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Investigation on the Suitability of Waste Plastic Bottle as Partial Replacement of Sand in a Cement Tile Production

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Abstract The rapid growth of the world's construction industry is profoundly affecting the cost of construction materials, as well as the natural resources required to produce the materials and environment. Besides, waste plastic bottles are also becoming other challenges in our surroundings due to its presence in the large amount and its non-biodegradability property. Even if various methods were attempted to manage this waste, applying it as the partial replacement for different construction materials seems feasible concerning solving the above-stated problems. The objective of this research was to investigate the competency of waste plastic bottles as partial replacement of sand in a cement tile production through conducting workability, dry density, water absorption and compressive strength test on it at the particular 7th and 21st days of curing. Experimental laboratory method used in this research design for testing some physical and mechanical properties of cement tiles. Other than this comparative method was also applied to compare different properties of controlled cement tile with cement tile made with just 3%-33% ground waste plastic bottle as sand at 3% incremental ratio and also cement tile produced by sodium hypochlorite treated plastic sand. The result showed an increment on the workability of the fresh concrete of the cement tile, decrement on the compressive strength, reduction in dry density and declined water absorption result. Finally, the study concluded the possibility of partial plastic replacement of sand in a cement tile production up to 32.11% replacement ratio for 21st day curing ages and even if the replacement above 32.11% had an adverse effect on the compressive strength and workability of cement tile, it also got an advantage with respect to dry density and water absorption. Also, the study revealed the power of sodium hypochlorite solution about improving the high physical and mechanical properties of cement tile. It recommended for the responsible parties to apply this technology in the real production process of cement tile.

Keywords: *cement tile, workability, water absorption, waste plastic bottle, plastic aggregate, and sodium hypochlorite solution.*

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1. Introduction

The construction industry is one of the significant sectors of the world. Due to rapid industrialization and urbanization, lots of infrastructure developments are taking place that leads to the acute shortage of construction material and increased dumping of waste materials [1]. Besides that, the consumption of raw materials by the construction industries is accumulating day by day, resulting in a depletion of natural resources, increasing the environmental impacts and CO_2 emissions all over the surrounding [2].

In addition to the environmental impact caused by the rapid growth of the construction industry solid waste is becoming another problem.

The quantity of solid waste is expanding rapidly. It estimated that the rate of expansion is doubling every ten years. Among the solid-waste materials, plastics have received a lot of attention because they are not biodegradable [3].

Waste plastic bottles are the primary cause of solid waste disposal. Polyethylene Terephthalate (PET, PETE or polyester) commonly utilized for carbonated beverages and water plastic bottle. It was an environmental issue as waste plastic bottles are difficult to biodegrade and involve processes either to recycle or reuse it [4]. Therefore, one of the logical methods for reduction of their adverse effects is the application of these materials in other industries [5].

So due to the highest expansion rate of construction and its excellent material consumption, Appling this concept in the construction industry as one of the concrete making materials seem feasible to solve different related problems.

Concrete is being a widely used construction material. Typical concrete ingredients are sand, coarse aggregates, and cement which used entirely for the production of concrete. Due to the great utility of concrete, with the passing of each day, these materials are getting deficient thus demanding for the alternatives [6].

As it is known, aggregate is one of the inert, granular ingredients of concrete that could either obtained naturally from the gravel pit, river run deposit and rock quarries or artificially from some industry by-products.

The aggregates typically account for 70–80 % of the concrete volume mix and play an important role in different concrete mix properties such as strength, workability, dimensional stability and durability [7]. Which extracted around the globe at a rate far more significant than their regeneration, the removal of aggregates has a substantial impact on rivers, deltas and marine ecosystems which results in deterioration of land through coastal or river erosion, Depletion of the water table and decrease in sediment supply" [8].

Sand is one of the natures obtained aggregate that consists of tiny fine grains and mostly found underwater, on water and desert areas which have a very high demand all over the world that leads to uncontrollable quarrying that damages the environment by causing the above-stated problems and shortening of natural aggregates.

