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AN EXPERIMENTAL STUDY ON SELF CURING CONCRETE

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Abstract-Concrete is a mixture of cement, aggregates and water with or without admixtures. To attain desirable strength and other properties, curing is necessary. Curing is the process of maintaining the proper moisture content to promote optimum cement hydration immediately after placement. The main objective of this experimental investigation is to find out behavior of self-curing concrete. The experiments are designed by adding a shrinkage admixture(POLYETHYLENE GLYCOL-400)at different percentages such as 0%, 0.5%, 1%, 1.5%, 2% of cement content .The specimens are cured without water for 28 days and later different strength characteristics such as compressive strength, tensile strength are studied.

ADVANTAGES OF INTERNAL CURING

- Internal curing is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.
- Provides water to keep the relative humidity (RH) high, keeping self-desiccation from curing.
- Eliminates largely autogenous shrinkage.
- Maintains the strengths of mortar/concrete at the early age (12 to 72 hrs.) above the level where internally& externally induced strains can cause cracking
- Can make up for some of the deficiencies of external & internal curing, both human related (critical period when curing is required in the first 12 to 72 hours) and hydration.

MATERIALS REQUIRED AND ITS PROPERTIES

- Cement
- Aggregates
- Water
- Shrinkage admixture(Polyethylene Glycol-400)

PROPERTIES OF POLY ETHYLENE GLYCOL-400

S.NO	PROPERTIES	VALUES
1	Molecular weight	400
2	Appearance	Clear liquid
3	Specific gravity	2.25
4	pH	5-7

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5	Density	1.128 g/cm^3
6	Melting point	4 to 8^0 c

CONCRETE MIX DESIGN

Mix design for "M30"Grade

(a) Stipulations for Proportioning:

1. Grade designation M30
2. Type of cement OPC53gradeconforming to IS 8112
3. Type of admixture Polyethylene glycol-400
4. Maximum nominal size of aggregate 20mm
5. Minimum cement content 320kg/m3
6. Maximum water-cement ratio 0.45
7. Workability 100 mm(slump)
8. Exposure condition Severe (For plain Concrete)
9. Method of concrete placing Hand placing
10. Degree of supervision Good
11. Type of aggregate Sub angular aggregate
12. Maximum cement(OPC)content 414.58 kg/m3

(b) Test Data for Materials:

1. Cement used MAHA OPC 53grade
2. Specific gravity of cement 3.10
3. Specific gravity of coarse aggregate 2.85
4. Specific gravity of fine aggregate 2.68
5. Water absorption
   Coarse aggregate 0.5 %
   Fine aggregate 1.0 %
6. Free (surface) moisture
   Coarse aggregate Nil
   Fine aggregate Nil

7. Sieve analysis

Coarse aggregate

Nominal max Size of aggregate 20mm as per IS 383 Confirming to grading Zone-III of table 4 of IS-383

Fine aggregate

(c) Target Strength for Mix Proportioning

′ = ′ + 1.65S

Where,

′ = Target average compressive strength at 28 days,
F_{ck}' = Characteristics compressive strength at 28 days,

And S = Standard deviation.
From Table I, Standard Deviations = 5 / ².
Therefore, target strength = 30 + 1.65 5 = 38.25 / ².

(d) Selection of Water-Cement Ratio:

From Table 5 of IS 456, maximum water-cement ratio (see Note under 4.1) =0.45.

Based on experience, adopt water-cement ratio as 0.45.

Hence, Ok.

(e) Selection of Water Content:

From Table 2, maximum water content

For 20 mm aggregate = 186 liter (for 25 to 50 mm slump range)

Sub angular aggregates =186-10 =176 liter
Estimated water content for 75 mm slump = 176 + ($_{100}^{6}$) x176

= 186.56 liter

(f) Calculation of Cement:

Water-cement ratio = 0.45
Cement content = $\frac{186.56}{0.45}$ = 414.58kg/m^3

From Table 5 of IS 456, minimum cement content for 'Severe' exposure conditions = 320kg/m^3

414.58kg/m^3> 320 kg/m^3

Hence, ok.

