Effect of Triethanolamine on Concrete Made Up of PPC

Prashant N. Patel[1], Prof. Chintan D. Patel[2], Dr. K.G. Mehta[3], Prof. Z. R. Chhaya[4]
[1]Dept of Civil engineering
[2]Dept of Applied Mechanics
[3]Principal
[1, 3]Merchant Institute of Technology
[2, 4]L.D. College of Engineering, Ahmadabad, India

Abstract- *The present study investigates the working principle upon the accelerating-retarding effect of triethanolamine dosage on the initial setting time of concrete made up of portland pozzolana cement. The triethanolamine added in concrete will increase the strength of concrete such as compressive strength and flexural strength. This type of concrete gives more strength than the conventional concrete.*

Keywords- Triethanolamine, Concrete, Compressive strength, Portland pozzolana cement

I. INTRODUCTION

The concrete in which common ingredients such as aggregate, water and sand cement are used is known as normal concrete. It is also known as normal weight concrete or normal strength concrete. It has a setting time of 30 - 90 minutes depending upon humidity, grain size of cement etc. At about 90 days almost 90% of strength is achieved. The slump varies from 1 to 4 inches. Density ranges from 140 to 175 pcf. It has weak tension but strong compression. Air content is about 1 to 2%. Normal concrete does not withstand severe conditions like freezing and thawing.

In the past several years, the use of organic admixtures to alter the physical and rheological properties of portland cement concrete has become common practice in the construction industry. However, the low concentrations typically used, and the organic nature of the admixtures, present problems to the analytical chemist who may be called upon to determine the amounts and types of admixtures originally added to the concrete.

Triethanolamine (TEA) is the main chemical used as cement additive with multi functions as grinding aid during cement comminution process and setting time regulator for cement hydrations. These couple of functions is the main advantage from using TEA in addition to the relatively small dosage as well as the alkali and chloride free features. A unique characteristic of TEA is that it can either accelerate or retard cement hydration toward initial setting time depending on the dosage used.

TEA is a surface-active substance which is absorbed on the surface of cement particle and cement hydrated product. TEA imparts the solution some metallic ions Fe3+and Al+3 thus increasing the activity of C4AF compound and inhibiting the formation of Fe(OH)3 and Al(OH)3 on surface of the cement particle. The action of silicate and aluminate phases within the cement particle. TEA also reduces to some extent the surface tension of water that enables the cement powder wetting as well as highly reactive cement compound.

Thus, the addition of TEA with mixing with water reduces setting time, increasing the drying shrinkage but diminishing the mechanical strength of mortar and concrete.

An experimental comparative study on the influence of various type of accelerator on the compressive strength and flexural strengths of concrete at early and later ages, assumes greater importance to learn usefulness of non-chloride hardening accelerator in the early and later strength-gain of concrete mixtures typically for fast-track construction.

II. EXPERMENTAL PROGRAMME

The properties of materials used in preparation of concrete is determined as per the codal provisions and described as follows:

A. Materials

Cement- Portland pozzolana cement with specific gravity 3.15 was used. It was tested as per Indian Standard Specifications IS: 1489-1(1991), whose physical properties are given in Table-1.

Table - 1
Physical Properties of Cement

Cement	Specific Gravity	Setting time (minutes)		28 Days Compressive Strength (N/mm2)
		Initial	Final	
PPC	3.15	49	325	36.75

Aggregate- Locally available natural sand conforms to grading as per IS: 383-1970 was used as fine aggregate. Its physical properties are given in Table-2. Crushed stone with maximum 20 mm graded aggregates (nominal size) conforming to Table-2 of IS: 383- 1970 was used. Physical properties are given in Tables-2.

Table - 2
Physical Properties of Fine and Coarse Aggregates

Aggregate	Specific Gravity	Bulk Density (Loose), Kg/m3	Bulk Density (Compacted), Kg/m
Fine	2.70	1568	1680
Coarse	2.71	1537	1666

Triethanolamine- Triethanolamine, often abbreviated as TEA, is a viscous organic compound. Properties are given in Tables-3.

