Characteristics of Foam Concrete with usage of Foam Agent which Varies
(Review on Density, Strength, and Water Absorption)

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Abstract— Technology and innovation making foam concrete started to widely used on industrial building construction, especially on the wall of the building phase of the earthquake and the energy-efficient buildings. Existing commercial foam concrete with lightweight also has a strong that is still low so that necessary improvements in the manufacturing process, composition, and its characteristics. In this study used synthetic foam-agent ratio with water of 1:20. The composition of the foam concrete made with mixed cement: sand 1:2.75 with w/c 0.425 with the composition of the foam respectively 0%, 2%, 3% and 4% by weight of cement used. Testing is done to the density, strength and water absorption of foam concrete. Results of testing the density of foam concrete age 28 days obtained the lowest value of 1560.40 kg/m3 at 4% usage foaming agent. While the strength largest retrieved 13 MPa, as water absorption reached 8.54% in 2% foam agent, better than the concrete without the foaming agent with the composition of the mixture of cement and sand in the same

Index Terms— Foam concrete, foam-agent, density, strength, water absorption

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1 INTRODUCTION

ENERGY and environmental problems become major issues that occur in developing countries are no exception in Indonesia. Geographic regions of Indonesia with a dominant tropical climate has great potential to empower solar energy as the main energy source. Most of the buildings and houses in Indonesia requires great energy to the building to meet the operational needs of the convenience factor Uncontrolled energy consumption along with improved living standards and human needs. Up to now, there is no building made with the concept of energy efficient buildings and green environment in Indonesia to support sustainable construction. Buildings need to be designed with energy-efficient design, making it the Zero Energy and Green Building in the future. One effort to support is the use of building elements that can insulate like the walls and roof the building.

Technology and innovation in the construction industry have developed on the use of alternative building materials, especially wall material. Wall panels as an alternative lightweight concrete are popular in Indonesia. On this research examined the use foam agent in the manufacture of foam concrete. In addition to having foam concrete is lightweight that much-needed on the construction of earthquake resistant buildings, it also has other advantages such as the ability as an insulator and sound insulation that are widely used in energy efficient buildings. In addition to the strength of concrete examined also the absorption rate and porosity foam concrete by wearing a varied amount of foam agent.

The denseness of the slurry, the foaming speed, the condensation speed of the slurry, the additive amount of FA, and other influencing factors must be carefully considered to prepare a relatively high-quality product. In the formation of FC structures using chemical foaming, the foaming speed must match the setting and hardening speed of the slurry [1].

Lightweight Concrete masonry technology with system Aerated Lightweight Concrete (ALC) or Autoclaved Aerated Concrete (AAC) have many of developing until now.

2. EXPERIMENTAL PROGRAM

This research will make the 72 specimen cube (5x5x5) cm to know strength, density, and water absorption of foam concrete. Ratio foaming agent and water of 1:20, while a mortar makes with a ratio of cement: sand = 1:2.75 with w/c 0.425. The addition of a mixture of foam against the weight of cement was taken respectively 0%, 2%, 3% and 4% (see Table-1). The materials used in this research include cement, sand, water and foam agent, whereas the main equipment used in this research include Foam Generator Capacity 200 liters per minute, Compression Testing Machine Capacity 100 kN.

TABLE-1.
Composition of foam concrete

Mix concrete	Proportion			Foam agent (% by weight cement)	The number of cubes
	cement	sand	w/c		
Controls	1	2,75	0,425	0%	18
Job Mix-1	1	2,75	0,425	2%	18
Job Mix-2	1	2,75	0,425	3%	18
Job Mix-3	1	2,75	0,425	4%	18

