DYNAMIC EFFECT OF RE-VIBRATION ON COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

The dynamic effect of re-vibration on the compressive strength of concrete using concrete mix aggregate of 1:2:4 from Ordinary Portland cement with water to cement ratio of 0.75 is presented. Concrete cubes which were cast with re-vibration time lag intervals of 5minutes successions for 60minutes period of revibration process at 7, 21 and 28 days of curing were crushed for their respective compressive strength. Result shows that at successive time lag intervals there is an appreciable dynamic rise in compressive strength of concrete with such water to cement ratio. The result obtained suggests the use of 5minutes time lag interval of revibration process to depict the dynamic rise of compressive strength of concrete.

Keywords: Compressive strength, dynamic, re-vibration, time-lag intervals, water, cement, ratio.
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INTRODUCTION

Re-vibration is the process of vibrating placed concrete again after allowing it to remain undisturbed for some time and sometimes after consolidation is completed. A properly executed revibration will improve concrete quality in terms of increased compressive strength, bond and better impermeability, reduction of shrinkage and creeping, surface and other voids as well as cracks in the fresh concrete and so on. This tendency has enhances rise in compressive strength of concrete once done within the plastic state of the concrete. This is achieved because defects like honeycomb and voids leading to reduction in strength and performance of concrete are eliminated or reduced to minimal (Averard and Bhagat, 1970).

Revibration Time-lag interval can be one of the major factors that can affect the compressive strength of concrete. Krishna et al (2008) suggests the optimal time-lag intervals of revibration for different w/c ratios when a minimum revibration time lag interval of 30minutes to 4 hours was adopted. In view of this, this work adopts a revibration time lag of 5minutes successions for 60minutes period of revibration process to investigate possible dynamic effect on the compressive strength of concrete for a mix aggregate ratio of 1:2:4 concrete with water to cement w/c ratio of 0.75.

MATERIALS AND METHODOLOGY

The materials used for this study include Ordinary Portland cement which was used with crushed granite as coarse aggregate that passed 20mm mesh to those retained on 4.75mm mesh and fine aggregate that passed through 2.36mm mesh to those retained on the pan. Clean tap water was used to achieve the nominal mix of 1:2:4 and water to cement ratio of 0.75 was used. A total number of thirty nine concrete cubes specimen (150mm×150mm×150mm) were prepared, cast, cured and tested at ages of 7days, 21days and 28days in accordance with the standards (BS 1881: Part 108, 1983; BS 1881: Part 111, 1983; BS 1881: Part 115, 1983; BS 1881: Part 116, 1983).

Tests such as sieve analysis, moisture content, specific gravity, bulk density, absorption test, void ratio of aggregate, porosity of aggregate, workability/compacting factor test of fresh aggregate, slump test and finally the compressive strength test after curing for 7days, 21days and 28 days at a the test carried out in accordance with British Standard. To achieve compaction and revibration of these concrete cubes, a porker vibrator was used at intervals of 5minutes successively.

A well graded material is one containing fractions covering a wide range of particles more uniform in size. The particle size distribution of the coarse fraction of a

sample (sand and gravel) is normally obtained by sieving on British standard sieve. An assessment was made to classify the sample as fine grained – 90% passing a 2mm B.S test sieve, medium grained – 90% passing a 20mm B.S test sieve, and coarse grained – 90% passing a 37.5mm B.S test sieve (BS 812: Part 103.1, 1985).

RESULTS AND DISCUSSIONS

The results of all tests such as sieve analysis, moisture content, specific gravity, bulk density, absorption test, void ratio of aggregate, porosity of aggregate, workability/compacting factor test of fresh aggregate, slump test and finally the compressive strength test after curing are presented in summary on Tables 1, 2, 3, 4, 5, 6, 7 and 8.

Table 1. Sieve analysis for the coarse aggregate (weight of sample sieved = 1000g)

BS sieve (mm)	Weight of sieve (g)	Weight of sample+sieve (g)	Weight of sample retained (g)	% retained	cum % retained	cum % passing
28.00	1565.30	1565.30	-	-	-	100
20.00	1471.70	1612.60	143.9	14.39	14.39	85.61
14.00	1395.70	2065.60	657.60	65.76	80.15	19.85
10.00	1344.00	1434.40	91.40	9.14	89.29	10.71
6.30	1339.20	1434.60	94.40	9.44	98.73	1.27
5.00	1494.20	1504.10	9.90	0.99	99.72	0.28
Pan	811.20	808.30	2.80	0.28	100.00	-

Table 2. Sieve analysis for the Fine aggregate (weight of sample sieved = 500g)

