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A Work Paper on "Experimental Study on Partial Replacement with Wood Ash, Quarry Dust and Copper Slag for Light Weight Concrete"

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Abstract:
The primary elements of aggregate in concrete are to settle the measurements of the concrete part by decreasing the volumetric changes because of drying shrinkage of the bond water glue in solidified concrete, to diminish the warmth of hydration, and to go about as a filler materials to streamline in the using of concrete. Since aggregate is a noteworthy important piece of concrete, its qualities fundamentally influence the workability of crisp concrete, solidness, strength, warm properties and unit weight of solidified concrete. Concrete is one of the popular construction materials available today. Concrete is Concrete has found use in all types of construction form highway, canal, bridge, and dams to the most beautiful and artistic of buildings. It's formed by mixing cement, coarse and fine aggregates, water, and additives in a certain prescribed proportion. Aggregate is one of the main ingredients in concrete. It covers more than 60-75% of the overall volume of concrete mix.
Keywords: *Concrete, Fly-Ash mix Nano-Silica, compressive strength, tensile strength, Portland Cement, Variability, etc.*

1. Introduction

Concrete is a complex material, where coarse and fine aggregates are filler material and cement paste are binding material. Concrete is composite of rock, sand, crushed shake, or other aggregate held together by a solidified glue of pressure driven cement and water. The completely blended fixings, when appropriately proportioned, influence a plastic mass which to can be thrown or formed into a foreordained size and shape. Endless supply of the cement by the water, concrete finishes up noticeably stone like in quality and hardness and has utility for some reasons.

The main concrete like material created in history was gotten when Greek and Roman manufacturers found that by blending asserted limestone, lime, water, sand and crashed stone together, a solidifying blend could be delivered. For quite a while engineers have investigated the flexibility of materials with so much attributes as to be produce in a plastic state and later be solidified into a solid and tough product. It's helpful to divide concrete into 3 general classification based on compressive strength.

- **Low-strength concrete**: less than 20 MPa compressive strength.
- **Moderate-strength concrete**: 20 - 40 MPa compressive strength.
- **High-strength concrete**: more than 40 MPa compressive strength.

Moderate-strength concrete is standard or normal concrete, which is utilized for many structural works. The relation between the cement paste content and strength and also the water/cement ratio of the cement paste and strength ought to be noted from the data. It's impossible here to list all concrete types.

2. Literature Review

The literature study presents the present state of information and examples of productive uses of different materials in concrete technology, and especially the utilized of copper slag, wood ash & quarry dust with partial substitute of cement.

[Sumit L. Chauhan, Raju A.Bondre] Partial Replacement of Sand by Quarry Dust in Concrete. International Journal of Scientific and Research Publications.
Has clarified about the incomplete substitution of sand by quarry dust in concrete. This paper describe the exploratory examination which researched the 50% substitution of sand with quarry dust. At first cement concrete block was contemplated with different extents of cement concrete + quarry dust (M20 and M25). The test comes about determine that the expansion of quarry dust as fine aggregate proportion of percentage is 30, 40 & half was organized to upgrade the compressive properties. In view of the outcomes and discourse specified over, the accompanying conclusions are gotten:

- Mix proportion of 1:1.5:3 (cement: aggregate: sand+ quarry dust) give the ideal quality in this investigation.
- As the level of quarry dust bit by bit expands, the Compressive properties of concrete will likewise increment with condition that level of Quarry Dust ought not to surpass half.
- The compressive properties of packed concrete increment with the expansion of time of development. The calculation of quality for 28 days higher than the quality for 7 days.

[Lakshmidevi K., & Narasimha Rao A.] Effect of Fly Ash and Quarry Dust on Properties of Concrete. International Journal of Innovative Research in Science, Engineering and technology, pISSN: 2347-6710, 4(9), 8343-8350
The effect of quarry dust & fly ash on characteristics of concrete. In the existing work an effort is made to ponder the effect of concrete when cement is supplanted by fly ash at 0, 10, 20 & 30% by weight of cement and sand by quarry dust at 20, 30 & 40% for M20 blend. The exploratory examinations are made to get the characteristics of concrete like the pressure quality at the curing age of 7th, 14th, 28th, 56th & 90th days and compressive properties of chambers, split rigidity, modulus of flexibility and ultrasonic heartbeat speed of concrete at 28th days of curing period. Concrete blends were created, tried and contrasted and the traditional concrete.

