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Influence of Rochelle salt on Properties of Concrete

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Abstract: ***There is phenomenal rise in use of concrete as a structural material in the recent decades and till date a lot of research work is being done that are enhancing the mechanical properties of concrete.***
In this thesis, the admixture used is Rochelle salt. Rochelle salt is being used as admixture because of its piezoelectric properties and also it is the only piezoelectric salt available which is not harmful for the environment.
There are many failures of concrete structures in the recent times and upon investigation it has been concluded that if small structural disintegrities have been checked on time, the failure of those structures can be prevented. This led to very new research field viz, continuous monitoring of the structure. The study of this thesis is mainly focussed on observing the effects of Rochelle salt on properties of concrete such as workability of concrete, compressive strength of concrete and flexural strength of concrete and also to monitor the voltage output, if any, produced by concrete during loading.Different percentages of Rochelle salt will be used as admixture in concrete and the percentage of Rochelle salt at which optimal results are obtained will also be obtained during the research work of the thesis.
Keywords: Rochelle salt ;Compressive strength; Voltage Drop; Piezoelectricity

I. INTRODUCTION

The compressive strength of concrete can be enhanced with the addition of any admixture. At time of construction of concrete structure, uniform strength and quality cannot be ensured at each section and there is variation of strength from section to section. If this variation remains under threshold limits, structure is damage free but if it exceeds the threshold limits, the element is said to have been failed. If these variations are detected earlier, the complete collapse of structure can be avoided. For detection of these variations, piezoelectric transducers are most commonly used for concrete structures as sensors. A keen framework should be done for system for coordinating the sensors and actuators. Piezoelectric materials are savvy materials since they produce a surface charge in light of connected mechanical pressure. Rochelle salt is one of the old and mostly used salt in piezoelectric transducers but its use has been prohibited due to its deliquescent nature. Nowadays lead zirconate is mostly used piezoelectric salt in piezoelectric transducers. But it is a well known fact that lead is harmful for the environment whereas Rochelle salt is green salt. So this study is main focussed on replacing a part of cement with Rochelle salt and to conclude that if any voltage drop occurs on concrete due to addition of this admixture Rochelle salt as a result of the piezoelectric properties of Rochelle salt.
The occurence of all levels of damages can be inspected with the help of the transducers. Damage detection and severity of damages can be more accurately predicted by his piezoelectric transducers systems. However there is a difference between the surface bonded transducers and embeded piezoelectric transducers as discussed by Ramashanker. Environment conditions have an effect on the output produced by the piezoelectric sensors as cited by Hoon Sohn et al and Mohamed Abdel. Based on the changes in the dynamic properties, it has been proposed that artificial neuro network techniques and adaptive neuro fuzzy interface system have been applied to observe the damages as cited by J.S. Hakim et al. Andriy Andrusyk et al. has done a study on Rochelle salt and its properties. The final reason for the piezoelectric behavior of Rochelle salt has been discovered. The study has been done to find an explanation for the ferroelectric phase transition in Rochelle salt at microscopic level and also he thermodynamic and dynamic properties of Rochelle salt has been depicted. Based upon all these facts, it has been proposed to add Rochelle salt in concrete to figure out if concrete can be made piezoelectric that is if concrete is able to produce voltage being acted upon loads.

II. EXPERIMENTAL WORK

Based upon our objectives and literature survey, experimental work is proposed in which firstly the design of mix is done using salt admixture and secondly various tests are performed on the samples casted. The mix design is accordance with IS 456 and IS 10262.
The mix design has been prepared by taking different percentages of Rochelle saltfor grade M20. Intially the mix has been designed for 8 percentages of Rochelle salt - 0.25%, 0.5% ,.75%, 1%, 2%,2.5%, 5% and 10 %. the concrete was successfully set at two percentages 0.25 and 0.5. For more finer investigations, the experiments have been performed for 0.25,.35,.45 and .55 percentages. A part of cement has been replaced by the Rochelle salt with the above mentioned percentages of Rochelle salt. According to the

number of specimen to be cast, weight of all the materials is calculated from the mix design, and according to that materials are taken using weighing machine present in the laboratory. About one-half of the coarse aggregate should be added to the drum mixer, followed by the fine aggregate, cement and salt admixture and finally the remaining coarse aggregate on top. The salt admixture is added by making its solution in water .The water is added before starting the mixing process. Pan type mixture is used for mixing each batch of concrete. Mixing should be done for not less than 2 minutes and till an uniform mixture is obtained. Following is the table showing materials used for the experimental work for designing the mix of concrete.

