Publisher homepage: **www.universepg.com**, ISSN: 2663-7804 (Online) & 2663-7790 (Print)

https://doi.org/10.34104/ajeit.023.02160228

Australian Journal of Engineering and Innovative Technology

Journal homepage: www.universepg.com/journal/ajeit

Study on the Effect of OPC and PCC on the Properties of Concrete

Md. Abul Basar[1]*, Morshedul Hoque[2], Sakhawat Hossain[2], Makbul Hosain[2], and Md. Abdul Latif[2]

[1]Gangamandal Science and Technology College, Debidwar-3530, Cumilla, Bangladesh; and [2]Department of Civil Engineering, Dhaka International University, Satarkul, Badda, Dhaka, Bangladesh.

*Correspondence: abulbasar2424@gmail.com (Md. Abul Basar, Lecturer at Gangamandal Science and Technology College, Debidwar-3530, Cumilla, Bangladesh).

ABSTRACT

The objective of the study was to evaluate the effect of OPC and PCC on the compressive and tensile strength of concrete with age. Accordingly, cylindrical specimen was prepared by using cement OPC and PCC. Incasting the specimen only crushed bricks are used as coarse aggregate and Sylhet sand (FM=2.65) has been used as fine aggregate. Two different water cement ratios is 0.45, 0.60 and mix ratio 1:1.5:3 and 1:2:4 (by volume) has been adopted. Concrete cylinder made with OPC show higher compressive and tensile strength at 28 days then the those made with PCC. However, it has been from that Concrete made with OPC gains compressive strength at (45 days) a faster rate up to a certain age of concrete. While concrete with PCC attains larger strength at later age. In this study, it has been found that up to 45 days, the attained compressive strength of OPC concrete is larger than PCC concrete. However, the observed compressive strength beyond 60days is larger than OPC concrete. Similar trend has been observed in the case of tensile strength.

Keywords: Ordinary portland cement, Portland composite cement, Concrete, Bricks, and Coarse aggregate.

INTRODUCTION:

Concrete is a widely used construction material. It is manufactured from a mixture of binding and filling materials. At present, concrete is widely used in the building construction, airport installation, high way construction agriculture and water resources improvement, etc. The main advantage of concrete is that it can be made from widely available raw materials and then molded to particle any shape or form as desired. Therefore, an understanding of the properties of concrete is necessary. The commonly used binding materials in civil construction is cement based on the size of aggregate can be categorized into two ways a) Fine aggregate, b) Coarse aggregate. Sand is commonly used as fine aggregate in Bangladesh. Brick chips and stone chips are commonly used as the coarse aggregate in our country. However, brick chips are more used in Bangladesh. The properties of concrete can be divided into two groups, one of the properties of fresh concrete which are workability, cohesiveness, plasticity, and consistency and another property of hardened concrete that are durability, strength, modulus of elasticity water tightness, density, etc. (Inam *et al*., 2021).

The strength is the most important and desirable properties of concrete. The strength varies on several factors such as the quality of materials, method of proportioning, mixing, placing proper compaction, curing and the overall workmanship & supervision at site. The compressive strength is most important over the tensile, flexural and shear strength. It is generally determined by testing concrete cube or the cylinder specimens (Hasan *et al*., 2023).

Objectives of the Study

The objectives of the study are as follows:

1) To compare the effect of using PCC and OPC on the compressive strength gain of concrete with age for the instance at 7 days, 28 days, 60 days and 90 days.
2) To evaluate the effect on the tensile strength of concrete with age.

Scope of the Study

The present study involves the investigation of the strength of concrete by varying the cement. The compressive strength of the concrete depends upon various factor, such as water cement ratio curing condition concrete mix proportion, maximum size of coarse aggregate and so on. In this research, only brick chips have been selected as course aggregate. Fine aggregates are selected as Sylhet sand. Also, the relationship between the OPC & PCC of the compressive and tensile strength of concrete with age. For all the cases, the curing conditions are kept as the continuously immersed under water. In addition, for all the case cylinders of standard sizes that is 6" dia and 12" height used. In this study, OPC and PCC were used. Ratio of the cement, fine aggregate and coarse aggregate were (1:1.5:3) and (1:2:4). The water cement ratios used were 0.45 and 0.6. Only Sylhet sand was used (FM=2.65). ASTM standard requirements have been followed to determine the properties of ingredients and mechanical properties of concrete the maximum size of coarse aggregate 20 mm down 4.75 mm retain.

MATERIALS AND METHODS:

The methodology adopted in achieving the objective of the study is summarized as:

1) Selection of materials
2) Testing & preparation of ingredient materials
3) Preparation of sample
4) Curing of sample
5) Testing of specimen
6) Results and analysis
7) Recommendations and conclusions

Background of the Study

Developing high strength is most important issue in concrete Technology. Over the last two decades this type of concrete has come more and more into popular use. Now it seems to be universal agreement that the production and use of the high strength concrete is a worthy goal. OPC is widely used in Bangladesh for concrete making at present increasing used of PCC day by day. PCC produces lower heat of hydration due to pozzolanic reaction improve soundness & reduces thermal cracking and porosity. PCC increases the strength at early age goes will decrease but after long period of time it will shoot up. PCC is more efficient in saline weather. Big structure like PETRONAS tower, however dam and many other structure of the world constructed by using PCC. For a third world country like Bangladesh where continuous developing and infrastructure related construction are taking places PCC is widely used due to its benefits such as long term strength durability green construction and sustain ability.

