Utilization Plastic Waste Type PET (PolyEthylene Terephthalate) in the Making of Low-Quality Concrete in the City of Palangkaraya

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Abstract. The research about utilization plastic waste type PET (PolyEthylene Terephthalate) especially in fields of civil engineering is not much done in Palangka Raya. Even though every day in Palangka Raya, this type plastic waste is quite large. This type of waste management is still not optimal so that this type of garbage can disturb the environment in Palangka Raya. Therefore research is needed so that plastic waste can be used as civil engineering building materials in the case of a mixture of low-quality concrete. This study aims to determine whether PET (Poly Ethylene Terephthalate) plastic waste can be used as a mixture for low quality concrete in Palangka Raya City and the extent of its effect in the compressive strength of low-quality concrete. This research uses experimental methods in the laboratory. The planned concrete quality is K 225 which is classified as low quality concrete. Testing is carried out in 7, 14, and 28 days. PET plastic waste itself will be used as a substitute for coarse aggregate. The variation in the use of PET type plastic to coarse aggregate weight is 5%, 10%, and 15%. The number of samples for each condition is 3 samples so that the total sample used is 36 units. Concrete compressive strength value decreases with increasing levels of PET plastic waste. Average compressive strength for variations in the mixture of coarse aggregate PET plastic waste: 0% (normal), 5%, 10%, and 15% respectively: 272,40 kg/cm², 246,27 kg/cm², 239,82 kg/cm², dan 206,31 kg/cm².

1. Introduction

As one of the developing cities in Indonesia, Palangka Raya does a lot of physical work such as hotel construction, government office buildings, housing and so on. The work certainly required a relatively large amount of concrete making material and takes a relatively high cost. Research on concrete compressive strength using unconventional materials has been widely carried out in Palangka Raya City. An example is the use of husk ash in a concrete mixture that has been studied in Palangka Raya.

Even farther, subjects in research on concrete include gravel of coarse aggregate as one of the constituent materials of concrete. Form year to year the price of gravel is getting more expensive. Therefore, research to reduce the use of gravel in making concrete is pretty much done. To reduce the use of gravel as a concrete mixture, it is necessary to find a replacement material that is cheaper and
meets the requirements. One material that should be considered is PET (PolyEthylene Terephthalate) plastic waste.

The use of plastic waste as a concrete mixture material will be very beneficial in the economic terms because the price is much cheaper than coarse aggregate or gravel. But another big benefit is in terms of the environment. According to Pratikto (2010), the poison from the plastic is released when it decomposes or burns, so that no one bacterium can decompose this plastic waste. The more to used PET the waste from PET will also increase. From that opinion, it can be concluded that PET plastic waste is a type of waste that can damage the environment. In the City of Palangka Raya itself, the amount of waste generated from plastic waste quite large. Permana and Trihadiningrum (2015) in their research revealed that the composition of waste originating from plastic waste in Palangka Raya City reached 14.95% of the total waste generation. The conclusion obtained is that plastic is the second largest contributor of waste in Palangka Raya City.

The question that arises is whether PET type plastic waste can qualify as concrete making materials with aggregate conditions in Palangka Raya? Is planned compressive strength of concrete that will meet the requirement if the type of PET plastic waste is used to replace gravel? Pratikto (2010) concluded that PET can be used in making lightweight concrete with the ratio for each m3 mixture of lightweight concrete that is cement 263 kg, sand 420kg, water 279kg and aggregate PET 559 kg on the use of additive 50 ml. Whereas Haris (2015) states that PET plastic bottle waste can be used as a substitute for lightweight aggregate coarse concrete by going through the process off heating, cooling, and breaking.

From the research that has been done, it can be concluded that PET type plastic waste can be used in making concrete. The plastic waste is used as a substitute for gravel of coarse aggregate. However, the study was conducted outside the City of Palangka Raya where the fine aggregate material as a material for making other concrete certainly different from those in Palangka Raya. Research on the use of PET plastic waste in the manufacture of concrete in the City of Palangka Raya certainly needs to be done. Based on this, a study titled “Utilization Plastic Waste Type PET (PolyEthylene Terephthalate) In the Making Of Low- Quality Concrete In The City Of Palangka Raya”.

