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Fluorescent concrete with strontium phosphorus powder and plastic waste

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Abstract. Concrete as a structural material can also function in the aesthetic field. The use of fluorescent concrete can beautify buildings, roads and other construction buildings with concrete material. The use of plastic waste has added value to this concrete because it can reduce environmental damage. So that beautiful, environmentally friendly concrete is expected to be created. This research was carried out in the hope of utilising strontium phosphorus powder and plastic waste to increase the value of concrete benefits. The research that will be carried out consists of several stages. First, the problem identification phase and the materials were making up the concrete, so that the characteristics of the material can be known. The second stage is the concrete mix design using SNI 03-2834-2000 guidelines. The third stage is making the compressive strength and concrete panel specimens carried out in the laboratory. The fourth step is testing the compressive strength and concrete panel specimens and analyzing the test results. Concrete test results show that the more the percentage of strontium phosphorus powder instead of cement, the lower the compressive strength of the concrete. For the percentage of concrete plus 4% plastic waste and 5%, strontium phosphorus powder has a compressive strength of 11.69 MPa compared to normal concrete 26.03 MPa. Then the longest time the fluorescent concrete produced by panel concrete plus cement paste 10% strontium phosphorus powder is for 3 hours.

1. Introduction

Concrete is generally only intended for construction materials in terms of strength only. However, this changed because of the discovery of fluorescent cement by Mexican scientist named Jose Carlos Rubio Avalos, who discovered cement that could glow at night. This cement is made from energy-saving material that can absorb sunlight and start emitting light at nightfall. Light-emitting cement products can last for 100 years and will shine for 12 hours at night. Every one square meter that maybe 3 mm thick, will cost around 60 to 70 US dollars (Rp. 780,000-Rp. 910,000) [1].

Strontium phosphorus powder material has a function that can glow in the dark so that it can be used to make fluorescent concrete. However, for a review of strontium phosphorus content in mix design, compressive strength, and how long the light produced is still not much to discuss.

Another thing that is the focus of research to be carried out is the use of plastic waste that is increasing day by day. Jambeck data (2015) recorded that 187.2 million tons of plastic were produced in all regions of Indonesia and ranked second in the world [2]. The characteristic of the plastic that reflects light is a reason for the use of plastic in this study. It is expected that the light produced will be greater than with conventional concrete.



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Based on the formulation of the problem, this study has the objective of how to use strontium phosphorus powder and plastic waste as a fluorescent concrete manufacturing material. So that it is known how long the fluorescent concrete can be glowing, the compressive strength of concrete using strontium phosphorus powder and plastic waste, and the strength comparison of concrete using strontium phosphorus powder and plastic waste with conventional concrete strength.

2. Literature review

Rismayasari (2012) examined the manufacture of concrete with a mixture of plastic waste and its characteristics using the percentage of plastic waste of 0%, 2%, 4%, 6%, 8% and 10% obtained the result that the highest value of compressive strength of $21.8 + 0, 2 \times 10^6 \text{ N / m}^2$ at the percentage of plastic waste 4% and the lowest $16 + 0, 1 \times 10^6 \text{ N / m}^2$ at the percentage of plastic waste 10% [3].

Malek, et al. (2017) in their research on Post-event damage assessment of concrete using the fluorescent microscopy technique, explains that fluorescent is used to detect the level of damage caused by external loads. Fluorescent itself serves as a source of light energy to illuminate images of damage such as cracks seen using a microscope [4].

The test results showed that the FMWG has pozzolanic characteristics and using it as a mineral admixture in concrete, had a bad effect on workability, but improved the mechanical properties of concrete considerably at later ages. The optimum percentage of FMWG that gives the maximum values of compressive, splitting tensile and bond strengths is 10%. Results also showed that expansion due to the alkali-silica reaction was minimised obviously by the increase in the FMWG content [5].

