https://doi.org/10.15623/ijret.2018.0705005 Received: 27-02-2018, Accepted: 10-04-2018, Published: 01-05-2018

USAGE OF WOOD ASH AND GGBS IN THE PRODUCTION OF CONCRETE

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Abstract

The major problem the world is facing today is the environmental pollution. In the construction industry mainly the production of Portland cement will causes the emission of pollutants results in environmental pollution. The carbon dioxide produced by cement industries causes environmental pollution and global warming. In 1000Kg of cement manufacturing processes approximately 900Kg of CO_2 is emitted. In order to reduce the impact of cement production on atmosphere, wastes by products are used as admixture in this study, so that environmental pollution and natural resources consumption is reduced.In the present study wood ash is varied up to 20% (5%, 10%, 15% and 20%) and GGBS is added to optimum wood ash content cement concrete from 10% to 30% (10%, 20% and 30%).These two wastes are used as a partial replacement of cement and various properties like Compressive strength, Split tensile strength and Shear strength were determined.

Keywords: *Wood ash, GGBS, Concrete, aggregates, Compressive strength, Split tensile strength, Shear strength test and Fineness modulus.*

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1. INTRODUCTION

In the recent years growing consciousness about global environment and increasing energy security has led to increasing demand for renewable energy resources sand to diversify current methods of energy production. Among these resources, biomass (forestry and agricultural wastes) is a promising source of renewable energy. In the current trends of energy production, power plants which run from biomass have low operational cost and have continuous supply of renewable fuel. It is considered that these energy resources will be the CO2 neutral energy resource when the consumption rate of the fuel is lower than the growth rate. Also, the usage of wastes generated from the biomass industries (sawdust, woodchips, wood bark, saw mill scraps and hard chips offer a way for their safe and efficient disposal. The thermal combustion greatly reduces the mass and the volume of the waste thus providing an environmentally safe and economically efficient way to manage the solid waste.

The most prevailing method for disposal of the ash is land filling which accounts for 70% of the ash generated, rest being either used as soil supplement (20%) or other miscellaneous jobs (10%). The characteristics of the ash depend upon biomass characteristics (herbaceous material, wood or bark), combustion technology (fixed bed or fluidized bed) and the location where ash is collected.

1.1 Materials and Methodology

1.1 Cement

Ordinary Portland Cement (OPC) of 43 grade with brand name Ultra-Tech confirming to IS 8112-1989 was used to cast the specimens. To know the quality of selected cement few tests have been conducted in the Laboratory.

Table 1: Test Results of Cement

SL NO	Test	Test Results	IS 8112-1989 Requirements
1	Normal Consistency	32%	
2	Initial Setting Time	36 minutes	>30 minutes
3	Final Setting Time	260 minutes	< 600minutes
4	Specific Gravity	3.11	
6	Fineness of cement (Sieving method)	5%	<10%
7	Compressive Strength 3days strength 7days strength 28days strength	 22.45N/mm^2 29.86N/mm^2 47.41N/mm^2	 >16 N/mm^2 >22 N/mm^2 >43 N/mm^2

https://doi.org/10.15623/ijret.2018.0701001Received: dd-Mon-Year, Accepted: dd-Mon-Year, Published: dd-Mon-Year

1.2 Fine Aggregate (FA)

Locally available clean Manufactured Sand is utilized all through the experiment work. The physical properties of Fine aggregate acquired from the laboratory tests are appeared in Table 2

Table 2: Test results of Fine Aggregate

SL NO	Test	Test Results
1	Specific Gravity	2.50
2	Water Absorption	0.7%
3	Fineness Modulus	2.92

1.3 Coarse Aggregate (CA)

Crushed natural-granite aggregate from local crusher has been used and which has maximum size of 20mm. The tests for natural granite aggregate are conducted as per IS 383-1970 procedure and the obtained results are presented in Table 3.

Table 3: Test Results of Coarse Aggregate

SL NO	Test	Test Results
1	Specific gravity	2.65
2	FM	6.88
3	Water absorption	0.6%

1.4 Wood ash(WA)

Four different proportions of concrete mix (WA replacement of 5%, 10%, 15% and 20% by weight of the cement) including the control mixture were prepared with water to binder ratio of 0.50. The specific gravity of wood ash is found to be approximately equal to cement. Specific gravity of wood ash is 2.31. The suitablerangeof specificgravityof woodashis 1.6 to 2.8.

