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ANALYSIS OF COST (M30 GRADE) OF CONCRETE BY PARTIAL REPLACEMENT OF FLY ASH WITH CEMENT AND ADDITION OF STEEL FIBER

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ABSTRACT

This paper discussed an experimental study of M30 Grade of concrete using fly ash, steel fiber, cement, coarse aggregate and fine aggregate. Fly ash is the waste material produced from many thermal power. The disposal of fly ash is the one of major issue for environmentalists as dumping of fly ash as a waste material may cause severe environmental problem. A waste material with prompts to breathing issues and numerous destructive sicknesses which discharges heaps of dangerous. The cost of the development material is expanding step by step in creating nation which leads in the exploration of the option material in the structural designing development. Presently work is going on development material to diminish the cost of the development. So in this examination paper fly ash is being utilized as option material. Concrete with the typical total and fly ash with the 10%, 20% and 30% of supplanting with fly ash. Details of cost for 1.00 cum of concrete and the quantity of material was required 0.28 tonne of cement, 0.42 cubic meter of fine aggregate, 0.74 cubic meter of coarse aggregate, 2.75kg of steel fiber, 0.10 cubic meter of fly ash produces the desired strength and cost of M30 Grade of concrete.

Keywords: *Concrete, steel fiber, fly ash, compressive strength and cost.*

1. INTRODUCTION

Concrete is very strong in compression but weak in tension, the tensile strength of concrete is less due to widening of micro cracks existing in concrete subjected to tensile stress (Sabeena et al. 2016). Due to this, steel fiber is generally taken as a solution to develop concrete in view of enhancing its flexural and tensile strength. Fly ash is a waste product from thermal power plants (Rafat et al. 2013). The disposal of fly ash is one of major issue for environmentalists, as dumping of fly ash causes severe environmental problem (Nawaz et al. 2013). Utilization of fly ash as low cost material in concrete, instead of dumping it as waste material, and have great commercial and environmental benefits (Anita et al. 2016). It can be used particularly in mass concrete applications where main emphasis is to control the thermal expansion due to heat of hydration of cement paste (Edwin et al. 1950). It also helps in reducing thermal and shrinkage cracking of concrete at early stages (Sabeena et al. 2016). The replacement of cement with fly ash in concrete also helps to conserve energy (Nawaz et al. 2013). The inherent weakness in the concrete is to crack under small loads, at the tensile end and gradual propagation of cracks to the compression end of the member is taken care by addition of steel fiber. This is done to increases its structural integrity. The steel fiber added to concrete mix is measured as percentages of the total weight of composites. The composites matrix that is obtained by combining cement, fly ash, aggregates and steel fibers is known as “Steel fiber with fly ash concrete”. The fiber in the cement fly ash based matrix acts as cracks arresters, which restrict the growth of micro cracks and prevent these from enlarging under load (Sabeena et al. 2016. This type of mixture is not only reliable it is also cost effective.

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2. MATERIALS AND METHODS

Materials

Cement

The cement used in this experimental work is 43 grades Ordinary Portland cement. All properties of cement are tested by referring IS 12269-1987 specification for 43 grade Ordinary Portland cement.

Fine Aggregate

Locally available sand passed through 4.75 mm IS sieve was used. Fine aggregate of Specific gravity 2.84 and fineness modulus of 3.895 were used. (IS Code 383-1970)

Coarse Aggregate

20mm maximum size aggregate. Crushed aggregate available from local sources was used. The coarse aggregates with a maximum size of 20mm having the specific gravity value of 2.958 and fineness modulus of 7.136 were used as coarse aggregate. (IS Code 383-1970)

10mm maximum size aggregate. Crushed aggregate available from local sources was used. The Coarse aggregates with a maximum size of 10mm having the specific gravity value of 3.016 and fineness modulus of 5.829 were used as coarse aggregate. (IS Code383-1970)

Water

Potable water used for prepare the mixture.

