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EXPERIMENTAL INVESTIGATION OF GREEN CONCRETE USING BOVINE FAECES ASH AND NON-DEGRADABLE PLASTIC WASTE MATERIALS

EKSPERIMENTALNO RAZISKOVANJE SUROVEGA BETONA Z UPORABO PEPELA IZ GOVEJIH ODPADKOV IN NERAZGRADLJIVE ODPADNE PLASTIKE

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Concrete is widely used in all kinds of construction and it is composed of cement, fine and coarse aggregates. To make the eco-friendly and economical construction, this research partially replaces cement with cow-dung ash to prepare the concrete. Non-biodegradable plastic trash is thus added to the concrete as an admixture to increase the tensile and compressive strengths. Super plasticizers are also added to the concrete to increase its strength. In this study, the cement was partly substituted with cow-dung ash in the proportions of 5 %, 10 %, 15 %, 20 % while non-degradable plastic waste materials were used as an admixture in the proportions of 1 %, 1.5 %, and 2 % to create green concrete. To evaluate the performance and strength of the manufactured concrete samples (cube and cylinder), they were subjected to split tensile, flexural, and compressive strength tests after curing for (7, 14 and 28) d. For all the M20 grade of concrete mixes, the addition of 15 % cow-dung ash as a replacement for cement and 1.5 % of non-degradable plastic waste material gives the maximum compression and tensile strength when comparing the control mix concrete. Hence this proves that partial replacement of cement with cow-dung ash and the addition of non-degradable plastic waste material as a admixture gives better results than normal M20 grade concrete, which has better strength and is eco-friendly in nature.

Keywords: Bovine faeces ash, compressive strength, cow-dung ash, green concrete, plastic waste

Beton se vsestransko uporablja v gradbeništvu pri izdelavi vrste različnih konstrukcij. Sestavljen je iz točno določenih deležev cementa ter agregatov. Avtorji v članku opisujejo okolju prijazen beton v katerem so del cementa nadomestili s pepelom, ki je nastal pri sežigu govejih odpadkov. Poleg tega so primešali še nerazgradljivo plastiko in super plastifikatorje zato, da bi povečali natezno in tlačno trdnost betona. Avtorji tega članka so izbrali 5 %, 10 %, 15 % in 20 %-tne deleže pepela, ki so nastali pri sežigu govejih odpadkov in s katerimi so delno nadomestili cement.Za izdelavo surovega betona so bili izbrani še deleži dodanih delcev odpadne nerazgradljive plastike 1 %, 1,5 % in 2 %. Sledilo je ovrednotenje lastnosti iz betona izdelanih preizkušancev (v obliki kock in valjev). Avtorji so določili cepilno natezno, upogibno in tlačno trdnost preizkušancev po (7, 14 in 28) dneh utrjevanja betona. Beton vrste M20 s 15 %-tnim dodatkom pepela govejih odpadkov in 1,5 %-nim dodatkom odpadkov nerazgradljive plastike je imel od vseh vzorcev največjo tlačno in natezno trdnost in tudi večjo kot kontrolna mešanica betona M20. Avtorji v zaključkih poudarjajo, da so s preizkusi dokazali, da ima beton z delno zamenjavo cementa s pepelom govejih odpadkov in dodatkom odpadne nerazgradljive plastike boljše mehanske lastnosti kot normalni beton vrste M20. Tako izdelani beton naj bi bil tudi bolj prijazen do okolja.

