Utilization of Strapping Band Waste for Reviewed Mortar Againsts Compressive and Split Tensile Strength

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Abstract. The aim of the study was to make mortar with a fiber mixture that utilizes band strapping waste. The selection of strapping band material as fiber since this material is not environmentally friendly, the benefits of this research can reduce band strapping waste and increase the economic value of band strapping waste. This research was conducted to determine the optimum fiber concentration value which resulted in the value of split tensile strength, compressive strength of maximum mortar, fiber strapping band with a length of 50 mm and width of 2.5 mm in the composition of 0%, 1.25%, 2.5%, 3.75%, 5%. The size of the specimen is 150 mm in diameter and 300 mm in height for the split tensile strength test and the object size is 100 mm in diameter and 200 mm in height for the compressive strength test. The number of specimens is 35 pieces, with each composition as many as 3 samples. For compressive strength test using 15 test specimens and split tensile strength test using 15 test specimens. From the test results, the optimum composition occurs in 5% fiber strapping band with a maximum increase in compressive strength of 29.67% (40.3 Mpa), split tensile strength of 60.94% (1.03 Mpa). For volume weight of 100 x 200 mm decreased by 7.58% (1.955 gr / cm³) while for weight volume 150 x 300 mm decreased by 3.62% (1.868 gr / cm³). Due to the increased split tensile strength, this mortar mixture is suitable for the manufacture of plastering or mortar on the surface of the wall especially the outer wall.

Keywords: Fiber Strapping Band, Compressive Strength, Split Tensile Strength, Weight Volume.

1. Introduction

Along with the rapid population growth and the pace of the economy, it can affect the increase in infrastructure development that occurs in Indonesia. An increase in the need for infrastructure development will automatically increase the need for construction materials as well. The increase in the need for construction materials must be addressed with the existence of alternatives born from several studies and create new discoveries or the development of previous research to produce construction materials that are increasingly quality and efficient. Crystalline asbestos in addition, to a concrete building construction, it is also known as mortar. Mortar is a mixture of cement, sand and water that has a different percentage. As a binder, mortar must have a standard consistency / thickness. The consistency of mortar will later be useful in determining the strength of
mortar that becomes a species or wall plastering so that the expected mortar that determines the compressive force since the working load is not destroyed.

The use of mortar is for coat pairs of bricks, stone, or stone (brick making) so that the surface is not easily damaged and looks neat and clean. Mortar work is also carried out on foundation pairs, pairs of wall, brick floors, concrete layers, and so on.

Cement material is a hydroloic enhancer in the form of fine powder produced by smoothing the clinker (this material consists of silicates which are hydraulic, cement making consists of limestone, clay, iron sand containing dung silica, aluminia, iron oxidation, and the oxides used to glue, coat, make mortar.

This study applies the concept of using Polyester fiber waste from strapping band material in cement-sand mixture. To improve the ability of tensile strength and compressive strength of mortar, the effect of adding a number of Polyester fibers from the band strapping material to the sand cement mixture will be examined. [3]

The selection of strapping band material as fiber in this study is because this material is not environmentally friendly. For example, this material is difficult to destroy on the ground and can only be described for a long time, which is around 200-400 years. As a result of this decomposition, the chemicals in it will contaminate the soil. The combustion also contains dangerous chemical toxins that can cause respiratory diseases and lung cancer. Therefore, at least the benefits of this research can reduce the waste of band strapping and also increase the economic value of band strapping.

2. Research Methods

Portland Cement is hydraulic cement produced by smoothing a linker made of limestone (CaCO₃) which consists of silicate-calcium silicate, with casts as additional ingredients. The function of cement is to glue aggregate grains so that a period of compactness or solid occurs, in addition to filling cavities between aggregate granules.

Cement is an adhesive material that is very necessary to unite filler materials or aggregates into a solid period called concrete, so the quality of cement that determines the quality of concrete Portland cement is a hydraulic binder that has binding properties when mixed with water commonly called also with Pasta (a mixture of cement and water).