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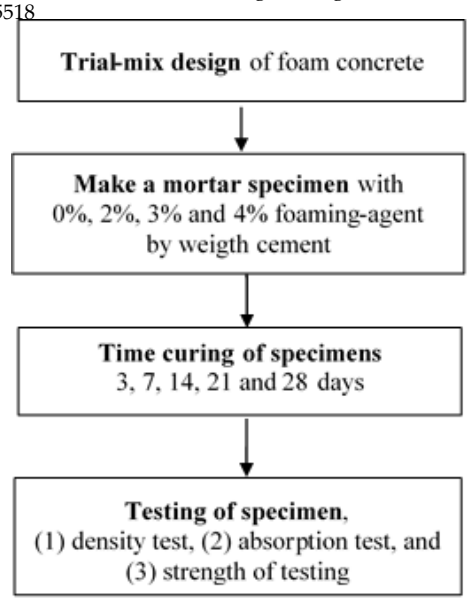

Figure-1. Experimental program

3. RESULT AND DISCUSSION

3.1 Density of concrete

The foaming agent is a concentrated solution of surfactants that must be dissolved in the water in use. Surfactant or surface active agent is a material that tends to be concentrated on the interface and enable the interface. Of usage foam concrete density affects the agent where the reaction of surfactants that are formed will be absorbed on the voids surface in the concrete. The air voids in the shape of bubble-bubble size is more or less 0.1 mm – 1 mm. The reaction of surfactants on concrete mix will decrease the surface tension of the liquid until a certain concentration. The increase in the concentration of surfactants on foam agent will increase the formation of cavities-cavity in concrete so that resulted in increased volume of concrete. The volume of concrete filled the air resulted in concrete density becomes lower so that the density of concrete added foam agent becomes smaller compared to normal concrete.

Figure-1 shows that with the use of foam agent that more can decrease the density of foam concrete, if compared to normal concrete (concrete without the foaming agent) the density of the concrete has a value of under 2000 kg/m3 as well as meet the concrete masonry category. The value of the lowest concrete density can reach 1560 kg/m3 on discharging foam agent amounted to 4% of the cement weight.

In research before [2] has been produced that the density of foam concrete with the use of foam agent 0%, 20%, 30%, 40%, 50%, and 60% of the volume ranges between 1880 kg/m3 to 760 kg/m3. While in this study produced a larger density but have the same tendency where the density of foam concrete decreases with the addition of amount foam agent used.