(g) Proportion of volume of coarse aggregate fine aggregate content:

From Table 3, volume of coarse aggregate corresponding to20mm size aggregate and fine aggregate (Zone III)

For water-cement ratio of 0.45 = 0.65
Volume of fine aggregate content = 1 – 0.65 = 0.35

(h) Mix Calculations:

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = $1m^3$

b) Volume of cement = $\frac{\text{mass of cement}}{\text{Specific gravity of cement}}$ X 1/1000
c)

= $0.134\ m^3$

d) Volume of water = $\frac{\text{mass of water}}{\text{Specific gravity of water}}$ X 1/1000
e)

= $0.187\ m^3$

f) Volume of all in aggregate = a-(b+c)

= 1-(0.134+0.187)

= $0.679m^3$

g) Mass of coarse aggregate = d X Volume of coarse aggregate X Specific gravity of coarse aggregate X 1000

= 0.679 X 0.65 X 2.85 X 1000

= 1257.85 Kg

h) Mass of fine aggregate = d X Volume of coarse aggregate X Specific gravity of coarse aggregate X 1000

= 0.679X0.35X2.69X1000x

= 639.28 Kg

Material required for M30 grade concrete per one cubic meter quantity:

Material	Water	Cement	Fine aggregate	coarse aggregate
Kg/m ^{3}	186 . 56	414 . 58	639 . 28	1257 . 85
Ratio	0 . 45 :	1	: 1 . 54 :	3 . 04

Quantities of Each Mould in kg:

Mix proportions of M30 grade: **1: 1.54: 3.04**

Water cement ratio = 0.45

Air content = 2%

Specific gravity of cement sc = 3.10

Specific gravity of fine aggregate = 2.68

Specific gravity of coarse aggregate = 2.85
V = volume of each cube = $0.15 \times 0.15 \times 0.15 = 3.375 \times 10^{-3} m^3$
V = volume of each cylinder = $0.15 \times 0.15 \times 0.3 \times \frac{4}{} = 5.3 \times 10^{-3} m^3$

For cubes:

Cement=1.39kg

Fine aggregate=2.15kg

Coarse aggregates=4.24kg

Water=0.63liter

For cylinders:

Cement=2.19kg

Fine aggregate=3.38kg

Coarse aggregates=6.67kg

Water=0.99liter

Quantities of addition of PEG-400 to concrete mix:

PEG-400 is the shrinkage admixture which givesmorestrength when those are added to the concrete than the normal concrete mix. PEG-400 is added to the concrete mix in the proportions of 0.5, 1.0, 1.5, 2.0 percentages of the weight of cement.

Addition of PEG-400 in Proportions to the Concrete Mix

Percentage of PEG-400 (In cement content)	**Weight of cement content (gram)**	**Weight of PEG-400 (gram)**	**PEG-400 (Liter)**
0.5	414580	2072.9	1563.27
1.0	414580	4145.8	3126.54
1.5	414580	6218.7	4689.8
2.0	414580	8291.6	6253.09

RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH VALUES FOR SELF CURING CONCRETE BY USING PEG-400

Cubes:

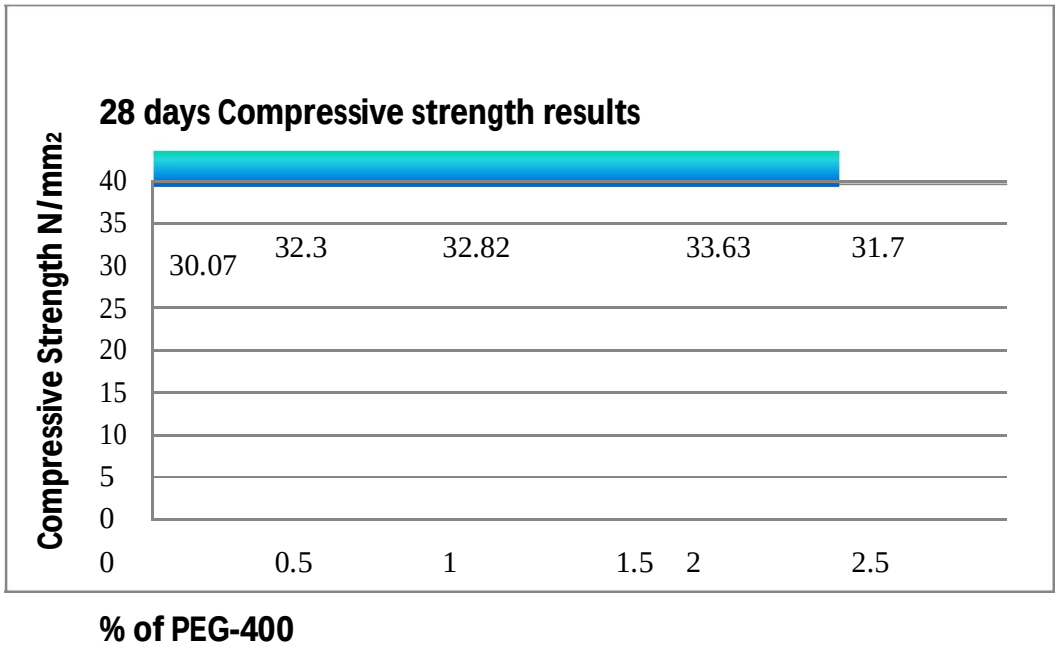
7-Days compressive strength results

S.NO	**Adding of PEG-400 in percentage weight of cement**	**Compressive strength (MPa)**
1	0	22.07
2	0.5	24.44

