Experimental Study on Self-Compacting Concrete using E-plastic waste materials in partial replacement of coarse aggregate

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Abstract - Use of waste materials and by-products is a partial solution to ecological and environmental problems. Utilization of these materials not only helps in getting them used in cement, concrete and other construction materials, it reducing the cost of concrete and cement manufacturing, but also has many indirect benefits such as reduction in land-fill cost, saving in energy, and protecting the environment from possible pollution effects. E-waste (EW) is abbreviation of Electronic waste, consists of discarded computers, TV, Laptop, refrigerators – basically all electrical or electronic appliance that has reached its end-of-life. Efforts have been made in the concrete area to use non-biodegradable components of E-waste (EW) as a partial replacement of the coarse aggregates.An experimental study is made by preparing specimens by utilizing E-plastic waste particles as coarse aggregates in Self-Compacting Concrete (SCC) with a percentage replacement from 0% to 30% i.e. (5%, 10%, 15%....up to 30%). And Conventional specimens are also prepared for M30 and M35 grade Self-Compacting Concrete (SCC) without using E-plastic waste aggregates. By conducting tests for both the specimens Fresh Properties and hardened properties of Self-Compacting Concrete (SCC) are studied. It is found that use of E- plastic waste aggregates results in the formation of Self-Compacting Concrete (SCC) which has lesser weight than that of conventional concrete. This study ensures that reusing of E-waste as coarse aggregate substitutes in concrete gives a good approach to reduce cost of materials and solve solid waste problems posed by E-plastic waste.

Key words: E-Plastic Waste materials (EWM), Natural Coarse Aggregate (NCA), Self-Compacting Concrete (SCC), Normal Vibrated Concrete (NVC).

IINTRODUCTION

Concrete has been important and best building material for all types of industrial and civil works. It increase in difficulty of construction and lack of skilled labors. In blocked or dense designed of steel fair as applied to concreting in blocked area, and it decrease the strength of concrete. Concrete is a widely used construction material around the world. Many types of concrete have been developed to enhance the different properties of concrete

When large amount of concrete of very high steel is to be placed in a reinforced cement concrete member, it is hard or difficult to ensure that the form work completely filled with cement concrete that is, fully compacted without voids. Compaction by manually mix or mechanically vibrators is very hard in normal condition. The methods of compaction, vibrations produces delay and it increase the cost of the overall project. In case of underwater concreting, the vibration or compaction are not possible, in that case self- compacting concrete (SCC) are adopted.

In the present scenario, no construction activity can be imagined without using cement concrete. Concrete is the widely used construction materials. Reason behind its popularity is its strength and durability. Today, the world is advancing too fast and our environment is changing progressively. Attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. One of the new waste materials used in the concrete industry is E-waste. For solving the disposal of large amount of E-waste material (EWM), reuse of E-waste(EW) in concrete industry is considered as the most feasible application. E-waste is one of the fastest growing waste streams in the world. E-Waste use in concrete is possible and Easy, because source of E-waste are large and available easily in market.

II OBJECTIVE

To evaluate the fresh properties (Slump test, L-box and V-funnel) of Self-Compacting Concrete (SCC) with use of E-Plastic Waste materials up to 30% Replacement with the increment of 5%.

To evaluate the harden properties (Compressive strength, Split tensile Strength and Flexural tensile Strength) of Self-Compacting Concrete (SCC) with use of E-Plastic Waste materials up to 30% Replacement with the increment of 5%.

To evaluate the durability Properties, Acid attack (HCL, H2SO4) and sulphate attack (MgSO4) of Self-Compacting Concrete (SCC) with use of E-Plastic Waste materials up to 30% Replacement with increment of 5%.

III E-PLASTIC WASTE MATERIALS

As per the title, the E-Plastic Waste materials collected from Pruthvi E- recyclepvt.ltd. Located at the Rajkot. After collecting, E-Plastic Waste materials crushed by the Grinder. The size of the used aggregate is 12.5 mm passing and 10 mm retained. This E-Plastic Waste materials replaced by the natural coarse aggregate by the increment of 5% interval respectively.