Ključne besede: pepel iz sežiga govejih odpadkov in kravjega blata, tlačna trdnost, surovi beton, plastični odpadki

1 INTRODUCTION

Concrete is the globally preferred building material. Though concrete has several ingredients, cement is considered as the key ingredient that gives it a binding property.[1] In recent years, the cement production has grown very rapidly all over the world due to the huge requirement of cement for many construction purposes. Worldwide, Portland cement production increases 9 % annually. India stands second in the world cement production and produces 6.9 % of world's output.[2] One ton of cement production emits equal amount of CO_2 to the atmosphere. Carbon dioxide is a primary greenhouse gas (GHG) that contributes to global warming.[3] Cement companies contribute 8 % of all GHG emissions to the environment and are the third greatest source of such emissions.[4] GHG emission causes a serious threat to the environment. In this world, nearly 12 billion tons of concrete are produced every year. Owing to the huge requirement of concrete this quantity may increase in the forthcoming years. Over-exploitation of natural resources and unused industrial waste by-products causes serious jeopardy to the environment.[5] So an alternate technology should be used in construction, which reduces the usage of cement in concrete. Using geopolymer concrete is a good way to make use of industrial waste materials and completely do away with cement.[6]

Alkali-silica reaction (ASR) concrete is made using fly ash, waste glass, powdered granulated blast furnace slag, and washed glass is suggested due to its improved

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strength and durability. It is highly advantageous to employ these wastes and they should be replaced with seashell ash. The use of rice husk ash, coal fly ash, or coal bottom ash as a substitute are examined for Portland cement in concrete.[7] In order to produce cement-free paver bricks, the use of plastic waste as a binding component by-products as an alternative element in concrete.[8] Several types of seashell debris are used as cement substitutes in concrete.[9] Studies suggest that 5–10 % of cement to completely replace cement.[10] M-sand, which is created by crushing aggregates, loses its angularity.[11] A significant percentage of the exploratory investigations were focused on replacing M-sand with silica sand.[12] There have not been many studies on employing eco-sand in cement concrete in place of fine aggregates. Silica sand is a granular mineral made up of quartz, coal, and clay in small proportions. Silica is widely used as a caulk or sealer due to its weather, wear and corrosion resistance. This research focuses on the morphological and mineralogical configurations of cement, cow-dung ash and plastic waste; to enhance the tensile, flexural as well as compressive strength; to strengthen the concrete by adding super plasticizers; to assess the performance and strength of the prepared concrete samples (cube and cylinder) and to compare the green concrete made of M20 grade mix with conventional concretes with and without plastic.

2 EXPERIMENTAL PART

The proposed concrete is prepared by replacing the cement with bovine faecal ash (cow-dung ash) in amounts of 5 %, 10 %, 15 %, and 20 %. Then add 1.5 % of plastic waste materials (typical bottle trash) as an additive. The control mix (standard concrete) is made using M20 design mix. The admixture (plastic waste) is kept as 1.5 % (constant) in all the trials to find the optimal mix proportion. A 15 % replacement of cement with bovine faeces ash along with 1.5 % of plastic waste will give the optimum mix value. To find the optimal mix proportion replacing cement with cow-dung ash and adding non-degradable plastics as admixture, prepared conventional concrete in M20 design mix by adding 1 %, 1.5 %, 2 % of non-degradable plastic waste in the concrete and find the percentage where a high strength is obtained. Then replaced cement with cow-dung ash in the ratio 5 %, 10 %, 15 %, 20 % and add non-degradable plastic waste materials in the ratio 1.5 % along with super plasticizer in M20 mix design of cube and cylinder and test the compression, flexural and tensile strengths. The specimens are labelled to classify the concrete mixtures such as mix-3 (M3), Cement content 85 % (C85), Cow-dung ash 15 % (CDA15) and Admixture-plastic waste 1.5 % (PW1.5). The microstructural properties of cement, cow-dung ash, and plastic trash are examined using scanning electron microscopy with energy-dispersive X-ray analysis (SEM-EDAX). X-ray diffraction analysis (XRD) is used to investigate the mineralogical compositions of the cement, cow-dung ash and plastic trash. The fine aggregates employed in this study are shown in **Figure 1**.

The various mix proportions are shown in **Table 1**. The concrete mixtures are prepared and they are cast in conventional moulds in accordance with IS 10262: Plastic Waste (PW) and Cow-dung ash (CDA) could reduce the workability of concrete because of the increased surface area of waste ash particles.

