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The Effects of Nano Materials and Egg Shell Waste Material on the Physical and Strength Properties of Floor Tiles.

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Abstract: *In a recent years, modification of cement composites by a nanoparticles has attracted intense attention among researchers. Concrete, as the most popular cement composite in practical applications, was also subjected to modification by replacing a portion of binder with nanoparticles such as Nano silica and Nano fly ash. Human activities often generate solid wastes such as egg shell waste. Disposal of these waste is usually a problem. The aim of this study was to investigate the feasibility of using Nano materials (Nano silica and Nano Fly ash) and egg shell together with white cement in the production of floor tiles. The use of Nano particles in developing materials with desired properties has gained popularity and is being applied in the construction field. Nano-technology potentially offers the opportunity to improve the properties of concrete to suit the specific requirements.*

Keywords*: *Floor Tiles, Egg Shell waste, Nano Materials, Physical and Mechanical Characteristics.

I. INTRODUCTION

Tiles are generally the manufactured piece of hard-wearing material such as ceramic, stone, metals, baked clay or even glass, commonly used for covering roofs, floors, walls or other objects and can range from simple square tiles to complex or mosaics. Tiles are most often made of ceramic, typically glazed for internal uses and unglazed for roofing, although recent technological advances have resulted in variety of flooring tiles.

Nano Materials: The particles size of the materials has significant influence on its physical and chemical properties. Especially, when the particles size is reduced to Nano meter scale, it behaves completely different from their bulk counterpart. Unusual physio-chemical properties of Nano particles are due to three main reason.
(i) The size of Nano particles is comparable to the Bohr radius of the excitons. This significantly alters the optical, luminescent and redox properties of Nano particles when compared to the bulk material.
(ii) The surface atoms constitute a considerable fraction of the total number of the atoms of the nanoparticle. The surface atoms contribute largely to the thermodynamic characteristics of solids and also determine the melting temperature and structural transitions of nanoparticles in the bulk material, atoms are evenly surrounded and the cohesive forces between the atoms tend to balance. However, there are atoms on only one side of a free nanoparticle surface, and there is an internal cohesive force. As the particle size decreases, the net internal cohesive force increases, and as a consequence the surface energy that depends on the internal cohesive force should increase with decreasing particle size.
(iii) The natural size of the nanoparticles is comparable with the size of molecules. This determines the peculiarities of the kinetics of chemical processes on the surface of nanoparticles.

Nano Silica: The modification of macroscopic properties of concrete by Nano silica addition has been subjected to intensive study. As far as compressive strength is concerned, controversial results were obtained sorting enhancements from notable to moderate, even though no gains were reported. A certain Nano silica content produced different effects on the strength when Nano silica was incorporated into concrete with different water/cement (w/c) ratios. For instance, employing a content of Nano silica around 1% Nano silica into concrete with w/c ratio of 0.4 and 0.48 resulted in quite different gains in compressive strength of about 20% and 12%, respectively. Similarly, utilization of 2% Nano silica in high volume binary blended concrete with water to binder (w/b) ratio of 0.4 and 0.45 produced null and 16% strength gain, respectively.

Nano Flyash: Fly ash not only improves the durability and strength but also reduces the requirement of cement. However, the unique properties of fly ash such as fineness, specific surface area, particle shape, hardness, freeze-thaw resistance, etc. have paved way for its use in Construction and polymer industry. In construction industry fly ash has been used as a partial replacement of cement in order to achieve strength, durability and economical concrete. In polymer industry fly ash is utilized in making polymeric composites where fly ash is being used as inorganic particulate filler without much breakthrough. The utilization of fly ash is determined based on their properties.

Egg Shell: Agricultural waste constitutes a significant proportion of the accumulated solid waste in many parts of the world. Egg shells are part of agricultural wastes that litter the environment. In the ever-increasing endeavors to convert waste to wealth, the efficacy of converting Egg shells to beneficial use becomes an idea worth investigating. The composition of the Egg shells lends the effects of its ash on the cement to be articulated. It is scientifically known that the egg shell is mainly composed of compounds of calcium.