1.5 GGBS (GGBFS)

Ground Granulated Blast furnace Slag consist essentially silicates and alumina silicates of calcium. Portland cement is a good catalyst for activation of slag because it contains the three main chemical components that activate slag: lime, calcium sulphate and alkalis. The material has glassy structure and is ground to < than 45 microns. The surface area is about 350 - 450 m2 / kg Blaine. The ground slag in presence of water and an activator which are commonly sulphates and alkalis which are supplied by ordinary Port land Cement react chemically with GGBS and hydrates and sets in a manner similar to Portland cement. The Specific gravity of GGBS 2.91.

1.6 Water

Clean fresh water is used for mixing and curing the specimens.

1.7 Casting

The cubes of inner dimensions 150X150X150mm were cast to find out the Compression strength of concrete. To evaluate the split tensile strength cylinders of 150mm diameter with 300mm height were cast and to evaluate Shear strength 150x60x90mm moulds were used. The proportions for various mixes were evaluated for 50mm slump. The mixes are designed for M20 grade concrete as per ISCodes. All materials are weighed, as in mix design separately. The cement, sand, natural-coarse aggregate. Wood ash and GGBS were dry mixed in pan mixer thoroughly till uniform mix is achieved required a quantity of water is added to the dry-mix. The fresh concrete was placed in the mould and the compaction was adopted by mechanical vibrator. The specimens were removed from moulds after 24 hours and placed in water pound for 28 days curing after a period of 28 days the specimens were taken out and allowed to dry under shade later the specimens are allowed for testing.

Table 4: Mix Proportions per Cubic Meter of concrete (W/c = 0.5)

Mix	**Cement (kg)**	**FA (Kg)**	**CA (kg)**	**Water (ltrs)**
Conventional	330	640	1106	165
5% WA	313.5	640	1106	165
10% WA	297	640	1106	165
15% WA	280.5	640	1106	165
20% WA	264	640	1106	165
Ratio	1	1.55	2.74	W/C = 0.5

2. TESTS FOR SPECIMENS

2.1 Compressive Strength Test

Thistestisconductedbyusing3000kN(CTM).Thecubewas kept in the CTM and the load is given at a constant rate of 140kg/cm^2,till the specimen fails and the corresponding load noted as ultimate load. The cube compressive strength is computed by using standard formula. The obtained results are indicated in Table 5.

2.2 Split Tensile Test

This test is conducted by using 3000kN compression testing machine (CTM). The cylinder is placed at the bottom compression plate and is aligned in such a way that center

https://doi.org/10.15623/ijret.2018.0701001Received: dd-Mon-Year, Accepted: dd-Mon-Year, Published: dd-Mon-Year

lines marked on the ends of the specimen which are a vertical. Then the top plate of the CTM is brought in contact at the top the cylinder.Theloadappliedattheuniformrateof140kg/cm2 and the failure load is noted. Strength is calculated by the splitting tensile the formula of 2P/πdl and results are presented in Table 6.

2.3 Shear Strength Test

Thistestisconductedbyusing3000kN(CTM).Thecubewas kept in the CTM and the load is applied at a constant rate of 140kg/cm^{2}the shear strength is characterized as the heap at which a protest can withstand toward a path of parallel to the substance of the material, instead of opposite to the surface. Shear strength is the most extreme shear stretch which a material can with stand without break. The cube is placed in such a manner the load is applying to the 150*90*60mmmould and the load at which it breaks are recorded.

3. RESULTS AND DISCUSSION

3.1 Compressive Strength

For every concrete mix, the compressive strength is determined on three 150×150×150mm cubes at 7 days and 28 days of curing. Following table5 gives the compressive Strength test results of concrete with constant 5%, 10%, 15% and 20% of Wood ash and varying 10%, 20% and 30% of GGBS for each interval. The test results of the cube compressive strength are presented in Table 5 and Figure 1 to 4.