Figure 1 E-Plastic Waste Materials

IV PHYSICAL PROPERTIES OF E- PLASTIC WASTE MATERIALS

Table 1 Physical Properties of E- Plastic Waste Materials

Properties	E-Plastic Waste Materials
Flakiness Index	8.7%
Elongation Index	2.3%
Abrasion Value	11.20%
Impact Value	4.65%
Crushing Value	2.10%
Specific Gravity	1.34
Water Absorption	0.28%

V FRESH PROPERTIES TEST RESULTS

There are three fresh property of Self-compacting concrete (SCC), first one is filling ability, second one is passing ability and third one is segregation resistance

Filling ability
Flows easily at suitable speed into formwork an completely fills intricate spaces with obstacles.
Passing ability
Passes through reinforcements without blocking and adhere to it without applied other external energy.
High resistance to segregation
The distribution of aggregate particles remains homogeneous in both vertical and horizontal directions.

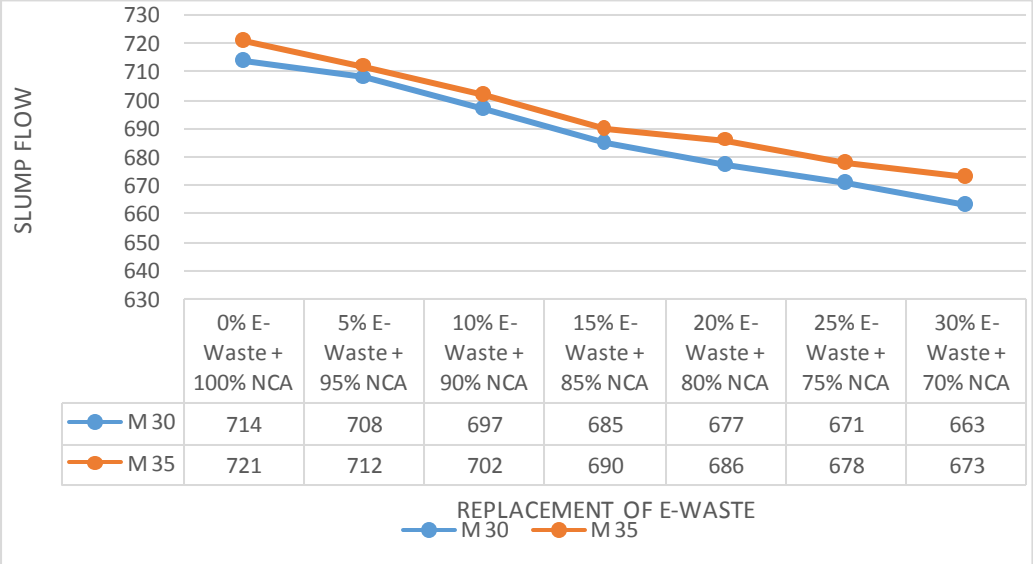
Table 2 Results of Fresh properties test M-30 grade concrete

Sr no.	Type of Mix	Slump (mm)	V-Funnel (sec)	L-Box (h2/h1)
		650-800 mm	6-12 sec	0.8-1
1	0% E-Waste + 100% NCA	714	8.1	0.87
2	5% E-Waste + 95% NCA	708	8.7	0.85
3	10% E-Waste + 90% NCA	697	9.3	0.84
4	15% E-Waste + 85% NCA	685	9.7	0.83
5	20% E-Waste + 80% NCA	677	9.6	0.84
6	25% E-Waste + 75% NCA	671	9.9	0.8
7	30% E-Waste + 70% NCA	663	10.1	0.79

Table 3 Results of Fresh properties test M-35 grade concrete

Sr no.	Type of Mix	Slump (mm)	V-Funnel (sec)	L-Box (h2/h1)
		650-800 mm	6-12 sec	0.8-1
1	0% E-Waste + 100% NCA	721	8.3	0.88
2	5% E-Waste + 95% NCA	712	8.8	0.86
3	10% E-Waste + 90% NCA	702	9.4	0.85
4	15% E-Waste + 85% NCA	690	9.4	0.84
5	20% E-Waste + 80% NCA	686	9.8	0.82
6	25% E-Waste + 75% NCA	678	10.3	0.81
7	30% E-Waste + 70% NCA	673	10.8	0.81

