Practical production of lightweight concrete floor tiles

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Abstract. The quality of concrete is influenced by fine aggregate. Lightweight concrete contains only fine aggregates. Tiles are one of lightweight concrete. The physical characteristics of fine aggregate need to be understood if you want to make a tile. For tiles to re-compete and attractive to use as home flooring, it is necessary to study to make light and aesthetic concrete tiles strong and aesthetic. This research is intended to make lightweight concrete based tiles. This research used the exploration method. The data begins with the selection of materials, work tools, and stages of manufacture. Information from various sources is captured and interpreted into a creative idea. The basic concept is done and developed pragmatically on the shape of the tile. The process of analysis is done qualitatively, so we get the form of tile. The tile shape is transformed from the parameters to the lightweight concrete-based tiles. This study concluded that the lightweight concrete-based tile material is made with the following stages: Preparation of work tools and work materials, basic coating, top-coating, printing, fresh tile removal, drying, polishing, as well as the application of resin oil.

1. Introduction

In times of current energy crisis, home needs are not easily served by architectures, especially concrete as building materials [1]. Concrete has the following disadvantages: 1) The shape is difficult to change; 2) Concrete work needs high accuracy; 3) The weight is heavy in the concrete; 4) High sound reflective power is held in concrete. Concrete has the following advantages: 1) Concrete is easily formed; 2) heavy loads capable of bearing in concrete; 3) High-temperature resistant concrete; 4) Small maintenance costs are held in concrete [2]. The sense of interest in the use of this concrete ultimately raises the number of types of concrete itself. One that we know is lightweight concrete. Lightweight concrete contains only fine aggregate, has a normal weight that meets ASTM C33M, and is met in ASTM C330M. The aggregate meets the requirements of ASTM C330M, weighing the volume of lumps of 1120 kg / m³ or less, and in accordance with ASTM C29M is a mild aggregate criterion [3]. The floor is called an important component of the house. Tiles are one of the lightest concrete used in the building and were known in the early 20th century. Since the 1980s, the use of tiles was marginalized by ceramic flooring products produced by large industries. The study results on the issue of global warming note that the embodied CO₂ from the tile floor is almost 7 times that of the embodied CO₂ Tiles. This shows that tile products are environmentally sound and sustainable compared to tile floors [4].

Natural sand as a result of natural disintegration of rocks or sand produced by the stone-breaking industry and having the largest size of 4.8 mm is called fine aggregate [5]. Aggregates that pass 4 or 4.75 mm sieve are called fine aggregates [2]. The quality of concrete and strength of concrete is
influenced by fine aggregate. Aggregates that all grains penetrate a 4.8 mm or 4.75 mm or 5.0 mm mesh are called fine aggregates. The characteristic quality of concrete is influenced in fine aggregate quality. The fine aggregate in the concrete functioned as a mixture bound by cement and water into a solid mass that solidified and filled most of the volume of concrete [6]. Fine Grain Modulus (MHB) of about 1.50-3.8 is present in fine aggregate. The results showed that the value of 2.5 <MHB <3.0 produced high-quality concrete with low Cement Water Factor (W/C), had compressive strength, and optimum crunch. The quality of the concrete is affected by the maximum aggregate grain size. High-quality concrete in maximum granules made should not be more than 15 mm. Aggregate granules up to 25 mm are still possible to be high-quality concrete [7].

The fine aggregate in SNI S-04-1989-F is required as follows: 1) The hard and non-porous grains are present in the fine aggregate; 2) The items can not be destroyed by weather effects. The items are tested with a sodium salt solution of a maximum crushed part of 12%. Item if tested with a maximum magnesium sulphate salt of 18%; 3) More than 5% mud is not contained in fine aggregates; 4) Alkali-reactive substances are not contained in fine aggregates; 5) Flat and long aggregate grains shall not contain more than 20% in fine aggregates; 6) fine modulus between 1.5 - 3.8 grains and grain variations adjusted to the gradation standard; 7) The maximum grain size shall not exceed 1/5 of the smallest distance between the side plates of the mold, 1/3 of the thickness of the concrete plate, 3/4 of the intercellular clearance; 8) The fine aggregate of the sea may be used provided that it has been instructed by a recognized institution [2]. The quality of the concrete is influenced by the fine aggregate shape. Minimum 33% smaller airspools are held in rounded aggregates rather than flat-shaped aggregates. Water is needed in fewer concrete in finely textured aggregates than coarse-grained aggregates. The compressive strength and concrete characteristics are influenced by fine aggregates. The test results of 4 types of fine aggregate are deduced as follows: 1) Different values are each owned in fine aggregate since they are influenced by the origin of the fine aggregate source. Aggregates with good conditions result from stone age; 2) The compressive strength, air content, weight, and shrinkage of concrete are influenced by fine aggregate characteristics [6]. Thus it can be concluded that fine aggregate affects the quality of concrete.