Due to that, the search for an alternate source is of high priority. Artificially manufactured sands are used as a substitute for the natural sands but are uneconomical. If an appropriate industrial or agricultural by-product, which is a waste material, is used to replace sand partially it will diminish the problems and complications due to the inadequacy of sand [9].

So to overcome the peak depletion of sand, the environmental disturbance caused by the mining process of natural sand and poor disposal, waste plastic bottles, using waste plastic bottles as partial replacement of sand seems an excellent and feasible choice.

This paper was designed to assess the possibility of the ground waste plastic bottle as partial replacement of sand in a cement tile production, which is one of the finishing materials that the demand and output are recently getting higher here in Ethiopia and mainly made by cement concrete.

Tiles are usually applied in different areas such as building floors, warehouse, and museum, art galleries, building walls, commercial garage, hall, and factory. They are structural or decorative items used to cover floors, roofs, and walls. "It could also be extended to include small flat pieces of surfacing material that is not ceramic, such as carpet, wood, stone or cork [10].

Therefore, applying these harmful and non-biodegradable wastes in a cement tile, concrete as a replacement of its sand could able to reduce environmental problems affected by poor disposal of the waste plastic bottle and over the mining of natural sand for construction.

2. Stud Area, Materials and Research Methodology

2.1. Study Area

This research conducted in Jimma town located 335km southwest of Addis Ababa. Its geographical coordinates are approximately 7^{o}41'N latitude and 36^{o}50'E longitude. The town is found in an area of average altitude, of about 5400ft (1780 m) above sea level.

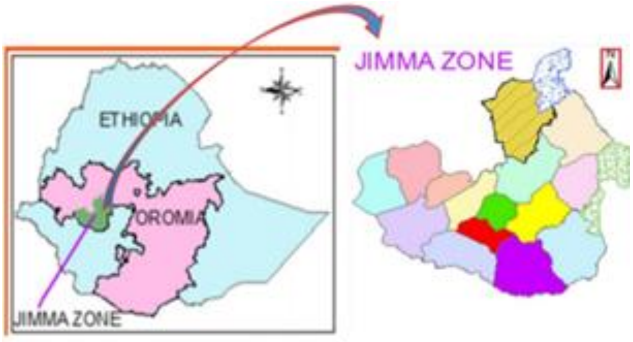

Figure 1. Geological map of Ethiopia, Jimma zone [11]

2.2. Materials

The materials used for the research study were Cement, Natural Sand, Coarse aggregates, Water, Pigment and plastic aggregates (ground waste plastic bottle). The entire laboratory experiments conducted at Jimma Institute of Technology (JIT) Construction Material Laboratory.

Cement: Muger Ordinary Portland Cement of Grade 42R used for the experiment which can be found in the local market.

Sand: Werabe sand used for the experiment. The silt contents appeared to be higher than expected. The sand washed and dried under the sun on a dry platform until it reached saturated dry, and different tests conducted on the samples.

Coarse aggregate: Small sized crushed stone with the size of (4.75mm-12.5 mm) which locally called 01 aggregate and obtained from a place found 15km away from Jimma town, and to keep the w/c ratio constant, the coarse aggregate air dried before using in any experiment and production of the cement tiles.

Water: In this research potable water utilized for the production to cure stage of the cement tiles as per ASTM C 1602.

Pigment: A powder form of iron oxide, even if a lot of colors were available in the market, red and black pigment (coloring agent) used to give color to the first layer of the cement tile as per ASTM C 979.

Plastic aggregate: waste plastic bottles collected from different dumping sites of Jimma town, the dirt was removed from it by washing, drying it at room temperature, the light covers removed, bottles were shredded and ground by plastic grinding machine to a smaller shape.

Figure 2. Preparation of plastic aggregate (It was collected, washed, shredded and ground)

2.3. Determining Engineering Property of Materials

Since the main focus of the study on the replacement of natural sand by waste plastic bottles, the ingredients of cement tiles gathered other than any aggregates. Therefore, different tests conducted on fine, coarse and plastic aggregate before the production of cement tiles. The test methods used for the aggregates listed in Table 1.

