International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Strength Characteristics of Different Types of Bricks

Dinesh W.Gawatre[1], Laxmikant N. Vairagade[2]

[1]Civil Engineering Department, Sinhgad Academy of Engineering, Khondhwa (BK), Pune 411048, India

Abstract: ***Bricks are widely used in construction as a material, 25% of material is bricks in construction. Clay bricks are used for construction purpose but pure clay is not available in suitable amount so fly ash brick is used which is the best replacement of clay brick. But now a days at some places the amount of fly ash is reduced or desire quantity of fly ash is not available which fulfill our requirement so new brick is introduced having a balancing amount of fly ash and stone dust which gives tenacious strength and enduring for life. In this paper consisting, comparison of compressive strength of bricks. Bricks manufactured with waste material such as stone dust and fly ash which are available in ample quantity which results economical in manufacturing. The strength gain by using stone dust in (fly ash + lime) brick gives a better strength as Compared to (fly ash + lime), (fly ash + cement, clay bricks. stone dust + fly ash + lime bricks also has less water absorption and negligible decrease in length in dimension test and its light in weight as compared with other bricks and addition of fly ash in this brick tends it to be use as thermal insulation. Stone dust bricks as waste material can be used for manufacturing brick which give high compressive strength as compare to other bricks. In market stone dust and fly ash is a waste material this also made the brick economical as compared to other bricks in market.***

Bricks are widely used in construction as a material, 25% of material is bricks in construction. Clay bricks are used for construction purpose but pure clay is not available in suitable amount so fly ash brick is used which is the best replacement of clay brick. But now a days at some places the amount of fly ash is reduced or desire quantity of fly ash is not available which fulfill our requirement so new brick is introduced having a balancing amount of fly ash and stone dust which gives tenacious strength and enduring for life. In this paper consisting, comparison of compressive strength of bricks. Bricks manufactured with waste material such as stone dust and fly ash which are available in ample quantity which results economical in manufacturing. The strength gain by using stone dust in (fly ash + lime) brick gives a better strength as Compared to (fly ash + lime), (fly ash + cement, clay bricks. stone dust + fly ash + lime bricks also has less water absorption and negligible decrease in length in dimension test and its light in weight as compared with other bricks and addition of fly ash in this brick tends it to be use as thermal insulation. Stone dust bricks as waste material can be used for manufacturing brick which give high compressive strength as compare to other bricks. In market stone dust and fly ash is a waste material this also made the brick economical as compared to other bricks in market. Bricks are widely used in construction as a material, 25% of material is bricks in construction. Clay bricks are used for construction purpose but pure clay is not available in suitable amount so fly ash brick is used which is the best replacement of clay brick. But now a days at some places the amount of fly ash is reduced or desire quantity of fly ash is not available which fulfill our requirement so new brick is introduced having a balancing amount of fly ash and stone dust which gives tenacious strength and enduring for life. In this paper consisting, comparison of compressive strength of bricks. Bricks manufactured with waste material such as stone dust and fly ash which are available in ample quantity which results economical in manufacturing. The strength gain by using stone dust in (fly ash + lime) brick gives a better strength as Compared to (fly ash + lime), (fly ash + cement, clay bricks. stone dust + fly ash + lime bricks also has less water absorption and negligible decrease in length in dimension test and its light in weight as compared with other bricks and addition of fly ash in this brick tends it to be use as thermal insulation. Stone dust bricks as waste material can be used for manufacturing brick which give high compressive strength as compare to other bricks. In market stone dust and fly ash is a waste material this also made the brick economical as compared to other bricks in market.

Keywords: Fly ash, Lime, Stone dust, clay brick, compressive strength, water absorption

1. Introduction

The principle source of energy in India is the coal and it will remain the major source of thermal power for the next few decades. Nearly 65% power in India is generated through thermal power plants (TPP).

