Experimental Study on Compressive Strength of the Cement Mortar Cubes with Partial Replacement of Fine Aggregate Using Polyvinyl Chloride (PVC) Plastic

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Abstract:- Mortar is a material that consists of cement and sand with a range of applications in the construction industry. However, the plain mortar materials are usually brittle and often crack and fail more suddenly than reinforced mortar. This experimental study is about the compressive strength of cement mortar stabilised with the use of the polyvinyl chloride (PVC) plastic powder. Generally the compressive strength of cement mortar of mix proportion (1:3) is 33 N/mm² to 53 N/mm² has been obtained after 28 days curing. The cement mortar ratio is 1: 3 respectively. The PVC powder is added along with the sand with percentages of 0%, 2.5%, 5%, 7.5%, 10% respectively.

And the water cement ratio is 0.5 with volume. The moulds of 70×70×70 mm size were used for the cube test, and the cubes were tested on the Compressive testing machine to determine the strength of cube for 3, 7, 28 days of time period respectively. The main aim of f this study to determine the compressive strength of cement mortar (1:3) of sand added with PVC powder,

Key Words:- Waste Plastic, Polyvinyl Chloride, Compressive Strength, Mortar.

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1. INTRODUCTION:-

1.1.Objective:-

1. The main objective of this experiment is to increase the strength of the cement mortar.
2. The PVC which has the high strength can be useful to mix in cement mortar to increase the strength.
3. The quantity of the fine aggregate is also gets reduced in the case of increase in PVC powder in the cement mortar.
4. The PVC is used up to only certain limit at where the excess main lead to the failure of mortar.
5. This PVC added cement mortar can be used at low line constructions which may useful to people economically.
6. To bind masonry blocks like stones, bricks and to plaster slabs and walls.
7. It is also used to prepare concrete blocks, to fill joints and cracks in walls and as a filler material in stone masonry and ferro-cement works.

1.2. Characterization of materials:-

1. **Polyvinyl Chloride**
2. **Cement**
3. **Sand**

Polyvinyl Chloride:

Polyvinyl Chloride (PVC) Polyvinyl chloride is a thermoplastics material which consists of PVC resin compounded with varying proportions of stabilisers, lubricants, fillers, pigments, plasticisers and processing aids. Different compounds of these ingredients have been developed to obtain specific groups of properties for different applications

However, the major part of each compound is PVC is PVC resin. The technical terminology for PVC in organic chemistry is poly (vinyl chloride): a polymer, ie chained molecules, of vinyl chloride. The brackets are not used in common literature and the name is commonly abbreviated to PVC.

- Density : 1.35 – 1.45 g/cm^3.

Cement:

The most common material used in the construction industry is ordinary Portland cement conforming to IS 12269-1987. This is made by heating limestone with small quantities of other materials. The cement reacted as binding to other materials, like cement mortar, cement concrete etc.

Fine aggregate:

River sand is the most common fine aggregate used in the Cement mortar. Aggregate which is passing through 475 IS sieve and retained on 75 microns (1.075 mm) IS sieve i9s termed as fine aggregate The sand used for experimental program was locally procured and conforming to zone n. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm. The fine aggregate was subjected to particle size distribution test was carried out in laboratory as per IS 383-970 and results were provided.

- Density of fine aggregate (g/cm³) : Typically around 2.64 g/cm^3.

Water:

Water should be clear, portable fresh water with pH value 7 to 8 which is free from organic matters for durability.

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2. LITERATURE REVIEW :-

I.M. AHO (2015):

From this study, the effect of the Raffia palm fruit peel has a mortar stabilizing agent has been presented. It could be concluded that reinforcing mortar beams with raffia palm fruit fibers improved the flexural strength but resulted in compressive strength at percentage composition of RPFP of 4% and above. This type of mortar were adequate enough for the construction of lightweight structural elements.

BALA MOHAN BALA KRISHNAN (2016):

This experimental study shows the flow properties and strength behavior of masonry mortar incorporating high volume fly ash. In this study masonry mortar incorporating high volume fly ash was made and tested for flow and strength behavior. The results obtained and the observation made indicate that the use of fly ash in making masonry mortar is highly promising. The high volume fly ash not only improved the flow properties of the mortar, but also increased compressive strength.

