

# Onyx Stone Waste As a Replacement of Coarse Aggregate In Concrete Mixture

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**Abstract**— To overcome the waste problem, the onyx and marble industries in Tulungagung are abundant and have the potential to be used as aggregates in concrete mixes designed as concrete. The compressive strength study was carried out on 30 concrete cylindrical specimens measuring 15x30 cm, tested at 28 days. The concrete mixture was planned to reach a strength of 20 MPa with a value of Water Cement Factor (W/C ratio); of 0.4. The results showed that the compressive strength of onyx reached the target, the strength ratio was almost the same as that of ordinary crushed coarse aggregate, and the difference was about 17% from the value of the compressive strength of standard concrete. From these results, the use of onyx stone as a substitute for crushed stone can be used as concrete with more aesthetic value.

**Keywords**— Onyx Waste; Compressive Strength; Age of Concrete; Water Cement Ratio

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## I. INTRODUCTION

Waste is the result of waste from a large or small industry that is no longer used. Waste that is not used can be reprocessed to get better results than being abandoned or thrown away and then burned. The combustion process even raises a new problem, namely air pollution everywhere. In Gamping Village, Campur Darat sub-district, Tulungagung, there is much onyx waste from the stone craft industry. Onyx stone waste is vast in volume and can potentially be used as a construction material, one which is that it can be used as a substitute for coarse aggregate in concrete mixtures.

Concrete consists of a mixture of portland cement or other hydraulic cement with fine aggregate, coarse aggregate, and water with or without, forming a solid mass, with a standard concrete density generally between 2200 – 2500 kg/m<sup>3</sup> using crushed natural aggregate. (Komajaya et al., 2020) To get good strength, the properties and characteristics of each constituent material of the concrete need to be studied.

Portland pozzolan cement is a hydraulic cement consisting of a homogeneous mixture of portland cement and fine pozzolanic material, which is produced by grinding portland cement clinker and pozzolan together or evenly mixing portland cement powder with pozzolan powder, or a combination of grinding and mixing, where the pozzolan content is between 6% and 40% by mass of portland pozzolan cement. (Rahman et al., 2020)

One factor that affects the cement's hardness is the cement grains' fineness. So that the more surface area of cement that can be hydrated, the more cement gel will form well at a young age of concrete, which will increase the concrete's initial strength. (Ningsih et al., 2012)

Coarse aggregate is gravel resulting from natural rock fragments or in the form of crushed stone obtained from the crushing stone industry and has grains with a size between 4.75 mm (No. 4) to 40 mm. (Jurnal, 2018)

According to ASTM C33, coarse aggregate consists of gravel or crushed stone with a grain size greater than 5 mm or between 9.5 mm and 37.5 mm. (Jamal et al., 2018)

Fine aggregate is aggregate with a maximum grain size of 4.76 mm originating from nature or fine aggregate resulting from the breakdown and separation of grains by filtering or other means from rock or the like. (Zain, 2017).

Natural rocks can be classified into 3 groups: Igneous rock, Sedimentary rock, and Metamorphic rock. (Panggabean & Tambing, 2022). The Most Important Minerals In Aggregate: (ASTM Standard C294-69) (Kosim & Hasan, 2014).

- Silica Mineral
- Micaceous Mineral
- Sulfate Mineral
- Ferromagnesian Mineral
- Iron Oxide Ion Minerals
- Feldspar
- Carbonate Mineral
- Iron Sulphide Mineral
- Zeolites
- Clay Mineral

The Marble Institute of America explained that the name "onyx" comes from the Greek word "onux" which means "paw" or "fingernail," which is called its similarity to the translucency and color of fingernails. (Wahjuni & Wisnumurti, 2021)

Onyx is a type of quartz stone that is often referred to as translucent marble. Generally yellowish white and slightly translucent, so translucent. Onyx occurs in the cavity or pressure of quartz stone that comes from a calcium carbonate solution at hot or cold temperatures, resulting in crystallization. From the results of laboratory tests obtained asus as much as 24%. (Annisa et al., 2016)

