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Analysis of Workability on Construction of Interlocking Concrete Pavement Blocks (ICBPs) Using Superplasticizer As Admixture

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Abstract: ***In this experimental study water proofing superplasticizer is used in M 35 mix design with adding it maximum 2 % of superplasticizer by weight of cement in the construction of concrete blocks pavements. Superplasticizer is added 0.5 %, 1.0 %, 1.5 % and 2.0 % by weight of the cement in construction of the concrete pavement blocks. The effect is shown in the workability of the M 35 mix design considering w/c ratio on 0.35, 0.40, 0.45, 0.50, and 0.55 and slump value considered. The use of superplasticizer helped also in reduction of water percentage in concrete mix with comparison to conventional mix design without using superplasticizer.***

Keywords: w/c ratio; mix design; superplasticizer; workability; compressive strength

1. Introduction

Workability of concrete is a property to determining the effort required to manipulate a freshly mixed quantity of concrete with minimum loss of homogeneity. Mindess et al. given a definition in 2003 on the workability of fresh concrete as “the amount of mechanical work, or energy, required to produce full compaction of the concrete without segregation.” Workability is not a fundamental property of concrete in the construction and methods of placing, compacting, and finishing. The workability in concrete technology has significance and it is one of the key properties which setisfied the concrete consruction.

Workability of fresh concrete has two aspects

1. **Consistency:** Consistency shows the flow of easily fresh concrete which is obtained by a slump-cone test, the compaction factor, or a ball penetration compaction factor test. As it has a simple index for fluidity of fresh concrete.
2. **Cohesiveness:** Cohessivness shows uniformity of the concrete to hold the all concrere material used and it is characterized by a Vebe test as an index of both the water-holding capacity (the opposite of bleeding) and the coarse-aggregate-holding capacity (the opposite of segregation) of a plastic concrete mixture.

2. Measurement of Workability

In the concrete construction there is no any test method to directly measure the workability. The obstucle to mesure the mechanical work in terms of workability impossible to find a well-accepted test method to measure workability. So slump test is used most widely which mainly measures the consistency of concrete.

3. Objects of Workability

- It will be mixed easily and transported.
- It will be uniform throughout a given batch, and between batches with added superplasticizer.
- It must keep its fluidity during the transportation period.
- It should have flow properties such that it is capable of completely filling the forms.
- It must have the ability to be fully compacted without segregation.
- It must set in a reasonable period of time.
- It must be capable of being finished properly, either against the forms or by means of trawling or other surface treatment.

4. History of Workability and Durability of Concrete

In INDIA, due to lack of education and awareness of the benefits of using workability and durability of the concrete , there were used to make low strength concrete like M15,M20,M25 and M30, which are really do not need of the use of the plasticizers in fifties.

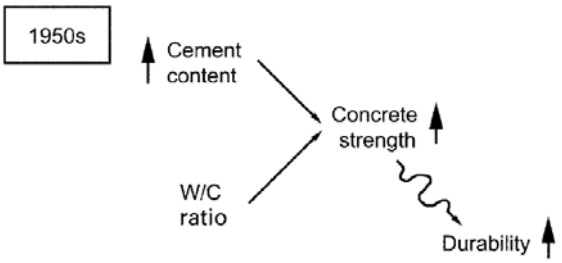

Figure 1: Chronicle cement contents and durability during 1950s

Developments in the 1960s includes increasing in the strength of cement, refined tolerance in the mix design and batching procedures, and increase efficiency through greater employment of statistical method in quality control.

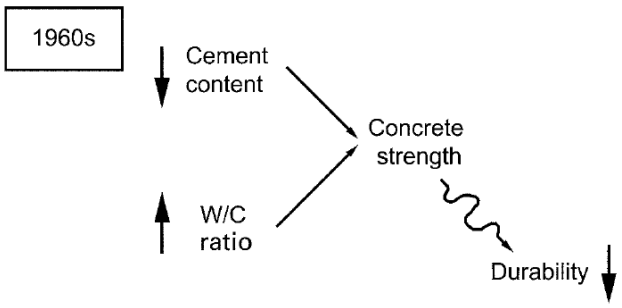

Figure 2: Statistical Method in Quality Control

Designers needed to specify for durability as well as strength led to concrete construction. The range included mixes that satisfied the designer's intention regarding strength but not the durability requirement.