3	1.0	25.04
4	1.5	25.63
5	2.0	23.41

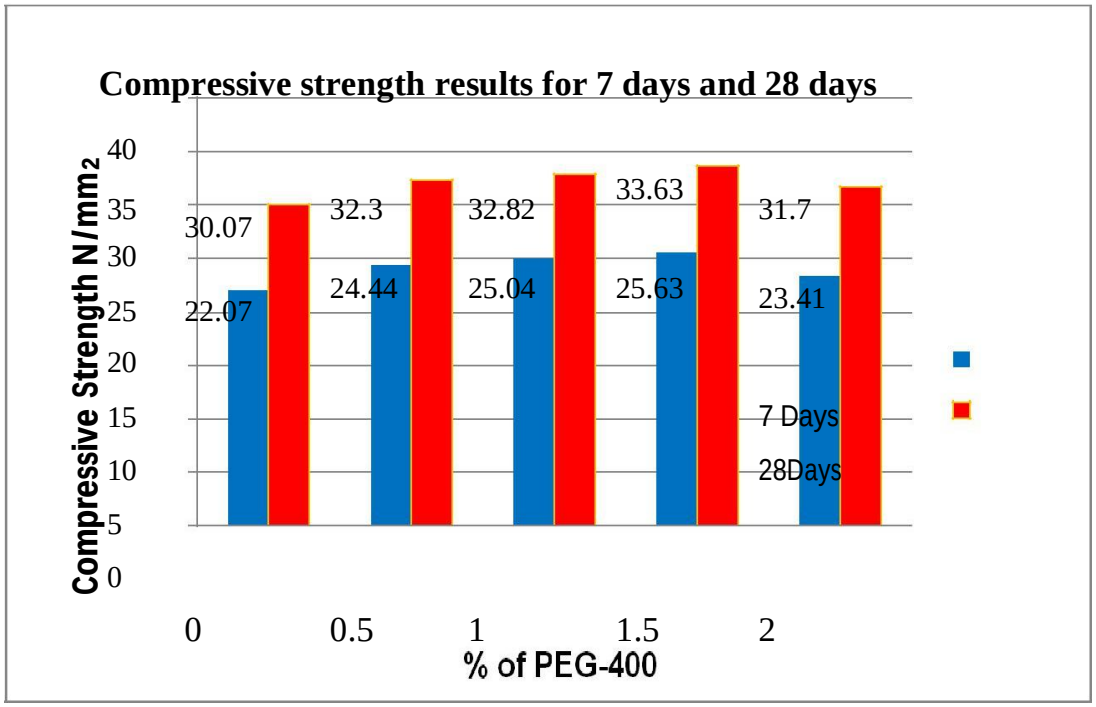
28-Days compressive strength results

S.NO	Adding of PEG-400 in percentage weight of cement	Compressive Strength (MPa)
1	0	30.07
2	0.5	32.30
3	1.0	32.82
4	1.5	33.63
5	2.0	31.7