Fine aggregates are natural or artificial mineral granules as fillers in mortar mixtures. Fine or sand aggregates have granular sizes ranging from 0.075 mm to 4.80 mm. Aggregate with a size of more than 4.80 mm is called coarse aggregate. Sand with sharp shape and very suitable for making mortar. This is because sand with this form will have a high binding capacity. Fine aggregate grains are eternal, meaning they are not easily broken or destroyed by the influence of the weather. Such as hot sun and rain. Fine aggregates should not contain more than 5% sludge (determined in dry weight). Sand with Modulus Fineness between 2.5 - 3.2 is very good to use for making mortar [9]

Fibers from polypropylene and polypropylene/vapor grown nano carbon fiber composite have been spun using conventional melt spinning equipment. At 5 wt% nano carbon fiber loading, modulus and compressive strength of polypropylene increased by 50 and 100%, respectively, and the nano carbon fibers exhibited good dispersion in the polypropylene matrix as observed by scanning electron microscopy[10]

A comprehensive set of experimental data were generated regarding the effects of collated fibrillated polypropylene fibers at relatively low volume fractions (below 0.3%) on the compressive, flexural
and impact properties of concrete materials with different binder compositions. Statistical analysis of results produced reliable conclusions on the mechanical properties of polypropylene fiber reinforced, concrete and also on the interaction of fibers and pozzolanic admixtures in deciding these properties. Polypropylene fibers were observed to have no statistically significant effects on compressive or flexural strength of concrete, while flexural toughness and impact resistance showed an increase in the presence of polypropylene fibers. Positive interactions were also detected between fibers and pozzolans[11]

The time of cement bonding is the time needed for cement to harden. This time is divided into the initial binding time and the final binding time. The initial binding time is the time from mixing cement with water until it becomes a paste to the loss of the plasticity properties of the paste. While the final binding time is the time between the formation of cement paste and the hardened concrete. For portland cement, the initial binding time ranges from one to two hours and the final binding time does not reach eight hours [8]. By knowing the initial binding time, the deadline for printing mortar mixes can also be determined.

Polyester fiber is also found in band strapping material. Strapping band is a box for various goods. The advantages of band strapping as a packaging device include, among other things, a lightweight and easy to use material for the packaging of items weighing up to 500 kg. Strapping bands also have high tensile strength between 60 to 250 kg/cm² [7]. So that it is expected to reduce early cracks and due to loads.

The purpose of this compressive strength testing is to determine the quality of each mortar mixture in the test object, to determine the effect of each variation of the mortar composition mixture. The test is carried out by giving the axial compressive force to the cylindrical test object with an increase in the specified load until the test object has collapsed. The amount of concrete compressive strength can be calculated by dividing the maximum load when the crushed test object with a cylindrical cross-sectional area. by using ASTM C-39 Compression Machine (Electric Pump)

The specimen is loaded until it is destroyed with an average loading speed of 0.14 to 0.34 MPa/sec. In accordance to SNI -03-6825-2002. The compressive strength of mortar is calculated by the equation (based on the Indonesian Reinforced Concrete Regulation, PBI, 1989) as below: From the results of the compressive strength of each specimen, the average mortar compressive strength is calculated.

The compressive strength formula is \[ F_c = \frac{P}{A} \]  

The purpose of this tensile strength testing is to determine the quality of the mortar. The test is carried out by giving lateral tensile force to the cylindrical test object with an increase in tensile load until the test object has collapsed. Test the magnitude of the tensile strength of mortar can be calculated by dividing the maximum load when the crushed test object with a cylindrical cross-sectional area. By using the Universal Testing Machine (UTM) capacity of 100 tons Brand Tokyo Testing Machine Type RAT - 200.

Split tensile strength Formula is \[ F_{ct} = \frac{(2 \times P)}{(\pi \times D)}. \]

The purpose of this volume weight test is to determine the volume weight for mortar, with the following formula.

Volume Weight formula is \[ BV \text{ volume} = \frac{\text{weight of mortar}}{\text{volume}}. \]
Stating that, by increasing the percentage of palm fiber and reducing sand by 0; 0.5; 1; 1.5; 2 and 2.5% respectively are 2.106; 2.094; 2.017; 1.930; 1.929; 1.902. [1]

Stating that, with a variety of palm fiber and coconut fiber mixture 0%, 0.25%, 0.5%, 0.75%, 1% which experienced the highest loading occurred in palm fiber and 1% coconut fiber composition which was 17 tons or with a compressive strength of 75.56 kg / cm² at the age of 7 days. [2]

Stating that, with variations in the mixture of strapping bands 0%, 1.25%, 2.5%, 3.75%, 5% which experienced an optimum increase in the composition of 1.25% fiber strapping bands with an increase in compressive strength of 0, 19% and 0.06% split tensile strength. [3]

Stating that, with a variation of palm fiber mixture of 0%, 2.5%, 5%, 7.5%, 10% experienced an optimum increase occurred in the composition of 2.5% palm fiber with a maximum increase in compressive strength of 50.07 % and split tensile strength of 8.72%. [4]

