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EXPERIMENTAL INVESTIGATION ON CONCRETE MIXTURE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH STONE DUST AND BRICK DUST POWDERS

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Abstract: Now a day's fine aggregate (sand) is very expensive; so that by adding admixtures like brick dust and stone dust as partial replacement in fine aggregate would give better saving and environment free. This project consists of a partial replacement of fine aggregate with stone dust and brick dust in cement concrete mix. In this project I have added two types of admixtures named as brick dust and stone dust in cement concrete mix. Here brick dust and stone dust is added in cement concrete mix with a percentage variation of 5%, 10%, 15%, 20% and 25%. By adding brick dust and stone dust there was a variation in test results of compressive strength, flexural strength and tensile strength. The strength increased when the admixtures content increased up to 20% replacement in cement concrete. Therefore it is better admixture to use in civil engineering and also overall cost may also reduce to 14.64% cost of cement concrete.
Key Words: Brick dust, Coarse aggregate, Compressive strength, Fine aggregate, Spilt tensile strength ,Flexural strength, Stone dust.

I. INTRODUCTION

Now a day the purpose of fine aggregate is very rapidly used in civil engineering constructions like apartments, water tanks, different types of roads etc. Fine aggregate was found from lakes, rivers, oceans etc. Will affect to the environment because it will be excavated and transported the fine aggregate with tones of load therefore there was a disturbance in below the layers of earth crest

problem identified to the environment. So that if we add brick dust and stone dust (waste material) in fine aggregate there was a reduced quantity of fine aggregate and the total quantity of fine aggregate will also be reduced. In The waste material do not poured into the dumping yard, so that this material was helpful for partial replacement in fine aggregate but also it environmentally free. By replacing the brick dust and stone dust. construction would give better result. In cement concrete mix the percentage of fine aggregate was replaced in 20% there was an increased strength in compressive strength, flexural strength and tensile strength of concrete.

1.1 Brick Dust

In developing countries bricks are still one of the most popular construction materials. India is the second largest producer of fired clay bricks after china. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually, employing about 10 million and consuming about 25 million Tons of coal annually. For brick making availability of good soil is crucial. Recently number of additives are added and replaced with clay to increase the performance of bricks including fly ash, bagasse ash, rice husk ash etc. The utilization of waste from different industrial sector is appreciable for the environment and for the economy of the state also. The waste from the brick production facilities is also a cause of concern as the brick Sector of India is unmanaged and has poor worker skill which causes high waste generation. The waste generated from the brick production can be broadly classified as

- Brick dust or Surkhi
- Deformed bricks
- Over burnt bricks
- Broken bricks
- Fly ash

The fly ash generated is being utilized by various other industries. Brick dust is a waste product obtained from different brick kilns and tile factories. There arenumerous brick kiln which have grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust or broken pieces or flakes of bricks (brickbat) come out from these kilns and factories. So far, such materials have been used just for filling low lying areas or are dumped as waste mater about and have sufficient recycling values. The rest of the waste is being dumped on the roadside or in land filling causing environmental concerns. It was used in the concrete by sieving from 4.75mm sieve passed material has to be taken in cement concrete mix.

Figure 1.1 Brick dust

1.2 Stone Dust

Stone dust is a waste material obtained from crusher plants during the process of making of coarse aggregate of different sizes, about 175 million tons stone dust is produced every year, which is kept in great quantity. This used quantity of stone dust requires a suitable disposal site for its easy and safe discarding a large land area is required to accomplish the requirement which would again be a great problem in a country of strongly populated like India. Stone dust, being final part of a coarse aggregate is a static material and may be used in concrete making as partial replacement of fine aggregate. Stone dust was collected from local stone crushing units. It was initially dry in condition when collected, and was sieved before mixing in concrete. It was used in the concrete by sieving from 4.75mm sieve passed material has to be taken in cement concrete mix.