Compressive strength results for self-curing concrete by using PEG-400

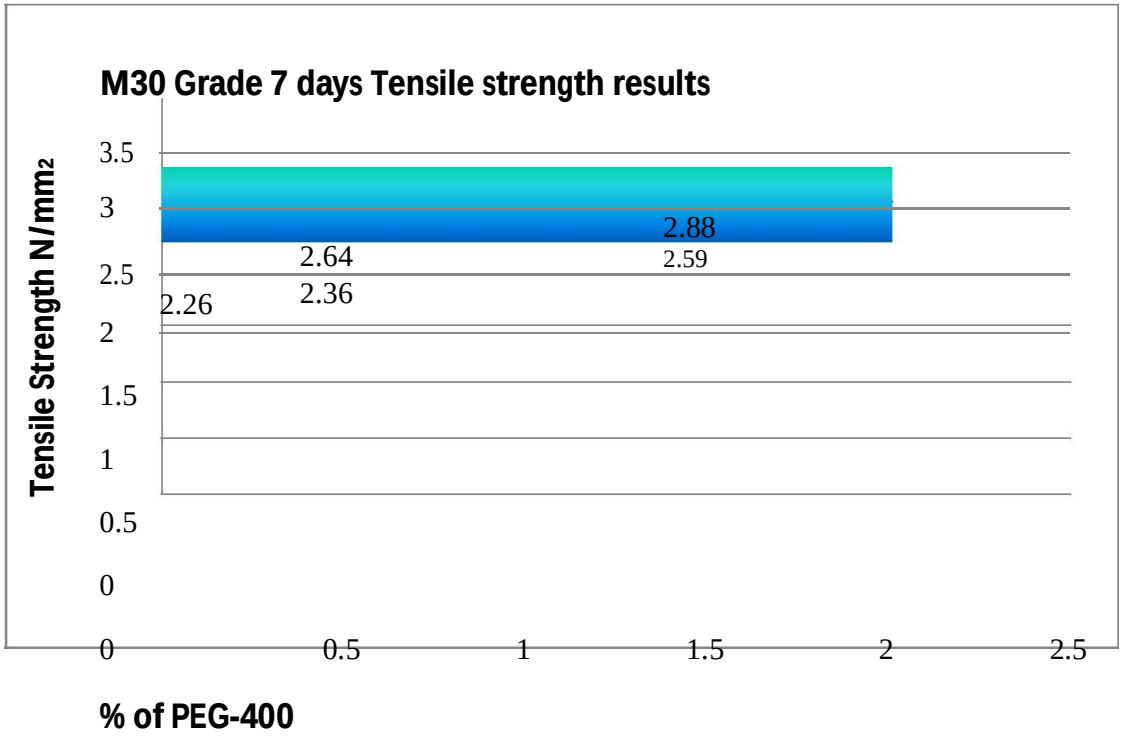
S.NO	Adding of PEG-400 in percentage weight of cement	7 Days	28 Days
1	0	22.07	30.07
2	0.5	24.44	32.30
3	1.0	25.04	32.82
4	1.5	25.63	33.63
5	2.0	23.41	31.7



Cylinders:

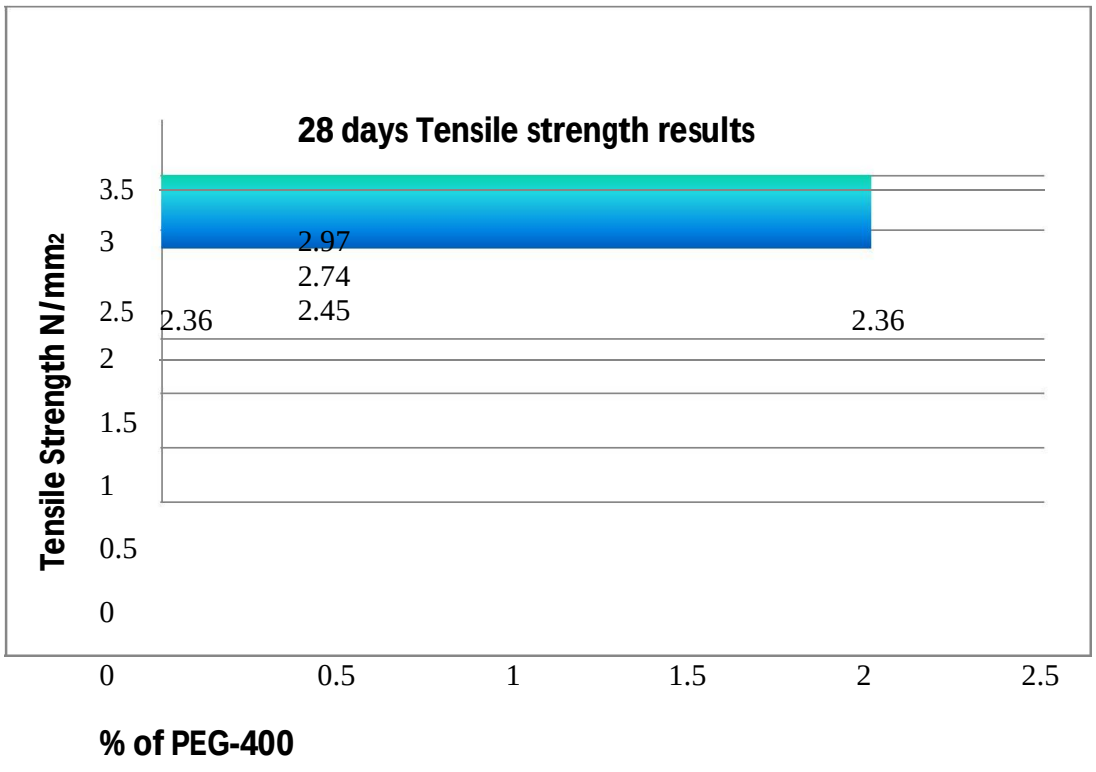
7-Days Tensile strength results

S.NO	Adding of PEG-400 in percentage weight of cement	Compressive Strength (MPa)
1	0	2.26
2	0.5	2.36
3	1.0	2.64
4	1.5	2.88
5	2.0	2.59