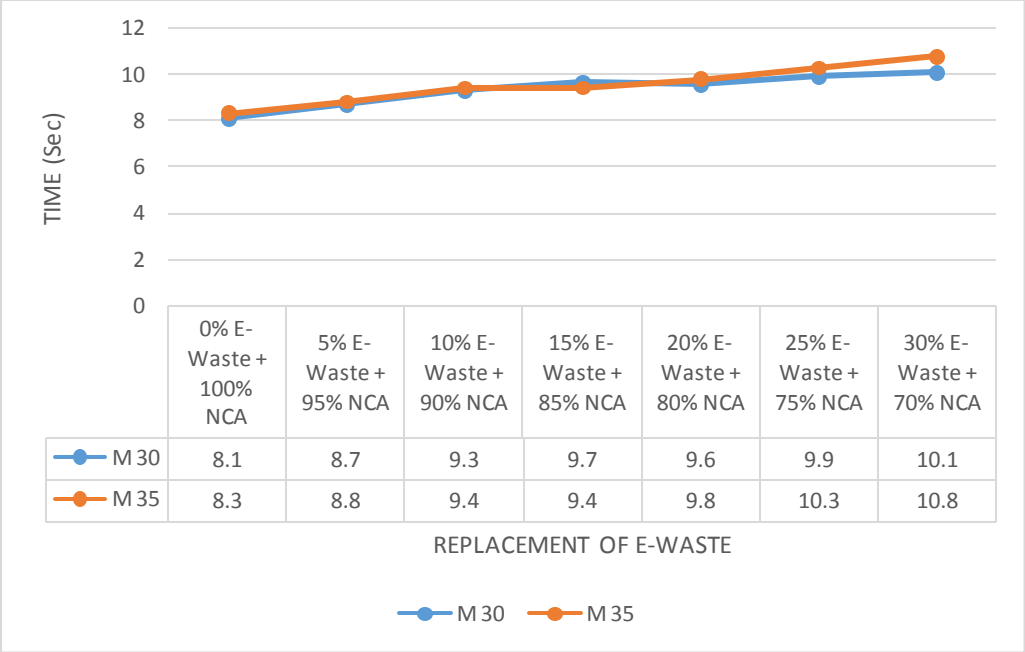
Chart 1 Slump Flow Chart



In M-30 grade concrete with the increment of E-waste materials up to 5% to 30% with increment of 5% the value of slump decreases in the rate of percentage 0.84, 2.38, 4.06, 5.18, 6.02, and 7.14 respectively.

In M-35 grade concrete with the increment of E-waste materials up to 5% to 30% with increment of 5% the value of slump decreases in the rate of percentage 1.25, 2.64, 4.30, 4.85, 5.96, and 6.66 respectively.

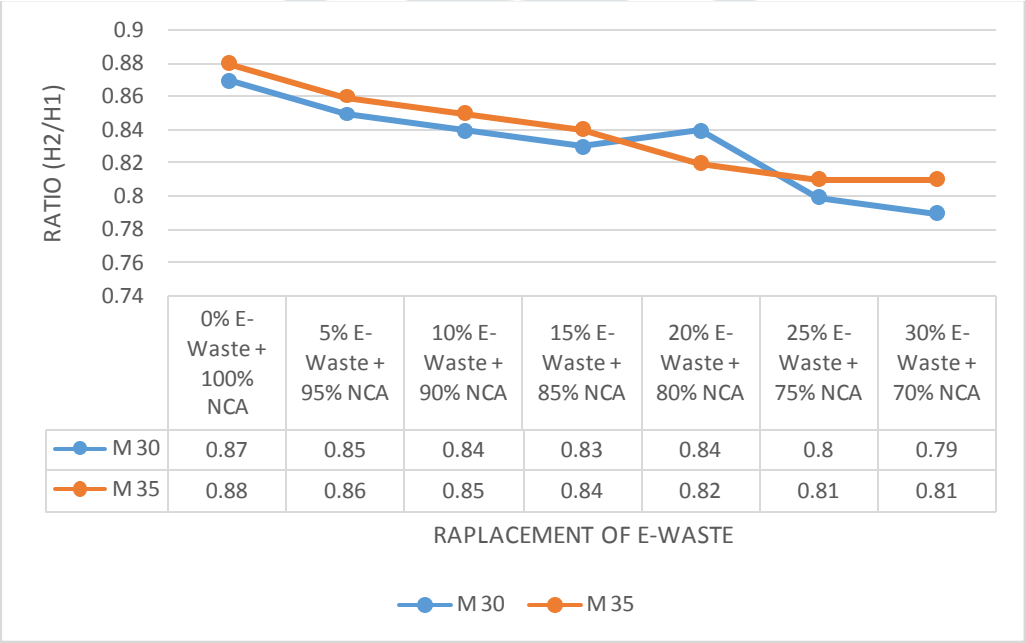
Chart 2 V-Funnel Chart



In M-30 grade concrete with the increment of E-waste materials up to 5% to 30% with increment of 5% the value of V-Funnel increases in the rate of percentage 7.41%, 14.81%, 19.75, 18.52, 22.22% and 24.69 respectively.

