EFFECT OF CHLORIDE ATTACK ON THE PROPERTIES OF CONCRETE PRODUCED BY REPLACING NATURAL SAND BY WASTE FOUNDRY SAND

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Abstract

Cement, sand and aggregate are essential desires for any construction industry. Sand is a major material used for preparation of concrete and performs an essential role in mix design. The world wide consumption of natural sand could be very excessive in concrete, due to rapid infrastructure growth. The developing nation like India also facing shortage of good quality natural sand. Rapid extraction of sand from river bed causing serious issues like losing water preserving soil strata, loss of vegetation on the bank of rivers, disturbs the aquatic life as well as disturbs agriculture due to fact that of lowering the water table within the well. Recently natural sand is becoming an expensive material because of its demand within construction industry due to this condition research began for cheap and easily available alternative material to natural sand. Some alternatives materials have already been utilized as a replacement of natural sand such as fly-ash, quarry dust, siliceous stone powder, filtered sand and copper slag are utilized in concrete as a partial or full replacement of natural sand. The main objective of this experimental investigation is to study the effect of replacement of natural sand by foundry sand in various percentages such as 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70% & 80% on the characteristic properties of concrete when subjected to chloride attack. The strength parameters considered are compressive strength, tensile strength, flexural strength, shear strength and impact strength after chloride attack. Chloride content is also found for each replacement after chloride attack.

Keywords: *Concrete, Natural Sand, Foundary Sand, Cement*

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1. INRODUCTION

Cement , sand and aggregate are essential desires for any construction industry. Sand is a major material used for preparation of concrete and performs an essential role in mix design. The world wide consumption of natural sand could be very excessive in concrete, due to rapid infrastructure growth. The developing nation like India also facing shortage of good quality natural sand. Rapid extraction of sand from river bed causing serious issues like losing water preserving soil strata, loss of vegetation on the bank of rivers, disturbs the aquatic life as well as disturbs agriculture due to fact that of lowering the water table within the well. Recently natural sand is becoming an expensive material because of its demand within construction industry due to this condition research began for cheap and easily available alternative material to natural sand. Some alternatives materials have already been utilized as a replacement of natural sand such as fly-ash, quarry dust, siliceous stone powder, filtered sand and copper slag are utilized in concrete as a partial or full replacement of natural sand.

1.1 Objective of the Study

The main objective of this experimental investigation is to study the effect of replacement of natural sand by waste foundry sand in various percentages such as 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70% and 80% on the characteristic properties of concrete when subjected to chloride attack. The strength parameters considered are compressive strength, tensile strength, flexural strength, shear strength and impact strength after chloride attack. Chloride content is also found for each replacement after chloride attack.Chloride content is also found for each replacement after chloride attack.

1.2 Materials Used

Cement: Ordinary Portland cementof **43**gradeis used which is conforming to IS: 8112-1989.

Foundry Sand: Foundry sand used in the experimentation is obtained from the metal industries in Harihar town.

Fine Aggregates: Locally available fine aggregate used in this project conforms to zone II of IS: 383-1970.

Coarse Aggregate: 20mm and down size locally available crushed aggregates are used.

Water: Potable water is used for mixing and curing.

2. METHODOLOGY

Cement, sand and aggregate were taken in mix proportion 1:1.54:2.65 which correspond to M30 grade of concrete. Fine aggregates were replaced by waste foundry sand in different percentages, such as 0%, 10%, 20%, 30%, 40%,

50%, 60%, 70% and 80%. In the dry mix, required amount of water (W/C=0.45) was added and the ingredients of concrete were uniformly mixed in mixer till uniform consistency is achieved. The cubes were casted and compacted on a vibrating table while the prisms were compacted using needle vibrator.The casted specimens to beremoved after 24 hours of casting.

3. EXPERIMENTAL RESULTS

Near surface characteristics test results

3.1 Water Absorption Test Results

Table 1 gives water absorption test results of concrete for different percentage replacement of fine aggregate bywaste foundry sand with and without chloride attack. The variation in the water absorption is shown in the fig 1.