BS sieve (mm)	Weight of sieve (g)	Weight of sample+sieve (g)	Weight of sample retained (g)	% retained	cum % retained	cum % passing
5.00	477.10	484.10	8.70	1.74	1.74	98.26
3.35	467.20	484.70	16.50	3.3	5.04	94.96
2.00	416.70	489.50	75.80	15.16	20.20	79.80
1.18μm	387.60	515.00	124.40	24.88	45.08	55.04
850μm	355.60	427.50	73.70	14.74	59.82	40.18
600μm	466.90	536.20	67.30	13.46	73.28	26.80
425μm	434.40	486.80	50.40	10.08	83.36	16.64
300μm	313.10	353.00	41.50	8.30	91.66	8.34
150μm	418.80	450.20	29.40	5.88	97.54	2.06
75μm	367.20	375.20	10.00	2.00	99.54	0.46
Pan	270.70	273.00	2.30	0.46	100	-

While Tables 1 and 2 represent the sieve analysis test of fine and coarse aggregates, the characteristics of fine aggregate, coarse aggregates and the concrete used are presented on Tables 3, 4 and 5 respectively. The compressive strength of concrete at 7days, 21days and 28days of curing are presented on Tables 6, 7 and 8 respectively.

Table 3. Characteristics of Fine Aggregate

S.No.	Test	Result	BS requirement
2	Specific Gravity	2.61	2.6 – 3.0
3	Bulk Density (kg/m^3)	1632.36	1500 - 1700
4	Moisture Content (%)	7.43	5 – 15

Table 4. Characteristics of Coarse Aggregate

S.No.	Test	Result	BS requirement
2	Specific Gravity	2.68	2.4 – 2.8
3	Bulk Density (kg/m^3)	1626.47	1300 – 1800
4	Moisture Content (%)	1.51	1 – 5
5	Water absorption (%)	0.75	0.5 – 5

Table 5. Characteristics of Concrete

S.No.	Test	Result
1	Water to cement ratio (w/c)	0.75
2	Mix Proportion, cement: fine aggregate: coarse aggregate	1:2:4
3	Slum in (mm)	65.0
4	Number of cubes cast	39
5	Maximum compressive strength after 28days curing (N/mm^2)	28.18

Table 6. Compressive strength of concrete after 7 days curing period

Label	Mode of revibration	Interval period of revibration (mins)	Weight (Kg)	Mean density (Kg/m^3)	Crushing load (KN)	Compressive strength (N/mm^2)
A	Non-revibrated	0	8.00	2370.37	269	11.96
B	Revibrated	5	8.10	2400.00	322	14.31
C	Revibrated	10	8.35	2474.07	326	14.49
D	Revibrated	15	8.41	2491.89	342	15.20
E	Revibrated	20	8.45	2503.70	363	16.13
F	Revibrated	25	8.47	2509.63	375	16.67
G	Revibrated	30	8.49	2515.56	386	17.16
H	Revibrated	35	8.42	2494.81	390	17.33
I	Revibrated	40	8.47	2509.63	396	17.60
J	Revibrated	45	8.44	2500.63	408	18.13
K	Revibrated	50	8.50	2518.52	413	18.36
L	Revibrated	55	8.52	2514.44	419	18.62
M	Revibrated	60	8.49	2515.56	425	18.89

Table 7. Compressive strength of concrete after 21 days curing period.

Label	Mode of revibration	Interval of revibration (mins)	Weight (Kg)	Mean density (Kg/m^3)	Crushing load (KN)	Compressive strength (N/mm^2)
1	Non-revibrated	0	8.10	2400.00	352	15.64
2	Revibrated	5	8.12	2405.92	428	19.02
3	Revibrated	10	8.15	2414.81	437	19.42
4	Revibrated	15	8.19	2426.67	440	19.56
5	Revibrated	20	8.27	2450.37	445	19.78
6	Revibrated	25	8.22	2435.56	451	20.04
7	Revibrated	30	8.25	2444.44	462	20.53
8	Revibrated	35	8.29	2456.29	469	20.84
9	Revibrated	40	8.26	2447.41	474	21.06
10	Revibrated	45	8.32	2465.19	480	21.33
11	Revibrated	50	8.30	2459.26	487	21.64
12	Revibrated	55	8.46	2506.67	495	22.00
13	Revibrated	60	8.41	2491.85	512	22.75

Table 8. Compressive strength of concrete after 28 days curing.

Label	Mode of vibration	Interval period of revibration (mins)	Weight, (Kg)	Mean density (Kg/m^3)	Crushing load (KN)	Compressive strength (N/mm^2)
I	Non-revibrated	0	8.11	2402.96	412	18.31
II	Revibrated	5	8.10	2400.00	490	21.78
III	Revibrated	10	8.14	2411.85	515	22.89
IV	Revibrated	15	8.17	2420.74	529	23.51
V	Revibrated	20	8.22	2435.56	537	23.87
VI	Revibrated	25	8.27	2450.37	548	24.36
VII	Revibrated	30	8.26	2447.41	554	24.62
VIII	Revibrated	35	8.31	2462.22	568	25.24
IX	Revibrated	40	8.26	2447.41	582	25.87
X	Revibrated	45	8.23	2438.52	591	26.27
XI	Revibrated	50	8.30	2459.26	611	27.16
XII	Revibrated	55	8.42	2494.81	627	27.87
XIII	Revibrated	60	8.44	2500.74	634	28.18

The result of the particle size distribution carried out in accordance with standard (BS 812: Part 103.1 1985) and presented in Table 1 and 2. Those retained on pan, 150µm, 300µm, 600µm, 1.18mm and 2.36mm were recorded as fine aggregate while those retained on 20mm mesh were rejected as being too coarse. Aggregates were proportioned according to percentage retained in every sieve test.