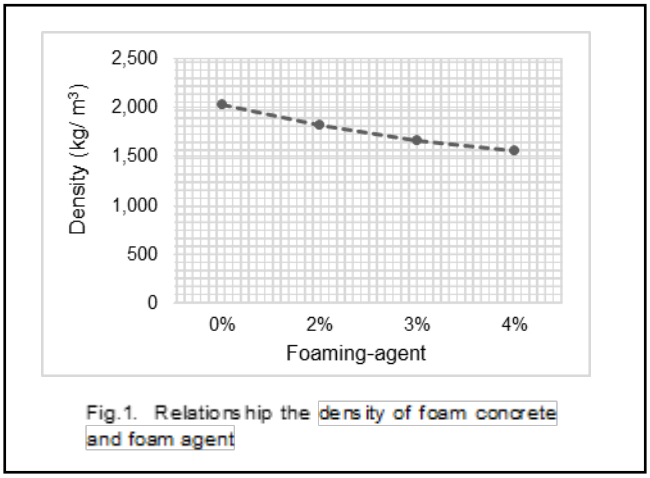

Fig.1. Relationship the density of foam concrete and foam agent

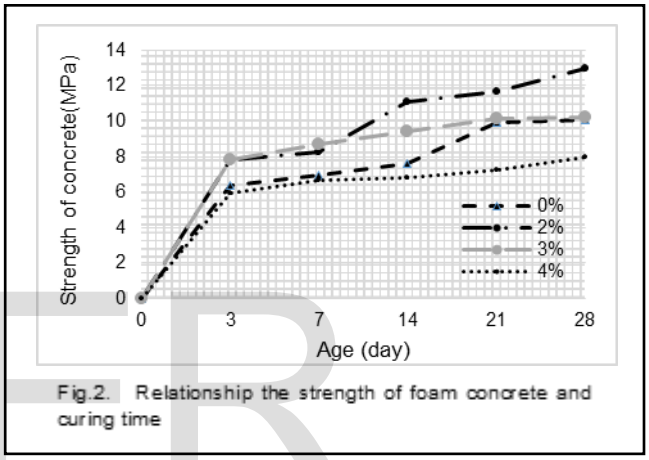

Fig.2. Relationship the strength of foam concrete and curing time

Research by [3] by wearing foam agent by 28%, 45%, 62%, and 78% by volume of concrete the resulting density between 1700 kg/m³ to 500 kg/m³ are also had a tendency of decrease in density over the addition of foam agent.

3.2 Strength of concrete

The strength of foam concrete will increase as we age where concrete (see figure-2) the percentage of concrete with 2% foam agent gave rise to strength tends to be stable and bigger compared to another concrete mix. The largest increase in foam concrete acquired for 13 MPa at 28 days by curing foam agent 2% by weight cement. Whereas if viewed from a comparison of strength and the density of foam concrete (see figure-3) retrieved on discharging foam agent of 2% from the weight of cement, where the density of concrete reaching 1825 kg/m3 with maximum strength 13 MPa. Use of the foaming agent 2% above the strong focus was more likely to decline. It is clear that the concentration of the surfactant reactions optimally retrieved on discharging foam agent 2%, where the voltage reaches a maximum in the interface holding the balance weight on the air voids cavity is formed. The use of foam concrete with foam agent 2% already meets the requirements for use of concrete masonry walls of a grade-1 structure according to [4].

The density of the foam concrete is influenced by foam agent, foam formation occurs when the surfactant is at the

water-air interface, with a hydrophobic group extends in the gas phase. At the time of the gas phase is divided, the foam will be formed. In this situation, the air is a non-polar media. Foam concentrate made from synthetic surfactant protein hydrolyzates or formulated to produce air bubbles are stable and able to withstand the physical and chemical force that occurs during the mixing process and the hardening concrete. Air bubbles that turn into air cavity made of concrete density decreases. The use of foam agent with a high percentage will result in the density and low compressive strength.

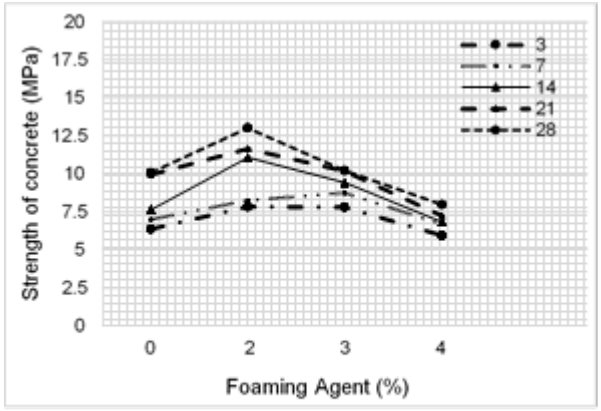

Fig.3. Relationship of strength and foam agent at each time curing

From the relationship compressive strength and density of foam concrete on the amount of foam agent used (see Figure-4), shows that the lower the density value of the compressive strength of concrete is not necessarily also low. On the use of foaming agent 2% will produce an optimum compressive strength of concrete density that is also relatively low, at 13 MPa compressive strength with the density of 1825 kg/m^3.

When compared result the other research [5] explained that foam concrete with a mixture of cement:fly-ash: sand (1:0.5:1.5) using the foaming agent of Sodium Lauryl Sulphate concentrate 1:15 with 10% of foam volume, can be used as lightweight structural concrete with strength can reach 25.38 N/mm^2 and dry density 1200 kg/m^3.