Table 1: Cement, cow-dung ash, plastic-waste mix proportions

Design grade mix	Cement (%)	Cow-dung ash (%)	Plastic waste (%) admixture
M1-C95-CDA5-PW1.5	95	5	1.5
M2-C90-CDA10-PW1.5	90	10	1.5
M3-C85-CDA15-PW1.5	85	15	1.5
M4-C80-CDA20-PW1.5	80	20	1.5

2.1 Experimental procedure for the preparation of conventional concrete, green concrete cubes and cylinders

In conventional concrete preparation, the amounts of coarse aggregates and water remained constant, the amount of cement dropped as the amount of cow-dung ash and plastic-waste ash increased. On a weight basis, the ratios of cement, cow-dung ash, and plastic garbage were estimated. Samples of the cubes and cylinders were made, and they were subsequently cured for (7, 14, and 28) d in the curing tank. The samples were removed from the curing tank after (7, 14, and 28) d, and a compression test, a tensile test, and a tensile test were then

Figure 1: a) Cow-dung ash, b) plastic waste, c) sieve examination of the fine aggregates

performed on the cube, cylinder, and cylinder. Beam samples were cast and the flexural test was made for the beam after (7, 14, and 28) d.

The experimental process for creating green concrete cubes and cylinders is by adding admixture in the amounts 1 %, 1.5 %, 2 % in normal concrete in the M20 design mix to find the constant admixture proportional percentage value. Cube samples were prepared for 1 %, 1.5 %, 2 % and cured for (7, 14, 28) d. The cube samples were tested in a compression-testing machine and the optimal mix was found. The strength of the concrete increased in 1.5 % as per the results and decreased in 2 %. Hence the 1.5 % of admixtures was taken as a constant value for the experimental procedures. Then replacing the cement with cow-dung ash in the amounts 5 %, 10 %, 15 %, 20 % and adding non-degradable plastic waste materials in the amount 1.5 %. Also, we added super plasticizers to the concrete so that the cluster formation could be avoided and to improve the workability of the concrete. The M20 design mix standards were followed in the concrete's preparation. The samples of cube and cylinder were prepared and cured for (7, 14, 28) d.

The aggregates, cementitious material and half of the water were added to the mixer and mixed for two minutes to make the concrete samples. The remaining water and super plasticizer were then progressively added while the mixing proceeded for another 3 min. The mixes were then subjected to the slump test. To measure the compressive and tensile strengths, the freshly mixed concrete was then poured into 100-mm cubic moulds. The specimens were removed in accordance with the ASTM C192 standard after 24 h and kept at 23 ± 2 °C until the compressive strength test. Using varying amounts of cow-dung ash (5 %, 10 %, 15 % and 20 %) and constant plastic waste of 1.5 % (admixture), conventional moulds were used to cast green concrete cubes and cylinders with dimensions of (150 × 150 × 150) mm^3. A compaction rod gave green concrete 25 hits at each interval to compress it. Following the third break, the cubes underwent a one- to two-minute vibratory treatment on a machine before having their top surfaces polished with a trowel. The moulds were then dried for 24 h. The cubes were taken out of the moulds after 24 hours and placed in water tanks to cure. Preparation and curing of the concrete cylinders and cubes are shown in **Figure 2**. The cubes and cylinders are made using various ratios of cement, cow-dung ash, and plastic waste. The compressive strength of the samples after curing for (7, 14, and 28) d was assessed using a 40-tonne universal testing apparatus. The sizes prepared are 45 Nos. of 100 mm × 100 mm × 500 mm concrete beams, 90 Nos. of 150 mm diameter by 300 mm high cylinders, 135 Numbers of (150 × 150 × 150) mm Cubes ,135 concrete cubes were tested with dimensions of (150 × 150 × 150) mm and 90 Concrete cylinders are tested with 150 mm diameter × 300 mm height.