In M-35 grade concrete with the increment of E-waste materials up to 5% to 30% with increment of 5% the value of V-Funnel increases in the rate of percentage 6.02, 13.25, 13.25, 18.07, 24.10, and 30.12 respectively.

Chart 3 L-Box Chart



VI HARDEN PROPERTIES TEST RESULTS

Compressive strength result

The compressive strength of self-compacting concrete is decreases with increase the percentage of E-waste materials. Compressive strength of SCC is lower at early age but comparable at later age due to fly ash content. The result of compressive strength of SCC is show as below.

Table 4 Compressive Strength of Cubes for M-30

Compressive Strength for M-30 Grade in Mpa				
Target mean strength-38.75				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	26.89	35.64	43.78
2	5%E-WASTE+95%NCA	26.4	33.48	42.96
3	10%E-WASTE+90%NCA	25.21	32.71	41.37
4	15%E-WASTE+85%NCA	24.98	31.48	40.89
5	20%E-WASTE+80%NCA	24.65	30.13	38.81
6	25%E-WASTE+75%NCA	24.11	28.71	36.46
7	30%E-WASTE+70%NCA	22.07	25.56	33.98

Chart 4 Compressive Strength of M-30

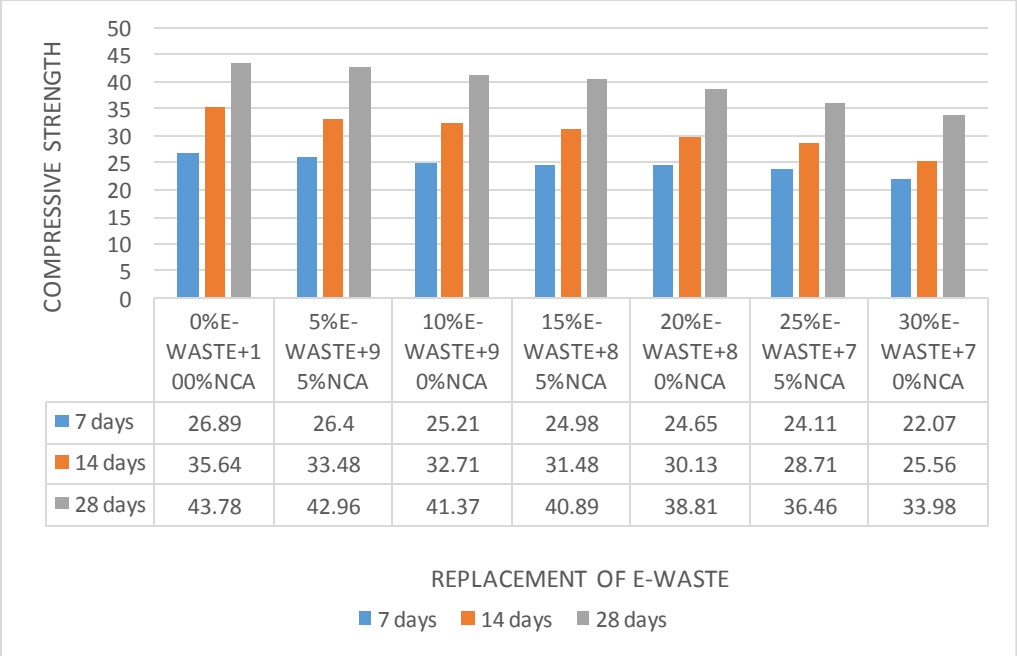
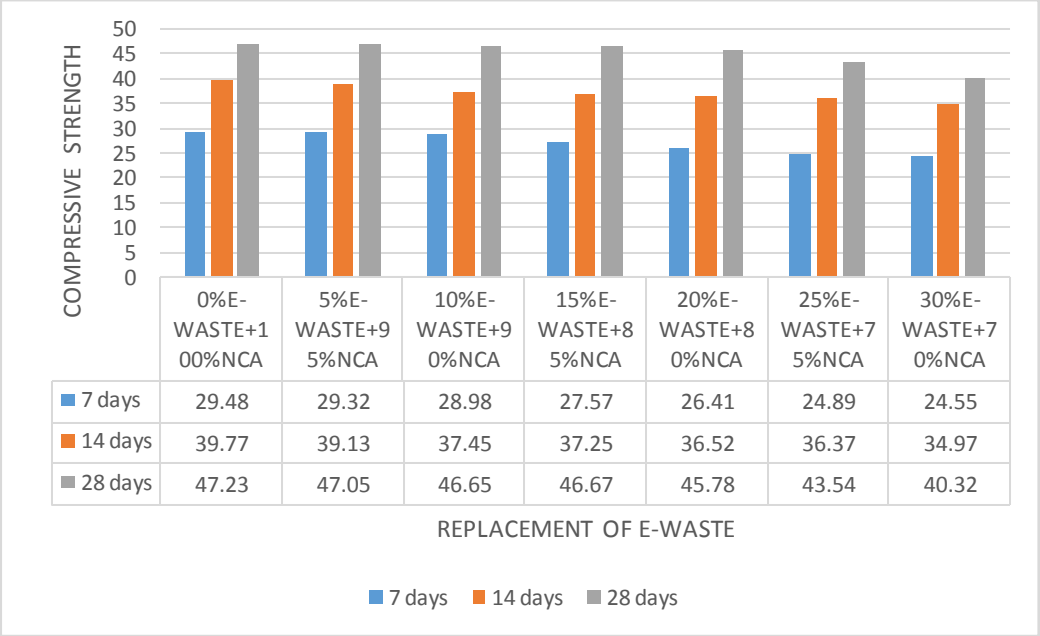