Steel Fiber

Steel Fiber with hooked ends of high-quality low carbon steel wire, with the characteristics of the high tensile strength, good toughness, and low price was used for concrete strengthening.

The content of steel fiber was varied from 0.5% steel fibers to 2% are used in the total volume of concrete

Fly Ash

Fly ash usually refers to ash produced during combustion of coal. Rafat Siddique et al 2008 Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash.

Mix Design

Mix design is known as the selection of mix ingredients and the proportion required in a concrete mix. In the present study the mix was prepared as per guidelines provided in IS Code: 10262-2009. The mix design takes care of the amount of cement, fine aggregate and coarse aggregate in addition to other related parameters depending on the properties of constituent material

The proportions for normal mix of M30 (1:1.7:2.6). Normal Mix was prepared as per IS Code: 10262-2009:

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Table no 1: mix design for m30 grade concrete:

Target Mean Strength	**38.28 Mpa**
Water cement ratio (w/c ratio)	0.45
Water content	191.58L
Cement content	425.73 kg/m^3
Fine aggregate content	674.04 kg/m^3
Coarse aggregate content	1151.4 kg/m^3

Test Specimen

Cubes of size (150x150x150) mm^3 were prepared using the standard modulus. The samples ware casted using the standard moulds. The samples ware casted using different percentages of fly ash (0%, 10%, 20% & 30%).
In the second set of experiments the content of steel fiber was varied from (0.5%, 1%, 1.5% & 2%), keeping other parameters constant. The samples ware demoulded after 24 hours from casting. Cubes ware kept in tank filled with water for 7, 21& 28 days.

Compressive Strength Test
For compressive strength test, for the cubes of dimensions 150 x 150 x 150 mm casted and cured as described in section 2.2 were tested on digital compression testing machine as per I.S. 516-1959. The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

Cost analysis: According to the DSR (Delhi schedule rate) 2014, each data was analysed and taken as reference for all the material required in the present research. The details was given in Table 3, 4, 5 and 6.

3. Results and discussions

Tests adopted for measurement of workability in the present investigation.

- Compressive tests were conducted on cube samples in accordance with the specification of Bureau of Indian Standards. The results for each sample was shown in table 2. The target mean strength was achieved even in 30 % of Fly ash replacing the cement wit adding 1% of steel fiber.

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Table No.2: Compressive Strength of cubic samples (Huda et al. 2017)

S.N	% FLY ASH	%STEEL FIBER	7 days Mpa	21 days Mpa	28 days Mpa
1	0%	0	31.76	38.66	42.51
2	0%	0.5	27.43	33.57	40.39
		1	31.63	39.42	42.35
		1.5	30.20	37.06	40.73
		2	28.45	34.66	38.07
3	10%	0.5	25.63	40.2	40.2
		1	30.90	43.8	44.76
		1.5	29.90	39.7	39.5
		2	26.66	33.25	39.86
4	20%	0.5	22.07	31.67	33.09
		1	30.45	40.41	41.36
		1.5	26.86	36.73	40.86
		2	25.03	30.9	37.13
5	30%	0.5	23.30	35.6	36.7
		1	25.80	37.03	40.2
		1.5	24.20	29.2	35.6
		2	21.60	28.23	33.09

- Cost Analysis. The cost was analyzed for all the sample taken which was achieving the target mean strength. The details were given in figure 1, 2 and Table 3, 4, 5, 6. 30 % of Fly ash replacing the cement with adding 1% of steel fiber, the cost was reduced effectively. Thus achieved the target by replacing the cement and make the concrete cost effective