3 RESULTS

The slump test is used to determine the workability of newly mixed concrete mixes before casting the specimens in moulds. The density of the concrete and compacting factor test as per the IS 1199: (1991). After 24 h, the specimens are de-moulded and cured inside the curing tank. After (7, 14 and 28) d, the concrete's hardened properties we examined. The split tensile capacity and compressive capacity of the cylinders and cubes were measured by compression testing machine (CTM) with a

Figure 2: Preparation of: a) conventional concrete, b, c, d, e) green concrete cubes and cylinders, f) Concrete cylinders and cubes cured in a curing tank for (7, 14 and 28) d

capacity of 2000 kN. A 400-kN capacity universal testing machine (UTM) was utilized for gauging the concrete beam's flexural strength.

3.1 Fresh characters of concrete mixtures

During the experiment, the significance of the plastic waste and the cow-dung ash on the new concrete was detected using the same percentages of cow-dung ash and plastic waste in concrete mixtures. The slump values and compacting factor test are shown in **Table 2** accordingly. The slump value is presented in Table 4 as a result of the increase in concrete mix design grade. The highest slump value was found in M3-C85-CDA15-PW1.5, demonstrating the best workability. Adding cow-dung ash increased from 15 % to 20 %, the compacting feature reduces from 0.94 to 0.86. With the addition of 15 % of cow-dung ash and 1.5 % of plastic waste to the concrete mixture, M1-C85-CDA15-PW1.5 demonstrated better compacting ability with higher density of concrete (2,611 Kg/m^3) when related to all the other concrete mixtures.

Table 2: Fresh properties of the CDA-PWA green concrete mixes

Design grade mix	Slump value (mm)	Density of concrete (kg/m^3)	Compaction factor (-)
M1-C95-CDA5-PW1.5	101.00	2,454.00	0.88
M2-C90-CDA10-PW1.5	112.00	2,595.00	0.92
M3-C85-CDA15-PW1.5	115.00	2,611.00	0.94
M3-C80-CDA20-PW1.5	98.00	2,564.00	0.86

3.2 Compressive Strength Testing

The control mix, according to IS 10262: (2019), was created for the M20 Grade. The result is 60.12 N/mm^2 for the M20 grade mix used as the control. For cube and cylinder specimens, data on the compressive strength of concrete mixes prepared from plastic waste and cow-dung ash are shown in **Table 3** for the M20 grade. The cube specimens had compressive strengths of 15.6 MPa after 7 d, 19.7 MPa after 14 d, and 28.4 MPa after 28 d The findings show that the compressive strength of the concrete mixture rises to 15 % and then begins to decline as the amount of cow-dung ash increases. This implies that the optimum compressive strength may be obtained by adding the right amount of non-biodegradable plastic waste materials (1.5 %) and cow-dung ash (15 %) to the concrete mixture. Additionally, the compressive strength rises as the number of curing days increases, peaking at 23.1 for M3-C85-CDA15-PW1.5 after 28 d of curing and a CDA of 15 %.

In cylinder specimens for cure times of (7, 14, and 28) d, conventional concrete (control mix) has compressive strengths of 2.32 MPa, 4.92 MPa, and 6.2 MPa, respectively. The compressive strength of the concrete reduces to 1.9 MPa, 4.8 MPa and 7.4 MPa after (7, 14, and 28) d of curing when 5 % cow-dung ash and 1.5 % non-biodegradable plastic trash are added to the concrete mixture. The compressive strength improves marginally to 8.2 MPa for 28 d of curing when 10 % of cow-dung ash and 1.5 % of non-biodegradable plastic waste materials are added. The compressive strength improves further when 15 % cow-dung ash and 1.5 % non-biodegradable plastic trash are added, reaching 3.78 MPa, 7.5 MPa, and 9.5 MPa for (7, 14, and 28) d of curing, respectively. The compressive strength drops to 3.05MPa for 7 d of curing when 20 % of cow-dung ash and 1.5 % of non-biodegradable plastic debris are added.