Table 5 Compressive Strength of Cubes for M-35

Compressive Strength for M-35 Grade in Mpa				
Target mean strength-43.25				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	29.48	39.77	47.23
2	5%E-WASTE+95%NCA	29.32	39.13	47.05
3	10%E-WASTE+90%NCA	28.98	37.45	46.65
4	15%E-WASTE+85%NCA	27.57	37.25	46.67
5	20%E-WASTE+80%NCA	26.41	36.52	45.78
6	25%E-WASTE+75%NCA	24.89	36.37	43.54
7	30%E-WASTE+70%NCA	24.55	34.97	40.32

Chart 5 Compressive Strength of M-35



In M-30 Grade concrete. Replacement adopted 5% to 30% of E-waste materials with increment of 5%, at the 5% strength decreases 1.87% and at the 30% strength decreases 22.38%.

In M-30 Grade concrete. Replacement adopted 5% to 30% of E-waste materials with increment of 5%, at the 5% strength decreases 0.38% and at the 30% strength decreases 14.63%.

Flexural strength Results

The flexural strength of SCC with E-waste materials and fly ash is decreases with increase the percentage of E-waste materials. Flexural strength of SCC is lower at early age but comparable at later age due to fly ash content. The result of flexural strength are shown as below:

Table 6 Flexural Strength of Grade M-30

Flexural Strength for M-30 Grade in Mpa				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	2.91	3.45	4.32
2	5%E-WASTE+95%NCA	2.8	3.41	4.21
3	10%E-WASTE+90%NCA	2.34	3.15	4.17
4	15%E-WASTE+85%NCA	2.01	2.91	3.81
5	20%E-WASTE+80%NCA	1.75	2.58	3.43
6	25%E-WASTE+75%NCA	1.89	2.56	3.19
7	30%E-WASTE+70%NCA	1.7	2.41	2.79