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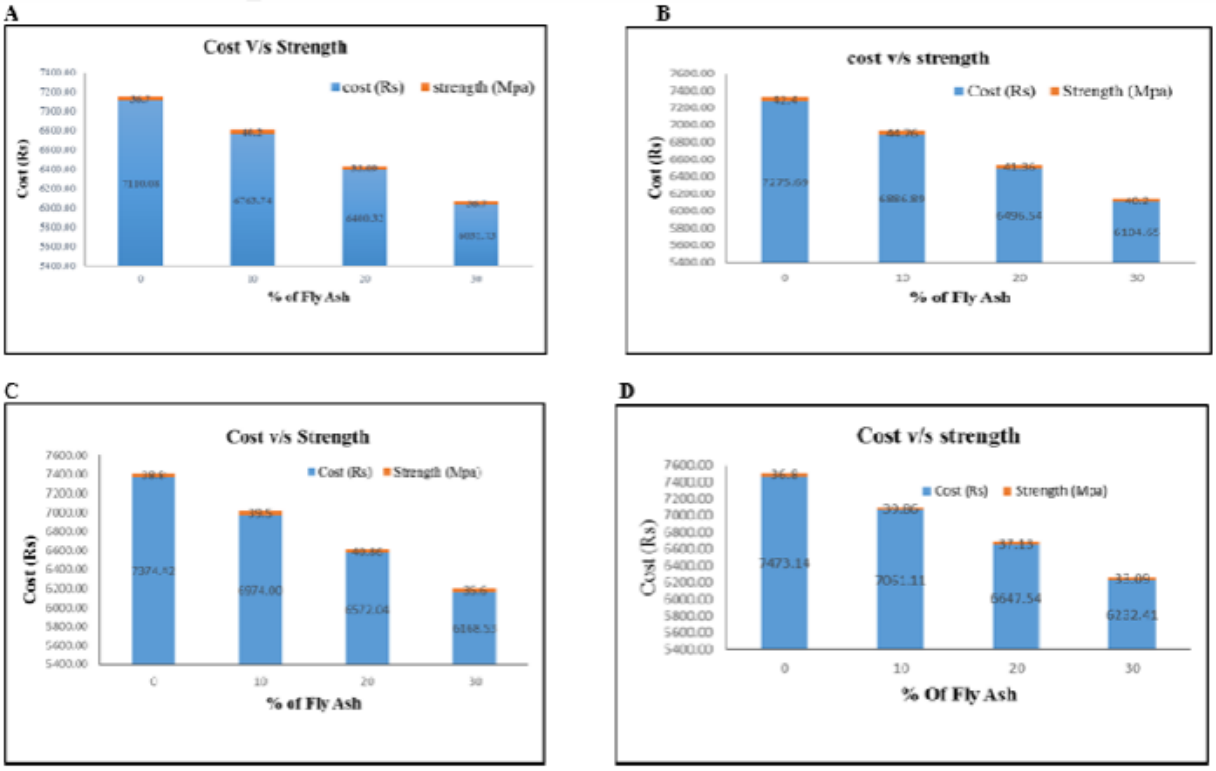

Figure 1. A, B, C, D shows variation in cost at different concentration of fly ash (0%,10%, 20% and 30%) with steel fiber (0.5%,1%,1.5% and 2%) respectively in concreate mix.