In this work the Compressive strength of concrete made with wood ash and GGBS. The compressive strength of partially cement replaced concrete made with5,10, 15 and 20% of wood ash and 10, 20 and 30% of GGBSrangesfrom18.11 to23.70MPa at 7 days and 30.22 to 34.52 at 28 days from the experimental results, it is clear that the compressive strength of concrete made with 10% WA and 20% GGBS shows higher compressive strength value than conventional concrete mix. From the results it is concluded that the WA and GGBS can lightly improve the Compressive strength of concrete. Hence it is viable to use WA up to10% replacement and GGBS up to 20% replacement without affecting the required strength.

Table 5: Compressive Strength of Concrete

SL N0	Mix(WA+GGBS)%	Compressive Strength in (N/mm^2)	
		7days	28days
1	Convectional	18.81	30.22
2	5+0	17.77	30.67
3	10+0	20.45	32.15
4	15+0	17.62	28.74
5	20+0	14.37	24.74
6	5+10	19.70	31.11
7	5+20	21.18	32.89
8	5+30	20.88	32.00
9	10+10	21.77	31.56
10	10+20	23.70	34.52
11	10+30	20.15	32.59
12	15+10	18.52	30.07
13	15+20	16.59	25.63
14	15+30	15.70	25.03
15	20+10	14.36	23.11
16	20+20	13.18	22.67
17	20+30	11.11	21.33

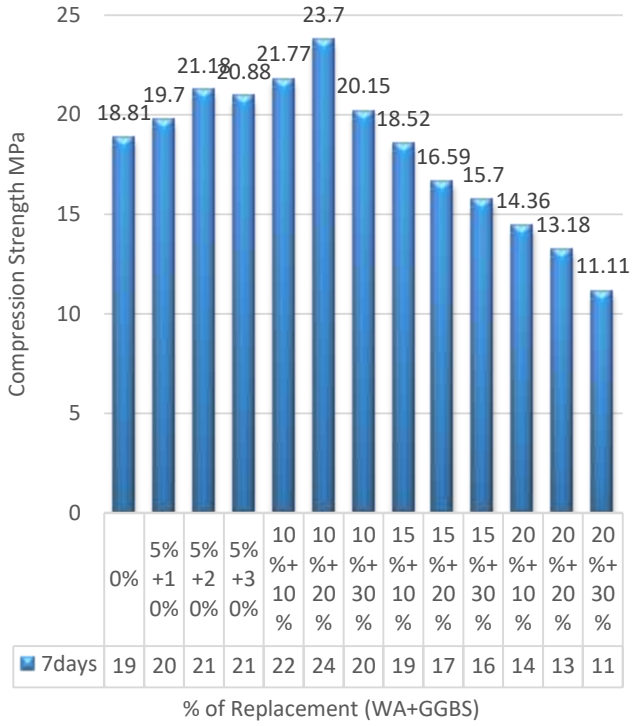

Fig 1: Compressive Strength of Concrete at 7 days

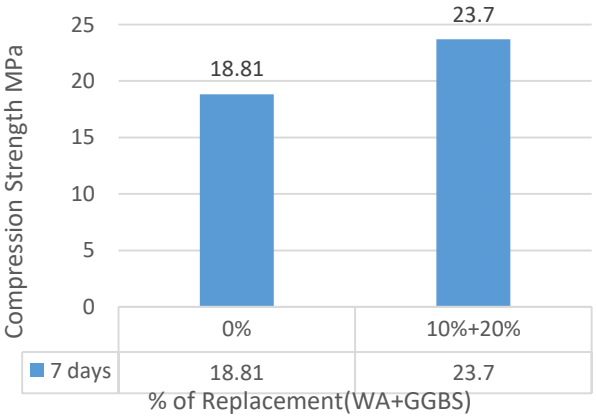

Fig 2: Comparison of Compressive Strength with Conventional Concrete at 7 days

https://doi.org/10.15623/ijret.2018.0701001Received: dd-Mon-Year, Accepted: dd-Mon-Year, Published: dd-Mon-Year

