International Research Journal of Engineering and Management Studies (IRJEMS)
Volume: 03 Issue: 05 | May -2019 ISSN: 2395-0126

STUDY ON STRENGTH PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF BASALT POWDER AS CEMENT REPLACEMENT MATERIAL

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Abstract

Concrete is most widely used man made construction material in civil engineering applications. Among the total co2 content in the world 7% of it generated by the cement industry. Every ton of cement production releases nearly one ton of CO2 to atmosphere. Then the production of cement polluted the environment, thought it has abutment benefits. The pollution effect on environment can be minimized by increasing the usage of basalt powder in our construction industry. Present study has been undertaken to study the effect of basalt powder on cement concrete on the basis of compressive, split tensile, flexural strength and thereby reduce the environmental problem by proper utilization. In this phase, concrete of M30 grade is considered experiments conducted on concrete cubes with and without addition of basalt powder as 0%, 5%, 10% and 15% by weight of cement in concrete. The results suggest that concrete made with addition of 10% of basalt powder gives more strength compared to all other mixes. The mechanical characteristics of concrete to be determined for optimum addition of basalt powder. Workability of concrete by replacing the basalt powder is to be evaluated.

Keywords: Cement, Basalt Powder, Durability, Structural behavior, Strength.

1.INTRODUCTION

Concrete is most widely used as a construction material due to its specialty of being cast in any desirable shape [1]. For the last few decades the construction techniques have been modernized with focus on high strength, dense and uniform surface texture, more reliable quality, improved durability, and faster construction. One of the recent advancement in construction industry is replacement of material in concrete. The amount of cement production emits approximately equal amount of carbon dioxide into the atmosphere[2]. Natural resources are slowly decreasing because continuous production of huge quality of cement on daily basis. Therefore additional burden has credit an opportunity to utilize the supplementary materials. As there are different wastes coming from the industries and these waste becoming problem to dispose. Hence, we can use those wastes as the constituents of concrete by replacing or partially replacing the cement, sand or aggregates which makes cost reduction, energy savings and production of environment, economical and finally conserves the natural resources. Sustainability in concrete production can be achieved by innovation in substitution of materials used in the constructions[3]. And the mineral admixtures also used in the concrete to increase the strength of structures.

The basalt powder also considers as the one of the mineral admixtures and it also increase the durability of concrete. In this study basalt powder is

S.NO	DESCRIPTION	RESULT
1	Specific gravity	3.13
2	Fineness	6%
3	Initial setting time	33min
4	Final setting time	320 min

replaced as cement, So we reduce the usage of cement in the construction[4]. And basalt powder also produced the same strength compared with cement using concrete. It is waste powder from the asphalt mixture production. In asphalt mixture production the mineral aggregate is dried in the temperature of 200 degree celcious[5]. The waste powder is leaves from the dryer after crushing. And the fine material is treated as a waste powder. And it can be estimated 27-35 thousands of waste powder has been per year in Kuyavian-Pomeranian Voivodeship in Poland[6].

2.OBJECTIVE

- To determine the properties of materials and mix proportion of concrete.
- To study the mechanical properties of concrete with and without addition of basalt powder in concrete for cement replacement material.
- To study the optimization of basalt powder is to be derived.

3. MATERIALS

3.1 Cement

Cement act as a binding material of concrete preparation. And it is bind the coarse aggregate and fine aggregate with the help of water, to a monolithic matter and also fills the void in the concrete. In the present report, Ordinary Portland cement of 53 grade confirming to IS 12269-2013 has been used. There are different types of cement will be used in the concrete according to types of structure and climate conditions. The physical properties of cement affect the strength parameters. The physical properties of cement as shown in table 1.

Table.1. Physical properties of cement

3.2 Fine Aggregate

For the present experimental investigation, locally available river sand is used as fine aggregate. The sand is free from clay and silt and organic impurities. The sand was washed and screened at site to remove deleterious materials and tested as per procedure given in IS 2386-1963. The physical properties of river sand are listed in table 2.The maximum size of fine aggregate was taken to be 4.74mm.

Table.2. Physical properties of fine aggregate

S.No	Physical properties	Fine aggregate
1	Particle Shape	Irregular
2	Appearance	Brownish yellow
3	Type	River sand
4	Specific gravity	2.63
5	Percentage of Voids(%)	41.16
6	Water Absorption	1.06
7	Grading Zone	II

3.3 Coarse Aggregate

Crushed granite coarse aggregate of maximum size 20mm is used. The experiments are carried out to find the property of coarse aggregate. Coarse aggregate was used with 20mm nominal size and specific gravity 2.75 and fineness modulus 8.28

and were tested as per IS:383-1970. The physical properties of coarse aggregate shown in table 3.