Chart 6 Flexural Strength of M-30

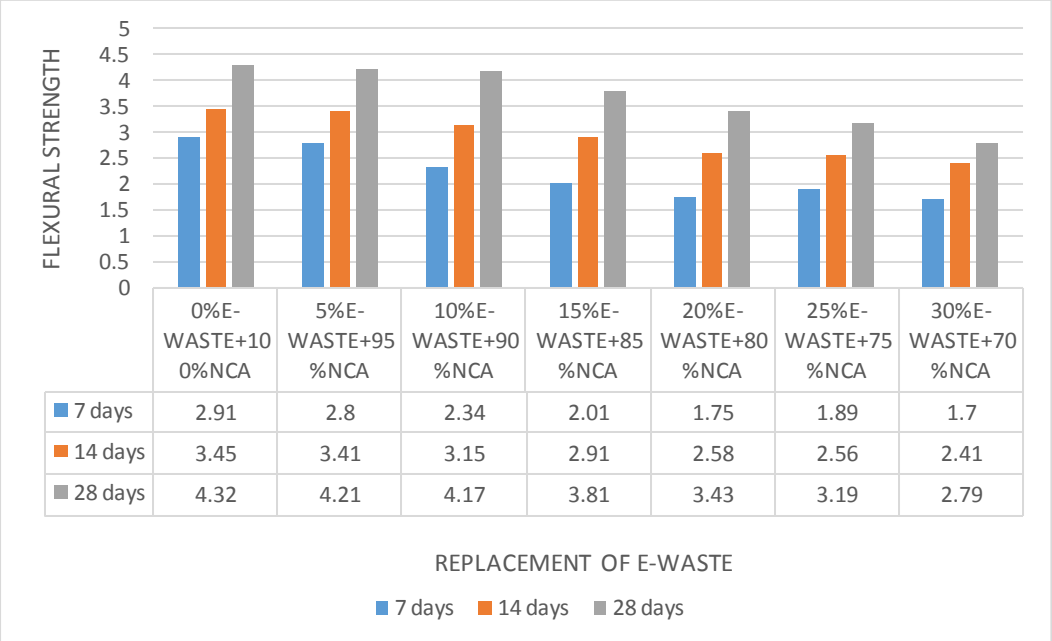
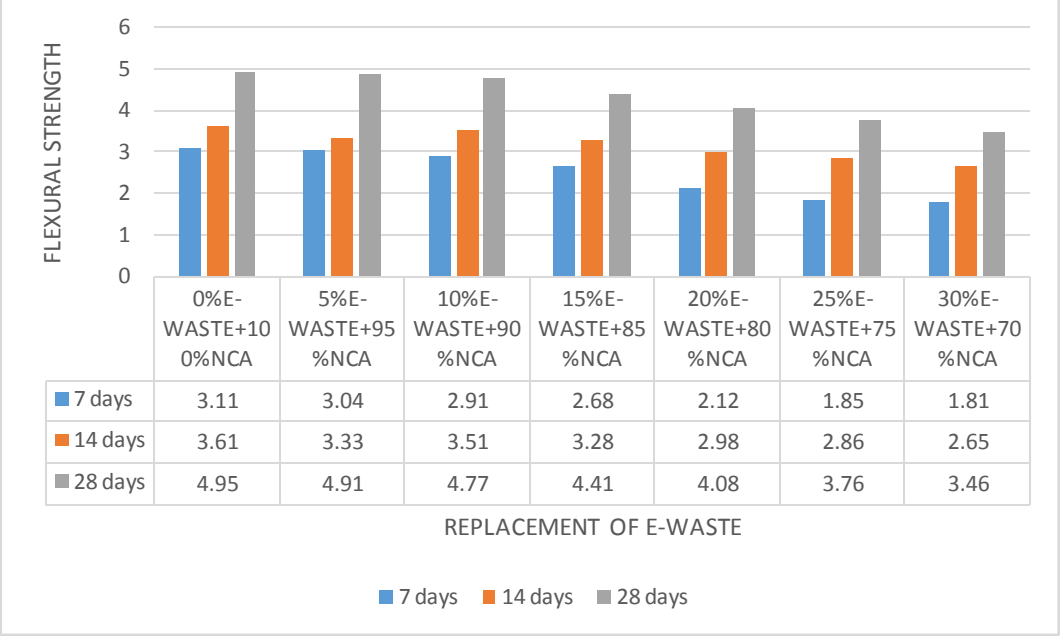


Table 7 Flexural Strength of Grade M-35

Flexural Strength for M-35 Grade in Mpa				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	3.11	3.61	4.95
2	5%E-WASTE+95%NCA	3.04	3.33	4.91
3	10%E-WASTE+90%NCA	2.91	3.51	4.77
4	15%E-WASTE+85%NCA	2.68	3.28	4.41
5	20%E-WASTE+80%NCA	2.12	2.98	4.08
6	25%E-WASTE+75%NCA	1.85	2.86	3.76
7	30%E-WASTE+70%NCA	1.81	2.65	3.46

Chart 7 Flexural Strength of M-35



In M-30 grade concrete Replacement of E-waste materials up to 5% to 30% with increment of 5%, at the 5% flexural strength decreases 2.54% and at the 30% flexural strength decreases 35.41%.

