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Properties of Brick by Using Granite Waste and Quarry Dust

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***Abstract*: The brick is a building material, which is used to build up the structures. The aim of this project is to determine the compressive strength and other characteristic of the bricks. The bricks with clay and granite sawing powder waste and quarry dust, which will give a better understanding on the properties of bricks like compressive strength, water absorption and size and shape of brick was good while comparing the other kind of bricks. The scope of this project is to determine and compare the strength of the bricks by using different percentage of granite sawing powder waste and quarry dust. The adding percentages are equal like 0%, 5%, 10%, 15%, and 20%. The investigation was carried out by various mix ratio using the laboratory test likes compression test, water absorption. For strength characteristics, the results showed that a gradually increase in compressive strength, water absorption values in bricks was good while comparing the characteristics compressive strength of bricks.**

***Keywords*: Bricks, granite powder, quarry dust, compressive strength, water absorption, hardness, efflorescence, soundness**

1. Introduction

The amount of industrial waste is increasing year by year. Industrial waste is defined as waste generated by manufacturing or industrial processes.one type of industrial waste is granite waste, the amount of granite waste is due to the mining process and manufacturing of granite. The deficient observance of the standard dimensions of the blocks, faults and piling of pieces are the main source of waste. Another type of industrial waste is quarry dust. It is obtained during the production of aggregates through the crushing process of rocks in rubble crusher units. By using these materials in to the clay we have to check properties of brick which are compressive strength, water absorption, density, shape, size, colour, efflorescence. The amount of granite waste from cutting and sawing process in ornamental stone industries can easily reaches 20-25% of the total volume of the block. In order to alleviate the pollution problem at plants air, water and land, several attempts have been made to handle or used granite waste in ceramics products. Hence, it was thought that using this waste in the production of clay bricks will not only remedy the environmental problems associated with it but also might improve the quality of bricks and/or lower the firing temperature leading to cost cuts. We can get the good results on addition of granite sawing wastes and quarry dust in clay bricks. In order to enhance the strength and water absorption. Sustainability practices can enhance the cost reduction in construction. The following sustainability practices can be achieved such as by using Clay, Granite Sawing Powder Waste with Silica Fume as Clay replacement. Disposal of Granite Sawing Powder Waste is a major problem in Granite Factories. Reusing of Granite Sawing Powder Waste is a good alternative to solve the problem of disposal of Granite Sawing Powder Waste. The Use of Granite Sawing Powder Waste for the production of bricks is a well-known fact and is gaining popularity day by day. In this experiment we are used the brick dimensions consist of length x breath x height as 228mm x 102mm x 82 mm. The brick should be manufactured by hand mould process, the mould is made by wood. In this experiment we are check the properties of brick by conducting the different tests on brick samples by adding the GWP and QW in clay. The test which are compressive strength, water absorption, shape, size, colour, density and efflorescence etc.

2. Objectives of Study

For the present study, the following objectives have been set.

1. To study the properties of bricks.
2. To determine the compressive strength of brick specimens (bricks with granite sawing powder waste and quarry dust) using mix ratio of clay, granite sawing powder waste and quarry dust. To study the compressive strength and water absorption of brick specimen's bricks with granite sawing powder waste and quarry dust. To study all kinds of materials used in bricks with granite sawing powder waste and quarry dust.

The artificial material in the form of clay blocks of uniform size and shape are known as bricks. The earths required for manufacturing of bricks are soil and clay. Clay is an earthen minerals mass. Purest clay consists of kaolinite with small quantities of minerals.

3. Literature Review

General: Various literatures were collected to study and investigate to do project about bricks. Based on these collected

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literatures, the type of ingredients and the addition of ingredients were proportioned and moulded.

N Akhtar & M.N Akhtar: Bricks With Total Replacement of Clay By Fly Ash Mixed With Different Materials. Fly ash is a powdery substance obtained from the dust collectors in the Thermal power plants that use coal as fuel. From the cement point of view the mineralogy of Fly ash is important as it contains 80% - 90% of glass. The impurities in coal-mostly clays, shale's, limestone & dolomite; they cannot be burned so they turn up as ash. The Fly ash of class C category was used as a raw material to total replacement of clay for making Fly ash bricks. In present study the effect of Fly ash with high replacement of clay mixed with different materials were studied at a constant percentage of cement i.e. 10%.

