

# **COMPATIBILITY ANALYSIS OF CEMENT WITH SUPER-PLASTICIZERS**

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# OBJECTIVE OF WORK

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- ❖ To determine the compatibility between cement and super-plasticizer by measuring the fluidity of the cement paste.
- ❖ Fabrication and arrangement of test equipment.
- ❖ Determination of saturation dosage.
- ❖ Determination of saturation dosage for change in w/c ratio for the same combination of C-SP.
- ❖ Analysis of behavior of C-SP couple for different w/c ratio.

# NEED OF STUDY

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- ❖ The increase in types in multitude of brands of chemical admixtures and cement are available in the market.
- ❖ The cement composition and its properties vary in the world; it has not become an easy task for admixture manufacturer to 'match' its products with any specific type of cement.
- ❖ This has created confusion among users to use which type of cement with which type of super-plasticizer and with how much dosage.
- ❖ Consequently, there may exist some problems of incompatibility of C-SP.

# NEED OF STUDY *cond..*

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- ❖ The use and quantity of super-plasticizer is generally based on trial and error method because of an incomplete understanding.
- ❖ It becomes essential to evaluate each C-SP combination.
- ❖ This study is a step to determine the solution against this difficulty to select the most efficient couple of C-SP.

# INTRODUCTION

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- ❖ Due to the change in composition within same grade or type of cement, super-plasticizers are not showing the same extent of improvement in fluidity.
- ❖ Some cement brand show higher fluidizing effect with a super-plasticizer than other cement brand with same super-plasticizer.
- ❖ There is neither the problem with cement nor with that of super-plasticizer.
- ❖ The fact is that they are just not compatible to show maximum fluidizing effect due to the change of composition or so.

# INTRODUCTION *contd...*

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- ❖ The use of super-plasticizer reduces the w/c ratio for making concrete of higher workability which increases strength and durability.
- ❖ An admixture can be effective or not depends upon various factors such as chemical or family of SP, chain length, dosage of admixture, temperature, molecular weight of the polymer and particle size distribution and composition of cement.
- ❖ The concrete made with low water- cement ratio require such suitable and compatible super-plasticizer which can adopt the behavior of cement and can also impart high workability.

# INTRODUCTION *contd...*

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- ❖ It is very difficult to ensure that an admixture produces all the desirable effect with cement A would do the same with cement B.
- ❖ Problems arising due to compatibility issues are often mistaken for problems with concrete mix design, because of the lack of information about the subject amongst practicing engineers.
- ❖ Admixture manufacturers have started formulating project specific chemicals, to overcome the problem. But this is only short term solution.

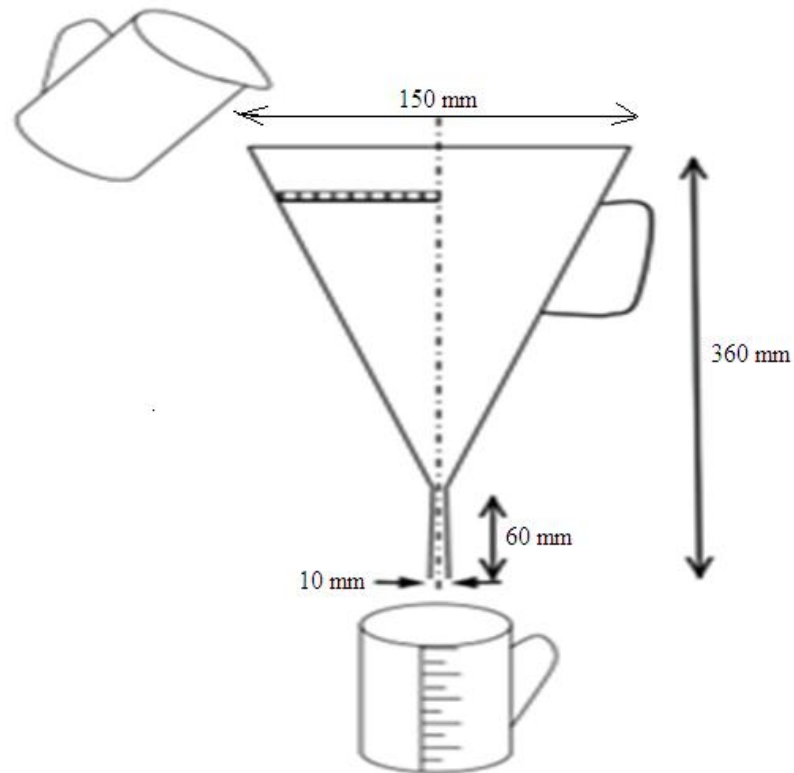


# COMPATIBILITY TEST

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- ❖ While assessing compatibility, the required dosage of the super-plasticizer should be established.
- ❖ The usual approach is to use Marsh cone for the determination of the time required for a specified volume of grout of cement and super-plasticizer to flow through the orifice of the funnel.
- ❖ Generally, this time is known as Marsh flow-time, which decreases with the increase of dosage of super-plasticizer up to certain value beyond which there is little remarkable improvement.

# TYPICAL LAYOUT OF MARSH CONE TEST



. Marsh cone used for measurement the cement paste fluidity.

# APPARATUS USED

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- a. Fabricated Marsh cone apparatus
- b. Stand to hold the Marsh cone apparatus
- c. Weighing machine
- d. Measuring flask
- e. Syringe
- f. Sieve
- g. Stop watch
- h. Medical gloves

