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THE STUDY OF THE EFFECT OF POLYVINYL CHLORIDE ON THE CONCRETE FOR ROAD WORK

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ABSTRACT

India has a road network of over 4,689,842 kilometers in 2013, the second largest road network in the world. The economic growth of country depends upon efficient road network. It is the duty of highway engineer to keep pavements in traffic worthy state by keeping pace with the rapid expansion and strengthening of the road network but they are having difficulty to keep the roads in good condition. Therefore road construction in our country will be a never ending process, with pavement strengthening to be a major activity for many years to come. Rigid pavements which are designed on the basis of flexural strength of cement concrete. However, when such pavements are constructed, the mix design of concrete is based on the compressive strength, which is used to ensure that the target flexural strength as envisaged in design is achieved in practice, though costly in initial investment, is cheap in long run because of low maintenance costs. The concrete flexural strength and compressive strength can be improved by addition of polymers in suitable dosages of 0.2 % and 0.4% in place of cement compared to normal concrete mix.

KEYWORDS: Polyvinyl Chloride (PVC), Concrete Mix Design, Compressive Strength, Flexural Strength**,** Slump Test

INTRODUCTION

Road transport in India is the dominant mode of transport accounting for 65% of freight movement and 85% of passenger traffic. Spectral growth has shown a growth owing to the strength of a huge domestic market, rapidly growing purchasing power, market-linked exchange rate and well-established market and corporate governance laws. Rigid pavement due to hard surface are fuel efficient, have good riding quality, increased load carrying capacity and have very low maintenance cost compared to the flexible pavements.

Several types of concrete pavements have been used in different countries depending upon the climate, availability of materials, soil types, experience and traffic. mix

design of concrete pavement start with the laboratory tests commence by finding physical properties of cement, aggregate, sand which must satisfy the requirement as per relevant IS codes. After that conventional concrete mix design test containing admixtures has been carried out to determine the compressive strength and flexural strength of cement concrete cube with normal mix at 7 days and 28 days. Comparison between concrete mix without polymer and concrete mix with polymers added in doses of 0.2% to 0.4% content in place of cement, to determine the compressive strength and flexural strength which is of utmost important to the highway engineers.

EXPERIMENTAL PROGRAM:

The basic properties of material are evaluated out for mix design and are taken into consideration in this paper. The experimental programmed was under taken to the standard concrete cube of size (150 × 150 × 150) mm for compressive strength of concrete and standard concrete beam of size (150 × 150 × 700) mm for flexural strength of concrete with an aim to compare the flexural strength and compressive strength of hardened concrete. Compare the flexural strength and compressive strength of concrete with and without polyvinyl chloride (PVC) resin powder. Concrete mix for **M – 40** grades was designed as per IRC: 44-2008. Due care is taken to follow codal provisions IS 516 (1959).

MATERIAL USED

CEMENT:

Concrete cubes and beams are casted using Ambuja OPC 53 grade cement. The basic properties of cement are evaluated in the laboratory satisfying relevant codal practice.

Table: 1.Properties of cement

Sr. No.	Characteristics	Result	Limitation As per IS code
1	Fineness	3.93 gm	< 10 gm.
2	Normal consistency	29%	-
3	Initial setting time	145 minute	30 min. Minimum
4	Final setting time	377 minute	600 min. Maximum
5	Specific gravity	3.15	-
6	Compressive strength at 28 days	54.2 N / mm^2	53 N / mm^2

FINE AGGREGATE:

The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate also assists the cement paste to hold the coarse aggregate particles in suspension. The fine aggregate used for the experimental programmed was locally procured and conformed to Indian standard specification IS: 383 – 1970. Sieve analysis is carried out to determine the zone for which the grading of sand is suitable (table: 2) correspondingly properties of fine aggregate are also worked out in the laboratory's shown in table 2.