Table 1: Water absorption test results

Percentage replacement of fine aggrgate by waste foundary sand	Water absorption test results (%)	
	Withchloride attack	Without chloride attack
0	0.950	0.940
10	0.930	0.920
20	0.900	0.890
30	0.880	0.860
40	0.865	0.850
50	**0.850**	**0.830**
60	0.870	0.855
70	0.880	0.865
80	0.900	0.880

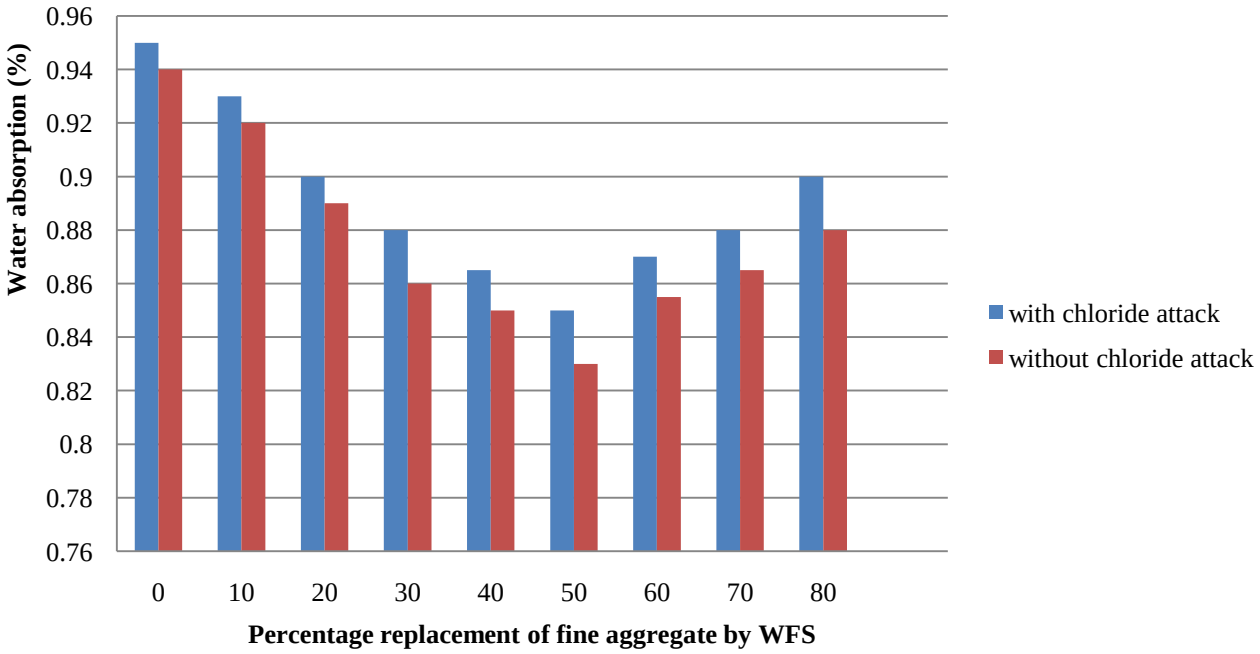

Fig 1: Variation of water absorption

3.2 Sorptivity Test Results

Table 2 gives sorptivity test results of concrete for different percentage replacement of fine aggregate by foundry sand with and without chloride attack. The variation in sorptivity is shown in fig 2.

Table 2 Sorptivity test result

Percentage replacement of fine aggrgate by waste foundary sand	Sorptivity test results (mm/min$^{0.5}$)	
	With chloride attack	Without chloride attack
0	2.96	2.92
10	2.90	2.85
20	2.84	2.80
30	2.75	2.71
40	2.68	2.60
50	**2.57**	**2.50**
60	2.70	2.65
70	2.79	2.75
80	2.87	2.82

