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POSSIBLE USE OF FLY ASH GENERATED FROM BARAPUKERIA POWER PLANT FOR SUSTAINABILITY

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ABSTRACT
Fly ash is extensively used in concrete as an admixture in order to reduce cost of cement. For sustainability in production of cement in Bangladesh, feasibility of fly ash generated from Barapukoria Power Plant was tested. This was used as an admixture with Shah Special cement in different proportion in order to reduce cost of cement and environmental pollution such as green house effect, problem of fly ash as solid waste. Laboratory test for different parameters such as compressive strength, workability of such mixtures were performed. The results show almost no sacrifice for the strength of cement due to mixture of fly ash with a proportion of 10%. The results show that curing of the even plain concrete in chloride environment is not desirable right from the time of demoulding

Keywords: fly ash, admixture, strength, concrete, cement, cost, pollution.

INTRODUCTION
Fly ash is extensively used in concrete as an admixture in order to reduce cost of cement. Up to 25% to 30% industrial fly ash was successfully blended with ordinary Portland cement without sacrificing strength and durability characteristics [1, 2]. In this study fly ash was colleted from Barapukoria Power Plant. Coal from Barapokoria was colleted and made it to ash by burning at 1200-1500^{0}C. Table-1 shows the chemical characteristics of fly ash.

Table-1. Characteristics of fly ash of Barapukaria Power Plant.

Constituents	% Weight
SiO_2	23.72
Al_2O_3	5.30
Fe_2O_3	2.8
CaO	65.80
MgO	1.26
K_2O	1.60
Surface area	755 m^2/g

Source: [3]

The data contained in Table-1 indicates that the percentage of reactive silica was 23.72, which is higher than that of fly ash of Kalurghat Power Plant [2].

MATERIALS AND METHODS
A concrete mix with a characteristics mean strength of 20Mpa was designed with an aggregate cementations ratio of 5.76 and water-cement ratio of 0.539. The total content of cementations material was maintained at 337kg/m^2. The fly ash/total cementations ratios used for replacement were 0.05, 0.10, 0.15, 0.20 apart from the plain concrete without any fly ash. The fineness of the fly ash used was 16,000cm^2/g on Blaine's apparatus as it was found that this fineness gave maximum strength.

For each of the fly ash addition, concrete cubes were cast as per design mix as per the specifications given ASTM. For determining, the flexural strength, beam specimens of 100mm x 100mm x 500mm was cast for all the fly ash. For determining, splitting tensile strength cylindrical specimens of 100mm diameter and 300mm long were cast for different fly ash contents.

Cubes of 100mm size of M20 grade concrete with the mix proportion of 0.465:1:1.70: 1.77- water: cement: fine aggregate: coarse aggregate were cast. 30 cubes each were immersed just after de-molding in 3 different sodium chloride solutions having salt concentration of 50, 100 and 150 g/l. One set of 30 cubes was cured under similar conditions in tap water as reference. Compressive strength was measured after curing 28, 120 and 540 days. The weights of the cubes cured in water and chloride solutions were measured at the time of demoulding (after 24hr of casting).

RESULTS AND DISCUSSION
The water content of a paste has a marked effect upon the time of set as well as upon other properties. The paste at normal consistency is fairly stiff and is used only for determination of time of set and soundness. The effect of increase of fly ash content on water content is shown in Table-2.

A soft plastic paste of Portland cement and water gradually becomes less plastic and finally becomes less stiff and hard. When the paste becomes sufficiently stiff it is said to have set. The definition of the term stiffness of the paste, which is considered, set is somewhat arbitrary.

Two terms, "initial" and "final" are used to distinguish between the beginning and ending of setting. The term hardening means a gain of strength of a cement paste follows the final setting. For practical reasons, it is essential that cement should set neither too rapidly nor too slowly. If a cement paste sets very rapidly there might be insufficient time to transport and place concrete before it becomes too stiff. This setting process is always accompanied by temperature changes in the paste, initial set corresponds to a rapid rise in temperature and final set to the peak temperature. Table-3 presented the effect on initial and final setting time by mixing of fly ash with cement.

Table-2. Comparison table of water content for Shah Special Cement, Shah Special Cement with 5%, 10%, 15% and 20% fly ash, respectively.

Type	Shah special cement	Shah special cement with 5% Fly ash	Shah special cement with 10% Fly ash	Shah special cement with 15% Fly ash	Shah special cement with 20% Fly ash
Water content (%)	28.6	29	28	27	27
Water content (ml)	185.9	188.5	182	175.5	172.4

Table-3. Comparison table for Setting Time of Shah Special Cement, Shah Special Cement with 5%, 10% , 15% and 20% Fly ash respectively.