Table 3: Compressive strength values of cube and cylinder specimen for various curing times in days

Design mix	Compressive strength of cube (MPa)			Compressive strength of cube (MPa)		
	7 d	14 d	28 d	7 d	14 d	28 d
Control mix (M20)	15.6	19.7	28.4	2.32	4.92	6.2
M1-C95-CDA5-PW1.5	15.2	19.2	29.9	1.9	4.8	7.4
M2-C90-CDA10-PW1.5	16.52	20.4	31.6	2.8	6.3	8.2
M3-C85-CDA15-PW1.5	18.69	21.6	33.5	3.78	7.5	9.5
M4-C80-CDA20-PW1.5	17.4	20.8	32.8	3.05	6.9	8.4

3.3 Split tensile test

BS1881-117 was followed in performing this test. Concrete cylindrical and cubical specimens were formed, and after (7, 14, and 28) d of water curing, their tensile splitting strength was evaluated. The automated universal testing device was used to perform the test. For every mix percentage employed, samples of identical size were created. 90 cylinders and 135 cubes were constructed and put through the testing. Each mould was filled with new concrete mixtures in two layers that were around 150 mm thick to create the casting. A total of 35 strokes of a steel tamping rod with a 25 mm diameter were used to manually compress each layer. Then, to hold the sample horizontally, hardened concrete cubes and cylinders were placed on the universal testing equipment with carefully placed hardboard packing sheets inserted at the top and bottom of the axis of loading. Prior to the application of a load without shock at a rate of 400N/s, the sample was placed in the middle. Based on BS 1881-117, the tensile splitting strength was estimated.

The tensile strength of M1-C95-CDA5-PW1.5, which contains 1.5 % of non-biodegradable plastic waste and 1.5 % of cow-dung ash, is 3.14 MPa after 7 d, 3.54 MPa after 14 d, and 3.86 MPa after 28 d as shown in **Table 4**. The M2-C90-CDA10-PW1.5 Mix 2 has a tensile strength of 3.45 MPa at 7 d, 3.74 MPa at 14 d, and 4.12 MPa at 28 d for cube specimen. It contains 1.5 % of non-biodegradable plastic waste and 10 % of cow-dung ash. The tensile strength of M3-C85-CDA15-PW1.5, which contains 15 % cow-dung ash and 1.5 % non-biodegradable plastic waste, was 3.76 MPa, 3.92 MPa, and 4.57 MPa at (7, 14 and 28) d, respectively. The tensile strength of M4-C80-CDA20-PW1.5, which contains 20 % cow-dung ash and 1.5 % non-biodegradable plastic waste, is 3.56 MPa after 7 d, 3.68 MPa after 14 d, and 4.32 MPa after 28 d. It is evident that as the amount of cow-dung ash rises, the tensile strength of the concrete mixture first drops for mix-1 compared to control mix, mirroring the results of the compression test. However, for mix-2, the tensile strength rises, peaking for mix-3 with 15 % CDA, before beginning to fall. This implies that the highest tensile strength may be achieved by adding the right amount of non-biodegradable plastic debris (1.5 %) and cow-dung ash (15 %) to the concrete mixture. Tensile strength rises as curing time in days increases, peaking at 4.57 MPa for mix-3 and 15 % CDA in 28 d.

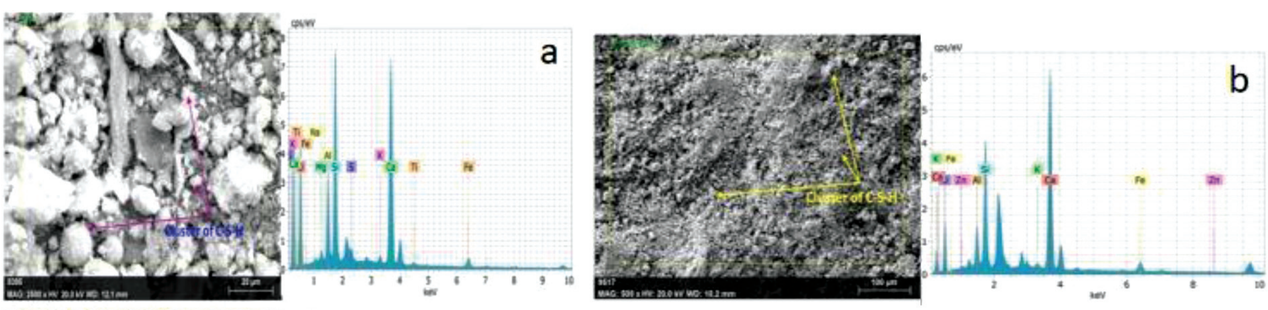
Table 4: Tensile strengths of cube and cylinder specimen for various curing time in days

