REVIEW ON WASTE MATERIAL USAGE IN CEMENT CONCRETE MIX

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Abstract:

Nature has blessed with natural resources like rocks / minerals, vegetation, air and water. These are about one crore eighty six lakhs living creatures existing in the world. Most of the living creatures are using their intellect and residing in the nature's nest, where as human being is blessed with unique knowledge and wisdom which propelled to discover wheel, moving machineries and established good shelter with ultra architectural designs. Ancient man was living in huts further more constructed mud houses with the available clay / mud. Over a period of time man discovered calcium oxide to use in construction. In 1840s, a scientist by name William Aspdin has invented the manufacturing process of Portland cement production. Over a period of time, lot of advancements took place in producing different types of cement. During 1950's fly ash was considered as a waste and used to land fill / dumps. Over a period of time man discovered compatible chemicals in fly ash and successful in mixing Ordinary Portland cement up to 30% which is called Pozzolana Portland cement. Several Researchers tried different waste materials to be used as a potential, concrete mix and have been successful in doing so. This paper deals in reviewing potential waste materials being used in cement concrete. Granite rocks are sliced to fine plates for the utility as flooring material. In the process of cutting and smothering the granite, fine dust of approximately 50µm is generated. Researchers discovered compatibility of granite saw dust in cement mix and were successful. Everyday hundreds and thousands of tones of plastic waste is generated. Researchers also tried to use plastic waste in civil construction and partially successful as plastic is organic in nature where as cement is inorganic in nature, nevertheless plastic waste is found as a potential mix in laying bitumen road. Limestone which consists of calcium atom and oxygen atom exists naturally in certain areas where as calcium oxide is also produced synthetically by cracking calcium carbonate at approximately 1000°C. Researchers have been successful in using calcium oxide, municipal waste in civil construction at different proportions. The optimal quality of final cement is governed by particle size and its distribution. Therefore adequate review is also done in terms of particle size, distribution and quality. The current objective of this review article is to give an insight about the sustainable technologies in cement using waste materials disposed in abundance.

Keywords: Granite waste, limestone, plastic waste, fly ash, particle size distribution, cement compressive strength

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1. Introduction

Ordinary Portland Cement (OPC) is normally utilized as best cement for construction and development, with various grades available including 33, 43 and 53 according to Bureau of Indian Standards [1]. OPC comprises of calcium silicates, aluminates, and iron. Calcium carbonate is first bifurcated at around 900°C [2] to create calcium oxide and carbon dioxide, further it is made to react at around 1400°C and made to respond with silica, alumina and iron, to shape little rocks called clinker, which is then granulated to roughly 100 micrometer size to deliver OPC cement. A measure of around 5% gypsum is added to hinder setting time, which fills in as a cradle time amid development. Portland Pozzolana Cement (PPC) is prepared by blending 35% of fly ash in OPC cement [3]. Fly ash generated at thermal power stations as a waste material, when a huge volume of coal is burnt in boilers. Fly ash comprises of silica, calcium oxide, and traces of alumina as well as iron, which is a perfect material for cementing.

The paper reviews about replacement of fly ash with granite waste, in OPC cement. Earlier, fly ash was considered as waste and was used for land filling and similarly granite waste is also used in land filling. The granite saw dust comprises of calcium and iron which has the compatibility to acid soils, and thus can be used as a suitable means to neutralize acid soils [4]. More recently, use of granite and marble rock waste found to be effective in the production of concrete for civil construction [5,6]. Granite sludge waste is also found to be effective filler for pozzolanic mortars, where a reddish pigment is produced by calcining at lower temperature (700-900°C) for short time, therefore granite sludge can be an effective additive in the preparation of colored mortar [7,8]. Recently researchers have mixed different proportions of granite saw dust collected from different locations of granite industry and performed studies for their compatibility with OPC. Further, before the advent of cement, lime mortar was effectively used in constructions by adding jaggery as a binder. Thus, a brief light is also thrown on use of plastic in lime mortar in this review.