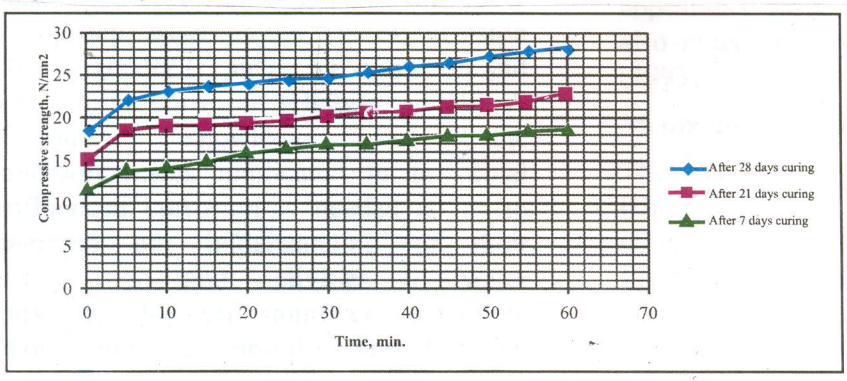
The slump and compacting factor test conducted on the sample indicated that increase in the water content or deficiency in proportion of fine aggregate results in an increase in slump and this reduces the compressive strength and stiffness constant of the specimen under test which was found to be 65.0mm within acceptable range of 35 – 75mm (Neville, 1996; Neville and Brook, 2003), a medium workability suitable for this study. The specific gravity obtained for fine aggregate was 2.61 and that of coarse aggregate is 2.68 which are found to be within the standard range of 2.6 −3.0 and 2.4−2.8 respectively (BS 812: Part 1072, 1995). The average moisture content obtained for fine aggregate from is 7.43% and that of coarse aggregate is 1.51% which are found to be within the standard range of 5−15% and 1−5% respectively (BS 812: Part 109, 1990). The average water absorbed by the coarse aggregate was 0.75% which is within the standard range of 0.5−5% (BS 812: Part 107, 1995).

The average bulk density obtained for fine aggregate was 1632.36kg/m³ while that of coarse aggregate was 1626.47kg/m³, which fall within the standard range of 1500−1700kg and 1300−1800kg/m³ respectively (BS 812: Part 2, 1995).

The compressive strength of concrete at different revibration time lag intervals of 5minutes for 7days, 21days and 28days of curing are presented on Tables 6, 7 and 8, while the graphical representation of this dynamic effect for their ages collectively is on Figure 1. It can be observed that the compressive strength generally increases dynamically for all categories of curing and at successive revibration time lag intervals of 5minutes giving maximum of 18.89N/mm^2, 22.75N/mm^2 and 28.18N/mm^2 for 7days, 21days and 28days of curing respectively.

It is also evident that the compressive strength of the un-revibrated concrete for the corresponding days of curing the least in value: 11.96N/mm^2, 15.64N/mm^2 and 18.31N/mm^2 respectively. The least of 28days concrete, 18.31N/mm^2 is also observed to be almost equal to the maximum compressive strength of 7days concrete. The time of revibration process is observed for 1hour which is below the initial setting time of the concrete following that the dynamic effect of revibration on the compressive strength will be on the increase provided the revibration process is done within the initial setting time of the concrete thus enhancing the compressive strength of the concrete. The result also shows that, the variation in compressive strength with the original concrete that is not revibrated is up to 14%.

Figure 1. Dynamic effect of revibration with time.



CONCLUSIONS

This paper has considered the dynamic effect of revibration on the compressive strength of concrete with 0.75 w/c ratio at successive revibration time lag interval of 5minutes for up to 1hour period of revibration process. Revibration has generally increased the compressive strength of the concrete, for instance, the increase in compressive strength with the original concrete that is not revibrated is up to 14%. Therefore, provided the revibration is done within the initial setting time, the compressive strength the concrete will be on the increase.

Revibration time lag interval of 5minutes presents clear picture of the dynamic effect of revibration than when it were revibrated at 30 minutes interval, therefore to obtain optimal time lag revibration of the concrete, the revibration process can be done at 5minutes interval successively for 3hours period of time. The minimum compressive strength of 28days concrete is almost equivalent to the maximum compressive strength in 7days concrete and therefore 28days can conveniently be considered for the concrete optimum strength.

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