- Fly ash expends more water for consistency and workability.
- Addition of fly ash to cement upgrades the underlying setting time though diminishes the last setting time.
- In general, all the blends accomplish more than the objective quality when compared with the controlled concrete regardless of curing period.
- All the blends pick up quality independent of curing period.
- The compressive properties of various mixes of barrel shaped examples are marginally not as much as that of the cube shapes examples.

[Prabagar Subramaniam, et. al.] Subramaniam, P., Subasinghe, K., & Fonseka, W. K. (2015). Wood ash as an effective raw material for concrete blocks. International Journal of Research in Engineering and Technology.
Has learned about wood ash as a successful crude substance for concrete squares. The present investigation centered to utilize wood ash as a partly substitution for cement material amid sand cement piece fabricating. The concrete blends have been blended with 10, 15, 20 & 25% of wood ash as a incomplete substitution for cement with sand and tried for compressive properties water retention and warmth discharge.

- Higher compressive quality was seen in the specimens of 15% containing wood ash substitution material.
- All the specimens another than 25% of wood ash substitution was indicated bring down water ingestion and most noteworthy was obtained in 15% wood ash content.
- Slower warm discharge was seen in the specimens of 15% & 20% of wood ash substitution following 21 days of curing time.
- Addition of 15% wood ash during the assembling of concrete squares was produced and these pieces meet standard breaking points.

3. Methodology

The methodology of mix configuration incorporates the possibility of properties and costs of fixings. Essentials of setting and finishing the new concrete and characteristic of cemented concrete for instance strength sturdiness. The standard goal of the concrete blend configuration would hence have the capability to be started as era of concrete which may be:

- Desired quality and sturdiness of cemented concrete which thusly is addressed by water-bond degree law.
- Conditions at the site, which helps in picking workability, quality and sturdiness prerequisites.

The compressive nature of set concrete which is by and large idea to be an once-over of its different properties, relies upon various sections, e.g., quality and measure of bond, aggregates and water, gathering and mixing, setting, compaction and curing.

Proportioning of a concrete blend incorporates choosing the relative measures of materials to be used in progress of concrete for a gave limit. The path toward picking degrees of these materials is called "Concrete Mix Design" and should not be confounded with assistant plan. Proportioning may be established on particular data got by sensible experience and examinations of test outcomes of various fixings or a correct data.

The central dispute in proportioning concrete or mortar mixes is the period of an extreme material of essential quality, water comfort and other major properties in any occasion cost. To satisfy these destinations careful idea must be given to the best of bond, aggregate and water to the running with contemplations

- In proportioning concrete or mortar which is to be subjected to solidifying temperatures not long after strategy, a base measure of water and a snappy setting security ought to be utilized.
- The mix must be workable so it can be set and completed without undue work.
- Concrete for road change ought to be made using an unquestionably investigated hard extraordinary aggregate bound together with as small a level of rich mortar as is steady.
- The quality and level of water comfort of mixes having like constituent materials, thickness and workability, increment with the concrete substance. With the bond substance, materials and workability all predictable the quality and level of water comfort increment with the thickness of the blend.
- Concrete with 4-7 for each penny, by volume, entrained air made by utilizing an air- entraining bond or by including air-entraining admixtures is more invulnerable to setting and defrosting development and in addition to scaling because of the utilization of salt for ice clearing than concrete made with general concrete and without air-entraining admixtures.

Figure 1: Curing specimen

Figure 2: Compressive Strength Test

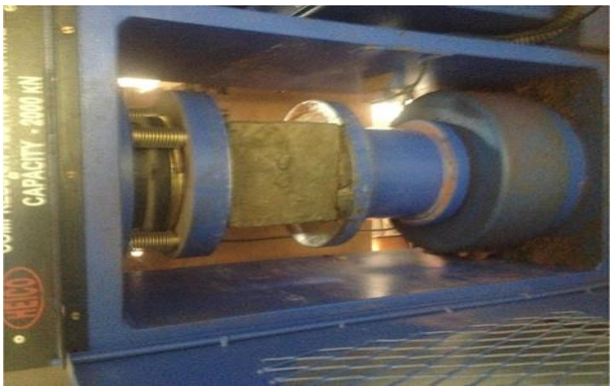

Figure 3: Compressive Strength Test perform

4. Experimental Results

Sample 1:

In this investigation the trial work is done by used cement, fine aggregate, coarse aggregate & **wood ash**. The experiment were casted for M25 grade of concrete by replace the cement 0%, 5%, 10%, 15% and 20% by wood ash.