In other developing countries Vietnam, the Malaysia, India, Indonesia, Sri-Lanka, PCC is being used as the core cement for durable higher strength concrete and self-compacting concrete, which can be a role model of using PCC in Bangladesh in the of coming day. At present, the cement industry, in line with new sustainable development policies, has been in the last decades, different industrial by-products (fly ash, silica flume and the blast furnace slag) as active additions in the manufacturing of blended cements. This practice is mainly due to the need to reconcile inherent environmental aspects in clinker production (reduction of impacts associated with CO_2 emissions and exploitation of natural resources) with purely financial aspects and the market (Horton, 2001).

Furthermore, the use of the additions provides other benefits of scientific, technical and economic nature such as the improvement in the mechanical performance and durability of cement, as well as the reduction of energy consumptions associated with the clinkerization process. On the other hand, in PCC costly clinker is replace by cheaper Pozzolanic material hence economical. As the fly ash is finer and of lower density the bulk volume of 50 kg bag is slightly more than OPC. Therefore, PCC give more volume of mortar than OPC.

Experimental Investigation

This chapter includes the different types of experimental data required to determine the properties of brick and the properties of ingredient of concrete, processes of manufacture of the concrete & tests to determine the properties of fresh and the hardened concrete.

Tests for Fine Aggregate

Fine aggregate is the aggregate most of which passes through a 4.75mm is sieve and contain only that much coarser material as is permitted by the specification. It should be clean and free from organic substances size should be uniformly distributed. The fine aggregate that had been used in this study was locally available and Sylhet sand mixed with it. The following tests were employed to determine the properties of fine aggregate.

Sieve analysis of fine aggregate

The sieve analysis is conducted to determine the particle size distribution and fineness modulus of fine aggregate called gradation. The test method for sieve analysis of fine aggregate conforms to the ASTM standard requirements of the specifications C136. The test data and result of sieve analysis of fine aggregate shown in the following **Table 1**.

Table 1: Gradation of Fine aggregate (Sylhet sand).

Sieve Size	Weight of Retain (gm)	% of Retain	Cumulative Retain%	% finer	F.M.
#4	4.00	0.80	0.80	99.20	
#8	21.00	4.20	5.00	95.00	
#16	89.50	17.90	22.90	77.10	
#30	152.50	30.50	53.40	46.60	2.65
#50	150.0	30.00	83.40	16.60	
#100`	75.00	15.00	98.40	1.60	
Sum	492.00		263		

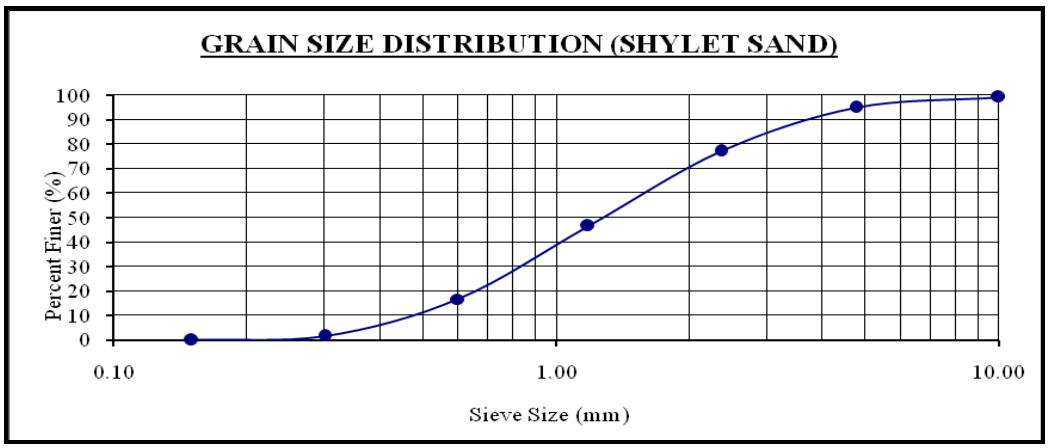

Fig. 1: Grain size distribution curve of fine aggregate (Sylhet sand).

Table 2: The other important properties of sands are tabulated.

Properties	Sylhet Sand	Method Conformed
Unit Weight (lb/ft^3)	99.01	ASTM C 29
% of Clay	1	ASTM C 128
% of Organic Content	0.615	

Unit weight of fine aggregate

This test covers the determination of unit weight in a compacted or loose condition of fine aggregates. Unit weight values of aggregate are necessary for selecting proportions for concrete mixture. They may also be used for determining mass/ volume relationship of aggregate. This test method conforms to the ASTM standards requirement of specification C 29.

Table 3: Data Table.