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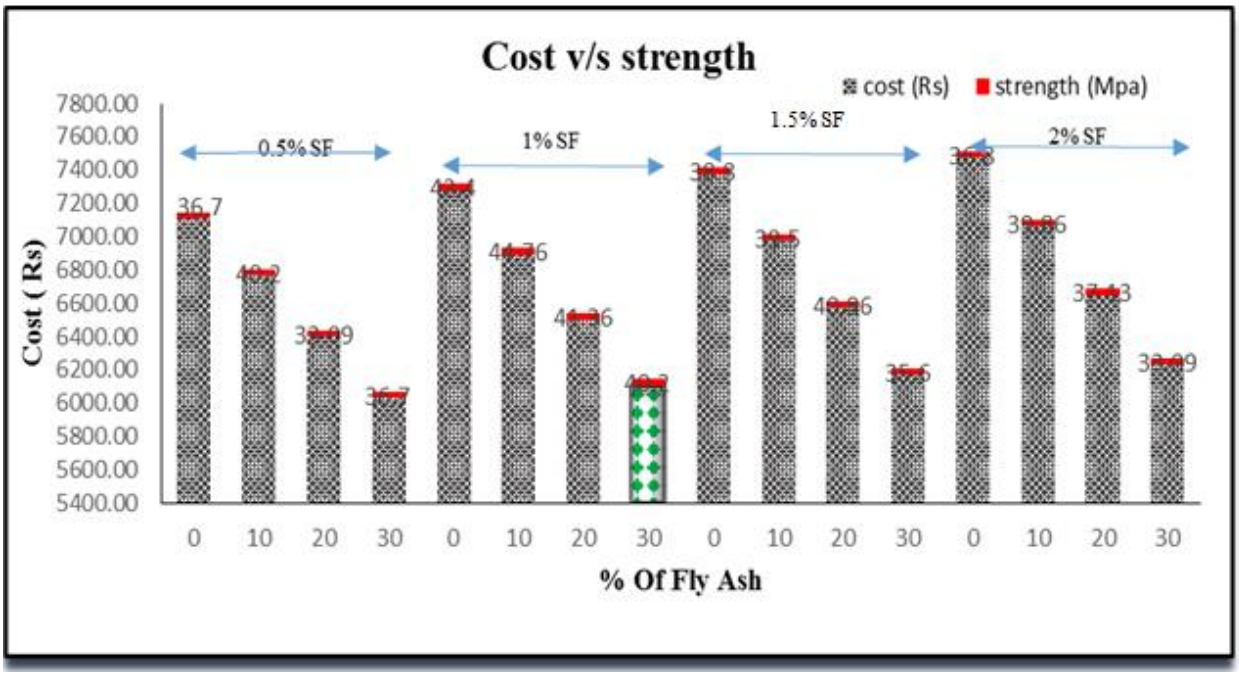

Figure 2. Represent cost v/s strength

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Table no.3: Detail of cost for 1.00 cum with 0.5% steel fiber

Details of cost for 1.00 cum with 0.5 % steel fiber															
			0% flyash			10% flyash			20% flyash			30% flyash			
DSR code	Description	unit	Quantity	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Remark
295	Coarse Aggregate (Size 20mm).	cum	0.78	1175.00	921.17	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	Density of 20mm stone = 1560 kg/m³
2202	Carriage of stone aggregate below 40 mm nominal size	cum	0.78	106.49	83.49	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	
982	Coarse sand (zone III)	cum	0.37	1200.00	438.00	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	Density of coarse sand =1600kg/m³
2203	Carriage of Coarse sand	cum	0.37	106.49	38.87	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	
367	opc cement	tonne	0.43	6300.00	2677.50	0.38	6300.00	2362.50	0.33	6300.00	2047.50	0.28	6300.00	1732.50	
2209	Carriage of cement	tonne	0.43	94.65	40.23	0.38	94.65	35.49	0.33	94.65	30.76	0.28	94.65	26.03	
1980	fly ash (grade f)	cum	0.00	8.00	0.00	0.06	8.00	0.50	0.12	8.00	0.99	0.15	8.00	1.18	Density of fly ash=860kg/m³
	Carriage of fly ash	kg	2.13	40.00	42.13	1.88	40.00	41.88	1.63	40.00	41.63	1.38	40.00	41.38	
2262	steel fiber (both side hooked)	cum	0.00	106.49	0.00	0.06	106.49	6.60	0.12	106.49	13.19	0.15	106.49	15.65	
2	Concrete Mixer and CTM machine charges	day	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	
	LABOUR:														
155	Mason	day	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	
114	Beldar	day	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	
101	Bhisti	day	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	
12	Vibrator (Needle type 40 mm)	day	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	
	TOTAL				6121.47			5823.28			5510.39			5193.05	
	Add miscellaneous & Water Charges @ 1%				61.21			58.23			55.10			51.93	
	Total Amount				6182.68			5881.51			5565.50			5244.98	
	add 15% of contractor profit				927.40			882.23			834.82			786.75	
	SUB TOTAL				7110.08			6763.74			6400.32			6031.73	
	COST FOR 1 CUM				7110.08			6763.74			6400.32			6031.73	