II. LITERATURE REVIEW

1. A.M. King'ori, **2011**, studied the, ***"Review of the uses of poultry egg shell and shell membrane".*** The study is important to find out multiple uses of egg shells and shell membranes. Egg shells are waste materials from hatcheries, homes and fast food industries and can be readily collected in plenty. Since the disposal of the egg shell waste contributes to environmental pollution, it can be used in art work, human, animal nutrition, building materials and to produce collagen. Egg shell consists of calcium carbonate, magnesium and phosphorous and the shell membrane comprises of collagen. The study also tells that pulverized egg shells have potential as a soil stabilizing agent. These pulverized egg shell can be used as an alternative for sand in making hollow blocks because they contain calcium carbonate that gives them hardness and strength. To compare the effectiveness of pulverized egg shells and sand in hollow blocks, a dry block from each mixture was dropped from a height of 2 feet. It was observed that the egg shell block got a crack while the sand block broke into pieces. This indicates that the egg shells are more effective than sand.

2. E.Rambaldi, A.Tucci, Esposlto, D. Naldi, G. Timellini, studied the ***"Effects of Nano-oxides on the surface properties of ceramic tiles".*** The paper presents a work to obtain ceramic tiles with superior surface, mechanical characteristics and chemical resistance, by the addition of Nano-oxide, such as zirconia and alumina. The test conducted are Vicker's hardness, Scratch test and chemical resistance test. Microstructural observations allowed how alumina and zirconia Nano particles acted to improve the surface of the ceramic tiles. The presence of the Nano-oxide layer has not changed the linear shrinkage and water absorption values. In this experiment two Nano-suspensions of alumina and zirconia were selected for the present work. In order to identify their mineralogical phases, the surface microstructural of the sample was studied with a SEM (EVO40, ZEISS, D) equipped with unEDS system. In order to qualitatively examine the crystalline phases developed on the ceramic surface with or without Nano particles.

3. Roy Harrison and Ralph Brough, 2006, studied that ***"The impact resistance of ceramic tiles and flooring".*** The study is of relative importance of impact resistance, breaking strength and modulus of rupture is discussed. Modulus of rupture has always been accepted as an appropriate means of regulating the production of tile bodies in manufacture. The British standard for wall tiles was revised in 1966. It was considered essential to have a method of test for strength but modulus of rupture was not considered. The appropriate method for tile in service and a simple pass/fail system based on impact loading was devised. This used a 19mm diameter steel ball weighing approximately 438 gm was dropped from height related to the actual thickness of glazed tile. This method of choosing height was not to achieve fine discrimination between different bodies but to ensure that each thickness of tile is strong enough.

III. MATERIALS AND METHODOLOGY

3.1 Collection of materials and its process

1. Nano materials

Required Nano materials (Nano Silica and Nano Flyash) were supplied from two different firms, which we had contact the person and brought to our work. The process involves adding of two different Nano materials to a ratio to get the physical and mechanical properties.

Fig 3.1: Nano Silica

Fig 3.2: Nano Fly ash

2. Egg shells

The egg shells are collected from poultry farm and locals as a waste material. This process involves soaking of egg shells in water for 24 hours for easy removal of dirt and membrane. These Eggshells were then dried and crushed using mortor and pestle. The crushed eggshells are then sieved to get the fine powder. The presence of Calcium Carbonate in them plays a vital role in providing strength to the tiles.

Fig 3.3: Egg shells

3. White Cement

The cement which is used for our research work is J.K White cement confirming to IS 8042:2015. The White Cement was collected from the nearby shop. White cement resists the water penetration by binding with Nano materials and egg shell since White cement contains little iron-oxide (Fe2 O3) and manganese (Mn).