Table 1. Property tests and test methods

Property Tests	Test Methods
Silt content (FA)	ASTM C117
Unit weight (FA, CA)	ASTM C-29
Sieve analysis (FA, CA and PA)	ASTM C-136
Moisture content (FA and CA)	ASTM C 566
Specific gravity and absorption (Ambo Sandstone FA, coarse aggregate)	ASTM C-128,

2.3.1. Silt Content of Sand

Test on the silt content of sand conducted to determine the amount of silt or particles finer than 75µm which creates a lesser bond between ingredients of concrete and affects the quality and strength of concrete.

2.3.2. Sieve Analysis and Fineness Modulus

The test conducted on fine, coarse and plastic aggregate to determine the grading (particle size distribution) of aggregates and the fineness modulus, an index to the fineness and coarseness and uniformity of aggregates. The results affect relative aggregate proportions as well as cement and water requirements, workability, pump ability, economy, porosity, shrinkage, and durability of concrete.

2.3.2. Unit Weight

The unit weight or bulk density of an aggregate is the mass or weight of the aggregates required to fill a container of a given unit volume that occupied by both aggregates and the voids between aggregate particles. In this particular rodding method used by filling a known volume container and weighing and dividing it the respective aggregate weight of the volume of the container.

The relative bulk density (unit weight) of aggregate commonly used in normal-weight concrete ranges from about 1200 to 1750 kg/m3 (75 to 110 lb/ft3) [12].

Figure 3. Silt content and Specific gravity of FA, Sieve analysis of PA, and unit weight of CA.

2.3.3. Specific Gravity and Absorption Capacity

The test conducted to determine the bulk specific gravity at oven dry and saturated surface basis, apparent specific gravity, and absorption of the given fine aggregates. It is the ratio of the mass of an aggregate to the mass of an equal absolute volume of water. Based on ASTM C33 Most natural aggregates have a specific gravity of 2.4 – 3, and absorption 0.2% - 2%. According to Duggal, 2000, a low specific gravity may indicate high porosity and therefore poor durability and low strength because the concrete density will significantly depend on specific gravity [13].

2.3.5. Moisture Content

The moisture content of an aggregate conducted to determine the amount of moisture present in the given aggregate which has an effect on the water per cement ratio of concrete that affects the workability and strength of concrete, as it is known to strength and water per cement ratio has an inversely proportional relation while workability got a reverse relationship.

The moisture content of the given sand and coarse aggregate was determined by oven drying 500gm and 2kg for the respective aggregate samples for about 24hrs with a temperature of 105 ℃ to 110 ℃ and cooling for an hour and calculated, dividing it by oven-dry mass.

2.3.6. Production of Cement Tile

Cement tile is one of the finishing materials used for indoor and outdoor services. In the present study these tiles were mainly made from cement, sand, gravel, water, pigment (color) by using a 20cm length, 20cm width and 2.5 cm depth mould in a two layers by proportioning, mixing, preparing the molding, casting, compacting, Drying, de-molding, curing and drying the prepared cement tiles and made it ready for the particular tests.`

As per to the aim of this study, which is to replace the sand of cement tile partially, concrete by ground waste plastic bottles through weight batching method. So the cement, coarse aggregate, water, and pigment of the given tiles were consistently taken except the weight of the sand that has been varied as per the (3%-33%) plastic replacement ratio.

Besides this the researcher of this paper also tried to experiment with other cement tiles, were made by treating the most significant plastic replacement ratios by sodium hypochlorite solution. It was done to know this chemical effect on the plastic and to be able to use the most significant replacement ratio of plastic as the sand by treating it with this chemical.

Which was inspired based on a previous concept done that plastics do not form chemical bonds with cementitious materials, only physical bonds? However, by being treated with oxidizing chemicals or treatments, the polymer chains would react with the substances modifying the surface functional groups. Rather than having reasonably stable hydrogen ions bonded to the carbon, hydroxide and oxygen ions will be bonded together. As these ions are more unstable, it is not difficult for the calcium in the cement paste to bind with them to create calcium oxides or calcium hydroxide. Hence, partial chemical bonding between cement and plastic could be possible. It found that compared to the concrete containing untreated plastic, both mixes had an increased compressive strength; however, the chemical bleach was the strongest and therefore the most effective at reducing the loss of compressive strength [14].

