IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"INFLUENCE OF PROCESSED WASTE TEA ASH (PWTA) ON MECHANICAL PROPERTIES OF CONCRETE BLOCK PAVING: AN EXPERIMENTAL STUDY"

[1]Garima Patle, [2]Dr. Rajeev Singh Parihar [1]Student, [2]Head of the Department

Department of Civil Engineering

Laxminarayan College of Technology, Bhopal, India

Abstract-Concrete is strong in compression but weak in tension and brittle extra. As immediately cracks start to appear because of where the concrete is, though., which causes a host of health problems. Waste tea ash can be utilized effectively as an alternative option for cement replacement in concrete. The consequences of PWTA insertion on concrete houses are discussed in this paper. PWTA is used in different percentages mix in manufacturing of paver blocks.M35 grade of paver block is designed and tested. The results of the Strength properties of PWTA in paver block is provided in this observation.

Introduction- In this experimental study crushed stone, sand, Cement, PWTA and water is used. Crushed Stone is a by-product from stonecrushing sites. To replace the amount of cement PWTA is used. Paver Blocks prepared with a percentage variation of PWTA as 0%, 10%, 20%, 30%, 40%, 50%, and 60% in Mix grade M35. This article discusses a recent study on the characteristics of concrete pavement blocks made from PWTA that have been contaminated with common building. For laboratory-prepared samples, the parameters of density, compressive strength, water absorption value, flexural strength, split tensile strength, initial and final setting time and workability is tested. The findings demonstrate that it is feasible to use.The specifications could be changed, it is suggested, to enable a wider use of PWTA with foreign materials.

Materials and methodology- Composite cement with a specific gravity of 3.25 is used in the present study. Natural river sand with a fineness modulus of 2.77 and a specific gravity of 2.58, respectively, is used as fine aggregate. Crushed stone with specific gravity 2.83 and maximum size aggregate 5mm, respectively is used as coarse aggregate. PWTA is a by-product obtained from tea factories. PWTA is oven dried at 105 ^{0}C for 24 hours. The PWTA has a specific gravity of 2.05 with maximum particle size of 300 mm. The chemical analysis showed that the main oxides of PWTA are silicon oxide (SiO_2), potassium dioxide (K_2O), calcium oxide (CaO), iron oxide (Fe_2O_3) which comprised 49.82 %, 4.04 %,43.74 %, and 1.30 %, respectively.

Preparation of test specimens-The paver blocks are prepared in laboratory to study the strength properties of PWTA in paver blocks as partial replacement of cement. The paver blocks prepared as mix design of M35 grade concrete mix design. The PWTA is used in proportion mix of 0%,10%,20%,30%,40%,50% and 60% respectively by weight of cement with required amount of water. Brick shape mould of size 200x100x60mm is used to make M35 grade of paver block. Mix proportion of specimens is given in table no.2.

Properties of PWTA is given in table no.1 below:

Table No.1 Properties of PWTA used

S. No.	Properties	PWTA
1	Maximum size particle	300µm
2	Specific Gravity	2.05
3	CaO	49.82
4	SiO_2	43.74
5	SO_3	0.32
6	MgO	0.11
7	P_2O_5	0.92
8	Al_2O_3	0.46
9	Fe_2O_3	1.30
10	K_2O	4.04
11	LOI	12.40

Mix Proportion of Specimens-

Table No.2 Mix Proportion of Materials used

S. No.	MIX ID	WATER (Kg/m^3)	CEMENT (Kg/m^3)	PWTA (Kg/m^3)	SAND (Kg/m^3)	CRUSHED STONE (Kg/m^3)
1	M_0	0.469	1.174	0	1.587	1.174
2	M_{10}	0.493	1.057	0.117	0.587	1.174
3	M_{20}	0.540	0.9392	0.2348	0.587	1.174
4	M_{30}	0.563	0.8218	0.3522	0.587	1.174
5	M_{40}	0.622	0.7044	0.4696	0.587	1.174
6	M_{50}	0.657	0.587	0.587	0.587	1.174
7	M_{60}	0.704	0.4696	0.7044	0.587	1.174

Tests and Results-

Compressive Strength Test: Compressive strength of the paver blocks is tested after 7 and 28 days in this study. Compressive strength of paver blocks is determined with the help of universal testing machine in the laboratory. The load applied gradually on paver blocks to identify the failure load of Paver blocks. The compressive strength is calculated by using formula given below:

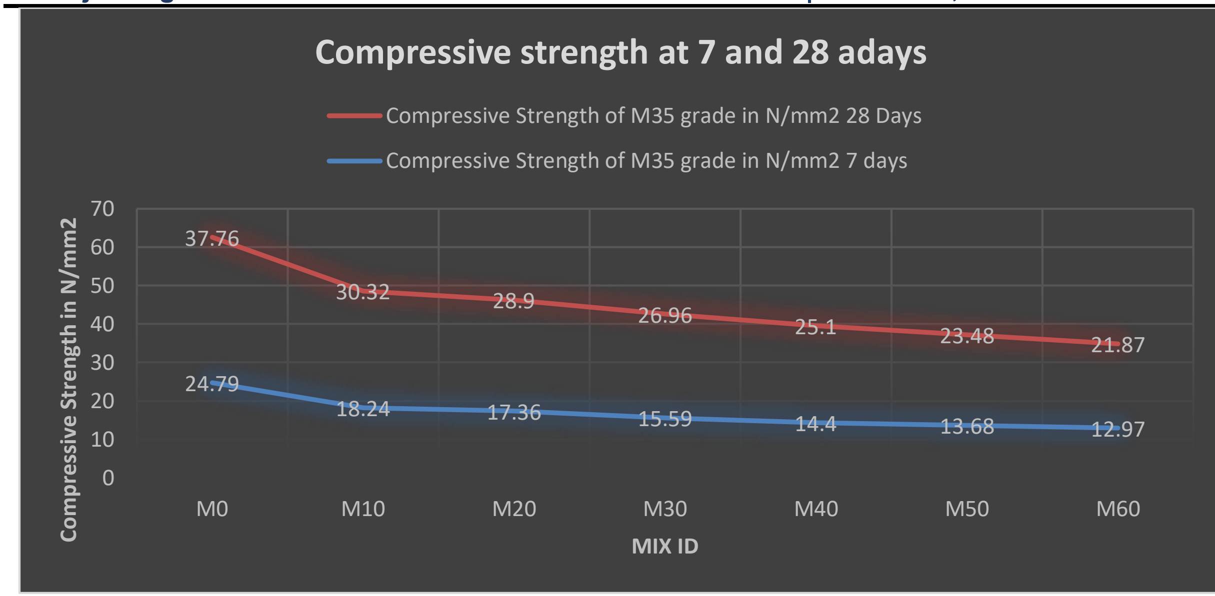
$$\sigma C = P/A$$

where, σ C is compressive strength in N/mm^2.P is the failure load of paver block in N, and A is the area of applied load. The compressive strength obtained after 7 and 28 days is given below in table no.3 and graph is plotted as graph no.1.

Figure no.1 Compressive strength testing

Table No. 3 Compressive strength test results of M35 grade Paver Blocks

S. No.	MIX ID	Compressive Strength of M35 grade in N/mm^2	
		7 days	28 Days
1	M_0	24.79	37.76
2	M_{10}	18.24	30.32
3	M_{20}	17.36	28.90
4	M_{30}	15.59	26.96
5	M_{40}	14.4	25.1
6	M_{50}	13.68	23.48
7	M_{60}	12.97	21.87