Recycle of plastic can be a solution to save mother earth as approximately 10,000 tons of plastic per day has been discarded as waste by disturbing the ecological balance [9]. About 45% of this waste is being recycled and the remaining 55% is left out ruining balance in the environment disturbing hydrogen, nitrogen, carbon, and phosphorus cycles [10]. To increase the effective use of plastic waste it is now being used in road laying and has shown better properties than conventional cement. When used in as an aggregate in concrete which is tested chemically, physically and mechanically by its properties [11,12]. Mohammed Jalaluddin studied the probability of mixing plastic waste like LDPE bags, pet bottles and LDPE thick gauge plastic bags, all these wastes were crushed and shredded to produce fine size mass and mixed in laying road construction. It has been observed that there is an increment in efficiency of plastic mixed bitumen concrete, this is due to compatibility of bitumen with plastic [13]. Massoud Sofi et al studied about the use of municipal solid waste in civil construction. Municipal solid waste was taken and fed inside the autoclave where 150°C and 5 bars of pressure is maintained. Furthermore metals, plastic and glass are separated. The end product is mixed in civil construction and it has been observed that 10 to 15% compatibility in civil construction [14]. Zhuo Tang et al studied the probable use of municipal solid waste as well as construction solid waste. Both solid wastes were mixed in a mixing chamber and tested for compatibility. The results indicated that addition of municipal solid waste as well as construction solid waste served like a geopolymer and maintained good strength [15].

P.O. Awoyera et al studied the probability of using plastic waste in civil construction and found best fit with regards to waste utility as well as maintaining good strength [16]. Mohammed Belmokaddem et.al., studied the probability of mixing plastic

in civil construction, and also studied on Polypropylene, High density polyethylene (HDPE), and Polyvinylchloride. Very shocking and good results were observed. Thermal conductivity of mixture has been decreased as well as optimizing acoustics [17]. V. Punitha et al studied the scope of mixing plastic waste in civil construction and used metakaolin as well as HDPE waste. The results indicate that up to 10% of metakaolin and 5% of HDPE plastic can be thoroughly mixed in civil construction [18].

Fine limestone powder has been added as clinker replacer which increases the number of nucleation centers which gives rise to high surface area [19]. Lime stone, an inert additive shows substantial proof that limestone is not inert during its process of hydration, supposedly products are formed by reactions of the limestone in addition to C_3A phase [20-23]. Research reports acknowledge partial replacement of clinker with added minerals influence the flow and durability of fresh cement in paste form [24-28]. The fundamental premise of the approach patented by blending finer and smoother cement with partially coarse additives is the product of a superior quality [29].

Several studies have been done by the researchers by mixing cements with multiple limestone powder particle sizes, at par with clinker particle. Multiple particle size and single particle size limestone powder distribution patterns was mixed in cement mortar and studied the performance to assess normal consistency. The characteristics were compared with original cement. It was observed that the cement mixture having limestone with uniform particle size, lesser than cement particle size had higher hydration rate as the surface area is more which infers higher number of nucleation centers. The density of packing was less than original cement. By replacing cement with lime stone of higher particle sizes than cement has been found to be reduced in hydration rate similarly higher packing density while using the large particles was higher to that of original cement [30]. The results depict lesser requirement of water for normal consistency yielding higher strength. For final setting of cement and response of 1 day and 28 days strength should be considered with surface area and powder packing density. Cement mixed with high surface area limestone yields higher hydration rate and incrementing density paste and porosity. Cement mixed along with smaller surface area lime stone particles yield a mix which shows feeble hydration rate. Cements mixed with limestone with the combination of particle sizes might disturb mechanisms and create cement paste with high packed density and with finer particles.

An amount of significant substitution of fly ash to be mixed with cement by maintaining 1 day and 28 days strength at appropriate volumetric water fractions has been accomplished by appropriate selection of cement and fly ash particle size distributions. Blending with fine cement and a coarser fly ash provides an appropriate increment to early age and 28 days strength at appropriate water compositions and particle size distributions. Mixing fine cement with coarser fly ash yields higher early age strength, while dealing with overall particle size distribution fly ashes of 20 to 35% mixing with conventionally available cement is found to be appropriate, which produces sustainable concretes. Compressive strength can be predicted by using a model on different variables like specific cement size, fly ash size and fly ash to volume proportion.