# FABRICATED MARSH CONE APPARATUS

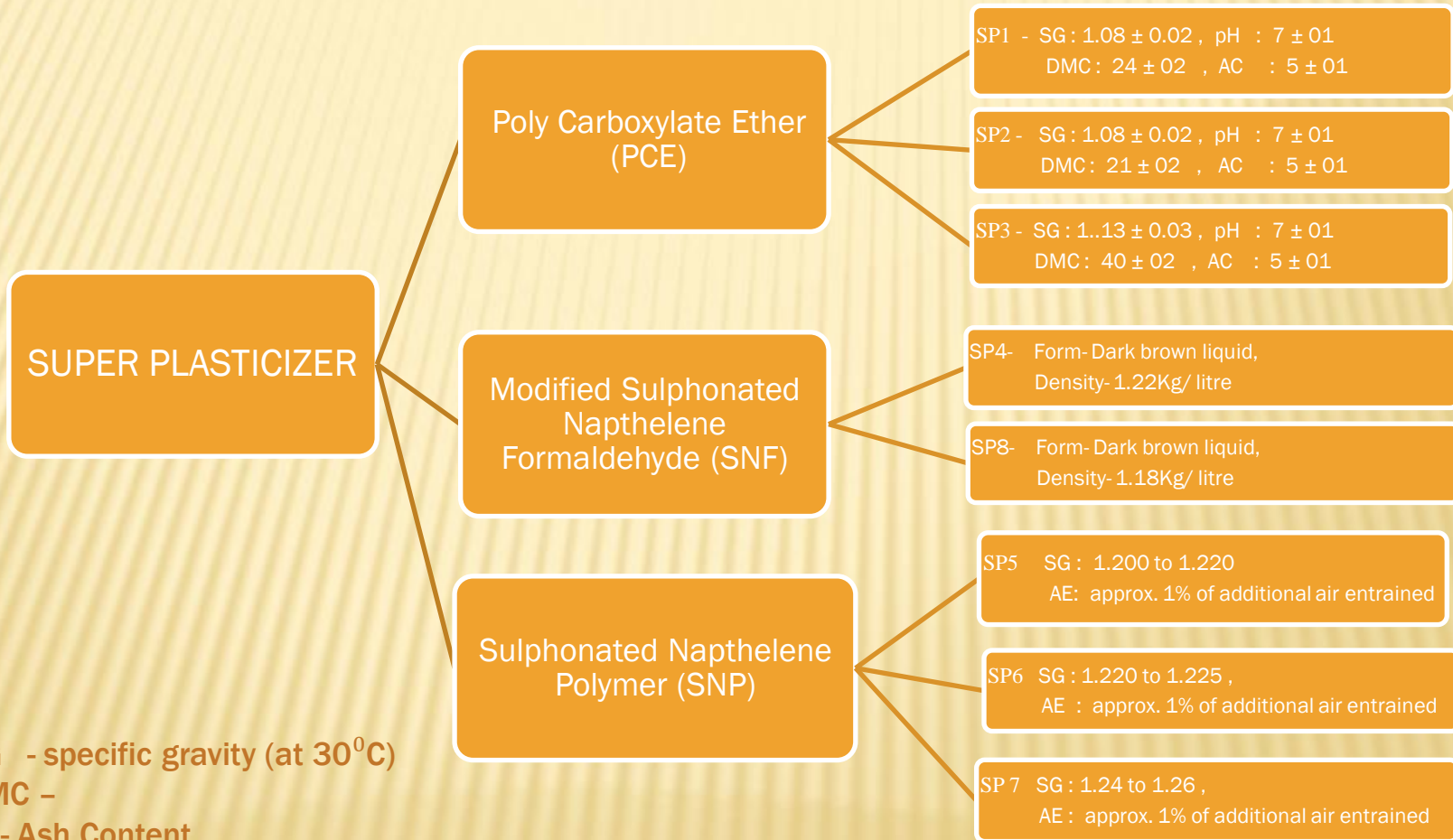


FABRICATED MARSH CONE

STAND

BUCKET

# MATERIAL USED



▪SG - specific gravity (at 30<sup>0</sup>C)

▪DMC -

▪AC- Ash Content  
(%w/w at 625± 25<sup>0</sup>C)

▪AE- Air Entrainment

# MATERIAL USED *contd....*

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## ❖ CEMENTS (PPC) used are :

- PPC based cement 1 (C1)
- PPC based cement 1 (C2)
- PPC based cement 1 (C3)

## ❖ WATER

# METHODOLOGY

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## TEST PROCEDURE

1. w/c ratio= 0.5
2. Take 2 kg of cement in bowl
3. Add 1 litre of water (as w/c ratio= 0.5)

# METHODOLOGY



STEP -4



STEP -5



STEP -6

4. Add 10ml of SP1 super-plasticizer. (i.e. 0.5% of cementitious material)
5. Mix them thoroughly with hand or mechanical mixer for 2 min.
6. If hand mixing is done, the cement slurry should be sieved through 1.18 sieve to avoid formed lumps to choke the funnel orifice.



# METHODOLOGY



STEP -7



STEP -8



STEP -9

7. Take one litre of cement slurry and pour it into the funnel by closing the orifice with the help of rubber stop or finger.
8. Close it for that time, for which the reading has to be taken i.e. 5min, 60min....so on.
9. Start a stop watch and simultaneously remove the finger. Note down the time taken in seconds, for the complete flow out of the slurry.

# METHODOLOGY

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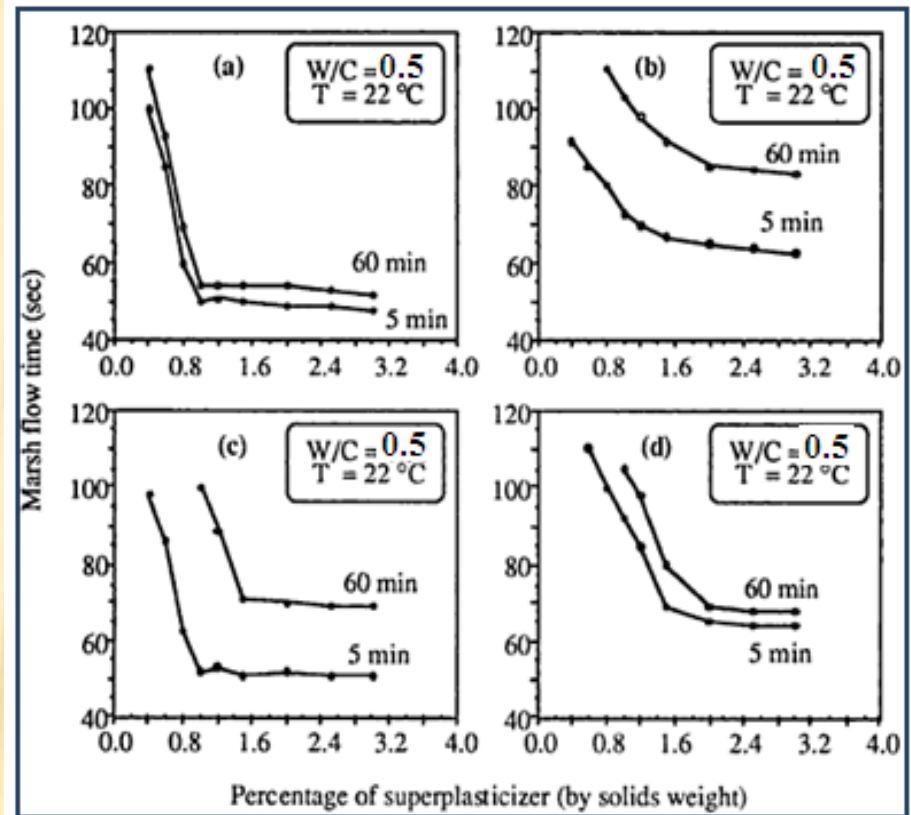
- ❖ Repeat the above steps with 0.7% , 0.9% , 1.1% , 1.3% , 1.5% dosages of super-plasticizer for 60min,120min,180min, 240min.
- ❖ Plot the graph between Marsh cone time and dosages of super-plasticizer.
- ❖ The dose at which the Marsh cone time is lowest is called the saturation point. The dose will be the optimum dose for that combination of cement and super-plasticizer.

Fig.(a) represents case of a perfectly compatible C-SP combination; the saturation dosage is low and 60 min curve is close to 5 min curve.

Fig.(b) represents case of an incompatibility between C-SP; the saturation dosage is very high and there is large gap between the 5 min and 60 min curve. In many cases, the grout stops to flow very rapidly.

Fig.(c) represents intermediate case. The 5 min curve is similar to 5 min curve in fig(a) but 60 min curve is similar to 60 min curve of fig(b).

Fig.(d) also represents intermediate case. The 5 min curve is similar to 5 min curve in fig(b) but 60 min curve has a relative position to 5 min curve similar to the situation in fig(a).

