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Numerical Simulation from Deterministic Model to Predict Various Grades of Normal and High Compressive Strength of Concrete

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ABSTRACT

The study monitored the compressive strength of concrete at different curing age applying numerical simulation from deterministic model. The grade of concrete considered in the system are from normal to high strength concrete, the study observed the growth rate to the optimum rate at ninety days, the growth rate of compressive strength generated at every twenty four hours were monitored, these express the efficiency of the mix design model for concrete grades, the efficiency of the additive's in mixed design for high strength concrete were experienced, linearization observed from the graphical representation shows the addictive express effectiveness for fast growth of compressive strength to carry any design of an imposed load, the study shows the behavior of additive's and normal strength concrete based on their designed model grades, the derived solution were subjected to simulation, numerical simulation were applied to monitor the compressive strength at every twenty four hours to ninety day of curing age, the predictive values were compared with experimental parameters, and both values generated close fit correlation, the study has express analytical solution that can predict such non homogeneous material of any mix design of concrete grades.

Keywords: *numerical simulation, deterministic model compressive strength*

INTRODUCTION

Concrete is an extraordinary and key structure in human history, over ten billion tons of concrete are produced annually. Man consumes no material except water in such tremendous quantities. It is no doubt that with the development of human civilization, Concrete will continue to be dominant construction material.

Not until the 1900's did Engineers and materials technologist become involved in Optimizing the strength of concrete, though concrete has been used throughout history as a building Material.

High strength concrete are concretes which possess high compressive strength greater than 50MPa (Niville and Brook 2002 Ode and Eluozo, 2016a, Ode and Eluozo, 2016bOde and Eluozo, 2016c).High strength concrete has been used for construction of various structures around the world. This structure includes: Water Tower Place (Chicago, 1975, this structure typifies the use of plasticize), Jingly Bridge (France 1989, which was constructed using High performance concrete without silica fume), Scotia plaza (Toronto 1987Ode and Eluozo, 2016: ASTM 1992, 2015 Edoghotu 1983), the concrete used contained both silica fume and blast furnace slag), etc. (Neville and brook 2002, Indian Concrete Journal).Concrete is defined as high strength concrete solely on the bases of its compressive strength measured at a given age However with the recent advancement in Concrete technology and availability of various types of chemical admixtures, such as silica fumes, fly ash, super plasticizer, using locally made 3/8 aggregate, concrete has moved into the next century in Nigeria and other Nations of the world.

Production of high strength concrete may or may not require special materials, but it definitely requires materials of highest quality and their optimum proportions (Carrasquillo, 1985Ode and Eluozo, 2016d). However many trial batches are often required to generate the data that enables the researchers and professionals to identify optimum mix proportions for high strength concrete.

Practical examples of mix proportions of high strength concrete used in structures already built can be useful information in achieving high strength concrete. Nagataki and Sakai (1994Ode and Eluozo, 2016eOde and Eluozo, 2016f, summarized the various techniques of producing high strength concrete, with eight numbers of trial mixes considered

THEORETICAL BACKGROUND

$$\frac{d\,c_d}{dx} + V(y)c_d = \Phi\,(y)c_d^n \qquad (1.0)$$

Dividing equation (1.0) all through by c_d^nus has

$$c_d^{-n}\frac{dc_d}{dx} + v(x)c_d^{1-n} = \Phi\,(y) \qquad (1.1)$$

Let

$$P = c_d^{1-n} \qquad (1.2)$$

$$\frac{dp}{dy} = (1-n)c_d^{-n}\frac{dc_d}{dy}$$

$$c_d^{-n}\frac{dc_d}{dy} = \frac{1}{1-n}\frac{dp}{dy} \qquad (1.3)$$

Substituting equation (1.2) and (1.3) into equation (1.1) we have that

$$\frac{1}{1-n}\frac{dp}{dx} + V(y)p = \Phi\,(y) \qquad (1.4)$$

Integrating both sides we have $\int d\left[e^{V(y)(1-n)y}p\right] =$ $\Phi\,(y)(1-n)\int e^{V(y)(1-n)y}\,dy$

$$p = \frac{\Phi\,(y)}{Vu\,(y)} + Ae^{-Vu\,(y)(1-n)y} \qquad (1.5)$$

Substituting equation (1.2) into equation (1.13) we have

$$c_d^{1-n} = \frac{\Phi\,(y)}{Vu\,(y)} + Ae^{-Vu\,(y)(1-n)y} \qquad (1.6)$$

MATERIALS AND METHOD

Experimental Procedures

Compressive Strength Test Concrete cubes of size 150mm×150mm×150mm were cast with and without copper slag. During casting, the cubes were mechanically vibrated using a table vibrator. After 24 hours, the specimens were remolded and subjected to curing for 1-90 days and seven day interval to 28 days in portable water. After curing, the specimens were tested for compressive strength using compression testing machine of 2000KN capacity. The maximum load at failure was taken. The average compressive strength of concrete and mortar specimens was calculated by using the following equation 5.1.Compressive strength (N/mm2) = Ultimate compressive load (N) Area of cross section of specimen (mm2)

Table1. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	11.27	10.27
8	12.88	12.88
9	14.49	13.49
10	16.1	15.11
11	17.71	16.71
12	19.32	18.32
13	20.93	22.93
14	22.54	23.54
15	24.15	25.15
16	25.76	26.76
17	27.37	28.37
18	28.98	29.98
19	30.59	32.59
20	32.2	34.24
21	33.81	35.81
22	35.42	36.42
23	37.03	39.03
24	38.64	30.64
25	40.25	42.25
26	41.86	43.86
27	43.47	44.47
28	45.08	46.08