Graph no. 1 Mix vs Compressive strength of paver blocks

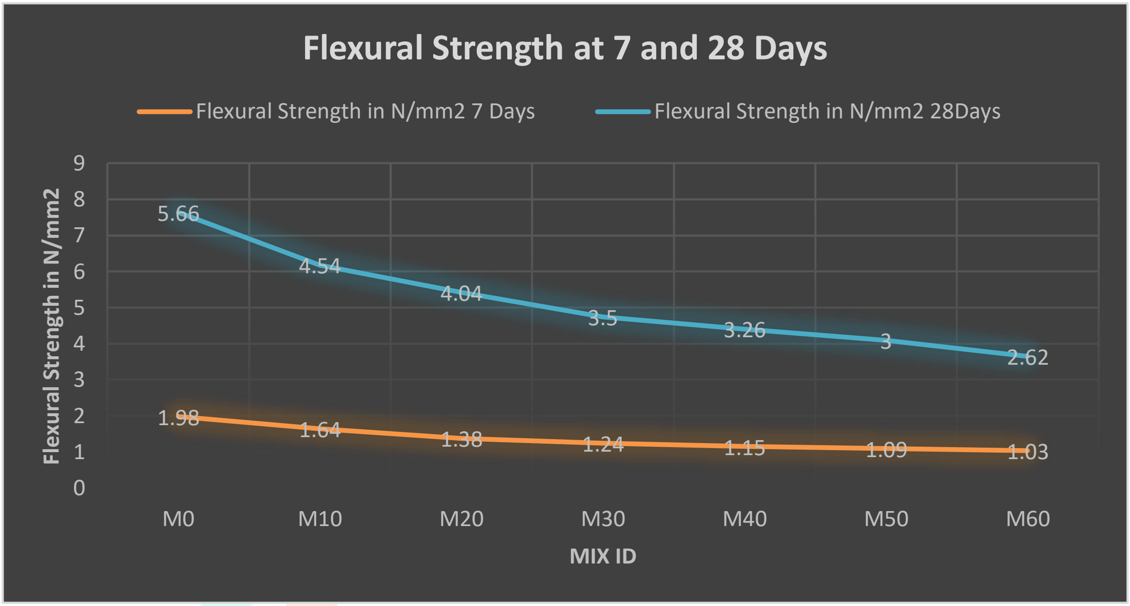
Flexural strength Test: Flexural strength of the paver blocks is tested after 7 and 28 days in this study. The block sample was placed in the flexural beam apparatus and subjected to a 3-point loading with a clear span of 170 mm. The load was applied to the paving block sample through a steel rod until failure of the sample. The flexural strength of each sample was determined using formula give below. of Paver blocks. The compressive strength is calculated by using formula given below:

$$\sigma_f = 1.5\ PL/(bd^2)$$

where, σ_f the flexural strength (N/mm^2), P is the failure load of the sample (N), L is the span length (mm); and b and d are the width and depth of the sample (mm), respectively. The flexural strength test results is given below in table no.4 and graph is plotted as graph no.2.

Table No.4 Flexural strength Results of M35 grade Paver blocks

S. No	MIX ID	Flexural Strength in N/mm^2	
		7 Days	28 Days
1	M_0	1.98	5.66
2	M_{10}	1.64	4.54
3	M_{20}	1.38	4.04
4	M_{30}	1.24	3.50
5	M_{40}	1.15	3.26
6	M_{50}	1.09	3.0
7	M_{60}	1.03	2.62



Graph no. 2 Mix vs Flexural strength of paver blocks

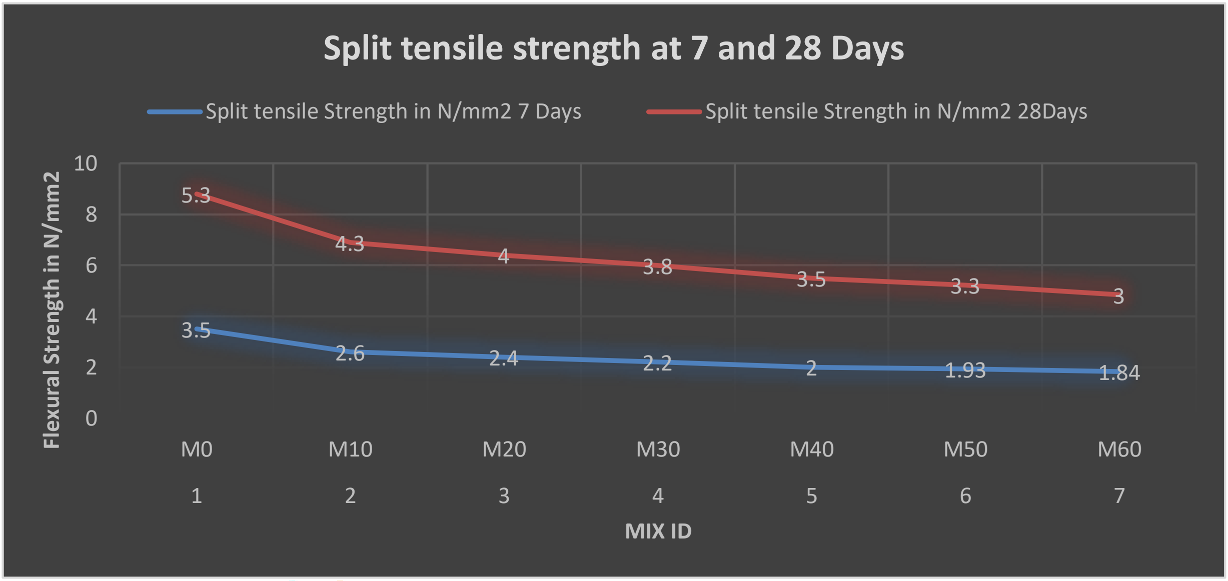
Split Tensile Strength: The split tensile strength is used to determined the tensile strength of concrete. Concrete is brittle in nature and it is weak in tension and causes cracks. It becomes necessary to perform tensile strength test in concrete. A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete. Apparatus used Testing machine, Plate or supplementary Bearing Bar, Bearing strips, Cylinder specimen, Tamping rod. The Split Tensile Strength is calculated as follows:

$$\mathbf{T = 2P \div \pi DL}$$

Where, T is the splitting tensile strength (N/mm^2), P is the maximum load on the specimen (N)D is the diameter of the specimen (mm),L is the length of the specimen(mm).Th split tensile strength results is given below in table no.5 and graph is plotted as graph no.3.

Table No. 5 Split Tensile Strength Results of M35 Grade Paver Block

S. No.	MIX ID	Split tensile Strength in N/mm^2	
		7 Days	28Days
1	M_0	3.50	5.3
2	M_{10}	2.6	4.3
3	M_{20}	2.4	4.0
4	M_{30}	2.2	3.8
5	M_{40}	2.0	3.5
6	M_{50}	1.93	3.3
7	M_{60}	1.84	3.0



Graph no. 3 Mix vs Split tensile strength of paver blocks

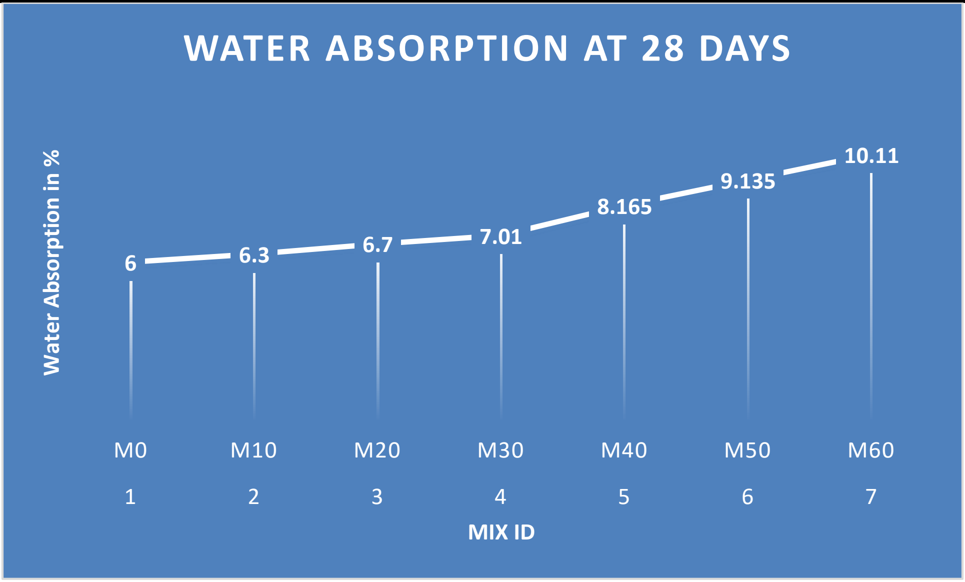
Water absorption: The water absorption of Paver Blocks is determined at 28days. The test is conducted as per IS:15658. For the water absorption test the specimens immersed in the water for 24 hours. After 24 hours the blocks taken out and wiped off with cloth and weight of the specimen in wet condition were recorded as W_2. After the saturation the specimen are dried in a ventilated oven at 105 ^{0}C for not less than 24 hours. The dry weight of each specimen W_1 is recorded in kg. Table no.6 contains 5% of water absorption of paver blocks and graph is plotted as graph no.4.