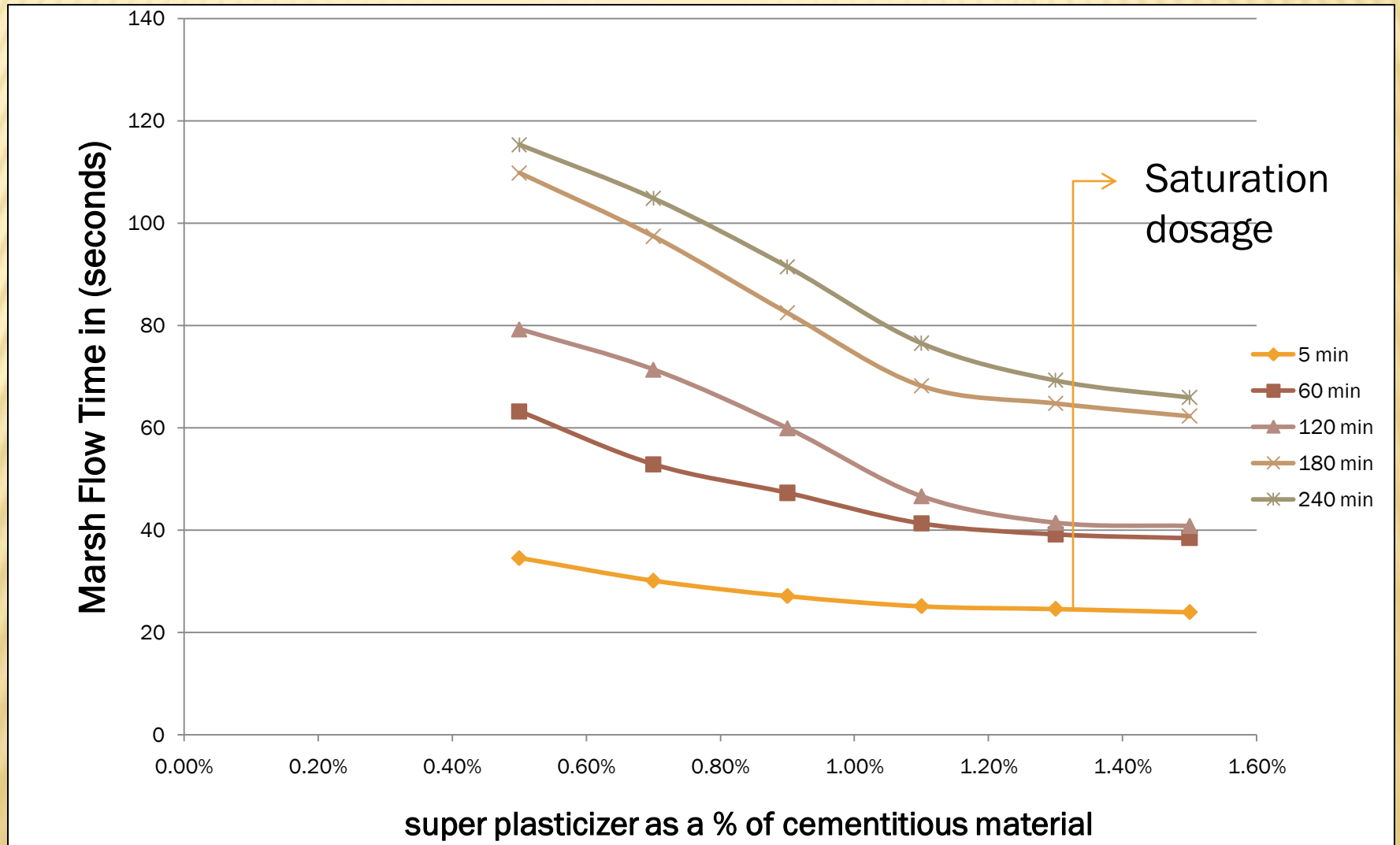


## BASIS OF STUDY

# FORMAT OF TABLE USED FOR STUDY

%age of Plasticizer	Name of super-plasticizer				
	5 min	60 min	120 min	180 min	240 min
0.5%					
0.7%					
0.9%					
1.1%					
1.3%					
1.5%					

# TYPICAL GRAPH



# COMBINATION OF TESTING

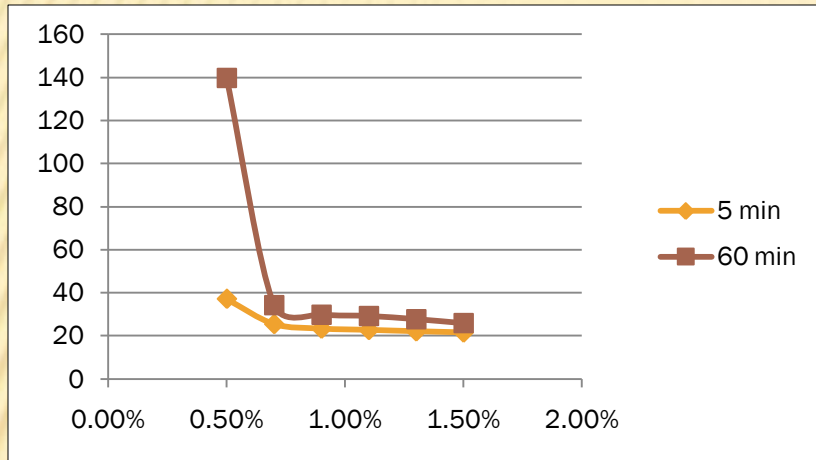
w/c ratio= 0.5			w/c ratio= 0.45		
C1- SP1	C2- SP1	C3- SP1	C1- SP1	C2- SP1	C3- SP1
C1- SP2	C2- SP2	C3- SP2	C1- SP2	C2- SP2	C3- SP2
C1- SP3	C2- SP3	C3- SP3	C1- SP3	C2- SP3	C3- SP3
C1- SP4	C2- SP4	C3- SP4	C1- SP4	C2- SP4	C3- SP4
C1- SP5	C2- SP5	C3- SP5	C1- SP5	C2- SP5	C3- SP5
C1- SP6	C2- SP6	C3- SP6	C1- SP6	C2- SP6	C3- SP6
C1- SP7	C2- SP7	C3- SP7	C1- SP7	C2- SP7	C3- SP7
C1- SP8	C2- SP8	C3- SP8	C1- SP8	C2- SP8	C3- SP8

# OBSERVATIONS – CEMENT (C1)

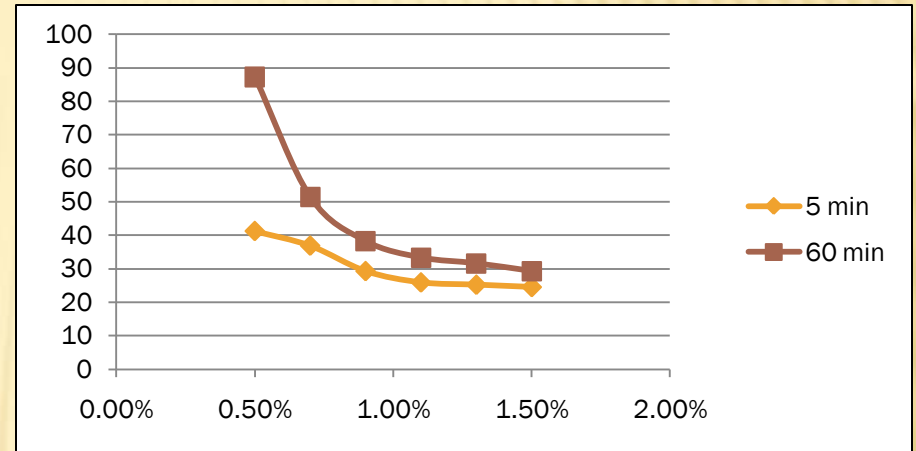
%age of plasticizer	SP1		SP2		SP3		SP4	
	5 min	60 min	5 min	60 min	5 min	60 min	5 min	60 min
0.5%	37.21	139.78	41.2	87.27	41.32	94.35	37.72	139.31
0.7%	25.50	34.34	36.86	51.39	35.87	72.87	30.03	42.89
0.9%	23.96	29.89	29.32	38.24	31.75	51.94	27.69	33.78
1.1%	22.72	29.16	25.96	33.31	29.22	35.53	26.44	29.25
1.3%	22.09	27.69	25.28	31.58	27.75	34.81	22.43	26.9
1.5%	21.54	25.82	24.59	29.28	27.47	33.25	17.16	22.58

%age of plasticizer	SP5		SP6		SP7		SP8	
	5 min	60 min	5 min	60 min	5 min	60 min	5 min	60 min
0.5%	86.64	166.79	40.5	138.88	35.16	96.60	20.72	151.72
0.7%	35.94	136.56	33.69	69.07	33.18	52.64	19.41	57.91
0.9%	34.78	89.25	29.1	49.89	24.56	34.81	19.06	24.34
1.1%	31.37	72.68	27.63	45.25	19.66	28.56	17.75	23.22
1.3%	23.47	58.75	27.97	43.67	16.47	24.31	17.28	22.82
1.5%	23.17	55.13	26.07	42.54	16.89	22.97	16.69	19.25