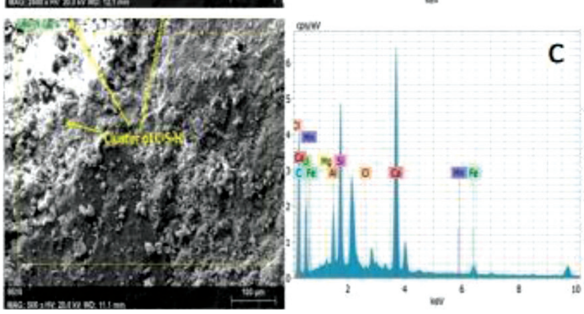
Design mix	Tensile strength of cube (MPa)			Tensile strength of cube (MPa)		
	7 d	14 d	28 d	7 d	14 d	28 d
Control mix (M20)	3.58	3.81	4.01	2.23	2.84	2.98
M1-C95-CDA 5-PW1.5	3.14	3.54	3.86	2.33	2.92	3.04
M2-C90-CDA 10-PW1.5	3.45	3.74	4.12	2.54	3.03	3.14
M3-C85-CDA 15-PW1.5	3.76	3.92	4.57	2.85	3.21	3.37
M4-C80-CDA 20-PW1.5	3.56	3.68	4.32	2.46	3.09	3.02

For 7 d of curing in cylinder specimen, the control mix (M20) has tensile strength of 2.23 MPa. The tensile-strength values of Mix-1 (with 5 % CDA and 1.5 % PW), and Mix-2 (with 10 % CDA and 1.5 % PW) are 2.33 MPa and 2.54 MPa, respectively. For 14 d of curing, control mix (M20) has tensile strength of 2.84 MPa. The tensile-strength values of Mix-1 (with 5 % CDA), and Mix-2 (with 10 % CDA) are 2.92 MPa and 3.03 MPa, respectively. When 1.5 % of non-biodegradable plastic trash and 15 % of cow-dung ash are added, the tensile strength rises to 2.85 MPa, 3.21 MPa, and 3.37 MPa for cure times of (7, 14, and 28) d, respectively. The tensile strength decreases for all curing times when 20 % of cow-dung ash and 1.5 % of non-biodegradable plastic debris are added. The findings show that the tensile strength of the concrete mixture rises to 15 % with an increase in cow-dung ash percentage (with a 1.5 % admixture of plastic waste), and subsequently decreases with an increase in CDA of 20 %. This implies that there is a perfect blend of non-biodegradable plastic trash and cow-dung ash that can be put to concrete to have the optimum tensile and compressive strength. The design mix M3-C85-CDA15-PW1.5 with 15 % of cow-dung ash and 1.5 % of non-degradable plastic waste materials has the highest tensile strength among the design mixes. Greater mortar strength, as a result of coarser particles interconnecting with mortar paste that is perfectly strong, increased the split tensile capacity of the concrete mixes of the studied specimens.

