 7-10% in normal strength of concrete

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