Three Categories of bricks were to be studied namely Plain Fly ash brick (FAB), Treated Fly ash brick (TFAB) and Treated Fly ash stone dust brick (TFASDB).In all the above mentioned categories the quantity of Fly ash was kept constant as 80%. It is found that the compressive strength of plain Fly ash brick (15FAB) and Treated Fly ash brick (15TFAB) was found to be higher with 5% coarse sand and 15% sand combination at 10% cement. The gain in strength continues for Treated Fly ash Stone dust Brick (10TFASDB) and found to be higher with 10% stone dust and 10% sand combination.

A variation in the quantity of Fly ash was also attempted and it was found that the 25TFASDB with 50% fly ash, 25% stone dust and 25% sand combination at 10% cement achieved highest compressive strength. The addition of lime to the fly ash increases the cementitious properties of Fly ash and it was found that at 1.5% of lime, the OMC is minimum and dry density maximum. The compressive strength of Treated Fly Ash Brick (15TFAB) is more than Plain Fly Ash Brick (15FAB). The compressive strength of Treated Fly Ash Stone Dust Brick (10TFASDB) is more than 15FAB and 15TFAB. Treated Fly Ash Stone Dust Brick designated as (25TFASDB) achieved highest compressive strength (79Kg/cm2) with 25% stone dust, 25% sand and 50% treated fly ash combination at 10 % cement as compared to15FAB, 15TFAB, 10TFASDB. Though the highest compressive strength (79Kg/cm2) obtained in case of 25TFASDB is less than the maximum strength (105Kg/cm2) of standard Ist class brick, even than the study is important as it replaces 50% of top soil by fly ash. More over the 25TFASDB bricks can be safely used in frame structure buildings as non-load bearing walls and also as load bearing walls in case of single storey constructions.

Ramkumar, Swaminathan & Dhanapandian. Utilization of Granite and Marble Sawing Powder Wastes as Brick Materials. The main objective of waste management system is to maximize economic benefits and at the same time protection of the environment. Granite and marble process industry generates a large amount of wastes mainly in the form of powder during sawing and polishing processes, which pollute and damage the environment. Granite and marble process industry generates a large amount of wastes mainly in the form of powder during sawing and polishing processes, which pollute and damage the environment. Therefore, this work aims to characterize and evaluate the possibilities of using the granite and marble sawing wastes, generated by the process industries from Salem District, Tamil nadu state, India, as alternative raw materials in the production of bricks. Samples of clay material and fired industrial bricks were collected from nearby District namely Namakkal, India. Their characterization was carried out with the determination of chemical composition, mineralogical and petrological analysis, particle size, plasticity, FTIR, and Mössbauer measurements. Secondly, technological tests were conducted on wastes incorporated brick specimens in order to evaluate the suitability of addition of wastes in the production of bricks. The results showed that granite and marble wastes can be added up to 50 wt. % into the raw clay material in the production of bricks. Red type clay out of which this brick has been made in industry. The physical property studies, records that the addition of granite and marble waste mixture imparts physical strength to the bricks when they are kilned at higher temperature. More specifically, bulk density, compressive strength, flexural strength was found to increase due to the addition of the above mixtures. This is because of the fact that the addition of the mineral matter especially quartz and feldspar to the clay, act as flux when they are kilned at higher temperature as evidenced by the physical test of the bricks. From the results of technological tests, it is suggested that granite and marble wastes can be incorporated up to 50 wt. % into clay materials for the production of bricks. The incorporation of granite and marble wastes has negligible effect on the mechanical properties during the entire process, anticipating no costly modifications in the industrial production line. The possibility to use the granite and marble wastes as an alternative raw material in the production of clay-based products will also induce a relief on waste disposal concerns.

4. Methodology

This study was carried out for the purpose of having a detailed understanding of the effect and uses of utilizing granite sawing powder waste and silica fume in bricks and to determine its compressive strength. To achieve the objectives stated previously, several laboratory testing were conducted. By using appropriate apparatus and methods, testing was conducted on the required materials, standard bricks and the bricks with granite sawing powder waste and quarry dust. The following steps were followed in this project study.

- Step 1 Collection of literatures relevant to bricks.
- Step 2 Selection of materials for brick from the literatures collected.
- Step 3 Collection of materials for moulding the bricks (Clay, Granite Sawing Powder waste& quarry dust) and mould.
- Step 4 Preparation of mix proportions according to literature.
- Step 5 Casting process of bricks with the help of Ground mould.
- Step 6 Drying process of bricks.
- Step 7 Burning process of bricks.
- Step 8 Analysis of brick behavior on compression and water absorption test.