The new concrete is tested for workability by slump test while threw example is tested for compressive, flexure & split tensile test at the age of 7, 14 and 28 days.

Sample 2:

In this investigation the trial work is completed by used cement, fine aggregate, coarse aggregate & **copper slag**. The experiment were casted for M-25 grade of concrete by replace the cement 0%, 5%, 10%, 15% and 20% by copper slag.

The new concrete is tested for workability by slump test while threw example is tested for compressive, flexure and split tensile test at the age of 7, 14 and 28 days.

Sample 3:

In this investigation the trial work is done by used cement, fine aggregate, coarse aggregate & **quarry dust**. The experiment were casted for M-25 grade of concrete by replace the cement 0%, 5%, 10%, 15% and 20% by quarrydust.
The new concrete is tested for workability by slump test while threw example is tested for compressive, flexure and split tensile test at the age of 7, 14 and 28 days.

Various Tests Were Performed on the Prepared Samples
Sieve Analysis

Sieve Analysis and Fineness Modulus of Coarse Aggregate
Sieve analysis and fineness modulus of coarse aggregates for 20mm size and 10mm size is given in table 4.1 and table 4.2 respectively., for example, 10 mm and 20 mm and so forth the aggregate utilized for making concrete are typically of the most extreme size 20 mm & 10 mm

Total Weight of Coarse aggregate to take sieve analysis: 2 Kg Coarse aggregate size: 20 mm.

Sum of cumulative weight retained % = 26.1
Coarse aggregates size = 10 mm Aggregates taking for sieving = 2 kg

Sum of cumulative weight retained %= 70.1

Sieve analysis of fine aggregate
Sieving for fine aggregates with various numbers of sifters is given in table 4.3 Reviewing limits for fine aggregates as per IS: 383-1970 is given in table 4.2

Sum of cumulative weight retained %= 70.1

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Table 1: Sieve Analysis of Coarse Aggregates (20mm size)

Sieve size	Weight Retained	Cumulative Weight Retained	Cumulative weight retained%	%weight passing
20mm	522	522	26.1	73.9
10 mm	1478	2000	100	0

Table 2: Sieve Analysis of Coarse Aggregates (10mm size)

Sieve size	Weight Retained	Cumulative weight retained	Cumulative weight retained %	%weight passing
10mm	1402	1420	70.1	29.9
4.75mm	598	2000	100	0

Specific Gravity
Specific Gravity of Fine Aggregate
Specific gravity of aggregate is necessary to be recognize when we manage light weight & overwhelming weight concrete. Normal specific gravity of the stones shift from 2.6 to 2.8.

Table 3: Specific Gravity for Fine Aggregates

S.No.	Particulars	Weight (gm)
1	Weight of Pycnometer (W_1)	674
2.	Weight of Pycnometer + Sample (W_2)	1176
3.	Weight of Pycnometer + sample + water (W_3)	1876
4.	Weight of Pycnometer + water (W_4)	1572

Specific gravity = (1176 – 674) / (1572 – 674) - (1876 – 1176)
= 502 / 898 - 700
= 2.54

Specific Gravity of Coarse Aggregate

Table 4: Specific Gravity for Coarse Aggregates (20mm and 10m

S.No.	Particulars	Coarse aggregates size 20mm (gm.)	Coarse aggregates
1.	Weight of Pycnometer (W_1)	676	676
2.	Weight of Pycnometer+ Sample (W_2)	1174	1174
3.	Weight of Pycnometer + sample + water (W_3)	1907	1895
4.	Weight of Pycnometer + water (W_4)	1582	1577

Specific gravity= (1174 - 676) / (1577 - 676) - (1895 - 1174)
= 498 / 901 - 721
Specific gravity= 2.7

Consistency of Concrete Mix:

The purpose of this test is to see the proportion of water required for preparing cement pastes for different tests. Normal consistency of pastes containing copper slag, wood ash & quarry dust are shown.