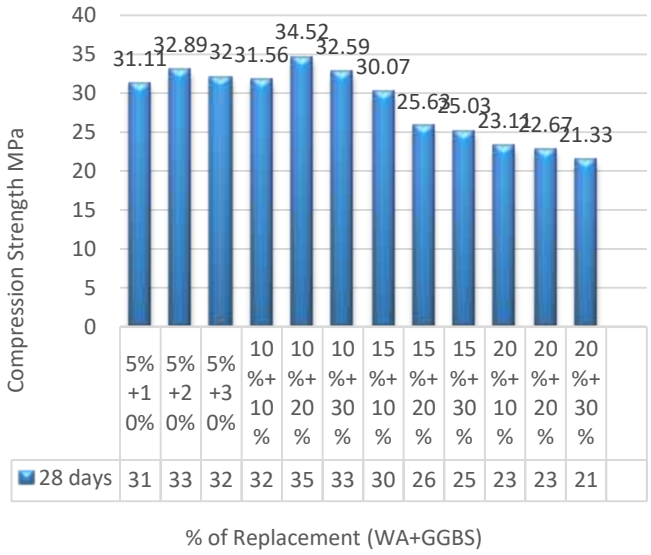

Fig 3: Compressive Strength of Concrete at 28 days

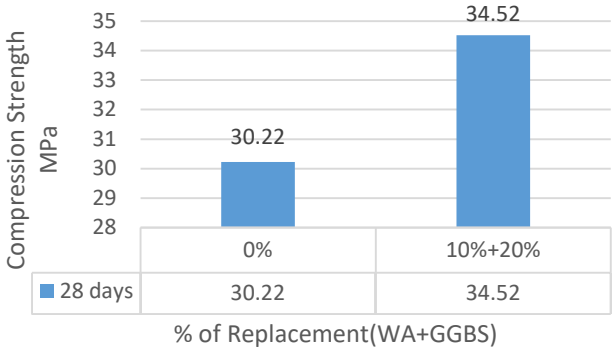

Fig 4: Comparison of Compressive Strength with Conventional Concrete at 28 days

3.2 Split Tensile Strength Test Result

Test has been conducted after7days and 28 days of curing. Split tensile test is conducted on 150 mm diameter and 300 mm length cylinders bas per IS 5816 – 1999. Following table 6 and figure 5 to 8 gives the split tensile strength resultsofconcretemadewith constant 5%,10%,15% and 20% of wood ash and varying 10%,20% and 30% of GGBS for each interval.

In this work the Split tensile strength of concrete made with wood ash and GGBS. The Split tensile strength of partially cement replaced concrete made with 5,10,15 and 20%Wood ash and 10, 20 and 30% of GGBSrangesfrom1.51 to2.26MPa at 7 days and 1.65 to 2.97 at 28 days. From the Experimental results it is clears that the Split tensile strength of concrete made with 10% WA and 20% GGBS shows higher Split tensile strength value than conventional concrete mix. From the results it is concluded that the WA and GGBS can lightly improve the Split tensile strength of concrete. Hence it is viable to use WA up to10% replacement and GGBS up to 20% replacement without affecting the required strength.

Table 6: Split Tensile Strength of Concrete

Sl.N0	Mix (WA+GGBS) %	Split Tensile Strength in (N/mm^2)	
		7days	28days
1	Convectional	1.98	2.40
2	5+0	1.93	2.97
3	10+0	2.40	3.25
4	15+0	1.98	2.54
5	20+0	1.55	2.12
6	5+10	1.83	2.40
7	5+20	1.79	2.31
8	5+30	1.74	2.31
9	10+10	1.98	2.45
10	10+20	2.26	2.97
11	10+30	1.98	2.54
12	15+10	1.60	1.98
13	15+20	1.50	1.93
14	15+30	1.65	1.98
15	20+10	1.55	1.79
16	20+20	1.50	1.74
17	20+30	1.51	1.65