29	46.69	47.69
30	48.3	49.33
31	49.91	50.91
32	51.52	52.52
33	53.13	54.13
34	54.74	55.74
35	56.35	57.35
36	57.96	58.96
37	59.57	59.67
38	61.18	61.38
39	62.79	62.79
40	64.4	64.46
41	66.01	66.23
42	67.62	67.52
43	69.23	69.63
44	70.84	73.84
45	72.45	74.45
46	74.06	75.06
47	75.67	76.67
48	77.28	77.48
49	78.89	78.79
50	80.5	80.55
51	82.11	82.24
52	83.72	83.66
53	85.33	85.45
54	86.94	86.88
55	88.55	88.61
56	90.16	90.24
57	91.77	91.67
58	93.38	93.48
59	94.99	94.79
60	96.6	96.65
61	98.21	98.65
62	99.82	99.85
63	101.43	101.55
64	103.04	103.24
65	104.65	104.67
66	106.26	106.44
67	107.87	107.78
68	109.48	109.55
69	111.09	111.34
70	112.7	112.55
71	114.31	114.64
72	115.92	115.88
73	117.53	117.66
74	119.14	119.34
75	120.75	120.67
76	122.36	122.54
77	123.97	123.88
78	125.58	125.65
79	127.19	127.34
80	128.8	128.73
81	130.41	130.44
82	132.02	132.34
83	133.63	133.66
84	135.24	135.45
85	136.85	136.66
86	138.46	138.77
87	140.07	140.45

88	141.68	141.62
89	143.29	143.34
90	144.9	144.88

Table2. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	8.995	9.0902
8	10.28	10.3888
9	11.565	11.6874
10	12.85	12.986
11	14.135	14.2846
12	15.42	15.5832
13	16.705	16.8818
14	17.99	18.1804
15	19.275	19.479
16	20.56	20.7776
17	21.845	22.0762
18	23.13	23.3748
19	24.415	24.6734
20	25.7	25.972
21	26.985	27.2706
22	28.27	28.5692
23	29.555	29.8678
24	30.84	31.1664
25	32.125	32.465
26	33.41	33.7636
27	34.695	35.0622
28	35.98	36.3608
29	37.265	37.6594
30	38.55	38.958
31	39.835	40.2566
32	41.12	41.5552
33	42.405	42.8538
34	43.69	44.1524
35	44.975	45.451
36	46.26	46.7496
37	47.545	48.0482
38	48.83	49.3468
39	50.115	50.6454
40	51.4	51.944
41	52.685	53.2426
42	53.97	54.5412
43	55.255	55.8398
44	56.54	57.1384
45	57.825	58.437
46	59.11	59.7356
47	60.395	61.0342
48	61.68	62.3328
49	62.965	63.6314
50	64.25	64.93
51	65.535	66.2286
52	66.82	67.5272
53	68.105	68.8258
54	69.39	70.1244
55	70.675	71.423
56	71.96	72.7216
57	73.245	74.0202
58	74.53	75.3188

59	75.815	76.6174
60	77.1	77.916
61	78.385	79.2146
62	79.67	80.5132
63	80.955	81.8118
64	82.24	83.1104
65	83.525	84.409
66	84.81	85.7076
67	86.095	87.0062
68	87.38	88.3048
69	88.665	89.6034
70	89.95	90.902
71	91.235	92.2006
72	92.52	93.4992
73	93.805	94.7978
74	95.09	96.0964
75	96.375	97.395
76	97.66	98.6936
77	98.945	99.9922
78	100.23	101.2908
79	101.515	102.5894
80	102.8	103.888
81	104.085	105.1866
82	105.37	106.4852
83	106.655	107.7838
84	107.94	109.0824
85	109.225	110.381
86	110.51	111.6796
87	111.795	112.9782
88	113.08	114.2768
89	114.365	115.5754
90	115.65	116.874

Table3. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	9.0902	9.5872
8	10.3888	10.9568
9	11.6874	12.3264
10	12.986	13.696
11	14.2846	15.0656
12	15.5832	16.4352
13	16.8818	17.8048
14	18.1804	19.1744
15	19.479	20.544
16	20.7776	21.9136
17	22.0762	23.2832
18	23.3748	24.6528
19	24.6734	26.0224
20	25.972	27.392
21	27.2706	28.7616
22	28.5692	30.1312
23	29.8678	31.5008
24	31.1664	32.8704
25	32.465	34.24
26	33.7636	35.6096
27	35.0622	36.9792
28	36.3608	38.3488
29	37.6594	39.7184