Table - 3
Properties of Triethanolamine (TEA)

Properties	
Chemical formula	C6H15NO3
Molar mass	149.19 g.mol-1
Appearance	Colourless liquid
Odor	Ammoniacal
Density	1.124 g mL−1
Melting point	21.60 °C; 70.88 °F; 294.75 K
Boiling point	335.40 °C; 635.72 °F; 608.55 K
Flash point	179 °C (354°F; 452 K)
Autoignition temperature	325 °C (617°F; 598 K)
Vapor pressure	1 Pa (at 20 °C)
Acidity (pKa)	7.74
UV-vis (λmax)	280 nm

B. Concrete Mix Proportioning

Concrete mixtures of grade M 20, M 30 and M 40 are designed as per new guidelines of IS 10262:2009. Table-4 shows the ingredient per cubic meter of concrete.

Table - 4
Concrete Mix Proportioning

Grade of Concrete	Water (Liters)	Cement (kg)	Sand (kg)	Crushed Metal/Gravel (kg)	
				20 mm	10 mm
M 20	179	358	795	800	359
M 30	178	395	738	717	467
M 40	168	400	793	714	476

C. Test Procedure

Cube moulds of size 150 mm x 150 mm x 150 mm were prepared. After 24 hours these moulds are removed and test specimens are put in water for curing. These specimens are tested using compression testing machine after 3, 7, 28 and 56 days of curing. Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. It is measured by loading 100 mm x 100 mm x 700 mm concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture (MPa) and is determined by third-point loading test.

III. TEST RESULTS

Compressive strength

Observed that the addition of TEA (0.1 - 1.0 %) accelerated the setting time of highlight cements while retarding the setting time of sulphate resistant cements. TEA acts as a set accelerator at low dosages (0.02 % – 0.05 % by weight of cement) and evidently enhances the early compressive strength of cementations materials, while in the case of the dosages of TEA higher than 0.1%, the opposite effects of set-retardation and the strength-loss at both early and late stages have been reported, at 0.25% as a mild set retarder, at 0.5% as a severe retarder, at 1.0% as a very strong accelerator in the hydration of Portland cement.

The results indicate that although TEA can reduce cement paste set time, TEA can significantly reduce early age compressive strength of Concrete. TEA can compromise concrete later age compressive strength in addition to early age compressive strength.

IV. CONCLUSION

- Effect of TEA on cement hydration is dosage dependent also. At small dosage (e.g. 0.02 %, weight percentage of cement) it acts as setting accelerator, at higher dosage

(e.g. 0.5 %) it acts as setting retarder, at more higher dosage (e.g. 1.0 %) it acts as setting accelerator once again.

- TEA is that it can either accelerate or retard cement hydration toward initial setting time depending on the dosage used.
- Triethanolamine increases compressive strength of concrete.
- Accelerating-retarding effects of TEA on initial setting time of hydrated cement are examined.
- Flexural strength leads to increased concrete strength at early age made by TEA.
- Adding Triethanolamine decreases the mechanical strength as compared with Portland cement mortar. It also decreased the setting time and increases chemical shrinkage.
- Shortens the interval between initial and final setting time of the fresh mortar pastes. Increases the mortar density.

REFERENCES

[1] Yohannes L. Yaphary, Zechuan Yu, Raymond H.W. Lam, Denvid Lau. ”Effect of triethanolamine on cement hydration toward initial setting time” Construction and Building Materials 141 (2017) 94 –103 (ELSEVIER).

[2] V. S. Ramachandran. ”HYDRATION OF CEMENT -- ROLE OF TRIETHANOLAMINE” Cement And Concrete Research. Vol. 6, pp. 623-632.

[3] ALI ALLAHVERDI, ZEINAB BABASAFARI. ”EFFECTIVENESS OF TRIETHANOLAMINE ON GRINDABILITY AND PROPERTIES OF PORTLAND CEMENT IN LABORATORY BALL AND VIBRATING DISK MILLS” Cement Research Center, School of Chemical Engineering, Iran University of Science and Technology, Narmak 1684613114, Tehran, Iran. Ceramics – Silikáty 58 (2) 89-94 (2014).

[4] M. T. McCall and J. Mannone. “ANALYSIS OF CEMENT PASTES FOR TRIETHANOLAMINE” Cement And Concrete research. Vol. 5, pp. 489-496.

[5] Necati Menek, Zerrin Heren. “Analysis of triethanolamine in white cement pastes by voltammetric methods” Cement and Concrete Research 29 (1999) 777–779.

[6] Zhang Yan-Rong, Kong Xiang-Ming, Lu Zi-Chen, Lu Zhen-Bao, Zhang Qing, Dong Bi-Qin, Xing Feng. “Influence of triethanolamine on the hydration product of portlandite in cement paste and the mechanism” Cement and Concrete Research 87 (2016) 64–76 (ELSEVIER).