Table 2.1- Different materials used in mix

Cement used	OPC 43 grade
Specific Gravity of cement	3.15
Maximum nominal size of aggregate	20
Specific gravity of coarse aggregate	2.74
Specific gravity of fine aggregates	2.74
Water absorption for coarse aggregate	.5
Water absorption for fine aggregate	1
Type of aggregate	Crushed angular aggregates
Free (surface) moisture	nil
Salt admixture	Rochelle salt
Specific Gravity of salt admixture	2.0

Different types of tests are done on the various concrete specimens containing different percentages of Rochelle salt viz. Compressive strength test for determining compressive strength of concrete , slump test for workability and flexural strength test for flexure strength. The tests are performed in accordance with IS 516. Compression test has been done both on cube and cylinderical specimens. The voltage drop is measured during all the tests performed on all all specimens containing different percentages of Rochelle salt with the multimeter. Two types of configurations were tested for the placement of the electrodes in tension phase and in compression phase. Results were same in the both of the cases. To keep the electrodes in place, conductive seal was made so that the electrodes just there is less variation in the readings. On cubes, the voltage drop has been measured on the surface where as for cylinders and beams the voltage drop have been measured by electrodes which are embeded in concrete.

III. RESULTS

The mix has been designed for workability 50-100mm.

Table 3.1 Following is the table for results for slump test for different specimens.

Mix Designation	CM	RS25	RS35	RS45	RS55
Slump Values(mm)	85	80	75	71	68

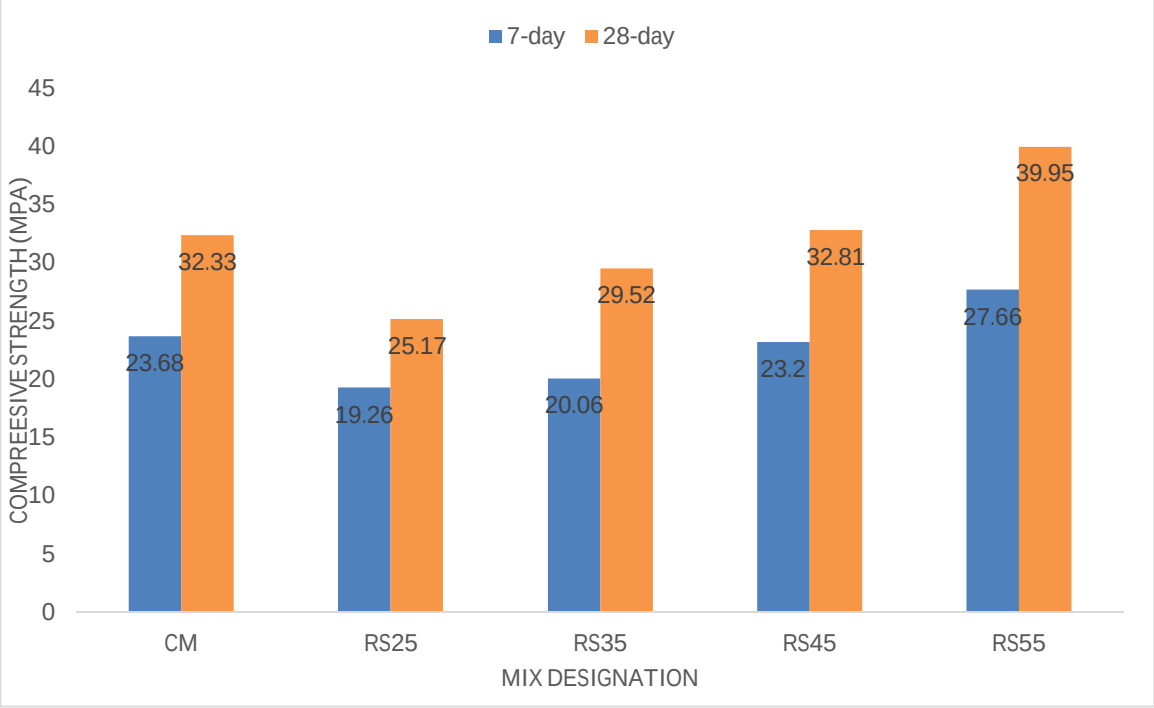
The compressive strength has been done on three specimens of each batch containing percentage of Rochelle salt of 0.25,0.35,0.45 and0.55. Same flexure strength test has been done on beams containing different percentages of Rochelle salt and following results have been obtained.