30	38.958	41.088
31	40.2566	42.4576
32	41.5552	43.8272
33	42.8538	45.1968
34	44.1524	46.5664
35	45.451	47.936
36	46.7496	49.3056
37	48.0482	50.6752
38	49.3468	52.0448
39	50.6454	53.4144
40	51.944	54.784
41	53.2426	56.1536
42	54.5412	57.5232
43	55.8398	58.8928
44	57.1384	60.2624
45	58.437	61.632
46	59.7356	63.0016
47	61.0342	64.3712
48	62.3328	65.7408
49	63.6314	67.1104
50	64.93	68.48
51	66.2286	69.8496
52	67.5272	71.2192
53	68.8258	72.5888
54	70.1244	73.9584
55	71.423	75.328
56	72.7216	76.6976
57	74.0202	78.0672
58	75.3188	79.4368
59	76.6174	80.8064
60	77.916	82.176
61	79.2146	83.5456
62	80.5132	84.9152
63	81.8118	86.2848
64	83.1104	87.6544
65	84.409	89.024
66	85.7076	90.3936
67	87.0062	91.7632
68	88.3048	93.1328
69	89.6034	94.5024
70	90.902	95.872
71	92.2006	97.2416
72	93.4992	98.6112
73	94.7978	99.9808
74	96.0964	101.3504
75	97.395	102.72
76	98.6936	104.0896
77	99.9922	105.4592
78	101.2908	106.8288
79	102.5894	108.1984
80	103.888	109.568
81	105.1866	110.9376
82	106.4852	112.3072
83	107.7838	113.6768
84	109.0824	115.0464
85	110.381	116.416
86	111.6796	117.7856
87	112.9782	119.1552
88	114.2768	120.5248

89	115.5754	121.8944
90	116.874	123.264

Table4. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	9.5872	10.9326
8	10.9568	12.4944
9	12.3264	14.0562
10	13.696	15.618
11	15.0656	17.1798
12	16.4352	18.7416
13	17.8048	20.3034
14	19.1744	21.8652
15	20.544	23.427
16	21.9136	24.9888
17	23.2832	26.5506
18	24.6528	28.1124
19	26.0224	29.6742
20	27.392	31.236
21	28.7616	32.7978
22	30.1312	34.3596
23	31.5008	35.9214
24	32.8704	37.4832
25	34.24	39.045
26	35.6096	40.6068
27	36.9792	42.1686
28	38.3488	43.7304
29	39.7184	45.2922
30	41.088	46.854
31	42.4576	48.4158
32	43.8272	49.9776
33	45.1968	51.5394
34	46.5664	53.1012
35	47.936	54.663
36	49.3056	56.2248
37	50.6752	57.7866
38	52.0448	59.3484
39	53.4144	60.9102
40	54.784	62.472
41	56.1536	64.0338
42	57.5232	65.5956
43	58.8928	67.1574
44	60.2624	68.7192
45	61.632	70.281
46	63.0016	71.8428
47	64.3712	73.4046
48	65.7408	74.9664
49	67.1104	76.5282
50	68.48	78.09
51	69.8496	79.6518
52	71.2192	81.2136
53	72.5888	82.7754
54	73.9584	84.3372
55	75.328	85.899
56	76.6976	87.4608
57	78.0672	89.0226
58	79.4368	90.5844
59	80.8064	92.1462

60	82.176	93.708
61	83.5456	95.2698
62	84.9152	96.8316
63	86.2848	98.3934
64	87.6544	99.9552
65	89.024	101.517
66	90.3936	103.0788
67	91.7632	104.6406
68	93.1328	106.2024
69	94.5024	107.7642
70	95.872	109.326
71	97.2416	110.8878
72	98.6112	112.4496
73	99.9808	114.0114
74	101.3504	115.5732
75	102.72	117.135
76	104.0896	118.6968
77	105.4592	120.2586
78	106.8288	121.8204
79	108.1984	123.3822
80	109.568	124.944
81	110.9376	126.5058
82	112.3072	128.0676
83	113.6768	129.6294
84	115.0464	131.1912
85	116.416	132.753
86	117.7856	134.3148
87	119.1552	135.8766
88	120.5248	137.4384
89	121.8944	139.0002
90	123.264	140.562

Table5. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	10.62	10.6207392	10.6246
8	12.14	12.1384512	12.1424
9	13.66	13.6561648	13.6602
10	15.178	15.17388	15.178
11	16.69	16.6915968	16.6958
12	18.21	18.2093152	18.2136
13	19.73	19.7270352	19.7314
14	21.24	21.2447568	21.2492
15	22.76	22.76248	22.767
16	24.28	24.2802048	24.345
17	25.8	25.7979312	25.8026
18	27.32	27.3156592	27.3204
19	28.83	28.8333888	28.8382
20	30.35	30.35112	30.356
21	31.87	31.8688528	31.8738
22	33.39	33.3865872	33.3916
23	34.9	34.9043232	34.9094
24	36.42	36.4220608	36.4272
25	37.94	37.9398	37.945
26	39.46	39.4575408	39.4628
27	40.98	40.9752832	40.9806
28	42.49	42.4930272	42.4984
29	44.01	44.0107728	44.0162
30	45.53	45.52852	45.534