Item	Unit
Unit weight of fine aggregate (M)	Ib/ft^3
Mass of aggregate +cylinder (G)	20.25 (Ib)
Mass of cylinder (T)	1.37 (Ib)
Volume of Cylinder (V)	0.1934 (ft^3)

Unit weight of aggregate M = (G – T)/V
= (20.25 – 1.37)/0.1936
= 99.01 Ib/ft^3

Clay lump of fine aggregate

This is a gravimetric method for determining the clay, fine silt and fine dust which includes particles up to 20 microns. The sample for test is prepared from the main sample, taking particular care that the test sample contains a correct proportion of this fine material. The test data and result of sieve analysis of fine aggregate shown in **Table 4**.

Table 4: Data table.

Max size present in substantial proportions (mm)	Approximate Weight of sample for Test (kg)
63 to25	6
20 to12.5	1
10 to 6.3	0.5
4.75 or smaller	0.3

Clay lump test of Sylhet sand

Table 5: Data table.

Item	Unit (gm)
Weight of Sand (W)	200
Sieve + sand weight (W1)	520
After washing (by water) & drying at 100^{0}c for 24 hrs Sieves + Sand (W2)	518

$$\% \text{ of clay} = \frac{w_1 - w_2}{w} \times 100$$
$$= \frac{520 - 518}{200} \times 100$$
$$= 1\%$$

Organic content test of fine aggregate

This is an approximate method for estimating organic compounds contents in the natural sand and verify whether it is within the permissible limit. The sand from the natural source is tested as delivered and without drying. A 350 ml graduated clear glass bottle is filled to the 75 ml mark with 3 percent solution of sodium hydroxide in water. The sand is added gradually until the volume measured by the sand layer is 125ml. The volume is then made up to 200ml by adding more solution. The bottle is then stopper and shaken vigorously. Roding also may be permitted to dislodge any organic matter adhering to the natural sand by using glass rod. The liquid is then allowed to stand for 24 hours. The color of this liquid after 24 hours is compared with a standard solution.

Organic content test of Sylhet sand

Table 6: Data table.

Item	Unit (gm)
Weight of Sand (W)	20
Cup + sand weight (W1)	58.902
After drying at 800^{0}c for 30 min Cup + Sand (W2)	58.777

$$\% \text{ of Organic content} = \frac{w_1 - w_2}{w} \times 100$$
$$= \frac{58.902 - 58.777}{20} \times 100$$
$$= 0.625\%$$

Tests for Coarse Aggragate

The aggregate most of which are retained on the 4.75 mm is sieve and the contain only that much of fine material as is permitted by the specifications are termed coarse aggregate. In this study brick chips had been used as coarse aggregate.

Sieve analysis of coarse aggregate

The sieve analysis is conducted to determine the particle size distribution and fineness modulus of fine aggregate, which are call gradation. The test method for sieve analysis of coarse aggregate conforms to the ASTM standard requirements of the specifications C136. The test data and result of sieve analysis of coarse aggregate shown in following table:

Table 7: Gradation of Brick Chips (Gas Burnt).

Sieve size	Weight of Retained (gm)	Percent Retained	Cumulative Percent Retained	% of finer	F.M.
19	0.00	0.00	0.00	100.00	4.86
16	2010	40.20	40.20	49.37	
12.5	1520	30.40	70.60	4.88	
9.75	620	12.40	83.00	0.84	
4.75	640	12.80	95.80	0.00	
2.75	110	2.20	98.00	0.00	
pan	100	2.00	100.00	0.00	
sum	5000.0		4.76		

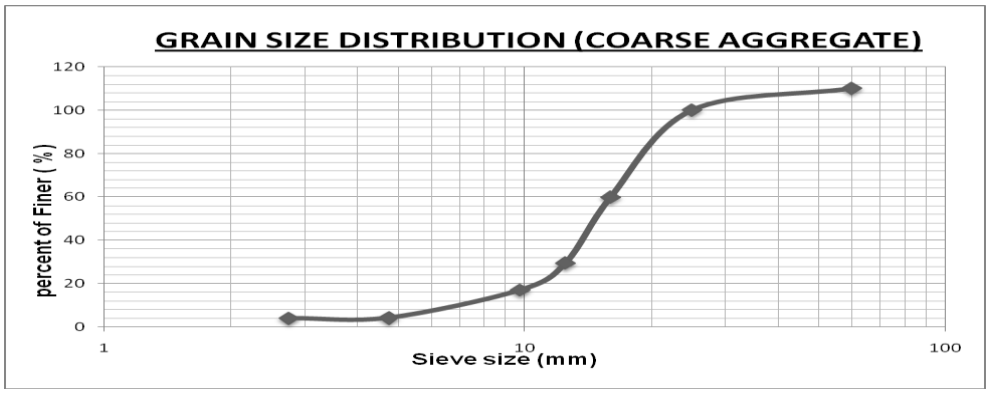

Fig. 2: Grain size distribution curve of coarse aggregate (Gas burn brick).

Test for specific gravity of brick aggregate

Aggregates generally contain pore, both permeable and impermeable, for which specific gravity has to be carefully defined with this specific gravity of each constituent known, its weight can be converted into solid volume and this is also required in calculating the compacting factor in connection with the workability measurements. This test method covers the determination of bulk specific gravity, apparent specific gravity & water absorption of fine aggregate.

Table 8: Data Table.