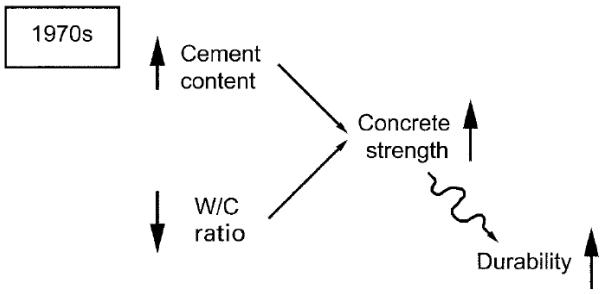

Figure 3: Strength satisfaction but durability not satisfied

Above draw back was overcome by Deacon and Dewar in 1982 by "durability grade concept" as shown in figure 4.

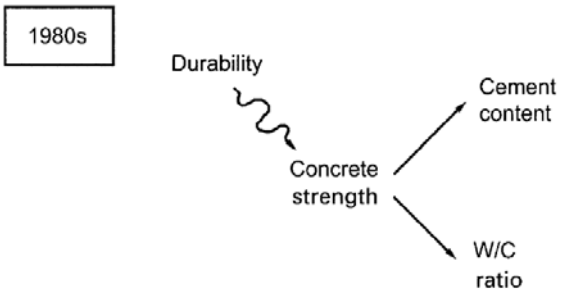

Figure 4: Durability grade concept

5. Material Used

Cement: For the construction of ICBPs there is used 43 grade OPC cement in this experiment as per local availability. So in workability test OPC 43 grade cement is going to be used.

Coarse Aggregate: As per given **IS 15658:2006** precast concrete block for paving there can be used only 12 mm nominal size of coarse aggregate in the construction of ICBPs.

Fine aggregate: As per IS 383:1970 Specification for Coarse and Fine Aggregates, fine aggregate has finesse modulus of 3rd zone which utilized in this experiment.

Admixture: Water proofing superplasticizer was used in this experiment which was in liquid form and had colour brown as shown in fig.5 below.

Water: Water which was portable and drinking having pH value 7.5 was used in this analysis. It concerned as IS 456:2000.

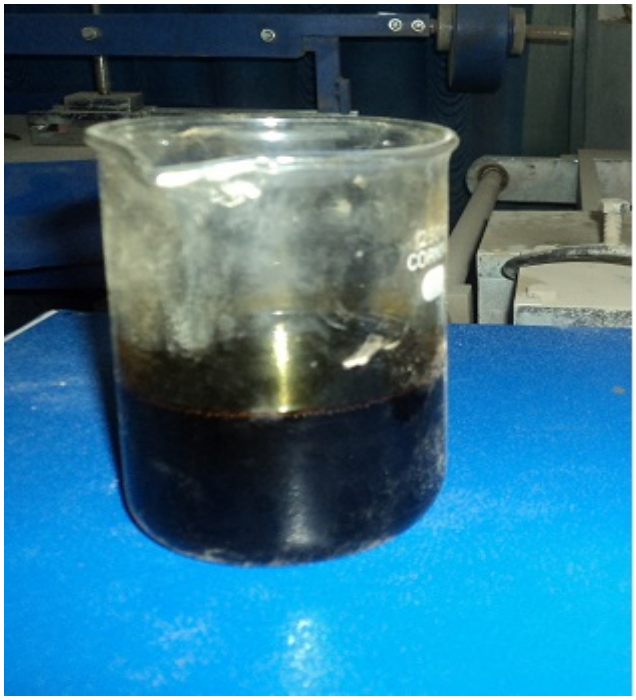

Figure 5: Waterproofing Superplasticizer in Liquid Form

Table 1: Values of slump for various types of construction as per ACI 211.1-81

S. No.	*Type of Construction*	*Range of Slump in mm*
1	Reinforced foundation walls and footings	20–80
2	Plain footings, caissons and substructure walls	20–80
3	Beams and reinforced walls	20-100
4	Building columns	20-100
5	Pavements and slabs	20–80
6	Mass concrete	20–80