31	47.05	47.0462688	47.0518
32	48.56	48.5640192	48.5696
33	50.08	50.0817712	50.0874
34	51.6	51.5995248	51.6052
35	53.12	53.11728	53.123
36	54.64	54.6350368	54.6408
37	56.15	56.1527952	56.1586
38	57.67	57.6705552	57.6764
39	59.19	59.1883168	59.1942
40	60.71	60.70608	60.712
41	62.22	62.2238448	62.2298
42	63.74	63.7416112	63.7476
43	65.26	65.2593792	65.2654
44	66.78	66.7771488	66.7832
45	68.3	68.29492	68.301
46	69.81	69.8126928	69.8188
47	71.33	71.3304672	71.3366
48	72.85	72.8482432	72.8544
49	74.37	74.3660208	74.3722
50	75.89	75.8838	75.89
51	77.4	77.4015808	77.4078
52	78.92	78.9193632	78.9256
53	80.44	80.4371472	80.4434
54	81.96	81.9549328	81.9612
55	83.479	83.47272	83.479
56	84.99	84.9905088	84.9968
57	86.51	86.5082992	86.5146
58	88.03	88.0260912	88.0324
59	89.55	89.5438848	89.5502
60	91.06	91.06168	91.068
61	92.58	92.5794768	92.5858
62	94.1	94.0972752	94.1036
63	95.62	95.6150752	95.6214
64	97.13	97.1328768	97.1392
65	98.65	98.65068	98.234
66	100.17	100.1684848	100.1748
67	101.69	101.6862912	101.6926
68	103.21	103.2040992	103.2104
69	104.72	104.7219088	104.7282
70	106.24	106.23972	106.246
71	107.76	107.7575328	107.7638
72	109.28	109.2753472	109.2816
73	110.79	110.7931632	110.7994
74	112.31	112.3109808	112.3172
75	113.83	113.8288	113.835
76	115.35	115.3466208	115.3528
77	116.87	116.8644432	116.8706
78	118.38	118.3822672	118.3884
79	119.9	119.9000928	119.9062
80	121.42	121.41792	121.424
81	122.94	122.9357488	122.9418
82	124.45	124.4535792	124.4596
83	125.97	125.9714112	125.9774
84	127.49	127.4892448	127.4952
85	129.01	129.00708	129.013
86	130.53	130.5249168	130.5308
87	132.04	132.0427552	132.0486
88	133.56	133.5605952	133.5664
89	135.08	135.0784368	135.0842

90	136.61	136.59628	136.602

Table6. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	10.9326	9.0902
8	12.4944	10.3888
9	14.0562	11.6874
10	15.618	12.986
11	17.1798	14.2846
12	18.7416	15.5832
13	20.3034	16.8818
14	21.8652	18.1804
15	23.427	19.479
16	24.9888	20.7776
17	26.5506	22.0762
18	28.1124	23.3748
19	29.6742	24.6734
20	31.236	25.972
21	32.7978	27.2706
22	34.3596	28.5692
23	35.9214	29.8678
24	37.4832	31.1664
25	39.045	32.465
26	40.6068	33.7636
27	42.1686	35.0622
28	43.7304	36.3608
29	45.2922	37.6594
30	46.854	38.958
31	48.4158	40.2566
32	49.9776	41.5552
33	51.5394	42.8538
34	53.1012	44.1524
35	54.663	45.451
36	56.2248	46.7496
37	57.7866	48.0482
38	59.3484	49.3468
39	60.9102	50.6454
40	62.472	51.944
41	64.0338	53.2426
42	65.5956	54.5412
43	67.1574	55.8398
44	68.7192	57.1384
45	70.281	58.437
46	71.8428	59.7356
47	73.4046	61.0342
48	74.9664	62.3328
49	76.5282	63.6314
50	78.09	64.93
51	79.6518	66.2286
52	81.2136	67.5272
53	82.7754	68.8258
54	84.3372	70.1244
55	85.899	71.423
56	87.4608	72.7216
57	89.0226	74.0202
58	90.5844	75.3188
59	92.1462	76.6174
60	93.708	77.916

61	95.2698	79.2146
62	96.8316	80.5132
63	98.3934	81.8118
64	99.9552	83.1104
65	101.517	84.409
66	103.0788	85.7076
67	104.6406	87.0062
68	106.2024	88.3048
69	107.7642	89.6034
70	109.326	90.902
71	110.8878	92.2006
72	112.4496	93.4992
73	114.0114	94.7978
74	115.5732	96.0964
75	117.135	97.395
76	118.6968	98.6936
77	120.2586	99.9922
78	121.8204	101.2908
79	123.3822	102.5894
80	124.944	103.888
81	126.5058	105.1866
82	128.0676	106.4852
83	129.6294	107.7838
84	131.1912	109.0824
85	132.753	110.381
86	134.3148	111.6796
87	135.8766	112.9782
88	137.4384	114.2768
89	139.0002	115.5754
90	140.562	116.874

Table7. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m^2	Experimental Values of Compressive Strength KN/m^2
7	10.9333	10.6207392
8	12.4952	12.1384512
9	14.0571	13.6561648
10	15.619	15.17388
11	17.1809	16.6915968
12	18.7428	18.2093152
13	20.3047	19.7270352
14	21.8666	21.2447568
15	23.4285	22.76248
16	24.9904	24.2802048
17	26.5523	25.7979312
18	28.1142	27.3156592
19	29.6761	28.8333888
20	31.238	30.35112
21	32.7999	31.8688528
22	34.3618	33.3865872
23	35.9237	34.9043232
24	37.4856	36.4220608
25	39.0475	37.9398
26	40.6094	39.4575408
27	42.1713	40.9752832
28	43.7332	42.4930272
29	45.2951	44.0107728
30	46.857	45.52852
31	48.4189	47.0462688