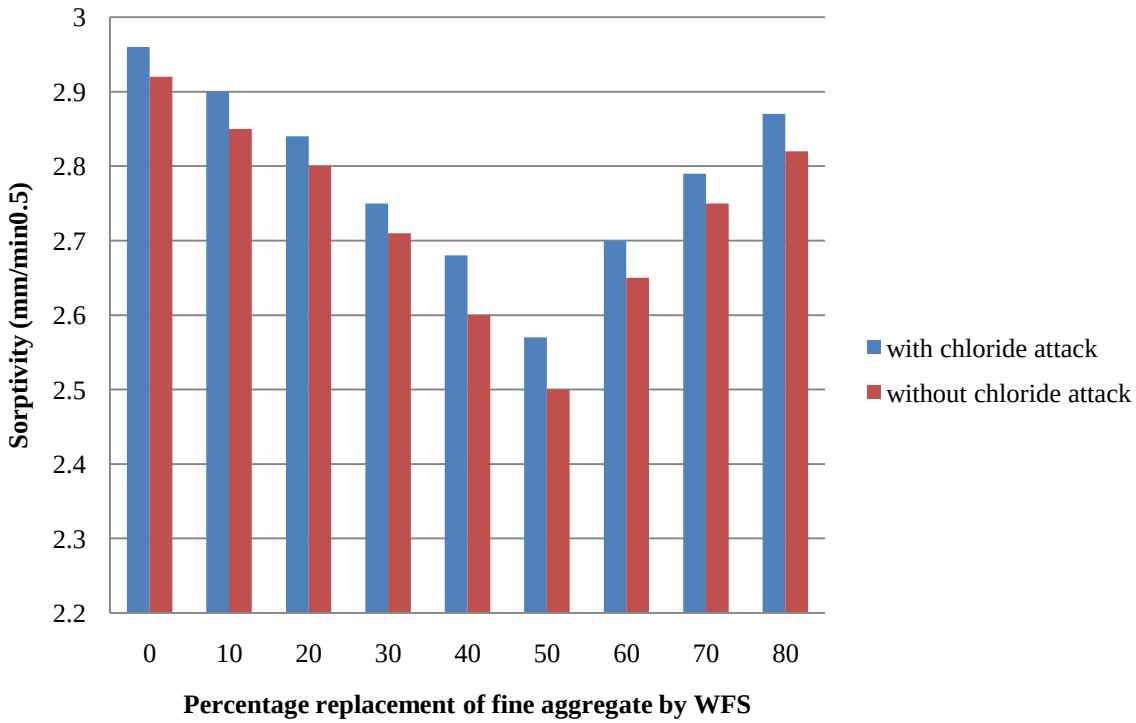

Fig 2: Variation of sorptivity

3.3 Strength Test Results

Compressive strength, tensile strength, flexural strength, shear strength and impact strength test results are given in table 3,4,5, 6 and 7 respectively. The variation of strength is rapicted in the form of graph as shown in fig 3, 4, 5, 6 and 7.

Table 3: Test results of compressive strength

Percentage replacement of fine aggregate by WFS	Compressive strength of concrete with chloride attack (MPa)	Percentage increase or decrease of compressive strength with chloride attack w.r.t ref mix	Compressive strength of concrete without chloride attack (MPa)	Percentage increase or decrease of compressive strengthwithout chloride attack w.r.t ref mix	Percentage decrease of compressive strength withchloride attack
0(Ref)	30.81		31.10		
10	31.84	3.33	32.14	3.34	0.29
20	32.51	5.51	33.03	6.20	11.12
30	33.69	9.33	34.07	9.54	2.20
40	34.14	10.79	35.03	12.63	14.56
50	**36.58**	18.70	**37.77**	21.44	12.77
60	34.44	11.77	35.33	13.60	13.45
70	32.29	4.79	32.88	5.72	16.25
80	29.47	4.34	30.14	3.08	20.90