Table 5: Normal Consistency of Cement with Different Properties of Different Material

S.No.	Material	Percentage of Replacement				
		0%	5%	10%	15%	20%
1	Wood ash	32	32.5	33	34	34.5
2	Copper slag	32	33	33.5	34.5	35
3	Quarry dust	32	32.5	34	34.5	35.5

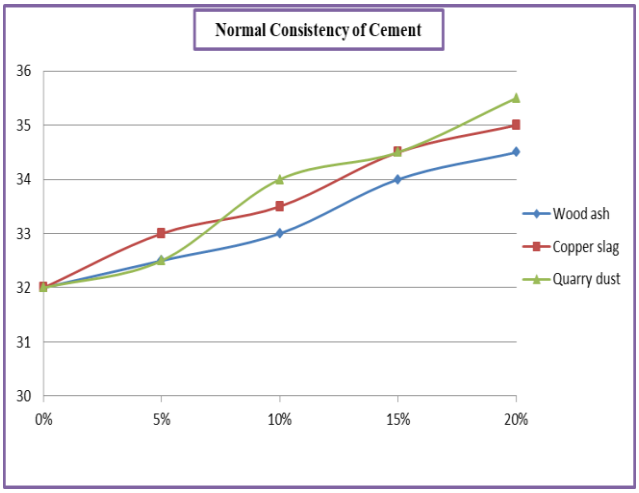

Figure 4 : Normal Consistency of Cement

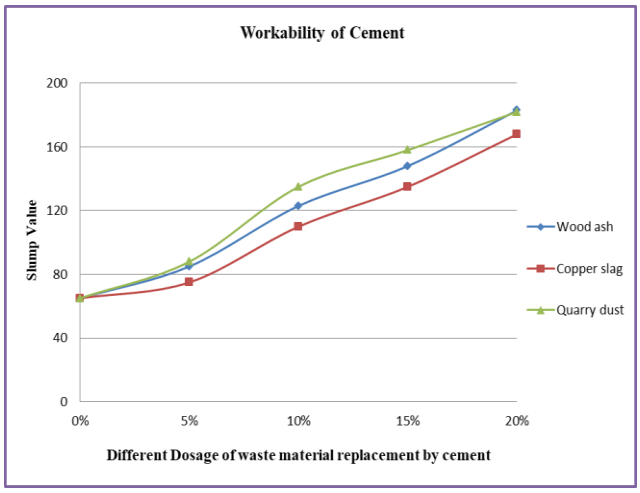

Figure 5 Slump Values of Different Waste Material

All of the pastes containing copper slag, wood ash & quarry dust showed normal consistency equal and higher than the control paste. Up to 5% 10%, and 15% replacement the standard consistency was mostly constant minor differences, at 20% replacement the standard consistency had shown a slight increment to 35%.

Workability of Concrete

In this part different test results on concrete are presented and analyzed. This includes workability of concrete include copper slag, wood ash & quarry dust blended mortar which is assessed by the compressive strength of concrete with M25 grade as shown.

From the above outcomes for slump demonstrates that the workability increments with the expansion in the rates of contain wood ash, copper slag and quarry dust. All explored containing wood ash, copper slag and quarry clean blends had stature slump esteems and worthy workability.

Compressive Strength

It is a destructive test. Concrete cubes specimens examples are tried by CTM. These sample specimens comprise of various synthesis of aggregate having ordinary aggregate piece test with 10 mm (40%) aggregate, and 20 mm (60%) aggregate having distinctive waste materials (copper slag, wood ash & quarry dust) utilized the extent of 5%, 10%, 15% and 20% as substitution of bond utilized in concrete solid shape examples.

Table 6: Workability of Cement with Different Properties of Different Material

S.No.	Material	Percentage of Replacement				
		0%	5%	10%	15%	20%
1	Wood ash	65	35	123	148	183
2	Copper slag	65	75	110	135	168
3	Quarry dust	65	88	135	58	182

Compressive Strength of Containing Wood Ash

The result /of CTM of M25 grade of concrete cube having wood ash as substitution of cement with percentage of 5%, 10%, 15% & 20% with normal

aggregate (20 mm of 60% aggregate and 10 mm of 40% aggregate) nominal mix is shown.