Fig 3.4: White Cement

4. Pigments

Pigments, synthetic or otherwise, used for colouring tiles shall have durable colour. These pigments were collected from the shop. It shall not contain detrimental to concrete and shall be according to the colour required by one of the following or their combination. Black or red or brown pigment IS 44, Green pigments IS 54, Blue pigments IS 55 or IS 56 or IS 3574 (Part 2), White pigments IS 411, Yellow pigments IS 50 or IS 3574 (Part 1).

Fig 3.5: Pigments

3.2 Methodology

The cubes of size (150 X 150 X 150) mm of different Proportions of (White Cement: Nano Silica: Egg shell) and (White Cement: Nano Flyash: Egg shell) were cast and cured for 28 days.

Table 3.1 Mixing proportion of Nano Silica, Egg shell, Cement.

Cement: Nano Silica: egg shells	Cement(Kg)	Nano Silica(Kg)	Egg shells(Kg)
(1:1:0)	0.94	0.26	0.00
(1:1:1)	0.62	0.17	0.56
(1:1:2)	0.47	0.13	0.84
(2:1:1)	0.94	0.13	0.42
(1:2:1)	0.47	0.26	0.42
(1:2:2)	0.37	0.21	0.67
(2:1:2)	0.75	0.10	0.67
(2:2:1)	0.75	0.19	0.30
(1:0:1)	0.84	0.00	0.84
(2:0:1)	1.25	0.00	0.56

Table 3.2 Mixing proportion of Nano Fly ash, Egg shell, Cement.

Cement: Nano Fly ash: egg shells	Cement(Kg)	Nano Fly ash(Kg)	Egg shells(Kg)
(1:1:0)	0.94	0.26	0.00
(1:1:1)	0.62	0.17	0.56
(1:1:2)	0.47	0.13	0.84
(2:1:1)	0.94	0.13	0.42
(1:2:1)	0.47	0.26	0.42
(1:2:2)	0.37	0.21	0.67
(2:1:2)	0.75	0.10	0.67
(2:2:1)	0.75	0.19	0.30
(1:0:1)	0.84	0.00	0.84
(2:0:1)	1.25	0.00	0.56

These cubes were then subjected to Compressive strength test and water absorption test. After obtaining the proportion that gave the maximum compressive strength and minimum water absorption, the tile moulds of size (200X200X10) mm are fabricated and making of tiles is commenced. These tiles were then subjected to Impact resistance test, Wet Transverse strength test, Bulk density and Perpendicularity and straightness test.

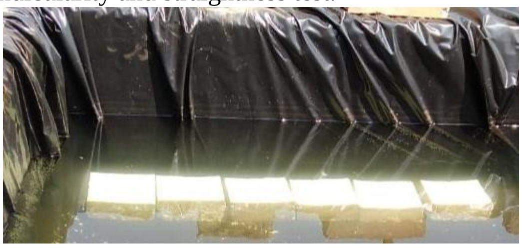

Fig 3.6: Cubes curing

Fig 3.7: Prepared Floor tile

3.2.1 Test conducted on cubes

1. **Compressive strength test (IS 516:1959)**

The Compressive strength of two cubes of all the proportions were tested by using Compressive testing machine of capacity 2000 KN. The average Compressive strength of each proportions is calculated.

2. Water absorption test (IS 2185 (Part 1): 2005)

For Water absorption test the dry weight of the specimen is taken first then the test specimen is completely immersed in water at room temperature for 24 hours. After 24 hours the specimen is removed from water and allowed to drain for one minute by placing on a 10 mm or coarser wire mesh, visible surface water is being removed with a damp cloth and immediately weighed.
Therefore, Water absorption is given by:

$$\text{Water absorption, percent} = \frac{A-B}{B} \times 100$$

Where, A=wet mass of unit in kg.
B=dry mass of unit in kg.