6. Experimental Setup of Slump Test

It consists of a truncated cone and a tamping rod. Truncated cone has 300mm in height, 100mm in diameter at the top, and 200mm in diameter at the bottom as shown in fig. 6 below. In this experiment trial mix proportion prepared as per IS 10262: 2009 to carry out by proportion of cement, water, admixture, fine aggregate, coarse aggregate. Admixture i.e. water proofing superplasticizer added 0.5 %, 1.0 %,1.5 % and 2.0 % by weight of cement and gives the various results as shown in the following tables. Mix ratio for M 35 grade trial was 1:2.54:2.1 and w/c ratio taken 0.35, 0.4, 0.45, 0.50, 0.55 and 0.60 with adding superplasticizer at various percentages and find out the workability of M 35 mix design.

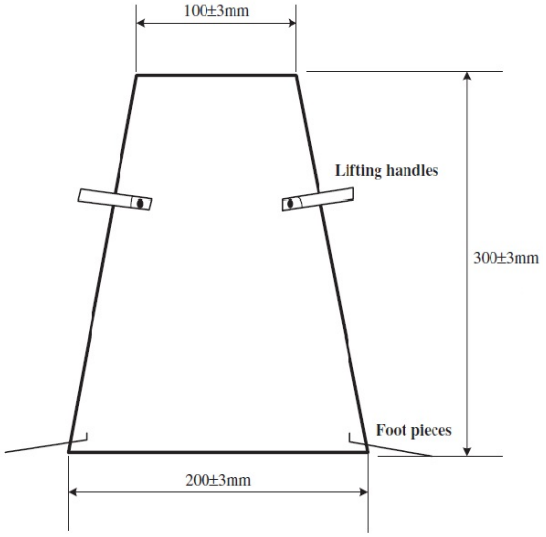

Figure 6: Slump Cone

Figure 7: Slump for M 35 mix design with adding 2 % of superplasticizer at W/C ratio 0.35

Figure 8: Slump for M 35 mix design without adding superplasticizer at W/C ratio 0.35

Table 2: Slump values for different w/c ratio

S. No.	*W/C Ratio*	*Water quantity in lit.*	*Slump in mm*
1	0.35	1.295	0
2	0.40	1.48	20
3	0.45	1.565	40
4	0.50	1.85	160
5	0.55	2.03	240
6	0.60	2.22	270

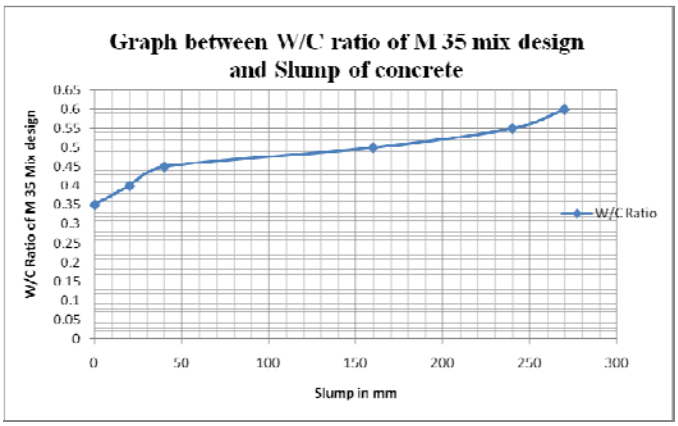

Figure 9: Graph between W/C ratios and slump of concrte without adding superplasticizer