Figure1.2 Stone dust

1.3 Common Advantages Of Brick Dust And Stone Dust

1. Brick dust is the potential workable material to be used as fine aggregate to produce durable concrete.
2. Its use as fine aggregate in concrete will help in alleviating the potential problem of dwindling natural resources.
3. Its use will also help in protecting the environment surroundings.
4. Brick dust as waste product from brick kilns and tile factories available in Bangladesh could be used as mineral admixtures in concrete. Its use in concrete could save as much as 20 percent of cement as binding material, while providing the same strength.
5. Brick dust concrete could be produced with satisfactory slump and setting times with nearly the same water cementing material ratio as in normal concrete without mineral.
6. Under certain conditions, replacement of cement by brick dust appears to increase the strength of concrete.
7. Under acid and sulfate attack, performance of cement concrete cube specimen prepared with 20 percent cement replaced by brick dust has been found to be comparable to that of the control specimen prepared without brick dust.
8. In mass concrete, use of brick dust as mineral admixture would reduce the heat of hydration, which could help to control the development of secondary stresses in the structures.
9. The brick dust mineral admixture has a reddish color, which could be aesthetically more pleasant.
10. By mixing of stone dust and brick dust the voids in the cement concrete are filled and densified. Therefore increase compressive strength with optimum dosage of fine aggregate of stone dust and brick dust.
11. By using the combination of brick dust and stone dust fulfill the requirement to reduced fine aggregate (sand) quantity .hence the economical cost of sand is decreased.
12. These are very vast material produced in industries like brick kiln industry and stone crushed machines they are not much effected to the environment and economical.

II. MATERIALS

2.1 Material Characteristics

Cement: The cement used in this experimental work is 53 grade jayapee ordinary Portland cement.

Fine aggregate: Locally available sand passed through 4.75mm IS sieve is used.

Coarse aggregate: The aggregate used for this study was 20mm single size coarse aggregates. The aggregate was collected from kommadi in Visakhapatnam.

Water: water was obtained from the college of SITAM at Visakhapatnam.

Stone dust: The stone dust obtained from the major crushing units.

Brick powder: The brick dust obtained from the brick kiln industry at yellamanchili.

2.2 Tests On Materials

Laboratory tests were conducted to know the properties of cement, fine aggregate and coarse aggregate and those are discussed below.

2.2.1 Tests on Cement

- Cement used in the present project is of 53 grade jayapee Ordinary Portland Cement.

➢ Specific Gravity

- Specific gravity of cement used is 3.0
- The specific gravity of cement as per IS requirements is in between 3-3.5.

➢ Fineness of Cement

- Fineness of cement is tested by sieving of cement.
- Fineness of cement is 95.00%.
- The residue of cement should not exceed 10% by mass as per IS 4031: 1968.

➢ Normal Consistency

- The standard consistency of a cement paste is defined as that consistency which will permit a Vicat's plunger to penetrate a depth of 5-7 mm from bottom of the mould.
- The percentage of water required to produce a cement paste of standard consistency is 27%.
- As per IS recommendations the standard consistency of cement should be in the range of 26% -33%.

➢ Initial Setting Time

- The time elapsed between the moment water is added to cement to the time that paste starts losing its plasticity is called initial setting time.
- The initial setting time of the cement used is 50 minutes. > 30 minutes (As per IS 4031- part5-1988 code).

➢ Final Setting Time

- The time elapsed between the moment of adding water to the cement, and the time when the paste has completely lost its plasticity is called final setting time.
- The final setting time of cement is 4hours 42minutes< 10

hours (As per IS 4031-part5-1988 code).

- ➢ Compressive strength of cement
- • Load obtained from compressive testing machine is265KN.
- • Compressive stress at 7days is 53.33MPa (IS code-part5-1988 code). Therefore the grade of cement as 53 confirmed.

2.2.2 Tests on Fine Aggregate

- ➢ Specific gravity
- • Specific gravity of fine aggregate is 2.64.
- • The specific gravity of fine aggregate as per IS requirements is in between 2.6-2.8.
- ➢ Sieve analysis

S.no	Size of sieve(mm)	Individual Weight retained(gm)	Cumulative weight retained	Cumulative weight retained (%)	% of finer	Standard% weight passing for zone-III
1.	4.75	15	15	1.5	98.8	90-100
2.	2.36	50	65	6.5	93.5	85-100
3.	1.18	80	145	14.5	85.5	75-100
4.	0.6	124	269	26.9	73.1	60-79
5.	0.3	343	612	61.2	38.8	12-40
6.	0.18	278	890	89.0	11	-
7.	0.13	80	970	97.0	3.0	-
8.	0.075	18	988	98.8	1.2	-
9.	Pan	10	998	100	0	-
				Total=494.6		