- Step 9 Based on the results obtained from the above tests optimum mix proportion is to be recommended.

5. Composition of Brick Earth

Following are the constituents of good brick earth:

1. Alumina
2. Silica
3. Lime
4. Iron oxide
5. Magnesia

1. *Alumina:* It is the chief constituent of every kind of clay. A good brick earth should contain about 20% to 30% of alumina. This constituent imparts plasticity to the earth so that it can be moulded. If alumina is present in excess, with inadequate quantity of sand, the raw bricks shrink and warp drying and burning and become too hard when burnt.
2. *Silica:* It exists in clay either as free or combined. As free sand, it is mechanically mixed with clay and in combined form, it exists in chemical composition with alumina. A good brick earth should contain about 50% to 60% of silica. The presence of this constituent prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks. The durability of bricks depends on the proper proportion of silica in brick earth. The excess of silica destroys the cohesion between particles and the bricks become brittle.
3. *Lime:* A small quantity of lime not exceeding 5 % is desirable in good brick earth. It should be present in a very finely powered state because even small particles of the size of a pin head cause flaking on the bricks the lime prevents shrinkage of raw bricks. The sand alone is infusible. But it slightly fuses at kiln temperature in presence if lime. Such fused sand works as a hard cementing material for brick particles. The excess of lime causes the brick to melt and hence it shape is lost. The lumps of lime are converted into quick lime after burning and this quick lime slakes and expands in presence of moisture. Such an action results in splitting of bricks into pieces.
4. *Iron oxide:* A small quantity of oxide of iron to the extent of about 5 to 6 % is desirable in good brick earth. It helps as lime to dust sand. It also imparts red color to the bricks. The excess of oxide of iron makes the bricks dark blue or blackish. If, on the other hand, the quantity of iron oxide is comparatively less, the bricks will be yellowish in colour.
5. *Magnesia:* A small quantity of magnesia in brick earth imparts yellow tint to the bricks and decreases shrinkage. But excess of magnesia leads to the decay of bricks.

6. Properties of Materials

Chemical Composition of Clay: The physical and chemical properties of clay are given in the Table.

Fig. 1. Clay

Chemical Composition of Clay

Chemical composition of clay	in percentages
SiO2	68.76
Al2O3	10.20
CaO	3.36
TiO2	0.02
Fe2O3	2.78
MgO	2.40
Mno	0.05
k2o	1.25
Na2O	0.67
P2o5	0.03
LOI	7.98
H2O	2.63
TOTAL	100

TABLE 1

1) Physical properties of granite powder waste

The basic tests on Granite Sawing Powder Waste were conducted as per IS-383-1987 In terms of granites sawing powder waste physical properties, it is a unique material. These properties lend uniqueness to granite are

1. *Co-efficient of expansion*: The co-efficient of expansion for granite vary from 4.7x10-6 – 9.0x10-6(inches x inches).
2. *Porosity/permeability*: Granite has almost negligible porosity range among 0.2 to 4%.
3. *Variegation*: Granite shows constancy in color and texture.
4. *Thermal Stability*: Granite is highly steady thermally, therefore shows no change with the change in temperature. It is impervious to weather from temperature and even from the air borne chemicals. Granite is the high confrontation to chemical erosion that makes it useful for making tanks to store highly caustic material.
5. *Hardness*: It is the hardest building stone and hardness of it that lends it excellent wear.
6. *Specific Gravity*:The specific gravity was around 2.74. vii) Water Absorption Water Absorption is found to be 0.60%.

