

# Experimental Investigation on Concrete Using Flyash As a Partial Replacement for Cement with Grey Water in Magnetic Field

E. Prabakaran, Jessy Rooby

**Abstract---** The performance of the concrete in structural aspect is been taken in mind when we go for the large structures and as well as the durability which plays a major role on it. India is fast growing country with more unskilled laborers and the lack of knowledge in concrete behavior which leads to complications in the performance of concrete. The replacement of industrial by-products has become common in the past two decades. But the need of super plasticizer is important to maintain the required water binder ratio. To avoid the failure of fresh concrete properties by using super plasticizer, the magnetic water addition recommended with various strength of magnetic field for the required slump value. The grey water can be reused by treatment with magnetic field. The variation of pH and chemical property produces more durable concrete. The present study aims to find out the physical, chemical, mechanical and durability properties of M20 grade concrete using grey water and 20% flyash with a magnetic power of 0T, 0.8T, 1T and 1.2T respectively. Specimens were also cast with normal water for comparisons. It is found that magnetized grey water with 1.2T shows good improvement in compressive strength, corrosion resistance.

**Keywords---** Magnetic water, grey water, fly ash, super plasticizer, durability.

## I. INTRODUCTION

Indian government officials are looking for better solution on environment pollution, in particular air pollution. Fast growing nation like India, with many factories that are using lignite as fuel produce a large volume of fly ash as waste and it has increased twice in three decades and become a problem. From the previous research works, it is observed that fly ash is a good pozzalonic material and ensures the durability properties for concrete structures. The limit of fly ash is generally controlled with 20% to avoid early shrinkage and long-term curing period (4). The class F fly ash has the chemical property of cement except the lime content. Water is the important ingredient in concrete making, which consumes more part when compared with using for the regular crop cultivation (2). Each year more than one million tons of water is needed for concrete industry (3). Magnetic water provides the better concrete mix with lower w/b ratio (1). The grey water usage of concrete limitation due to the impurities especially due to the total solids presents in the water. It is make the concrete defective in sever exposure conditions. The grey water after treating in effluent treatment plant, the magnetic field reduces the solids value in the treated grey water and improves the pH value appreciably.

Manuscript received February 01, 2019

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## II. EXPERIMENTAL INVESTIGATION

Magnetic water is prepared with a series of permanent magnets (ferrite type) assembled in a pipe line which is shown in the figure 1. The magnetic water produces lower mass water molecules which improves the hydration process (1). Magnetic water strength improves the lubrication of the cement paste with lower water content.-Magnetic water with 0.8T, 1T and 1.2T magnetic power was produced by maintain a velocity of 0.8 m/sec.

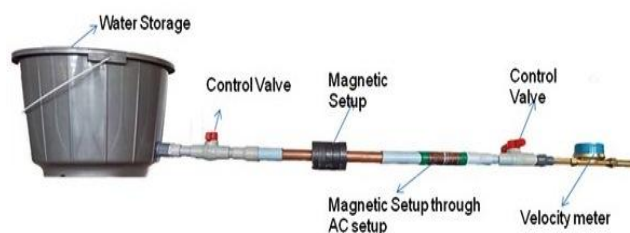


Figure 1: Experimental setup for preparation of Magnetic Water

Ordinary Portland cement (OPC 53 Grade conforming to BIS: 12269 – 1987), locally available zone II fine aggregate and 12.5 mm sized coarse aggregate was used for the concrete mix. Class F Fly ash is taken from Mettur thermal power plant with the fineness of 432 m<sup>2</sup>/kg and with specific gravity 2.62.

The chemical properties of OPC and Fly ash conforms the requirement to BIS: 9103 – 1999 and ASTM C – 494, used as a super plasticizer to attain the required slump in Flyash concrete without magnetic water. The Mix design for M20 grade concrete as per IS10262:2009 is carried with a target compressive strength of 28 (MPa) and it is shown in Table 1.

Water-to-cementations ratios of concrete samples (M20) are tap water (TW), fly ash (FA %) and magnetic power ratio of tesla (0T to 1.2T), mix proportion shown in table 2

Table 1: Mix design as per IS 10262:2009

Materials	Water	Cement	Fly ash	Fine Aggregate	Coarse Aggregate
Volume(kg/m <sup>3</sup> )	186	-	372	690.29	1156.47
Normal concrete	0.50	1	-	1.86	3.11
Fly ash concrete	0.50	0.80	0.20	0.80	3.11

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**Table 2: Mix Proportions**