Table: 2.Sieve analysis of fine aggregate

I.S. sieve size (mm)	Weight retained (gm)	% retained	Cumulative % retained	% passing	Specification of Fine Aggregate as per IS : 383 (Per cent Passing)			
					Zone-1	Zone-2	Zone-3	Zone-4
10	00	00	00	100	100	**100**	100	100
4.75	221	9.88	9.88	90.12	90-100	**90-100**	90-100	95-100
2.36	173	7.74	17.62	82.37	60-95	**75-100**	85-100	95-100
1.18	345	15.43	33.05	66.94	30-70	**55-90**	75-100	90-100
0.6	584	26.12	59.17	40.82	15-34	**35-59**	60-79	80-100
0.3	673	30.11	89.28	10.71	5-20	**8-30**	12-40	15-50
0.15	178	7.96	97.24	2.75	0-10	**0-10**	0-10	0-15

Table: 3.Properties of fine aggregate

Sr. No.	Characteristics	Result	Limitation As per IS code
1	Type	Natural	-
2	Specific Gravity	2.605	-
3	Water absorption	1.23%	2%
4	Fineness modulus	2.69	-
5	Grading zone	Zone - II	-

The fineness modulus represents the massed average size of the sieve on which material is retained; the sand is of medium category. As the grading zone falls in 2nd, the sand is normal one.

COARSE AGGREGATE:

The aggregate occupy a significant volume of concrete and hence their influence on various properties of concrete is considerable. Properties of aggregates greatly affect the properties of concrete such as workability, strength, durability and economy. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate.

Table: 4.Combined sieve analysis of coarse aggregate

`I.S. Sieve size (mm)	% of Passing		% of Mix proportion		Total % of Passing	Specification Limits as per IS:383 - 1970
	20 mm	10 mm	20 mm	10 mm		
			50%	50%		
40	100	100	50	50	100	100
20	94.95	100	47.48	50	97.48	95-100
10	5.12	91.79	2.56	45.90	48.46	25-55
4.75	0.54	11.38	0.27	5.69	5.96	0-10

Table: 5.Properties of coarse aggregate

Sr. No.	Characteristics	Result	Limitation as per IS code
1	Type	Crushed angular aggregate	-
2	Maximum size	25 mm	-
3	Specific gravity	2.827	-
4	Water absorption	0.985%	< 2%
5	Crushing value	17.70%	< 30%
6	Impact value	14.45%	< 30%
7	Los Angeles abrasion test	17.3%	< 30%
8	Shape test (combined Index)	24 %	< 30%

POLYVINYL CHLORIDE RESIN POWDER:

Polyvinyl chloride (PVC) is a versatile polymer which can be added easily by weight of cement during dry mix. Water in required quantity causes changes in property of mix. The density of material depend on its morphology, particle structure and particle size distribution. PVC is made up of many vinyl chloride molecules that, linked together, form a polymer (**C_2H_3Cl**)n. Properties of PVC are shown in table specified by supplier.

Table: 6.Properties of polyvinyl chloride resin powder

Sr. No.	Properties	Specification
1	Type	Rigid pvc
2	External appearance	White powder
3	Specific gravity	1.4 (20ºC)
4	Density	1.45 g / cm^3
5	Compressive strength	65.50 N / mm^2
6	Flexural strength	72.40 N / mm^2

ADMIXTURE

Rheobuild 1126 is composed of synthetic polymers specially designed to allow considerable reduction of mixing water while maintaining control on extend of set retardation. It also has good dispersion quality, High workability for longer periods, and resistance to segregation even at high workability, reduced water content for a given workability and increased ease in finishing concrete. It is added 0.9 % by weight of cement in concrete.

WATER:

Water suitable for drinking is usually good enough for concrete and is used in the study.