3.4 Scanning Electron Microscopy with Energy-Dispersive X-Ray Analysis (SEM-EDAX) Analysis

SEM-EDAX were used to analyse the microstructural characteristics of the cement, cow-dung ash, and plastic trash. For the identification of C-S-H, three elements must be present: oxygen (O), silica (Si), and calcium (Ca). The Ca:Si ratio can be calculated using an auto-





d

Design Grade mix	Number of days		
	7	14	28
M1-C95-CDA5-PW1.5	1.82	1.73	1.57
M2-C90-CDA10-PW1.5	1.85	1.75	1.64
M3-C85-CDA15-PW1.5	1.88	1.76	1.68
M4-C80-CDA20-PW1.5	1.84	1.74	1.65

Figure 3: SEM-EDAX of M3-C85-CDA15-PW1.5 specimen on: a) 7^{th} day, b) 14^{th} day and c) 28^{th} day, d) Ratio (Ca:Si) for various grades of mixtures on various days

mated table of atomic counts (in percent) that is typically created after the SEM EDAX analysis, as shown in **Figure 3**. According to the EDAX study, pozzolanic reactions occur at different ages and have an impact on the C-S-H quantities on all combinations. A lower atomic Ca:Si proportion indicates that a large portion of the cements interacted with portlandite (CH). Research from the past reveals that the Ca:Si ratio for a thoroughly hydrated C-S-H phase varies from 1.5 to 2.0 since C-S-H is a hyphenated and ill-defined molecule. The Ca:Si ratio for all four classes of concrete mixes is between 1.5 and 1.7 after 28 d. The ideal combination M3-C85-CDA15-PW1.5, which makes sure that the whole hydration process has occurred on all concrete mixes, yielded the greatest results.

3.5 XRD analysis

In order to analyse the phase nature of the materials and identify the primary reactive chemicals, such as ettringite, ($Ca(OH)_2$), and C-S-H, XRD characterization were performed on M20 grade mixed concrete mixes at (7, 14, and 28) d, as shown in **Figure 4**. The XRD analysis can be used to quantitatively determine C-S-H. C-S-H structurally changes from short-range order to long-range order in 16 h. The short-range ordered intermediate phase completely changes within 24 h. Ettringite is formed when sulphatic fluids attack concrete. Ca(OH), CH, and C-S-H are the principal substances that XRD can identify. The strength of the C-S-H peaks has increased, whereas that of the other peaks has decreased. In general, peak width or widening grows as crystallite size decreases. The XRD results for the ideal mix percentage M3-C85-CDA15-PW1.5 were supported by SEM-EDAX findings. The decrease of $Ca(OH)_2$-(CH) in all mixes is advantageous to the quality of concrete strength, which significantly impacted by the high intensity counts of C-S-H compounds when compared to the production of the $Ca(OH)_2$ compounds. This indicates that the pozzolanic processes are not halted.

The results of microstructural studies on this new type of composite material with cow-dung ash and plastic waste ash in the production of green concrete are consistent with the behaviour of traditional concrete materials, and as a result, it has advantages because these two materials are innovative products made from waste and renewable resources as sustainable alternative materials. Additionally, it should be noted that the hardened properties of concrete made with cement partially replaced with cow-dung ash in the ratios of 5 %, 10 %, and 15 % and plastic waste added as an admixture in amounts of 1 %, 1.5 %, and 2 % are higher in all the M20 with (M3-C85-CDA15-PW1.5) grade of concrete mixes. These findings are drawn from mechanical and microstructural studies:

4 DISCUSSION

When cow-dung ash and plastic waste ash are used in lieu of cement, the slump value can drop by up to 14 %. The maximum slump value for all M20 grade concrete mixes was M1-C95-CDA5-PW1.5. For all concrete mixtures, the increase in compressive strength at 7 d was rather quick. For grade M20 concrete mixes, the substitution of both 5 % cow-dung ash and 2 % plastic waste ash resulted in a 7th day compressive strength that was about 76 % of the 28^{th} day strength. With the exception of the mix with 5 % replacement, the split tensile capacity of concrete mixes of M20 grade is comparable to or slightly higher than that of ordinary concrete, whether it contains plastic waste or not. For M20 grade, the M3-C85-CDA15-PW1.5 concrete mix outperformed other mixes in terms of flexural strength. All three classes of concrete mixtures have undergone hydration, according to SEM photos. Therefore, substituting cow-dung ash and plastic waste ash for cement has no impact on the conventional cement hydration processes, independent of the M20 grade of concrete mixtures.[13] According to the EDS study, the ideal mix (M3-C85-CDA15-PW1.5) guarantees that the whole hydration process has occurred on all concrete blends by having a Ca:Si ratio that is between 1.5 and 2.0 at the end of 28 d for M20 grade concrete blends. The primary substances identified by XRD are C-S-H and $Ca(OH)_2$ (CH). The XRD results for the ideal mix percentage M3-C85-CDA15-PW1.5 were supported by SEM and EDS findings.

