Influence of various industrial effluents on concrete structures

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Abstract

Population explosion coupled with urbanization has raised the demand for water resulting in its scarcity. With industrialization, the quantum of wastewater generated too has soared up warranting appropriate measures for utilization of the same. An attempt has been made in this direction towards utilization of industrial effluents in construction industry. Laboratory scale concrete blocks of M25 grade were moulded and used for strength analysis. Effluents from chocolate factory (E3), powder coating industry (E2) and automobile industry (E1) were used for curing concrete and its strength parameters like compression, tension and flexure were tested after 28 days. It was observed that E3 enhanced the compressive strength of concrete by 3.84%, tensile strength by 2.46% and flexural strength by 1.96% compared to conventional water curing, indicating its direct applicability in concrete curing sector. E1 and E2 too have been proved to be beneficial, though to a lesser extent and can be used endemically based on availability.

Key words: *Industrial effluents, Strength of concrete, Curing.*

1. Introduction

Waste is a resource, but out of place and time. Almost all industries dispose their effluents either into waste lands or into natural water bodies, thus causing pollution. So a great challenge now for civil and environmental engineers is to divert industrial waste towards useful construction purposes. A considerable amount of work has been carried out by various scientists on use of industrial effluents as admixtures for cement and concrete. It was found that the compressive strength and setting time can be increased by using treated effluents for mixing of concrete according to Ooi Soon Lee et al, (2001) [1]. The use of acid resistant supplementary cementitious material (flyash or silica fumes) and quartz aggregate increases the denseness of microstructure (Robin E. Beddo and Karl Schmidt, 2004) [2]. Addition of concare and calcium nitrate to textile effluents considerably reduces the corrosion effects of concrete (K.Nirmalkumar & V.Shivakumar, 2008) [3]. The presence of poly acids in effluents degrades cementitious material according to Alexandra Bertron et al, (2009) [4]. The use of tertiary treated wastewater in concrete shows similar properties to that of water (Jasem M. Alhumoud et al, 2010) [5].

2. Experimental program

2.1 Materials

Cement: In this experimental investigation ordinary Portland cement of 43 grade was used.

Fine aggregate: Locally available river sand free from impurities was used. The size of it is less than 4.75mm. The specific gravity and fineness modulus of the fine aggregate were found to be 2.67 and 2.56 respectively. The percentage of passing is within the limits as per IS383-1970 [8].

Coarse aggregate: The coarse aggregate used is 20mm in size, crushed, angular in shape and free from dust. The specific gravity and fineness modulus were found to be 2.82 and 7.03 respectively. The percentage of passing is within the limits as per IS383-1970[8].

Effluents: The effluents used are coolant oil from automobile industry, effluent from powder coating and chocolate factory. The properties of these effluents were studied and are given tables 1, 2 and 3 respectively.

Table 1 properties of coolant oil

S.NO	Parameter	Quantity
1	Physical state and colour	Viscous Liquid
2	Appearance	Dark Brown Colour Liquid
3	Specific gravity	0.868
4	Solubility in water	Good soluble.
5	Flash point (COC),°C	150° C.
6	Kinematic Viscosity cSt	20, min @ 40° C
7	Percent Volatiles	2 % min.
8	Emulsion Test (20 : 1 ratio)	0.1 ml and 0.2ml cream permitted

Table 2 properties of powder coating effluent

S.NO	Parameter	Quantity
1	pH	4
2	Total suspended solids	560 mg/L
3	Total settleable solids	2500 mg/L
4	Chloride content	800 mg/L
5	Nitrogen content	45 mg/L
6	Oil and grease	20 mg/L
7	BOD	20 mg/L
8	COD	400 mg/L

Table 3 properties of chocolate effluent

S.NO	Parameter	Quantity
1	pH	7.53
2	Total suspended solids	56 mg/L
3	Total dissolved solids	1300 mg/L
4	Chloride content	704 mg/L
5	Sulphate content	74 mg/L
6	Oil and grease	<1 mg/L
7	BOD	29 mg/L
8	COD	192 mg/L

Coolant oil(E1) Powder coating effluent(E2) Chocolate effluent (E3)

Figure 1 Various effluents

2.2 Grade of concrete

The concrete mix is designed as per IS 456-2000[6] and IS 10262 – 1982[7]. The water cement ratio is 0.45.