The fly ash generation is increasing in such a proportion that it will not be possible for the cement industry alone to utilize the same. New avenues of gainful utilization of fly ash have to be found and promoted. The generation of fly ash in different five year plans.

Fly ash is the by-product of coal combustion collected by the mechanical or electrostatic precipitator (ESP) before the flue gases reach the chimneys of thermal power stations in very large volumes. Clay bricks monograms which is given in national building code SP: 10-1975. [1]

Indian coal on an average has 30% to 40% Ash and this is one of the prime factors which shall lead to increased ash production and hence, Ash utilization problems for the country.

The disposal of this waste material is a matter of great concern from the environmental and ecological point of view. The safest and gainful utilization of this material has been one of the topics of research over the last few decades. The advantages of fly ash utilization are:

- Saving of space for disposal and natural resources
- Energy saving and Protection of environment

The options of ash utilization including the ash based products are at development stage and need to be made more environments friendly by bringing ash revolution.

Fly-ash bricks are slow but surely replacing conventional clay bricks For wall constructions[1] The utilization of this

environmentally safe waste material in the manufacture of building bricks in Turkey will help significantly to reduce the negative environmental impact of coal-fired power generation and clay pits while meeting increasing demands for greener building materials domestically and globally.[2] It is observed that as the lime content increasing the strength is also increasing but amount of increase in strength from 5 % to 10% is more and from 10 % to 15% is less. [3] the various Mix Design as per Bureau of Indian Standards (BIS) methods were made by replacement of cement from 10% to 40% by fly ash.[2]

2. Codal Provisions

2.1 Material Selection

The materials used for the experimental programmer are:
a) Cement b) Fly ash c) Lime d) Water e) Stone dust

2.1.1 Cement
Physical analysis of 53 Grade Portland cement as per IS 12269-1987

2.1.2 Aggregates
Fine aggregate from a natural sources for concrete as per IS 383-1970. Methods of test aggregate for concrete as per IS 2386-1963.

2.1.3 Fly ash
Fly ash governed by IS 3812(part 1)2003 The BIS specification limit for chemical and physical requirement are given in tables 5.14 and 5.15.

2.2 Properties of Fly Ash

Fly ashes vary in colors, perfect size, and mineral constituents depending upon origin of coal ad burning. Indian fly ashes contain higher content of un burnt carbon (10% to 16%) where as in American fly ashes it is less (around 5%).

IS 12894: 2002 Pulverised Fuel Ash-Lime Bricks – Specification (first Revised)

In this is code test of tolerance & dimension for fly-ash brick is given (clause 5.1 & 5.2 pg no. 62). The most commonly used and manufactured brick size is the "Imperial Brick". It is 222 mm long x 106 mm wide x 73 mm high with a mass between 3 and 3, 5 kg, depending on the materials used, the degree of vitrification and the perforations provided.

Other sizes of bricks and blocks are made by individual manufacturers. Various combinations of dimensions in millimetres are:

- Length: 220 190 222 290 390
- Width: 110 106 140 150 190
- Height: 73 90 114 190 90

3. IS 3495 Method of Testing of Burnt Clay Building Brick

3.1 Determination of Compressive Strength (IS 3495-1992 part 1 Pg No.1 Clause No.4)

For clay bricks Apparatus like compression testing machine (CTM) Compression plate which have ball setting in the form of portion of spare the centre of each of coincide with the centre of plate. Place the specimen with flat faces horizontal and mortar filled facing upward between two 3 ply plywood sheets each of 3mm thick. Applying load axially at uniform rate of 14N/mm^2 per minute till failure occurs that is maximum load at failure. In place of plywood sheet plaster of Paris may be used for uniform surface for application of load.

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{maximum load at failure(N)}}{\text{Average area of bed surface (mm}^2\text{)}}$$

3.2 Determination of Water Absorption (IS 3495-1992 part 2 Pg No.3 Clause No.4)

3.3 Determination of Efflorescence (IS 3495-1992 part 3 Pg No.5 Clause No.4)

3.4 For Fly-ash lime brick (IS 2180 & IS 1077)

Fly-ash lime brick having weight compressive strength less than 30 N/mm^2 approximately 300 KGF/Cm^2 for higher strength.