Aggregate	Gas burnt
Saturated surface dry weight W1(gm)	3278
Dry weight W2	3000

For gas burnt brick aggregate specific gravity

$$= \frac{W_1}{W_1 - W_3}$$

$$= \frac{3278}{3278 - 2795.3} \qquad W_3 = \text{Weight of sample in water} = 2795.3\text{gm}$$

$$= 6.79$$

Test for absorption capacity of brick aggregate

Total inter moisture content of an aggregate in the saturated surface dry condition may be termed as "absorption capacity", although it is the sometimes referred to the simply absorption values are used to calculated the change in the weight of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition. The test data and result of sieve analysis of coarse aggregate shown in **Table 9**.

Table 9: Absorption Capacity of Brick Aggregate.

Aggregate	Gas burnt
Saturated surface dry weight W1(gm)	3278
Dry weight W2	3000

For gas burnt brick aggregate,

Absorption capacity = (W1 – W2)/ W2

= (3278 – 3000) / 3000

= 0.0926

= 9.26%

Fig. 3: Photo view of 1st class brick aggregate used as coarse aggregate.

Unit weight of aggregate

This test covers the determination of unit weight in a compacted or loose condition of coarse aggregates. Unit weight values of the aggregate are necessary for use for many methods of selecting proportions for concrete mixture. They may also be used for determining mass/ volume relationship of aggregate. This test method conforms to ASTM standards requirement of specification C 29. The test data and result of sieve analysis of the coarse aggregate shown in table. This test method conforms to ASTM standards requirement of specification C 29.

Table 10: Data table.

Item	Unit
Unit weight of coarse aggregate (M)	Ib/ft3
Mass of aggregate +cylinder (G)	13.56 (Ib)
Mass of cylinder (T)	0.35 (Ib)
Volume of Cylinder (V)	0.1934 (ft^3)

Unit weight of aggregate M = (G – T)/V

= (13.56 – 0.35)/0.1936

= 68.30 lb/ft^3

Test for Binding Material

A binding material can be described as a material with adhesive and cohesive properties which make it capable of bending inert aggregate in to a compact whole of adequate strength durability. In this study OPC and PCC both are used as binding materials.

Compressive and tensile strength test of cement

Table 11: The average compressive and tensile strength of cement.

Days	Compressive strength (MPa)	Tensile strength (MPa)
03	16.87	1.10
07	19.14	1.95

Normal consistency & setting times test of cement
These test method conforms to the ASTM standard requirements of specification C 187 and C191 for normal consistency and setting times respectively. The consistency value of cement was between 22 to 30 percent by weight of dry cement. The initial setting time was 34 minutes and final setting time 250 minutes.

Water
Water in the production of concrete in order to the precipitate chemical with the cement, to weight the aggregate, & to lubricate the mixture for easy workability. Since it helps to form the strength giving cement gel. The quantity and quality of water is required to be looked in to very carefully. In this study drinking water was used in mixing of concrete. Water having harmful ingredients, salt, oil, sugar, or chemical is destructive to the strength and setting properties of the cement. It can disrupt the affinity between the aggregate and the cement paste and adversely affect the workability of mixture.

Slump Test
Slump is study to determine the consistency of fresh concrete of given proportion. Slump test is prescribed by the ASTM C-143-90a and BS 1881 part 120:1983. The test is very useful in the detecting variation in the uniformity of a mixing of given nominal proportion.

Table 12: Data table.

Types of cement	ratio	Water cement ratio	Slump (mm)
OPC	1:1.5:3	0.45	50
PCC	1:1.5:3	0.45	50
OPC	1:2:4	0.60	50
PCC	1:2:4	0.60	50

Process of Casting of the Test Specimens
Production of quality concrete requires meticulous care exercised at every stage manufacture of concrete. The various stages of casting of test specimen:

1) Batching
2) Mixing
3) Placing
4) Compacting
5) Curing

Batching
A proper and accurate measurement of all the materials used in the production of concrete is essential to ensure uniformity of proportions & aggregate grading in successive batches. In this study, volumetric batching had been used for measuring the materials.

Mixing
The objective of mixing of is to coat the surface of all aggregate particles with cement paste, & to blend all the in gradients of concrete in to a uniform mass. In this study concrete mixing had been done by tilting type mixture. Speed of the mixture was about of 15to 20 revaluations per minute. Mixing time was 5 to 6 minutes.

Placing
The methods used in placing in its final position have an important effect on its homogeneity, density and behavior in service. In this study concrete was placed cast in situ.

Compacting
The process of removal of entrapped air and of uniform placement of concrete to form a homogeneous dense mass is termed compaction. In this study hand compaction was done according to ACI code.

Curing of concrete
The physical properties of concrete depend largely on extend of hydration of cement & the resultant microstructure of the hydrate cement. Hydration of cement is activated in the presence of water. For this reason, curing of concrete is obviously required. Structural design is generally based on 28 days strength, about 70 percent of which is reached at the end of the first week after placing. In this study water curing method was used for curing of concrete. Test specimens were immersed in curing tank for 28 days.

Compressive Strength of Concrete
The compressive strength of concrete is one of the most important and useful properties of concrete. Strength of concrete is its resistance to rupture. In those cases, where strength in tension or in shear is of primary importance the compressive strength is the frequently used as a measure of these properties.