Fig. 2. Granite Powder

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Chemical composition of granite saving powder

Chemical composition	Standard range in percentage	Tested sample in percentage
SIO2	70-77	74.3
AL2O3	11-14	16.3
TIO2	<1	0.38
Fe2O3	1-2	0.19
MGO	0.5-1	3.36
MNO	<1	0.08
Na2O	3-5	1.24
P2O5	3-5	2.24
LOI	3-6	2.16
H2O	<1	0.03

TABLE 2

Chemical composition of quarry dust

constituents	Standard range in percentage
SIO2	62.48
Al2o3	18.72
Fe2o3	6.54
Cao	4.83
Mgo	2.56
Na2o	0.21
k2o	3.18
Tio2	0.29
Loi	1.01

TABLE 3

Fig. 3. Quarry Dust

Mixed percentage of raw materials

TABLE 4

Brick samples	Raw materials (wt.%)		
	Clay soil (%)	Granite waste (%)	Quarry dust(%)
Sample 1	100	0	0
Sample 2	90	5	5
Sample 3	80	10	10
Sample 4	70	15	15
Sample 5	60	20	20
Sample 6	50	25	25
Sample 7	40	30	30

7. Manufacturing Process

The various process involved in the manufacturing of bricks are:

1. Clay Preparation.
2. Moulding.
3. Drying
4. Burning or Firing of bricks

1) Clay Preparation: Selection of the Site and Unsoiling

For the manufacturing of bricks, the site for taking out earth shall be selected after giving due consideration to the suitability of the soil. After selecting the site, the top layer of the soil, about 20cm in-depth, is removed and thrown out. This top layer of the soil contains roots of the grass, vegetation, other organic matter, etc. and is, therefore rejected. The soil below 20 cm is dug out preferably before rains. It is then cleaned off stones, vegetation or other organic substances. All the lumps of the soil should be broken into powder form. The loose soil thus obtained after cleaning is exposed to the weather for softening. The period of weathering varies from a few weeks to full season, depending upon the type of the soil and time available. Clay preparation methods may have to accommodate the physical characteristics of the raw material and special provision may have to be made to deal with certain impurities. Preparation consists of transforming the clay rock into plastic moldable material by a process of grinding and mixing with water. A typical factory might have a Primary crusher, these are used to break down large lumps of rock to manageable size, which can then be fed to a Secondary crusher, for example Pan mill, where the clay is reduced in size further. Water can be added here or if it is a dry pan the clay is reduced to dust and water added later. Further crushing takes place through conveyor rollers reducing the clay particles to about 1- 2mm.

Fig. 4. Brick Moulding Process

2) Moulding

Mouldings are two types they are:

1. Hand moulding
2. Machine moulding

We are followed by hand moulding process, Moulds are rectangular boxes of wood or steel, which are open at top and bottom. Steel moulds are more durable and used for manufacturing bricks on large scale. Bricks prepared by hand moulding are of two types. a) Ground moulded bricks b) Table moulded bricks. In this experiment the bricks are prepared by ground moulding. The materials are mixed as per above given table4, after the completion of the mixing for samples1, then the mould is clean with waste cloth, then sand is sprinkled on the inner sides of the mould, because When sand is used to prevent the sticking of earth to moulds, and moulded bricks have better finish sharper edges. Then the mixed specimen is taken in to the mould then level the top surface with the help of brick trowel then placed on the levelled ground. then given the number as sample 1. And then follow the same procedure for sample 2, sample 3, 4, 5,.7. We are manufactured five bricks for samples1, and 2, 3, 4, ….. Sample 7.

3) Drying

The damp bricks, if burnt, are likely to be cracked and distorted. Hence After the completion of moulding, the green specimens were left to dry in the atmosphere for 24 hours. After drying the samples are taken for firing. Bricks are laid along and across the stock in alternate layers.

4) Burning

Firing is the last operation in brick making process. The firing process determines the properties of the fired brick — strength, porosity, stability against moisture, hardness etc. Burning of bricks is done either in clamps or in kilns. Clamps are temporary structures and they are adopted to manufacture bricks on scale. Kilns are permanent structures and they are adopted to dried before they are taken for the next operation. Here the firing and is followed by clamp burning. Heating of clay leads to removal of moisture and carbonaceous material, chemical changes and colour change in the final product.

3. A trapezoidal shape in plan with shorter is slightly in excavation and wider end raised at an angle of 150from ground level.
4. A brick wall with mud is constructed on the short end and a layer of 70cm to 80cm thick fuel (grass, cow dung, ground nuts, wood or coal) laid on the floor.
5. A layer consists of 4 or 5 courses of raw bricks laid on edges with small spaces between them for circulation of air. Manufacture bricks on a large scale. A typical clamp is as shown small in fig
6. A second layer of fuel is then placed, and over it another layer of raw bricks is putape. The total height of clamp in alternate layers of brick is about 3 to 4 m.
7. When clamp is completely constructed, it is plastered with mud on sides and top and filled with earth to prevent the escape of heat.
8. Period of burning is about 2 to 3 days Burnt bricks are taken out from the clamp for testing.