Therefore three different cement tile samples were prepared by treating the most significant replacement ratio of plastic using sodium hypochlorite. So the following stages were used in the preparation of the cement tiles for this study.

Proportioning: In this research the above stated raw materials were proportioned by the mass batching method at the ratio of 1:2:4 of cement, sand and gravel and another0.1:1:2 ratio of pigment, cement and 0.3 mm sieve finer and was also prepared for first (facing) layer of it. The water-cement ratio used 0.62 for the concrete layer of the cement tiles [15].

Mixing: The mixing stage was done separately for the two respective cement tile layers. The first layer (facing layer) prepared by mixing the proportioned pigment, cement, and finer sand thoroughly at dry state for at least 5 min., add water on it and remixed it in wet stage for another 5 min. The second layer or the main body part composed by mixing the gravel and sand dry (i.e., the proportioned plastic aggregates added to the previous dry mix for plastic replaced cement tiles). It mixed thoroughly for 5 minutes to 10 minutes.

Preparing the mold: The plastic molds cleaned, oiled and then prepared for casting the two layers of the cement tiles.

Casting: Casting of the first layer applied on 0.5 cm of the total 2.5 cm depth of cement tile, and the rest of the mold depth was filled with the prepared cement tile concrete and placed on the previous cast facing layer.

Compacting: The next step conducted after casting was to combine the two layers into one by vibrating the cast fresh cement tile, concrete on the vibrating table, besides combining the two layers into one this vibrating stage eliminated the voids of the concrete and made the cement tile dense.

Drying: This process conducted after placing the cement tiles in a shaded area away from direct sunlight and covered it tightly by plastic fabric for 24 hrs.

De-molding: This de-molding or to take the cement tile out of the mold was done by tamping the back of the mold by hand and by smooth up the molds.

Curing: The last stage was to cure the de-molded cement tiles in a curing tanker for 7 to 21 days. In the meantime, the curing water changed in 3 days of interval, and finally, the cement tiles were taken out of the tanker and exposed in the open air for 24 hrs. Then, the sample preparation for the respective tests conducted in this study.

2.3.7. Tests Conducted on the Cement Tiles

2.3.7.1. Slump Test

The slump test has been conducted on the fresh concrete of cement tiles to check the workability of it, and this test was done based on the procedures stated on ASTM C143, and in this test, all of the fresh concrete samples made for controlled and each plastic replacement ratio checked by using the standard slump cone.

2.3.7.2. Dry Density Test

The dry density of the cement tiles determined after the cement tiles got out of the curing tanker, dried and weighed its mass. In this particular study, this test was conducted on the 7^{th} and 21th-day cement tiles to find out the dry density of the cement tile as per the plastic replacement ratio, and it was obtained by dividing the weighed mass of the cement tile by the volume of it.

2.3.7.3. Compressive Strength Test

The cement tiles were taken out of the curing tanker after it was cured for 7 and 21 days respectively. The 20 by 20 cement tiles placed in the compression strength machine plate and the load gradually applied until failure occurred.

2.3.7.4. Water Absorption Test

This test was conducted to check the water absorption of cement tile as per the increment of the plastic replacement ratio. The procedure for determining the water absorption test of these cement tiles was conducted based on ASTM C373.

2.4. Sample Technique and Sampling size

Non-probability sampling and purposive method of it was selected. The waste plastic bottles have been selected based on purposive sampling for the specified purpose from all available areas of the collection.

There was three individual cement tile sample used for each test for the respective 7 and 21 days of age. A total of 132 cement tiles cast to examine the above-stated tests at controlled (0% plastic replacement), at partially plastic replaced by its sand state at a total of 3-33% of the plastic replacement ratio. Also for the partial sodium hypochlorite treated plastic that used to improve the strength loss caused by the highest replacement ratio plastic to the sand of cement tile.