Table 3.2 Results for Compressive strength and flexural strength.

Different percentages of Rochelle salt used in specimens	Average compressive strength in case of cubes(MPa)	Average compressive strength in case of cylinders(MPa)	Average flexural strength in case of beams(MPa)
.25%	25.17	20.30	2.35
.35%	29.52	23.49	3.65
.45%	32.81	31.33	4.25
.55%	39.95	35.28	5.475

Table 3.3 Resullts for voltage drop for different specimen

Percentage of Rochelle salt(→) Maximum Voltage(mV) obtained in case of (↓)	0.25	0.35	0.45	0.55
Cube	5.21	6.5	23.6	142
Cylinder	16.8	25.5	28.5	93
Beam	13.3	33.5	65.5	153



`Fig 3.1 Comparison of compressive strength of concrete in case of cube specimens

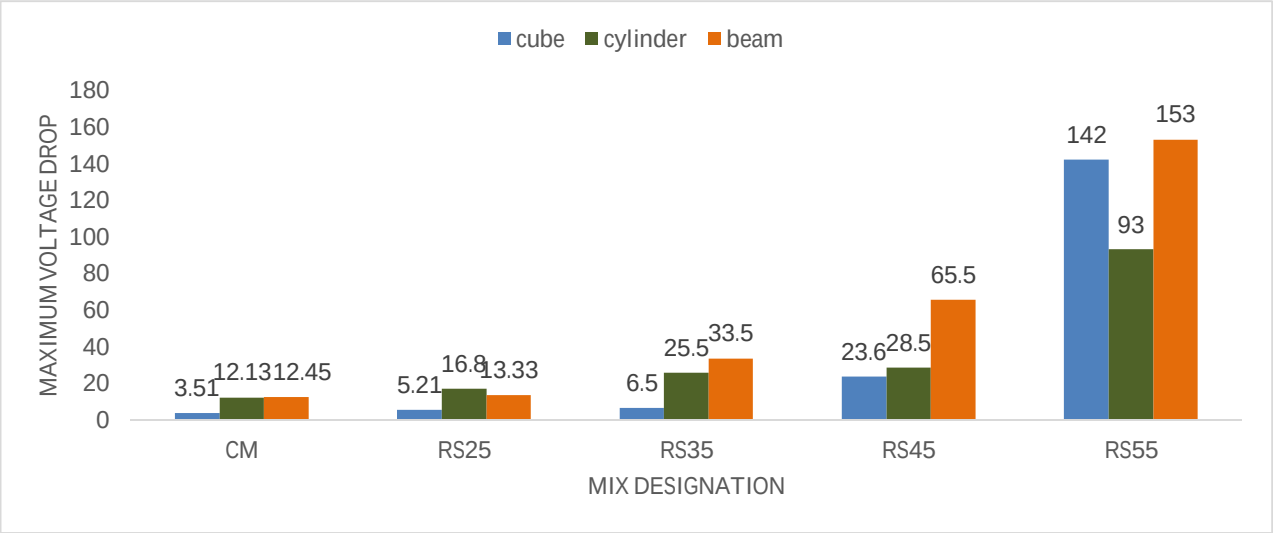


Fig 3.2 Comparison of the voltage drop for different mix designations

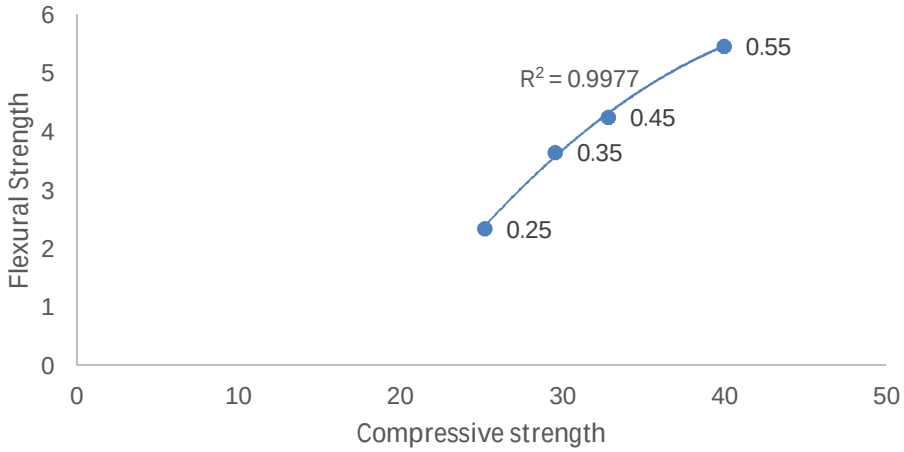


Fig 3.3Comparison of the voltage drop for different mix designations

IV. DISCUSSIONS

The test for 7-day strength and 28-day strength has been done and it has been observed that the strength at all percentages are more than for what they have been designed for. Also as the percentage of Rochelle salt is more, the strength is also more.In case of cube specimens of batch RS25, the 7-day strength has been decreased by 18.6% and 28-day strength has been decreased by 22.14% and in case of cube specimen of batch RS35, the percent decrease in 7-day strength and 28-day strength 15.28% and 8.69% respectively. There is slight increase in strength of cubes of batch RS45, the percent increase in 7-day strength and 28-day strength has been found to be 2% and 1.48% respectively, however, for the batch RS55, the percent increase in strength is 16.8% and 23.5%.There is decrease in flexural strength of concrete on addition of Rochelle salt, however similar results are obtained for beams of batch RS55. The percentage decrease in flexural strength is 59%,36% and 26% for batches RS25, RS35 and RS45 respectively. There is slight increase in flexural strength in case of batch RS55. The voltage drop has additionally been recorded alongside each test and it has been watched that at first glance the voltage drop is less when contrasted with the voltage drop that has been obtained when the electrodes are embedded into concrete. When the loading is applied on the concrete sample, the voltage drop just increases with the loading. Desirable results are obtained for the concrete specimen containing .55% of Rochelle salt. Both maximum strength and maximum voltage drop has been obtained at this percentage.