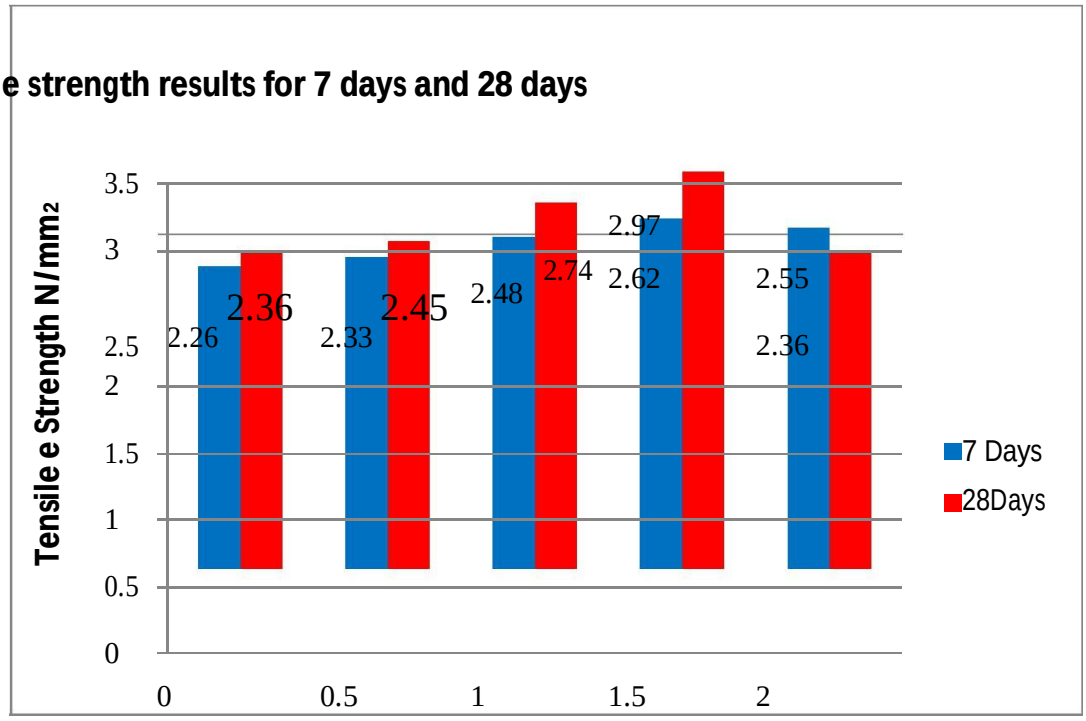
28-Days Tensile strength results

S.NO	Adding of PEG-400 in percentage weight of cement	Compressive Strength (MPa)
1	0	2.36
2	0.5	2.45
3	1.0	2.74
4	1.5	2.97
5	2.0	2.36



Tensile strength results for self-curing concrete by using PEG-400

S.NO	Adding of PEG-400 in percentage weight of cement	7 Days	28 Days
1	0	2.26	2.36
2	0.5	2.36	2.45
3	1.0	2.64	2.74
4	1.5	2.88	2.97
5	2.0	2.59	2.36



CONCLUSIONS

- From the above study we conclude that the compressive strength of the concrete cubes has gradually increased up to adding admixture of 1.5% of cement by PEG-400.
- Compared to compressive strength of 0.5%, 1.0% and 1.5% adding admixture of cement by PEG-400, the compressive strength of 2.0% PEG-400 concrete has been decreased.
- Whereas comparing to traditional concrete, compressive strength of concrete has been increased by adding 1.5% of cement by PEG-400.
- Hence for economical view 2.0% adding admixture is preferable and in the perspective of compressive strength 1.5% adding is suggested.
- The gain in compressive strength is improved depending upon the adding admixture level of PEG-400 in weight of cement.
- The shrinkage admixture (PEG-400) inclusion generally improves tensile strength, compressive strength and also increases the service life of concrete structures.

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