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Concept of Regression Analysis in Concrete Mix Design

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ABSTRACT

In civil engineering, on site concrete mixing is very important .To determine compressive strength of concrete mix, statistical method is very useful. Regression analysis is an effective statistical technique. By analysing the laboratory concrete block/ cylinder tests , we can determine not only the correlation between compressive strength at different curing ages of concrete but also variation in material properties, ratios and variation in % of fly ash as a partial replacement of concrete.

Keywords: *Statistical analysis, compression strength ,concrete mix design , fly ash , correlation between compressive strength and days of curing.*

I. INTRODUCTION

We use concrete as a construction material worldwide. Because of its advantages like low cost, availability of construction, workability, durability and convenient compressive strength. These advantages depend on the concrete mix, placing and curing. In construction industry, strength is a primary criterion in selecting a concrete for a particular application .Concrete used for construction gains strength over a long period of time after pouring. The characteristics strength of concrete is defined as the compressive strength of a sample that has been aged for 90 days.

The aim of the present study is to predict compressive strength of concrete for a given samples made by using industrial waste fly ash as a partial replacement of cement of different hoppers for different concrete grades like M20, M25 and M30 at curing ages of 7, 28 and 90. And finding correlation between them by using regression analysis.

In this project, we add fly ash as a partial replacement of concrete. And percentage of fly ash varies from 0% to 37.5%. The work presented in this project reports an investigation on the behaviour of concrete produced from blending cement with FA. Percentages of fly ash are 0%, 12.50%, 25.00% and 37.50% for each hopper of namely 1, 2, 3 for M20, M25 and M30 grades. The utilization of fly ash as cement replacement material in concrete or as additive in cement introduces many benefits from economical, technical and environmental point of view.

II. EXPERIMENTAL DATA

Since the aim this study is studying the effect of mix proportions on the compressive strength of concrete, different mixes were used. The details of all mix proportions are shown in Tables below.

Compressive strength test was performed and evaluated. Specimens were immersed in water until the day of testing at 7, 28 and 90 days. Tables below show the test results.

TABLE I : PHYSICAL PROPERTIES

Test Conducted	Cement	Hopper No: 1	Hopper No:2	Hopper No:3
Specific gravity (gm/cc)	3.15	2.040	2.061	2.173
Fineness % by wt by sieving (%retention on 45 micron sieve-wet sieving)	….	45.55	24.45	2.70
Fineness (specific surface)(Sq.m./kg) By Blains Air Permeability	….	229	320	536

QUANTITIES FOR M20 GRADE OF CONCRETE

Same for hopper no 1 , 2 and 3

Sr no	1	2	3	4
CEMENT(Kg/m3)	383	383	383	383
FA(%)	00.00	12.50	25.00	37.50
FA(Kg/m3)	00.00	47.87	95.75	124.47
CEMENT(Kg/m3)	383.00	335.13	287.25	258.53
SAND(Kg/m3)	559.00	559.00	559.00	559.00
AGG(Kg/m3)	1213.00	1213.00	1213.00	1213.00
WATER (Lit)	186.71	186.71	186.71	186.71

QUANTITIES FOR M25 GRADE OF CONCRETE:

Same for hopper no 1 , 2 and 3

Sr no	1	2	3	4
CEMENT(Kg/m3)	456	456	456	456
FA(%)	00.00	12.50	25.00	37.50
FA(Kg/m3)	00.00	57.00	114.00	171.00
CEMENT(Kg/m3)	456.00	399.00	342.00	285.00
SAND(Kg/m3)	540.00	540.000	540.00	540.00
AGG(Kg/m3)	1171.00	1171.00	1171.00	1171.00
WATER (Lit)	186.877	186.877	186.877	186.877

QUANTITIES FOR M30 GRADE OF CONCRETE

Same for hopper no 1 , 2 and 3

Sr no	1	2	3	4
CEMENT(Kg/m3)	479	479	479	479
FA(%)	00.00	12.50	25.00	37.50
FA(Kg/m3)	00.00	59.875	119.75	179.625
CEMENT(Kg/m3)	479.00	419.125	359.25	299.375
SAND(Kg/m3)	534.00	534.00	534.00	534.00
AGG(Kg/m3)	1132.00	1132.00	1132.00	1132.00
WATER (Lit)	186.80	186.80	186.80	186.80