Table.3. Physical properties of coarse aggregate

S.No	Properties	Observed value
1	Fineness modulus	8.28

S.NO	DESCRIPTION	RESULT
1	Specific gravity	2.89
2	Water absorption (%)	2.2
3	Fineness test	2 to 300µm

2	Specific gravity	2.75
3	Water absorption (%)	2.8
4	Size of aggregate(mm)	20

3.4 water

Generally, water that is suitable for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it is suspected that water may contain sewage, mine water or wastes from industrial plants or canneries, it should be avoided since the quality of the water could change due to low water by intermittent discharge of harmful wastes into the stream. In the present experimental program, portable tap water was used foe preparation of specimens.

3.5 Basalt powder

Basalt powder is a by-product of stone crusher in basalt quarry. Basalt is well known as rock found in virtually every country around the world. And waste basalt powder was obtained from Asphalt Batch mix plant. Asphalt mixture production leads to formation of significant amounts of by- product in the form of mineral powder. Mineral aggregate used in asphalt mixture production in dried at the temperature of about 200 degree celcious. An exhaust leaves the dryer with particles of powder. And the basalt powder has maximum percentage of SiO2 so it has good binding property. The particle diameters are in the range of 2 to 300 µm. The largest volume, i.e. 36% is occupied by particles about 17.51µm in diameter. The physical properties of BP are given table 4. The picture of basalt powder shown in figure 1.

Table.4. Physical properties of basalt powder

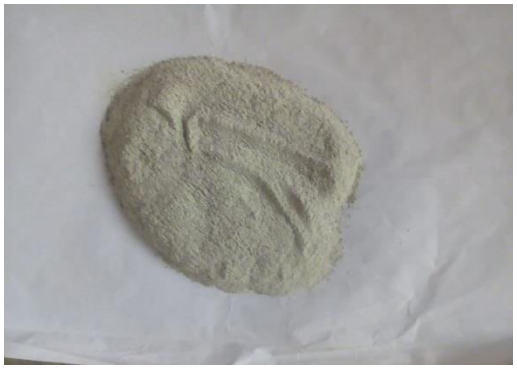


Figure.1.Basalt Powder

3.6 Concrete Mix Design

The mixes were designated in accordance with IS 10262-2009 mix design method. Based on the results, the mix proportion M_{30} was designed. The detail of mix proportion and materials for 1m3 of concrete is shown in table 5.

Table.5. Mix Proportion (Kg/m^3)

Grade	Cement	FA	CA	Water
M_{30}	425	661.1	1167.8	191.6
Mix ratio	1	1.55	2.74	0.45

4. TEST ON FRESH CONCRETE

4.1 Slump Cone Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. Workability of concrete is mainly affected by consistency may vary in workability. It is also used to determine consistency between individual batches.

4.2 Compaction Factor

The degree of compaction is called as compaction factor. The compaction factor is measured by density ratio of the density actually achieved in the test to the density of same concrete fully compacted in the same specimen. And the compaction test is determined in the lab testing compaction machine. The compaction factor value shown in table 6.

Table.6. Compaction factor value

S.No	Specimen type for M30 grade concrete	Compaction factor
1	0%	0.89
2	5%	0.86
3	10%	0.85
4	15%	0.83

5. RESULT AND DISCUSSION

5.1 Compression test

The most common of all test of hardened concrete is the compressive strength test because of the intrinsic importance of the compressive strength of concrete in construction. For cube compression testing of concrete, 150mm cubes were employed. All the cubes were tested in saturated condition, after wiping out the surface moisture. For each trial mix combination, three cubes were tested at the age of 7 and 28 days of curing using 500 tone capacity compression testing machine as per BIS: 516-1959. Compressive strength of concrete mixes made with and without basalt powder was determined at age of 7, 14 and 28 days. The test results are given in table 7. Maximum strength was obtained with 10% of basalt powder in concrete. From the results it came to know that addition of basalt powder increases strength more than conventional concrete. The figure 2 explains the trend of compressive strength at 7, 14 and 28 days.And figure 3 represent the test set up of compression test.

Table.7. Compression test value

Mix Identity	Addition of BP (%)	Compressive strength at 7	Compressive strength at 14	Compressive strength at 28

		days(Mpa)	days(Mpa)	days(Mpa)
BP0	0	16.40	24.63	32.55
BP1	5	18.50	26.89	35.40
BP2	10	19.99	29.57	39.00
BP3	15	17.23	23.87	30.78

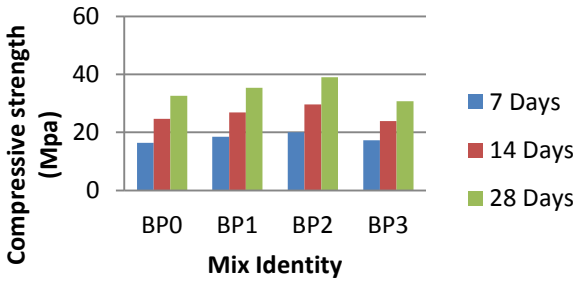


Figure.2. Test results for compression test

Figure.3. Test setup for compression test

5.2 Split tensile test

The cylinder of standard size 150mm diameter and 300mm height is tested at the age of 7,14 and 28 days curing, using 400 tone compression testing machinesper BIS:5816- 1970. The load was applied till the specimen was fail. And the split tensile strength value will increased by increasing the replacement level of basalt powder. The value of split tensile strength is increased by increasing the basalt powder. The value of split tensile strength represent in table 8. The figure 4 explains the trend of split tensile strength at 7, 14 and 28 days. And figure 5 represent the test set up of split tensile test.