$$\sigma(t) = A_t + B_t * CSA * \rho_{cem} * \left(1 - \frac{FA}{100}\right) + C_t * FASA * \rho_{FA} * \left(\frac{FA}{100}\right) + D_t * FA \quad (1)$$

This equation helps in assessing volumetric replacement of cement with fly ash nevertheless these blended compositions did proved a minor decrement of several hours in relation to 100% Portland cement mix, where $\sigma(t)$ is the compressive strength at time t, CSA is the cement surface area, ρ_{cem} is the specific gravity of the cement, $FASA$ is

the fly ash surface area, ρ_{FA} is the specific gravity of the fly ash, FA is the fly ash volume fraction in percent, and A, B, C and D are the regression coefficients.

2. Materials & Methods

2.1. Granite samples

Different granite saw dust was collected at different intervals for the purpose of our study based on the requirement of the clients and in testing the different percentages to test the strength of the cement. Granite industry dumps solid waste and uses it into fine powder in constructions. Sample 1 was collected just below the cutting zone of the granite industry and then granite saw was blended with different percentages of 20% to 35% in ordinary Portland cement. Similarly sample 2 was collected from the middle of the path in between sawing zone and dumping zone, which was blended with different percentages ranging from 20 to 35% in ordinary Portland cement. Likewise sample 3 was collected from the endpoint that is our dumping zone and the mix was blended with different percentages starts from 20 to 35% in the ordinary Portland cement [2]. Aggregates are prepared with reference to the BIS standards by mixing laboratory grade sand, cement and water, in the ratio of 3:1 (sand: cement-granite mix-mass basis), water is added based on the normal consistency. These composites are thoroughly mixed in pony mixer for 2 minutes, poured into standard mould of 7.5 x 7.5 x 7.5 cm, then subjected to compression in vibrating machine for 2 minutes, and then kept in humidity chamber for 24 hours, maintaining 27°C. The specimens are then taken out and cured for 1, 3, 7, and 28 days in curing chambers of same temperature.

2.2. Samples were prepared for plastic/limestone/fly ash as follows

1. Fine Sand aggregate: A mixture of 0.24 mm, 0.75 mm and 2 mm sand is taken as an aggregate material. The properties of sand fulfill BIS standards, of bulk density 1378 Kg / m³.
2. Soil aggregate: An average of 2 mm of earthen mass is taken which consists of fine rock, silt and clay mass, of the bulk density 1120 Kg / m³.
3. Waste plastic – Low Density Poly Ethylene (LDPE): plastic waste is collected from different places (littered) and shredded into small pieces of bulk density 3.2 Kg / m³.
4. Reference Plastic: Fine LDPE powder of 0.3 mm size is brought from 'Balaji Plastics Industries Ltd., Hyderabad, of bulk density of 377 Kg/ m³.
5. Reference aggregates mixture: Aggregates are prepared with reference to the BIS standards by mixing laboratory grade sand (supplied by Tamilnadu minerals Ltd, Innore, Chennai) cement and water, in the ratio of 3:1 (sand: cement-mass basis), water is added based on the normal consistency. These composites are thoroughly mixed in pony mixer for 2 minutes, poured into standard mould of 7.5 x 7.5 x 7.5 cm, then subjected to compression in vibrating machine for 2 minutes, and then kept in humidity chamber for 24 hours, maintaining 27°C. The specimens are then taken out and cured for 3 and 7 days in curing chambers of same temperature.
6. Waste Plastic - Cement mixture preparation: Littered plastic is collected from different places, shredded into small pieces of 4 cm x 6 cm approximately. Mixtures are prepared by mixing laboratory grade sand, cement, and waste plastic, in the ratio of 3:1(sand: cement - mass basis). In addition to this, varying amount of plastic is added.

7. Soil - Calcium Oxide - Jaggery - Plastic mixture preparation: Mixtures are prepared by mixing soil, Calcium Oxide, jaggery in the ratio of 3: 1: 0.35, in addition to this, varying amount of shredded plastic is added.
8. Brick - Calcium Oxide - Jaggery- Plastic mixture preparation: Mixtures are prepared by mixing brick, Calcium Oxide, jaggery in the ratio of 3: 1: 0.35, in addition to this, varying amount of waste shredded plastic is added [9].
9. Cement used in all specimen mixtures is ordinary Portland Cement (OPC).
10. Use of fly ash at different composition and size fraction.