Table 3: Slump value for w/c ratio 0.35

S. No.	*W/C Ratio*	*Water quantity in lit.*	*% age of superplasticizer by wt. of cement*	*Slump in mm*
1	0.35	1.295	0.5	0
2	0.35	1.295	1.0	20
3	0.35	1.295	1.5	25
4	0.35	1.295	2.0	30

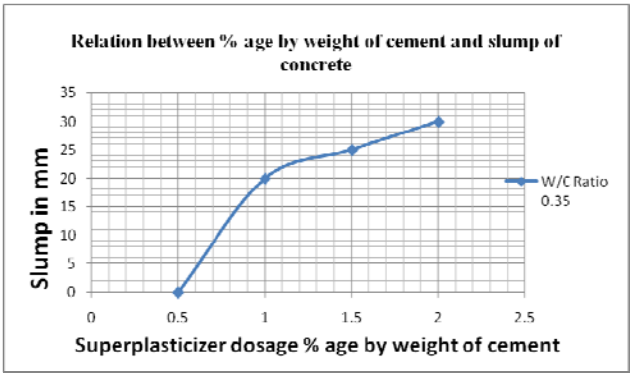

Figure 10: Graph between W/C ratio 0.35 and slump of concrte with adding superplasticizer

Table 4: Slump value for w/c ratio 0.40

S. No.	*W/C Ratio*	*Water quantity in lit.*	*% age of superplasticizer by wt. of cement*	*Slump in mm*
1	0.40	1.48	0.5	40
2	0.40	1.48	1.0	60
3	0.40	1.48	1.5	100
4	0.40	1.48	2.0	180

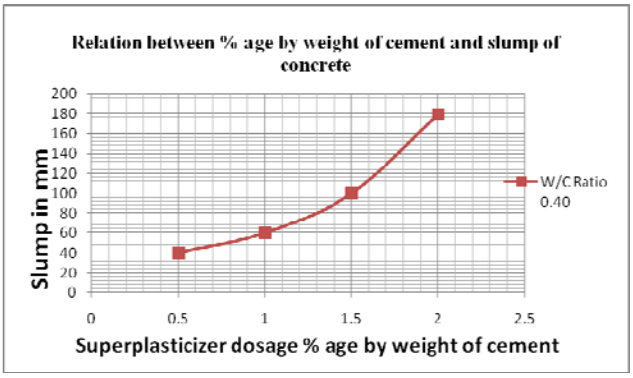

Figure 11: Graph between W/C ratio 0.40 and slump of concrte with adding superplasticizer

Table 5: Slump value for w/c ratio 0.45

S. No.	*W/C Ratio*	*Water quantity in lit.*	*% age of superplasticizer by wt. of cement*	*Slump in mm*
1	0.45	1.565	0.5	70
2	0.45	1.565	1.0	120
3	0.45	1.565	1.5	160
4	0.45	1.565	2.0	225

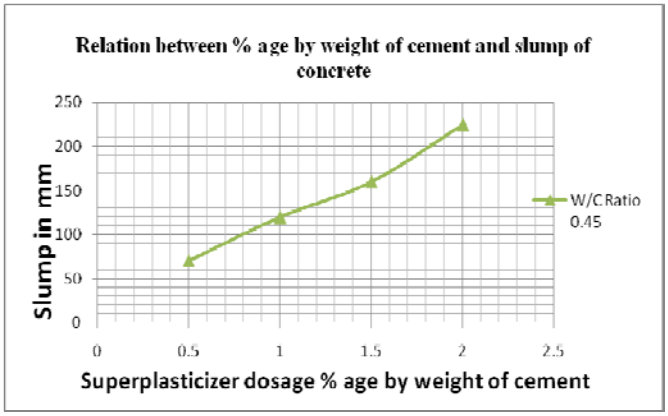

Figure 12: Graph between W/C ratio 0.45 and slump of concrte with adding superplasticizer