Therefore, the concrete making properties of various ingredients of mix are usually measured in term of the compressive strength. Compressive strength is also used as a qualitative measure for other properties of hardened concrete. In this study cylinder cube and cylinder specimens were used. The size of the cylinder specimen was 6-inch diameter and 12-inch height.

Fig. 4: A photo view of the crushing strength testing of cylinder.

The size of cube specimen was 6*6*6-inch universal testing machine was used to apply load capacity of the testing machine was 1000 kN.

Tensile Strength of Concrete

Although concrete is not normally designed to resist direct tension. The knowledge of tensile strength is of value in estimating the load under which cracking will develop. There are three types of test for the strength in tension:

1) Direct tension test
2) Flexure test
3) Splitting tension test

Splitting tension test

In this test a concrete cylinder, of the type used for compression test is placed with its axis horizontal between a platens of a testing machine and the load is increased until failure in direct tension. In the form of splitting along the vertical diameter takes place.

Fig. 5: A photo view of the crushing strength testing of cylinder.

RESULTS AND DISCUSSION:

Testing of harden concrete plays an important role in controlling and confirming the quality of cement concrete work. This chapter includes the test results of compressive strength of cylinder and analysis of the test results of the compressive strengths. The variation of strength under different condition and the relation between maximum size of coarse aggregate and cylinder compressive strength are presented. The following table shows the variation of the concrete strength as obtained from the experimental investigation.

Table 13: Compressive Strength of Cylinder Mix ratio= 1:1.5:3, water cement ratio = 0.45, Cement = OPC.

Day	Specimen size (mm)	Area (mm^2)	Crushing Value (N)	Compressive Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	150.30	17742.26	338000	19.05	18.51	2683.92
	152.20	18193.67	330000	18.14		
	152.50	18265.46	335000	18.34		
28	150.30	17742.26	440000	24.80	24.66	3575.85
	151.08	17926.89	439000	24.49		
	151.30	17979.13	444000	24.69		
	152.00	18145.88	472000	26.01		

60	150.73	17843.92	466000	26.12	26.12	3787.50
	151.67	18067.18	474000	26.23		
90	153.16	18423.90	478000	25.95	26.25	3806.56
	153.50	18505.79	495000	26.75		
	152.33	18224.76	475000	26.06		

Table 14: Compressive Strength of Cylinde Mix ratio= 1:1.5:3, water cement ratio = 0.45, Cement = PCC.

Day	Specimen size (mm)	Area (mm^2)	Crushing Value (N)	Compressive Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.68	18308.6	281000	15.35	15.48	2244.71
	150.16	17709.22	278000	15.70		
	150.53	17796.60	274000	15.40		
28	151.97	18138.72	432000	23.82	23.84	3456.71
	152.53	18272.65	426000	23.31		
	149.83	17631.47	430000	24.39		
60	150.00	17671.50	478000	27.05	26.77	3881.56
	152.83	18344.59	489000	26.66		
	151.57	18043.36	480000	26.69		
90	150.67	17829.72	498000	27.93	27.49	3986.77
	151.10	17931.63	487000	27.16		
	151.83	18105.31	496000	27.42		

Table 15: Compressive Strength of Cylinde Mix ratio= 1:2:4, water cement ratio = 0.60, Cement = OPC.

Day	Specimen size (mm)	Area (mm^2)	Crushing Value (N)	Compressive Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.90	18361.4	252000	13.72	13.75	1993.15
	153.07	18402.26	254000	13.8		
	152.37	18234.33	250000	13.71		
28	148.93	17420.29	336000	19.29	18.39	2667.07
	152.27	18210.4	331000	18.18		
	152.83	18344.59	325000	17.72		
60	152.23	18200.84	348000	19.12	19.27	2793.98
	151.33	17986.26	346000	19.24		
	152.23	18200.84	354000	19.45		
90	150.33	17749.34	346000	19.49	19.46	2821.49
	151.00	17907.91	349000	19.49		
	150.50	17789.51	345000	19.39		

Table 16: Compressive Strength of Cylinder Mix ratio= 1:2:4, water cement ratio = 0.60, Cement = PCC.

Day	Specimen size (mm)	Area (mm^2)	Crushing Value (N)	Compressive Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.73	18320.60	212000	11.57	11.64	1687.82
	150.57	17806.06	207000	11.63		
	150.30	17742.26	208000	11.72		
28	151.70	18074.32	322000	17.82	17.84	2586.79
	150.90	17884.19	320000	17.89		
	150.90	17884.19	319000	17.84		
60	151.23	17962.50	354000	19.71	19.81	2873
	150.73	17843.92	357000	20.01		
	150.30	17742.26	350000	19.73		
90	152.50	18265.46	368000	20.15	20.34	2949.97
	152.67	18306.20	366000	19.99		
	151.17	17948.25	375000	20.89		

Table 17: Tensile Strength of Cylinde Mix ratio= 1:1.5:3, water cement ratio = 0.45, Cement = OPC.