2.3. CEM I 52.5 R - A Portland cement with high initial strength

When Portland cement is slightly replaced with limestone powder of different size in proportion. Among distribution three variety limestone powders showing different particle diameters either smaller than or larger than or of same size to that of the original CEM I with an average particle size of 17 μm was to be tested. The limestone powder with the smaller size and the same size has to be taken from a variety source. Hence the quality and purified density of the lime stone powder has to be similar. Take sample of two different limestone powder to be prepared and enquired (i) Single-particle-size distribution system: the original cement has to be slightly replaced with limestone of single particle size distribution either smaller size than the larger size or of the similar size to the cement particles. Investigations were done to verify the effects of cement replacement using different limestone. Cement mixtures of which the limestone powder must be 5%, 10%, 20%, or 30% of the mixture by mass (ii) Combined-particle-size distribution system: similarly the original cement has to be partially mixed with limestone powder which contains a combination of particles of cement supposed to be larger than or smaller than the cement particles [30]. Among those mixtures few samples were tested with the ratio of large to small limestone particles were varied (1/4, 3/2, or 4/1). The result of the analysis proved only 5% of lime stone in its contents.

3. Results & Discussion

3.1. Studies on compressive strength

The critical quality parameter 'compressive strength' samples of granite saw waste mix is shown in Table-1. A maximum of 41.71 MPa for 20% granite mix and minimum of 36.23 MPa for 35% granite mix is observed for sample 1, similarly for sample 2 maximum of 42.81 MPa and minimum of 37.15 MPa is observed, and for sample 3, a maximum of 43.51 MPa and a minimum of 38.39 is observed, after curing 28 days [2]. The compressive strength is increasing as the number of days of curing increases, in line with the established research [32]. The values of compressive strengths of sample 1 and 3 for 1, 3 days compressive strength found to be increasing as the percentage of granite waste increased, this could be because of initial reaction of iron. As the sample 1 is collected right below sawing zone, percentage of iron could be little higher, similarly sample 3 is collected at the dumping zone, where sedimentation takes place there by yielding slightly higher percentage of iron, in comparison with sample 2. Iron is present in granite waste as eroded powder of iron saws, during sawing operation. The compressive strengths of 28 days found to be decreasing as the percentage of granite waste increases for all samples. The compressive strength values obtained after mixing with granite shows the same trend as in case of fly ash mix [8] therefore, granite waste can be perfect mix as a cementing material.

Table 1. Compressive strength of sample 1, 2 and 3 at different ages of curing and different percentages of granite saw waste mix

Grani te%	Day/Compressive strength (MPa)											
	Sample 1				Sample 2				Sample 3			
	1	3	7	28	1	3	7	28	1	3	7	28
20	12.54	18.79	31.27	41.71	4.88	18.95	25.55	37.15	9.17	25.93	34.14	43.51
25	13.13	22.02	30.28	40.57	12.23	27.71	26.32	42.04	11.24	25.99	35.23	42.32
30	13.75	23.09	31.58	37.22	12.76	23.85	28.59	42.81	11.26	26.17	30.04	39.39
35	14.15	23.79	30.21	36.23	12.34	22.84	37.94	39.56	15.53	26.87	29.35	38.39

3.2. Soil – CaO – Jaggery aggregate compressive strength response

The results of compressive strength for mixture of soil, Calcium Oxide, and Jaggery aggregate is tested, shown in Figure 1. In this case jaggery of different percentages is used as a reference test, to find optimal percentage of jaggery. The results are favoring at 0.35 mass ratio (3:1:0.35). Higher percentage of Jaggery is seen sticking, and has the property of elongation, compaction and curing is not observed at higher percentages. Lower percentage of jaggery is not miscible properly, thereby responding feeble strength [9]. Mass ratio of 0.35 is found to be optimal value.