3.2.2 Test conducted on tiles

1. **Impact resistance test (BS-1966)**

In this test the spherical steel ball weighing approximately 438 grams and 19 mm diameter which was dropped from height related to the actual thickness of floor tile and the degree of shuttering or indention was recorded.

2. **Wet Transverse strength test (IS 1237-1980)**

In this test six full size tiles are selected and are immersed in water for 24 hours. After 24 hours the specimen is placed horizontally on two parallel supports with wearing sides upwards. The load is then applied and the breaking load 'P' is noted.
The wet transverse strength (f) shall be calculated as follows:

$$f = \frac{3PI}{2bt^2} \text{ N/mm}^2$$

Where, P is breaking load in N.
I is span between supports in mm.
b is tile width in mm.
t is tile thickness in mm.

3. **Bulk density (IS 13630 (Part 2): 2006)**

In this test dry mass of the specimen is noted first and then the specimen is immersed in boiling water for 3 hours. The height of the water should be at least 50 mm. The specimen is then cooled and measured after 1 hour.
Therefore, Bulk density is calculated by the formula given below:

$$\text{Bulk density} = \frac{m_1}{V} \text{ g/cm}^3$$

Where, m_1 = mass of the dry tile in gm.
V =exterior volume in cm^3 (m_2-m_3).
m_2 = mass of the wet tile in gm.
m_3 = mass of the tile impregnated by boiling water method.

4. **Perpendicularity and Straightness test (IS 1237:2012)**

In perpendicularity test one arm of the square, the arm of which is longer than the sides of the tile is placed along one of the edges of the tile, so that the corner of the square touches the corner of the tile and the largest gap between the edge of the tile and the arm of the square is recorded.

In straightness test two corners of the tile surface are connected with a fine thread alongside one of the tile edges and the largest gap between the thread and the plane is recorded.

IV. RESULTS AND DISCUSSION

1. Compressive strength and Water absorption for all the Proportions of (White cement: Nano Silica: Egg shells)

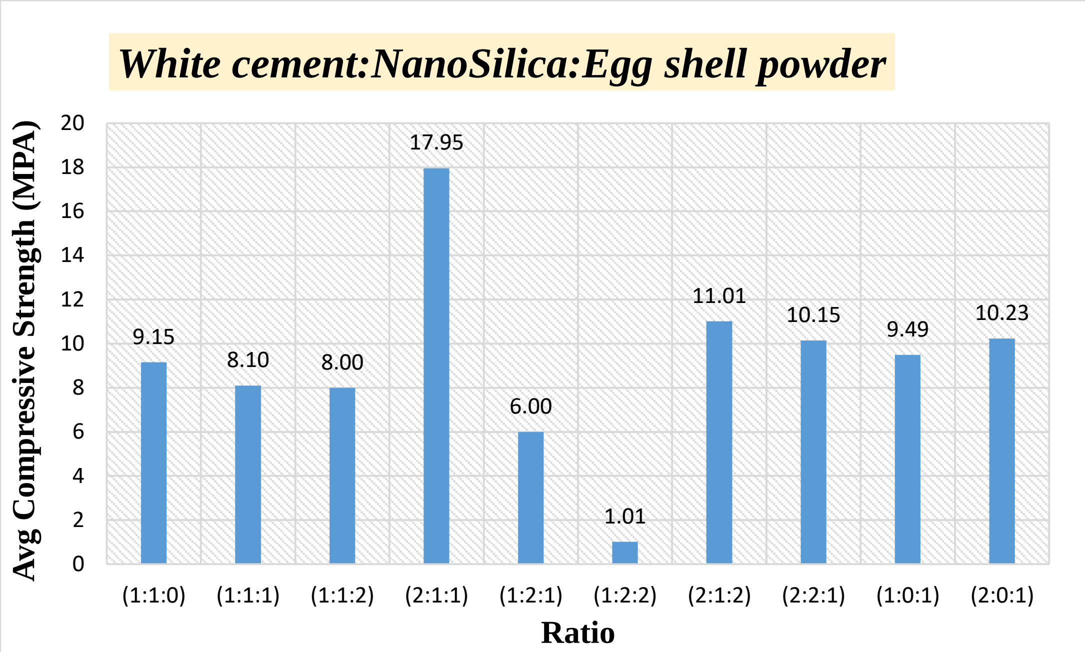

Fig 4.1: Graph represents Compressive Strength of cubes.