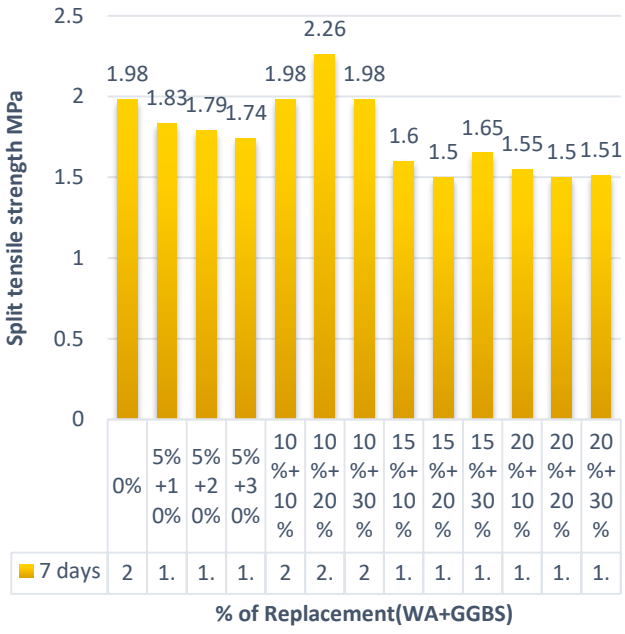

Fig 5: Split Tensile Strength of Concrete at 7 days

https://doi.org/10.15623/ijret.2018.0701001Received: dd-Mon-Year, Accepted: dd-Mon-Year, Published: dd-Mon-Year

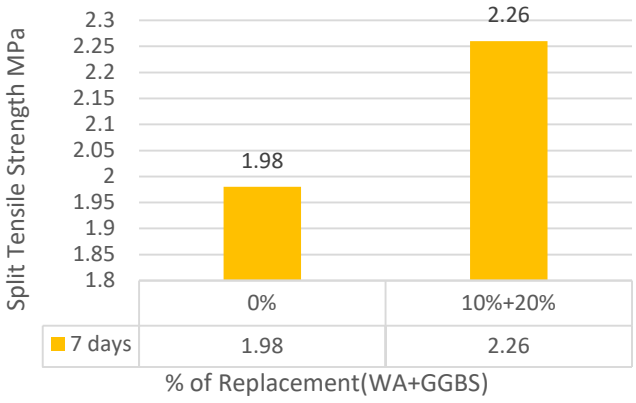

Fig 6: Comparison of Split Tensile StrengthWith conventional concrete at 7 days

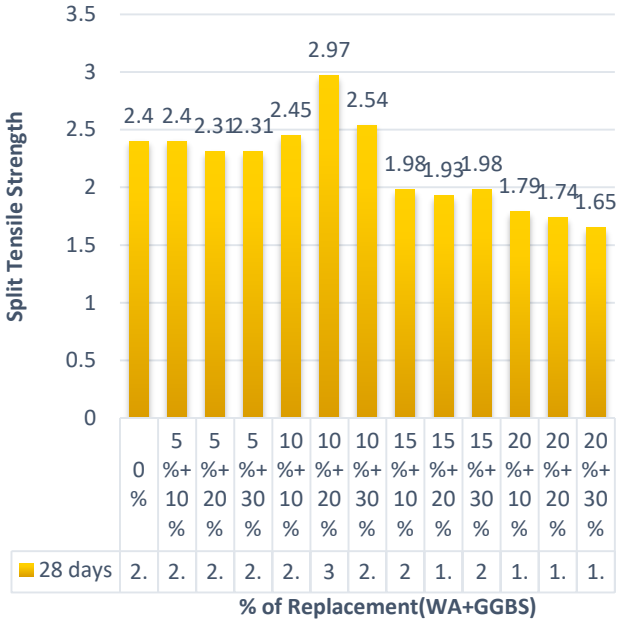

Fig 7: Split Tensile Strength of Concrete at 28 days

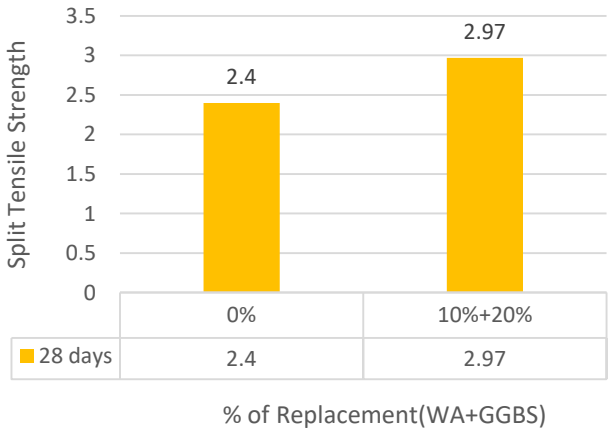

Fig 8: Comparison of Split Tensile Strength with Conventional Concrete at 28 day

3.3 Shear Strength Test Result

The shear strength test for concrete is additionally one of the essential and furthermore imperative properties of the concrete. The shear strength is characterized as the heap at which a protest can withstand toward a path of parallel to the substance of the material, instead of opposite to the surface

