

Experimental Study on Different Tests of Self Curing Concrete by Using Polyethylene Glycol (PEG-400) As Self Curing Agent

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ABSTRACT: Today concrete is most widely used construction material due to its good compressive strength and durability. Concrete is a mixture of cement, aggregate and water with or without suitable admixtures. Concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Curing is the process by which moisture is maintained to promote optimum cement hydration after placement and to obtain desirable strength and other process. Self-curing concrete is one of the best concretes in mitigating insufficient curing due to human negligence scarcity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. This paper reports an experimental study carried out to investigate the usage of polyethylene glycol (PEG-400) as self-curing agent. In this study compressive strength and split tensile strength of self-curing concrete with varying percentages (0.5%, 1%, 1.5%) for 7, 14 and 28 days are analysed, tested and compared with Conventional concrete of similar mix design were studied for M25 grade.

KEYWORDS: To reduce water, workable concrete and to reduce crack.

I. INTRODUCTION

Most of the concrete that is produced and placed each year all over the world already does self-cure to some extent. Some of it is not intended to have anything done to its exterior surface, except perhaps surface finishing. Yet the concrete stability to serve its intended purpose is not significantly reduced

[1]. Proper curing of concrete structures is important to meet performance and durability requirement. In conventional curing this is achieved by external curing applied after mixing, placing and finishing. Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. There are cases in which concrete has been greatly assisted in moving toward a self-curing status either inadvertently or deliberately through actions taken in the selection and use of materials.

[2]. To achieve good cure, excessive evaporation of water from a freshly cast concrete surface should be prevented. Curing can be performed in a number of ways to ensure that an adequate amount of water is available for cement hydration to occur. Curing of concrete without external curing method is not possible at all times.

[3] The concept of self-curing concrete need to be practiced in such a way that it is locally available for an effective implementation in field conditions. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking.

[4]. Various factors such as wind velocity, relative humidity, atmospheric temperature, water cement ratio of the mix and type of the cement used in the mix.

[5]. The function of self-curing agent is to reduce the water evaporation from concrete, and hence they increase the water retention capacity of concrete compared to the conventionally cured concrete.

II. OBJECTIVE

- To improve the effectiveness of the water content of a concrete mix by using Poly Ethylene Glycol.
- To determine the characteristics of self-curing concrete such as compressive and split tensile strength by adding self-curing agent in varying percentage.
- To compute the strength between conventional and self-curing concrete.

MATERIAL

i. Cement

The Ordinary Portland cement of 43-grade OPC was used in this study conforming to IS: 12269 1987 [11]. The specific gravity of cement is 3.15. The initial and final setting times were found as 30 minutes and 600 minutes respectively. Standard consistency of cement was 29%.

ii. Fine Aggregates

The Manufactured sand is used as fine aggregate conforming to the requirements of IS: 383-1970 [9], having specific gravity of 2.54 and fineness modulus of 3.25 has been used as fine aggregate for this study.

iii. Coarse Aggregate

Coarse aggregate obtained from local quarry units has been used for this study, conforming to IS: 383-1970 [9] is used. Maximum size of aggregate used is 20mm with specific gravity of 2.6 and fineness modulus of 7.3. The aggregates were tested as per IS 2386-1963.

iv. Fly ash

According to IS 3812-1981, Fly Ash

Fly ash is fine powder which is by product from burning pulverized coal in electric generation power plants. Fly ash can be expensive replacement for Portland cement in concrete although using it improves strength, segregation, and ease of pumping concrete. Specific gravity of fly ash 2.2

v. Water

The water used for experiments was potable water conforming as per IS: 456-2000.

vi. Polyethylene Glycol-400(PEG-400)

The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules of water which in turn reduces the vapors pressure, thus reducing the rate of evaporation from the surface. The physical and chemical properties of PEG 400

III. LITERATURE REVIEW

ShikhaTyagi in his study, the effect of curing compound on workability (slump and compaction factor) and compressive strength is studied. In this study the percentage of PEG by weight of cement from 0% to 2% as the dosage of internal curing compound was fixed. The test results were studied both for M25 and M40 mixes. It is found through this experiment study that PEG 400 help in self curing by giving strength on par with that of the conventional curing method and also improved workability. The optimum dosage of PEG400 for maximum strength was found to be 1% for M25 and 0.5% for M40 grade. As percentage of PEG400 increased slump increased for M25 and M40 grades of concrete.