D.N. GOMEZ-BALBUENA (2018):

In this study they discussed about the polymer cement mortar with quarry waste as sand replacement It is concluded that the polymer material uses low amounts of cement with respect to the traditional mortar, ands it is elaborated with the recycled quarry as they are presented un its granulometry, which saves the process of size selection.

BALA MURALI KRISHNA (2021):

In this study they conducted the effect of addition of alccofine on the compressive strength of cement mortar cubes. The main objective of this experiment is a total twenty different combinations with Ordinary Portland cement, Portland Pozzolana cement, Ennore sand, River sand and Alccofine with different dosages were investigated in terms of compressive strength of cement mortar cubes. Among the different twenty combinations the maximum compressive strength of cement mortar cubes is achieved by using AL. 10% (OPC AF ES) of the volume of cement is 53.12 N/mm².

YANIKA AOCHAROEN (2021):

This study was about compressive mechanical properties of cement mortar containing recycled high-density polyethylene aggregates (stress-strain) relationship. They evaluate the effects of HDPE sand used as a a substitute for natural sand on the mechanical properties and stress strain relationships of cement mortar at the ages of 7 and 28 days.

L ARUN (2021):

In this paper, characteristics of high strength stone masonry using cement soil mortar are conducted. The compressive strength and geological characteristics of stones from different locations have been experimentally studied. Sixteen types of stones brought from different locations have been considered in this study. The compressive strength and shear bond strength of each stone has been determined through masonry prisms.

ALESSANDRA MERLO (2021):

This work focused on the recycling of WEEE plastic waste as a partial substitute for aggregate in light mortars. The explanation of this phenomenon was found in both the scarce mechanical properties of the used plastic and in the poor adhesion between the matris and plastic that resulted in the extra porosity, are also demonstrated by comparing the results with several models in the literature.

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3. CHARACTERIZATION OF MATERIALS:-

1. Proportioning
2. Mixing
3. Moulding
4. Settling
5. Curing
6. Drying

3.1 Proportioning:-

Proportioning is known as taking or calculating the percentage/quantity of the required materials as per the taken mix mix ratio mix proportion. According proportion we have taken 1:3 ratio. As per er the 1: 3 ratio 1 is proportion of cement and 3 is proportion of fine aggregate.

3.2 Mixing:-

The mixing of 2 or 3 materials into a single material is known mixing of materials. Each type of mortar mix contains different quantities of materials. Be sure to use the correct type of mortar mix for the application. As per mix ratio and type of work the cement and fine aggregate is taken for the mixing with small amount of adding to it. By using the manpower to mixer the mortar for 15 minutes time period.

3.3 Moulding:-

We are taking the size of mould is 70*70*70mm because of availability of moulds. Then, placed the mixer into the moulds by the layers and gives the 20 blows to each layer for Ssec by using of tamping rod. After finishing of compacting, then vibrating the moulds to remove the voids and pores. Those moulds are placed in sunlight and required temperature for 24 hours

3.4 Settling:-

After the moulding process completed the moulded cubes were demoulded after 24 hrs of period. After the demoulding the cubes, the cubes are placed in the order and checked for the cracks, dampness and shape. If the cubes were free from cracks, dampness and in regular shape, then it is confirmed that the cubes are settled in the moulds Placed it also at sunlight because of remove of moisture content in cubes

3.5 Curing:-

After the demoulding The weight of the cubes were taken by the weighing machine. After that the cubes were placed in the water for 28 days for curing. As per time period the curing are conducted 3 days, 7 days and 28 days. For the best result of compressive strength.

3.6 Drying:-

After the curing process completed the cubes were taken out respectively for 3, 7, 28 days. The cubes are kept at a room temperature or in sunlight, to get dry. And again the dried cubes weight is taken by the weighing machine. And this will helps in known the water absorption of the cubes.