III. RESULTS AND DISCUSSION

FOR HOPPER NO:1 [M20 GRADE]

Sr. No.	1	2	3	4
7 Day	20.15	18.22	17.92	17.92
28 Day	27.71	23.50	24.67	22.97
90Day	28.30	26.23	28.89	25.34
Square of Coeff. of Correlation	0.548	0.803	0.841	0.784
Equation	Y=0.078X+22.13	Y=0.084X+19.12	Y=0.117X+18.92	Y=0.077X+18.83
Predisicted C.S. For 28 Day	24.314	21.472	22.196	20.986

FOR HOPPER NO:1 [M25 GRADE]

Sr. No.	5	6	7	8
7 Day	21.63	17.63	17.92	18.82
28 Day	35.85	30.82	31.41	26.52
90Day	36.89	29.71	33.63	32.00
Square of Coeff. of Correlation	0.544	0.408	0.154	0.866
Equation	Y=0.145X+25.38	Y=0.108X+21.53	Y=0.062X+22.69	Y=0.142X+19.83
Predisicted C.S. For 28 Day	29.41	24.554	24.426	23.806

FOR HOPPER NO:1 [M30 GRADE]

Sr. No.	9	10	11	12
7 Day	31.11	29.03	27.70	20.74
28 Day	41.78	32.15	34.97	28.75
90Day	43.26	35.70	40.59	40.00
Square of Coeff. of Correlation	0.595	0.943	0.881	0.967
Equation	Y=0.118X+33.777	Y=0.075X+29.16	Y=0.140X+28.56	Y=0.220X+20.64
Predisicted C.S. For 28 Day	37.074	31.26	32.56	26.80

FOR HOPPER NO:2 [M20 GRADE]

Sr. No.	13	14	15	16
7 Day	20.15	18.50	18.37	17.77
28 Day	27.71	24.60	27.27	25.34
90Day	28.30	27.56	29.78	26.52
Square of Coeff. of Correlation	0.548	0.790	0.690	0.607
Equation	Y=0.078X+22.13	Y=0.095X+19.58	Y=0.115X+20.33	Y=0.085+19.63
Predisicted C.S. For 28 Day	24.314	22.24	23.55	22.01

FOR HOPPER NO:2 [M25 GRADE]

Sr. No.	17	18	19	20
7 Day	21.63	21.56	20.74	18.87
28 Day	35.85	32.60	32.23	29.04
90Day	36.89	35.71	37.04	31.41
Square of Coeff. of Correlation	0.544	0.689	0.761	0.659
Equation	Y=0.145X +25.38	Y=0.143X +23.99	Y=0.169X+ 22.94	Y=0.125X +21.21
Predisicted C.S. For 28 Day	29.44	27.994	27.672	24.71

FOR HOPPER NO:2 [M30 GRADE]

Sr. No.	21	22	23	24
7 Day	31.11	29.50	28.50	21.70
28 Day	41.78	35.70	32.89	29.19
90Day	43.26	37.49	41.03	41.04
Square of Coeff. of Correlation	0.595	0.693	0.989	0.978
Equation	Y=0.118X +33.77	Y=0.080X +30.85	Y=0.146X+ 28.03	Y=0.223X +21.33
Predisicted C.S. For 28 Day	37.074	33.09	32.118	27.574

HOPPER NO:3 [M20 GRADE]

Sr. No.	25	26	27	28
7 Day	20.15	19.00	19.11	18.07
28 Day	27.71	24.60	28.30	26.60
90Day	28.30	28.15	31.56	26.97
Square of Coeff. of Correlation	0.548	0.843	0.730	0.520
Equation	Y=0.078X +22.13	Y=0.098X +19.82	Y=0.127X+ 20.99	Y=0.084X +20.37
Predisicted C.S. For 28 Day	24.314	22.564	24.546	22.722

M25 GRADE

Sr. No.	29	30	31	32
7 Day	21.63	23.64	21.48	18.96
28 Day	35.85	36.60	33.56	31.26
90Day	36.89	39.26	38.07	32.45
Square of Coeff. of Correlation	0.544	0.641	0.739	0.563
Equation	Y=0.145X +25.38	Y=0.155X +26.70	Y=0.171X+ 23.91	Y=0.129X +22.14
Predisicted C.S. For 28 Day	29.44	31.04	28.698	25.752