Fineness modulus=494/100=4.94

Table 2.1 Sieve analysis for fine aggregate

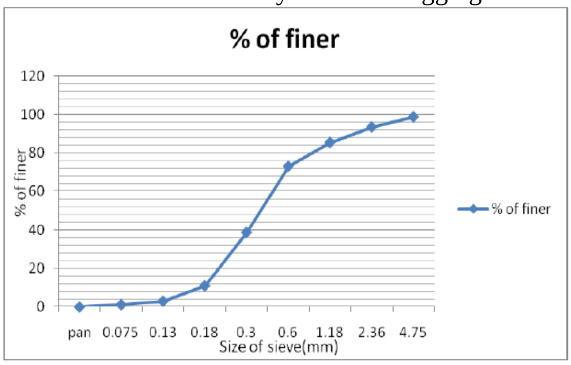

Figure 2.1 Grain size analysis of sand

2.2.3 Tests on Coarse Aggregate

- ➢ Specific gravity
- • Specific gravity of coarse aggregate is 2.91.
- • The specific gravity coarse aggregate as per IS requirements is in between 2.8-3.0.
- ➢ Sieve analysis

S.no	Size of sieve(mm)	Weight retained(gm)	Individual retained(%)	Cumulative retained(%)	% of finer
1.	4.75	-	-	-	-
2.	10	2026	67.53	67.53	32.47
3.	20	974	32.46	99.99	0.01
4.	40	-	-	-	-
5.	60	-	-	-	-
6.	80	-	-	-	-
			Total=167.52		

Table 2.2 sieve analysis for coarse aggregate

Fineness modulus=167.52/100=1.675

- ➢ Aggregate crushing value
- • Average crushing value of aggregate sample = 26.15%.
- • The aggregate crushing value not more than 45% for any concrete work.
- ➢ Aggregate impact value test
- • Average value of impact value of aggregate sample=13.06%
- • The aggregate impact value should not more than 30%.

2.2.4 Tests on Stone Dust

- ➢ Specific gravity
- • Specific gravity of stone dust is 2.50.
- ➢ Sieve analysis

S.no	Size of sieve(mm)	Weight retained(gm)	Cumulative weight retained	Cumulative weight retained (%)	% of finer	Standard% weight passing for zone-III
1.	4.75	53	53	5.3	94.7	90-100
2.	2.36	87	140	14	86.0	85-100
3.	1.18	77	217	21.7	78.3	75-100
4.	0.6	183	400	40.0	60.1	60-79
5.	0.3	240	640	64.0	36.0	12-40
6.	0.18	60	700	70	30.0	-
7.	0.13	7	707	70.7	29.3	-
8.	0.075	213	910	91.0	9.0	-
9.	Pan	87	997	99.7	0.3	-
				Total=477.1		

Fineness modulus for stone dust=477.1/100=4.77

Table 2.3 sieve analysis for stone dust

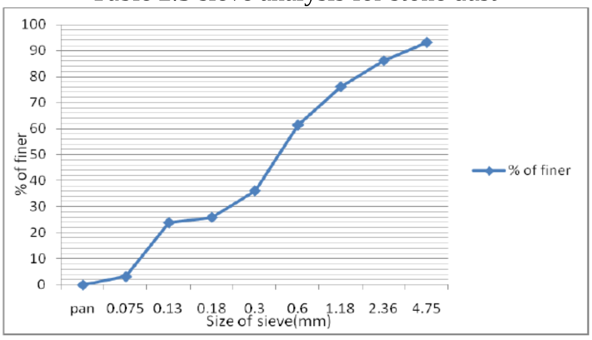

Figure 2.2 Grain size analysis of Stone dust

2.2.5. Tests on Brick Dust

- ➢ Specific gravity
- • Specific gravity of brick dust is 2.6
- ➢ Sieve analysis

S.no	Size of sieve(mm)	Weight retained(gm)	Cumulative weight retained	Cumulative weight retained (%)	% of finer	Standard% weight passing for zone-III
1.	4.75	34	34	6.8	93.2	90-100
2.	2.36	35	69	13.8	86.2	85-100
3.	1.18	51	120	23.8	76.2	75-100
4.	0.6	73	193	38.5	61.5	60-79
5.	0.3	127	320	63.8	36.2	12-40
6.	0.18	50	370	74	26.0	-
7.	0.13	10	380	76	24.0	-
8.	0.075	104	484	96.8	3.2	-
9.	Pan	16	500	100	0	-
				Total=466.5		