3. Results and Discussion

3.1. Physical Properties of Materials

The physical properties of materials conducted to check the quality of materials used for cement tile production since the primary concern of the study were to replace sand by the plastic aggregate only physical property of aggregate conducted and the other materials considered as constant.

3.1.1. Property of Fine Aggregate

Moisture content, silt content, specific gravity and unit weight of sand

The moisture content found at 1.206%. According to the given standard, the range of fine aggregate moisture content stated as 0.5-2%. If the moisture content of sand obtained within the limit, it closed to the upper limit, so the sand dried in the air before any experimental work and the water-cement ratio used as it is after the stated process. This study, both laboratory and field tests of silt content tests conducted based on ASTMC117-95 and the field test of silt content determined as per the procedure stated in ES C. D3. 201. Results indicated 3% of silt content, less than 6% per Ethiopian standard.

The bulk specific gravity at the oven-dried, the saturated surface dry, apparent specific gravity and water absorption of the specimen indicated 2.44, 2.47, 2.53 and 1.57, respectively. According to the standard, the result was within the limit. It means the higher specific gravity result, indicating the sand comprised lower porosity and lower water absorption.

Gradation of sand conducted based on ASTM 33, and the fineness module on it found at 2.938, which is acceptable in ASTM C 33 but as the FM increases the coarser sand is, so it can be concluded as the where sand is the coarse sand. To get the finer part of it, the sand was sieved on 4.75 mm sieve before any experiment.

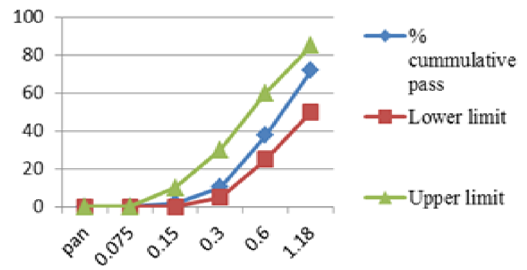

Figure 4. Gradation curve of fine aggregate

Table 2. Summary of the property of fine aggregates

Material	Material Type	Type of tests		Test Result
Natural river sand	Werabe sand	Moisture content		1.26%
		Silt content	Laboratory	1.5%
			Field	3%
		Specific gravity	Oven dry state	2.44
			SSD state	2.47
			Apparent state	2.53
			Absorption	1.57
		Unit weight	Compacted	1525.55
			Loose	1470.32
		Fineness modulus		2.94

Table 3. Sieve analysis of plastic aggregate

Sieve size (mm)	Mass retained (gm)	% of retained	%cum. Retained	%cum. Passing
9.5	0	0	0	100
4.75	269.42	13.471	13.471	86.529
2.36	121.04	6.052	19.523	80.477
1.18	351.16	17.558	37.081	62.919
0.6	523.72	26.186	63.267	36.733
0.3	604.2	30.21	93.477	6.523
0.15	22.08	1.104	94.581	5.419
0.075	30.12	1.506		
Pan	74.32	3.716		0
Sum			321.4	

Since the ground waste plastic bottle serves as the sand replacement, the size of the waste plastic bottle needs to be matched with sand. The researcher considered the grading requirement and the fineness modulus of aggregate by ASTMC33. Results on the gradation of the plastic aggregate indicated the fineness modulus of 3.214, which was out of the range of F.M of the plastic aggregate based on ASTM C 136 standard. But it passed the criteria based on ES C. D3. 201. It was within the limit for fineness modulus from 2.0 - 3.5 having a tolerance of ±0.2. Therefore, though the plastic aggregate did not satisfy the range of fine aggregate, it can be used as a partial replacement of sand as per ES. To make the size of plastic closest to the size of sand, the plastic aggregate sieved on 4.75µm sieve before replacement.