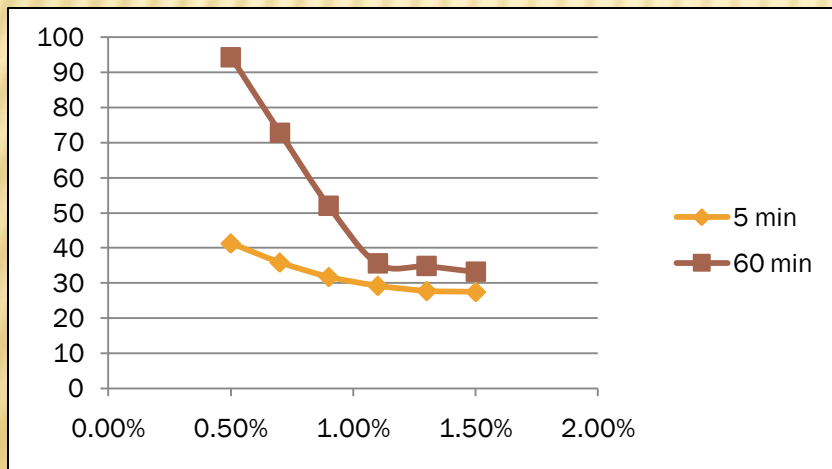
# GRAPHS AND RESULTS(C1)



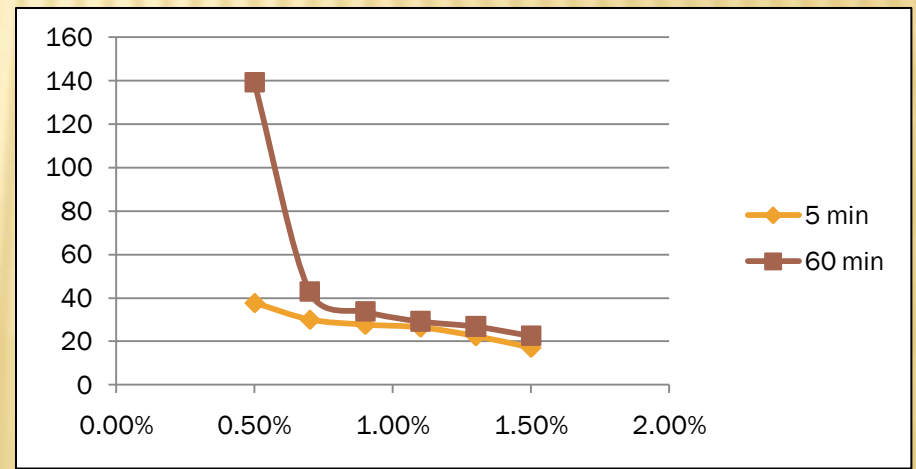
Optimum dose- 0.7%



Optimum dose- 1.1%



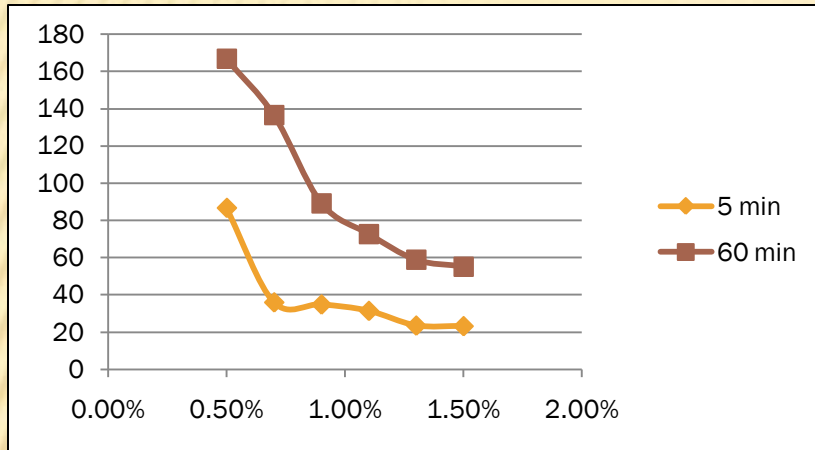
Optimum dose- 1.1%



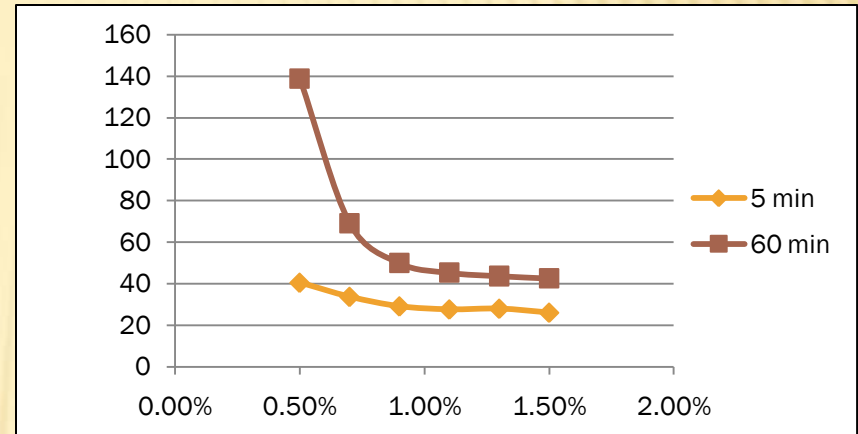
Optimum dose- 0.7%



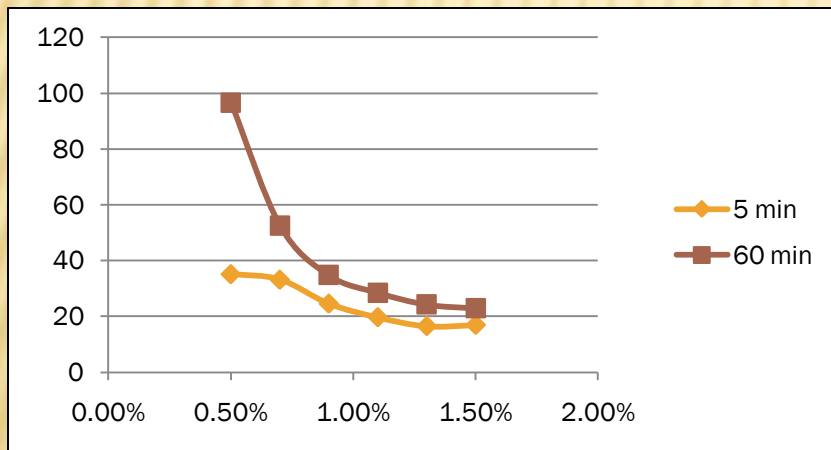
# GRAPHS AND RESULTS(C1)



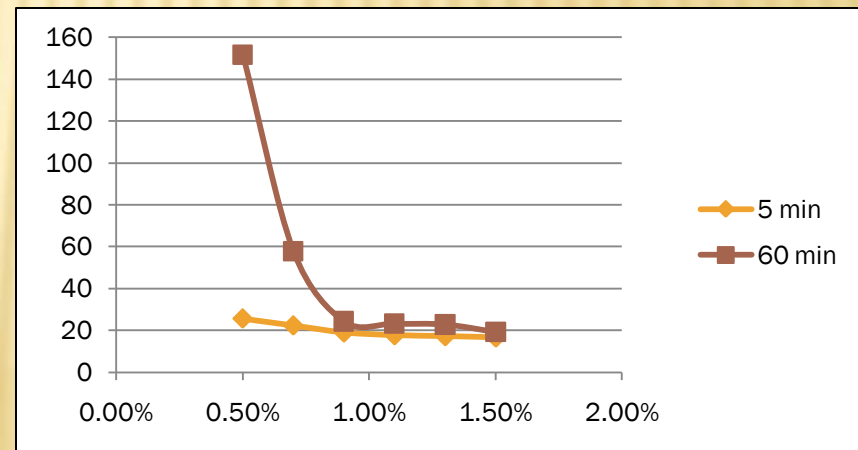
Optimum dose- 1.3%



Optimum dose- 0.9%



Optimum dose- 1.3%



Optimum dose- 0.9%

# OBSERVATIONS – CEMENT (C2)

%age of Plasticizer	SP1				
	5 min	60 min	120 min	180 min	240 min
0.5%	75.5	96.34	102.59	111.94	117.19
0.7%	56.13	76.38	86.37	91.32	96.73
0.9%	36.47	49.61	59.78	69.02	72.53
1.1%	33.69	44.97	51.66	57.91	59.94
1.3%	32.17	42.61	45.32	48.96	51.54
1.5%	31.56	41.82	42.67	46.9	50.11

