Effect of Mixture Composition Composite of Used Tire Powder, Asphalt and rHDPE on Tensile Test Value and Impact Strength as a Material Asbestos Replacement

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Abstract. This research aims to analyze the effect of composition on used tire powder asphalt composites and recycled plastic (rHDPE) on tensile strength and impact strength. There are two types of composition in this research; the first is 500 grams of used tire powder, 100 grams of asphalt with rHDPE variations of 20, 30, 40, 50, 60, 70, 80, 90, 100, 120 grams, and the second composition is 500 grams of used tire powder, 200 grams of asphalt with rHDPE variations of 40, 60, 80, 100, 120 grams. The results of the tensile and impact tests for a mixture of 500 grams of used tires and 100 grams of asphalt, the highest tensile stress and impact strength values were obtained by the 120 grams rHDPE variation with a tensile stress value of 0.1332 N/mm2 and an impact strength of 1.493 N/mm2. For a mixture of 500 grams of used tire powder and 200 grams of asphalt, the highest tensile stress and impact strength values were the 120 grams rHDPE variation with a tensile stress value of 0.045 N/mm2 and an impact strength of 1.436 J/mm2.

Keywords: Used Tire Powder, rHDPE, Tensile Stress, Impact Strength.

1. Introduction

Waste accumulation continues to increase to dangerous levels. Waste tires are one of the causes of severe environmental problems due to the rapid growth and many types of modern waste worldwide [1]. Therefore, recycling rubber waste needs to be done. Rubber tire waste management (WTR) is an increasingly developing severe problem [2]. Every year, it is estimated that one billion tires reach the end of their useful life, of which around 50% are currently recycled, and the rest just become trash [3].

Waste tire processing is a worldwide problem requiring more attention to recycling and reusing materials – said material [4]. The main factors in utilizing waste tires comprehensively include renewable fuels, renovation of waste tires, recycled rubber production, thermal decomposition, and vulcanized crumb rubber (CR) production [5].

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Using recycled tires in asphalt mixtures using a dry process can improve the properties of the asphalt mixture and affect the performance of resistance to permanent deformation and cracking at high temperatures. One way to prevent environmental pollution is recycling. Rubber-polyethylene terephthalate (PET) high-density polyethylene (HDPE) waste can be used as a composite mixture [6]. To minimize used tire waste and improve the properties of the asphalt mixture, used tire rubber can be recycled by mixing it with asphalt using a dry process [7].

The addition of used recycled rubber tires in asphalt mixtures using a dry process can improve the properties of rubber asphalt mixtures and have a significant effect on the performance of resistance to deformation. Some people have researched the high impact, and modified WCR asphalt has good low-temperature resistance [8] [9].

In the research, used tire powder and recycled plastic (rHDPE) will be processed into composites. On the future, this composite can be used to replace the role of asbestos as interior material (house ceilings). Asbestos is a dangerous material because it can cause dust which will interfere with breathing. A substitute for asbestos was discovered so its use is still maintained. It is hoped that this composite from recycled raw materials will be able to replace the role of asbestos.

2. Methods

2.1. Research Methods

Research methods are research plans that provide direction for conducting research so that the necessary data can be collected. In this research, an experimental method was used to determine the effect of the composite composition of used tire powder, asphalt and rHDPE, which will be subjected to a tensile test to determine the tensile stress and then compared with the tensile stress of asbestos. Apart from the tensile test to determine the mechanical properties of the composite, this research also carried out an impact test.

2.2. Tensile Test Method

To find out the mechanical properties of a material, we have to test the material. In this research, tensile testing was carried out to determine the tensile stress of the composite. The tensile test was carried out in accordance with the ASTM D638 Type I standard with object dimensions as [in figure 1 and table 1 below [10].

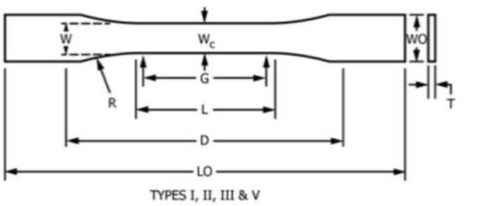

Fig 1. Tensile Test Specimen

Table 1. Tensile Test Workpiece Sizes

Dimension (see drawing)	Type I (mm)	Type II (mm)	Type III (mm)
W – Width of narrow section[E,F]	13	6	19
L – Length of narrow section	57	57	57
WO – Width overall, min[G]	19	19	29
LO - Length overall, min[H]	165	183	246
G – Gage length[E]	50	50	50
D – Distance between grips	115	135	115
R – Radius of fillet	76	76	76

2.3. Impact Charpy Test Method

The Charpy impact test method is commonly used in America Pressing Tool Union, and is a testing method where the workpiece is installed horizontally with both ends placed on a support, while the notch on the workpiece is placed in the middle with the direction of loading directly above the notch[11]