Type	Shah special cement	Shah special cement with 5% Fly ash	Shah special cement with 10% Fly ash	Shah special cement with 15% Fly ash	Shah special cement with 20% Fly ash
Initial setting time (minutes)	135	90	120	75	72
Final setting time (minutes)	195	150	180	135	132

Workability

From Figure-1, it can be observed that for the fly ash concretes; there is an improvement in workability up to 10% of replacement beyond which it is reduced for replacements up to 20%. Similar results were reported by other researchers [4,5].

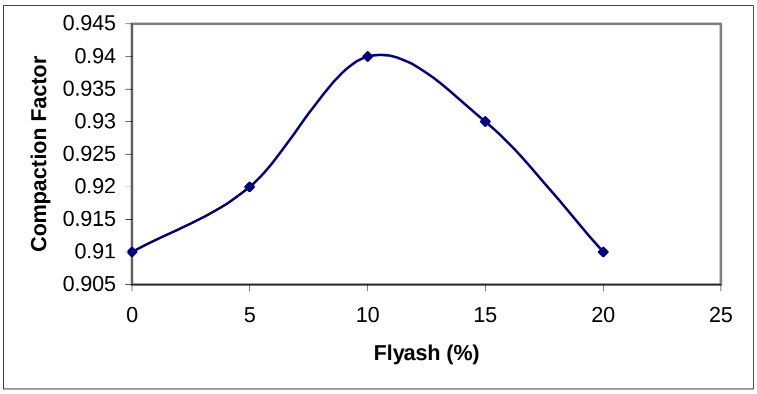

Figure-1. Variation of compaction factor with percentage of fly ash.

Compressive strength

The compressive strength of high fly ash concrete for a given cement ratio, decreases as the fly ash content increases. Rao [6] reported that addition of 30% rich hush ash with fly ash (30-60%) showed in improvements in 7-days strengths from 31% to 53%. Table-4 shows the effect of fly ash on compressive strength. The above analysis clearly indicates that the presence of silica in fly ash of Barapokoria Power Plant has a complex impact on compressive strength. Otherwise percentage of reduction of strength (compressive) would be more.

Table-4. Comparison table for compressive strength of Shah Special Cement, Shah Special Cement with 5%, 10%, 15% and 20% fly ash, respectively.

Types of cement / **Age** (Days)	**Stress** (psi) **of Shah special cement**	**Stress** (psi) **of Shah special cement with 5% Fly ash**	**Stress** (psi) **of Shah special cement with 10% Fly ash**	**Stress** (psi) **of Shah special cement with 15% Fly ash**	**Stress** (psi) **of Shah special cement with 20% Fly ash**
3	2332.08	2187.08	2189.01	2165.33	2078.45
7	3169.06	2929.84	3196.28	3081.25	2976.42
28	4046.46	3547.18	3991.4	3651.1	3579.55

Chloride resistance of fly ash based cement

The compressive strength of different specimens is shown in Table-5. Each point on a table is the average of ten test values. The relative compressive strength of fly ash-based cement cured in chloride solutions to the strength of sample cured in tap water is presented in Table-5. It is clear that curing of the even plain concrete in chloride environment is not desirable right from the time of demoulding. The percentage changes in weights of fly ash based cubes in chloride solutions and in tap water are presented in Table-6. The data contained in Table-6 indicates the diffusion of chloride salts in samples cured in the chloride solutions and in tap water at the curing period of 28, 120 and 540 days, respectively. Table-6 pertaining to samples at specific curing period indicates steeper profiles against chloride salt concentration increase.

Table-5. Change of strength ratio with salt concentration.

Salt concentration (g/l)	**Strength ratio**		
	28 days	**120 days**	**540 days**
0	1.00	1.00	1.00
50	0.97	0.96	0.84
100	0.89	0.94	0.84
150	0.78	0.72	0.79

Table-6. Change of weights with salt concentration.

Salt concentration (g/l)	**% of weights**		
	28 days	**120 days**	**540 days**
0	0.34	0.55	0.80
50	0.70	1.10	1.30
100	0.82	1.20	1.34
150	0.98	1.34	1.42

CONCLUSION

From this study, the following conclusion can be made:

- The waste from the Power Plant is extensively used in concrete as a partial replacement for cement and an admixture and is used as a suitable conventional material for road constructions.
- From the test results, it is observed that 5-10% Barapukaria fly ash was successfully blended

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with ordinary Portland cement without sacrificing strength and durability characteristics.

- It was observed that the geotechnical properties of fly ash are suitable for the use of conventional material in building and road constructions.
- The analysis of the samples at specific curing period indicates steeper profiles against chloride salt concentration increase.
- Fly ash is actually a solid waste. Hence it is priceless. The use of fly ash in Portland cement is economical and environment friendly. It can also reduce the cost of production of cement.

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