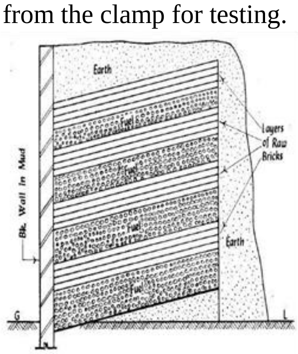


Fig. 5. Clamp Burning

8. Properties of Bricks

The following are the required properties of good bricks:

1) *Colour:* Colour should be uniform and bright.
2) Shape: Bricks should have plane faces. They should have sharp and true right angled corners.
3) *Size*: Bricks should be of standard sizes as prescribed by codes.
4) *Texture:* They should possess fine, dense and uniform texture. They should not possess fissures, cavities, loose grit and un-burnt lime.
5) *Soundness*: When struck with hammer or with another brick, it should produce metallic sound.
6) *Hardness*: Finger scratching should not produce any impression on the brick.
7) *Strength*: Crushing strength of brick should not be less than 3.5 N/mm2. A field test for strength is that when dropped from a height of 0.9 m to 1.0 m on a hard ground, the brick should not break into pieces.
8) *Water Absorption*: After immersing the brick in water for 24 hours, water absorption should not be more than 20 per cent by weight. For class-I works this limit is 15 percent.
9) *Efflorescence*: Bricks should not show white patches when soaked in water for24 hours and then allowed to dry in shade. White patches are due to the presence of sulphate of calcium, magnesium and potassium. They keep the masonry permanently in damp and wet conditions.
10) *Thermal Conductivity*: Bricks should have low thermal conductivity, so that buildings built with them are cool in summer and warm in winter.
11) *Sound Insulation*: Heavier bricks are poor insulators of sound while light weight and hollow bricks provide good sound insulation.
12) *Fire Resistance*: Fire resistance of bricks is usually good. In fact bricks are used to encase steel columns to protect them from fire.

9. Results and Discussion

For the tests that had been done on the bricks, several statements could be made based on the results obtained and observation done during the tests.

1) Compressive Tests on Bricks

During the compressive tests on the bricks, failure could be seen occur along the horizontal middle axis of four sides of the bricks. The sides of the bricks were broken off in the form such that several layers were being peeled off from the sides of the bricks when loading was applied onto the specimens. The surfaces were broken off and got into crack at the middle of the bricks. Figure 8 shows the brick with crack. The characteristic compressive strength of the bricks obtained was 4.2N/mm2.

Fig. 6. Compression Testing Machine

Compressive strength = Maximum load at failure (N/mm2)/

Area of specimen (mm2).

Compression testing for sample 1

Trail no.	Actual size of brick (Length x breadth) in mm	Compressive load in KN	Compressive strength in N/mm2
1	228 x 102	181	7.78
2	228 x 102	183	7.87
3	228 x 102	183	7.87

table 5 Average = 7.8

2) Calculations

Compressive strength = maximum load at failure (N/mm2)/area of specimen (mm2).

1kn =101.97kg

1kg= 9.81N

Area of specimen= 228x102=23256mm2

3) Sample 1

Trail 1= 181x101.97 = 18456.57kg

18456.57x9.8 = 181058.952N/23256mm2

Compressive strength = 7.78N/mm2

Trail 2= 183x101.97 = 18660.51Kg

18660.51x9.81= 183059.603N/23256mm2

Compressive strength = 7.87N/mm2

Trail 3= 183x101.97 = 18660.51Kg

18660.51x9.81 = 183059.603N/23256mm2

Compressive strength = 7.87N/mm2

Average compressive strength = 7.78+7.87+7.87/3 = 7.8N/mm2

Compression testing for sample 2

Trail no.	Actual size of brick (Length x breadth) in mm	Compressive load in KN	Compressive strength in N/mm2
1	228 x 102	171	7.35
2	228 x102	174	7.48
3	228 x 102	172	7.40