Investigated mix compositions are based on silica fume and its combination with glass powder. Testing results indicate that silica fume replacement by additionally ground fluorescent glass (up to 50%), slightly increases consumption of water and delays the setting time of cement paste. All concrete mixes with glass powder show decreased early-age strength and considerable strength gain after long-term hardening. It is concluded, that the best way of glass application in High-Performance Concrete is to use fine ground glass powder together with silica fume as complex admixture [6].

Based on consideration of the references used in this test, it is planned that concrete has more properties than conventional concrete. Things to be achieved are concrete that can glow by utilising strontium phosphorus powder material that can glow in the dark and environmentally friendly concrete by utilising the remaining plastic bottle waste to reduce environmental damage.

In this study, the percentage of plastic waste that will be used is 4%, and for the percentage of strontium-phosphorus powder is taken at 1%, 3% and 5% for concrete. The hope is the result of compressive strength and light levels produced under optimal conditions.

3. Methods

The research process is divided into several stages:

1. Preparation stage, collecting data and basic theories about the material to be used as well as data collection and preparation of tools and materials.
2. Stage of material testing
 - a. Fine Aggregate
 - b. Coarse Aggregate
 - c. Cement
3. Stage of manufacture specimens (Mix Design)
 - a. Determination of Concrete Mix Design (mix proportions)
 - b. Slump test
 - c. Manufacture of specimens for compression test.
 - d. Manufacture of specimens for fluorescent concrete.
4. Curing Stage
The specimens that have been made are left in a cylindrical mould for ± 24 hours after they have dried enough, the specimens are put into the sink for the planned age of 7, 14, and 28 days. For specimens, concrete panels are allowed to stand and watered periodically.
5. The testing of concrete cylindrical specimens and concrete panels
This stage is carried out testing the compressive strength of concrete, aged 7, 14, and 28 days for cylindrical concrete specimens. For concrete panel test specimens, the measurement

conditions for long glowing concrete are reviewed in conditions illuminated by the sun, room lights, and by a flashlight.

6. Data Analysis Stage

At this stage the data obtained from the compressive strength test results are analyzed with the help of a calculation program to get the relationship between the variables examined in the study.

7. Conclusion Stage

This stage makes conclusions related to the research objectives from data that has been analyzed in the previous stage.

Table 1. Concrete Cylinder Specimens.

Percentage of plastic waste (%)	<i>Strontium phosphorus powder</i> (%)	Testing day -			Number of Test Objects	Variation Type
		7	14	28		
4	5	3	3	3	9	Variation 4
4	3	3	3	3	9	Variation 3
4	1	3	3	3	9	Variation 2
Normal Concrete		3	3	3	9	Variation 1
TOTAL		12	12	12	36	

Table 2. Concrete Panel Specimens.

Cement (%)	<i>Strontium phosphorus powder</i> (%)	Number of Test Objects
90	10	1
95	5	1
97	3	1
Total		3

Concrete cylindrical specimens measuring 15 cm in diameter and 30 cm in height were used as many as 36 pieces with each variation of 9 test specimens. While the concrete panel test specimens measuring 1x1x0.025 m. Strontium phosphorus powder is used as a substitute for cement in the cement paste.

4. Results and Discussion

From the material data obtained, a mix design mix for 4 variations has been made which is explained in Table 1. The mix design procedure follows SNI 03-2834-2000. The mix design results obtained by concrete mix with material requirements as follow :

Table 3 Compressive Strength Test Results.

Type	Age of Concrete Cylinders (Days)	Compressive Strength (MPa)			Average Compressive Strength
Variation 1	7	18.11	18.11	17.54	17.92
	14	22.64	19.24	23.77	21.88
	28	27.16	26.03	24.90	26.03
Variation 2	7	7.36	11.32	11.32	10.00

	14	14.71	14.15	13.58	14.15
	28	14.71	16.98	14.71	15.47
Variation 3	7	9.05	9.05	9.05	9.05
	14	12.45	11.32	11.88	11.88
	28	13.58	14.71	13.58	13.96
Variation 4	7	9.05	7.92	11.32	9.43
	14	9.62	11.32	11.88	10.94
	28	12.45	11.32	11.32	11.69