Concrete with a mixture of onyx stone waste as an aggregate to replace crushed stone has been investigated for its physical, mechanical, and chemical properties, which show a tendency for concrete properties that are pretty good and can meet the required standards. A mixture with a water-cement ratio (W/C ratio) of 0.4 in a concrete mix with onyx waste aggregate produces the highest strength compared to other W/C ratio values. (Romadhon & Suwarno, 2019)

Concerning the porosity of concrete, the porosity value of the onyx waste concrete indicates a decrease in the porosity value (Aditya, 2012). In contrast, the value of the modulus of elasticity of concrete increases the value of the modulus of elasticity compared to standard concrete with crushed stone aggregates. (Soelarso & Baehaki, 2016) which shows properties that strongly support the possibility of using onyx stone waste as aggregate in concrete mixtures.

The Effect of Using Onyx Waste as a Substitute for Coarse Aggregate in Concrete Mixtures on the Flexural Strength of Concrete was found that the W/C ratio variation had an effect on the flexural strength of the beam. (Hepiyanto & Kartikasari, 2018)

Mahmud & E. W., Setyowati & Soehardjono, and Agoes (Nugroho et al., 2021) showed no difference between the flexural strength (flexural moment) of onyx concrete panels before polishing and after polishing.

It is possible to use marble waste as a substitute for aggregate in the concrete mix. This replacement can be done up to 100% and reach the optimal condition at 75 % aggregate replacement in the concrete mix.(Benhalilou et al., 2020) This coarse and fine aggregate

replacement can also be done with the combination of paving and nonstructural concrete, increasing strength and workability. (Gencel et al., 2012)

Previous research entitled "Concrete with onyx waste aggregate as aesthetically valued structural concrete" by Edhi Wahyuni Setyowati et al. (E. Setyowati & Soehardjono, 2017) from Civil Engineering Universitas Brawijaya shows that the mechanical test results of the Tulungagung onyx waste concrete have a strength level that meets the requirements for use as structural concrete with a higher aesthetic level.

Onyx waste as a substitute for coarse aggregate in concrete was able to improve the porosity value of the concrete (Kürşat Esat Alyamaç & Aydın, 2015). Concrete made from granite and marble wastes as aggregate still needs a plasticizer. However, these components can still be used to improve the concrete's mechanical nature, workability, and chemical endurance.(Singh et al., 2017)

Coarse aggregate has a significant impact on the color of the concrete. The bright color onyx turns concrete into a more brilliant color. The marble aggregate also gives a pattern to the concrete's surface so it can be used as exposed concrete.(K E Alyamaç & Tuğrul, 2014) Using Tulungagung onyx waste as the aggregate of the concrete mix in a good mixture will produce adequate concrete strength and fulfill the strength criteria for the structural concrete.(E. W. Setyowati, 2016). Concrete made with beautiful colored onyx aggregates produces concrete that can add aesthetic value when used in building structures and is environmentally friendly.

## II. RESEARCH METHOD

The population is all the research subjects or the subjects studied, while the sample is partly taken from all the subjects studied and is considered to represent the entire population. (Arianti et al., 2019). If the research subject is less than 100, then the sample is better taken all so that the research is a population study. (Saleh & Malinta, 2020)

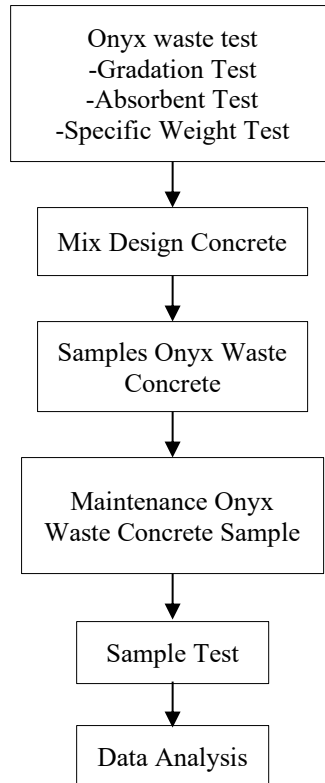
So the number of samples = population.