4. Study of Material

4.1Characteristics / Quality of Materials

Before making a mixture, the selection of proper constituent materials and determination of their proportions is the first step toward obtaining a concrete that will meet the specified strength. It should be noted that in practice many mix design parameters are interdependent; therefore their influences cannot really be separated

The materials given below are use:

- **Cement**: 53 grades used for Brick.
- **Fly Ash:** Abhijeet Thermal Power Station, Near Hiingna road Nagpur.
- **Water:** potable water was used.(pH <6)
- **Stone dust:** Khadgaon crusher plant, Wadi (Nagpur)
- **Lime:** katani, Madhya Pradesh.

4.2 Testing Parameters

4.2.1 Compressive Strength
Minimum average compressive strength of brick shall not be less than 7.5 N/mm2 when tested as per IS-3495 (Part-1):1976. The compressive strength of any individual brick shall not be fall below the minimum average compressive strength by more than 20%.

4.2.2 Water Absorption

The bricks when tested in accordance with the procedure laid down in IS: 3495 (Part-2):1976 after immersion in cold water for 24 hours, shall have water absorption not more than 20%.

4.2.3 Efflorescence Test

The bricks when tested in accordance with the procedure laid down in IS: 3495 (Part-3):1976 shall have the rating of efflorescence not more than 'Moderate'

5. Material Properties

The selection of suitable ingredients of concrete is to cater with the objective to produce a concrete of the required, strength, durability, and workability as economically as possible.

5.1 Material Selection

The materials used for the experimental programme are a) Cement b) Fly ash
c) Water d) Stone dust e) Lime

5.1.1 CEMENT [Physical analysis of 53 Grade Portland cement as per *IS 12269-1987]*
Make: Ultra Tech
Grade: 53
Type: Ordinary Portland cement
The physical properties of cement were evaluated from the laboratory as below.

- **Consistency**
  Testing was done as per IS code 12269- 1987
  Result: - Normal consistency was found to be 22% on the Vicat's apparatus.(Testing was done as per IS code 8112 - 1976).
- **Initial Setting Time**
  Testing was done as per IS code 12269- 1987.
  Result: - Initial Setting Time: 30 min.
- **Final setting time**
  Result**: -** Final setting time: 600 min.
- **Specific gravity of cement**
  Result**: -** Specific gravity of cement: 3.15
- **Fineness of cement**
  Testing was done as per IS code 4031 - 1996 {Part -I}.
  Result**: -** Fineness of cement is found to be 5.0%.
- **Soundness of cement**
  Procedure: Apparatus - Le-Chatelier Apparatus. (Testing was done as per IS code 4031 - 1996 {Part -III}, and IS 5514-1996)
  Result**: -** Soundness of cement is 2 mm.
- **Compressive strength of cement**
  Testing was done as per IS code 12269- 1987
  Result**: -** 3 days = 27.52N/mm2
  7 days = 36.28 N/mm2.

5.1.2 Fly-Ash

Table 1: Chemical Properties of Fly Ash(Hopper No.)

Test Conducted	Requirement as per IS3812 (part 1)-2003	1	2	3
Loss of ignition -%	Max. 5.0	1.43	2.52	4.11
Silicon Dioxide (Sio2) in percentage by mass	Min 35	56.02	56.05	53.11
Silicon Dioxide (SiO2)+Aluminum Oxide (al2o3)+ iron oxide (fe2o30 in % by	Sio2+fe2o3+al2o3 Minimum 70%	88.89	88.76	85.2
Magnesium oxide (MgO) in %	5.0 Max	0.55	0.19	0.54
Total sulphur as So3 in % by mass	Max 3.0	Below 3.0	0.32	0.24
Calcium oxide (Cao) %		1.53	0.995	0.29