Subtraction is referred to as the process of closing an area with tiles without gaps and without overlap. Tiles used to cover the area can be a lot of wake-ups. The steps to create a tile consist of creating a design, arranging coloring, and arranging blocks of tiles. Staining stages selected 4 different colours such as maroon, brown, milk-white, and orange. The dyeing technique is made by coloring the tiles and made with the same number. The width of the arbitrary tile area is calculated using the determinant formula. The results of the comparison of maroon, brown, milk, and orange are obtained 11: 13: 7: 6. The comparison of each color is intended to make it easier for the ceramic entrepreneur to provide the tile color in the pattern. The tile blocks are formed from the four basic tile patterns, 16 tile base patterns, and various other tile archer formations. The pattern of tiles formed varies. Everyone has their own style to create patterns, so it takes creativity and high persistence in the process of making tile patterns [8].

Floor tiles are often used in buildings. This tile is used instead of floor plates to make the floor more comfortable and look better. Tiles consist of ceramic and tile type. Floor tiles are made to be able to guarantee the strength and function of the tiles. The tiles are made to be strong enough to hold the load on it. Tiles need to be calculated in the right thickness to have a high strength so that efficient materials can be used. Floor materials began to be developed and adapted to the needs of the times. Based on this, tiles can be made from tile fractions. The fractional composition of tile compared with different sand composition, the compressive strength and flexural strength is lower than the normal tile. Floor tiles made from mortar mixture consist of cement, fine aggregate (sand), fine aggregate (tile fraction), and water. The mixture is poured in a tile mould and left, it will harden like a rock. This hardening occurs due to a chemical reaction between water and cement. Hard Mortars are considered artificial stones.

The strength, durability, and mortar properties are based on the properties of the base material, the value of the material comparison, the stirring, the way of execution, the mode of compaction, and the
way of treatment. The results of the test were strongly urged that the specimen with 4.5 cm thickness had a strong pressure equivalent to an ordinary tile with 2.5 cm thick. The result of bending strength test was found that the test specimen with 3 cm thick had strong pressure equivalent with ordinary tile with 2.5 cm thick. The result of shear tensile strength test was found that the specimen with 3 cm thick has strong pressure equal to ordinary tile with 2.5 cm thick.

The above test results show that the optimum thickness of the tiles with the tile aggregate is about 3 cm in order to have the same strength as the usual tiles [9]. Mixture in the manufacture of tiles is important to note the composition of the working materials. Tile-making materials are prepared, weighed, and stirred using a dry mix mixer. Sand 1539.7 kg / m³, 512.5 kg / m³ cement, 205 kg / m³ of water, silica fume 20.5 kg / m³, and white cement 2.3 kg / m³ are the working materials used to make tiles [4]. Thus, if you want to create a tile need to understand the fine physical characteristics of aggregate. For tiles to re-compete and attractive to use as home flooring, it is necessary to study to make light and aesthetic concrete-based tiles strong and aesthetic. This research is aimed to make tiles lightweight concrete basis.

2 Research method
This research used the exploration method. The data begins with the selection of materials, work tools, and stages of manufacture. Information from various sources is captured and interpreted into a creative idea. The basic concept is done and developed pragmatically on the shape of the tile. The process of analysis is done qualitatively, so we get the form of tile. The tile shape is transformed from the parameters to the tiles based light concrete.

3 Result and discussion

3.1 Preparation

3.1.1 Work tools
Mould floor, cast bucket, lorries, cement spoon, screwdriver, used oil, kape, sponge, old newspapers, measuring cups, brushes, dough press tools, and spoons.

