AN EXPERIMENT ON CAPILLARY SUCTION WATER ABSORPTION OF CONCRETE WITH METAKAOLIN

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Abstract : In this paper, In this thesis of research project Sustainable resources management and development have been at the forefront of an important issue concerning the construction industry for the past several years a study has been carried out to look into the performance of Metakaolin as cement alternative material in concrete. Nowadays availability of natural coarse aggregate is a big constraint, so alternative material called Recycled Coarse Aggregate (RCA) is using in the concrete mix; it has mostly similar properties as Natural Coarse Aggregate (NCA. In this present study, the experimental using RCA is 20%, 40%, 60%, 80%, and 100%, replacement with natural coarse aggregate and constant weight replacement of metakaolin with the weight of the binder. The Finally obtained results to increasing compressive strength as well as tensile strength mix. 20%RCA+10%MK than the percentage of recycled aggregate increasing with decreasing both compressive and tensile strength. The Further study use in RCA in concrete with MK to replacement in a certain limit. Find the surface absorption test in minimum for mix M1and M2 with an increasing percentage of RCA with MK than increasing capillary section values.

Keywords: concrete, Electronic waste, Metakaolin, Admixture, Workability, Capillary Suction Absorption Test (CSAT Test)

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1. INTRODUCTION

The present-day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete is the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using metakaolin in concrete up to certain proportions. By replacing cement with MK increases the strength and durability and reduces the porosity in the concrete and reduces the permeability also. Natural Coarse Aggregate is one of the most important constituent materials as far as characteristic strength of concrete is concerned. Increase in demand and a decrease in natural sources of natural coarse aggregate for the production of concrete has resulted in the need to identify the new sources of coarse aggregate. Now a day due to the increasing cost and unavailability of Natural Coarse Aggregate, there is a necessity of rethink about the alternative sources for the NCA. In Europe and some countries in Asia, instead of NCA utilization of the recycled waste material in the form of recycled coarse aggregate (RCA) is increasing. RCA is the most emerging replacement for NCA in the production of the concrete.

Recycled Concrete Aggregate (RCA)

Construction and devastation squander contributes up to 40 percent of all waste produced around the world. The lion's share of reused total that is utilized in Australia is reused solid total (RCA) created shape development and destruction squander, as it is the most appropriate substitution of regular coarse total. Fine reused totals are likewise used to supplant regular sand anyway this isn't as noticeable. Using reused total can result in around 60 percent less waste and 50 rate less mineral exhaustion per cubic meter of cement delivered. The quality of normal Portland bond concrete using reused total depends to a great extent on the level of reused total utilized. The bigger the level of RCA, the weaker the solid progresses toward becoming in both compressive and rigidity. Reused solid total Portland bond based cement likewise experiences high water retention and in this manner up to 160% higher shrinkage and creep concrete made with regular totals.

Problems of Recycled Aggregate

Presence of Construction & Demolition waste and other inert material (e.g. drain silt, dust and grit from road sweeping) is significant about a third of the total municipal solid waste generated. Construction & Demolition waste needs to be focused upon in view of:

- The potential to save natural resources (stone, river sand, soil etc.) and energy.
- Its bulk which is carried over long distances for just dumping.
- It is occupying significant space at landfill sites.
- Its presence spoiling processing of bio-degradable as well recyclable waste. Construction & Demolition waste has potential use after processing and grading.
- Utilization of Construction & Demolition waste is quite common in industrialized countries but in India so far no organized effort has been made.

2. LITERATURE REVIEW

In this part we have talked about the distinctive materials which are much of the time utilized for mentioning the concrete and objective facts of the diverse creators by utilizing the diverse materials by literature review.

Tammi Sai Krishna (2015) meant to ponder the "Test Investigation on Flexural Behavior of Recycle Aggregate

Fiber Reinforcement Concrete". In their exploration work diverse rates of halfway substitutions of RA have been considered for M20 review of cement. The likelihood of utilizing the reused total in basic use has been surveyed by estimating a definitive quality and the basic conduct of reused total fiber strengthened cement. One more particular target of this exploration is to deliver steel fiber with locally accessible fiber for expanded Indian applications. Keeping this in view, the locally accessible low elasticity steel wire has been utilized as fiber in the present examination. The viewpoint proportion utilized is 50. At last he presumed that, Recycled total cement showed moderately low usefulness in this way representing no issues as far as portability and place capacity control in field work. Because of the nearness of surface covering with bond and different materials, the reused total does not give great oil; consequently reused total isn't as useful as normal total. Keeping in view alternate preferences, for example, protection of common assets and transfer of annihilated waste, the somewhat substandard properties of reused total Concrete can be endured. Along these lines, reused total with fiber strengthened cement can be considered as appropriate and potential elective development material in development industry.