Figure 1. Compressive Strength response with varying % Jaggery in Soil-Cao aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

3.3. Soil - CaO - Jaggery - Shredded plastic mixture compressive strength response

It has been found compatible of mixing plastic mass with soil, calcium oxide. The results are shown in Figure 2 since plastic mass and jaggery is organic in nature, the results are little favoring. But there has been decrement in strength, upon increase in percentage of plastic [9]. The strength has been increasing in all the ages of curing.

Figure 2. Compressive strength response with varying % shredded plastic in Soil - CaO - Jaggery aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

3.4. Sand – Cement - Plastic powder mixture compressive strength response

The results are illustrated in Figure 3 compressive strength of mixture of sand, cement with plastic powder is not much favoring compared to plastic waste mixture. However, the compressive strength found to be increasing as curing age proceeds [9]. Increment in percentage of plastics resulted in depletion of strength.

Figure 3. Compressive strength response with varying plastic powder % in sand-cement aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

3.5. Sand – Cement - Shredded plastic mixture compressive strength response

Results of mixture of sand, cement and shredded plastic is shown in Figure 4, compressive strength mixture shows good response as the age of curing proceeds [9]. However there has been sluggishness in strength upon increasing percentage of shredded plastic.

Figure 4. Compressive strength response with varying shredded plastic % in sand-cement aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

3.6. Brick -CaO - Jaggery - Shredded plastic mixture compressive strength response

Results of mixture is shown in Figure 5, Brick mixture shows good affinity of bonding and the compressive strengths are increasing as the age of curing proceeds [9].

Figure 5. Compressive strength response with varying shredded plastic % in Brick-Cao-Jaggery aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

3.7. Sand – CaO – Jaggery - Plastic powder mixture compressive strength response

Results are shown in Figure 6. Use of plastic powder mix is not encouraging, however as the ageing proceeds, compressive strength shows increasing values. As the percentage of plastic increases, strength found to be decreasing. Compressive strength values of waste plastic specimen are showing encouraging results. Up to addition of 10% of waste plastic is showing good strength without hampering much on overall strength [9]. However, upon increment in plastic percentage, strength is decreasing. Fig 1 to 6 and its description were reused by one of the co-author.

Figure 6. Compressive strength response with varying % plastic powder in Sand-Cao-Jaggery aggregate mixture. Plot 1, 2, 3 correspond to compressive strength at day 1, day 3 and day 7 respectively

Table 2. Density of mixtures of various aggregates

S.No.	Aggregate	Major Compound	% Plastic Mixture	Bulk Density of Mixture Kg/m ³
1	Soil	CaO-Jaggery	5	1920
			10	1750
2	Sand	Cement	5	1900
			10	1730
3	Sand	CaO-Jaggery	5	1910
			10	1790
4	Brick	CaO-Jaggery	5	2020
			10	1960

The density of mixtures as shown in Table 2. The density of soil, cao, jaggery and plastic mixture is higher to cement and sand aggregate. As the percentage of plastic increases density decreased. This may be due to absorption of moisture content. Density of sand cement mixture found to be very less than any aggregate [9]. As the percentage of plastic increases, density decreased. Upon addition of CaO and jaggery, density is increasing. Density of brick mixture is high than other aggregates. However, upon increasing percentage of plastic density is decreasing.

The quality parameter, compressive strength is taken critically from samples as shown in Table 3. A maximum 39.59 MPa for 20% limestone mix and minimum of 34.01 MPa for 35% limestone mix is learned from sample 1, in the same way take sample 2 maximum and minimum MPa 40.82 and 32.93 is observed, likewise when sample 3 is taken maximum and minimum of MPa 41.30 and 36.17 is noticed, all these details were observed after curing period of 28 days. What we observe here is the number of days of curing increases the compressive strength which shows a prime factor in the foundation of our research. The values of compressive strength of sample 1 and sample 3 for 1, 3 days was found to be increase with the percentage increase of limestone determining compressive strength. This increase can be reasoned by the initial reaction of iron. The compressive strength of 28 days was found to be decreasing [8] because percentage of limestone increases in all the samples collected from different cement vendors.