Split tensile strength=2P/πdl

Where,P- Tensile load in N ,

d- Diameter of cylinder in mm

l- Length of cylinder in mm

Table.8.Split tensile strength value

Mix Identity	Addition of BP (%)	Split tensile strength at 7 days(Mpa)	Split tensile strength at 14 days(Mpa)	Split tensile strength at 28 days(Mpa)
BP0	0	2.33	3.79	4.96
BP1	5	2.56	2.91	4.85
BP2	10	2.85	3.95	5.67
BP3	15	2.24	2.86	5.12

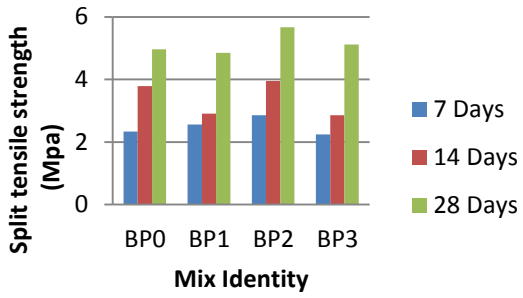


Figure.4.Test result for split tensile strength

Figure.5. Test set up for split tensile strength

5.3 Flexural strength

This test was conducted to find out the flexural strength of concrete. The prism was casted in the size of 500x100x100mm. It was conducted by Uniform Testing machine (UTM). The load was given to the sample by two point load method. In each percentage of Basalt powder replacement of M30 grade was determined at 7,14 and 28 days. The flexural strength value is given in table 9. The figure 6 explains the trend of Flexural strength at 7, 14 and 28 days. And figure 7 represent the test set up of flexural test.

$$\text{Flexural strength} = Pl/bd^2$$

Where, P- Tensile load in N

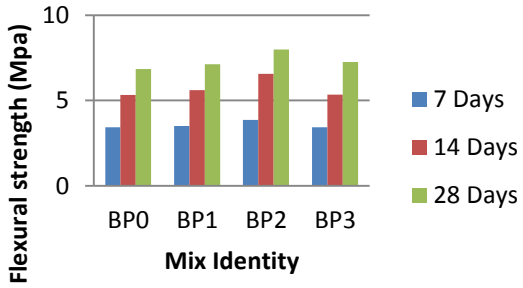
l- Length of specimen in mm

b- Breath of the specimen in mm ,

d- Width of the specimen in mm

Table.9. Flexural strength value

Mix Identity	Addition of BP (%)	Flexural strength at7 days(Mpa)	Flexural strength at 14 days(Mpa)	Flexural strength at 28 days(Mpa)
BP0	0	3.44	5.32	6.85
BP1	5	3.50	5.60	7.13
BP2	10	3.87	6.57	7.98
BP3	15	3.43	5.34	7.25



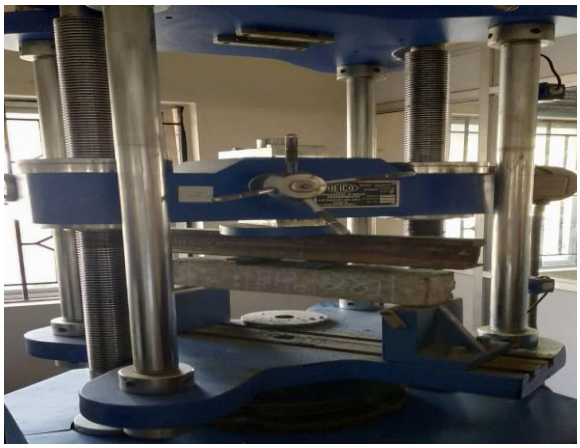


Figure.6. Test result for flexural strength

Figure.7. Test set up for flexural strength

6.CONCLUSION

A preliminary study on basalt powder concrete was attempted with different replacements. The basic properties were determined for materials and basalt powder. The mix proportion was designed for M30 grade of concrete. The workability test was made for fresh concrete with and without addition of basalt powder by weight of concrete. The compressive strength of hardened concrete for different mixes with and without addition of basalt powder by weight of concrete is determined. From the result of compression, Split tensile and Flexural test on concrete with and without addition of basalt powder indicates that concrete with 10% of basalt powder by weight of concrete gives more strength when compared to other mixes.

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