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4. TEST CONDUCTED ON CEMENT MORTAR CUBES:-

4.1 Compressive strength test on normal mortar cubes (0% of PVC Powder):

S.No	Days	Date of testing	Weight(gm)	Load(KN)	Compressive strength(N/mm^2)	Average compressive strength(N/mm^2)
1.	3 days	06/01/2024	845	182	36.4	36.60
2.			851	179	35.8	
3.			855	188	37.6	
4.	7 days	10/01/2024	847	209	41.8	42.87
5.			853	215	43.0	
6.			851	219	43.8	
7.	28 days	31/01/2024	848	256	51.2	51.60
8.			845	267	53.4	
9.			852	251	50.2	

4.2 Compressive strength test by adding 2.5% of PVC Powder:

S.No	**Days**	**Date of testing**	**Weight(gm)**	**Load(KN)**	**Compressive strength(N/mm^2)**	**Average compressive strength(N/mm^2)**
1.	**3 days**	**09/01/2024**	**838**	**193**	**38.6**	**38.33**
2.			**837**	**187**	**37.4**	
3.			**834**	**195**	**39.0**	
4.	**7 days**	**13/01/2024**	**836**	**220**	**44.0**	**44.07**
5.			**834**	**219**	**43.8**	
6.			**841**	**222**	**44.4**	
7.	**28 days**	**03/02/2024**	**842**	**262**	**52.4**	**52.60**
8.			**840**	**267**	**53.4**	
9.			**839**	**260**	**52.0**	

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4.3 Compressive strength test by adding 5% of PVC Powder:

S.No	Days	Date of testing	Weight(gm)	Load(KN)	Compressive strength(N/mm^2)	Average compressive strength(N/mm^2)
1.	3 days	13/01/2024	830	199	39.8	39.33
2.			831	194	38.8	
3.			829	197	39.4	
4.	7 days	17/01/2024	833	226	45.2	45.20
5.			830	224	44.8	
6.			829	228	45.6	
7.	28 days	07/02/2024	827	267	53.4	53.87
8.			829	270	54.0	
9.			833	271	54.2	

4.4 Compressive strength test by adding 7.5% of PVC Powder:

S.No	Days	Date of testing	Weight(gm)	Load(KN)	Compressive strength(N/mm^2)	Average compressive strength(N/mm^2)
1.	3 days	20/01/2024	824	204	40.8	40.47
2.			823	203	40.6	
3.			821	200	40.0	
4.	7 days	24/01/2024	826	236	47.2	47.00
5.			821	234	46.8	
6.			822	235	47.0	
7.	28 days	14/02/2024	827	271	54.2	54.40
8.			826	273	54.6	
9.			824	272	54.4	

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4.5 Compressive strength test by adding 10% of PVC Powder:

S.No	Days	Date of testing	Weight(gm)	Load(KN)	Compressive strength(N/mm^2)	Average compressive strength(N/mm^2)
1.	3 days	06/02/2024	816	185	37.0	37.44
2.			815	187	37.4	
3.			814	190	38.0	
4.	7 days	10/02/2024	811	206	41.2	41.93
5.			814	211	42.2	
6.			816	212	42.4	
7.	28 days	02/03/2024	817	249	49.8	49.53
8.			814	245	49.0	
9.			817	249	49.8	

5. CONCLUSION:-

1. The cement mortar consists of cement, fine aggregate and water. The polyvinyl chloride (PVC) powder is partially replaced as 0%, 2.5%, 5%, 7.5% and 10% to fine aggregate

2. The compressive strength of the cement mortar is increased with the addition of PVC powder upto 7.5%

3. Beyond 7.5% of addition of PVC powder, the compressive strength is gradually decreased.

4. By the addition of PVC powder to the cement mortar, the unit weight is decreased, when compared to the normal cement mortar

5. Though PVC powder is less absorbent to water, the water usage is reduced.

6. Sand usage is reduced as it is partially replaced with PVC powder in percentage

7. Hence the unit weight is reduced, it can be use in high raised buildings.

8. The usage of Plastic in Construction may be helpful in control of environmental effects on humans, animals etc.

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