2. Research Methods
2.1 Research Procedures
2.1.1 Rough Aggregate Preparation from PET Waste
This stage starts with the manufacture of coarse aggregate from PET plastic waste types. Then the coarse aggregate from the waste is heated which is then cooled. After that, it is broken down into a predetermined size to that it becomes a coarse aggregate.

2.1.2 Concrete Material Testing Phase
The stages of testing the concrete constituent materials are as follows:

Test The Aggregate Water Content
The standard use in this test is SNI 03-1971-2008. The purpose of this test is to obtain a percentage of the water content contained in the aggregate. The material tested is fine aggregate (sand) and coarse aggregate (broken stone). The material comes from Bukit Rawi and Bukit Batu Kota Palangka Raya.

Test The Gross Aggregate Specific Gravity
The standard used in this test is SNI 03-1969-2008. The purpose of this test is to obtain figures of bulk density, surface dry density and the amount of absorption. The material tested is coarse aggregate (from PET type plastic waste).

Test The Fine Aggregate Specific Gravity
The standard used in this test is SNI 03-1970-2008. The purpose of this test is to determine the specific gravity and sand absorption under saturated surface dry (SSD) conditions and at saturation. The material tested is fine aggregate (sand).
Coarse and Fine Aggregate Filter Analysis
The standard used in this test is SNI 03-1968-2008. The purpose of this test is to obtain a distribution of the amount or the percentage of grains both fine aggregate and coarse aggregate. The distribution obtained can be shown in the table or graph. The material tested is fine aggregate (sand) and coarse aggregate (from PET type plastic waste).

Testing Fine Aggregate Mud Content Through Filter No.200
The purpose of this experiment is to determine the level of sludge contained in fine aggregate through the No. 200 filters by washing. The material tested is sand.

Test Aggregate Wear With a Los Angles Abrasion Machine
The standard use in this test is SNI 03-2417-2008. The purpose of this test is to determine the resistance of coarse aggregate to wear that occurs using the Los Angles Abrasion Machine. The material tested is coarse aggregate (from PET type plastic waste).

2.1.3 Planning a Concrete Mix Design (Mix Design)
Concrete mixture planning is carried out to determine the exact composition between the weight of cement, the weight if each aggregate and the weight of water needed to achieve the desired strength. In concrete technology it is explained that the factors which greatly affect the strength of concrete are:
- Cement water factor (water-cement ratio) and density.
- Age of concrete.
- Type of cement.
- Amount of cement.
- Aggregate properties.
Concrete mix planning can be done in various ways including: designing the America model based on the American Concrete Institute (ACI) and designing the British model based on the British Standard (BS) and known as the DOE (Departemen Of Environment) Method.

2.1.4 Making Test Objects
This stage includes the planning of mixing concrete mixes, which will use a mixture method according to SNI standard book of 2008 under the book title ‘‘Tata Cara Pembuatan Rencana Campuran Beton Normal’’ the concrete quality planning planned at 28 days is (K-225) with a concrete cube as a test object measuring 15cm x 15cm totaling three samples.

2.1.5 Testing Objects
Testing the compressive strength for K-225 quality concrete is carried out at the age of concrete 7, 14 and 28 days using 3 samples for each variation.

2.2 Slump Test
This test is intended to measure the value of a slab of fresh concrete slabs so that it can be seen as the ease of doing (workability).

2.3 Compressive Strength Test
The standard used in this test is SNI 03-1974-2008. The purpose of this test is to obtain the compressive strength value with the correct procedure.