Fineness modulus for brick dust=466.5/100=4.6

Table 2.4 Sieve analysis for Brick dust

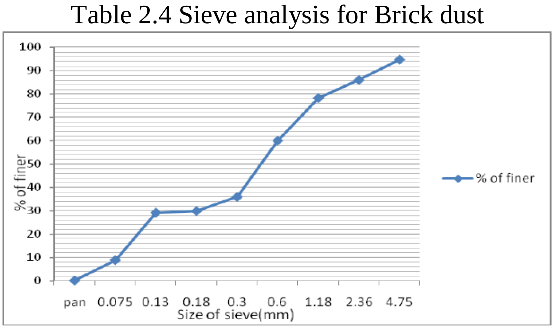

Figure 2.3 Grain size analysis of Brick Dust

III. PREPARATION OF SAMPLES

3.1 Mix design

All the concrete mixes in the project are prepared as per IS: 10262- 2009 of M15 grade.

Ingredient	Cement	Water	Fine aggregate	Coarse aggregate	Water cement Ratio
Weight	312.002 kg/m^3	17.56 liters	538.28 kg/m^3	1390.57 kg/m^3	0.55

Table 3.1 Mix design

Mix designation	Description of Mix
Conventional concrete	C.C
C1	C.C+5%BD,SD
C2	C.C+10% BD,SD
C3	C.C+15% BD,SD
C4	C.C+20% BD,SD
C5	C.C+25% BD,SD

Table 3.2 Description of Concrete mix

3.2 Workability of Concrete

Slump cone test was performed to determine the slump of the concrete mixes. The slump values for various mixes as shown in below table.

% of SD&BD mixture	Slump(mm)
0	110
5	106
10	95
15	87
20	74
25	80

Table 3.3 Slump values for different % of brick dust and stone dust mixture

IV. TEST RESULTS

Compressive strength:

The compressive strength of a material is that value of uni-axial compressive stress reached when the material fails completely. The compressive strengths of concrete has been evaluated by testing cubes of size 15cm*15cm*15cm. The compressive strength is determined by the ratio of failure load to the cross sectional area of the specimen.

Mix	7 days(MPa)	14 days(MPa)	28 days(MPa)
C.C	18.77	22.00	25.36
SD&BD(5%)	19.31	25.37	30.91
SD&BD(10%)	20.31	28.50	32.00
SD&BD(15%)	22.01	30.05	33.19
SD&BD(20%)	24.12	31.00	35.27
SD&BD(25%)	22.03	32.30	34.02

Table 4.1 compressive strength SDBD cube specimens

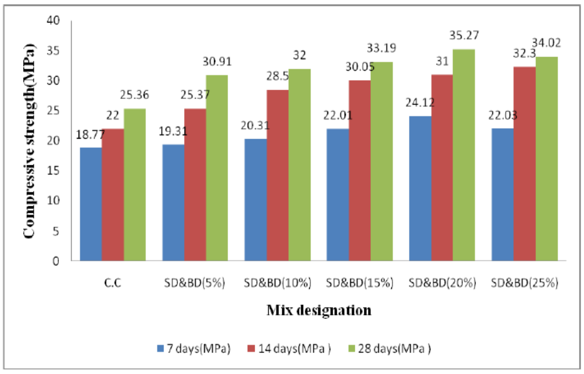

Figure 4.1 Compressive strength values of C.C and SDBD at 7, 14 and 28 Days.

Split tensile strength :

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs. Splitting Tensile Strength shall be calculated by using the formula. $F_{ct} = 2p/pld$.