Praveen Mathew et al. (2014) considered on Recycled total cement (RAC). In this examination the conduct of cement under different level of swap for Natural Aggregate (NA) with Recycled Aggregate (RA) is analyzed for its basic property. Properties of RAC, for example, compressive quality, split rigidity, flexural quality and modulus of flexibility were analyzed. At 20, 30, 40% proportion specimens are tested. At 40% replacement this investigation gives maximum values of strength .By better gradation of RA more % NA aggregates can be replaced with RA.

D.V. Prasada Rao et al. (2014) aimed to study the "Experimental Investigations of Coarse Aggregate Recycled Concrete". The goal of their examination work is to get the attributes of RCA concrete for development industry applications. At that point properties of RCA concrete are to be contrasted and the NCA concrete. The present examination is centered around the compressive quality and strength attributes of RCA concrete. The full supplanting of NCA with RCA is explored. Three evaluations of cement M20, M25 and M30 are embraced in their examination. At long last they presumed that, RCA concrete has compressive quality equivalent to the NCA concrete compressive quality for all evaluations of cement at 3, 7, 28 and 90 days. This can be ascribed to the concrete mortar coat present on surface of RCA takes an interest in hydration process and contribute extra quality. Along with strength, concrete should also be durable. Based on the test results, it can be recommended for the full replacement of NCA concrete with RCA concrete in structural concrete. RCA concrete can be effectively utilized to meet the objective of disposal of waste and also to meet the replacement for the depleting NCA.

D. Suresh Kumar et al. (2013) meant to consider the "Exploratory Study on Strength and Durability Characteristics of Fiber Reinforced Recycled Aggregate Concrete". In their examination work they meant to center around the likelihood of auxiliary utilization of reused total cement by concentrate the mechanical properties and solidness qualities of ordinary total cement, reused total cement and fiber fortified cement. Arrangement of test examples containing solid shapes, barrels and light emissions measurements were threw for cement blends with various rate substitution 0%, 25%, half, 75% and 100% of traditional coarse totals with reused solid totals to consider the quality and sturdiness parameters. The review of cement embraced for all solid blends was M20. Essentially five more solid extents were delivered with ideal measurements of 900 gms/m3of Recron 3s engineered strands alongside various rates of reused coarse totals (0%, 25%, half, 75% and 100%) for the examination. The quality parameters were learned at the ages 3, 7, 28 and 56 days. At long last they inferred that all the blends accomplished the objective mean quality. Solid shape Strength of RAC is around 36.89 MPa to 28.44 MPa with the substitution rate in the scope of 25 to 100. Reusing and reuse of building squanders have been observed to be a suitable answer for the issues of dumping huge amounts of garbage went with lack of common totals. The utilization of reused totals in cement ends up being a significant building material in specialized, condition and prudent regard as per the exploratory eliminate conveyed in this investigation.

3. MATERIAL & TESTS

A.GENERAL:- In this examination an endeavor has been made to think about the Flexural Strength of RCC Beams having Flaky and Normal Aggregates. The methodology took after, tests directed for determination of configuration blend is examined in this part .

1) Workability Test
2) destructive Test

Compressive Strength
Split Tensile Strength Test

3) Capillary suction– Sorptivity

MATERIAL USED:-

A) Materials:-

a) Cement:

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens. Ordinary Portland cement having 28days compressive strength of 46 MPa (ASTM 1994) was used for preparation of all concrete cubes. By using one type of cement, the effect of varying the types of coarse aggregate in concrete is investigated.