VishnuKumar.Maim to compare strength of M30 grade concrete achieved by conventional curing method and self-curing method. The present study involves the use of shrinkage reducing admixture polyethylene glycol in concrete which helps in self-curing and helps in better hydration and hence strength. Both PEG-400 and PEG-200 are used in the study in 0% to 2% by weight of cement. The compressive strength of concrete mix increased by 12.04% by adding 1.0% of PEG 400 and 9.18% by adding 0.5% of PEG 200 as compared to the conventional concrete. The optimum dosage of PEG400 for maximum compressive strengths was found to be 1% of weight of cement for M30 grades of concrete. The optimum dosage of PEG200 for maximum compressive strengths was found to be 0.5% of weight of cement for M30 grades of concrete.

IV. MATERIAL CALCULATIONS

Conventional concrete: For 1 cube

Mix grade	w/c ratio in %	Cement [kg]	Fine agg [kg]	Coarse agg [kg]	Water (ml)
M25	0.45	1.54	2.26	3.9	693

Natural sand with PEG-400:

PEG-400 content	Mix grade	w/c ratio in %	Cement [kg]	Fine agg [kg]	Coarse agg [kg]	Water (ml)	PEG- 400 (ml)
0.5	M25	0.45	1.54	2.26	3.9	693	7.7
1.0	M25	0.45	1.54	2.26	3.9	693	15.4
1.5	M25	0.45	1.54	2.26	3.9	693	23.1

Manufactured sand with PEG-400:

PEG-400 content	Mix grade	w/c ratio in %	Cement [kg]	Fine agg [kg]	Coarse agg [kg]	Water [ml]	PEG- 400 (ml)
0.5	M25	0.45	1.53	2.35	3.88	688.5	7.65
1.0	M25	0.45	1.53	2.35	3.88	688.5	15.3
1.5	M25	0.45	1.53	2.35	3.88	688.5	22.95

Natural sand with PEG-400 and fly ash 20%:

PEG-400 content with fly ash 20%	Mix grade	w/c ratio in %	Cement [kg]	Fine agg [kg]	Coarse agg [kg]	Water [ml]	PEG-400 (ml)
0.5	M25	0.45	1.28	2.43	3.88	576	6.4
1.0	M25	0.45	1.28	2.43	3.88	576	12.8
1.5	M25	0.45	1.28	2.43	3.88	576	19.2

Manufactured sand with PEG-400 and fly ash 20% :

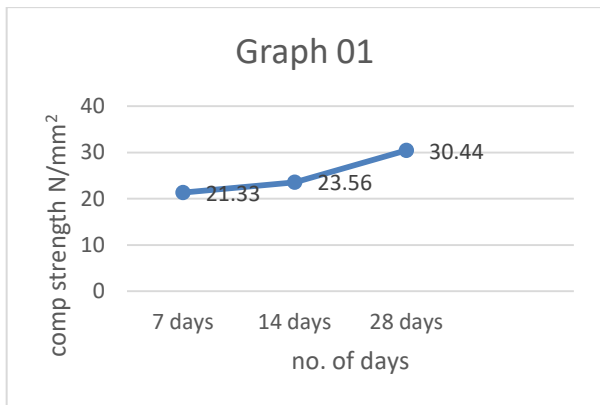
PEG-400 content	Mix grade	w/c ratio in %	Cement [kg]	Fine agg [kg]	Coarse agg [kg]	Water (ml)	PEG-400 (ml)
0.5	M25	0.45	1.25	2.5	3.78	562.5	6.25
1.0	M25	0.45	1.25	2.5	3.78	562.5	12.5
1.5	M25	0.45	1.25	2.5	3.78	562.5	18.75



1. Compressive Strength Test

The compression test is carried out on a specimen cubical or cylindrical in shape. For compressive strength, cubes of size 150mm x 150mm x 150mm were casted. Cubes for compressive strength are tested at 7 day, 14 days, and 28 days using compression testing machine.