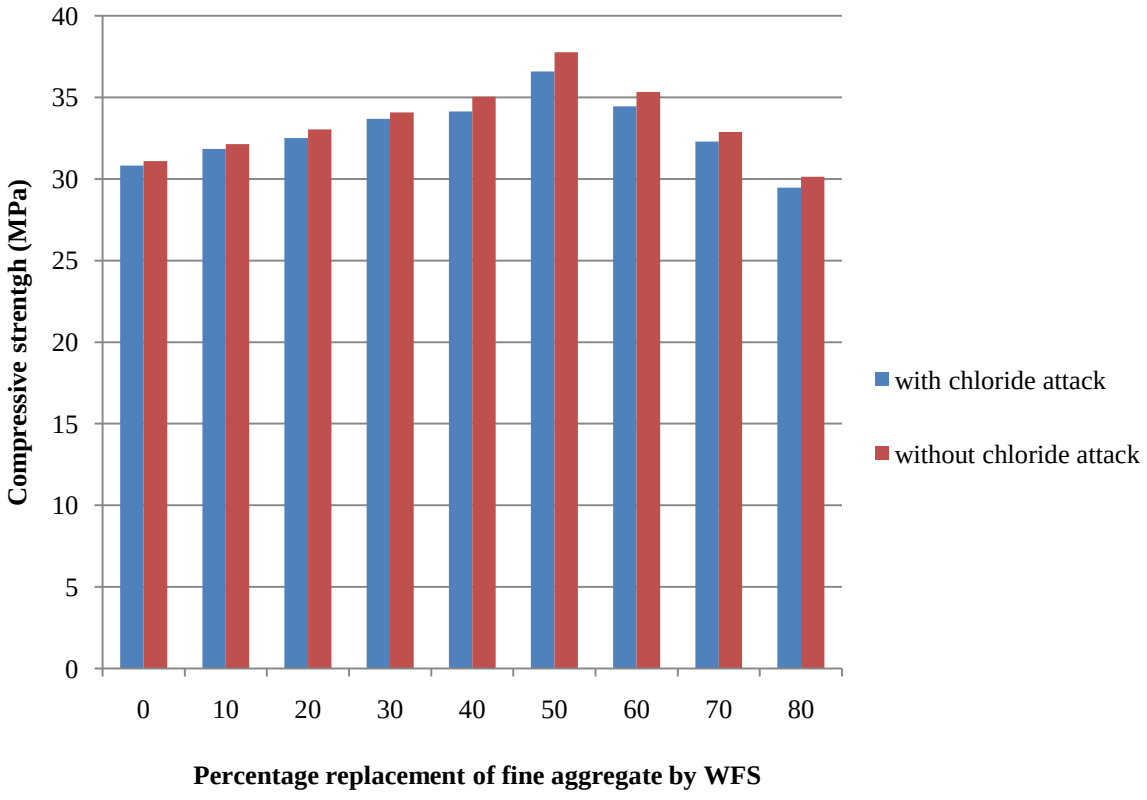

Fig 3: Variation of compressive strength

Table 4: Test results of tensile strength

Percentage replacement of fine aggregate by WFS	Tensile strength of concrete with chloride attack (MPa)	Percentage increase or decrease of tensile strength with chloride attack w.r.t ref mix	Tensile strength of concrete without chloride attack (MPa)	Percentage increase or decrease of tensile strength without chloride attack w.r.t ref mix	Percentage decrease of tensile strength withchloride attack
0(Ref)	2.35		2.44		
10	2.54	8.08	2.63	7.78	-3.85
20	2.77	17.87	2.96	21.31	16.14
30	3.06	30.21	3.15	29.09	-3.85
40	3.40	44.68	3.46	41.80	-6.88
50	**3.58**	52.34	**3.69**	51.22	-2.18
60	2.87	22.12	2.97	21.72	-1.84
70	2.45	4.25	2.55	4.50	5.55
80	2.07	-11.91	2.26	-7.37	-61.60