Table 3. Compressive strength of sample 1, 2 and 3, at different ages of curing and different percentages of limestone mix

Lime stone %	Day/Compressive strength (MPa)											
	Sample 1				Sample 2				Sample 3			
	1	3	7	28	1	3	7	28	1	3	7	28
20	10.32	16.57	29.05	39.59	2.66	16.72	23.33	32.93	7.05	23.71	32.02	41.30
25	11.01	20.00	28.06	38.35	10.01	25.59	24.10	40.82	9.02	23.77	32.01	40.10
30	11.53	21.87	29.36	35.00	10.54	21.63	26.37	40.69	9.04	24.95	28.82	37.27
35	12.03	21.57	28.09	34.01	10.12	20.62	35.72	37.34	13.31	24.65	27.13	36.17

The particle size distribution along with the surface area of the original cement with limestone powders are given in Table 4. The statistics shows the mean particle size of each sample powder based on particle size distribution analysis was to be determined by its volume. In Table 4, the mean sample sizes of each limestone powder and the original cement has to be underlined. The three different samples of limestone powder particle sizes which were used here has to be taken as mean particle size of 53 μm , 25 μm and 3 μm , each sample to be designated by CCX, such that X stands for the particle size, e.g., CC3 is the limestone powder with mean particle size 3 μm considered limestone powder with the largest mean particle size of 53 μm , only a small portion of its particles were larger than 45 μm to 100 μm from that of the original cement [30]. Except limestone powder with smallest mean particle size 3 μm most of its particles smaller than the particles of the original cement powder.

Table 4. Mean particle size and the surface area of the tested limestone and cement powders

Type	Cement	CC53 μm	CC25 μm	CC3 μm
Average size, (μm)	17.02	53.40	25.78	2.99
Surface area, (m^2/g)	1.533	0.390	1.371	6.222

The proportion of blended powder (limestone & cement) to that of the original cement which functions as the percentage of original cement in ratio to be replaced by limestone is shown in the Table-5 for variety of sample limestone powders (e.g., CC3 μm , CC25 μm , and CC53 μm). Area multiplier scaling factor [33] show the relative change in the solid surface area which was induced by filling addition to the surface area provided comparatively by mass of unit of cement. The impression of limestone replaced content on the solid surface area is also presented in Table-5. By using area multiplier on unit base in case of blended cement samples, the surface area was connected with strong base in comparison with the limestone powder used in the mixture for the three tested cements. The finest limestone powder CC3 μm observed as the greatest area multiplier factor [30] on exhibition increased the AM factor in its content in the blended cement.

Table 5. Surface area of the tested limestone and cement powders and the correlation between the area multiplier to the limestone content in the blended cement

CaCO ₃ %	Type	Original Cement	CC53 μm	CC25 μm	CC3 μm
0	Area Multiplier	1.0	1.0	1.0	1.0
	Surface area %	95	95	95	95
5	Area Multiplier	1.0	1.0	1.05	1.2
	Surface area %	95	92	95	112
10	Area Multiplier	1.0	1.02	1.1	1.5
	Surface area %	95	88	95	130
20	Area Multiplier	1.0	1.05	1.2	2.0
	Surface area %	95	70	95	160
30	Area Multiplier	1.0	1.1	1.4	2.75
	Surface area %	95	60	95	190

Table 6 depicts results of compressive strength of samples. It was found that by mixing 20% fly ash a maximum of 43.93 MPa compressive strength was observed. Similarly, a minimum of 38.45 MPa was observed at 35% fly ash mix for sample 1. Similarly, a maximum of 44.03 MPa and minimum of 39.37 MPa was observed. For sample 3 maximum of 45.73 MPa and minimum of 40.51 MPa were observed at the end of 28 days curing. It was also observed that the compressive strength is increasing as the number of days curing increases, which is also matching in line with the available literature [8]. Compressive strength values of sample 1 and 3 for 1day and 3 days compressive strength observed to be increasing as the percentage of fly ash increased then the compressive strength of 28 days was observed to be decreasing as the percentage of fly ash increases for all samples. Fly ash was obtained from different thermal power plants.