Stating that mortar uses mortar from Three-wheel Cement. Research shows that the increasing composition of sand, the compressive strength of mortar decreases. Where the compressive strength of mortar at the age of 28 days for variations in the composition of the mixture using 1: 3 Three Wheel Cement was 9.1 Mpa; 1: 5 of 8.03 MPa; 1: 7 of 8.0 Mpa and 1: 9 of 6.3 Mpa. [5]

| Fiber composition strapping band (%) | The amount of experiment Pressure test (fc) 10 x 20 cm | Split and pull test (ft) 15x 30 cm |
|-------------------------------------|------------------------------------------|---------------------------------|
| 0                                   | 3                                       | 3                               |
| 1.25                                | 3                                       | 3                               |
| 2.5                                  | 3                                       | 3                               |
| 3.75                                 | 3                                       | 3                               |
| 5                                    | 3                                       | 3                               |
|                                     | 15                                      | 15                              |

3. Results and Discussion

Testing compressive strength

Testing the compressive strength of mortar was carried out to determine the compressive compressive strength of the specimen. The specimen used is slinder with a size of 10 x 20 cm. Testing of compressive strength of mortar is carried out when mortar is 28 days old with variations in fiber strapping bands that vary 0%, 1.25%, 2.5%, 3.75% and 5%. The number of mortar tested was consisting of 3 samples for each mixture. Length of fiber strapping band 50 mm and width of fiber strapping band 2.5 mm.

On graph 1, it showed a mortar with 1.25% fiber strapping band composition decreased compressive strength by 36.2 Kg / cm² (down 36.82%), on the composition of 2.5% fiber strapping band experienced a decrease in compressive strength of 35, 7 Kg / cm² (down 37.7%), in the composition of 3.75% fiber strapping band had a decrease in compressive strength of 31.8 Kg / cm² (down 44.5%), in the composition of 5% strapping band fiber experienced a strong decrease press 40.3 Kg / cm² (down 29.67%), with mortar without fiber strapping band used as a reference fc = 57.3 Kg / cm²
Graph 1. Compressive Strength of Mortar to Composition of Fiber Strapping Band

[3] Stating that, with variations in strapping band mixtures, which are 0%, 1.25%, 2.5%, 3.75%, 5% compressive strength on the composition of 0% fiber strapping bands at 446.285 kg / cm², in fiber composition strapping band 1.25% has increased by 531,370 kg / cm², in the composition of 2.5% fiber strapping band has decreased by 378,891 kg / cm², in the composition of the strapping band 3.75% fiber has a decrease of 349,375 kg / cm², and the composition of 5% strapping band fiber has an optimum reduction of 320,981 kg / cm².

Graph 2. Weight Volume on Mortar Testing

On graph 2, it shows the volume of mortar weight on the composition of 1.25% fiber strapping band by 2.036 gr / cm³ (down 3.79%), on the composition of 2.5% fiber strapping band has decreased volume weight of 1.985 gr / cm³ (down 6.16%), in the composition of 3.75% fiber strapping band, the volume weight decreased by 1.958 gr / cm³ (down 7.58%), in the composition of 5% strapping band fiber volume volume decreased by 1.955 gr / cm³ (down 7.58%), with mortar without fiber strapping band used as reference BV = 2.115 gr / cm³.

Testing tensile strength

On graph 3, it shows the mortar with the composition of 1.25% fiber strapping band having an increase in split tensile strength of 0.75 MPa (up 17.19%), in the composition of 2.5% strapping band fiber has an increase in tensile strength of 0.85 MPa (up 32.81%), in the composition of the strapping band 3.75% fiber had a decrease in split tensile strength of 0.80 MPa (up 25%), in the composition of 5% strapping band fibers had an increase in tensile strength of 1.03 MPa (up 60.94%), with mortar
without fiber strapping band used as reference f'ct = 0.64 Mpa. [3] Stating that, with a variety of strapping band mixtures that are 0%, 1.25%, 2.5%, 3.75%, 5% split tensile strength at 0% strapping band fiber composition of 38.096 kg / cm², in the composition 1.25% fiber strapping band increased by 40,283 kg / cm², in the composition of 2.5% fiber strapping band decreased by 36.558 kg / cm², in the composition of 3.75% fiber strapping band experienced a decrease again of 34.515 kg / cm², and the composition of 5% strapping band fiber has an optimum reduction of 31,895 kg / cm².

Graph 3. Splitting Tensile Strength of Mortar to Composition of Fiber Strapping Band

4. Conclusion
Based on the results of laboratory tests, it can be concluded that the addition of fiber mortar band strapping with the composition of fiber strapping band 1.25%, 2.5%, 3.75%, 5% decreased significantly to the compressive strength, while for testing tensile strength split, the optimum composition of fiber strapping bands at 1.25% is 1.93 Kg / cm². With the increase in split tensile strength, the mortar mixture can be used to manufacture specimens on the wall surface, especially the outer wall which has high shrinkage, thereby reducing cracks.

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