32	49.9808	48.5640192
33	51.5427	50.0817712
34	53.1046	51.5995248
35	54.6665	53.11728
36	56.2284	54.6350368
37	57.7903	56.1527952
38	59.3522	57.6705552
39	60.9141	59.1883168
40	62.476	60.70608
41	64.0379	62.2238448
42	65.5998	63.7416112
43	67.1617	65.2593792
44	68.7236	66.7771488
45	70.2855	68.29492
46	71.8474	69.8126928
47	73.4093	71.3304672
48	74.9712	72.8482432
49	76.5331	74.3660208
50	78.095	75.8838
51	79.6569	77.4015808
52	81.2188	78.9193632
53	82.7807	80.4371472
54	84.3426	81.9549328
55	85.9045	83.47272
56	87.4664	84.9905088
57	89.0283	86.5082992
58	90.5902	88.0260912
59	92.1521	89.5438848
60	93.714	91.06168
61	95.2759	92.5794768
62	96.8378	94.0972752
63	98.3997	95.6150752
64	99.9616	97.1328768
65	101.5235	98.65068
66	103.0854	100.1684848
67	104.6473	101.6862912
68	106.2092	103.2040992
69	107.7711	104.7219088
70	109.333	106.23972
71	110.8949	107.7575328
72	112.4568	109.2753472
73	114.0187	110.7931632
74	115.5806	112.3109808
75	117.1425	113.8288
76	118.7044	115.3466208
77	120.2663	116.8644432
78	121.8282	118.3822672
79	123.3901	119.9000928
80	124.952	121.41792
81	126.5139	122.9357488
82	128.0758	124.4535792
83	129.6377	125.9714112
84	131.1996	127.4892448
85	132.7615	129.00708
86	134.3234	130.5249168
87	135.8853	132.0427552
88	137.4472	133.5605952
89	139.0091	135.0784368
90	140.571	136.59628

Table8. *Compressive Strength Variation of Water Cement Ratio at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m2 [0.5] Water cement Ratio	Predictive Values of Compressive Strength KN/m2 [0.23] Water cement Ratio
7	10.878	12.698
8	12.432	14.512
9	13.986	16.326
10	15.54	18.14
11	17.094	19.954
12	18.648	21.768
13	20.202	23.582
14	21.756	25.396
15	23.31	27.21
16	24.864	29.024
17	26.418	30.838
18	27.972	32.652
19	29.526	34.466
20	31.08	36.28
21	32.634	38.094
22	34.188	39.908
23	35.742	41.722
24	37.296	43.536
25	38.85	45.35
26	40.404	47.164
27	41.958	48.978
28	43.512	50.792
29	45.066	52.606
30	46.62	54.42
31	48.174	56.234
32	49.728	58.048
33	51.282	59.862
34	52.836	61.676
35	54.39	63.49
36	55.944	65.304
37	57.498	67.118
38	59.052	68.932
39	60.606	70.746
40	62.16	72.56
41	63.714	74.374
42	65.268	76.188
43	66.822	78.002
44	68.376	79.816
45	69.93	81.63
46	71.484	83.444
47	73.038	85.258
48	74.592	87.072
49	76.146	88.886
50	77.7	90.7
51	79.254	92.514
52	80.808	94.328
53	82.362	96.142
54	83.916	97.956
55	85.47	99.77
56	87.024	101.584
57	88.578	103.398
58	90.132	105.212
59	91.686	107.026
60	93.24	108.84
61	94.794	110.654

62	96.348	112.468
63	97.902	114.282
64	99.456	116.096
65	101.01	117.91
66	102.564	119.724
67	104.118	121.538
68	105.672	123.352
69	107.226	125.166
70	108.78	126.98
71	110.334	128.794
72	111.888	130.608
73	113.442	132.422
74	114.996	134.236
75	116.55	136.05
76	118.104	137.864
77	119.658	139.678
78	121.212	141.492
79	122.766	143.306
80	124.32	145.12
81	125.874	146.934
82	127.428	148.748
83	128.982	150.562
84	130.536	152.376
85	132.09	154.19
86	133.644	156.004
87	135.198	157.818
88	136.752	159.632
89	138.306	161.446
90	139.86	163.26

Table9. *Compressive Strength Variation of Water Cement Ratio at Different Curing Age*

Curing Age	Predictive Values of Compressive Strength KN/m2 [0.4 Water cement Ratio]	Predictive Values of Compressive Strength KN/m2 [0.25] Water cement Ratio
7	11.508	12.558
8	13.152	14.352
9	14.796	16.146
10	16.44	17.94
11	18.084	19.734
12	19.728	21.528
13	21.372	23.322
14	23.016	25.116
15	24.66	26.91
16	26.304	28.704
17	27.948	30.498
18	29.592	32.292
19	31.236	34.086
20	32.88	35.88
21	34.524	37.674
22	36.168	39.468
23	37.812	41.262
24	39.456	43.056
25	41.1	44.85
26	42.744	46.644
27	44.388	48.438
28	46.032	50.232
29	47.676	52.026
30	49.32	53.82
31	50.964	55.614
32	52.608	57.408

33	54.252	59.202
34	55.896	60.996
35	57.54	62.79
36	59.184	64.584
37	60.828	66.378
38	62.472	68.172
39	64.116	69.966
40	65.76	71.76
41	67.404	73.554
42	69.048	75.348
43	70.692	77.142
44	72.336	78.936
45	73.98	80.73
46	75.624	82.524
47	77.268	84.318
48	78.912	86.112
49	80.556	87.906
50	82.2	89.7
51	83.844	91.494
52	85.488	93.288
53	87.132	95.082
54	88.776	96.876
55	90.42	98.67
56	92.064	100.464
57	93.708	102.258
58	95.352	104.052
59	96.996	105.846
60	98.64	107.64
61	100.284	109.434
62	101.928	111.228
63	103.572	113.022
64	105.216	114.816
65	106.86	116.61
66	108.504	118.404
67	110.148	120.198
68	111.792	121.992
69	113.436	123.786
70	115.08	125.58
71	116.724	127.374
72	118.368	129.168
73	120.012	130.962
74	121.656	132.756
75	123.3	134.55
76	124.944	136.344
77	126.588	138.138
78	128.232	139.932
79	129.876	141.726
80	131.52	143.52
81	133.164	145.314
82	134.808	147.108
83	136.452	148.902
84	138.096	150.696
85	139.74	152.49
86	141.384	154.284
87	143.028	156.078
88	144.672	157.872
89	146.316	159.666
90	147.96	161.46

