Compressive Strength and Workability Assessment for Compacting Concrete

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ABSTRACT: Honeycombing is always an aesthetic problem, and depending on the depth and extent may reduce both the durability performance and the structural strength of the member**.** One of the causes of honeycombing is the compaction, not having been adequate to cause the mortar to fill the voids between the coarse aggregate. To minimize the occurrence of honeycombed concrete use a mix with appropriate workability for the situation in which it is to be placed and ensure the concrete is fully compacted, check that the formwork is rigid and well braced, the joints are watertight.

In this present study workability of concrete mix increased by adding Naphthalene Formaldehyde base superplasisizer, keeping constant water cement ratio 0.4, to reduce the efforts of compaction and increase the time of retention. By increasing workability air voids reducing and no spatial attention required in the operation of needle vibrator. The result shown in substantial improvement in compressive strength of concrete after increasing the workability.

Keywords: Admixture, Compaction, honeycombing, slump, superplastisizer, Workability.

1. INTRODUCTION

Concrete is the most widely used construction material today. The versatility and mouldability of this material, its high compressive strength and reinforced by the steel bars for tensile strength. In present scenario, large numbers of cement concrete roads are constructed but many of them are damaged soon after their opening to traffic or premature damages occur before their anticipated life. The difference between good concrete and bad concrete lies in quality control. Quality of the concrete depends as much, and perhaps more, on the man on the job as on the constituent materials. Concrete durability is affected by several varied factors such as improper choice of materials, poor mix design etc. These factors, however, can be brought under control with improved material and better design by opting for wider sections and use of modern automatic batching plants to produce good quality of concrete. By literature review I have found that the hundred per cent compaction of concrete is an important parameter for contributing to the maximum strength.

Quality produced concrete may still give poor results due to lack of compaction. Immersion vibrators are the most common equipment used for compacting concrete. They are highly efficient and comparatively easy to use. However to achieve a homogeneous and well compacted concrete proper planning of vibration procedure is necessary. Close supervision of the compaction process at construction sites is very much necessary.

The quality of concrete satisfying the lubrication, handling without segregation, placing without loss of homogeneity, compacting with the amount of efforts and to finish it easily. Poorly compacted concrete allowing moisture and other gases to penetrate and corrode the steel also does not allow proper bond to be developed between the concrete and reinforcement.

2. COMPACTION OF CONCRETE

Compaction is process, which expels entrapped air from freshly placed concrete, and packs the aggregates together so as to increase the density of concrete. In the process of mixing, transporting and placing of concrete air is likely to get entrapped in the concrete. The lower the workability, higher is the amount of air entrapped and therefore would need higher compacting efforts than high workable mixes.

If this air is not removed fully, the concrete loses strength considerably. 5 per cent voids reduce the strength of concrete by about 30 per cent and 10 per cent voids reduce the strength by over 50 per cent that of the concrete when fully compacted as shown in Fig.1.It is imperative that 100 per cent compaction of concrete is one of the most important aim to be kept in mind in good concrete-making practice. Compaction methods should be such that they will not cause segregation of aggregate and will result in a dense homogeneous concrete free of voids and porous pockets.

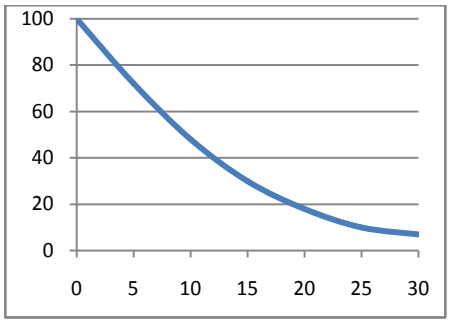

Fig.1. Loss of strength of concrete due to incomplete compaction

Permeability is also increased by insufficient compaction, resulting in easy entry for aggressive chemicals in concrete, which attack concrete and reinforcement to reduce the durability of concrete.

In order to achieve full compaction and maximum density, with reasonable compacting efforts available at site, it is necessary to use a mix with adequate workability.

3. COMPACTING METHODS :

There are two methods are commonly used for compaction of concrete at site works:

(i) Hand compaction: - This is adopted in case of unimportant concrete works of small magnitude. Hand compaction consists of rodding, ramming or temping. When hand compaction is adopted, the consistency of concrete is maintained at higher level. The compaction by hand, if properly carried out on concrete with sufficient workability, gives satisfactory results, but the strength of the hand compacted concrete will be necessarily low because of higher water cement ratio required for full compaction.

(ii) Compaction by Vibrator:- Immersion vibrator and surface vibrator or screed vibratory are commonly used in highway structures. Both vibrators are simultaneously used in deck slab, rigid pavement etc. Some times form work vibrator also used in precast works and heavy reinforced concrete works.