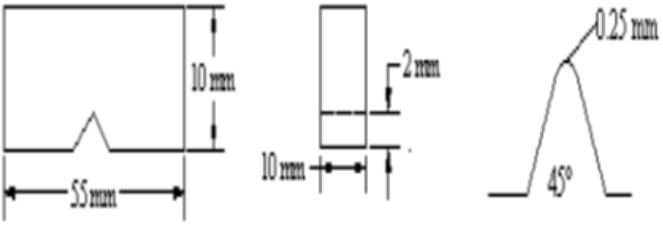

Fig 2. Research Flow Diagram

2.4. Researches Flow Diagram

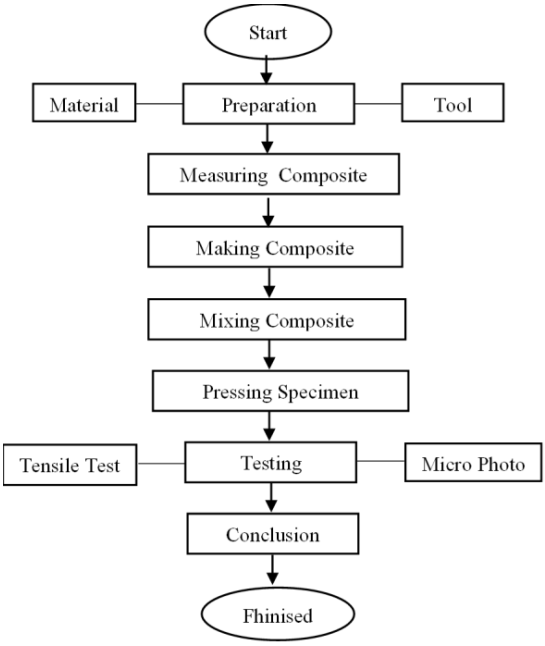

Fig 3. Research Flow Diagram

2.5. Research Material

The research materials used in this research are:

Recycled HDPE (High Density Polyethilene)

HDPE is High Density Polyethylene –a resin tough, strong and stiff which comes from petroleum which is often formed by blowing it. Recycled HDPE is obtained from seed producing factories plastic in the solo area [12]. HDPE plastic used in this research it is a type of recycled HDPE engine oil bottle in the shape of a small tube with length 2 mm and diameter 1 mm. Seed form rHDPE plastic as shown in Figure 4.

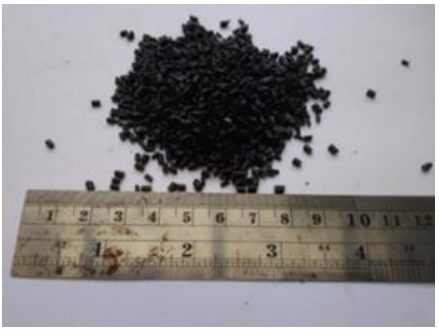

Fig 4. rHDPE Plastic Seeds

Bundle Tire Powder

Used tire powder used in this research obtained from the process of cutting the car tires vulcanized to determine the size of tire powder used, first carry out sieving so that the powder size can be determined as 6 – 7 mesh. Form from used tire powder is shown in Figure 5.

Fig 5. Used Tire Powder

Asphalt

The type of asphalt used in this research is solid asphalt from the DPU (Public Works Department) which is used for highways. This form of asphalt can be seen as figure 6.

Fig 6. Solid Asphalt

2.6. Composite Composition

The initial step in making specimens begins with weighing 15 pieces of used tire powder weighing 500 grams. Weighing 15 pieces of asphalt weighing 100 grams, and rHDPE plastic pellets weighing 20, 30, 40, 50, 60, 70, 80,90, 100, 120 grams respectively as shown in Table 2.

Table 2. The Composite Composition

No	Used Tire (gram)	Asphalt (gram)	rHDPE (gram)
1	500	100	20
2	500	100	30
3	500	100	40
4	500	100	50
5	500	100	60
6	500	100	70
7	500	100	80
8	500	100	90
9	500	100	100
10	500	100	120
11	500	200	40
12	500	200	60
13	500	200	80
14	500	200	100
15	500	200	120

3. Results and Discussion

3.1. Tensile Test

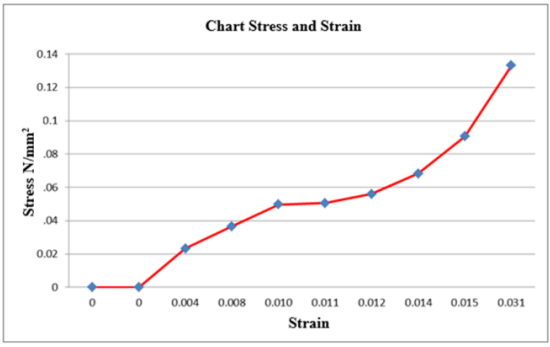

Fig 7. Stress and strain Specimen with a composition of 500 grams of used tire powder, 100 grams of asphalt.