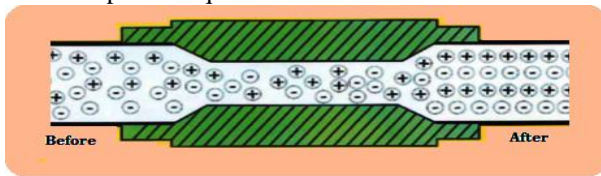
Specific name	Cement (kg/m <sup>3</sup> )	Fly ash (kg/m <sup>3</sup> )	Fine aggregate (kg/m <sup>3</sup> )	Coarse aggregate (kg/m <sup>3</sup> )	Water (lit/m <sup>3</sup> )
GW	372	-	690.29	1156.47	186
GW+20%FA + 0T	297.6	74.4	690.29	1156.47	186
GW+20%FA + 0.8T	297.6	74.4	690.29	1156.47	186
GW+20%FA + 1.0T	297.6	74.4	690.29	1156.47	186
GW+20%FA + 1.2T	297.6	74.4	690.29	1156.47	186

Concrete cube in size 150\*150\*150 mm were cast to determine the compression strength of concrete. Cylinders of 100 mm dia with 150 mm height were used to determine the durability tests like voids permeability and water absorption, acid attack and permeability tests in concrete. 150 mm dia with 300 mm height cylinders were used to determine the split tensile strength of concrete.

### III. RESULTS AND DISCUSSION

#### 3.1. Property of water in magnetic field

The influence of magnetic field and effect in the grey water is shown in Table 3 and figure 1 respectively. The pH of grey water increased with the increase in magnetic strength. The chemical and physical properties of water after magnetizing has produced desired values for preparing concrete as per IS requirement.



**Figure 2: Effect of magnetic field on water molecules**

**Table 3: Properties of grey water after magnetic treatment at 29°C**

Properties	NW	GMW	GMW			Standard values
			(0.8 T)	(1.0T)	(1.2 T)	
pH	7.17	7.56	7.42	7.53	7.63	6.5-8 As per IS456
Chlorides (mg/lit)	74.97	104.68	102.1	96.56	94.69	500 mg/l As per IS456
Total solids (mg/lit)	0.8	1.2	1.1	1.0	0.8	-
Total Volatile Solids (mg/lit)	0.8	1.2	1.2	1.0	0.8	-
Total fixed solids (mg/lit)	00	00	00	00	00	-
Turbidity (NTU)	8.1	8.2	6.3	4.8	3.3	2000 NTU
Hardness (mg/lit)	25	900	864	829	805	-
Sulphate	25	125	85	74	52	0-150
Nitrate (mg/lit)	9.96	0.07	0.07	0.07	0.07	45ppm
Calcium	96	100	88	82	76	200ppm
Pottocium	2.7	4	3.6	3.6	3.6	12ppm
Sodium	35.6	45.1	45	45	45	45ppm

#### 3.2. Fresh concrete properties

Properties of fresh concrete with and without magnetic field influence is found out using slump test, compaction factor test and water absorption test, the workability has improved with the effect of magnetic field without the use of super plasticizer. The test specimen pattern and designation shown in Table 4. The improved workability attained through the magnetic field provides better use of Flyash for high performance concrete production.

**Table 4: Specimen Pattern**

Specimen Details	Specimen Designation
NW	MNM1
GW	MNM2
F20%+NW	MNM3
GMW	GNM4
F20%+GW	GNM5
F20%+GMW	GNM6

**Table 5: Properties of fresh concrete**

Physical Properties	Specimen Pattern	Magnetic field treated water (Tesla)			
		0T	0.8T	1.0T	1.2T
Slump values (from top)mm	MNM1	55	58	72	85
	MNM2	71	73	88	96
	MNM3	70	82	103	105
Compaction Factor	MNM1	0.8	0.83	0.89	0.93
	MNM2	0.78	0.82	0.88	0.94
	MNM3	0.58	0.8	0.89	0.92
Water absorption (%)	MNM1	3.1	3.0	2.8	2.7
	MNM2	2.5	2.4	2.4	2.4
	MNM3	2.4	2.35	2.3	2.3

The result shows an improvement in fresh concrete properties with magnetic water addition. The slump values increases about 2.36 times with the addition of 1.2T magnetic grey water in concrete.

#### 3.3. Hardened concrete properties

#### 3.4. Durability concrete properties for 1.2T magnetic added concrete

##### 3.4.1 Water absorption and porosity properties of concrete

The table 5 shows 50% improvement in the water absorption and porosity value with the addition of magnetic water in concrete.

All the specimens provide better improvement in the porosity and water absorption which leads to good durability property.