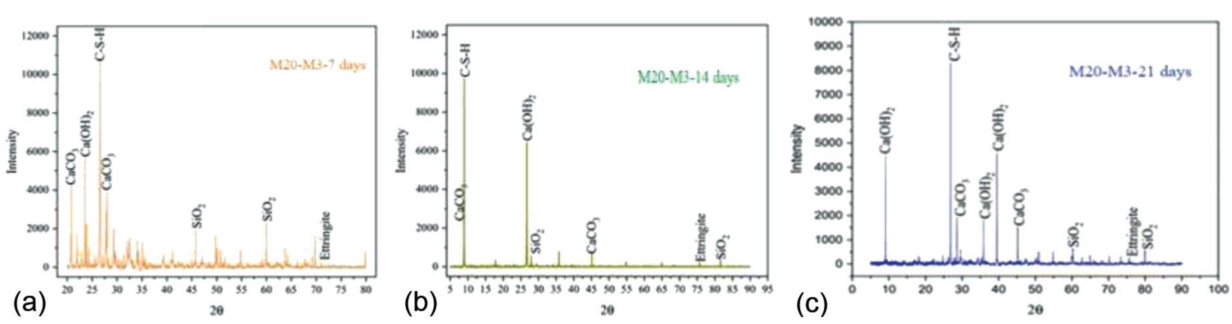


Figure 4: XRD image of M3-C85-CDA15-PW1.5 specimen on: a) 7^{th} day, b) 14^{th} day, c) 28^{th} day

5 CONCLUSIONS

This study examined how cow-dung ash performed experimentally when used in various amounts to partially replace cement in concrete. A 15 % replacement of cement with bovine-faeces ash along with 1.5 % of plastic waste will give us the optimum mix value. From the XRD and SEM-EDAX investigations the principal mineralogical and morphological features in cow-dung ash and plastic waste ash particles are understood. It was found that for all the M20 grade of concrete mixes, M1-C95-CDA5-PW1.5 had the maximum slump value. The concrete mix M3-C85-CDA15-PW1.5 had higher compression and tensile strength than other mixes for M20 grade. This study, however, is restricted to just hardened qualities; as a result, more research is necessary to make conclusive statements on the benefits of bonding, durability, plastic-drying shrinkage, deflection characteristics, fractures, and strain compatibility of structural parts. The proposed research is dedicated to finding the sustainable and cost-efficient solution to the concrete building by incorporating cow-dung ash for some quantity of cement and plastic wastes as an admixture. Nonetheless, cow-dung ash possesses excellent binding properties, which in combination with the plastic waste results in greater tensile and compressive strengths of concrete. This novel method not only improves concrete's mechanical characteristics but also conforms to environmental sustainability by using waste materials. The use of bovine dung ash with non-biodegradable plastics as substitution for cement and admixture, respectively, shows some positive outcomes and side effects which cannot be ignored in actual construction projects, especially their long-term durability, environmental effects and scalability. Although laboratory tests show the material's good strength parameters, long-term tests are needed to examine the material's performance, e.g. bonding, durability, curing and deflection characteristics under the action of loads and fractures. Also, scalability and global diffusion of this method will face some difficulties. The availability as well as the affordability of cow-dung ash and plastic waste make them potential waste sources. However, their collection, processing, and integration into large-scale concrete production require careful studies and comprehensive planning of infrastructure development. Also consideration on regulatory approvals and industry acceptance of the new method could help it to properly utilized in regular construction ventures. The resultant confirms the expectation of the possibility of manufacturing so called "green concrete" which strength features surpass those of the currently widely used formulations.

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