Where strength is required, it is necessary that stiff concrete, with low water cement ratio be used. To compact such concrete, mechanically operated vibrator are used.

The vibrators impart a vibratory force into the concrete through a combine effort of frequency and amplitude. The effectiveness of an immersion vibrator is dependent on its frequency and amplitude. The amplitude is dependent on the size of needle, the eccentric moment and the needle weight. The area of vibrating needle action is 100 times the cross sectional area of the needle in concrete having 25mm to 35 mm slump, for example radius of action of 60mm diameter vibrator needle shall be 300 mm.

4. WORKABILITYOFCONCRETE:

The behavior of green or fresh concrete from mixing up to compaction depends mainly on the property called workability of concrete. Workability of concrete is a term which consists of the following four partial properties of concrete namely, Mixability, Transportability, Mouldability and compactibility.

In general terms, workability represents the amount of work which is to be done to compact the concrete in a given mould. The desired workability for a particular mix depends upon the type of compaction adopted and the complicated nature of reinforcement used in reinforced concrete.

Workable concrete is the one which exhibits very little internal friction between particle and particle or which overcomes the frictional resistance offered by the formwork surface or reinforcement contained in the concrete with just the amount of compacting efforts forthcoming.

The factors helping concrete to have more lubricating effect to reduce internal friction for helping easy compaction are given below:

a. Water content
b. Size of aggregates
c. Surface texture of aggregate
d. Use of admixtures
e. Mix proportions
f. Shape of aggregates
g. Grading of aggregates

5. RESEARCH SIGNIFICANCE:

Many a times honey combing or exposed rusted reinforcements are seen on the surface of concrete structures. The main causes of honeycombing are improper compaction, the layman using vibrator and stiff concrete. If compaction delayed, the mix becomes more stiff, then they added extra water to fluidise the mix, this extra water leakage from shuttering along with cement, and honey comb appeared on the surface. Therefore adequate workability should be adopted by adding admixtures (plastisizer, superplastisizers, retarder etc.) to achieve hundred per cent compaction by less efforts of compaction at same water/ cement ratio.

6. EXPERIMENTAL PROGRAMME:

The main aim of this experimental programme was to study the effect of different workability of mix to achieve hundred per cent compaction by less efforts of compaction. The workability of concrete increased by adding different dosage of superplastisizer at constant water cement ratio for pavement quality concrete M40 grade. The important property of concrete, compressive strength also studied. Mix design for PQC (M 40) was carried out as per the guidelines laid in IS 10262, IRC 44 and IRC SP: 23.

7. MATERIALS AND PROCEDURE:

Ordinary Portland Cement (OPC) 43 grade confirming to IS:8112-1989 was used. The various properties of cement shows in table-1. Locally available sand and aggregate were used in the experimentation.

Table-1. Properties of Cement

Particulars	Test Results	IS Code Limits
Specific gravity	3.15	Not specified
Fineness (m^2/kg)	273	225minimum.
Standard Consistency %	27	
Initial setting time (min)	150	30 minimum
Final setting time (min)	200	600 max.
Soundness of cement Le-chat Expansion %	1.0	10 max.
Compressive strength 3- Days in MPa 7- Days in MPa 28-Days in Mpa	 32.6 42.9 58.0	 23 min 33 min. 43 min.

Maximum size of aggregate used in the mix was 20 mm. The preliminary tests on fine aggregate and coarse aggregate were conducted as per IS: 2386-1975 and IS: 383, results of the preliminary tests are given in table 2 and 3. The fine aggregate was confirming to zone II. The admixture superplastisizer Rheobuild 1126 has been used for the present investigation. The technical details of superplastisizer (conforming to IS: 9103-1979) as given by the manufacturer's literature are given in table No. 4.

Table-2. Properties of Fine Aggregate

Particulars	Test Results
Specific gravity	2.59
Fineness modulus	2.75
Water absorption %	0.74
Grain size distribution	Zone II

Concrete mix of grade M40 chosen for the present investigation. A total of 6 castings have been made, out of which the first is a control mix of M40 gave a slump 46mm. In each casting 3 cubes are cast. The next set of 5 castings are at variable dosage of super plastisizer of 0.2%, 0.4%, 0.6%, 0.8% and 1.0% of weight of cement.