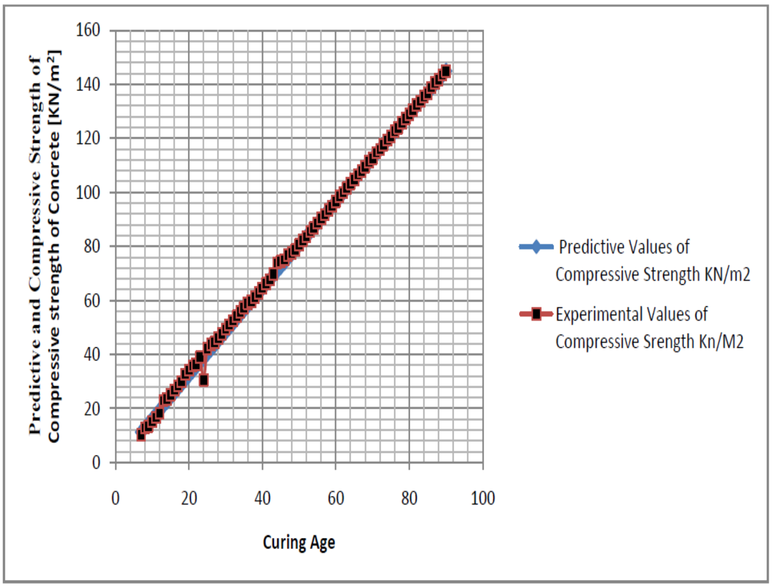

Figure1. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

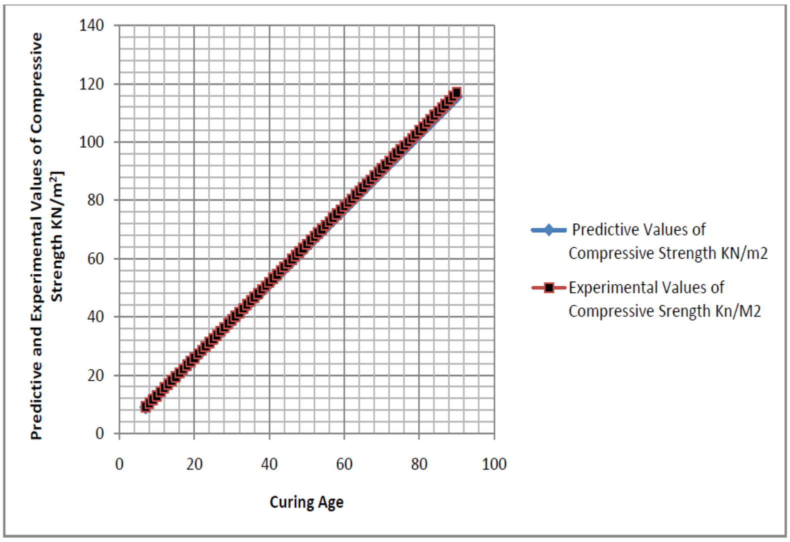

Figure2. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

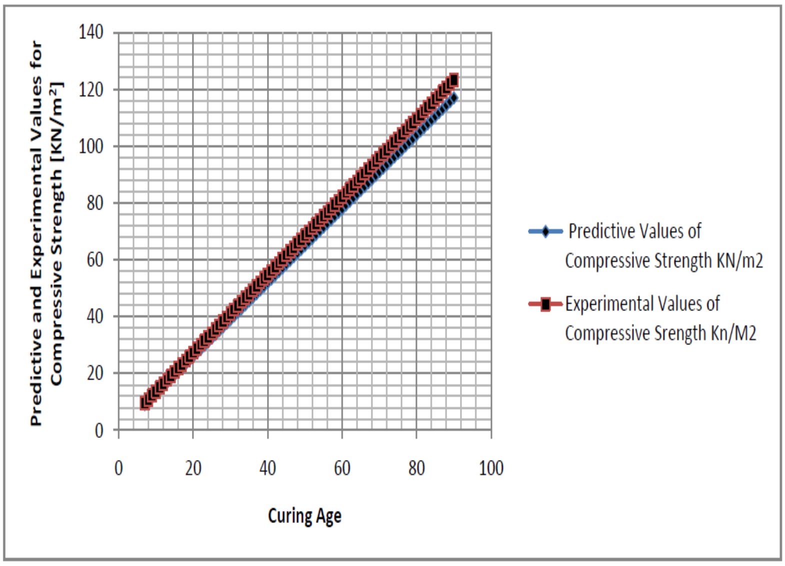

Figure3. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

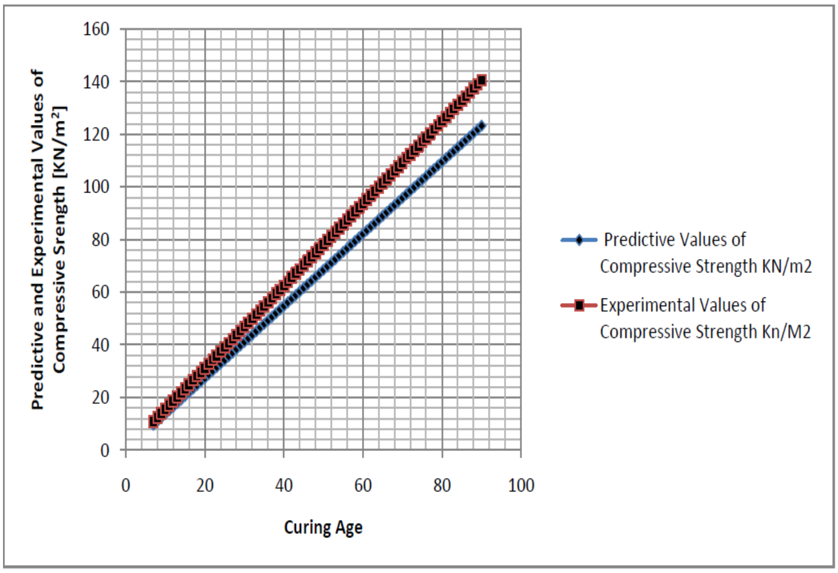

Figure4. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

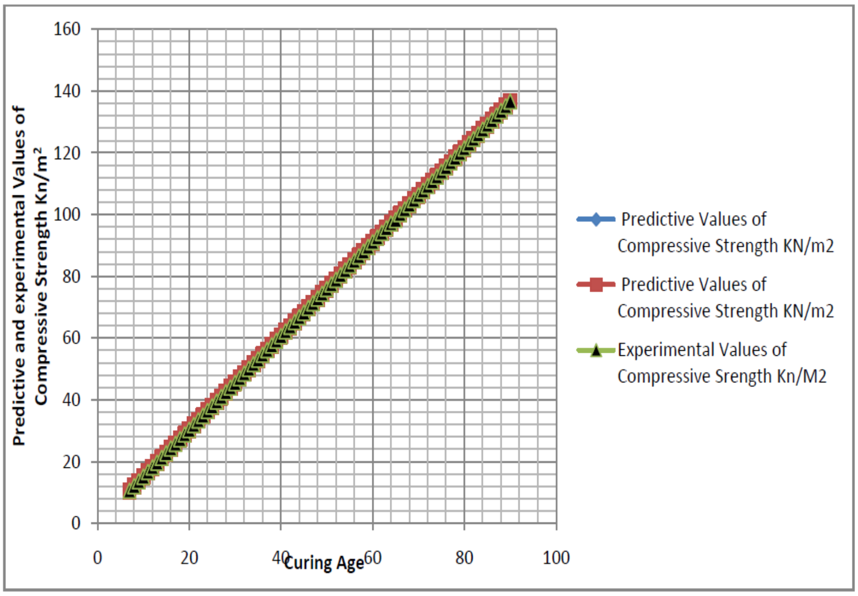

Figure5. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

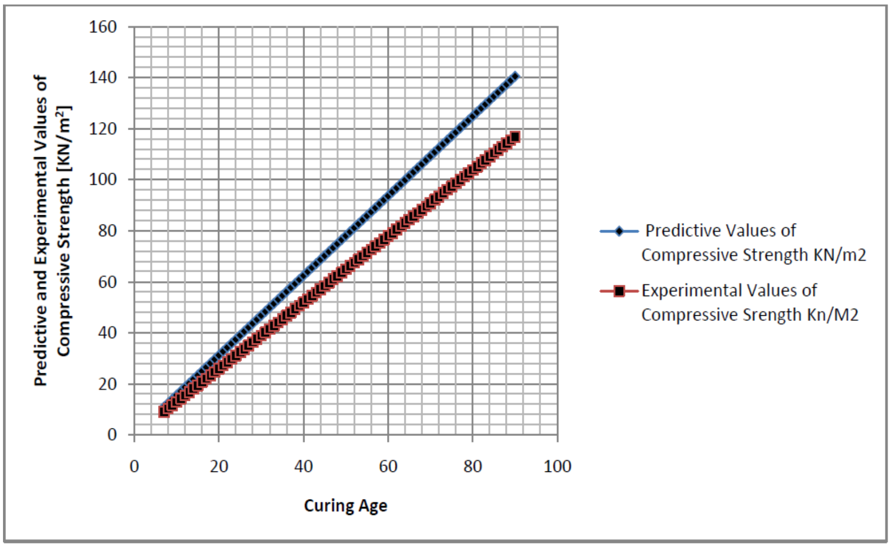

Figure6. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

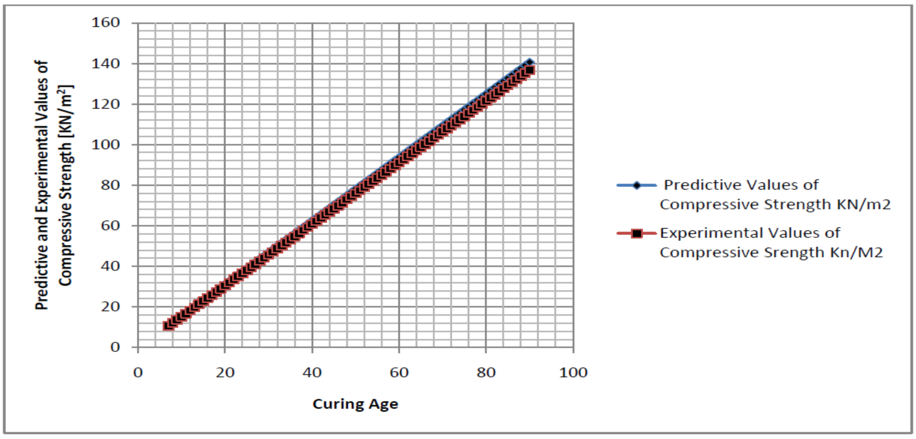

Figure7. *Predictive and Experimental Values of Compressive Strength at Different Curing Age*

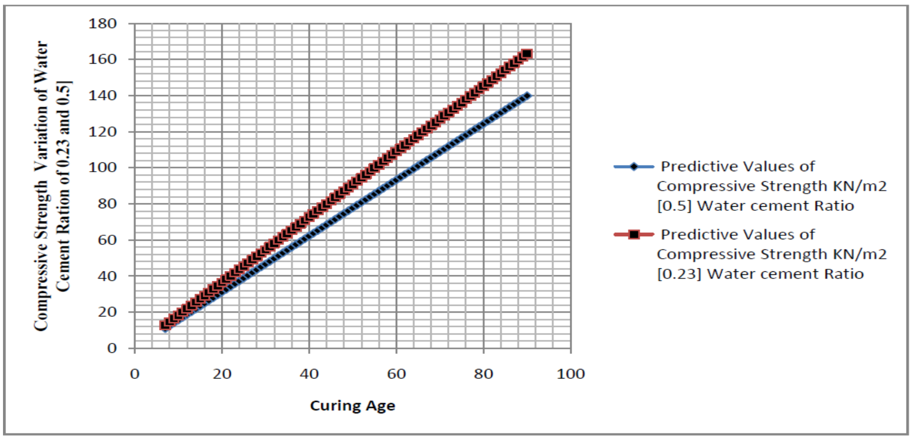

Figure8. *Compressive Strength Variation of Water Cement Ratio at Different Curing Age*

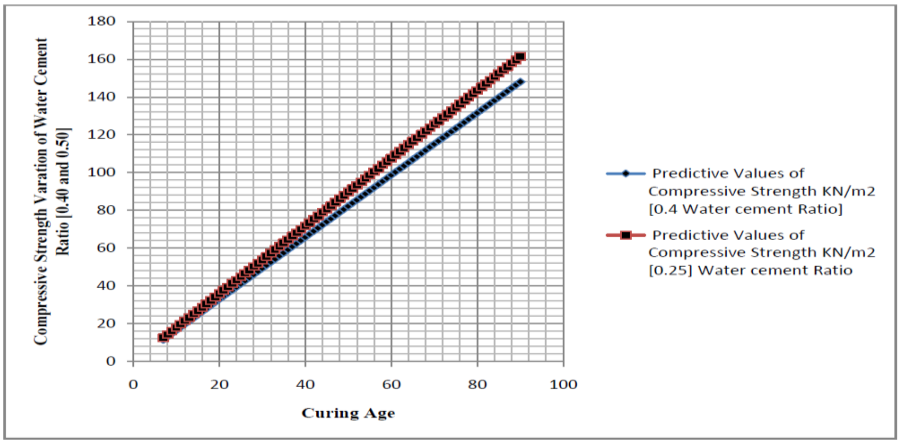

Figure9. *Compressive Strength Variation of Water Cement Ratio at Different Curing Age*

Results and Discussion

Figure one to seven express linear strength of concrete from normal to high rate of it strength development, this condition validate the efficiency of mix design that generated these model grade of