The effect of tire ash to the compressive strength of concrete

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Abstract. The purpose of this study was to determine the effect of the addition of tire ash as a partial replacement of cement for concrete slumps. This study has experimented with cylindrical specimens with a diameter of 150 mm and a mixture length of 300 mm. It was planned to establish a cement water factor of 0.49 with the concrete compressive strength 25 MPa and a reduction plan of 60-180 mm, the percentage of tire ash substitution from the weight of cement 2.5%, 5%, 7.5%, and 10%, the cement used in this study was PCC type I cement from PT. Semen Padang. The results of the use of tire ash as a substitution showed that the greater the addition of tire ash, the greater the value of the slump obtained, meaning that the concrete produced is thinner so that it can facilitate the processing and compaction process. The use of tire ash cannot influence the increase or the same as of the concrete compressive strength and cannot be used as a substitute or reduction in the use of cement with the type I composite cement produced by PT. Semen Padang. Further research is needed on the content of the physical and chemical properties of tire ash.

1. Introduction
The growth of the automotive industry has increased demand for vehicle tires, thus also causing an increase in the number of used tires that are not used. At this time, the more needs and the use of tires, the more waste is produced, the waste from used tires is very difficult to process naturally, one of the efforts in waste treatment is by combustion through the process of crushing the tire to be smooth. Tire ash is included in the natural pozzolan material because it contains silica (SiO₂). Silica is a substance contained in cement. Cement is a very complex industrial product, with different mixtures and arrangements.

In the construction world, the material used is material available in nature, for example in the manufacture of concrete. Concrete is the mixing of fine and coarse aggregate materials, namely sand, stones, or other similar materials, by adding enough cement adhesives and water for chemical reactions during the hardening and concrete treatment process. Fine and coarse aggregates are referred to as mixed coarse materials, are the main components of concrete.

In this study, researchers tried to utilize tire waste that is difficult to be degraded by nature as a substitute or a partial replacement of cement which is expected to be a material that can be used in concrete mixes and one of the efforts to handle waste generated from used tires.

The research used to fly ash has been carried out [1-10]. Rubber ash as part substitute the sand in the cement mixture has been examined [11-14]. Sinabung volcanic ash is lighter, so can fill the void in the asphalt mix [9]. Fly-ash used to replace cement in concrete must be have conditions determined by appropriate standards and techniques [6].
2. Research methodology

Tire ash is the result of burning from vehicle tires. Most of us burn tires just like that, regardless of their effect on our environment. Therefore, this study shows that tire ash has enormous benefits for concrete, as a substitute for cement. How the influence of the strength of the concrete on the addition of a portion of the ash of the vehicle tire is explained in the next discussion. The vehicle ash can be seen Figure 1.

![Vehicle tire ash.](image)

This research was conducted material preparation, material testing or aggregate inspection, mix design, manufacture of test specimens. The method used in planning the mix design is based on SNI 03-2834-2000 and slump test SNI 03-1972-1990 [15].

Test items made using cylinders (150 mm x 300 mm). The test variable was the percentage of tire ash. The samples in this study were 15 samples. The concrete compressive strength was 25 Mpa with slump 60-180 mm. The cement water factor was 0.49. This specimen used fine aggregate from Teratak Buluh and PCC cement type 1 from Padang cement.

Table 1. Variable of specimens.

| No | Percentage of ash tire | number of test specimens |
|----|------------------------|--------------------------|
| 1  | 0                      | 3                        |
| 2  | 2.5                    | 3                        |
| 3  | 5                      | 3                        |
| 4  | 7.5                    | 3                        |
| 5  | 10                     | 3                        |

Formula concrete compressive strength ($f_{c'}$).

$$f_{c'} = \frac{P}{A}$$

($f_{c'}$ is Concrete compressive strength (Mpa), $P$ is Maximum load (N) and $A$ is The cross-sectional area of the test object (mm$^2$)). The research stages were shown in Figure 2. The specimens and set up were shown in Figure 3.
Figure 2. Research stages.

Figure 3. Specimens and set up specimen.
3. Results and discussion

Compressive strength testing is carried out after 28-day specimens for each stirring both normal concrete and using tire ash. The results of the examination of the slump test aim to check for changes in water content in the concrete mix, while the slump value is intended to determine the nature of the workability (ease in processing) of concrete in accordance with the specified conditions, the lower the value of the slump shows the concrete is thicker and the process compacting or concrete work will experience difficulties and take a long time. Meanwhile, high slump value indicates that the concrete is runny, in the process of compaction or compaction is easier to do and does not require a long time in the compaction process.

![Graph of the relationship of the percentage of tire ash to the value of slump.](image)

Based on Figure 4, it can be seen that the examination of slump values both normal concrete mix and concrete mixture added with tire ash shows the value in the slump value of the plan which is 60-180 mm. the addition of tire ash as a substitute for cement increases the value of concrete slump from normal concrete. A more additional percentage of the resulting slump tire ash mixture rises which makes the concrete mixture thinner than normal concrete.

From the results of cylindrical test specimens using compressive strength machine, the results for each stirring, analysis can be seen in Figure 5.

![Relationship between tire ash percentage and concrete compressive strength.](image)

Substitution material which is estimated to be able to replace or help cement to increase the strength of concrete has not produced higher compressive strength or is equivalent to the quality of the plan which can be due to the element from the ash of the tire itself has not helped the process of hardening concrete.
In this study, the results obtained showed that the more the percentage of substitution of tire ash used, the compressive strength concrete continued to decrease in each percentage of substitution of tire ash. The decrease compared to normal concrete, in the substitution of 2.5% tire ash has decreased by 4.44%, in the substitution of 5% tire ash has decreased by 12.88%, in substitution 7.5% tire ash has decreased by 14.25% and 10% in tire ash substitution experienced the largest decrease of 34.47%. It can be seen that the additional material for tire ash cannot yet become a cement substitution material.

4. Conclusion and recommendation
The results of this study indicate that the addition of tire ash as a substitute for cement increases the value of concrete slump from normal concrete, it can be seen from the results of slump testing where concrete becomes thinner than normal concrete which does not use tire ash so that it can facilitate the process fresh concrete work. From the results of compressive strength testing of the sample obtained at the use of 2.5% compressive strength of ash decreases 4.44%, the use of 5% compressive strength of ash decreases 12.88%, the use of 7.5% compressive strength of ash decreases 14.25%, the use of 10% ash compressive strength of tires fell 34.47% of normal concrete compressive strength. In this study, it can be seen along with increasing the use of tire ash making the compressive strength of concrete decreases. Therefore, it can be concluded that the use of tire ash cannot influence the increase or equalization of the compressive strength of concrete and cannot be used as a partial replacement or reduction in the use of cement in the manufacture of concrete.

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