2.3 Preparation of specimens

The strength characteristics of M25 grade concrete cured in effluents were studied by casting cubes, cylinders and prisms. The cement, fine aggregate and coarse aggregate were collected and mixed to appropriate proportion by adding water. Moulds of interior dimensions (150X150X150mm) for cube,(150mm diameter X 300mm height) for cylinder and (500X100X100mm) for prisms were prepared and concrete was poured in to the mould layer by layer and vibrated thoroughly. The specimens were removed from the moulds after 24 hours and then the specimens were cured with water and effluents E1, E2, and E3 for 28 days. The numbers of each specimen casted are given in table 4.

Table 4 Number of specimens

Specimen numbers	**Curing medium**			
	Water	**E1**	**E2**	**E3**
Number of cubes	3	3	3	3
Number of cylinders	3	3	3	3
Number of prisms	3	3	3	3

Figure 2 Curing of specimens in effluents 1, 2 and 3.

3. Testing

Concrete specimens were taken out of curing chambers after 28days. Cubes were tested for compressive strength using a compression testing machine, cylinders were tested for their split tensile strength using a compression testing machine and prisms were tested for their flexural strength using universal testing machine.

4. Results and discussions

From the tests conducted it is found that the compressive strength, split tensile strength and flexural strength has increased for the specimens cured in effluents when compared to the specimens cured in potable water. The test results obtained are given in table 5.

Table 5 Experimental test results

Strength	M25 (N/mm^2)			
	Conventional	E1	E2	E3
Compressive strength	28.44	28.98	28.94	29.53
Split tensile strength	2.9	2.95	2.94	2.97
Flexural strength	3.62	3.68	3.67	3.7

4.1 Influence on compressive strength of concrete

Experimental investigations have revealed that the compressive strength of concrete has increased by 1.9%, 1.8% and 3.83% when cured with the effluents E1, E2 and E3 respectively, in comparison with curing by water, as shown in figure 3. So, it is obvious that curing with E3 increases the strength of concrete considerably indicating its practical field applicability.

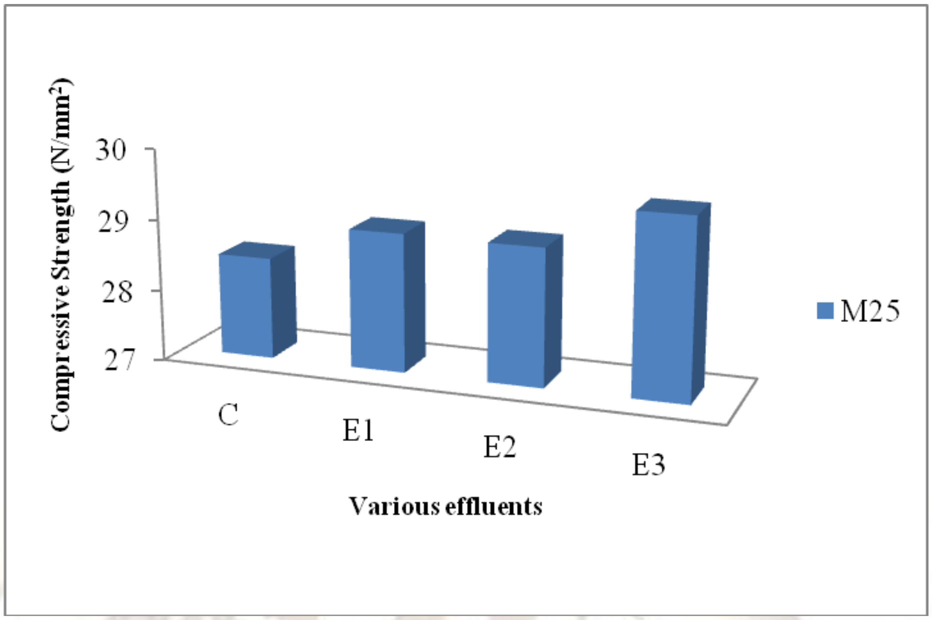

Figure 3 Compressive Strength of concrete after 28 days of curing

4.2 Influence on tensile strength of concrete

Curing of concrete cylinders with industrial effluents E1,E2 and E3 over a period of 28 days have shown that there is a considerable increase in split tensile strength compared to conventional water curing. The percentage improvements in split tensile strengths after curing were found to be 1.72%, 1.64% and 2.4% with E1, E2 and E3 respectively, proving the efficacy of E3 over the other effluents as depicted in figure 4.