concrete, the rate of strength development shows the efficiency of the mix designs that where considered in the system to generated the derive mathematical model, this, represent these type of compressive strength. The growth rate of these compressive strength where observed to express the behavior of these non-homogeneous system that developed the growth rate of the concrete model, such condition were experienced from these trend as it linearization were observed from the graphical representation, it express numerical condition of the compressive strength.

Slight insignificant fluctuation were experienced between thirty five at twenty one days curing age in figure one, but that the effect where experienced from placement of concrete and it compaction state, the derive model simulation values were observed at various figures based on it variation at different dosage of addictive' s the comparison with experimental values developed best fits correlation, variation of water cement experienced decrease and increase in its model concrete were considered in the study, graphical representation express the validation of the derived solution values, these conditions validated the application of these derived mathematical model thus its numerical application to developed these compressive strength at different curing age

CONCLUSION

The study monitored the strength development of compressive strength at various different curing age, compressive from seven to ninety days were monitored, linear trend were observed predominantly as concrete strength experienced exponential growth, numerical simulation techniques were applied to monitor the discrete of the compressive strength, these were carried to observed the growth rate of it strength developed from normal to high strength concrete model, the efficiency of mix design express the rate that the compressive strength were observed. More so the concrete model experienced the efficiency of the addictive applied to generate high strength as it is observed from the figures, concrete being a non-homogeneous material behaved in hetero geneous state, but it work based on the rates of designed approach to achieved any form of strength to carry a given design imposed loads. The derived mathematical solution from non-homogeneous system generated model that produced compressive strength that were validated with experimental values, and both parameters express favorable fits.

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