The percentage of water absorption was calculated as:

$$\textbf{Water absorption (\%)} = (W_2 - W_1)/W_1 \times 100$$

Table No.6 Water absorption of Paver block of M35 grade with % of PWTA

S. No.	Mix ID	28days % of water
1	M_0	6.0
2	M_{10}	6.3
3	M_{20}	6.7
4	M_{30}	7.01
5	M_{40}	8.165
6	M_{50}	9.135
7	M_{60}	10.11



Graph no. 4 Water absorption of paver blocks

Density: The density of M35 Grade paving blocks is determined by applying the sample into a drying oven at 105^0C for 24h and then cooled at $25\pm 2\ ^0$C for 5h. Afterward, the samples are weighted. Density is calculated by dividing the weight by the volume of the sample. Density results of M35 grade paver blocks with PWTA is given below in the table no.7.

Table No. 7 Density of Paver Blocks

S. No.	Mix ID	Density (kg/m^3)
1	M_0	2446
3	M_{10}	2410
5	M_{20}	2395
7	M_{30}	2334
9	M_{40}	2281
11	M_{50}	2240
13	M_{60}	2212

Workability: The workability of the paving blocks depends on the amount of water added into the mix to prevent the block sag after the removal of the molds. Workability is defined as water to cement ratio(w/c) the amount of water required so that the concrete mix should not bleed or segregate. W/C of M35 grade is given below:

Table No.8 Workability of M35 Grade Paver Blocks

S. No.	MIX ID	Water/binder ratio
1	M_0	0.4
3	M_{10}	0.42
5	M_{20}	0.46

7	M_{30}	0.50
9	M_{40}	0.53
11	M_{50}	0.56
13	M_{60}	6.0

Initial Setting Time: Initial setting time is the time when paste starts hardening. Final setting time is the time when paste gets sufficiently hard and does not allow any penetration. Initial and final setting time both are calculated with the help of Vicats Apparatus. The vicat square needle penetrates a depth of 33-35mm from the top (5 to 7mm) from the bottom of the mould of the Vicat Apparatus. The device which is used to find the initial setting time of cement is called as Vicats Apparatus.It has a square needle of 1mm size and 50mm length and a mould, which is 40mm n height and 80mm in diameter.

The initial and final setting time observed are 30-35minutes and 2-4 hours respectively.

Carbon emissions: The present study estimated the CO_2 emissions of Paver block mixture containing PWTA as a cement replacement. Estimation of CO_2 emissions is carried out based on per cubic meter of concrete, which has been commonly used by previous researchers to estimate the CO_2 emissions of concrete [10–12]. The CO_2 emission factors of the mixture components (water, cement, PWTA, sand and crushed stone) is based on previous research works and databases [11,13]. The CO_2 emissions is calculated by using formula given below:

For concrete with Hand Mixing:

$$\mathbf{EF = W_C \times EF_c + W_{ca} \times EF_{ca} + W_{fa} \times EF_{fa}}$$

Where, W_C is weight of cement per 1 m3 of concrete (kg)

W_{Ca} is Weight of coarse aggregate per 1 m3 of concrete (kg)

W_{fa} is Weight of fine aggregate per 1 m3 of concrete (kg)

EF_c is Emission factor-cement (kg-CO_2/t-cement)

EF_{ca} Emission factor-coarse aggregate production (kg-CO_2/t-aggregate)

EF_{fa} Emission factor-fine aggregate (kg-CO_2/t-fine aggregate)

Replacing cement with PWTA can reduce CO_2 emissions, and it depends on the amount of PWTA used. It is observed that total CO_2 emissions for whole project for M35 grade Paver blocks prepared with PWTA generated is 75.312 kg/m ^{3}.

Conclusion: The present study utilized PWTA as a replacement for cement to produce paving blocks. The results showed that the porous surfaces of PWTA increased the water to binder ratio of paving block with increasing the PWTA content as a cement replacement. The density of the PWTA paving blocks decreased as the percentage of cement replacement increased because the PWTA has a lower density than that of the cement. Increased PWTA content decreased the paving block quality in terms of compressive strength, flexural strength, split tensile strength

The results of compressive strength and water absorption showed that the replacement of cement with up to 30%. PWTA as a replacement for cement in paving blocks could help in decreasing CO_2 emissions from cement production and allow the production of a more sustainable and low-cost paving block. Workability is increasing as w/c ratio is increasing with PWTA. Initial and final setting time is 30-35 minutes and 2-4 hours recorded.