Day	Specimen size (mm)	Length (mm)	Area (mm^2)	Crushing Value (N)	Tensile Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.23	306	146343.21	88000	1.2	1.25	181.66
	152.83	309	148360.39	99000	1.33		
	153.83	305	147398.06	90000	1.22		
28	148.77	301	140680.13	138000	1.96	1.79	259.98
	149.33	300	140740.54	114000	1.62		
	153.63	309	149137.00	134000	1.8		
60	152.20	309	147748.82	142000	1.92	1.88	272.90
	152.23	305	145864.96	136000	1.86		
	151.43	303	144146.94	134000	1.86		
90	150.53	305	144236.04	136000	1.89	1.92	277.84
	153.37	308	148402.78	143000	1.93		
	150.67	310	146736.91	142000	1.94		

Table 18: Tensile Strength of Cylinder Mix ratio= 1:1.5:3, water cement ratio = 0.45, Cement = PCC.

Day	Specimen size (mm)	Length (mm)	Area (mm^2)	Crushing Value (N)	Tensile Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.43	305	146056.60	84000	1.15	1.12	163.11
	153.60	303	146212.58	78000	1.07		
	153.27	305	146861.47	85000	1.16		
28	152.00	300	143256.96	120000	1.68	1.73	250.88
	152.47	305	146094.92	138000	1.89		
	151.67	302	143898.91	117000	1.63		
60	152.77	305	146382.38	148000	2.02	1.95	283.29
	150.20	309	145807.31	142000	1.95		
	149.23	300	140646.29	133000	1.89		
90	150.30	308	145432.20	150000	2.06	2.02	292.56
	151.90	308	146980.38	141000	1.92		
	150.67	308	145790.22	151000	2.07		

Table 19: Tensile Strength of Cylinde Mix ratio= 1:2:4, water cement ratio = 0.60, Cement = OPC.

Day	Specimen size (mm)	Length (mm)	Area (mm^2)	Crushing Value (N)	Tensile Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	151.83	304	145004.69	60000	0.83	0.88	127.19
	149.87	306	144074.47	68000	0.94		
	150.00	306	144199.44	62000	0.86		
28	151.23	300	142531.25	85000	1.19	1.25	181.38
	152.83	305	146439.87	90000	1.23		
	153.7	305	147273.5	98000	1.33		
60	150.27	307	144931.09	110000	1.52	1.35	195.9
	152.97	307	147535.16	94000	1.27		
	149	305	142770.01	90000	1.26		
90	152	306	146122.1	100000	1.37	1.31	190.49
	150.5	306	144680.1	98000	1.35		
	151.33	304	144527.17	88000	1.22		

Table 20: Tensile Strength of Cylinder Mix ratio= 1:.2:4, water cement ratio = 0.60, Cement = PCC.

Day	Specimen size (mm)	Length (mm)	Area (mm^2)	Crushing Value (N)	Tensile Strength (MPa)	Avg. (MPa)	Avg. (Psi)
7	152.33	305	145960.78	57000	0.78	0.78	112.99
	151.83	302	144050.72	52000	0.72		
	150.00	300	141372.00	59000	0.83		
28	149.77	300	141155.23	79000	1.12	1.21	175.59
	151.10	300	142408.73	89000	1.25		
	151.13	300	142437.00	90000	1.26		
60	149.97	300	141343.73	106000	1.5	1.39	200.89
	150.97	300	142286.21	86000	1.21		
	149.53	300	140929.03	102000	1.45		
90	152.23	305	145864.96	112000	1.54	1.43	207.32
	149.83	300	141211.78	90000	1.27		
	153.33	306	147400.67	109000	1.48		

Graphical Presentation of Results

Concrete strength varies different age. Strength of PCC concrete is less than OPC concrete at the age of 28 days. After 28 days' strength of PCC concrete is increasing than OPC concrete which is investigated from below the graph.

Effect of Compressive strength PCC concrete and OPC concrete

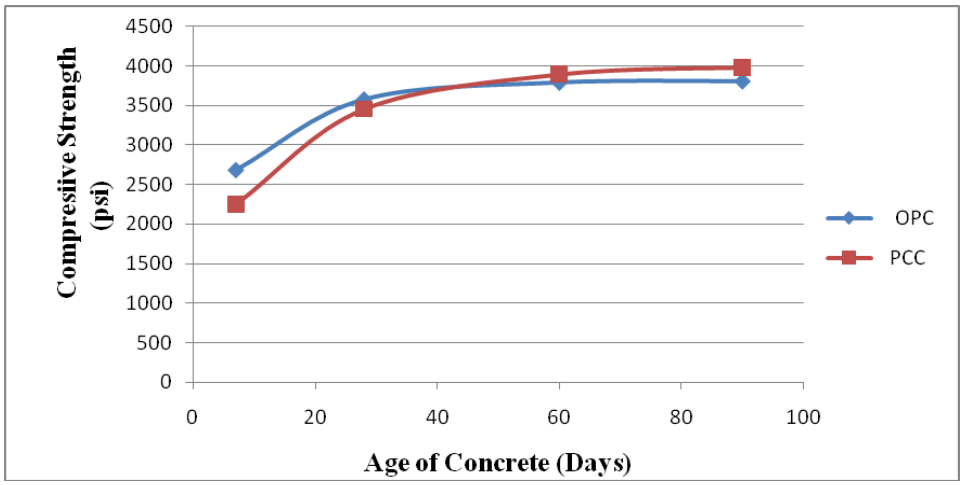

Fig. 6: Compressive strength (Psi) Vs Age of Concrete (Days) Mix ratio 1:1.5:3, water cement ratio: 0.45.