TABLE:-I Properties of cement

S. No.	**Characteristics**	**Values obtained**	**Standard values**
1	Normal consistency	34%	
2	Initial Setting Time	44 min	Not less than 30 min.
3	Final Setting Time	578 min.	Not Greater than 600 min.
4	Sp.Gr.	3.13	
5	Fineness	4.7	

b) Fine Aggregate:
The sand used for the experimental programmed was locally procured and conformed to Indian Standard Specifications 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.

c) Coarse Aggregate:
The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per Indian Standard Specifications IS: 383-1970.

d) Metakoalin

Endothermic lack of hydration of kaolinite starts at 550°–600 °C delivering disarranged metakaolin, however nonstop hydroxyl misfortune is seen up to 900°C. Albeit verifiably there was much difference concerning the idea of the metakaolin stage, broad research has prompted a general accord that metakaolin is certainly not a basic blend of nebulous silica (SiO_2) and alumina (Al_2O_3), but instead a complex undefined structure that holds some more drawn out range arrange (yet not entirely crystalline) because of stacking of its hexagonal layers.
$Al_2Si_2O_5(OH)_4 \rightarrow Al_2Si_2O_7 + 2\ H_2O$
Metakaolin is brought from the Vadodara having Specific gravity 2.5 and white in color.

Sr. No	Properties	values
1	Particle shape	Spherical
2	Color	White
3	Specific gravity	2.5

Table 5 Physical Properties of Metakaolin

Chemical formula of Metakaolin is $Al_2O_3.2SiO_2$.Chemical reaction as follows Cement + water = C-S-H gel + $Ca(OH)_2$ $Ca(OH)_2$ + Metakaolin = C-S-H gel

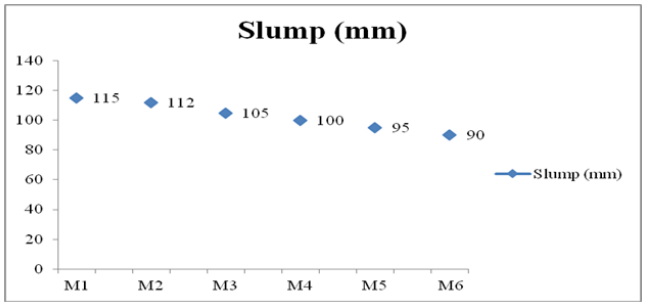
e) Super-plasticizer
Water-reducing also, set-impeding admixtures are allowed with the end goal to expand the functionality of the solid. Super plasticizer Gelenium hky 8765 was utilized for the functionality.

4. RESULT AND DISSCUSSION

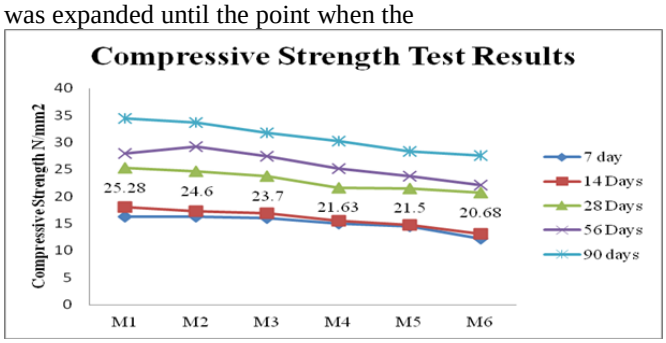
4.1 CONSISTENCY OF CEMENT TEST
The Normal Consistency of Cement is portrayed as that level of water required to convey a bond paste of standard consistency. For affirmation reason, run of the mill consistency is taken as the water content at which vicat's plunger penetrates up to a condition of 5 to 7 mm from the base of the vicat's frame. When we add water to the bond, the paste starts solidifying and gets quality. The fundamental point is to find the water content required to make a security paste of standard consistency as demonstrated by the May be: 4031 (Part 4) – 1988. The control stick had normal consistency of 34%.
Standard initial and final setting time of cement

Type of cement	Initial setting time			Final setting time		
Portland-pozzolona cement 43 grade	As per IS (IS 4031: PART 5)		Test time 44 min	As per IS (IS 4031: PART 5)		Test time 578 min
	Minimum	Maximum		Minimum	Maximum	
	30 min	55 min		190 min	600 min	

4.2 Workability Test
The workability of concrete mixes was found out by slump test as per procedure & the compaction factor was found out using the procedure as given in chapter 3. Water-binder (w/b) ratio was kept constant 0.4 for all the concrete mixes. Super-plasticizer Gelenium hky 8765 was used to maintain the required slump. Dosage of super-plasticizer was kept 1.0-1.25% by weight of binder.