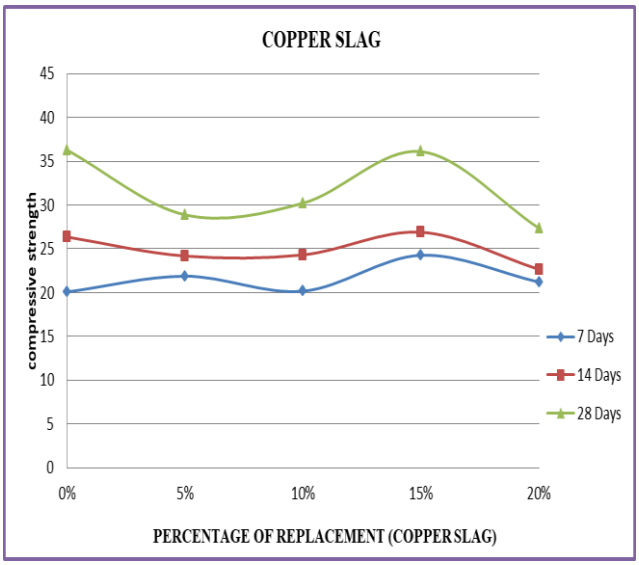

Figure 6 Compressive Strength of M25 Grade Contain of Copper Slag

Compressive Strength of Containing Copper Slag

The result of CTM of M25 grade of concrete cube having copper slag as substitution of cement with percentage of 5%, 10%, 15% & 20% normal aggregate (20 mm of 60% aggregate and 10 mm of 40% aggregate) nominal mix is shown in Table 4.9

From the below table it is observed that the compressive strength results represents that concrete casted with M25 grade of concrete at 7, 14 and 28 days are decrease with replacements of 5 to 10%, and increments, when the percentage of the copper slag increment from 15 to 20% at 7, 14 and 28 days.

Compressive Strength of Containing Quarry Dust
The result of CTM of M25 grade of concrete cube having quarry dust as substitution of cement with the percentage of 5%, 10%, 15% and 20% with normal aggregate (20 mm of 60% aggregate and 10 mm of 40% aggregate) nominal mix is given in Table.

Table 7: Compressive strength of M25 Grade containing Wood Ash

Compressive strength of M25(N/mm^2)					
Days/ %	**0 %**	**5 %**	**10 %**	**15 %**	**20 %**
7	20.08	17.76	6.11	7.28	12.57
14	26.36	21.89	7.46	10.17	13.06
28	36.30	29.85	8.98	12.51	16.42

From the above table it is observed that the compressive strength results represents that concrete casted with in M25 grade of concrete at 7, 14 and 2 8 days are decrease when the percentage of the wood ash increment from 0% to 20%.

Table 8: Compressive Strength of M25 having Copper Slag

	Compressive strength of M25(N/mm^2)				
Days	**0 %**	**5 %**	**10 %**	**15 %**	**20 %**
7	20.08	21.88	20.17	24.27	21.20
14	26.36	24.18	24.31	26.90	22.65
28	36.3	28.89	30.22	36.11	27.35

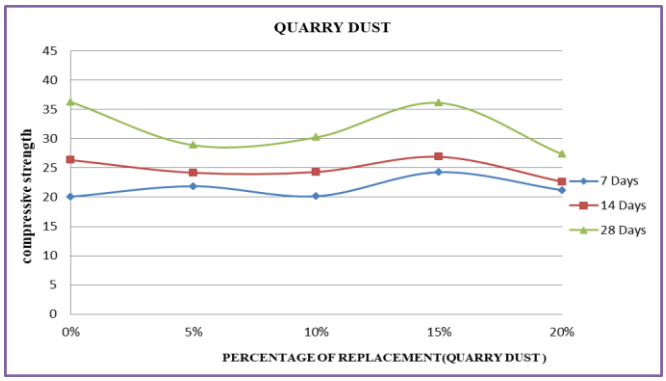

Figure 7 Compressive Strength of M25 Grade Contain of Quarry Dust

Split Tensile Strength of Cylinder Concrete Contain Wood Ash

The split tensile strength of concrete material is tried by making cylinder of size 150mm x 300mm and is consistently cured for 28 days testing. Absolutely 39 cylinder were casted for ordinary M25, grade and for 5%, 10%, 15% and 20% by weight fractional substitution of wood ash for cement. Three examples are tried and the normal esteems are taken as tensile strength of concrete. The estimations of split tensile strengths are appeared in table 4.11