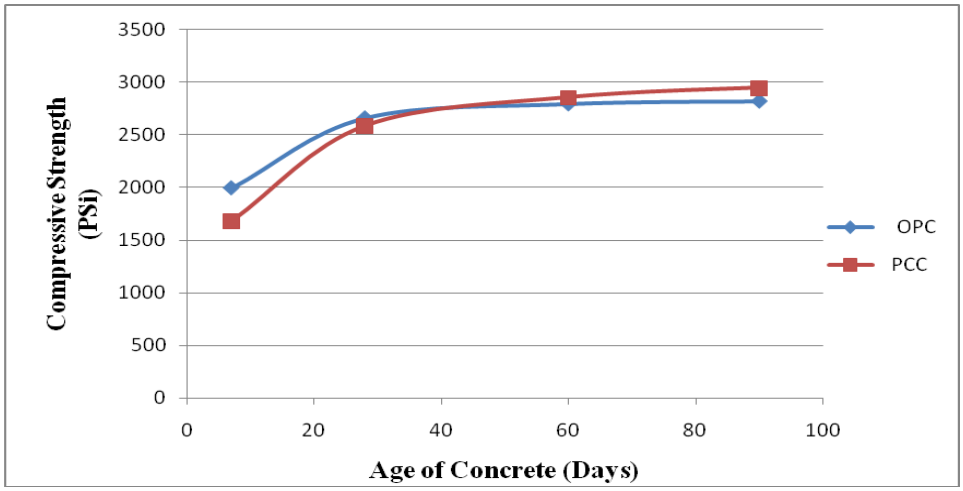

Fig. 7: Compressive strength (Psi) Vs Age of Concrete (Days) Mix ratio 1:2:4, water cement ratio: 0.6.

Effect of Tensile strength PCC concrete and OPC concrete

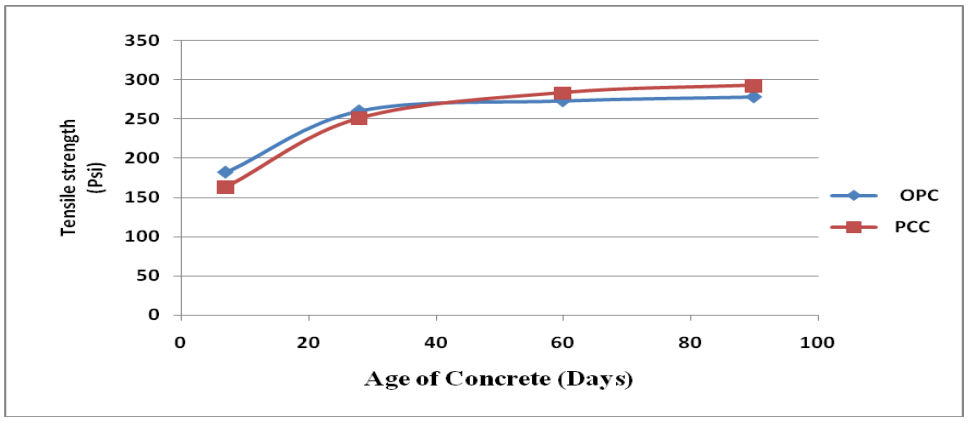

Fig. 8: Tensile strength (Psi) Vs Age of Concrete (Days) Mix ratio 1:1.5:3, water cement ratio: 0.45.

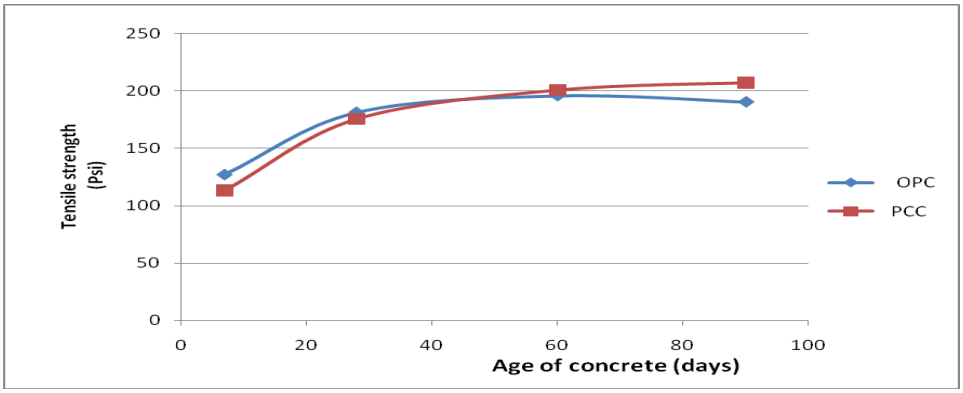

Fig. 9: Tensile strength (Psi) Vs Age of Concrete (Days) Mix ratio 1:2:4, water cement ratio: 0.6.