Mix Designation	7 days(MPa)	14days(MPa)	28 days(MPa)
C.C	1.00	1.2	1.58
SDBD(5%)	1.5	1.65	1.805
SDBD(10%)	1.7	1.86	2.07
SDBD(15%)	2.5	2.73	3.53
SDBD(20%)	3.01	3.5	4.38
SDBD(25%)	2.7	3.2	3.57

Table 4.2 Tensile strengths of SDBD cylindrical specimens

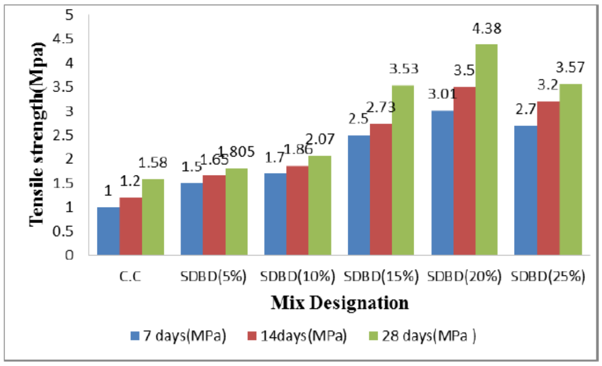

Figure 4.2 Split tensile strength values of C.C and SD&BD at 7, 14 and 28 Days

Flexural strength :

The flexural strength may be expressed as the modulus of rupture f_b,

$$f_b = pl/bd^2$$

When "a" is greater than 20.0 cm for 15 cm specimen, or greater than 13.3 cm for a 10.0 cm specimen

$$f_b = 3p*a/bd^2$$

When a is less than 20.0 cm but greater than 17.0cm for a 15.0 cm specimen, or less than 13.3 cm but greater than 11.0cm for a 10.0cm specimen.

Mix	7 days(MPa)	14days(MPa)	28 days(MPa)
C.C	3.9	4.2	4.9
SDBD(5%)	4.1	4.7	5.5
SDBD(10%)	4.5	5.0	6.45
SDBD(15%)	4.9	5.3	6.66
SDBD(20%)	5.5	6.2	7.00
SDBD(25%)	5.2	5.8	6.05

Table 4.3 Flexural strengths of SDBD cube specimens

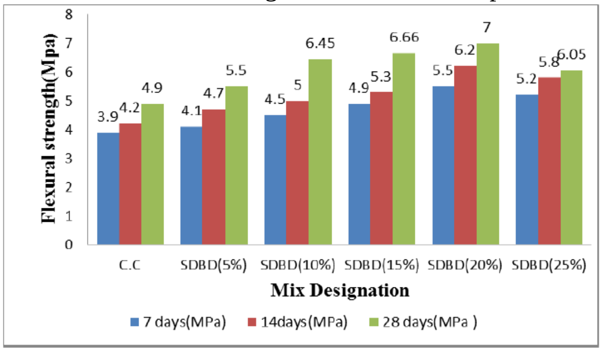

Figure 4.3 Flexural strength values of C.C and SD&BD at 7, 14 and 28 Days

V. CONCLUSION

The tests conducted on various samples and results obtained as follows.

It is observed that Slump values of the concrete are decreasing as the admixtures
percentage increasing. The reduction in slump with the increase in the admixture will be attributed to presence of admixture which causes obstruction to the free flow of concrete.

Compressive Strength enhancement ranges from 5.55% to 9.91% when % of admixture increases from 5% to 20% when compared to the conventional concrete at 28 days. 20% is observed as the optimum value.

Split tensile Strength enhancement ranges from 0.225% to 2.8% % when % of admixture increases from 5% to 20% when compared to the conventional concrete at28 days. 20% is observed as the optimum value.

Flexural Strength enhancement ranges from 0.6% to 2.1% when % of admixture increases from 5%to 20% when compared to the conventional concrete at 28 days.20% is observed as the optimum value.

From the results it is observed that 20% is the optimum dosage of addition of stone dust and brick dust admixture increases the compressive strength, flexural strength and split tensile strength.

Addition of more than 20% of brick dust and stone dust admixture would result decreasing the values of compressive strength, split tensile strength and flexural strength.

REFERENCE

[1] Celik, T. and Marar, K. 1996. Effects of crushed stone dust on some properties of concrete. Cement Concre.Res. 26(7): 1121-1130.

[2] Eren, S., Khaled, K., Irassar, E.F. and Barai, S.V. 2007.Partial replacement using crusher stone dust. IE J-CV.87: 2006.

[3] Hameed, M.S. and Sekar, A.S.S. 2009. Quarry dust as replacement of fine aggregate in concrete. ARPN J.Engg. Appl. Sci. 4(4): 83-89.

[4] IS 1489:1991. Portland Pozzolana Cement Specification-Part 1: Fly Ash Based, Bureau of Indian standard institution, New Delhi.