From the above graph we can see that the highest ratio that satisfies our requirement is 2:1:1 with the higher compressive strength of 17.97 MPa. As the (White cement: Nano Silica: egg shell) ratio changes, the values also increases and decreases respectively.

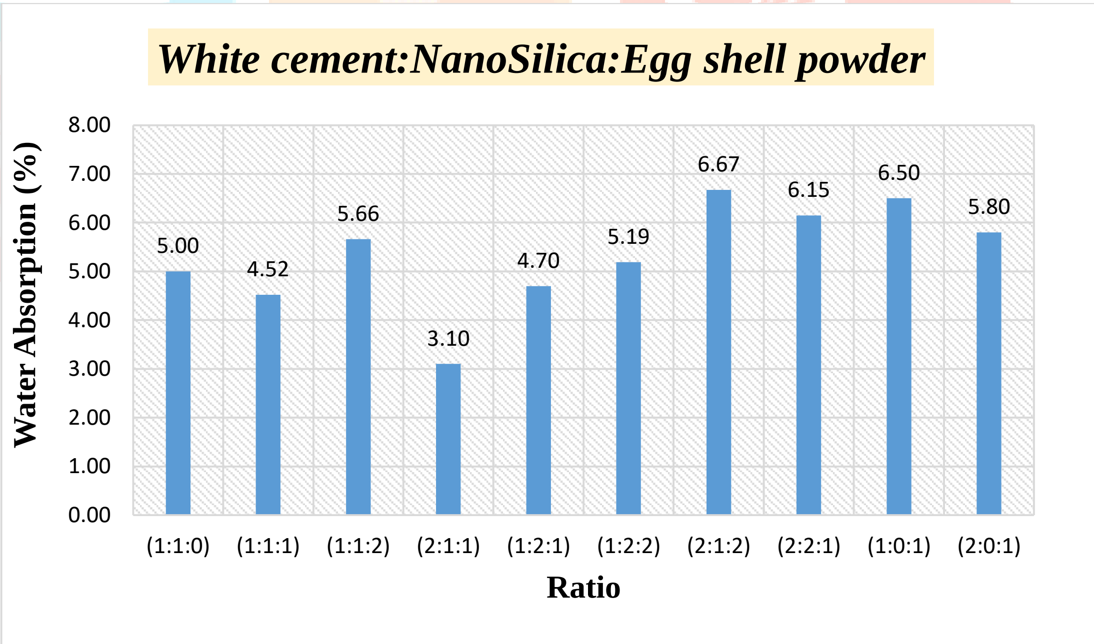

Fig 4.2: Graph represents Water absorption of cubes.

In general, the water absorption with less value will be considered for making of tiles. From the above graph the ratio that satisfies our requirement is 2:1:1 (White cement: Nano Silica: egg shell) with the minimum water absorption of 3.10 %.