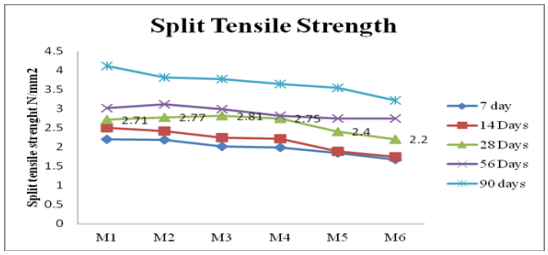
4.3 Compressive Strength
Three cubes of 150 mm dimension are casted and cured for 7, 14, 28, 56, and 90 days to evaluate the compressive strength of concrete made with RCA with MK. The solid shapes are tried on 200T limit pressure testing machine as appeared in Fig.4.1. The immediate weight to weight substitution of characteristic coarse total is done with the Recycled solid totals at various substitution proportion of 0% (control examples), 20%, 40%, 60%, 80% and 100%. In the present examination the water-concrete proportion is kept consistent. The examples are set midway in testing machine and load was connected persistently, consistently he stack was expanded until the point when the



example comes up short. The most extreme load taken by the example was noted. Experiment was repeated for three specimens of the same mix.

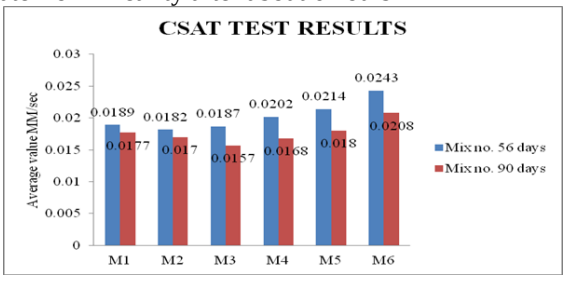
4.4 Splitting Tensile Strength

Two cylindrical specimens of 100 mm diameter and 200 mm height are casted and cured for 7, 14, 28, 56, and 90 days to evaluate the split tensile strength of concrete made RCA with MK. The round and hollow examples are tried on 200T limit pressure testing machine as appeared in Fig.4.1.The examples are put halfway in testing machine and load was connected consistently, consistently the heap was expanded until the point that the example comes up short. The most extreme load taken by the example was noted. Trial was rehashed for three examples of a similar blend.



4.5 CAPILLARY SUCTION (SORPTIVITY) TEST RESULTS

Sorptivity is characterized as the rate of development of a waterfront through a permeable material under slender activity. Sorptivity test varies from the ISAT as the previous estimates the rate of slim suction instead of the mass impact of narrow suction in the last at a predetermined time. The lower the sorptivity esteem, the higher the opposition of cement towards water retention. The decline in sorptivity is because of a few variables. Initially, as the water attacks the pores it experiences littler pores henceforth abating the rate of sorption. Furthermore, regardless of whether the fine pores frame a solid interconnected system all through the solid, the entrance of water particles may in any case be moderate as the air-water interface rests at a steady setup in the pore space. The aftereffects of the slender suction tests directed on solid examples of various blends restored at various ages are exhibited and examined in this area. Typical plots of cumulative water absorption against the square root of time for all concrete mixes at curing time of 56 and 90 days are shown from Fig. 4.8 to 4.23. Each set of plots refer to the three specimens tested for each concrete mix. The tests conducted on the three specimens at a particular curing time give identical slopes, particularly during the early part of the test, i.e. the relationship between cumulative water absorption and the square root of time of exposure begins to deviate from linearity after about 6 hours



5. CONCLUSION

Following are the salient conclusions of the study:-

- It was observed than efficiently used to produce good quality concrete with satisfactory slump. The usefulness of cement diminishing with expanding reused concrete with metakaolin.
- Under certain conditions, supplanting of normal total with reused solid total of seems to build the compressive quality of cement at 28 estimation of most extreme acquired is 24.60 MPa and least esteem same blend is 20.38 MPa individually.It was observed that tensile strength is maximum at mix. 60%NA+40%RA+10%MK is 2.81MPa at 28 days and minimum at same days for mix 0%NA+100%RA+10%MK is 2.20MPa.
- It was observed that increasing percentage of recycled aggregate and metakaolin with decreasing compressive strength as well as tensile strength respectively.
- It is clear that result show the water absorption capacity is increasing with increasing recycled concrete aggregate and minimum value in MM/cec1/2is 0.0182 and 0.0170 at 56 days and 90 days respectively.
- It was observed that the water absorption capacity increasing with increasing percentage recycled concrete aggregate minimum water absorption in this research at mix. 80%NA+200%RA+10% and maximum at mix no. M6 respectively.

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