[5] IS: 10262:1982. Recommended guidelines for 1. Bonavetti, V., Donza, H., Rahhal, V. and Irassar, E.1993. Influence of initial curing on properties of concretecontaining limestone blended cement. Cement Concre.Res. 30: 703-708. concrete mix design, Bureau of Indian standards, New Delhi.

[6] IS: 2386-1963. Indian standards code of practice for methods of test for Aggregate for concrete, Bureau of Indian standard Institution, New Delhi.

[7] IS: 383-1970. Specification for Coarse and Fine Aggregates from natural sources for concrete" (Secondrevision).

[8] IS: 516-1959. Method of test for strength of concrete Bureau of Indian standards. New Delhi, India.

[9] Jain, M.E.M., Safiuddin, M. and Yousuf, K.M. 1999.A study on the properties of freshly mixed high performance concrete. Cement Concre. Res. 29(9):1427-1432.

[10] Patel, A.N. and Pitroda, J. 2013. Stone waste: Effective replacement of cement for establishing green concrete.Int. J. Innov. Technol. Exploring Engg. 2(5): 1782-1785.

[11] Sahu, A.K., Kumar, S and Sachan, A.K. 2009. Utilization of crushed stone waste in concrete. NCACM Method and Management (AC3M-09) 21-22 January, 2009 Hyderabad, India.

[12] Edward Allen, Robert Hallon. Fundamental of residential construction (3rd edition), 672 pages. John Wiley & Sons, San Francisco, USA, 2011.

[13] Roy chudley, Roger Greeno. Construction Technology (4thedition), 634 pages. Prentice Hill, New Jersey, USA,2000.

[14] Jeorge J. Venta, P.Eng. "Life cycle analysis of brick and mortar products", the ATHENATM Sustainable MaterialInstitute, Canada, Ottawa, 1998.

[15] Jeorge J. Venta, P.Eng. "Life cycle analysis of brick and mortar products", The ATHENATM Sustainable Material Institute, Canada, Ottawa, 1998.

[16] Aeslina AK, Abbas M, Felicity R, John B. "Density, strength, thermal conductivity and leachate characteristics of light weight fired clay bricks incorporating cigarette butts", International Journal of Civil and Environmental Engineering, Vol. 2. Pp 179-184, 2010.

[17] Hanifi B, Orhan A, Tahir S. "Investigation of fibre reinforced mud brick as a building material", Construction and building material, Vol. 19. Pp. 313-318, 2005.

[18] Rahman MA. "Properties of clay-sand-rice husk ash mixed bricks", International Journal of Cement

Composite Lightweight Concrete, Vol. 9. Pp. 105–108, 1987.
[19] Demir I, Serhat M, Mehmet O. "Utilization of kraft pulp production residues in clay brick production", Building and Environment, Vol. 40. Pp. 1533–1537, 2005.
[20] Demir I. "An investigation on the production of construction brick with processed waste tea", Building and Environment, Vol. 41. Pp. 1274–1278, 2006.
[21] Caroline EV, Dylmar PD, Jose N, Ronaldon P. "The use of submerged-arc welding flux slag as raw material for the fabrication of multiple-use mortars and bricks", Soldagem Insp. Sao Palo, Vol.14. Pp. 257–262, 2009.
[22] R. Alonso-Santurde, A. Coz, J. R. Viguri, A. Andrés. "Recycling of foundry byproducts in the ceramic industry: Green and core sand in clay bricks", Construction and Building Material, Vol. 7. Pp. 96-106, 2012.
[23] Romualdo R.Menzeses, Heber S .Ferriera, Gelmieres A. Neves, Heliolira, Heber C. Ferriera. "Use of the granite sawing waste in the production of ceramic bricks and tiles", Journal of European Ceramic Society, Vol. 25. Pp.1149-1158, 2005.
[24] Kay Hamer, Volker Karius. "Brick production with dredged harbour sediments. An industrial-scale experiment",Journal of Waste Management, Vol. 22. Pp. 521-530, 2002.

IS Codes
[1] IS: 2386 (part-1)-1963, " Methods of testing for aggregate for concrete".
[2] IS: 10262-2009, "Recommended guidelines for concrete mix design, Bureau of Indian standards", New Delhi, India.
[3] IS: 516-1959, Indian standard methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, India.