Average Compressive Strength of M25

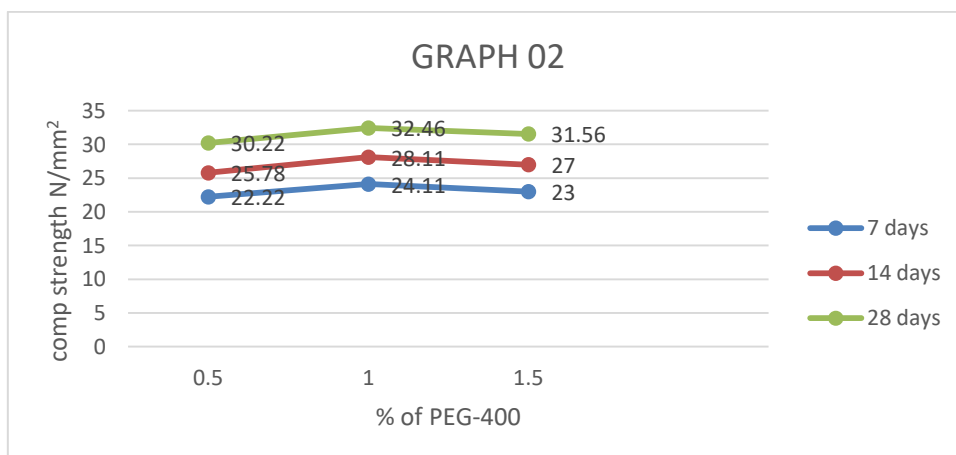


Mix ID	Average compression strength (N/mm ²)		
Conventional concrete	7- days	14- days	28- days
	21.33	23.56	30.44

Mixes are prepared by adding PEG-400 in different percentages (0.5%, 1.0%, and 1.5% by weight of cement) and 28 day strength values are tabulated below.

Graph 2: Average compressive strength of Natural sand with PEG-400 with fly ash 20 %.

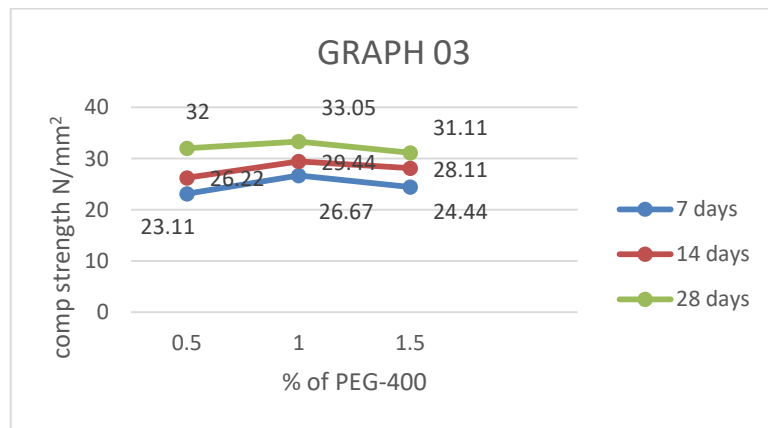
SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	7.7	22.22	25.78	30.22	65	0.84
2	1.0	15.4	24.11	28.11	32.46	72	0.86
3	1.5	23.1	23.00	27.00	31.56	89	0.92





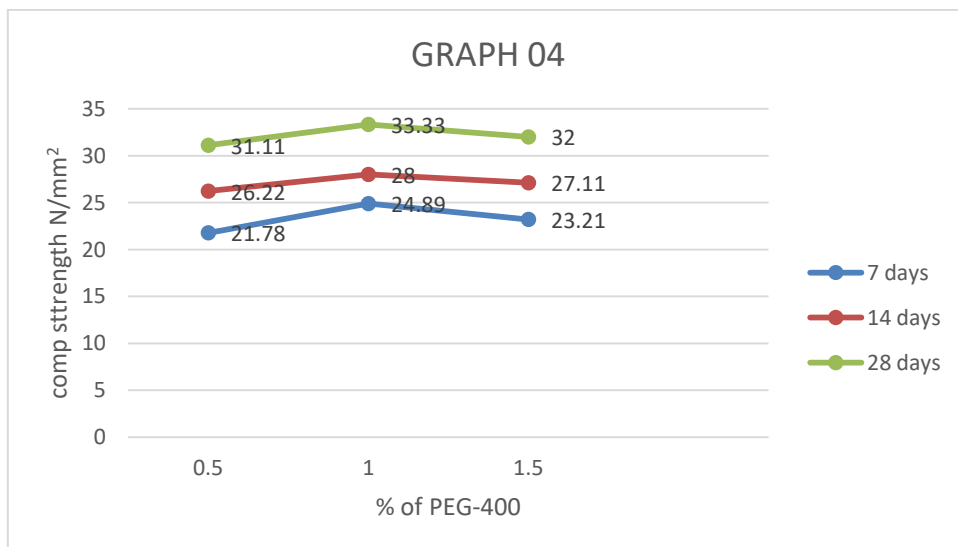
Graph 3: Average compressive strength of Manufactured sand with PEG-400 with fly ash 20 %

SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	7.65	23.11	26.22	32.00	68	0.85
2	1.0	15.3	26.67	29.44	33.05	82	0.9
3	1.5	22.95	24.44	28.11	31.11	94	0.94



Graph 4: Average compressive strength of Natural sand with PEG-400

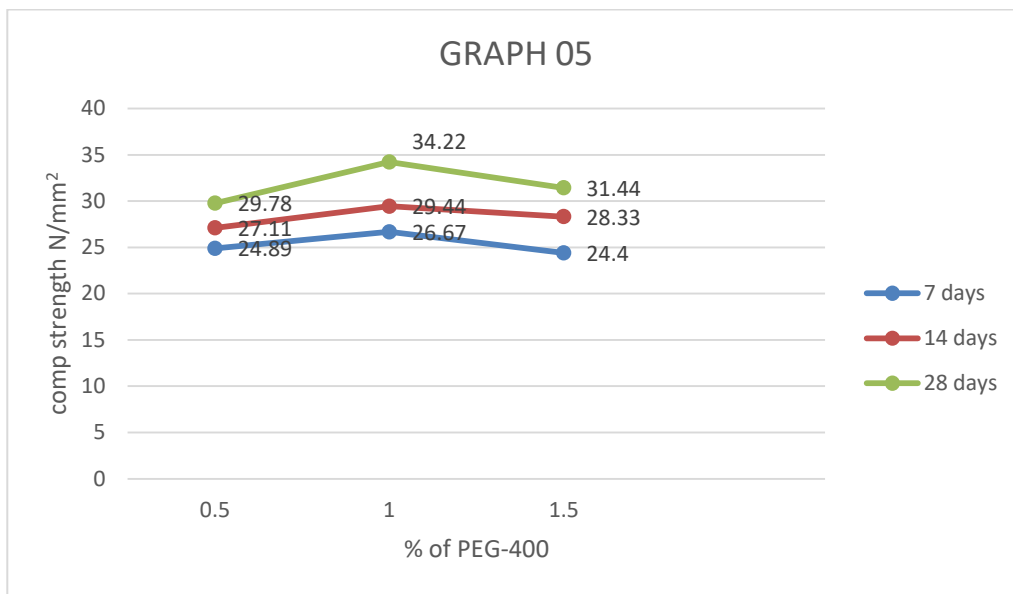
SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	6.4	21.78	26.22	31.11	65	0.80
2	1.0	12.8	24.89	28.00	33.33	80	0.83
3	1.5	19.2	23.21	27.11	32.00	84	0.87





Graph 5: Average compressive strength of Manufactured sand with PEG-400

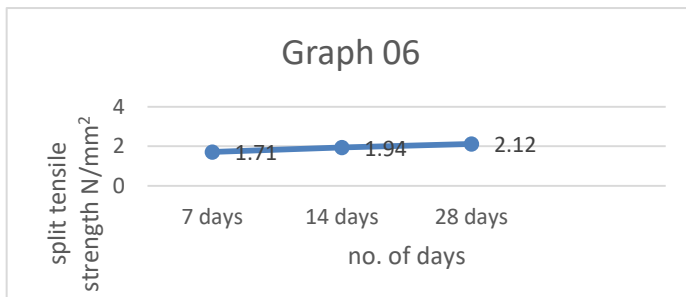
SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	6.2	24.89	27.11	29.78	67	0.81
2	1.0	12.5	26.67	29.44	34.22	73	0.86
3	1.5	18.75	24.40	28.33	31.44	87	0.89



2. Split tensile Test

The tensile test is carried out on a specimen cylindrical in shape. For tensile strength, cylinder of size 150mm diameter and 300mm height were casted. Cylinder for tensile strength are tested at 7 days, 14 days, and 28 days using compression testing machine.