In this research, tests are conducted on 30 concrete cylinders for 28-days to see the compressive strength based on ASTM standards, with details as follows:

**Table 1.** TEST SAMPLE

No	Specimen	
	Type Aggregates	Total
1	Normal Concrete	15
2	Onyx Concrete	15

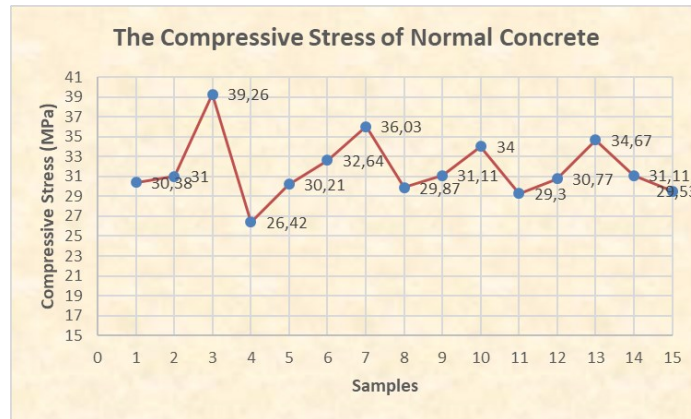
The concrete mix design is based on the standard of Indonesian standard SNI (Hudori et al., 2022) (Hunggurami et al., 2017) (Hermanto, 2017) with the ratio of water/cement is 0.4, slump value is 180 mm, with the proportion of mix cement: fine aggregate: coarse aggregate = 1:1.40:1.78 for standard concrete, and the ratio of mix cement: fine aggregate: coarse aggregate = 1:1.36:1.73 for onyx concrete; targeting to create strength of 32 MPa. The test is done through stages corresponding to research steps stated in the diagram as in Fig. 1.



**Figure 1.** DIAGRAM OF RESEARCH

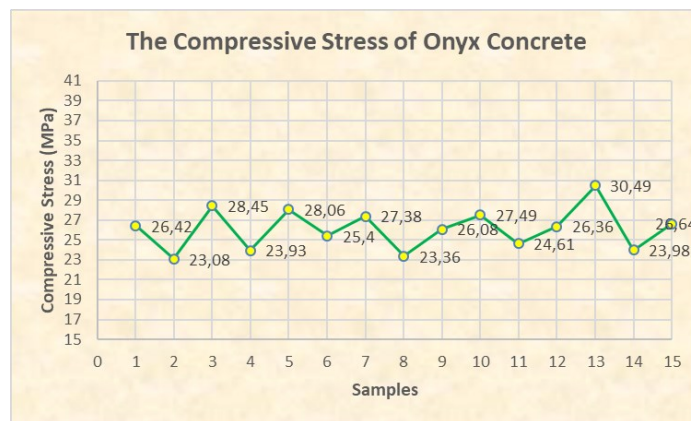
### III. RESULT AND DISCUSSION

From the tests done on the 28-days old concrete samples, the result of the measurement of weight and strength of concrete are shown in the figures follows. The Compressive Strength of Normal concrete achieves an average of 31.75 MPa, for the mix with the ratio of water/cement is 0.4.



**Figure 2.** THE COMPRESSIVE STRENGTH OF NORMAL CONCRETE

By replacing the aggregate with onyx waste aggregate in the concrete mix, it resulted in a very well strength that achieved an average of 26.11 MPa for the blend with the ratio of water/cement is 0.4; therefore, it can be determined that replacing aggregate with onyx waste to the concrete mix can be used as structural concrete. The difference was about 17% with the value of the compressive strength of ordinary concrete.



**Figure 3.** THE COMPRESSIVE STRENGTH OF ONYX CONCRETE

#### IV. CONCLUSION

From the observation of all tests done for characteristic changes in onyx concrete, it can be concluded that:

- Concrete using Tulungagung onyx waste aggregate has strength that meets the qualification as structural concrete material for standard construction. The strength ratio was almost the same as that of ordinary crushed coarse aggregate, and the difference was about 17% from the compressive strength value of standard concrete.
- With its brighter color and appearance, concrete using Tulungagung onyx waste aggregate has the potential to be used as a block of exposed concrete.

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