Table 2: Physical Properties of Fly Ash

Test Conducted	Requirements as per IS3812	Test Result		
		Hopper No.1	Hopper No.2	Hopper No.3
Consistency (%)		27.5	27.5	25
Specific gravity (gm/cc)		2.04	2.061	2.173
Setting Time Initial (min) Final (min)		250 330	245 325	240 325
Soundness Test (mm) By Autoclave expansion method (%)	Max 0.8	-0.0516	-0.0502	-0.0312
Fineness % by weight by sieving (% Retention on 45 micron sieve-wet sieving)	Not more than 34	45.55	24.45	2.7
Fineness (Specific Surface) (Sq.m/kg) By Blains Air Permeability	Min 320	229	320	536
Flow %		15	14	12
Compressive Strength (MPa) 1) 7 Days 2) 28 Days 3) 90 Days	Not less than 80 % of cement at 28 days.(Min.33)	19 31 46	20 34 58	31.5 47 67

5.1.3 LIME

Hydrated lime is used for Fly-Ash Brick making should conform to class C grade as specified in IS: 712:1984. The Cao purity in the lime should not be less than 85% which can be ascertained by testing and as well as taking test certificate from the lime suppliers. It has tendency to react with CO_2 present in the air in presence of moisture and produces $CaCO_3$ which does not have binding properties and spoils the quality of lime to be used for Fly Ash Bricks.

Table 3: Chemical Properties of Lime

Properties of Lime	Types of Lime			
	Quick Lime		Hydrated Lime	
	High Calcium	Dolomitic	High Calcium	Dolomitic
Primary Constituents	CaO	CaO. MgO	$Ca(OH)_2$	$Ca(OH)_2.MgO$
Specific Gravity	3.2-3.4	3.2-3.4	2.3-2.4	2.7-2.9
Bulk Density	55-60	55-60	25-35	25-35
Specific Heat At100°F	0.19	0.21	0.29	0.29
Angle of Repose	55°	55°	70°	70°

Table 4: Specification of Lime

Parameters	Hydrated Lime	Slurry Lime	Test Method
Chemical Requirement	Requirement		
Available calcium oxide %(w/w)	Min:68.0	Min:65.0	MS850:1997
Available calcium hydroxide (Dry basis), %(w/w)	Min:90.0	Min:85.0	MS850:1997
Calcium car-bonate %(w/w)	Max:9.0	Max:9.0	MS850:1997
Water content %(w/w)	Max:1.5	60-70	MS850:1997
Impurities	Limit		
Insoluble matter(dry basis), %(w/w)	Max:5.0	Max:5.0	MS850:1997
Physical Requirement	Requirement		
Fineness-wet sieving (dry basis)	Min:90% pass through BSS 200 (75um) sieve	Min:90% pass through BSS 200 (75um) sieve	AS 4489.2.1

5.1.4 Stone Dust

5.1.4.1 Sieve Analysis

5.1.4.2 Water Absorption

5.1.4.3 Aggregate Crushing Value

This test helps to determine the aggregate crushing value of coarse aggregates as per IS: 2386 (Part IV) – 1963.

5.1.4.4 Aggregate Abrasion Value

5.1.4.5 Workability (Slump Value)

Table 5: Physical Properties Stone Dust

Properties	Stone dust	Test Method
Specific Gravity	2.54-2.60	IS 2386 (PART III) 1963
Bulk Relative Density (kg/m^3)	1720-1810	IS 2386 (PART III) 1963
Absorption (%)	1.20-1.50	IS 2386 (PART III) 1963
Moisture Content (%)	NIL	IS 2386 (PART III) 1963
Fine particles less than 0.075mm (%)	Dec-15	IS 2386 (PART I) 1963
Sieve Analysis	Zone II	IS 383- 1970

Table 6: Chemical Properties of Stone Dust

Constituent	Stone Dust (%)	Test Method
SiO_2	62.48	IS:4032-1968
Al_2O_3	18.72	
Fe_2O_3	6.54	
CaO	4.83	
MgO	2.56	
Na_2O	Nil	
K_2O	3.18	
TiO_2	1.21	
Loss of ignition	0.48	

5.2 Mix Proportion

Proportion of raw materials is an important aspect for making of desired quality of Fly Ash Bricks. The proportion will depend on the quality of the raw materials and the compressive strength and water quality of brick required. The following mix proportion can be adopted for manufacturing of Fly Ash Brick.