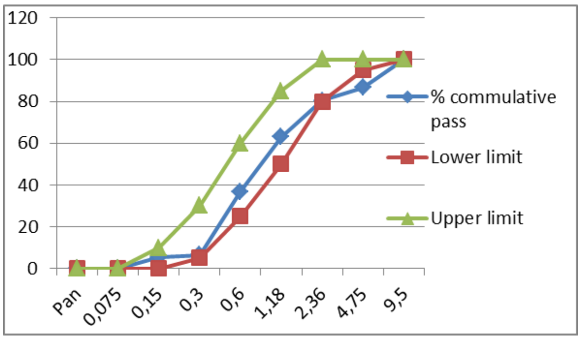

Figure 5. Gradation curve of plastic aggregate

3.2. Workability of Concrete Result

The workability of fresh concrete of cement tile determined based on the procedure of ASTM C143, for a concrete of cement tiles made from 0% - 33% ground waste plastic bottle replacement at 3% gradual plastic increment and also cement tiles made by treating the highest replacement ratio of plastic aggregate by sodium hypochlorite, and then used it as sand.

The result indicated the slump test, the amount of concrete increased with the percentage increment of plastic aggregate. The workability of concrete was also increasing which could be due to the non-absorbent property of plastic during the mixing stage of the ingredients that lead to the presence of moisture content and the uniform size of plastic aggregate.

Another exceptional case occurred in concrete prepared due to the high percentage replacement of sodium hypochlorite solution of the treated plastic aggregates. In this case, the slump showed small value than the other experiments due to its workability and lesser than the value of the controlled concrete without treatment. The reason behind, the sodium hypochlorite capability of changing the smoothness of the ground plastic made it harder and durable. It indicated the porosity decreased, while the workability decreased.

3.3. Compressive Strength Test Result

Similar to workability test, the compressive strength test conducted on the previously stated cement tile at the 7^{th} and 21^{st} day of curing period to check the strength of the cement tile to resist the stress without failure based on ASTM C39. The result showed the minimum compressive strength of cement tile is 4000 Psi (27.56 MPa).

The mean compressive strength result of 3 cement tiles tested after the 7^{th} and 21^{st} day of the curing period, the compressive strength indicated a decrement as the plastic replacement ratio increased. The result at 7^{th}-day curing showed that cement tiles with a 3% - 18% plastic replacing the sand, provided a maximum compressive strength result than 27.56MPa (i.e., the minimum limit of cement tile). Likewise, when the replacement ratio reached 21% of the sand, it indicated 27.36Mpa which was less than the minimum threshold (or 27.56 MPa). At 21^{st} day curing period, the compressive strength found to have a higher value than 27.56 MPa from 0%-30% plastic replacement percentage. Extended tests conducted to observe the failure of the specimen. The failure indicated at 33% plastic replacement of sand.

The possible caused due to the less bonding created between plastic aggregate and the other ingredients of concrete. The presence of excess amounts of water within the mixture indicated less absorption property of ground waste plastic bottles.

On the other hand, the test results on cement tiles comprised the highest chemical treatment plastic replacement ratio, 21% and 33% at the respective 7^{th} and 21^{st} day revealed a considerable increment in compressive strength which was better than the controlled value. It means the sodium hypochlorite solution provided a high capability in improving a strength loss caused by using a ground waste plastic bottle as a plastic aggregate in a cement tile production.

3.4. Dry Density Test Result

The specimens or samples checked the density at controlled, plastic replaced and sodium hypochlorite treated plastic replaced state on a similar plastic replacement ratio, before testing the compressive strength of cement tiles.

The density of cement tile tested at 21^{st} day indicated lesser value than the results at 7^{th} day. The amount of density decreased, based on the plastic replacement ratio in both cases. Since the volume of cement tile for all plastic replacement was kept constant, the weight of plastic is lesser than the weight of sand. The possible decreased of density, caused by the reduction of plastic amount in the cement tile mass. Similar to the above conditions, the density of cement tiles prepared by considering the highest replacement ratio of plastic with sodium hypochlorite solution of 21% and 33% of the respective 7^{th} and 21^{st}-day curing period. The density of the treated cement tile indicated higher than that of the untreated specimen on both cases. Thus, the sodium hypochlorite solution showed its ability to improve the bulk density of plastic, make it denser and finally increased the mass of the cement tile made by chemically treated plastic as a partial replacement of its sand.