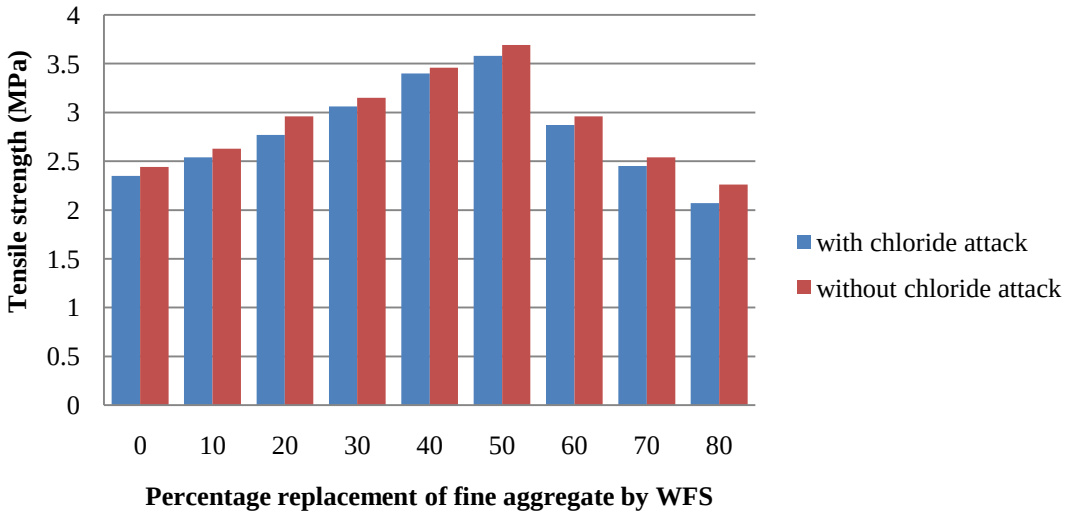

Fig 4: Variation of tensile strength

Table 5: Test results of flexural strength

Percentage replacement of fine aggregate by WFS	Flexural strength of concrete with chloride attack (MPa)	Percentage increase or decrease of flexural strength with chloride attack w.r.t ref mix	Flexural strength of concrete without chloride attack (MPa)	Percentage increase or decrease of flexural strength without chloride attack w.r.t ref mix	Percentage decrease of flexural strength with chloride attack
0(Ref)	3.46		3.86		
10	4.40	27.16	4.73	22.53	-20.55
20	5.46	57.80	5.86	51.81	-11.56
30	6.34	83.23	6.60	70.98	-17.25
40	7.06	104.04	7.33	89.89	-15.74
50	**7.86**	127.16	**7.94**	105.69	-20.31
60	6.26	80.92	6.80	76.16	-6.25
70	5.20	50.28	5.73	48.44	-3.79
80	4.53	30.92	4.67	20.98	-47.37

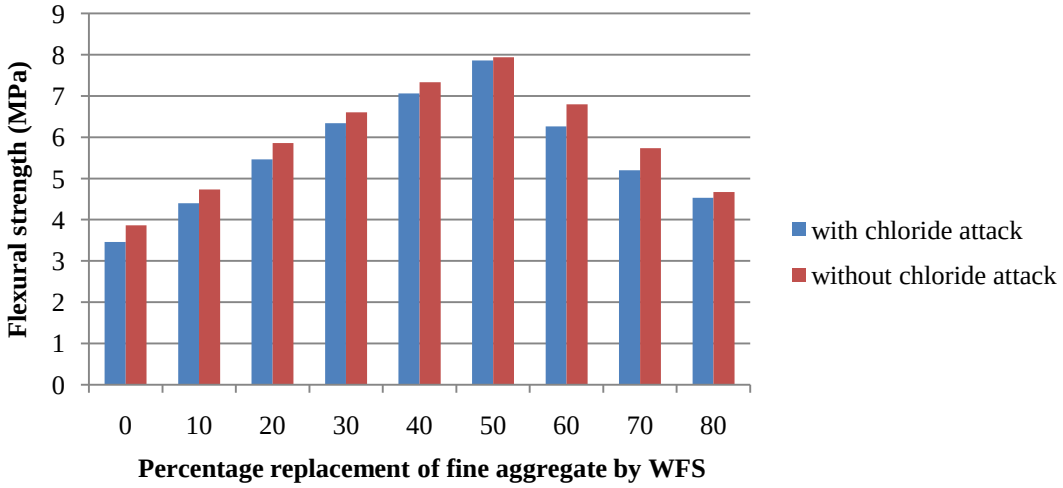

Fig 5: Variation of flexural strength

Table 6: Test results of shear strength

Percentage replacement of fine aggregate byWFS	Shear strength of concrete with chloride attack (MPa)	Percentage increase or decrease of shear strength with chloride attack w.r.t ref mix	Shear strength of concrete without chloride attack (MPa)	Percentage increase or decrease of shear strength without chloride attack w.r.t ref mix	Percentage decrease of shear strength with chloride attack
0(Ref)	1.57		1.85		
10	2.13	35.66	2.22	20.00	-78.3
20	2.68	70.77	2.96	60.00	-17.95
30	3.05	94.26	3.25	75.67	-24.56
40	3.33	112.10	3.79	104.86	-6.90
50	**3.97**	152.86	**4.06**	119.45	-27.96
60	3.14	100.00	3.52	90.27	-10.77
70	2.40	52.86	2.59	40.00	-32.15
80	1.47	-6.36	1.75	-5.40	-17.77