**Table 6: Durability properties of concrete with porosity values:**

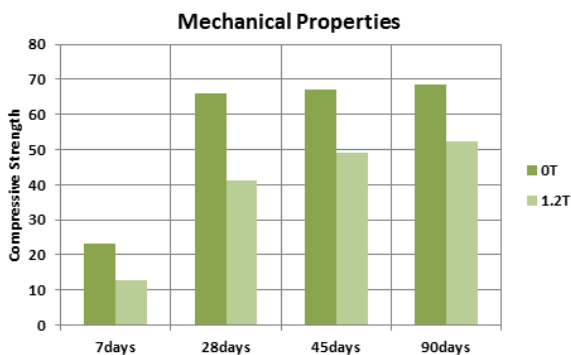
Specimen Pattern	Coefficient of water absorption in (m <sup>2</sup> / sec x 10 <sup>-11</sup> )	Water absorption in %	Effective porosity (%)
MNM1	3.58	3.10	0.686
MNM2	2.25	2.60	0.549
GNM3	1.06	2.33	0.469
GNM4	1.86	2.17	0.511
GNM5	1.84	2.19	0.49
GNM6	1.69	1.78	0.376

**3.4.2 Compressive strength of concrete in exposure conditions**

The compressive strength of the concrete conducted after acid exposure (H<sub>2</sub>SO<sub>4</sub>) with gray magnetic field water. The test results and specimen details shown in table 7. The compressive strength of concrete is improved with 1.2T magnetic field in acid exposure and compressive strength increased about 23% when 20% of Fly ash is replaced with and also with 1.2T magnetic grey water. The lower lime content of Fly ash gives the higher response in later age shown in bar chart figure 3. The greywater with magnetic field improves the concrete strength in aggressive environment.

**Table 7: Compressive strength of concrete after acid attack (H<sub>2</sub>SO<sub>4</sub>)**

Specimen Details	Magnetic field Strength (Tesla)	Mechanical Properties			
		7days	28days	45days	90days
MNM1	0T	25.33	57.48	58.74	65.84
	1.2T	16.56	34.74	34.99	42.62
MNM2	0T	22.01	56.90	60.02	66.49
	1.2T	15.44	30.82	34.03	47.84
MNM3	0T	34.06	61.06	60.79	62.83
	1.2T	29.45	41.88	40.45	46.41
MNM4	0T	23.38	66.04	66.95	68.41
	1.2T	12.64	41.29	49.01	52.52



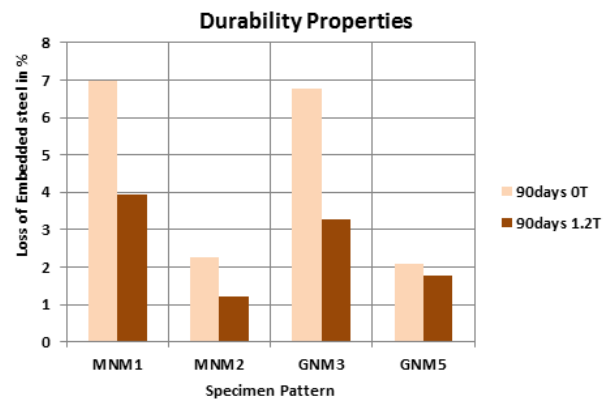
**Figure 3: Compressive strength of concrete after acid attack**

**3.4.3 Corrosion resistance of concrete in exposure conditions**

Concrete cylindrical specimens of 100 mm dia and 150 mm height will be immersed in 10% NaCl solution under alternate wetting (3days) and drying (3days) conditions over a period of 30 days to find out the corrosion resistance.

**Table 8: Durability Properties of concrete for corrosion level:**

Specimen Designation	Magnetic Field Strength, (Tesla)	Loss of Embedded steel in %	
		28 days	90 days
MNM1	0T	3.33	7.00
	1.2 T	3.00	3.93
MNM2	0T	4.50	2.27
	1.2 T	3.58	1.20
GNM3	0T	3.63	6.77
	1.2 T	2.21	3.28
GNM5	0T	2.20	2.07
	1.2 T	1.87	1.77



**Figure 4: Concrete for corrosion level**

% Loss of weight = ((Initial weight – Final weight) / Initial weight) x100

The table 8 and corresponding graphical chart figure 4 shows the magnetic water addition with fly ash concrete having 30% reduced value of corrosion due to the dense property.

**IV. CONCLUSIONS**

- Industrial waste product Fly ash, which has pozzolanic properties, can provide an alternative binder material for cement.
- The physical properties of concrete with fly ash have been investigated for workability and W/B ratio.
- The setting time and workability has been influenced with 20% addition of Fly ash. Fly ash addition increases the setting time and magnetic water increase the workability.
- The placing of concrete in large scale can be done with magnetic water, reducing the usage of super plasticizer.
- The use of a Fly ash, as pozzolan will result in denser in the cement paste matrix. The chemical reaction of lime crystals to form binders has a direct effect of increased paste density, reduced porosity over time, and will enhance the matrix chemical resistance to many aggressive environments.



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Increasing level of Fly ash in concrete produce increased resistance to cracking.

- It has been noticed that the compressive strength capacity of concrete depends on the adhesive strength of hydration cement paste-aggregate (transition zone).
- Class F Flyash produces better durability in corrosion due to the low lime content.
- The magnetic water reduces the corrosion value in the specimen with the addition of Fly ash about 23%.
- Greywater improves the corrosion due to its turbidity and TDS values in both normal and magnetic condition.
- The lower corrosive effect (9%) in magnetic greywater is attained with an addition of 20% Flyash.

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