References:

1. A Anisah, I A Pratama, D Daryati, S Musalamah, K A Sambowo, P Prihantono1 and R A Sumarsono1 (2021)"Performance quality of waste-based paving block using rebar tie wire supplementary", Published under license by IOP Publishing Ltd, IOP Conference Series: Materials Science and Engineering, Volume 1098, Chemical Engineering, Citation A Anisah et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1098 022085, DOI 10.1088/1757-899X/1098/2/022085.
2. Anees Pradeep, B. karthick, J. jayakumar,(2020) “Experimental Investigation about Replacement of Cement with Plastic Waste in Paver Block”. International Journal of Scientific and Engineering Research Volume 11, Issue3, March -2020.ISSN 2229-5518.
3. A.S. Muntohar, M.E. Rahman, Lightweight masonry block from oil palm kernel shell, Constr. Build. Mater. 54 (2014) 477–484.
4. Aaryakant Soni, Toshan Singh Rajput, Kuldeep Sahu, Sachin Rajak “Utilization of Waste Plastic in Manufacturing of Paver Blocks”, International Journal for Research in Applied Science & Engineering Technology (IJRASET). ISSN:2321-9653; IC Value:45.98; SJ Impact Factor;7.538 Volume 10 Issue 2 Feb. 2022. https://doi.org/10.22214/ijraset.2022.40410
5. Abbas Solouki ORCID, Piergiorgio Tataranni 1ORCID and Cesare Sangiorgi 1, (2022)"Mixture Optimization of Concrete Paving Blocks Containing Waste Silt" Sustainability 2022, 14(1), 451; https://doi.org/10.3390/su14010451, Received: 23 November 2021 / Revised: 20 December 2021 / Accepted: 31 December 2021 / Published: 1 January 2022.
6. Abdul Rachman Djamaluddin, Muhammad Akbar Caronge, M.W. Tjaronge, Asiyanthi T. Lando, Rita Irmawaty, Evaluation of sustainable concrete paving blocks incorporating processed waste tea ash, Case Studies in Construction Materials, Volume 12,2020,e00325,ISSN 2214-5095,
7. Bhairob Deori1 Vishal Gupta(2016) “Utilization of Jute Fiber in Cement Concrete Paver Blocks”. International Journal for Scientific Research and Development/ Volume 4, Issue 05,2016/ISSN (online):2321-0613.
8. Chi-Sun Poon and Dixon Chan, Effects of contaminants on the properties of concrete paving blocks prepared with recycled concrete aggregates, Construction and Building Materials, Volume 21, Issue 1,2007,Pages 164-175,ISSN 0950-0618,https://doi.org/10.1016/j.conbuildmat.2005.06.031.
9. D.M. Sadek, M.M. El-Attar, A.M. Ali, Physico-mechanical and durability characteristics of concrete paving blocks incorporating cement kiln dust, Constr. Build. Mater. 157 (2017) 300–312.
10. M. Elchalakani, T. Aly, E. Abu-Aisheh, Sustainable concrete with high volume GGBFS to build Masdar City in the UAE, Case Stud. Constr. Mater. 1 (2014) 10–24.
11. K.H. Yang, S.H. Tae, D.U. Choi, Mixture proportioning approach for low-CO2 concrete using supplementary cementitious materials, ACI Mater. J. 113 (4)(2016) 533–542.
12. 12.S.J. Kwon, X.Y. Wang, Optimization of the mixture design of low-CO2 high-strength concrete containing silica fume, Adv. Civ. Eng. (2019) ID 7168703.
13. N. Hill, E. Bonifazi, R. Bramwell, E. Karagianni, B. Harris, Government GHG Conversion Factors For Company Reporting: Methodology Paper For Emission Factors – Final Report, Department for Business.
14. 14.IS 10262: 2009 Indian standard -Concrete mix proportioning - guidelines, Bureau of Indian standard, 2009, New Delhi.
15. 15.IS 16415: 2015 for composite cement, Bureau of Indian Standards
16. IS 456:2000 Indian standard -Plain and reinforced concrete – Code of Practice, Bureau of Indian Standards , 2000, New Delhi.
17. IS: 15658:2006, Pre cast concrete block for paving, Bureau of Indian Standards”, New Delhi.
18. IS: 383-1970, “Specifications for coarse and fine aggregates from Natural Sources for Concrete”, 1970.
19. IS: 516- 2006, Indian Standard Methods of tests for strength of concrete,