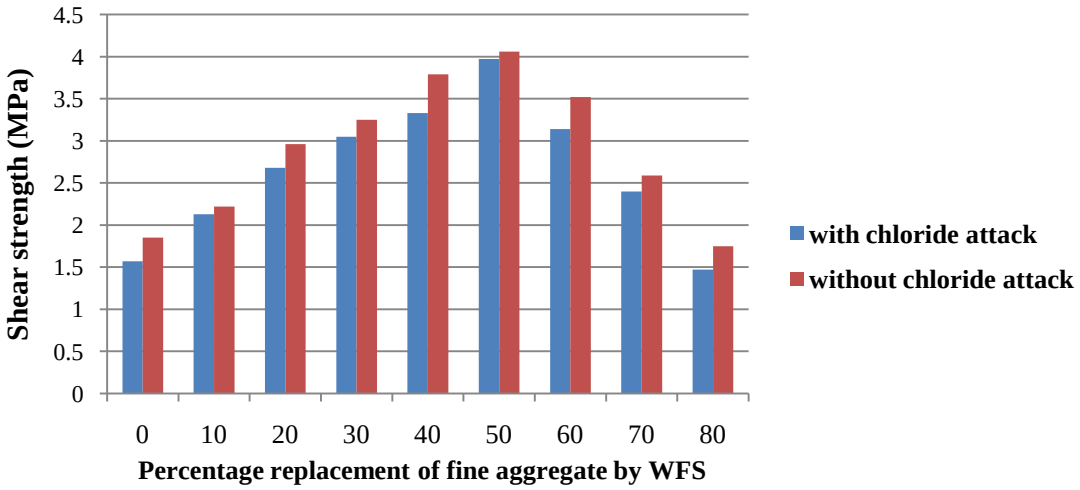

Fig 6: Variation of shear strength

Table 7: Test results of impact strength

Percentage replacement of fine aggregate by WFS	Impact strength of concrete with chloride attack (N-m)	Percentage increase or decrease of impact strength with chloride attack w.r.t ref mix	Impact strength of concrete without chloride attack (N-m)	Percentage increase or decrease of impact strength without chloride attack w.r.t ref mix	Percentage decrease of impact strength with chloride attack
0(Ref)	1065.04		1182.62		
10	1327.85	24.67	1417.76	19.88	-24.09
20	1590.66	49.35	1715.14	45.02	-9.61
30	1832.71	72.07	1950.28	64.91	-11.03
40	2026.36	90.26	2220.02	87.72	-2.89
50	**2399.82**	125.32	**2524.31**	113.45	-10.48
60	2012.53	88.96	2012.44	70.16	-26.79
70	1798.03	68.82	1977.95	67.25	-2.33
80	1403.93	31.81	1576.82	33.33	-4.56