CONCRETE MIX DESIGN M-40 GRADE (IRC: 44 - 2008)

The PQC mix proportion (dry weight in kg)

Material	Quantity 1 m^3	Quantity 0.1305 m^3
Cement	416	54.28
Water	179	23.35
Sand	690	90.00
Aggregate (20 mm)	613	80.00
Aggregate (10 mm)	613	80.00
Admixture	3.74	0.49

MEASUREMENT OF WORKABILITY BY SLUMP TEST:

SLUMP TEST:

The slump test is time honored ritual in concrete technology for knowing the consistency and uniformity of mix. It is dependent on aggregate moisture content, concrete temperature and mixing. One can determine the mixture's vulnerability to segregation when placed. Slump test fulfills the criteria's laid down in MoRTH cl. 602.3.4.2

Table: 7.Result of slump test

	Normal concrete	0.2% polyvinyl chloride	0.4% polyvinyl chloride
Required	30 ± 15	30 ± 15	30 ± 15
Initial	57	55	56
After 30 min	45	45	48
After 60 min	32	35	34
After 90 min	25	28	24

COMPRESSIVE STRENGTH:

Compressive strength test indicates the load carrying capacity by the hardened concrete mix. Hence the concrete mixtures can be designed to meet the mechanical and durable properties for the structure. Specimens are tested at the ages of 7 and 28 days. To state the compressive strength make average of

strengths of three specimens. The individual variation should not be more than ± 15 percent of the average as per codal practice.

Table: 8.Compressive strength of concrete

Sr. No.	Description	7 days Avg. Comp. Strength of concrete (N/mm^2)	28 days Avg. Comp. Strength of concrete (N/mm^2)
1	Normal Concrete Mix design	38.52	53.53
2	Concrete Mix design with 0.2% polyvinyl chloride in place of Cement	39.39	54.89
3	Concrete Mix design with 0.4% polyvinyl chloride in place of Cement	41.04	55.76

FLEXURAL STRENGTH

Flexural strength is the ability of a beam or slab to resist failure in bending. It is a measure of an unreinforced concrete beam to resist failure in bending. The flexural strength of the specimen is expressed as the modulus of rupture f_{cr}

Let **a** be the distance between the lines of the tensile side of the specimen. Then, for finding modulus of rupture, there will be two cases should be considered.

CASE (I): When, a > 200 mm for 150 mm specimen

$$f_{cr} = P.L / bd^2$$

Where,

P = fracture load for beam b = width of the beam

d = depth of the beam. L = span

CASE (II): When, 170 mm < a <200mm for 150 mm specimen

$$f_{cr} = 3P. a / bd^2$$

- In my study the second case was found to be suitable.

Table: 9.Flexural strength of Concrete

Sr. No.	Description	7 days Avg. Flexural strength N/mm^2	28 days Avg. Flexural strength N/mm^2
1	Normal Concrete Mix design	3.82	5.24
2	Concrete Mix design with 0.2% polyvinyl chloride in place of Cement	3.97	5.42
3	Concrete Mix design with 0.4% polyvinyl chloride in place of Cement	4.30	5.75

CONCLUSIONS:

Flexural strength can be used for design purposes, but the corresponding compressive strength used to order and accept the concrete is a must. This study has been made to determine the influence of polyvinyl chloride powder in suitable doses on strength of concrete. The laboratory investigations gave the following conclusions:

- The concrete is to be transported from the place of ready mix by mobility to the place of placing the mix for road work; accordingly the slump time needs to be worked out. Both 0.2% poly vinyl chloride & 0.4**%** polyvinyl chloride satisfy the criteria are laid down in MoRTH cl. 602.3.4.2.
- compressive strength of concrete at 7 days increase 1.70% by adding 0.2% poly vinyl chloride, 6.15% by adding 0.4% poly vinyl chloride, compressive strength of concrete at 28 days increase shows 2.48% by adding 0.2%poly vinyl chloride, 4.0% by adding 0.4% poly vinyl chloride. This indicates that compressive strength increases by the addition of poly vinyl chlorid**e.**
- Flexural strength of concrete at 7 days increase 3.77% by adding 0.2% poly vinyl chloride, 10.94% by adding 0.4% poly vinyl chloride and the flexural strength of concrete at 28 days increase 3.32% by adding 0.2%poly vinyl chloride, 8.87% by adding 0.4% poly vinyl chloride. The tests shows significance rise in flexural strength.

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