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Table no.4: Detail of cost for 1.00 cum with 1% steel fiber

Details of cost for 1.00 cum with 1 % steel fiber															
			0% fly ash			10% fly ash			20% fly ash			30% fly ash			
DSR code	Description	unit	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Remark
295	Coarse Aggregate (Size 20mm).	cum	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	Density of 20mm stone = 1560 kg/m³
2202	Carriage of stone aggregate below 40 mm nominal size	cum	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	
982	Coarse sand (zone III)	cum	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	Density of coarse sand = 1600kg/m³
2203	Carriage of Coarse sand	cum	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	
367	opc cement	tonne	0.43	6300.00	2677.50	0.38	6300.00	2362.50	0.33	6300.00	2047.50	0.28	6300.00	1732.50	
2209	Carriage of cement	tonne	0.43	94.65	40.23	0.38	94.65	35.49	0.33	94.65	30.76	0.28	94.65	26.03	
1980	fly ash (grade f)	cum	0.00	8.00	0.00	0.04	8.00	0.35	0.08	8.00	0.60	0.10	8.00	0.77	Density of fly ash = 860kg/m³
2262	Carriage of fly ash	cum	0.00	106.49	0.00	0.04	106.49	4.64	0.08	106.49	8.05	0.10	106.49	10.22	
	steel fiber (both side hooked)	kg	4.25	40.00	170.00	3.75	40.00	150.00	3.25	40.00	130.00	2.75	40.00	110.00	
2	Concrete Mixer and ctm machine charges	day	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	
	LABOUR:														
155	Mason	day	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	
114	Beldar	day	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	
101	Bhisti	day	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	
12	Vibrator (Needle type 40 mm)	day	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	
	TOTAL				6264.05			5929.31			5593.23			5255.83	
	Add miscellaneous & Water Charges @ 1%				62.64			59.29			55.93			52.56	
	Total Amount				6326.69			5988.60			5649.17			5308.39	
	add 15% of contractor profit				949.00			898.29			847.38			796.26	
	SUB TOTAL				7275.69			6886.89			6496.54			6104.65	
	COST FOR 1 CUM				7275.69			6886.89			6496.54			6104.65	

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Table no.5: Detail of cost for 1.00 cum with 1.5% steel fiber.

Details of cost for 1.00 cum using 1.5% steel fiber														
			0% fly ash			10% fly ash			20% fly ash			30% fly ash			
DSR code	Description	unit	Quantity	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Remark
295	Coarse Aggregate (Size 20mm).	cum	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	Density of 20mm stone = 1560 kg/m³
2202	Carriage of stone aggregate below 40 mm nominal size	cum	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	
982	Coarse sand (zone III)	cum	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	Density of coarse sand = 1600kg/m³
2203	Carriage of Coarse sand	cum	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	
367	opc cement	tonne	0.43	6300.00	2677.50	0.38	6300.00	2362.50	0.33	6300.00	2047.50	0.28	6300.00	1732.50	
2209	Carriage of cement	tonne	0.43	94.65	40.23	0.38	94.65	35.49	0.33	94.65	30.76	0.28	94.65	26.03	
1980	fly ash (grade f)	cum	0.00	8.00	0.00	0.04	8.00	0.35	0.08	8.00	0.60	0.10	8.00	0.77	Density of fly ash = 860kg/m³
2262	Carriage of fly ash	cum	0.00	106.49	0.00	0.04	106.49	4.64	0.08	106.49	8.05	0.10	106.49	10.22	
	steel fiber (both side hooked)	kg	6.38	40.00	255.00	5.63	40.00	225.00	4.88	40.00	195.00	4.13	40.00	165.00	
2	Concrete Mixer and CTM machine charges	day	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	
	LABOUR:														
155	Mason	day	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	
114	Beldar	day	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	
101	Bhisti	day	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	
12	Vibrator (Needle type 40 mm)	day	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	
	TOTAL				6349.05			6004.31			5658.23			5310.83	
	Add miscellaneous & Water Charges @ 1%				63.49			60.04			56.58			53.11	
	Total Amount				6412.54			6064.35			5714.82			5363.94	
	add 15% of contractor profit				961.88			909.65			857.22			804.59	
	SUB TOTAL				7374.42			6974.00			6572.04			6168.53	
	COST FOR 1 CUM				7374.42			6974.00			6572.04			6168.53	