Graph 6: Average split tensile strength of M25

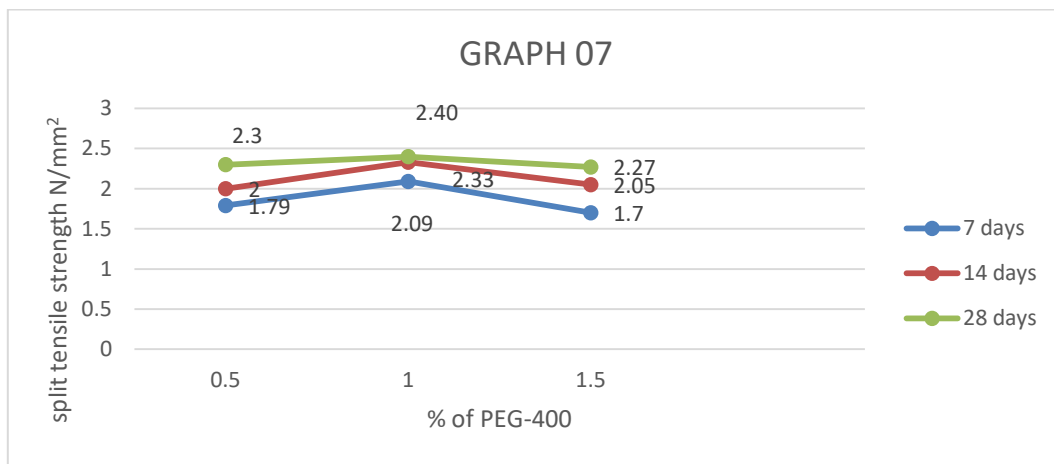


Mix ID	Average tensile strength (N/mm ²)		
Conventional concrete	7- days	14- days	28- days
	1.71	1.94	2.12



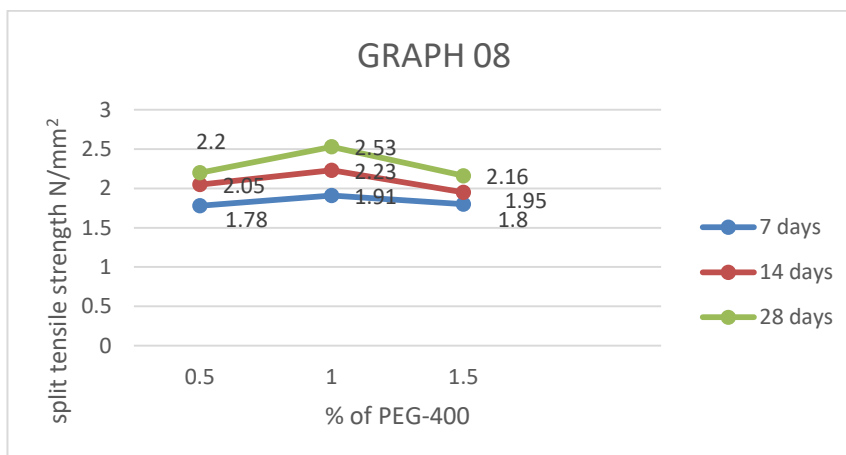
Graph 7: Average tensile strength of Natural sand with PEG-400 with fly ash 20%

SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	14	1.79	2.0	2.30	80	0.72
2	1.0	28	2.09	2.33	2.4	85	0.77
3	1.5	42	1.70	2.05	2.27	92	0.78



Graph 8: Average tensile strength of Manufactured sand with PEG-400 with fly ash 20 %

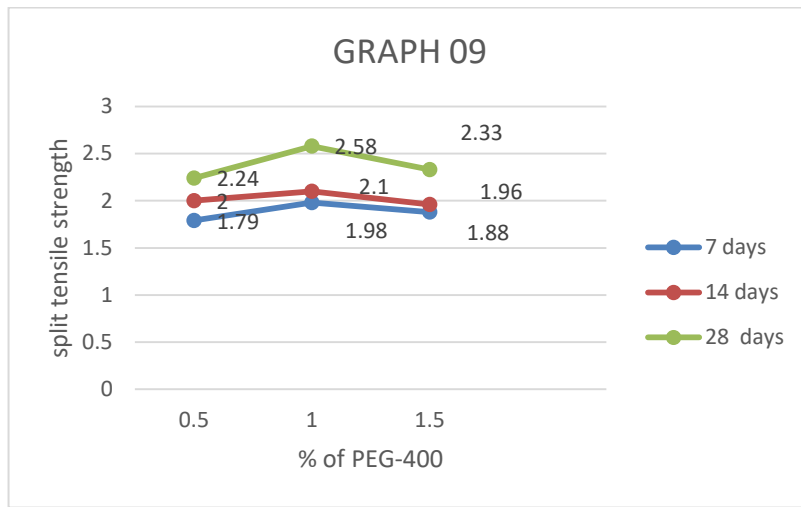
SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	13.8	1.78	2.05	2.2	70	0.76
2	1.0	27.6	1.91	2.23	2.53	82	0.79
3	1.5	41.4	1.80	1.95	2.16	91	0.82