3.1.2 Work materials
Anti-leak paint (blue color), resin oil, hardener, mild (Pohara) sand, coarse (Nambo) sand, cement, and water.

3.2 The development stages

Figure 1. The base layer dough is pressed with a cement spoon.

3.2.1 Basic layer creation
The base layer dough is pressed with a cement spoon. The base layer is made with a mixture of Pohara sand material and Nambo sand material. The color of the red sand tends to be light, the sand contains a
lot of soil, pebbly sand, and the white pebbly color is owned in the features of Nambo sand. Nambo Sand is valued at Rp. 200,000,-/ret up to Rp. 400,000,-/ret. The color of gray sand tends to be dark, slightly rough, and grained sand like sugar/salt is owned in the characteristics of Pohara sand. Sand Pohara valued at Rp. 600,000,-/ret. The composition of the sand material is mixed with a ratio of 3 Pohara sand and 1 Nambo sand. The dry mixture consists of mixing the dry dough and stirring damp dough (figure 1).

Dry dough mixing is carried out in the following manner: 1) Sand Pohara rests on the work floor; 2) Pair Nambo poured on the sand of Pohara; 3) Cement is poured on nambo sand; 4) The dough is stirred by forming a mountain at least 3 times. The dough is always thrown towards the top when forming a mountain. The color of the dough has become one color (the color of cement) is characterized in a well-mixed dry dough; and 5) The dough is recovered approximately 10 cm thick to the dough mixer. Stirring damp dough is done in the following way: 1) The dough is splashed water until moist. Moist dough is obtained in a situational way; 2) The damp dough is stirred by forming a mountain at least 3 times. The dough is always thrown towards the top when forming a mountain. The color of the dough has become a color (color of sand) and moist is characterized in a well-mixed moist dough.

3.2.2 Basic layer creation
The top layer is made with a mixture of cement and Pohara sand. The material composition of Pohara sand and cement mixed with the ratio of ½ lorry takes 3-4 of cement shovels. Sand and cement sifted. The result of the sieve is watered so that it becomes moist. Stirring damp mixture stirred at least 3 times. The dough is stirred by forming a mountain.

3.2.3 Printing
The top layer dough is poured into a mold with a thickness of about 0.7 - 0.8 mm. The top layer dough is flattened by hand. Next, the dough of the base layer is poured into the top layer. The base layer dough is pressed with the press (Figure 1). The base layer dough is poured again soaring in the mold. The dough needs to be trampled to solid. The dough is flattened on the surface of the mold using a cement spoon.

3.2.4 Release
Fresh tiles are removed from the mold in the following manner: 1) The top mold is provided with a used newspaper; 2) Mold is reversed and placed on the work floor; 3) The bolts on the mold are opened with a screwdriver; 3) The sides of the mold are pulled up. Prints are pulled up carefully.

3.2.5 Drying
Fresh tiles are dried for one day. Drying process in a roofed area (figure 2).

Figure 2. Tiles that have been dry for one day.
3.2.6 Printing
Dry tiles are given anti-leak paint (blue color). The top layer is smeared with anti-leak paint. Anti-leaking paint smeared in layers. The first layer is horizontally smeared and the second layer is vertically applied. Kape should be used in the process of painting anti-leak paint. The process of paint drying takes a fast time (15 minutes) is shown in figure 3.

![Image of tiles being painted](image)

**Figure 3.** Tiles are given anti-leak paint.

3.2.7 Resin Oil Dyeing
The tiles are smeared with resin oil. The resin oil is mixed with the hardener. The composition between resin and hardener oil is mixed with a ratio of 150 ml: 5 ml hardener. The oil of resin and hardener is mixed evenly. The resin oil is poured into the tile until smooth. The resin oil layer is flattened on the tile surface using a cape. The tile is aired for 15 minutes. Tiles are made with size 20 cm x 20 cm x 20 cm and 2.5 cm thick (figure 4).

![Image of lightweight concrete based tiles](image)

**Figure 4.** Lightweight concrete based tiles.
4. Conclusions
This study concluded that the lightweight concrete-based tile material is made with the following stages: Preparation of work tools and work materials, making base layer, top layer making, printing, fresh tile release and drying. This research can be continued to examine economic feasibility studies on lightweight concrete based tiles.

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