M30 GRADE

Sr. No.	33	34	35	36
7 Day	31.11	29.78	29.78	22.52
28 Day	41.78	33.64	36.89	32.45
90Day	43.26	43.26	42.97	41.18
Square of Coeff. of Correlation	0.595	0.998	0.899	0.904
Equation	Y=0.118X +33.77	Y=0.160X +28.86	Y=0.145X+ 30.50	Y=0.205X +23.47
Predisicted C.S. For 28 Day	37.074	33.34	34.56	29.21

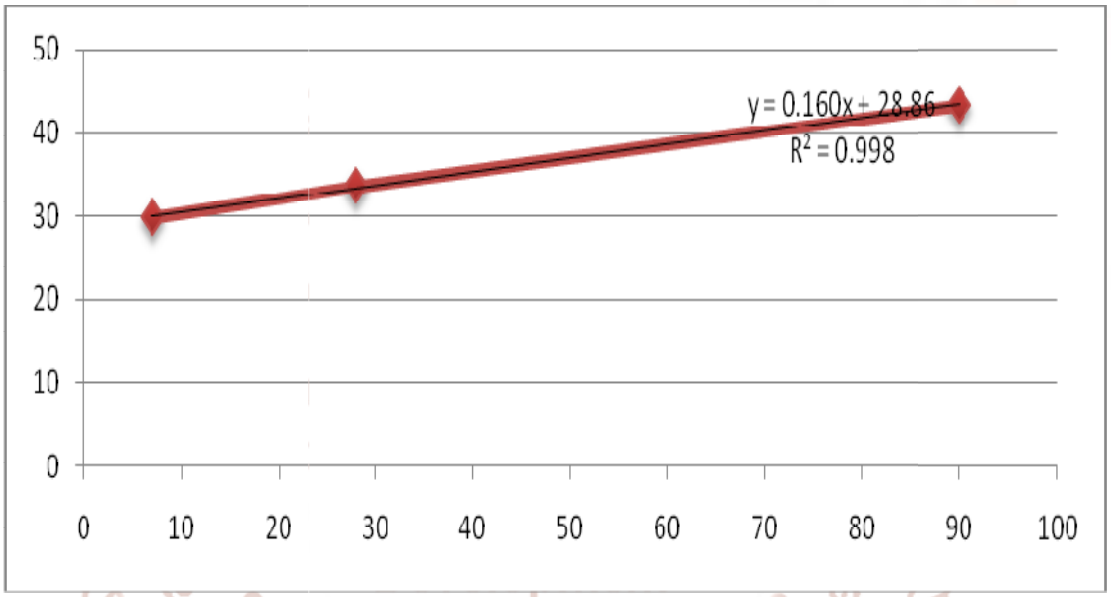

Fig.Days vs comp. Strength graph with equation and correlation coefficient.

IV. CONCLUSION

I

1) A Correlation greater than 0.8 is generally described as strong, whereas a correlation less than 0.5 is generally described as weak.
2) As we get coefficient of correlation by using regression analysis, more is the coefficient of correlation; more is the predicted compressive strength. If coefficient of correlation is nearer to 0.999, predicted values became observed.
3) Also, for higher grade of concrete we have greater coefficient of correlation.
4) For M20 grade , minimum coefficient of correlation is 0.520 and maximum is 0.843
5) For M25 grade, minimum coefficient of correlation is 0.154 and maximum is 0.866
6) For M30 grade, minimum coefficient of correlation is 0.544 and maximum is 0.989.

II

1) Coefficient of correlation lies between -1 to 1.
2) When it is nearer 0.999efficiency of getting accurate compressive strength of concrete is more.
3) Coefficient of correlation lies between 0.5 to 0.7, results i.e. predicted values at 28th day compressive strength have difference of 2 N/mm2 to 3 N/mm2 than observed values.

III

1) By deriving equation, we can predict the values of compressive strength at any curing days like 28th day.
2) We get more deviated equation when coefficient of correlation is less.

3) And relatively accurate equation when we have large coefficient of correlation.
4) Eg. In 34th result. Observed compressive strength is 33.64 and that of predicted value is 33.34 and having coefficient of correlation 0.998 when Fly ash mixing is 12.5%.

V. SUMMARY

In this way, regression analysis helps to predict compressive strength at any stage of curing days and correlation between compressive strength at different stages.

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