In M-35 grade concrete Replacement of E-waste materials up to 5% to 30% with increment of 5%, at the 5% flexural strength decreases 0.80% and at the 30% flexural strength decreases 30.10%.

Split Tensile Strength Results

The Split tensile strength of SCC with E-waste materials and fly ash is decreases with increase the percentage of E-waste materials. Split tensile strength of SCC is lower at early age but comparable at later age due to fly ash content. The results of split tensile strength of SCC are show as below.

Table 8 Split Tensile Strength of Grade M-30

Split Tensile Strength for M-30 Grade in Mpa				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	2.53	3.29	4.11
2	5%E-WASTE+95%NCA	2.5	3.19	4.02
3	10%E-WASTE+90%NCA	2.35	3.15	3.93
4	15%E-WASTE+85%NCA	1.88	2.96	3.71
5	20%E-WASTE+80%NCA	1.77	2.78	3.41
6	25%E-WASTE+75%NCA	1.68	2.47	3.11
7	30%E-WASTE+70%NCA	1.43	2.32	2.75

Chart 8 Split Tensile Strength of M-30

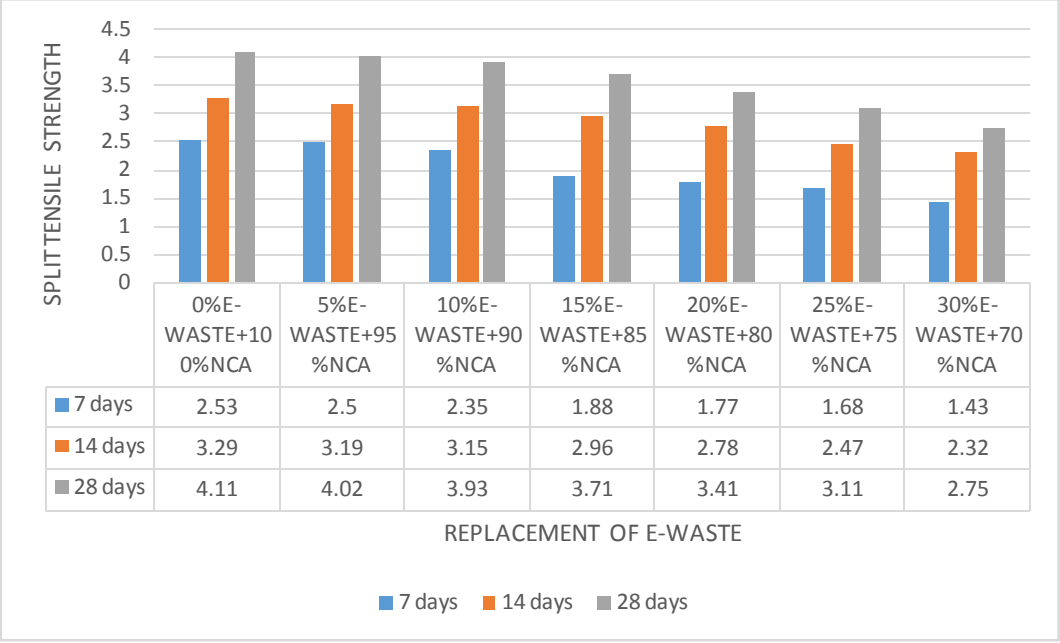
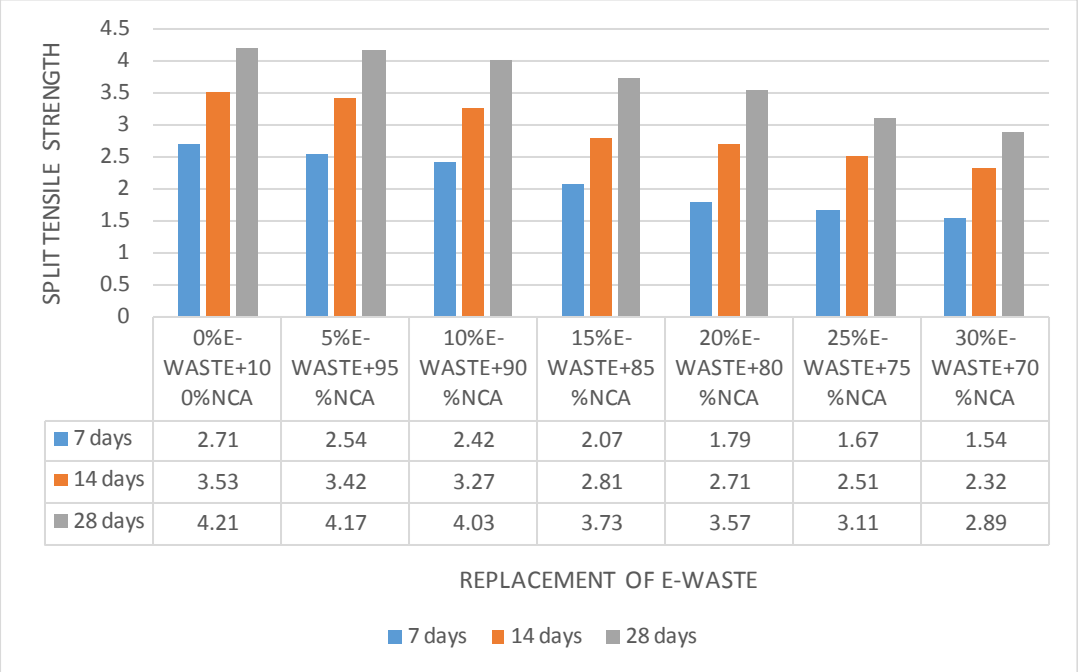