The fine aggregate, cement and coarse aggregate were dry mixed, approximately 80% of calculated quantity water (w/c = 0.4) was added into the dry mix and entire mass was mixed homogeneously. Now the superplastisizer was added in the remaining 20% water and this liquid was added to the concrete. The concrete was mixed again, the workability test (slump test) were conducted, Table 5 shows the slump test results. After 45 min, the concrete was remixed by hand using a shovel just enough to counteract any bleeding or segregation and slump of concrete was determined, and found same slump. This homogeneous concrete mass was poured into the cube moulds in three layers, Set-A cube was temped 35 strokes in each layers and others cubes were temped 1/3rd times of standard temping (35 strokes) i.e. 12 strokes in each layer by standard temping bar. After consolidation the top surface was finished smooth and they were covered with wet gunny bags. After 24 hours, the specimens were demoulded and transferred to the curing tank where in they allowed to cure for 7 days. After 7 days of water curing, the specimens were weighed and tested for compressive strength under compressive testing machine as per IS:516-1959.

Table-3. Properties of Coarse Aggregate

Particulars	Test Results
Specific gravity	2.65
Fineness modulus	16.08
Impact value %	14.16
Flakiness index %	16.37

Table -4. Properties of Superplstisizer, Rheobuild 1126

Parameters	Test Results
Physical state	Dark Brown free flowing liquid
Chemical name of active Ingredient	Naphthalene Formaldehyde Polymer
Relative Density at 25^{0}C	1.251
pH	7.8
	0.0016
Dry Material Content	47.75

Table – 5. Slump test for different dosage of superplastisizer.

Set	Dosage of Superplastisizer By weight of cement	Slump in mm	Remarks
A	Nil	46 mm	
B	0.20 %	52 mm	
C	0.40 %	61 mm	
D	0.60 %	73 mm	
E	0.80%	100 mm	
F	1.00%	180 mm	Concrete segregated

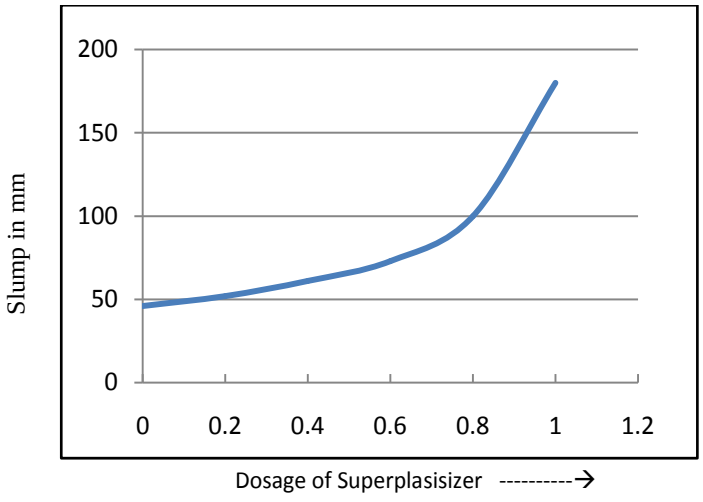

Figure -2 Dosages of Superplastisizer vs Slump in mm

Table 6. Compressive Strength Test results

Set	Dosage of Superplastisizer By weight of cement	7 days Compressive strength of concrete N/mm^2	Weight of cube in gms
A	Nil	35.11 35.60 33.30	8310 8340 8290
A1	Nil	19.32 23.80 18.60	7479 7506 7461
B	0.20 %	22.60 24.30 19.80	7490 7530 7420
C	0.40 %	24.70 26.10 23.80	7602 7800 7512
D	0.60 %	33.40 32.10 32.80	8302 8130 8200
E	0.80%	36.20 37.50 34.80	8350 8365 8315

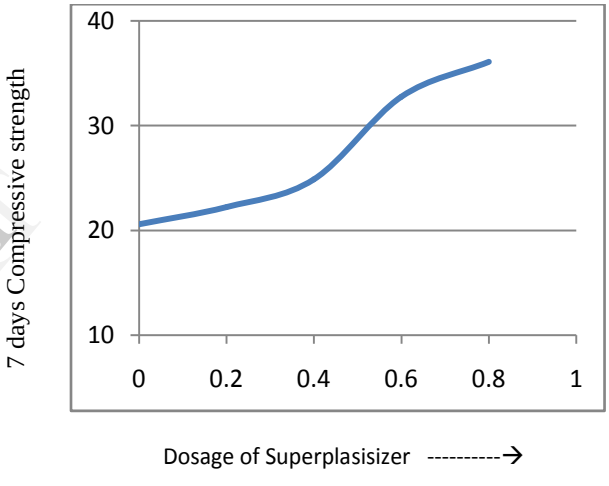

Figure -3 Dosages of Superplastisizer vs Compressive strength.

8. EFFECT ON COST:

The initial cost of the concrete pavement is increased by adding superplastisizer, but the strength and durability of concrete increased and maintenance cost and life cycle cost decreased.

9. CONCLUSION :

On basis of observation honeycombing free concrete can be casted by increasing workability. Strength and durability of concrete will also increased by small addition of admixtures. The design of concrete mix should be at higher workability and admixtures must be added for durable concrete.

10. REFRENCE

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