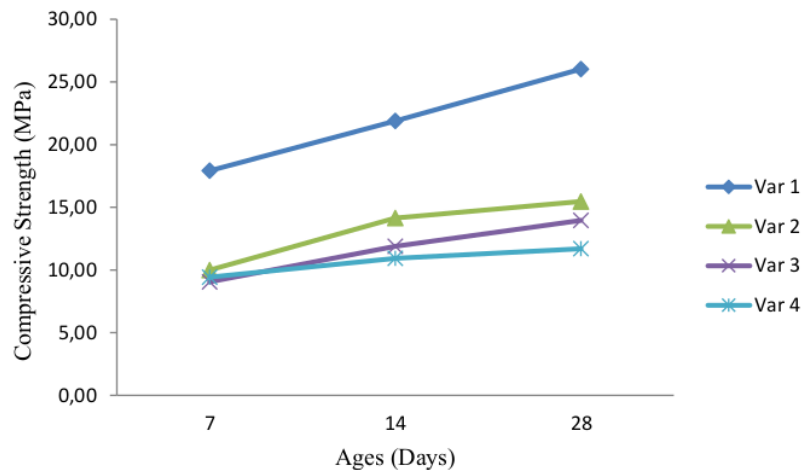


Figure 1. Comparison of Compressive Strength Variations.

The lowest compressive strength values obtained for variation 4 using concrete plus 4% plastic waste and 5% strontium phosphorus powder which has a compressive strength of 11.69 MPa while normal concrete is 26.03 MPa. The compressive strength value of the plan is 25 MPa.

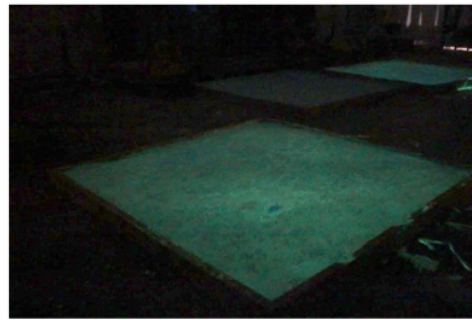


Figure 2. Concrete Panel Specimens.

Concrete panels are made the same as cylindrical concrete variations 2, 3 and 4. The size of the concrete panels is 1x1 m and 2.5 cm thick. Preliminary test results show that concrete panels are almost invisible at all glowing. So it was decided to make cement paste with the percentage replacement of strontium phosphorus powder to cement at 3%, 5% and 10%. Figure 3 shows the condition of the concrete panel after being illuminated with a flashlight with a high lux level.



Condition + 3% strontium phosphorus powder



Condition + 5% strontium phosphorus powder



Condition + 10% strontium phosphorus powder

Figure 3. Conditions of Concrete Panels after a Flashlight.

Fluorescent conditions were reviewed in several concrete panel irradiation conditions. It aims to determine the effect of the irradiation process of concrete panels that have been coated by cement paste + strontium phosphorus powder with the most visible time and fluorescent level. The best results are obtained by irradiation with a flashlight with a high lux level with a glowing period of 3 hours until the concrete panel is completely invisible to the eye.

Table 4. Test Results for Time and Level of Concrete Panel.

No	Condition	Length of fluorescent (hours)	Fluorescent level
1	By the sun	1	Almost Invisible
2	By the lamp	1	Almost Invisible
3	By Flashlight	3	Visible

5. Conclusion

The test results show that the more levels of strontium phosphorus powder as a substitute for cement, the lower the quality of concrete. This shows that strontium phosphorus powder does not have properties that can replace cement, so it is better to use it for cement paste. The lowest compressive strength values obtained for variation 4 using concrete plus 4% plastic waste and 5% strontium phosphorus powder which has a compressive strength of 11.69 MPa while normal concrete is 26.03 MPa. The compressive strength value of the plan is 25 MPa. For the long glowing time is best obtained by irradiation with a flashlight with a high lux level with a glowing period of 3 hours. The more levels of strontium phosphorus powder, the brighter the level of light produced.

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