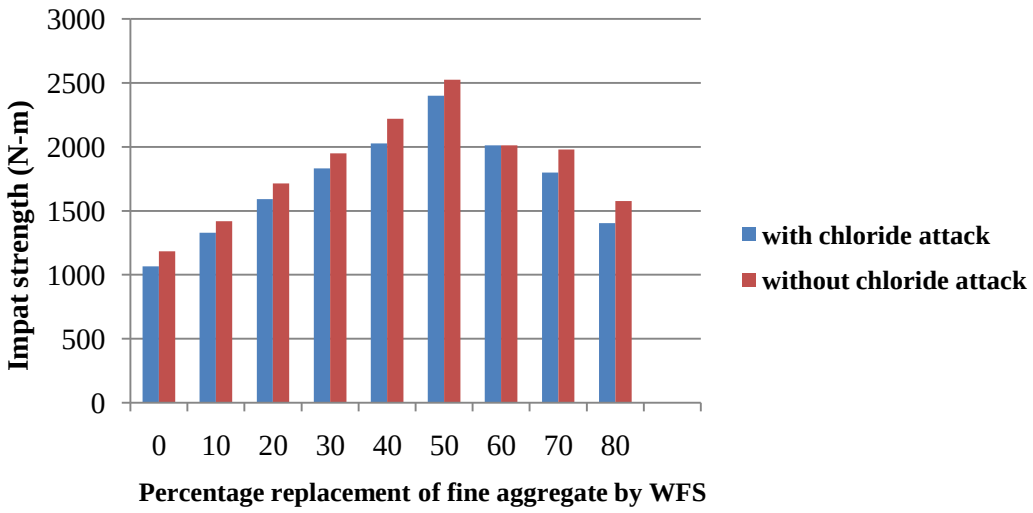

Fig 7: Variation of impact strength

3.4 Chloride Test Results

Table 8 gives the chloride content test results in concrete after chloride attack. Fig. 8 gives the variation of chloride content.

Table 8: Chloride test results

Description of samples		Burette reading			Chloride Content (mg/lit)
		Initial reading	Final reading	Difference	
		0.00	9.00	9.00	**134.30**
Distilled water		9.00	11.30	2.30	
Percentage replacement of fine aggregate by WFS	**0**	0.00	39.60	39.60	747.68
	10	0.00	36.70	36.70	689.55
	20	0.00	35.50	35.50	665.49
	30	0.00	32.60	32.60	607.36
	40	0.00	30.80	30.80	571.28
	50	**0.00**	**28.90**	**28.90**	**533.20**
	60	0.00	31.80	31.80	591.33
	70	0.00	33.20	33.20	619.39
	80	0.00	34.60	34.60	647.45

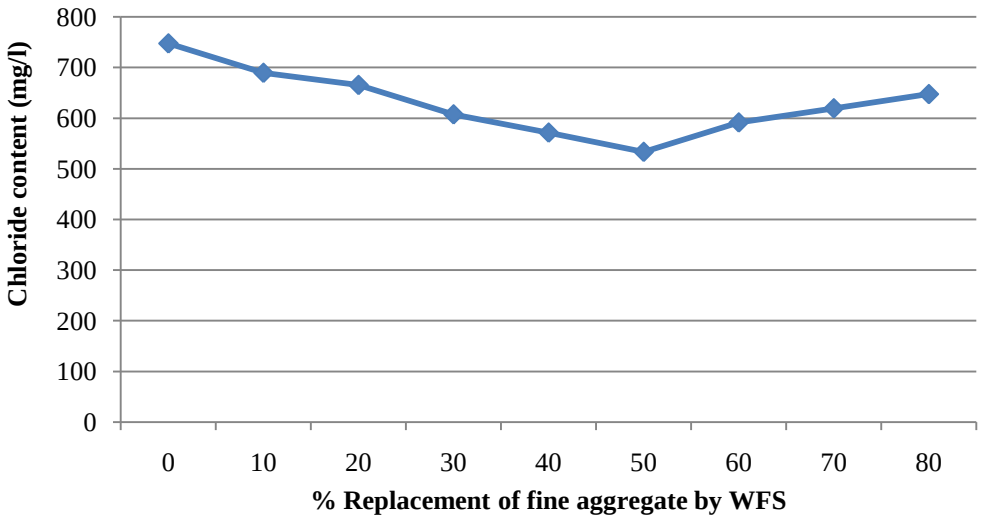

Fig 8: Variation of chloride content

4. CONCLUSION

Following conclusions may be drawn on the study conducted on the behavior of concrete containing waste foundry sand under chloride attack.

- Minimum values of water absorption and sorptivity may be obtained by replacing 50% fine aggregate by waste foundry sand. It is true for concrete with chloride attack and without chloride attack.
- Water absorption and sorptivityare little higher for the concrete produced by replacing fine aggregate by waste foundry sand, when subjected to chloride attack.
- Higher values of strength characteristics for concrete such as compressive strength, tensile strength, flexural strength, shear strength and impact strength may be obtained by replacing 50% replacement of fine aggregate by waste foundry sand. This is true for concrete with chloride attack and without chloride attack.
- Strength characteristics for concrete produced by replacement of fine aggregate by waste foundry sand and without subjecting to chloride attack exhibit higher values as compared to the concrete which is subjected to chloride attack.
- 50% replacement of fine aggregate by waste foundry sand yields low chloride content.

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