%age of Plasticizer	SP2				
	5 min	60 min	120 min	180 min	240 min
0.5%	51.53	66.32	78.48	89.21	104.83
0.7%	37.22	43.31	46.56	50.98	57.19
0.9%	30.49	37.94	41.38	46.68	49.35
1.1%	29.94	34.72	36.39	41.97	44.51
1.3%	27.75	30.47	33.21	37.23	41.98
1.5%	21.93	26.18	28.86	32.61	37.65

%age of Plasticizer	SP3				
	5 min	60 min	120 min	180 min	240 min
0.5%	27.06	68.38	77.28	92.31	101.48
0.7%	23.89	52.46	58.41	67.79	71.39
0.9%	23.09	42.82	49.74	54.32	57.21
1.1%	22.24	41.56	45.81	49.84	51.63
1.3%	22.41	40.89	43.19	47.12	49.5
1.5%	22.13	40.13	41.96	43.38	46.33

%age of Plasticizer	SP4				
	5 min	60 min	120 min	180 min	240 min
0.5%	41.45	68.03	74.72	79.37	86.47
0.7%	36.31	58.19	61.95	66.55	69.94
0.9%	31.63	51.23	53.37	56.11	59.6
1.1%	25.25	45.13	49.22	50.98	51.56
1.3%	23.92	43.93	45.39	46.21	48.31
1.5%	22.69	42.81	43.65	43.91	46.44

# OBSERVATIONS – CEMENT(C2)

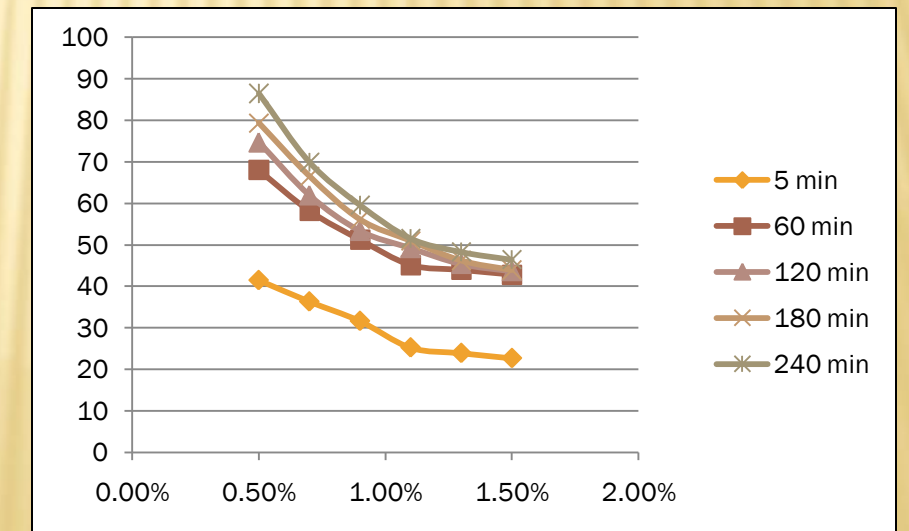
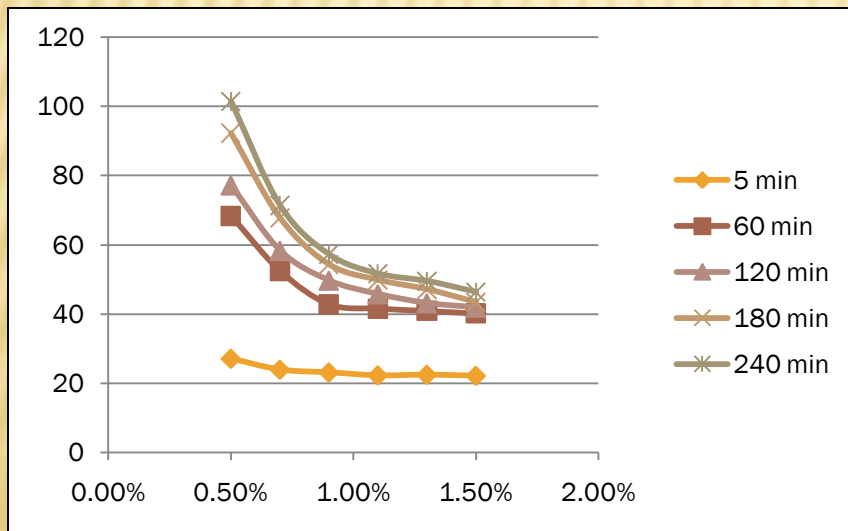
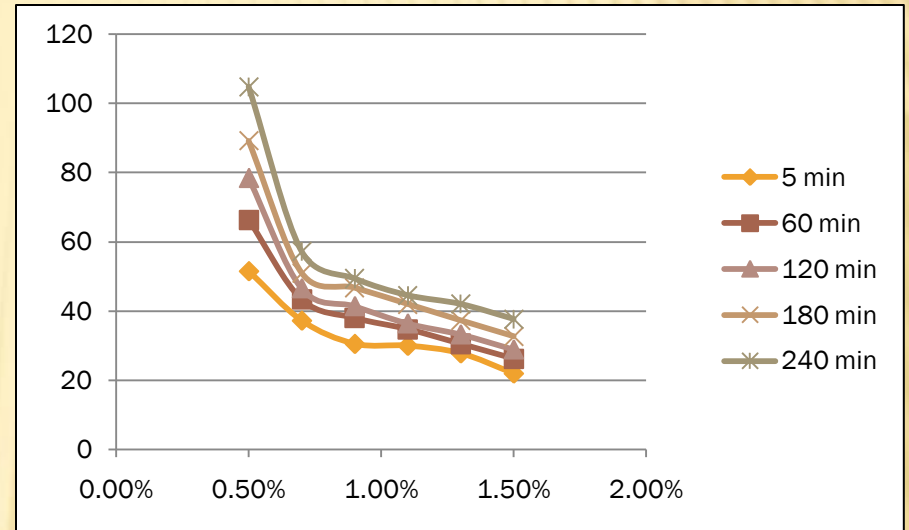
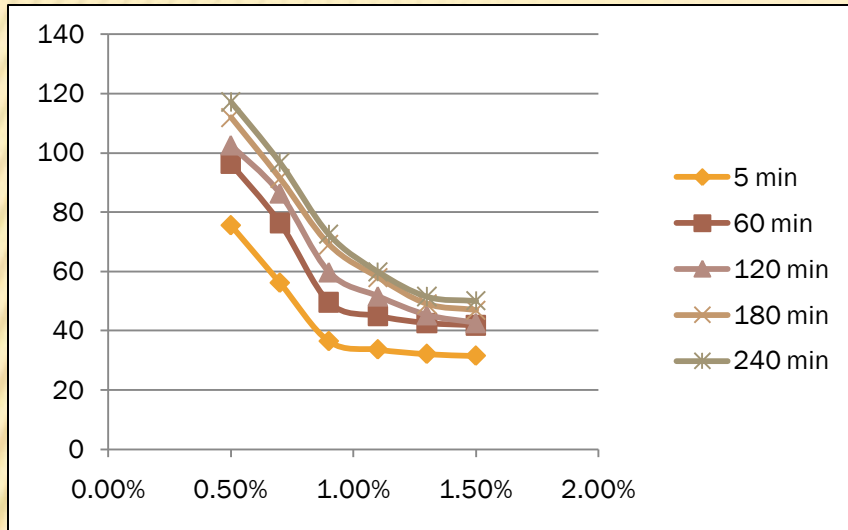
%age of Plasticizer	SP5				
	5 min	60 min	120 min	180 min	240 min
0.5%	46.72	151.75	165.34	171.81	183.93
0.7%	38.21	62.9	68.09	79.16	85.69
0.9%	35.34	57.21	64.21	72.91	77.07
1.1%	32.25	56.53	63.44	68.47	70.18
1.3%	31.46	56.13	59.51	62.59	64.96
1.5%	30.66	55.25	56.75	59.73	62.64