Table 9 Split Tensile Strength of Grade M-35

Split Tensile Strength for M-35 Grade in Mpa				
Sr. No.	**Type of Mix**	**7 days**	**14 days**	**28 days**
1	0%E-WASTE+100%NCA	2.71	3.53	4.21
2	5%E-WASTE+95%NCA	2.54	3.42	4.17
3	10%E-WASTE+90%NCA	2.42	3.27	4.03
4	15%E-WASTE+85%NCA	2.07	2.81	3.73
5	20%E-WASTE+80%NCA	1.79	2.71	3.57
6	25%E-WASTE+75%NCA	1.67	2.51	3.11
7	30%E-WASTE+70%NCA	1.54	2.32	2.89

Chart 9 Split Tensile Strength of M-35



In M-30 grade concrete Replacement of E-waste materials up to 5% to 30% with increment of 5%, at the 5% split tensile strength decreases 2.18% and at the 30% flexural strength decreases 33.09%.

In M-35 grade concrete Replacement of E-waste materials up to 5% to 30% with increment of 5%, at the 5% split tensile strength decreases 0.95%% and at the 30% flexural strength decreases 31.35%.

VII CONCLUSION

Various tests were carried out on different mixes of concrete containing E-plastic waste materials and fly ash along with control mixes in self compacting concrete (SCC).

- From the study of SCC with replacement of E-waste materials with NCA up to 30% with the increment of 5%, the concrete satisfy the fresh properties according to EFNARC Guideline including slump, L-Box, and V-Funnel.
- It is observed that, the concrete fulfilled the requirement of guideline, But with the increment of E-waste materials the value decrease respectively.
- In the slump flow test, replacement of E-waste materials up to 5% to 30% with increment of 5%, the value of flow decreases 0% to 7.14% respectively.
- In L-Box test replacement up to 5% to 30% with increment of 5% there is maximum increment in Ratio of H2/H1 is 9.20%
- V-funnel with the same replacement there is increase time up to 24.69%.
- The study shows that the Hardened properties decrease with increment of replacement of E-waste materials.
- Up to replacement of 5% to 30% with increment of 5%, the compressive strength decrease 1.87% to 22.38% respectively.
- From the result it is observed that up to replacement of 5% to 30% with increment of 5%, the split tensile strength decrease 2.18% to 33.09% respectively.
- And in flexural strength, up to replacement of 5% to 30% with increment of 5%, the strength decreases 2.54% to 35.41% respectively.

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