

# AN EXPERIMENTAL INVESTIGATION ON CEMENT CONCRETE WITH PVC POWDER AS PARTIAL REPLACEMENT TO CEMENT

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**Abstract** - The aim of the present paper is to show the effect of cement modifier behaviors in PVC materials. The PVC and the Portland cement are important materials in the industrial area. It can reach excellent properties if mixing the two materials with each other. The cement worked as filler in PVC, as shown the mechanical tests. The oxygen index was determined, accordingly the result show higher oxygen index value. That means the blend shows higher fire resistance comparing to neat PVC. The cement worked as a structural modifier, it caused modification in the blends structure and properties. The research presented in this paper shows that the cement mixed with PVC shows higher stability, fire resistance and similar mechanical properties as rigid PVC. For this experiment were carried out to measure and study fresh and hardened properties of the M30 grade of concrete with PVC powder. The cement was replaced at dosages of **12.5%** and **15%**. The physical properties (density, workability and water absorption), mechanical properties (Split tensile and compressive strength) were found and

studied. Results indicate that the performance of concrete in terms of all the above stated parameters is within acceptable limits as per the codes.

**Key Words:** *Concrete, PVC powder, compressive strength, Oxygen Index, Fire Resistance.*

## 1.0 Introduction

Concrete is one of the construction material which consists of cement, fine aggregate or M-sand, coarse aggregate and water. Concrete is heavy and 5% of the world's CO<sub>2</sub> is created during the manufacture of the cement that goes into the concrete. Hence in order to overcome this disadvantage a new type of concrete is introduced. That is cement concrete with PVC powder as partial replacement to cement. In this type of concrete in which some amount of the cement is replaced by the PVC powder which are made by the PVC powder, which gives the good fire resistance to the building. Out of the total cost of house construction, building materials contribute

to about 70 percent of the cost in developing countries like India. Therefore, the need of the hour is replacement of costly and scarce conventional building materials by innovative, cost effective and environment friendly alternate building materials. Concrete is a mixture of naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. Cement is occupied second place as most used material in the world after water. The rapid production of cement creates big problems to environment. First environment problem is emission of CO<sub>2</sub> during the production process of the cement. The CO<sub>2</sub> emission is very harmful which creates big changes in environment.

### 1.1 Binding Materials

Cement or limes are used as the binding material. They bind the individual units of fine aggregate and coarse aggregate by virtue of its properties of setting or hardening in combination with water. The binding material helps to fill voids and imparts density to concrete.

### 1.2 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter.

### PVC Powder

Polyvinyl Chloride (PVC) that is a widely used thermoplastic polymer. Polyvinyl Chloride (PVC) finds application in diverse construction

applications. We procure superior quality Polyvinyl Chloride (PVC) from reliable manufacturers across the country. It has been observed that the composites reinforced with PVC are more advantageous in terms of post-cracking behavior, good fire resistance and load carrying capacity



*Fig.1.PVC powder*

### 1.3. Coarse Aggregate

It is the main filler and forms the bulk of concrete, broken stones, broken bricks and gravels are generally used as coarse aggregates. Granite, basalt are also excellent coarse aggregate. Crushing strength, sand water tightness of concrete and its resistance to wear and tear depend upon the aggregates. The aggregate should be clean, dense, hard, strong, durable and sound.

### 1.4. Water

Water facilitates the spreading of cement over the aggregate and regulates the consistency. Water used should be clean. Sea water should not be used as it retards setting.

### 1.5. Properties of Materials

#### 1.5.1. Cement

- Initial testing time should be less than 30 minutes.
- Final setting time should not more than 10Hrs.
- Compression strength after 7 days should not less than 22N/mm<sup>2</sup>.
- Tensile strength after 7 days should be 2.5 N/mm<sup>2</sup>.
- By I.S 90 micron sieve, residue by weight should not exceed 10%.
- Ratio of percentage alumina to that iron oxide should not be less than 0.65%.
- Weight of magnesia should not exceed 5%.
- Weight of insoluble residue should not be greater than 1.50%.

#### 1.5.2 Fine Aggregate

- It should be clean and coarse.
- It should be free from any organic or vegetable matter; usually 3-4% clay is permitted.
- It should be chemically inert
- It should contain sharp, angular, coarse and durable grains.
- It should not contain salts which attracts moisture from the atmosphere.
- It should be well grade; it should contain particles of various sizes in suitable proportions.
- It should be strong and durable.
- It should be clean and free from coating of clay and silt.

#### 1.5.3 Coarse Aggregate

- It should be contain sharp, angular, coarse and durable grains.
- It should be clean and free from coatings of clay and slit.
- It should be strong and durable.
- It should be free from any organic or vegetables matter; usually 3-4% clay is permitted.
- It should be clean and coarse.