%age of Plasticizer	SP6				
	5 min	60 min	120 min	180 min	240 min
0.5%	34.57	63.22	79.31	109.87	115.38
0.7%	30.13	52.88	71.43	97.47	104.89
0.9%	27.12	47.31	59.97	82.51	91.53
1.1%	25.13	41.34	46.68	68.24	76.57
1.3%	24.61	39.21	41.51	64.81	69.31
1.5%	23.98	38.46	40.87	62.31	65.97

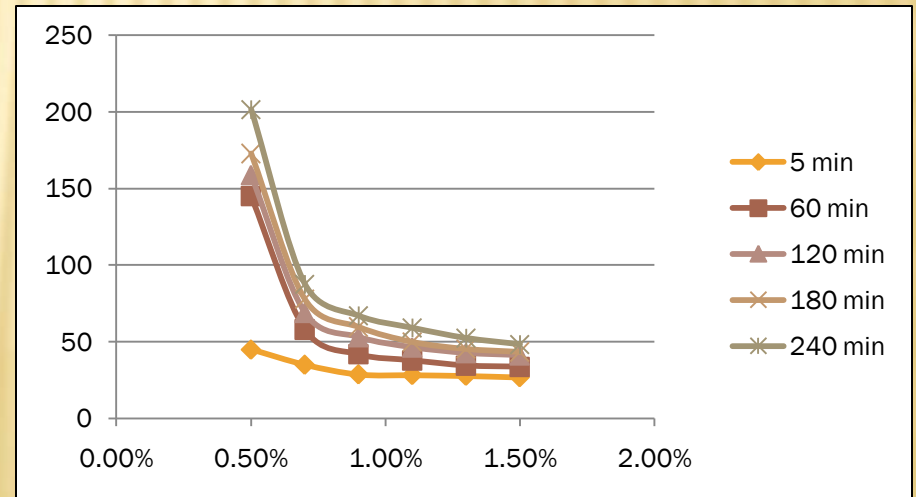
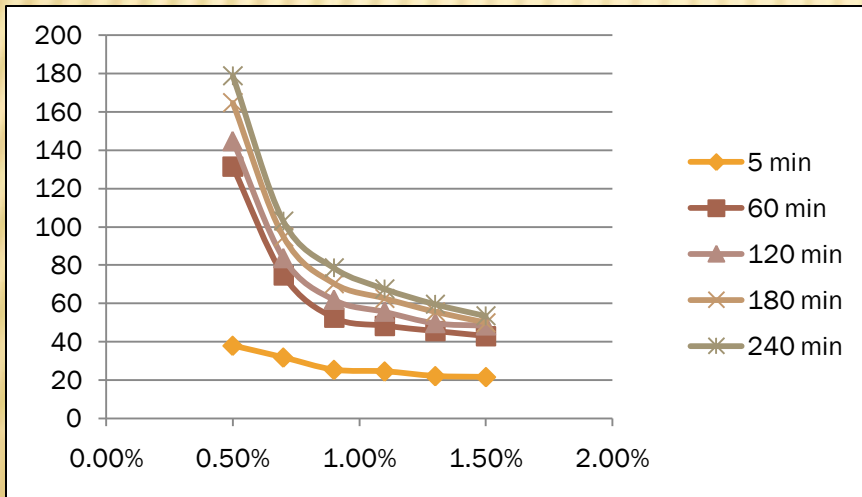
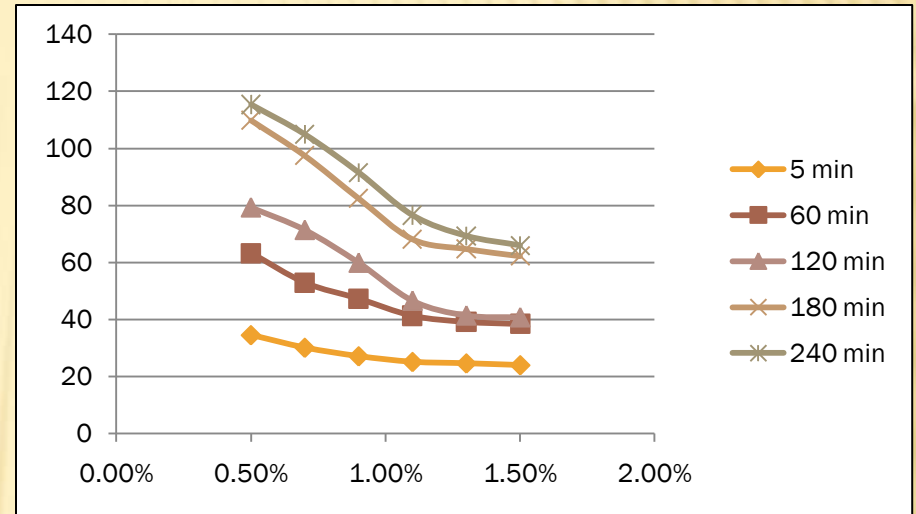
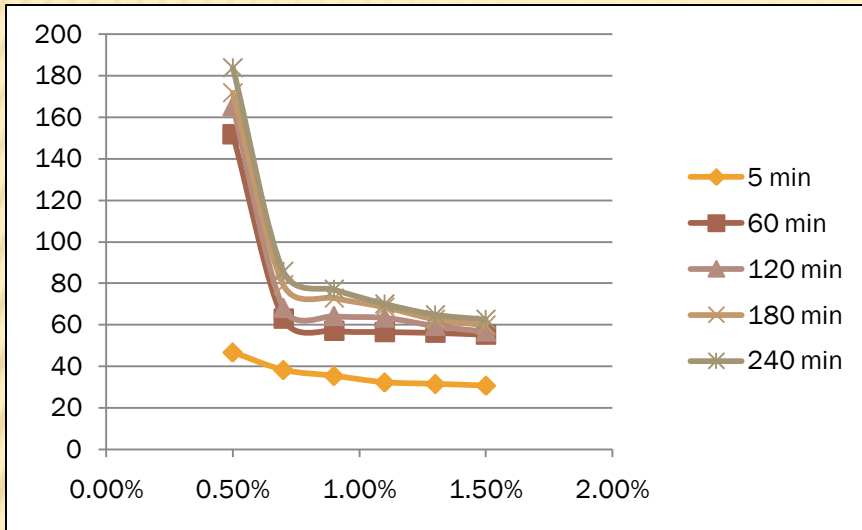
%age of Plasticizer	SP7				
	5 min	60 min	120 min	180 min	240 min
0.5%	37.93	131.41	144.84	164.75	178.81
0.7%	31.75	74.69	83.66	94.78	102.88
0.9%	25.31	52.44	61.89	70.31	78.48
1.1%	24.47	48.29	55.67	62.54	67.57
1.3%	22.03	45.51	49.71	55.52	59.58
1.5%	21.53	42.93	48.49	49.93	53.43

%age of Plasticizer	SP8				
	5 min	60 min	120 min	180 min	240 min
0.5%	44.87	144.93	158.81	172.82	201.53
0.7%	34.91	57.94	68.98	77.66	87.47
0.9%	28.63	41.75	53.09	59.59	66.83
1.1%	28.19	37.78	46.38	49.84	58.91
1.3%	27.68	34.41	42.71	45.27	52.26
1.5%	26.74	33.61	41.22	43.34	48.17

# GRAPHS AND RESULTS(C2)



# GRAPHS AND RESULTS(C2)



# OBSERVATIONS – CEMENT (C3)

%age of plasticizer	SP1				
	5 min	60 min	120 min	180 min	240 min
0.5%	45.77	57.75	81.66	93.91	Sample set. No flowability
0.7%	38.62	53.62	70.12	78.08	
0.9%	34.59	48.94	55.59	62.16	
1.1%	31.04	41.43	46.17	56.31	
1.3%	29.21	39.59	44.45	51.82	
1.5%	29.11	39.72	43.5	50.36	