Table 9 : Compressive Strength of M25 having Quarry dust

	Compressive strength of M25(N/mm^2)				
Days	**0 %**	**5 %**	**10 %**	**15 %**	**20 %**
7	20.08	19.31	22.74	19.78	19.43
14	26.36	24.52	29.36	25.98	23.82
28	36.3	33.20	37.10	31.95	29.22

From the above table it is observed that the compressive strength results represents that concrete casted with in M25 grade of concrete at 7, days are decreases with substitution of 5%, 15% and 20% at 10% have increments, and 14, 28 days have decrease with substitution of 5%, 15% to 20% and increments when the level of the quarry dust increase from 0% to 20% at 28 days.

Split Tensile Strength Test

The result of the Split tensile strength determine by compression testing machine, with the incomplete substitution of copper slag, wood ash & quarry dust by cement with level of 5%, 10%, 15% and 20% with result determine the age of 28 days are appeared in the fig. 4.6 for M-25 concrete.

From the above table is seen that the tensile strength in M 25 grade of concrete at 28 days are decrease when the percentage of the wood ash increment from 0% to 20%.

Split Tensile Strength of Cylinder Concrete Contain Quarry Dust

The split tensile strength of concrete material is attempted by making barrel of size 150mm x 300mm and is reliably cured for 28 days testing. Totally 39 cylinders were threw for standard M25, grade and for 5%, 10%, 15% and 20% by weight fragmentary replacement of quarry dust for cement. Three illustrations are attempted and the ordinary regards are taken as tensile strength of concrete. The estimations of split tensile strengths are given in table 4.12

Table 10: Split Tensile Strength of M25 having Wood Ash

	Tensile Strength in N/mm^2 Contain Wood Ash				
Day's/	**0%**	**5%**	**10%**	**15%**	**20%**
28	2.17	1.95	1.51	0.81	1.73

Table 11: Split Tensile Strength of M25 having Quarry Dust

Tensile Strength in N/mm^2 contain Quarry Dust					
Day's / %	**0%**	**5%**	**10%**	**15%**	**20%**
28	2.17	2.40	2.75	2.23	2.51

From the above table is seen that the tensile strength in M25 review of concrete at 28 days are increments when the level of the quarry dust increment from 0% to 20% usage of quarry dust.

Split Tensile Strength of Cylinder Concrete Contain Copper Slag

The split tensile strength of concrete material is attempted by making chamber of size 150mm x 300mm and is reliably cured for 28 days testing. Completely 39 cylinders were casted for standard M25, grade and for 5%, 10%, 15% and 20% by weight fragmentary substitution of copper slag for cement. Three illustrations are attempted and the typical regards are taken as tensile strength of concrete. The estimations of split tensile strengths are given in table 4.13

Table 12: Split Tensile Strength of M25 having Copper Slag

Tensile Strength in N/mm^2 Contain Copper Slag					
Day's/	**0%**	**5%**	**10%**	**15%**	**20%**
28	2.17	2.67	2.71	2.62	2.43

From the above table is seen that the tensile strength in M25 review of concrete at 28 days are higher than when the percentage of the copper slag are increases from 5, 10, 15 and 20% usage of copper slag.

It is observed that the Split tensile strength of concrete is decreases with the substitution of wood ash. Also, tensile strength is expanded with the substitution of quarry dust and copper slag increments, with the age of 28 days.

Flexural Strength Test

Flexural power additionally called as modulus of rapture. In concrete flexure is the bowing minute caused by the applied load, in which a concrete beam has pressure at top and tensile worry at the base side. Shafts on testing will bomb in strain because of its property and shear will show up on concrete. In this test works absolutely 39-beams of size 700 x 150 x 150 are casted of M25 grades concrete and other level of replacements concerning 5%, 10%, 15% and 20% by copper slag, wood ash & quarry dust with cement.

At that point analyze the estimations of both plan blends. The flexural estimations of various blends.