table 6 Average = 7.41

4) Sample 2

Trail 1= 171x101.97 = 17436.87kg

17436.87x9.81 = 171055.695N/23256mm2

Compressive strength = 7.35N/mm2

Trail 2= 174x101.97 = 17742.78Kg

17742.78x9.81 = 174056.672N/23256mm2

Compressive strength = 7.48N/mm2

Trail 3= 172x101.97 = 17538.84Kg

17538.84x9.81 = 172056.02N/23256mm2

Compressive strength = 7.40N/mm2

Average compressive strength = 7.35+7.48+7.40/3 = 7.41N/mm2

5) Sample 3

Trail 1= 153x101.97 = 15601.41kg

15601.41x9.81 = 153049.832N/23256mm2

Compressive strength = 6.58N/mm2

Trail 2= 154x101.97 = 15703.38Kg

15703.38x9.81 = 154050.158N/23256mm2

Compressive strength = 6.62N/mm2

Trail 3= 152x101.97 = 15499.44Kg

15499.44x9.81 = 152049.506N/23256mm2

Compressive strength = 6.54N/mm2

Average compressive strength = 6.58+6.62+6.54/3 = 6.58N/mm2

Compression testing for sample 3

Trail no.	Actual size of brick (Length x breadth) in mm	Compressive load in KN	Compressive strength in N/mm2
1	228 x 102	153	6.58
2	228 x 102	154	6.62
3	228 x 102	152	6.54

table 7 Average 6.58

6) Sample 4

Trail 1= 133x101.97 = 13562.01kg

13562.01x9.81 = 133043.318N/23256mm2

Compressive strength = 5.71N/mm2

Trail 2= 136x101.97 = 1386792Kg

1386792x9.81 = 13604429.5N/23256mm2

Compressive strength = 5.85N/mm2

Trail 3= 138x101.97 = 14071.86 Kg

14071.86x9.81 = 138044.947N/23256mm2

Compressive strength = 5.93N/mm2

Average compressive strength = 5.71+5.85+5.93/3 = 5.83N/mm2

Compression testing for sample 4

Trail no	Actual size of brick (Length x breadth) in mm	Compressive load in KN	Compressive strength in N/mm2
1	228 x 102	133	5.71
2	228 x 102	136	5.85
3	228 x 102	138	5.93

table 8 Average 5.83

7) Water Absorption Test

From observing the Water Absorption when tested in accordance with the procedure Limit for bricks having different mix laid down in IS 3495 Part II-1976. The proportions, the dried brick was immersed following table 9 shows the results obtained completely in clean water at temperature of from the water absorption limit of bricks.

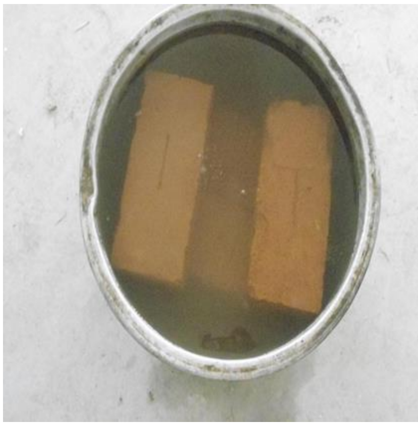


Fig. 7. Water Absorption of Brick

Water absorption limit of bricks

bricks	Weight of dry brick m1 in kg	Weight of soaked bricks For 24 hours m2 in kg	Water absorption limit in %
Sample 1	3.62	3.81	5.24
Sample2	3.63	3.92	7.98
Sample3	3.60	4.01	11.38
sample4	3.64	4.10	12.63

table:9

8) Calculations

Water absorption (%) = ((W2-W1)/W1) x 100

Where

W1 =Dry brick weight

W2 =Wet brick weight (after immersion for 24 hours)

Sample 1 = ((3.81-3.62)/3.62) x 100 = 5.24 %

Sample 2 = ((3.92-3.63)/3.63) x 100 = 7.98%

Sample 3 = ((4.01-3.60)/3.60) x 100 = 11.38%

Sample 4 = ((4.10-3.64)/3.64) x 100 = 12.63%

9) Efflorescence test

The soluble salts, if present in cause efflorescence in brick work. For finding out the presence of soluble salts in a brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry in shade. The absence of grey or white deposits on indicates absence of soluble salts. If the white deposits cover about 10 per cent surface, the efflorescence is said to be slight and it is considered as moderate, when the white deposits cover about 50 per cent of surface. If grey or white deposits are found on more than 50 per cent of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass.

In this experiment,

For sample 1 brick have 3 percent of soluble salts.