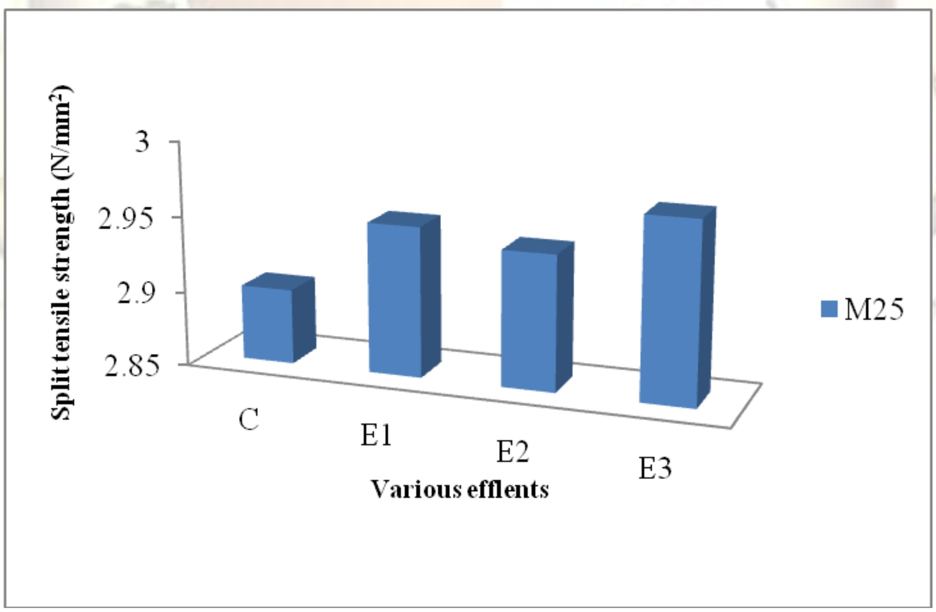

Figure 4 Split tensile Strength of concrete after 28 days of curing

4.3 Influence on flexural strength of concrete

Prisms cured with industrial effluents E1, E2 and E3 have increased the flexural strength of concrete. From figure 5, it can be observed that concrete cured with effluent E3 has maximum increase of flexural strength by 2.1%, compared to water curing, whereas effluents E1 and E2 have shown 1.66% and 1.5% increase respectively.

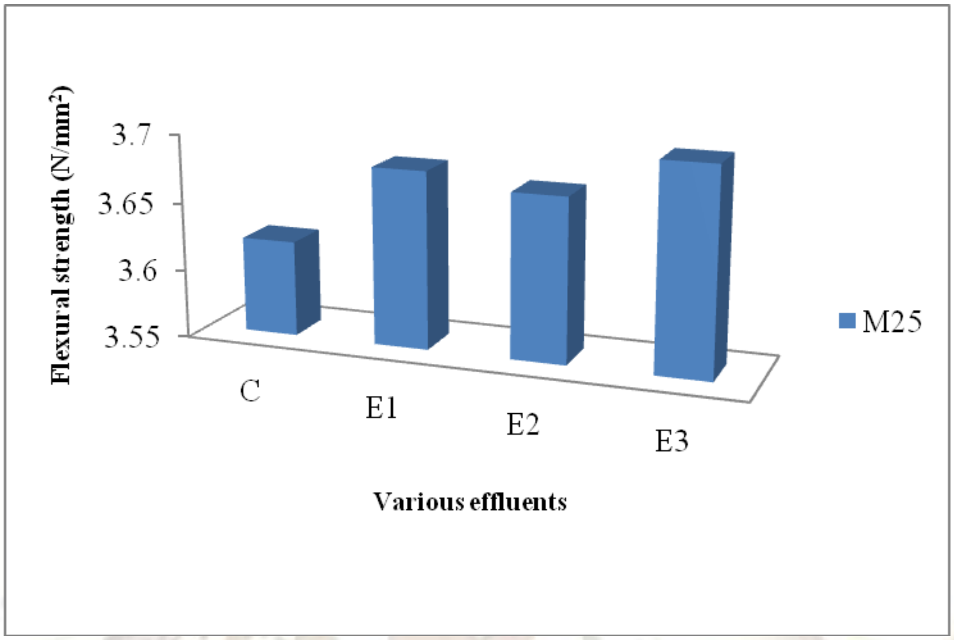

Figure 5 Flexural strength of concrete after 28 days of curing

Figure 6 Tensile failure

Figure 7 Flexural failure

6. Conclusion

Industrial effluent E3 can very well be used for curing concrete structures instead of water, as it has shown considerable increase in compressive, tensile and flexural strengths of 3.83, 2.4 and 2.1 percentages respectively, compared to conventional water curing. As a marginal increase in mechanical strength parameters of concrete was observed, E1 and E2 can be used for curing where they are sufficiently available.

7. REFERENCES

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