Brick Type	Fly Ash	Stone dust	Sludge lime	Hydrated lime	Gypsum
I	55-60	20-25%	15-20%	00%	5%
II	60-65	18-27%	00%	8-12%	5%
III	50-60	32-40%	8-10%	00%	00%

About 1% gypsum can also be mixed by reducing same percentage in stone dust in this proportion. The strength of bricks manufactured with the above proportion is generally to the order 7.5 to $10N/mm^2$ after 28 days. Mix proportion suggested above can be used as guide lines. Mix proportion largely depends upon characteristics and quality of raw material used. Based on the qualities of raw material, the exact mix proportion may be finalized by trial mixes to produce good quality bricks of required compressive strength.

6. Research Program

6.1 Process of Manufacturing Bricks

6.2 Winning – Crushing and blending- grinding-screening-shaping-drying – firing -Brick

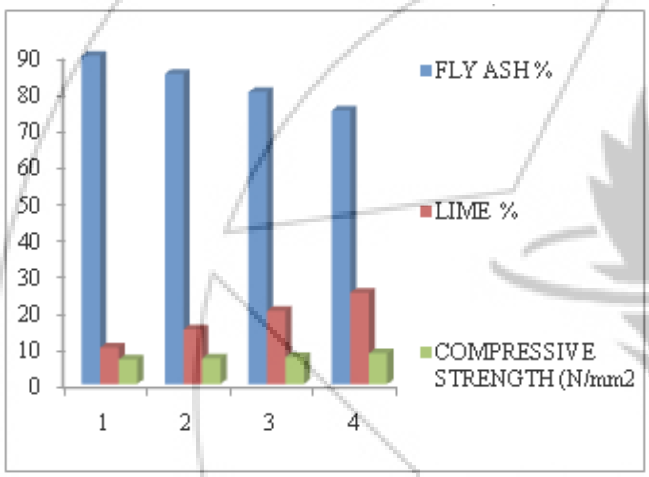
6.3 Testing Result of Bricks

6.3.1 Compressive Strength

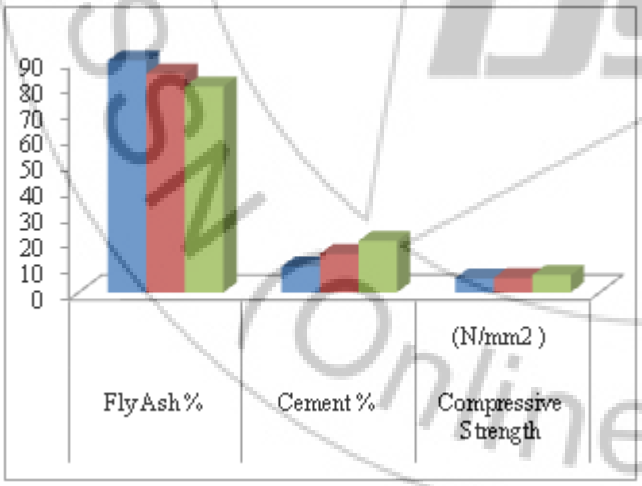
Minimum average compressive strength of brick shall not be less than 7.5 N/mm2 when tested as per IS-3495 (Part-1):1976. Compressive Strength

$$= \frac{\text{Maximum load at failure in N(kgf)}}{\text{Average area of bed faces in mm}^2\ (\text{cm}^2)}$$