3.5. Water Absorption Test Result

Water absorption test conducted on the physical property of cement tile at the 7^{th} and 21^{st}-day curing period to provide hydration in a controlled, plastic replaced and sodium hypochlorite treated plastic replaced state of sand by different replacement ratios. The procedure of the water absorption test performed per ASTM C140 and the water absorption of cement tiles should be less than 12%.

Results indicated that the water absorption of cement tiles at 21^{st} day less than the value on the 7^{th} day. However, both specimens showed similarity in a decrement in water absorption with the incremental ratio of ground waste plastic as sand. The decrease in water absorption in the mixture was due to the non-water absorbent nature of the plastic material.

On the other hand, another specimen tested the water absorption of cement tiles considering partially replaced sand by sodium hypochlorite treated plastic, and it showed an increase in value than the untreated specimen. The effect of increasing dosage of chemical content made less absorbent nature of the plastic.

4. Conclusion

One hundred thirty-two samples of cement tiles considered in the study. The samples prepared in a controlled state, and 3%- 33% of sand content replaced by a mass of ground waste plastic bottles, including sodium hypochlorite solution treated plastics, tests for the workability of fresh concrete of the cement tiles, compressive strength, dry density, and water absorption at 7^{th} day and 21^{st} day of curing period. From the results of the study, the following conclusions are drawn:

- The incremental result of workability of concrete from the slump test conducted, by increasing the plastic aggregate content up to 33% indicated an increased of workability of 53.78%. While, the concrete tiles produced with chemical treatment of 21% and 33% plastic, provided 22.14% and 21.16% decrement respectively, than the untreated specimen. It was found out that the reason for the increment of workability due to the presence of more free water content in the mixes of plastic aggregate than in the concrete blended containing the natural aggregate.
- Based on the result of decrement on dry density obtained as per the incremental level of plastic aggregate and cement tiles, prepared by 21% plastic aggregate indicated a 16.58% of density decrement. Likewise, the specimen made by 33% plastic aggregate showed 32.92% decreased in dry density. The result was due to the lesser waste plastic bottle mass and bulk density than natural sand. The chemically treated specimen with 21% and 33% plastic aggregate concrete indicated 3.91% and

7.81% increment than the untreated samples. Hence, the sodium hypochlorite solution improved the less bulk density of the ground plastic.

- As per the test conducted on compressive strength of cement tile, it showed a decrement in compressive strength for both samples at 7^{th} day and 21^{st} day due to the increment of the plastic aggregate ratios used. The cement tiles prepared with 18% and 30% plastic aggregates respectively, as partial replacement of sand. Test results on compressive strengths at 7^{th} day and 21^{st}-day curing period obtained 31.16% and 34.12% decrement than the control values. Likewise, the chemically treated samples with 21% content indicated 47.44% increment in compressive strength than that of the untreated samples based on the optimum plastic replacement ratio for the 7^{th} day and 21^{st} day curing period of 20.6% and 32.11%, respectively.
- The water absorption test results of cement tile at 7^{th} day and 21^{st} day with a 21% and 33% plastic replacement ratio indicated a 32.83% and 37.78% decrement with respect to the corresponding increment of plastic aggregate. In addition, the cement tiles prepared with 21% and 33% chemical content treated plastic act as sand, showed higher decrement water absorption of 1.27% and 3.13% at the curing periods than the untreated specimen. The decrement of water absorption showed a lesser water absorption capacity of plastic aggregate.
- Finally, **t**he researcher concluded that the ground waste plastic bottle is suitable to replace the sand of cement tiles of about 20.6% and 32.11% when tested at 7^{th} day and 21^{st}-day curing periods. Also, it could produce a lightweight, and less water absorbent cement tiles by using the sampled plastic aggregates. It is suggested to use sodium hypochlorite as a chemical treatment for plastic and requiring more substantial plastic ratio as partial replacement of sand in a cement tiles production.

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