Table 6: Slump value for w/c ratio 0.50

S. No.	*W/C Ratio*	*Water quantity in lit.*	*% age of superplasticizer by wt. of cement*	*Slump in mm*
1	0.50	1.85	0.5	190
2	0.50	1.85	1.0	210
3	0.50	1.85	1.5	230
4	0.50	1.85	2.0	-

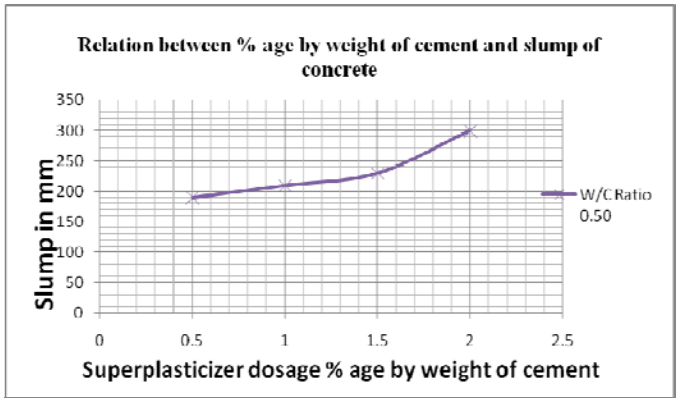

Figure 13: Graph between W/C ratio 0.50 and slump of concrte with adding superplasticizer

Table 7: Slump value for w/c ratio 0.55

S. No.	*W/C Ratio*	*Water quantity in lit.*	*% age of superplasticizer by wt. of cement*	*Slump in mm*
1	0.55	2.03	0.5	-
2	0.55	2.03	1.0	-
3	0.55	2.03	1.5	-
4	0.55	2.03	2.0	-

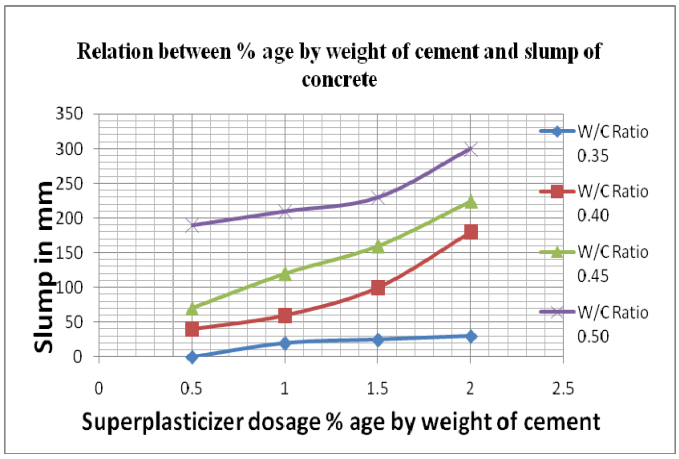

Figure 14: Comparisons graph between different w/c ratios with superplasticizer

7. Results and Discussions

Table 2 shows that W/C ratio and slump value for M 35 mix design at various water percentages. As water percentage increases the value of the slump is also increasing. After that at each percentage of water superplasticizer is added at 0.5 %, 1.0 %, 1.5 % and 2.0 % by weight of cement then analyzed the workability of the concrete mix for construction of ICBPs.

8. Conclusions

From this experimental study it has been concluded that w/c ratio for the m 35 mix design is decided at 0.40 with adding water proofing superplasticizer maximum 1 % by weight of the cement and having slump value 60 mm as compared to get the slump 20 mm without using superplasticizer.

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Author Profile

Sharda Sharma pursuing M. Tech (2nd year) in Civil Engineering Department specialization in structural engineering from MMMUT Gorakhpur and accomplished B. Tech in Mechanical Engineering from I.E.T. Sitapur in 2010 and has experience of production engineer one year in Automax a unit of Omax in Haryana. I also published papers in international journals.