2. Compressive strength and Water absorption for all the Proportions of (White cement: Nano Fly ash: Egg shells)

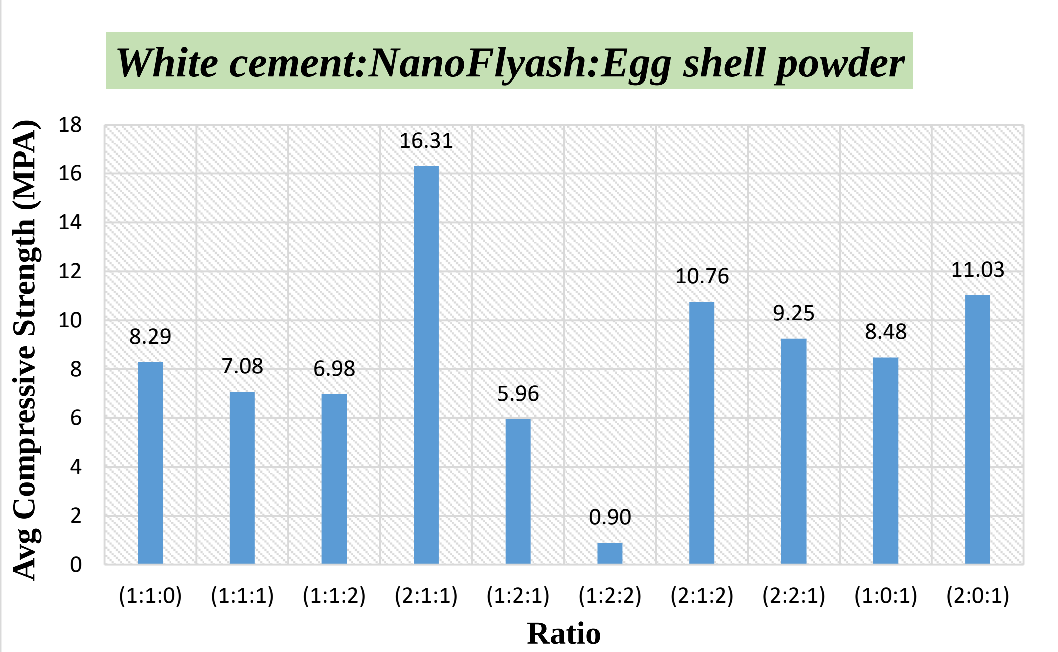

Fig 4.3: Graph represents Compressive Strength of cubes.

From the above graph we can see that the highest Compressive strength is 16.31 MPA for Proportion 2:1:1. But, this value is less than 17.97 MPA which is the Compressive strength of (White cement: Nano Silica: egg shell) for Proportion 2:1:1. Hence, Nano Fly ash is not considered for making of floor tiles.