%age of plasticizer	SP2				
	5 min	60 min	120 min	180 min	240 min
0.5%	28.85	32.88	35.07	38.5	41.75
0.7%	24.97	26.41	29.38	31.93	34.68
0.9%	23.44	24.81	27.38	29.22	32.36
1.1%	23.02	23.93	25.51	27.23	30.71
1.3%	22.33	23.53	24.68	26.71	29.13
1.5%	22.18	22.81	23.91	25.87	28.83

%age of plasticizer	SP3				
	5 min	60 min	120 min	180 min	240 min
0.5%	32.42	35.02	37.54	40.18	41.25
0.7%	30.38	32.71	34.41	36.27	37.54
0.9%	29.12	31.21	32.77	34.44	35.21
1.1%	28.87	30.46	31.56	32.64	34.15
1.3%	28.61	29.89	31.46	31.83	32.61
1.5%	28.69	29.25	30.32	31.57	31.88

%age of plasticizer	SP4				
	5 min	60 min	120 min	180 min	240 min
0.5%	40.94	52.79	61.29	84.91	89.75
0.7%	37.67	49.63	55.58	72.38	77.48
0.9%	35.46	46.81	50.43	63.45	69.22
1.1%	32.02	41.54	45.23	51.69	58.36
1.3%	31.12	39.62	41.19	47.61	53.41
1.5%	29.82	38.27	40.33	45.81	52.37

# OBSERVATIONS – CEMENT(C3)

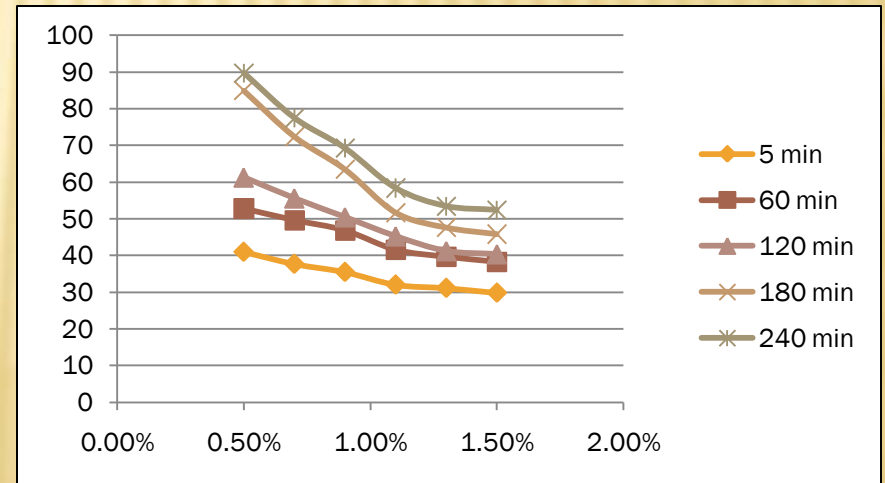
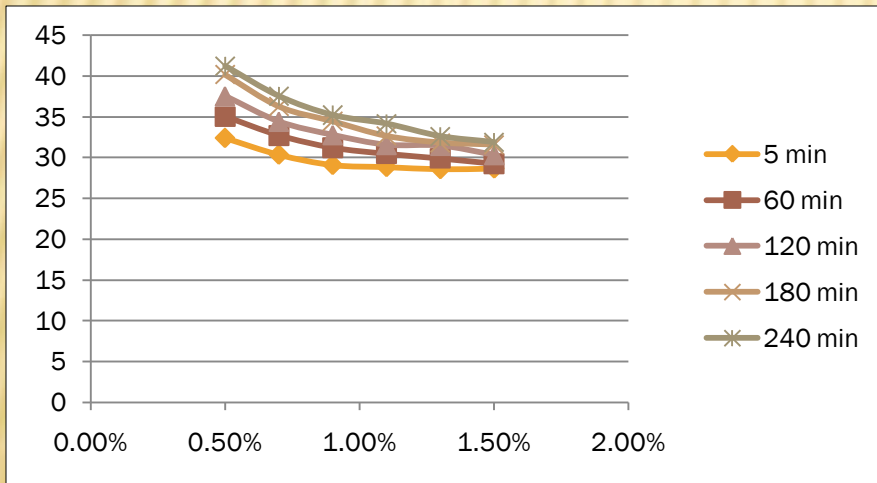
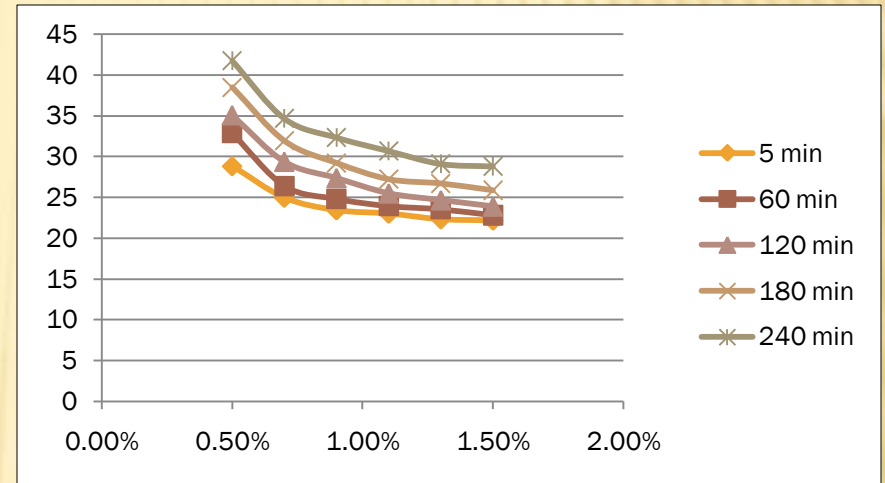
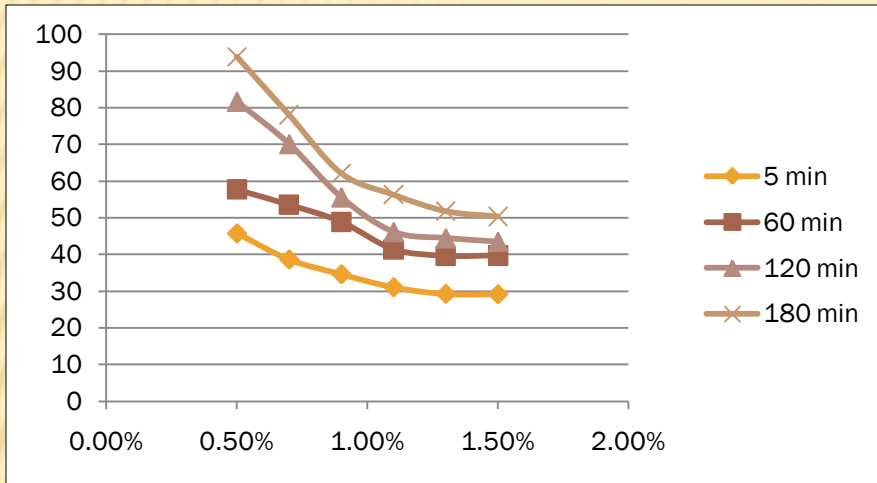
%age of plasticizer	SP5				
	5 min	60 min	120 min	180 min	240 min
0.5%	54.39	74.61	82.58	95.19	104.53
0.7%	48.46	59.44	67.72	76.18	86.64
0.9%	39.76	46.73	57.14	61.41	71.59
1.1%	33.87	39.46	43.82	46.63	54.55
1.3%	29.04	36.29	38.88	40.58	48.62
1.5%	28.77	35.91	37.92	39.78	47.55