For sample 2 brick have 3.3 percent.

For sample 3 brick have 3.8 percent.

For sample 4 brick have 4.1 percent.

10) Shape and size, colour

In this test, a brick is closely inspected. its shape should be truly rectangular with sharp edges. For this purpose, 20 bricks of actual size (228 mm x 102mm x 82 mm) are selected at random and they are stacked lengthwise, along the width and along the height. colour should be uniform red, coper colour.

The bricks should be good quality bricks.

11) Hardness test on bricks

In this test, a scratch is made on brick surface with the help of a finger nail. There is no impression is left on the surface, the brick is sufficiently hard.

12) Soundness test on brick:

In this test, the two bricks are taken and they are struck with each other. The bricks should not break and a clear ringing sound should be produced.

10. Classification of Bricks

1) First class brick

Compressive strength = 7.8N/mm^2

Water absorption = 5.24%

Second class brick:

Compressive strength = 7.4N/mm^2

Water absorption = 7.98%

Third class brick:

Compressive strength = 6.58N/mm^2

Water absorption = 11.38%

Fourth class brick:

Compressive strength = 5.83N/mm^2

Water absorption = 12.63%

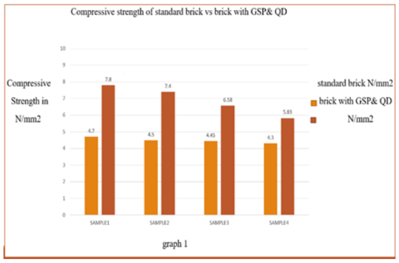
11. Statistical Analysis

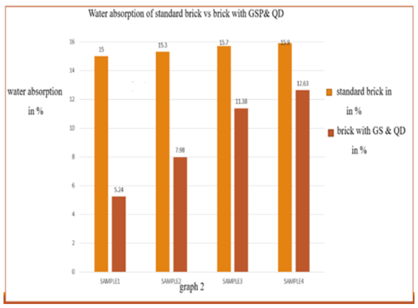
1) General

The study presents the results obtained from the experiment testing done on the standard bricks and the bricks granite sawing powder waste and silica fume. Analysis was done on the results obtained and presented them in the more appropriate formats, such as tables, charts or statements. Comparison among the results was also done for the purpose of evaluation.

2) Statistical Analysis

Based on several past researches, some of the properties of the bricks (bricks with granite sawing powder waste and silica fume) which required in the calculation for the compressive strength and water absorption could be obtained. The properties obtained and other required information was obtained from the results of experiment. By using the various collected literatures, the compressive strength of standard bricks was obtained and compared. The information obtained from the experimental study was shown below. Water Absorption Limit of bricks was not more than 15 % by weight. The Standard Bricks Vs Bricks with water absorption limit for the bricks using Granite Sawing Powder Waste & quarry dust was obtained as 7.18 to 13.26% by weight From the theoretical studies, it was observed that the water absorption limit for the standard taken after 24 hours. The graph is shown below.





12. Conclusion

General: Based on the scope of the investigation, the following conclusions can be drawn: Clay was found to be partially replaced by granite sawing powder with quarry dust as into 50%. From the compressive strength test, it was determined that the brick using granite sawing powder waste and quarry dust as clay gives more compressive strength as comparing the standard brick, i.e., 5.83 to 7.84 N/mm^2. From the water absorption test, it was found that the brick using granite sawing powder waste and quarry dust as clay gives less percentage of absorption as comparing the standard brick, i.e., 7.18 to 13.26 % by weight. From the results of technological tests, it is suggested that granite sawing powder waste and quarry dust can be incorporated up to 50 wt. % into clay materials for the production of bricks. The incorporation of granite wastes has negligible effect on the mechanical properties during the entire process, anticipating no costly modifications in the industrial production line. This kind of bricks with granite sawing powder waste and quarry dust can widely use to build the structures like walls, parapet walls and etc.

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Bureau of Indian Standards for relevant standards as under:

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[13] IS: 3102–1971 Classification of burnt clay solid bricks.

[14] IS: 3495(Part I to IV) 1992 Methods of tests on burnt clay building bricks.

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[17] IS 4326:1983 Earthquake resistant design and construction of building code of practice?

[18] IS 13759: 199 Fly ash building bricks specification.

[19] IS: 6042–1969 Code of practice for construction of light weight concrete block masonry.