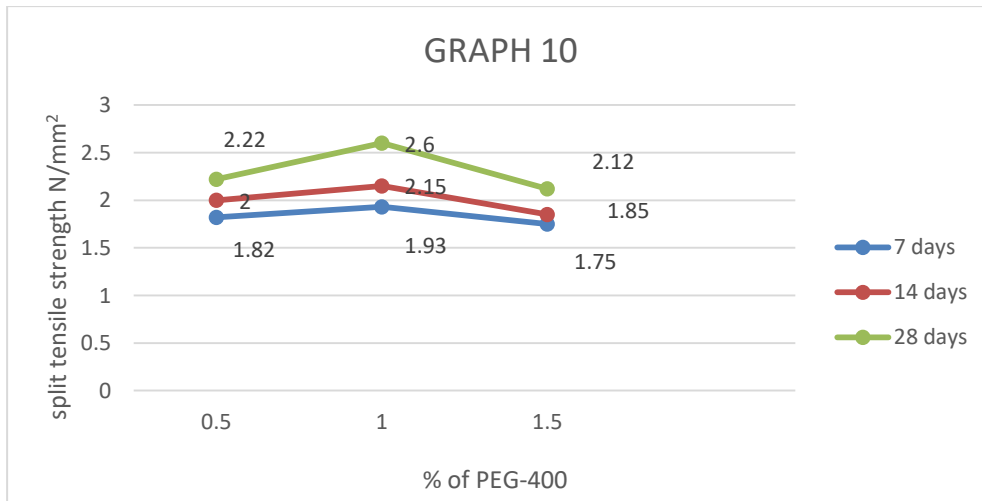
Graph 9: Average tensile strength of Natural sand with PEG-400

SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	6.4	1.79	2.0	2.24	65	0.72
2	1.0	12.8	1.98	2.10	2.58	72	0.73
3	1.5	19.2	1.88	1.96	2.33	83	0.79



Graph 10: Average tensile strength of Manufactured sand with PEG-400

SL.no	% of PEG-400	PEG-400 in ml	7 days N/mm ²	14 days N/mm ²	28 days N/mm ²	Slump in (mm)	Compaction factor
1	0.5	6.2	1.82	2.0	2.22	75	0.75
2	1.0	12.5	1.93	2.15	2.6	79	0.76
3	1.5	18.75	1.75	1.85	2.12	85	0.78



V. RESULT

- 1) The compressive strength of conventional concrete is 30.44 N/mm^2 which is less than (Natural sand + PEG-400 + fly ash 20%) i.e. 32.46 N/mm^2 and also compressive strength of concrete (Manufactured sand + PEG-400 + fly ash 20%) i.e. 33.05 N/mm^2 . Which are increased by 6.63% and 8.57%.
- 2) The compressive strength of concrete (Natural sand + PEG-400) is 33.33 N/mm^2 which is lesser than compressive strength of concrete (Manufactured sand + PEG-400) i.e. 34.22 N/mm^2 . Hence the compressive strength is increased by 2.67%.
- 3) The split tensile strength of conventional concrete is 2.12 N/mm^2 which is less than tensile strength of concrete (Natural sand + PEG-400 + fly ash 20%) is 2.4 N/mm^2 and also tensile strength of concrete (Manufactured sand + PEG-400 + fly ash 20%) i.e. 2.53 N/mm^2 . Which are increased by 13.20% and 19.33%.
- 4) The split tensile strength of concrete (Natural sand + PEG-400) is 2.58 N/mm^2 which is lesser than split tensile strength of concrete (Manufactured sand + PEG-400) i.e. 2.6 N/mm^2 . Hence the strength is increased by 5.1%.

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