%age of plasticizer	SP6				
	5 min	60 min	120 min	180 min	240 min
0.5%	34.59	44.98	52.38	55.19	61.43
0.7%	31.16	39.61	42.93	45.24	52.61
0.9%	30.86	38.73	40.84	43.43	50.59
1.1%	29.95	37.29	39.52	41.23	49.55
1.3%	29.14	36.56	38.78	40.68	48.72
1.5%	28.67	34.41	36.02	38.76	47.45

%age of plasticizer	SP7				
	5 min	60 min	120 min	180 min	240 min
0.5%	31.59	37.85	43.35	49.49	55.24
0.7%	29.76	34.41	39.89	43.26	49.17
0.9%	27.86	31.79	36.39	39.44	42.29
1.1%	25.94	30.29	33.58	37.21	40.75
1.3%	25.14	29.52	33.36	36.63	38.59
1.5%	24.67	28.76	32.81	35.56	37.88

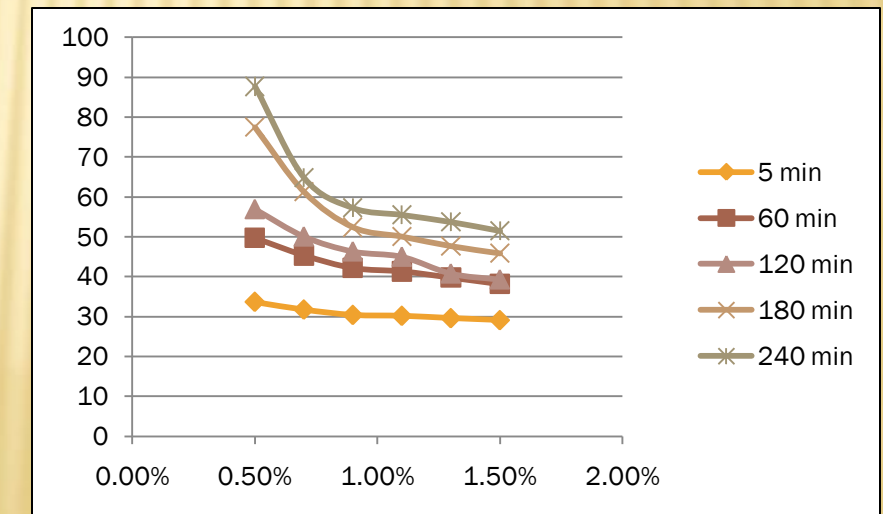
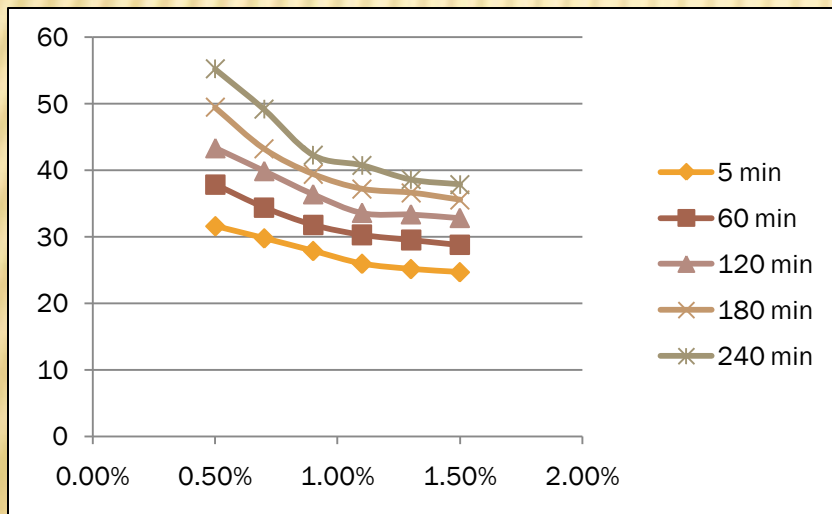
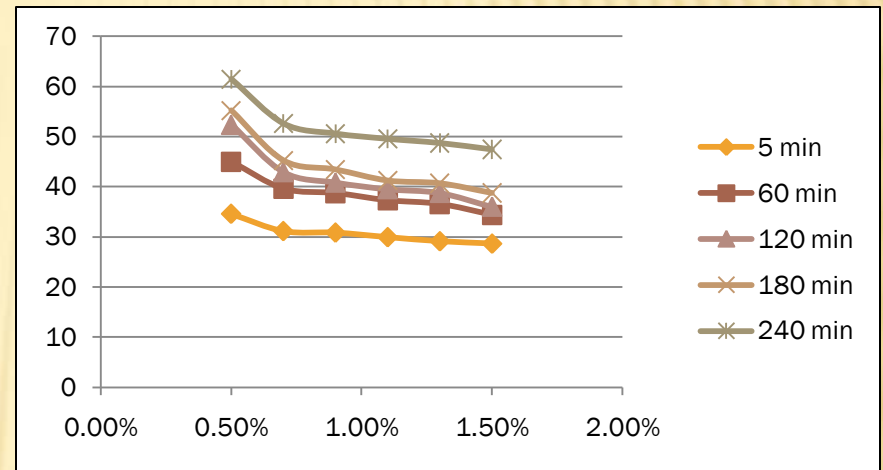
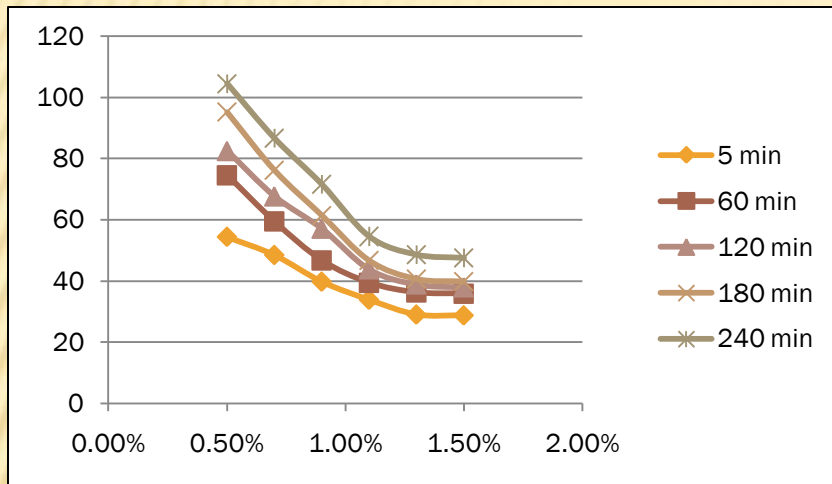
%age of plasticizer	SP8				
	5 min	60 min	120 min	180 min	240 min
0.5%	33.69	49.7	56.92	77.49	87.71
0.7%	31.76	45.36	50.08	61.3	64.84
0.9%	30.42	42.18	46.34	52.42	57.24
1.1%	30.2	41.35	45.02	50.07	55.51
1.3%	29.62	39.77	40.81	47.68	53.73
1.5%	29.12	38.15	39.33	45.86	51.49

# GRAPHS AND RESULTS(C3)





# GRAPHS AND RESULTS(C3)



# INFERENCE

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- ❖ For the cement C1, SP1, SP4 and SP8 are most compatible combination among all the combinations. Super-plasticizer with chemical base PCE (SP1) and SNF (SP4 and SP8) is most compatible as compared to super-plasticizer with SNP base.
- ❖ For the cement C2, SP2 and SP8 are most compatible combination among all the combinations. Super-plasticizer with chemical base PCE (SP2) and SNF (SP8) is most compatible as compared to super-plasticizer with SNP base.
- ❖ For the cement C3, SP2, SP3 and SP5 are most compatible combination among all the combinations. Super-plasticizer with chemical base PCE (SP2 and SP3) and SNP (SP5) is most compatible as compared to super-plasticizer with SNP base.

# WORK FOR MAJOR

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- ❖ Determination of saturation dosage for the above combination of C-SP for  $w/c=0.45$ .
- ❖ Analysis of behavior of C-SP couple by results obtained for change in  $w/c$  ratio.
- ❖ To find the saturation dosage for specific brand of cement and chemical family based SP for different  $w/c$  ratio.

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**Thank you for your attention**