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Table no.6: Detail of cost for 1.00 cum with 2% steel fiber.

Details of cost for 1.00 cum with 2% steel fiber														
			0% fly ash			10% fly ash			20% fly ash			30% fly ash			
DSR code	Description	unit	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Quantity (cum)	Rate	Amount	Remark
295	Coarse Aggregate (Size 20mm).	cum	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	0.74	1175.00	867.24	Density of 20mm stone = 1560 kg/m³
2202	Carriage of stone aggregate below 40 mm nominal size	cum	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	0.74	106.49	78.60	
982	Coarse sand (zone III)	cum	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	0.42	1200.00	505.53	Density of coarse sand = 1600kg/m³
2203	Carriage of Coarse sand	cum	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	0.42	106.49	44.86	
367	opc cement	tonne	0.43	6300.00	2677.50	0.38	6300.00	2362.50	0.33	6300.00	2047.50	0.28	6300.00	1732.50	
2209	Carriage of cement	tonne	0.43	94.65	40.23	0.38	94.65	35.49	0.33	94.65	30.76	0.28	94.65	26.03	
1980	fly ash (grade f)	cum	0.00	8.00	0.00	0.04	8.00	0.35	0.08	8.00	0.60	0.10	8.00	0.77	Density of fly ash = 860kg/m³
2262	Carriage of fly ash	cum	0.00	106.49	0.00	0.04	106.49	4.64	0.08	106.49	8.05	0.10	106.49	10.22	
	steel fiber (both side hooked)	kg	8.50	40.00	340.00	7.50	40.00	300.00	6.50	40.00	260.00	5.50	40.00	220.00	
2	Concrete Mixer and CTM machine charges	day	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	1.00	800.00	800.00	
	LABOUR:														
155	Mason	day	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	0.17	417.00	70.89	
114	Beldar	day	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	2.00	329.00	658.00	
101	Bhisti	day	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	0.90	363.00	326.70	
12	Vibrator (Needle type 40 mm)	day	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	0.07	350.00	24.50	
	TOTAL				6434.05			6079.31			5723.23			5365.83	
	Add miscellaneous & Water Charges @ 1%				64.34			60.79			57.23			53.66	
	Total Amount				6498.39			6140.10			5780.47			5419.49	
	add 15% of contractor profit				974.76			921.01			867.07			812.92	
	SUB TOTAL				7473.14			7061.11			6647.54			6232.41	
	COST FOR 1 CUM				7473.14			7061.11			6647.54			6232.41	

4. CONCLUSIONS

Based on the compressive strength and tensile strength it can be concluded that the optimum percentage of steel fiber to be added in the concrete mix is 1% by volume fraction. The combination of cement with fly ash concrete with the addition of steel fiber and the replacing the 30% of cement with fly ash in the addition of 1% of steel fiber, it will get the minimum cost (5283.64 Rs), Also get our target mean strength (38.28). So combination is economical.

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