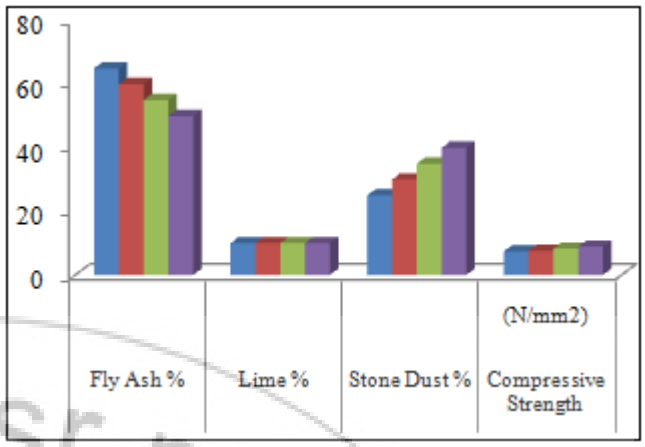
Brick Type	Proportion	Mix no.	Percentage	Compressive Strength
I	Fly Ash + Lime	1	(90% FA, 10% Lime)	6.74 N/mm^2
		2	(85% FA, 15% Lime)	6.95 N/mm^2
		3	(80% FA, 20% Lime)	7.39 N/mm^2
		4	(75% FA, 25% Lime)	8.36 N/mm^2
II	(Fly ash + cement)	1	(90% FA, 10% Cement)	5.43 N/mm^2
		2	(85% FA, 15% Cement)	5.65 N/mm^2
		3	(80% FA, 20% Cement)	6.73 N/mm^2
		4	(75% FA, 25% Cement)	6.93 N/mm^2
III	(Fly ash + lime + stone dust)	1	(65% FA, 10% Lime, 25% Stone Dust)	7.39 N/mm^2
		2	(60% FA, 10% Lime, 30% Stone Dust)	7.60 N/mm^2
		3	(55% FA, 10% Lime, 35% Stone Dust)	8.26 N/mm^2
		4	(50% Fa, 10% Lime, 40% Stone Dust)	8.90 N/mm^2
IV	Clay Brick			4.562 N/mm^2



Graph 1: Compressive Strength Brick I (Fly Ash + Lime)



Graph 2: Compressive Strength Brick II (Fly Ash + Cement)



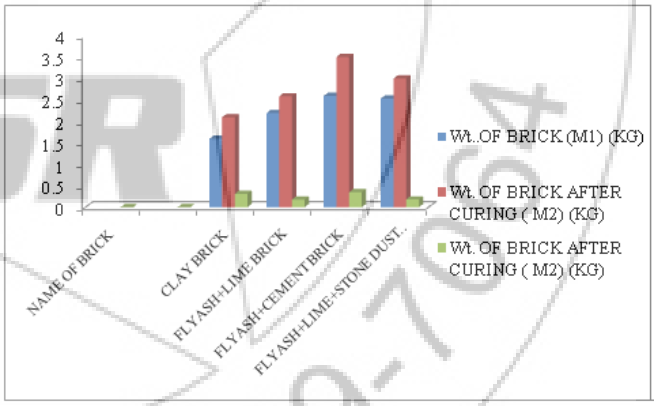
Graph 3: Compressive strength Brick III (Fly Ash + Lime + Stone Dust)

6.3.2 Water Absorption

The bricks when tested in accordance with the procedure laid down in IS: 3495 (Part-2):1976 after immersion in cold water for 24 hours, shall have water absorption not more than 20%.

$$\text{Water Absorption} = \frac{M_2 - M_1}{M_1} X100$$

Sr. No.	Proportion	Water Absorption	Dimension Test (Length 20mm)
1	Fly Ash + Lime	17.72%	- 0.5 mm
2	(Fly ash + cement)	35%	-1.9 mm
3	(Fly ash + lime + stone dust)	17.2%	- 0.1 mm
4	Clay Brick	31.25%	+ 0.5 mm