Flexural Strength of Beam Contain Wood Ash

The results are determined from UTM with M25 grade of contain wood ash with the substitution of cement as shown in Table 4.14

From the above table it observed that the flexure strength in M25 grade of concrete at 28days. Flexure Strength is increase when the 5% of wood ash increment and abatement from 10%, 15% and 20% used of wood ash.

Flexural Strength of Beam Contain Quarry Dust

The results are determined from UTM with M25 grade of concrete contain quarry dust with the substitution of cement as shown in Table 4.15

From the above table is seen that the flexure strength in M25 grade of concrete at 28 days. Flexure strength is increase when the 5% 10% & 20% of quarry dust increment and reduction from 15% used of quarry dust.

Flexural Strength of Beam Contain Copper Slag

The results are determined from UTM with M25 grade of concrete contain copper slag with the substitution of cement as shown in Table 4.16

Table 13: Flexural Strength of M25 having Wood Ash

Flexure Strength in Div. Contain Wood Ash					
Day's/ %	**0%**	**5%**	**10%**	**15%**	**20%**
28	15.60	17.30	11.60	11.30	9.30

Table 14: Flexural Strength of M25 having Quarry Dust

Flexure Strength in Div. Contain Quarry Dust					
Day's/ %	**0%**	**5%**	**10%**	**15%**	**20%**
28	15.60	22.30	19.30	11.00	24.46

Table 15: Flexural Strength of M25 Having Copper Slag

Flexure Strength in Div. Contain Copper Slag					
Day's/ %	**0%**	**5%**	**10%**	**15%**	**20%**
28	15.60	10.30	17.00	15.30	15.00

From the above table is seen that the flexure strength in M25 grade of concrete at 28 days. Flexure strength is increase when the 10% and 15% of copper slag increment and reduction from 5% and 20% used of copper slag.

It is observed that the flexure strength in M25 grade of concrete at 28 days, with the increments, when the 5% of level of the wood ash increment and decreasing from 10%, 15% and 20% used of wood ash with the age of 28 days.
Flexural strength is increments when the 5% 10%and 20% of level of the quarry dust increment and reduction from 15% used of quarry dust with the age of 28 days.
Flexural strength is increases when the 10% and 15% of level of the copper slag increment and decline from 5% and 20% used of copper slag with the age of 28 days.

5. Conclusion

From the above experiments, the study concentrate on the relative performance of concrete by utilization the copper slag, wood ash & quarry dust as partial substitute of cement. In the current work the strength analysis is execute which is analyzed in the following points:

- All of the concrete containing copper slag, wood ash & quarry dust showed normal consistency equal and more than the control concrete. Up to 5% 10%, and 15% of replacement the normal consistency was mostly constant minor differences, at 20% replacement the normal consistency had shown a slight increment to 35%.
- Slump shows that the workability increase with the increase in the percentages of copper slag, wood ash & quarry dust. All investigated containing copper slag, wood ash & quarry dust mixtures had height slump values and acceptable workability.
- The compressive strength outcome represents that as the proportion of wood ash increases for M25 grade, compressive strength is decreased, when the level of the wood ash increment from 0% to 20%.
- The compressive strength outcome represents that concrete casted with M25 grade at 7th, 14th,& 28th days are decrease with replacements of 5% to 10%, and increments, when the level of the copper slag

increment from 15% to 20% at 7th, 14th, and 28th days.

- The compressive strength outcome represents that concrete casted with M25 grade at 7th days are decreases with replacement of 5%, 15%, 20% & 10% have increments, and 14th, 28th days have decrease with replacement of 5%, 15% to 20% and increments when the percentage of the quarry dust increase from 0% to 15% and slightly decreased with 20% replacement at 28th days.
- Flexural strength is increments when the 5% of level of the wood ash increment and decreasing from 10%, 15% & 20% with the age of 28th days. Flexural strength is increments when the 5% 10% and 20% of level of the quarry dust increment and reduction from 15% with the age of 28th days. Flexural strength is increments when the 10% and 15% of level of the copper slag increment and decline from 5th and 20% with the age of 28th days.
- Tensile strength of concrete is decreases with the replacement of wood ash. But, tensile strength is expanded with the replacement of copper slag and quarry dust increments with the age of 28th days.

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