3. Result And Discussion
The result obtained from this study are as follows
3.1 Concrete K 250 Without Addition Of PET Waste
The compressive strength of the K 250 concrete before PET waste can be seen in Figure 1 below
In Figure 1 it can be seen that the compressive strength value of concrete has increased with increase concrete age. The graph shows that the compressive strength of normal concrete at 7 days is 246,93 kg/cm$^2$, and increase again at the second concrete test age of 14 days, which is compressive strength reaching 248,80 kg/cm$^2$, and at the third test at 28 days the compressive strength increase slowly until reaching compressive strength 272,40 kg/cm$^2$.

**3.2 K 250 Concrete With 5% PET Waste Addition**

The compressive strength of the K 250 concrete after the addition of 5% of PET waste can be seen in Figure 2 below.

In Figure 2 it can be seen that the compressive strength value of concrete has increased with increase concrete age. The graph shows the compressive strength of concrete at the age 7 days is 207,60 kg/cm$^2$, and increase again in the second concrete test age of 14 days namely compressive strength reached 224,62 kg/cm$^2$, and in the third test at 28 days the compressive strength increased significantly until it reached 246,27 kg/cm$^2$.

**3.3 K 250 Concrete With Addition Of 10% PET Waste**

The compressive strength of the K 250 concrete after the addition of PET waste by 10% can be seen in Figure 3 below.
Concrete Compressive Strength

Graph of K-250 Concrete Compressive Strength with 10% PET Waste Addition

Figure 3. K 250 Concrete Compressive Strength With 10% PET Waste Addition

In Figure 3 it can be seen that the compressive strength value of concrete has increased with increasing age of the concrete. The graph shows the compressive strength of concrete at the age 7 days is 194.67 kg/cm², and increased again at the second concrete test age of 14 days namely compressive strength reached 202.89 kg/cm², and in the third test at 28 days the compressive strength increased significantly until it reached the compressive strength 239.82 kg/cm².

3.4 K 250 Concrete With The Addition Of 15% PET Waste

The compressive strength of the K 250 concrete after the addition of PET waste by 10% can be seen in the following Figure 4.

Graph of K-250 Concrete Compressive Strength with 15% PET Waste Addition

Figure 4. K 250 Concrete Compressive Strength with 15% PET Waste Addition

In Figure 4 it can be seen that the compressive strength value of concrete has increased with increasing age of the concrete. The graph shows the compressive strength of concrete at the age 7 days is 173.33 kg/cm², and increase again at the second concrete test age of 14 days namely compressive strength reached 202.00 kg/cm², and in the third test at 28 days the compressive strength increased significantly until it reached the compressive strength 206.31 kg/cm².

3.5 K 250 Concrete Compressive Strength Without And With The Addition Of PET Waste

The overall compressive strength of the K 250 can be seen in Figure 5 below.
Figure 5 shows that the compressive strength value of concrete decreases with increasing levels of PET plastic waste. Average compressive strength for variations in the mixture of coarse aggregate PET plastic waste 0% (normal), 5%, 10%, and 15% respectively: 272,40 kg/cm², 246,27 kg/cm², 239,82 kg/cm², dan 206,31 kg/cm². From this, it follows that the addition of PET plastic waste is recommended not to exceed 5% by weight of coarse aggregate.

4. Conclusion
Based on the result of the study, the following conclusions can be given.

Maximum concrete compressive strength without PET waste is 272,40 kg/cm² at age 28 days.
Addition of 5% waste obtained by the maximum concrete compressive strength 246,27 kg/cm² at age 28 days.
Addition of 10% PET waste obtained by the maximum concrete compressive strength 239,82 kg/cm² at age 28 days.
Addition of 15% waste obtained by the maximum concrete compressive strength 206,31 kg/cm² at age 28 days.
The addition of effective PET waste is carried out by 5% of the weight of coarse aggregate.

5. Suggestion
Based on the conclusions of the result of this study, the following suggestions can be given.
The use of PET waste does not exceed 5% of the weight of coarse aggregate.
Further research is needed to see the compressive strength of concrete when all the coarse aggregate is replaced with PET waste.

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