Discussion on Test Result

It has been found from the experimental result that at early stage that both the tensile and compressive strength is lager for concrete with OPC, which the concrete with PCC achieves higher strength at larger stage. Form the figure it can been from the continuous graph obtained by the using the experiment results that up to 40~45 days of age of concrete, concrete with OPC possess higher strength after that concrete with PCC gains larger strength than OPC concrete. However, for all the cases 28 days compressive and tensile strength is larger for the OPC concrete. Above the graph we investigate that, after 40 to 45 days the compressive strength and tensile strength of PCC concrete is increases. The increasing rate of compressive strength is 0.135% and the increasing rate of tensile strength is 0.175% up to 90 days.

CONCLUSION AND RECOMMENDATIONS:

The primary objective of this study is to obtain the effect of using Ordinary Portland cement (OPC) and Portland composite cement (PCC) on the strength of concrete with age. Mix proportion of fresh concrete, quality of the various ingredients, water/cement ratio, and compaction quality are the maintained carefully. The conclusion along with recommendation for the future study are presented in the following way.

Concrete cylinders have been prepared using brick aggregate as coarse aggregate. In the study, the fundamental parameter is types of the cement. Ordinary Portland Cement (OPC) and the Portland Composite Cement (PCC) have been used in the investigation. The following conclusion is drawn from the experimental investigation carried out in the study.

1) Concrete made with OPC gains compressive strength at (45 days) a faster rate up to a certain age of concrete. While concrete with PCC attains larger strength at later age. In this study, it has been found that up to the 45 days, the attained compressive strength of OPC concrete is larger than the PCC concrete. However, the observed compressive strength beyond 60 days is larger than OPC concrete.
2) Similar trend has been observed in the case of tensile strength.

Recommendation for Further Study

On the basis of the present study, the following recommendations are suggested for further study,

(a) Further study may be carried out for the stone aggregate as well as bond strength also.
(b) Cube specimens may be used for further study.
(c) In order to obtain the rigorous relationship, the range of parameters & number of parameters for the instance mix ratio, water cement ratio, maximum size of coarse aggregate and F.M of fine aggregate may be increased for the further study.
(d) Further study may be carried out for the bond strength also.

ACKNOWLEDGEMENT:

First of all, I would like to acknowledge the blessings as of almighty Allah for carry out the study successfully. We are like to express our sincerely gratitude to our supervisor Md. Mahfujur Rahman, Assistant Professor in the Dept. of Civil Engineering, Dhaka International University, for his constant support and guidelines during this course of research work. We are like to express our profound gratitude to Prof. Dr. Ganesh Chandra Saha, Vice-Chancellor (In-charge), Department of Civil Engineering, DIU, for guiding to write this thesis book. We are grateful to all the supporting persons in the laboratory.

CONFLICTS OF INTEREST:

We have no conflicts of interest to disclose. All of the authors declare that they have no conflicts of interest.

REFERENCES:

1) Aziz, M.A. (1973). "Engineering Material" 1st edition. Dhaka, Bangladesh. https://www.ijert.org/study-on-the-effect-of-silica-fume-on-the-properties-of-brick-aggregate-concrete
2) Ghambhir, M. L. (1993). "Concrete Technology" 1st edition, Tata *McGraw-Hill publishing Company Ltd. New Delhi, India*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8272018/
3) Hasan SMA, Billah M, Moniruzzaman M, Billah MM, Chowdhury MSH, Amin R, Parven MS, and Islam MO. (2023). Chemical attack on concrete in wastewater treatment plant: a review. *Aust. J. Eng. Innov. Technol.*, **5**(5), 192-205. https://doi.org/10.34104/ajeit.023.01920205
4) Inam I, Nasiry MK, Sediqmal M, Wahdat MN, and Momand I. (2021). A study on the carbonation rate of concrete exposed in different climatic conditions. *Aust. J. Eng. Innov. Technol.*, **3**(6), 128-136. https://doi.org/10.34104/ajeit.021.01280136
5) Krishna Raju, N. (1993). "Design of Concrete Mixes" 3rd edition, *CBS publishers and distributors, New Delhi, India*. https://www.simplifiedcivil.com/2023/04/testing-of-aggregates-flakiness-and-elongation-test-pdf.html
6) Neville, A.M. (1941). "Properties of Concrete" 3rd edition, *London, Pitman publishing limited* (119-339). https://www.civilalliedgyan.com/2021/04/
7) Nilson, H. (1979). "Design of Concrete Structure" 7th edition, *McGraw-Hill publishing Company Ltd*. https://www.astm.org/c0029_c0029m-07.html
8) Nilson, H. (1997). "Design of Concrete Structure" 12th edition, printed in Singapore. https://www.constructioncivil.com/sieve-analysis-of-coarse-aggregate-test/
9) Shetty, M. S. (1986). "Concrete Technology" 2nd edition, published by *S. Chand & Company Ltd, New Delhi, India*. http://www.iscowa.org/cdrom09/pdf/present/pozzol/vegas.pdf

Citation: Basar MA, Hoque M, Hossain S, Hosain M, and Latif MA. (2023). Study on the effect of OPC, and PCC on the properties of concrete. *Aust. J. Eng. Innov. Technol.*, **5**(6), 216-228. https://doi.org/10.34104/ajeit.023.02160228