Table 7: Shear Strength of concrete

Sl.N0	Mix (WA+GGBBS)%	Shear Strength in (N/mm^2)	
		7days	28days
1	Convectional	11.48	14.44
2	5+20	13.33	17.78

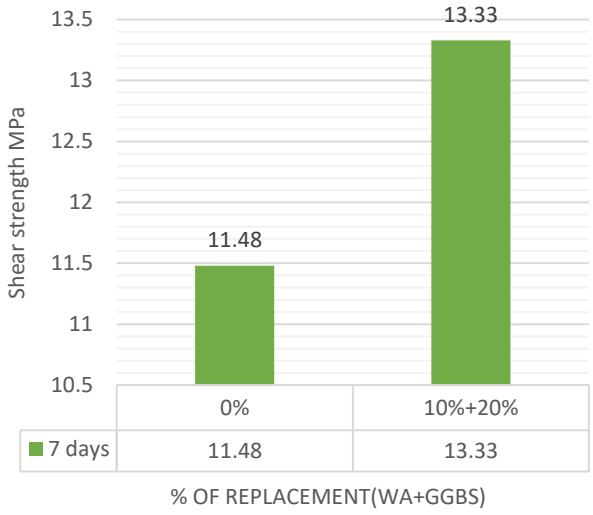

Fig 9: Comparison of Shear Strength with Conventional Concrete at 7 days

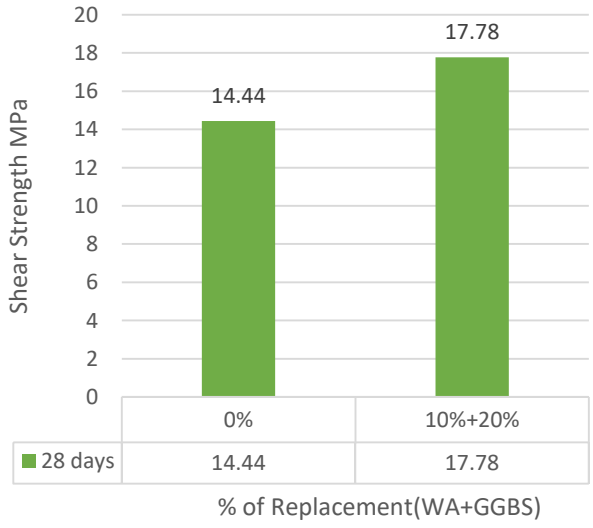

Fig 10: Comparison of Shear Strength with Conventional Concrete at 28 days

https://doi.org/10.15623/ijret.2018.0701001Received: dd-Mon-Year, Accepted: dd-Mon-Year, Published: dd-Mon-Year

4. CONCLUSION

1. The Compressive strength of conventional concreteis 18.81Mpa at 7 days, where as compressive strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 7 days found to be 23.7Mpa. Also it is found that the compressive strength of partially replaced concrete have 20.63 % ehigher1 strength than1 the conventional concrete respectively.
2. The Compressive strength of conventional concrete is 30.22Mpa at 28days, whereas compressive strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 28 days found to be 34.52Mpa. Also it, is found that the compressive strength of partially replaced concrete have 12.45%higherstrength than1 the conventional concrete respectively.
3. The Splittensile strength of conventional concrete is 1.98Mpa at 7days, where as split tensile strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 7 days found to be 2.26Mpa. Also it is found that the Splittensile strength of partially replaced c0ncrete has 12.38% higher strength than the conventional concrete respectively.
4. The splittensile strength of conventional concrete is 2.40Mpa at 28days, where as split tensile strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 28 days found to be 2.97Mpa. Also it is found that the Splittensile strength of partially replaced concrete has 19.19% higher strength than1 the conventional concrete respectively.
5. The shear strength of conventional concrete is 11.48Mpa at 7days, where as shear strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 7days found to be 13.33Mpa. Also it is found 1that the shear strength of partially replaced concrete have 13.87% higher strength 1than the conventional concrete respectively.
6. The shear strength of conventional concrete is 14.44Mpa at 28 days, where as shear strength of partially replaced cement concrete by an amount of 10% wood ash and 20% of GGBS at 28 days found to be 17.78Mpa. Also it is found 1that the shear strength of partially replaced concrete have 18.78% higher strength than the conventional concrete respectively.

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