### 2.0 Material Testing and Results

**Cement:** Ordinary Portland cement of 53 grades is taken for the test and the results are follows;

S.No	Brand Name	Test	Results
1	OPC	Fineness	4%
2	OPC	Initial Setting Time	30 min
3	OPC	Final Setting Time	480min/8Hrs
4	OPC	Normal Consistency	32%

Table 1: Cement Tests and Results

#### Sand, Coarse Aggregate and PVC Powder

Pycnometer apparatus is used to measure specific gravity and bulk density, fineness modulus of aggregate is found by using set of sieves.

S.NO	Properties	Specific Gravity
1	Cement	3.15
2	Fine Aggregate	2.65
3	Coarse Aggregate	2.75
4	PVC powder	2.4

Table 2: Test Results of Sand, Coarse and Fine aggregate



FIG.2. Specific gravity of PVC

**Test Setup and Procedure for Compressive Strength**

- Testing is done after 7 days 28 days, the days taken into account is from the time of water added to the ingredients.
- Test a minimum of 3 specimens at a time.
- Test the specimen immediately after taking it from the water and while they are in wet condition, wipe of the surface water. If the specimen received and dry, then keep them in water for 24hours before testing.
- Note down the dimension nearest to 02.mm and also note down height 1.



Fig.3.Compressive Strength test on Cube

**Conducting Experiment**

- Place the specimen in such manner that load shall be applied to opposite side of cubes.
- Align carefully, at the Centre of the thrust of the spherically seated plate.
- Apply the loads slowly and at the rate of 140Kg/cm<sup>2</sup> per min till the cube breaks.

Note down the maximum load and appearance of the concrete failure.

**Results and Discussion**

The compressive strength of concrete using PVC was found and the results are discussed.

PVC in %	Compressive Strength MPa(N/mm <sup>2</sup> )		
	7 days	14 days	28 days
0	22.13	30.81	31.19
12.5	24.49	29.83	33.58
15	23.06	27.56	29.18

Table 3: Results of Compression Tests on Concrete

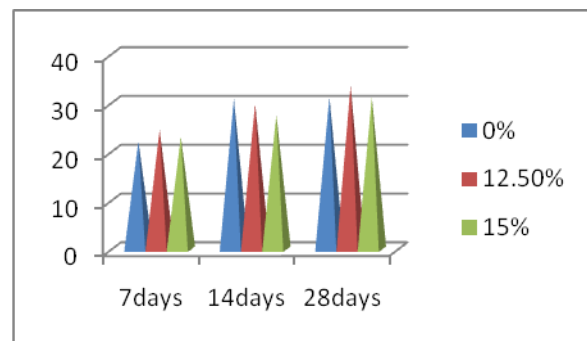


Fig .4.Comparison of Compressive Strength of 7,14& 28 Days Curing

PVC in %	Split Tensile StrengthMPa(N/mm <sup>2</sup> )		
	7 days	14 days	28 days
0	2.23	3.56	3.92
12.5	2.49	3.0	5.08
15	2.35	3.01	4.12

Table 3: Results of Split Tensile Tests on Concrete

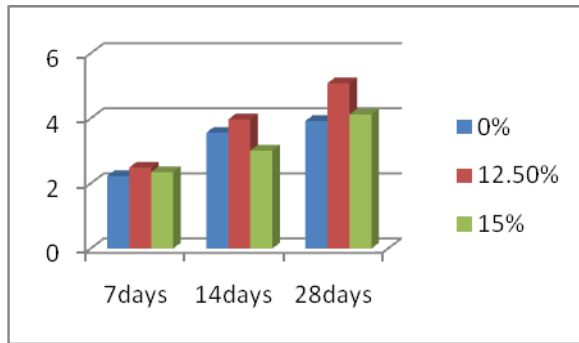


Fig .5.Comparison of Compressive Strength of 7,14& 28 Days Curing

### Conclusion

The effectiveness of internal curing by means of PVC applied to concrete is higher when 45 kg/m<sup>3</sup> water is added by means of 1kg/m<sup>3</sup> of PVC. The self-cured concrete using PVC was more economical than conventional cured concrete. The performance of the self-curing agent is mainly affected by the cement content and w/c ratio. Concrete is casted for 7 days, 14 days and 28 days with PVC of 0%, 12.5%, 15% was casted with M30 grade, which gives a slump value of 100mm which produce greater workability in a gradually increase of with PVC of 0%, 12.5% and 15%. The optimum value of compressive strength of Self curing concrete with PVC of 12.5% for 7 days, 14 days and 28 days for curing period, which was 5 to 10 % gradual increase in PVC of 0%, 12.5% and slight decrease in PVC 15%. Also, the optimum value of split tensile strength of concrete with PVC of 12.5% 7 days, 14 days and 28 days for curing period, which was 4 to 8 % gradual increase in PVC of 0% and 12.5% and decrease in PVC 15%.

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