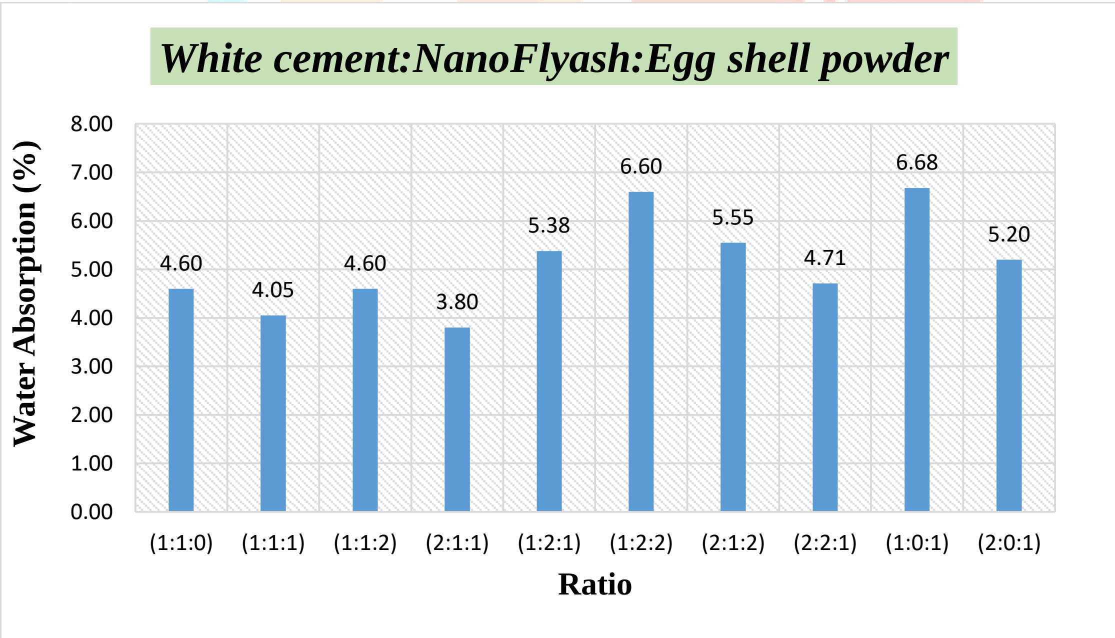

Fig 4.4: Graph represents Water absorption of cubes.

Here, We can see from the above graph the minimum water absorption is 3.80 % for Proportion 2:1:1 which is more compared to Water absorption obtained for Proportion 2:1:1 (White cement: Nano Silica: egg shell) that is 3.10 %.

3. Impact resistance test

As the steel ball was dropped 1st from a height of 0.5m there was no dents or cracks or marks on the tile. Then the height was increased to 0.7m and the steel ball was dropped again but, still there was no cracks or dents. Later the height was increased to 0.85m and there was some dents that occurred on the tiles. Again the height was increased to 0.95m and it was observed that the tiles had bigger cracks.

4. Wet Transverse strength test

The tiles were soaked in the water for about 24 hrs. After 24 hours, 3 tiles of the ratio (2:1:1) of size (200X200X10) mm was dried and tested on the same day on the machine.

Table 4.1 Wet Transverse strength of floor tiles

Specimen identification	Wet Transverse strength(f)	Average Wet Transverse strength
Tile 1 (T1)	4.5	
Tile 2 (T2)	4.8	4.5N/mm^2
Tile 3 (T3)	4.2	

As per IS Specification the Wet Transverse strength should not be less than 3 N/mm^2. The average Wet Transverse strength of 3 tiles have been recorded as 4.5 N/mm^2 which satisfies the above condition.

5. Bulk density test

As per the IS Specifications for ceramic floor tiles the Bulk density is 2.94 g/cm^3. The value obtained after calculating the bulk density for the floor tiles was found to be 2.43 g/cm^3 which is close to the bulk density of the ceramic floor tiles as per IS Specifications.

6. Perpendicularity and Straightness test

The test was conducted in the lab with a right-angle square. All the tiles were examined with the right-angle square and it was noticed that the corners of the tiles were correct with 90^0 angle and also the edges were parallel.

Similarly, In Straightness test the test was conducted with the help of thread in which the thread was moved parallel to the surface of the tile and it was observed that there was no gap between the thread and the surface of the tile.

V. COST ANALYSIS

Table 5.1 Cost comparison for floor tiles

Cost Comparison for 100 Floor Tiles (2:1:1) of Size (200 x 200 x 10) mm			
Material	**Quantity in Kg**	**Rate/Kg**	**Total Cost**
White Cement	28.2	Rs. 35 /-	Rs. 987 /-
Nano Silica	1.6	Rs. 800 /-	Rs. 1280 /-
Egg Shell Powder	12.6	Nil	Nil
Note: Since Egg Shell is a Waste Material, the Cost is Generally Nil			
Pigments	1	Rs. 300 /-	Rs. 300 /-
Total cost for 100 Floor tiles			Rs. 2567 /-
Market Price for 100 (Ceramic) Floor tiles			Rs. 3445 /-
Therefore Total Savings made for 100 Floor tiles			Rs. 878 /-

Hence From the above cost analysis we can say that the Floor tiles made by using White Cement, Nano Silica and Egg shell Powder of Proportion (2:1:1) is cost effective compared to tiles available commercially.

VI. CONCLUSIONS

- These kind of tiles are easy to manufacture, easy to install and replace in household flooring.
- The production process is cheap since it does not involve more expensive industrial equipment hence the tiles made using White cement, Nano material and egg shell mixture are affordable compared to ceramic tile available commercially.
- Areas with poor waste disposal facilities can be used for these wastes (egg shell) in making floor tiles, this study is very important in protecting the environment.
- Compressive strength, wet transverse strength, impact resistance test intensifies the reliable means of judging the quality of flooring tiles.