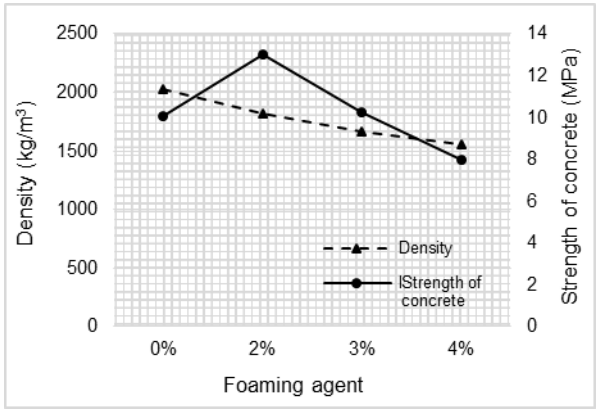

Fig.4. Relationship of strength and density at each foam agent

3.3 Water Absorption

Water absorption is one of the very important parameters to predict and know the strength and quality of foam concrete. A good quality of foam concrete has a water absorption which a number of pores on the surface of the fewer meeting. Figure-5 shows the results of water absorption in foam concrete with the use of foam agent that the greater number of foam agent used the value of water absorption of concrete is also declining. This is due to air bubbles that are formed in the reaction of surfactant foam agent has made the air cavity cannot into again by water because the pores between aggregates on the concrete are already filled by the stable air bubbles. The smallest value for the water absorption of concrete can reach 7.83% on concrete usage by 4% foam agent. So the foam concrete can be categorized in the grade-I value water absorption maximum under 25%.

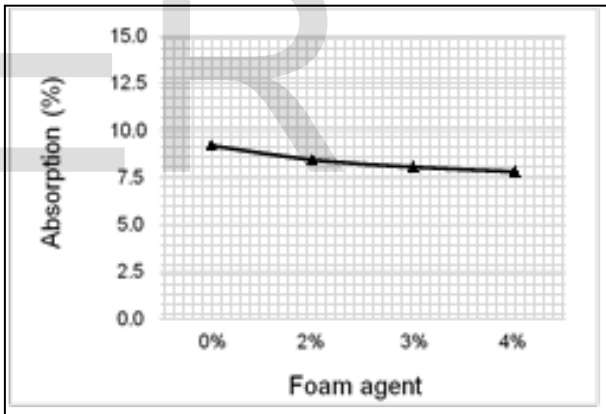

Fig. 5. Relationship the absorbtion of foam concrete and foam agent

This result is also the same with research by [6], where the use of fly ash as of fine aggregate to foam concrete with a ratio of 1:1, 5 with cement ratio 1:0,65 can result the density of 1300, 1400 and 1500 kg/m3 and high compressive strength between 10-18.8 MPa and moderate water absorption was below 10%.

Discharging foam on foam concrete with an aggregate replacement of waste clay bricks from 25% to 100% has also been performed [8] and produces water absorption ranges between 16.02% to 19.26%.

Research of fiber on foam concrete has also been conducted [7], where a mix ratio of one part binder to two parts of filler (1:1.5) was used with constant water to binder ratio (W/B) of 0.45. Synthetic and natural fibers consisting of AR-glass, polypropylene, steel, kenaf and oil palm fiber were used. Two percentages of fibers included in each fibrous specimen at 0.25% and 0.4% respectively.

The research results obtained that the usage of fiber on foam concrete affects the level of water absorption which each kind of fiber has a different surface morphology that plays an important role in the water absorption. The water absorption rate is enhanced by adding steel and polypropylene fibers, where is the water absorption value below 8%

4 Conclusion

Use of the foaming agent in foam concrete mix that will generate growing density and absorption rate of concrete that is getting low. The density of foam concrete with a mixture of 1:2,75: 0.5 earned on discharging foam agent 4% by weight of cement used i.e. amounting to 1560,40 kg/m^3 and 7.83% respectively for strength and water absorption rate.

Lowering the density of foam concrete is also followed by a strength decrease and water absorption in foam concrete too. Strength optimum of foam concrete is obtained at a 2% foam agent where strength 13 MPa with a density of 1824.87 kg/m^3.

Acknowledgments

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