V. CONCLUSION

Workability of concrete was decreased with addition of Rochelle salt. However, workability of all mixes was suitable for structural use. The compressive strength of concrete has been increased with increasing percentages of Rochelle salt. However, the compressive strength is found to be less in case of concrete specimens containing 0.25% and 0.35% of Rochelle salt than the specimens of the control mix. But the compressive strength in case of specimens containing 0.45% and 0.55% of Rochelle salt is more than specimens of the control mix, this can be due to the reaction of sodium and potassium ions with aluminosilicates resulting in rigid and porous mass.

The flexure strength of concrete has been decreased with addition of Rochelle salt. The failure is quite brittle. The flexural strength achieved at 0.55% of Rochelle salt is slight more than the flexural strength of normal concrete.

We had obtained the curves for variation of voltage drop with strain and we reached on a conclusion that prior to loading, there is already some voltage drop and this voltage drop increases with the loading as can be observed from the graphs in the previous chapter. This can be due to the piezoelectric effect produced by the Rochelle salt present as admixture in concrete. From the experimental work done and results obtained, we can conclude that the optimal results are obtained for the concrete specimens which are having 0.55% of Rochelle salt. Workability obtained at 0.55% of Rochelle salt is lower than all other percentages, but compressive strength and flexural strength obtained at this percentage is higher than all other mixes. The voltage drop obtained for specimens at this percentage is also higher than all other percentages. Hence it can be said that the for all the tests done the results are obtained for this percentage are most desirable.

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