VII. REFERENCES

[1] A.A. Momin[a]*, R.B. Kadiranaikar[b], Siddarooda T[b], and Nagaraj K[c], (2014) *"Plastic floor Tiles".*

[2] ASTM C648-84: American Society for testing and Materials, Standard test method for breaking strength of ceramic tiles.

[3] B.Viswanathan *"Nano Materials",* Textbook Narosa publication, 2011.

[4] Christophe Bressot, Nicolas Manier, Cecilepagnonx, Olivier Aguerre-Chariol, Martin Morgeneyer, 25 september 2018, *"Environmental release of engineered Nano materials from commercial tiles under standardized abrasion conditions",* Journal of hazardous materials (PP 322,276-283), 2018.

[5] E. Rambaldi, A.Tucci, Esposito, D.Naldi, G.Timellini *"Effects of Nano-oxides on the surface properties of ceramic tiles".* Centro Ceramico Bologna, Italy (PP 1-10).

[6] Forood Torabian Isfahani[1],Elena Redaelli[1],Federica Lollini[1],Weiwen Li[2] and Luca Bertolini[1],March 2016, *"Effects of Nano silica on compressive strength and durability properties of concrete with different water to Binder Ratios",* Advances in material science and engineering, Volume 2016 , (PP 1-16).

[7] IS 1237-1980: Indian Standard, Specification for cement concrete flooring tiles.

[8] IS 2185 (part 1) 2005: Indian Standard, Concrete Masonry units–Specifications, part-1 Hollow and Solid concrete blocks.

[9] IS 13630(Part 2): 2006, Indian Standard, Ceramic tiles – "Methods of test sampling and basis for acceptance", Part 2 Determination of water absorption and bulk density.

[10] IS 1237-2012, Indian Standard, Cement Concrete Flooring Tiles-Specification.

[11] King 'Ori A.M (2011), *"A Review of the uses of Poultry Egg shells and Shell Membranes",* International Journal of Poultry Science 10(11): PP 908-912.

[12] M N .Freire[1,2], J.N.K. Holanda, 2006 *"Characterization of Avian Egg shell Waste aiming its use in a Ceramic wall tile Paste"*, Ceramica 52(2006) (PP 240-244).

[13] Micheal Kornmann and CTTB (2007), *"Clay bricks and Roof tiles, Manufacturing and properties",* Technical Centre for Roof tiles and Bricks in Paris, Soc. Industry Mineral, Paris.

[14] Micheal F.B (2008), *"Properties of Ceramic tiles".*

[15] Mikhail Gamero, 2nd Nov 2017, *"Ceramic Nano materials for high temperature applications",* Department of Materials Science and Engineering, USA.

[16] Praveen Kumar.R, Vijaya Sarathy.R, Jose Ravindraraj .B, April 2015, *"Experimental Study on Partial Replacement of Cement with Egg shell Powder".* International Journal of Innovations in Engineering and Technology (IJIET).

[17] Prince Arulraj.G[1], Jemimah Carmichael. M[12], 2011, *"Effect of Nano Fly ash on Strength of Concrete"* – International Journal of Civil and Structural Engineering, Volume 2, No. 2, 2011 (PP 475-482).

[18] Properties and Applications of Nano Materials http://www.brighthubengineering.com/manufacturing-technology/59084-what-are-nanomaterials-and-their-applications

[19] Roy Harrison and Ralph Brough, 2006 *"The Impact Resistance of Ceramic Tiles and Flooring"* Ceram Research, Stoke-on-Trent, UK (PP 143-154).

[20] Shambhubhusan Rana, March 2017, *"Development of Ceramic Tiles Using Waste Materials".*