Graph 4: Water Absorption Test

7. Rate Analysis

FOR 1 BRICK

I) Fly ash + lime
II) Fly ash + cement
III) Fly ash + stone dust + lime
IV) Clay brick

Specification	Brick (Rs.)			
	I	II	III	IV
Fly ash	0.60	0.60	0.30	-
Lime	0.90	-	0.90	-
Cement	-	1.00	-	-
Clay	-	-	-	2.50
Stone dust	-	-	0.20	-
Labour	0.42	0.42	0.42	1.20
Electricity	0.10	0.10	0.10	-
Maintenance/Other charges	0.05	0.05	0.05	0.20
Losses	0.03	0.03	0.03	0.10
TOTAL	**2.10**	**2.20**	**2.00**	**4.00**

8. Conclusion

1) Stone Dust is waste material obtain from stone crushing plant and available in ample quantity.
2) Stone Dust is economical material as compare to other material use for manufacturing of brick.
3) Stone Dust has high impact value.
4) Stone Dust reduces the quantity of fly ash use in brick and it also gives high compressive strength when mixed with bad ash.
5) Bonding between fly ash and cement is weak as compare to fly ash and lime. Where both are tenacious bonding material.
6) Increment in the ratio of lime with fly ash the strength increases gradually up to certain limit but extensive use of lime does not increase the strength.
7) Percentage of water absorption in Brick -III (fly ash + lime + stone dust) is low as compare to Brick-I (fly ash + lime).
8) Brick-I (fly ash + lime), Brick-II (fly ash + cement), Brick-IV (clay brick) is replace with Brick-III (fly ash + lime + stone dust).

9. Future Scope

- We can reduce the weight of brick by using lacron thermacol balls.
- The brick used as reinforced brick by keeping the portion hollow, as the impact value is maximum.
- In future we increase the size of brick.

References

[1] Dhaval m. vaviya "comparing clay bricks nomograms with fly ash bricks" PG-Construction Engineering & Management student, B.V.M. Engineering college, Gujarat Technological University, Vallabh Vidhayanagar.
[2] Dr. Akshaya Kumar Sabat "A study of nalco fly ash on compressive strength for effective use in high volume mass concrete for a sustainable development" kiit university,bhubaneswar-751024,Orissa
[3] Tabin Rushad "Experimental studies on lime-soil-fly ash bricks" ph d scholar, department of civil engineering, motilal Nehru national institute of technology, Allahabad.
[4] Jayeshkumr Pitroda "Comparative Study on Rice Husk Shell in Fly Ash Bricks" Assistant Professor of Civil Engineering Department Birla Vishvakarma Mahavidyalaya Engineering
[5] Prakash K.B "Feasibility Study of Fly Ash as a Replacement for Fine Aggregate in Concrete and its Behaviour under Sustained Elevated Temperature" , Principal, Government Engineering College, Haveri, Karnataka – 581110
[6] J. N. Akhtar "An experimental study on fibre reinforced fly ash based lime bricks" Civil Engineering Section, University Polytechnic A.M.U., Aligarh India
[7] U.Sanjana Malaimagal "Experimental Studies on Pond Ash Brick" Professor, AC Tech College of Engineering and Technology, Karaikudi
[8] Sangeeta D.Agarwal "Effect of Silica Fume on Fly Ash Cement Bricks - An Experimental Study" Assistant Professor, Department of Civil Engg., SSVPS BSD College of Engineering, Dhule
[9] Gunavant k. Kate "Effect of addition of fly ash on shrinkage characteristics in high strength concrete" department of civil engg. Malegaon(bk), asst.prof., baramati, India
[10] Mamta Rajgor "Stone Sludge: Economical Solution for Manufacturing of Bricks" Student of final year M.E. C E & M, B.V.M. Engineering College, Vallabh Vidyanagar.