From the results of the tensile tests that have been carried out, tensile stress value data will be obtained and the mechanical properties of the composite or specimen being tested will be known. The tensile test results of the first specimen, namely with a composition of 500 grams of used tire powder and 100 grams of asphalt, will produce a graph of the stress and strain relationship shown in Figure 7.

Data from tensile testing results for the second specimen with a composition of 500 grams of used tire powder will produce a graph of the relationship between stress and strain in Figure 8.

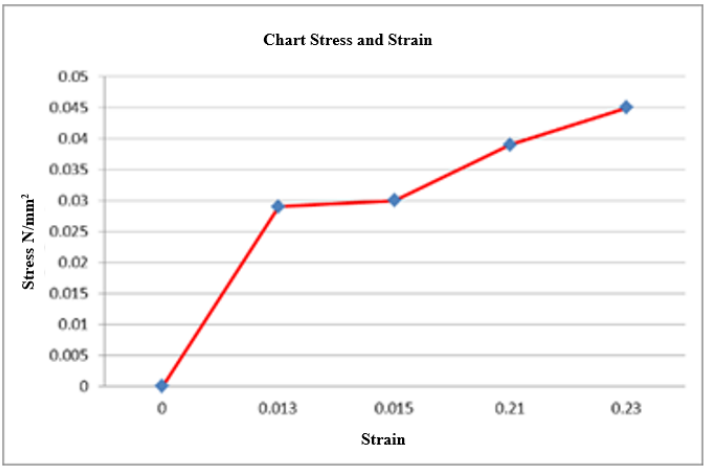

Fig 8. Stress and strain Specimen with a composition of 500 grams of used tire powder, 200 grams of asphalt.

Figure 8 is a stress and strain relationship curve from tensile test results. From the curve we can see the relationship between the load applied is directly proportional to the change in length of the material. The curve shows that the higher the tensile stress value of the specimen, the higher the strain value shows the specimen with the composition of 500 grams of used tire powder, 100 grams of asphalt has the highest stress value for the specimen with a variation of 120 grams of rHDPE of 0.1332 N/mm2. The lowest stress value was owned by the specimen with the 40 grams rHDPE variation of 0.2333 N/mm2. The stress and strain values show that variations in rHDPE influence the tensile stress of the specimen, the greater the rHDPE content, the higher the tensile stress. This proves that rHDPE is useful as a reinforcement in a composite.

Figure 8 shows the stress and strain curve of the tensile test results of specimens with a composition of 500 grams of used tire powder, 200 grams of asphalt with rHDPE variations of 60 grams, 80 grams, 100 grams, 120 grams. The curve shows that the higher the tensile stress of the specimen, the higher the strain value for the composition of 500 grams of used tire powder and 100 grams of asphalt, the highest tensile stress value had the specimen with the 120 grams rHDPE variation of 0.045, while the lowest tensile stress value had the 60 grams rHDPE variation. In this composition the tensile stress value is lower than the previous composition. This is because the asphalt composition is greater, making the specimen tend to be softer.

3.2. Impact Testing

For impact testing results, the difference in impact value of the work piece is caused by several things. Among other things, this is because the strength of the work piece is not evenly distributed so that the energy absorbed in the composite is different. From the impact test results data, it can be seen that the specimen with a composite composition of 120 grams has the highest impact strength value of 1.493 J/mm^2

The lowest value in this variation is found in the composition of 20 grams with an impact value of 0.992 J/mm^2. The results of the impact test can be seen in Figure 8. The rHDPE content influences the impact strength of the work piece, the greater the rHDPE content of the work piece, the higher the impact strength.

From Figure 9, it can be seen that the more rHDPE content inthe specimen, the greater the impact strength value it will get higher. In this variation, the highest impact value of 1.246 J/mm^2 was obtained by the specimen with an rHDPE content of 120 grams. However, the highest impact value in this variation is still less than the impact value of the first variation. This is because the asphalt composition is greater. The asphalt content in the specimen does not affect the tensile stress or impact strength. Asphalt only functions as an adhesive, and as a reinforcement it is influenced by the rHDPE composition.

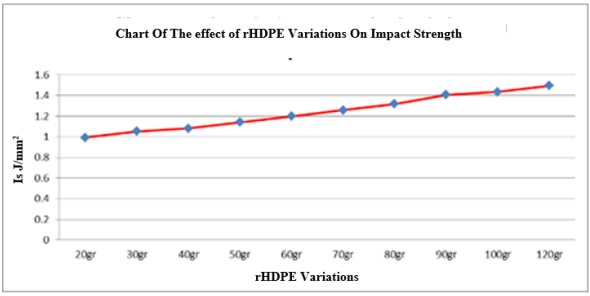

Fig 9. Effect of rHDPE composition on Impact strength value for variations of 500 grams of powder old tires, 100 grams of asphalt.