Table 6. Compressive strength of sample 1, 2 and 3 at different ages of curing and different percentages of fly ash mix

Fly ash %	Day/Compressive strength (MPa)											
	Sample 1				Sample 2				Sample 3			
	1	3	7	28	1	3	7	28	1	3	7	28
20	14.76	20.91	33.49	43.93	6.00	20.17	27.77	39.37	11.39	27.15	36.36	45.73
25	15.35	24.24	32.40	42.79	14.46	29.93	28.54	44.26	13.46	27.00	37.46	44.54
30	15.97	25.21	33.70	39.44	14.98	25.07	30.71	44.03	13.48	28.39	32.26	41.52
35	16.37	25.91	32.43	38.45	14.56	24.06	39.16	41.78	17.75	28.09	31.57	40.51

Volumetric analysis resulted in groups by fly ash three investigated variables, these variables have large influence on measured compressive strengths. Usually, mixtures with 20% fly ash have the ability to develop compressive strength and those exceeded of the control mixture during six testing ages. Mixtures with 50% to 65% fly ash provided compressive strength, these mixtures were tested signifying to those below of the controls

[31]. Finally, all the mixtures investigated with different variables were prepared by the same volumes of fractions of water, sand and bind powders.

4. Conclusion

Since cement is an inorganic material, accordingly Granite also possesses similar chemical characteristics. Granite saw wastes are found to be compatible to mix in cement and addition of its fine dust is encouraging up to the percentage mix of 35%, beyond that the overall quality of cement is found to be decreasing. It is about 35% of the granite waste is to be mixed with ordinary Portland cement resulting in maintaining good quality of cement. In the long run it was found that the expected curing time increases the compressive strength will also increase. The granite waste collected in the form of saw from any corner is not having any physical effects or chemical effects when tested in parameters.

In the same way plastic waste up to 10% can be used in preparation of cement without hampering or compromising the standard quality strength of the cement as announced by BIS. Plastic waste in powdered form less useful than shredded form is better to put in use. The strength of the mixture of lime mortar with plastic in shredded form shows comparatively greater results. The organic nature of Jaggery and plastic gives strength to the mixture of lime mortar plastic. This sample cement holds to high pressure and high temperature which is strong as time passes. Since lime mortar is weather resistant with its nature and properties are compatible with plastic and Jaggery, use of this solution in future will help us in mitigation of pollution and in curbing plastic solid waste. Waste plastics in soil mixture when used give us great results. This can be one of the solutions in future in utilizing for lying roads in rural areas. When the age of curing proceeds 1, 3 and 7 days strength and holding capacity will also increase in all proportions to that of aggregate mixtures. Likewise, the percentage of plastic increases in a sample cement mixture resulting density of the mixture decreases, this optimal solution plastic, lime, mortar is a future of light weight concrete with added smooth finish.

Density of the product, with low packaging where cement is blended with fine lime stone particles of smaller size than those of the cement produces a paste with larger surface area by increasing its hydration rate, the porosity of the paste is increased resulting in lower packing density. Contrary a smaller surface area with slow hydration rate and with higher packing density is possible by cement blended with larger lime stone particles than those of the cement. Cement blended comprises of a combination of particle sizes of cement and lime stone can be exploited with two mechanisms to create new cement system both with higher package density and with larger surface area. Application of correct design of particle sizes and the lime stone content will make this approach enabling the development of a creative cement blend which possesses high rate and high degree of hydration with enhanced compressive strength at later ages. The evaluation of the study brought us the conclusion with a refined and active component that is the clinker with an inert additive lime stone thereby improving performance of the cement paste by increasing its packing density of the cement system. This is the most prominent pronunciation when the clinker is replaced with lime stone powder which contains combination of varied particle sizes of the cement.

Since fly ash also possess constituents compatible with cement, the study so far indicated that using this approach, of volumetric substitutions on the order of 20% to 35% is feasible if processed readymade available cement and fly ash. This substitution levels provide us an important contribution in the large goal of concrete producing sustainable with reduced cement contents. The variables are independent when enquired in this study of cement surface area, fly ash surface area and fly ash volume proportion, all these

predictions were used on a model based of compressive strength. Each individual model contains in it an accurate surface area of cement and fly ash in the mortar mixture of the cement. All these techniques of equations are employed in illustrations to estimate the maximum use of or replacement of fly ash volumetric for cement and fly ash with known surface areas.

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