The energy absorbed by specimens with rHDPE composition will affect the impact value. It is proven that the rHDPE composition contained in the specimen will play an important role as reinforcement.

In Figure 10 you can see a graph of the effect of rHDPE composition on impact strength for variations of 500 grams of used tire powder, 200 grams of asphalt, variations of 500 grams of used tire powder, 200 grams of asphalt. Impact test results data can be obtained.

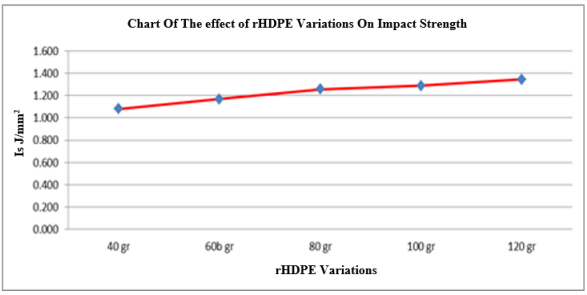

Fig 10. Chart of the influence of rHDPE composition on impact strength on variations of 500 grams of used tire powder, 200 grams of asphalt.

3.3. Micro Photo Result

From the results of the micro photos in Figure 10 below, you can see the micro structure of the composite with different variations.

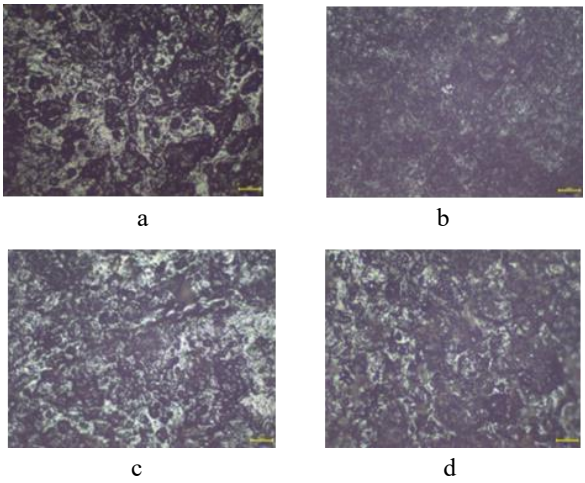

Fig 11. (a) Micro composite photo of 500 grams of used tire powder, 100 grams of asphalt, and 20 grams of rHDPE.(b) Micro composite photo of 500 grams of used tire powder, 100 grams of asphalt, and 120 grams of rHDPE. (c) Micro composite photo of 500 grams of used tire powder, 200 grams of asphalt, and 40 grams of rHDPE. (d) Micro composite photo of 500 grams of used tire powder, 200 grams of asphalt, and 120 grams of rHDPE.

From the results of micro-photographs of specimens of all variations, it can be seen that specimens with a small amount of rHDPE composition, the structure is dominated by asphalt in most parts. This can cause specimens containing rHDPE to have quite small tensile stress and impact strength. The cause is that the specimen is soft due to the influence of asphalt.

In contrast to specimens that have a high rHDPE content, from the results of micro photos of these specimens, asphalt no longer dominates. It can be seen that the three compositions are starting to spread evenly to all parts of the workpiece. From this we can know that rHDPE acts as a reinforcement for the specimen

3.4. Comparison of the Mechanical Properties of Used Tire

It is hoped that the composite from the results of this research will produce a composite that can be used as a substitute for asbestos used for plasterboard (house ceilings). From tensile testing and asbestos impact testing, the tensile stress value was 2.822 N/mm^2 and impact strength of 0.40 J/mm^2. It is known that the highest composite tensile stress value is 0.1332 N/mm^2, so it is still inferior when compared to the tensile stress value of asbestos. The highest impact value of the composite in this study was 1.493 J/mm^2, which is greater than the impact strength of asbestos. The higher the impact value of the workpiece indicates the higher its ductility, while the low impact value indicates the workpiece is brittle. From the

comparison of these strength values, with a high impact value, the composite of used tire powder, rHDPE, and asphalt can still be used for house ceilings as a replacement for asbestos to beautify the appearance. We just need to add color to this composite to create a shape according to its use.

4. Conclusion

From the results of the research and data analysis that has been carried out, conclusions can be drawn, including the following:

1. Composites with the highest rHDPE composition have high tensile stress and impact strength values.
2. In a mixture of 500 grams of used tire powder and 100 grams of asphalt, the highest tensile stress and impact strength values were obtained in the 120 grams rHDPE variation.

In a mixture of 500 grams of used tire powder and 200 grams of asphalt, the highest tensile stress and impact strength values were obtained for the 120 grams rHDPE variat.

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