UTILIZATION WASTE OF FLY ASH AS A ADDITIONAL FOR CONCRETE MIXTURE WITH IMPLEMENTATION OF ECO GREEN CONCRETE

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Seeing the progress in the current industrial era, science and technology are also growing rapidly. On the other hand, there are many facilities and access that need to be built, especially in the construction sector. In the field of construction itself includes the construction of buildings, bridges, roads, airports, and others. Almost all developments in the construction sector use concrete-based materials.

In terms of buildings that use concrete-based materials, the need for concrete is also increasingly needed, especially concrete-forming materials. Good quality concrete is in accordance with material planning that is durable and free (Mulyono, 2005). In general, concrete consists of a mixture of cement, water, sand and gravel. Sometimes it also requires additional materials (admixture) to improve the quality of the concrete (Asroni, 2017). To keep the concrete-forming materials stable and not run out in the future, other alternative materials are needed. However, it is necessary to do testing or research on these materials so that they can be used properly and effectively so that they can be used as materials for concrete mixtures.

The use of cement in the construction world is also increasing rapidly. Cement is also the main material needed in making concrete for the basic materials of building construction. The type of cement used is portland cement. The content in cement includes materials containing lime, iron oxide, and silica. The chemical composition of portland cement includes CaO, SiO2, AI2O3, and Fe2O3 where the components belong to the dominant oxide. But in cement there are also other oxides that amount to only a few percent of the weight of cement are MgO, SO3, Na2O, and K2O.

In Indonesia, a lot of waste is scattered and the waste if not processed can accumulate. Untreated waste can have a negative impact both in terms of the environment and human resources around. This needs to be done in handling waste both in terms of benefits and the direction to go, one of which is the use of eco green concrete. By applying eco green concrete, waste that is no longer used can be reprocessed into basic materials for construction.

One of the construction waste that will be used is Coal Ash (Fly Ash). Fly ash is the residue from the combustion of coal from power plants. Based on (SNI 03-6414-2002), the definition of fly ash is coal combustion waste in a steam power generating furnace and has pozzolanic properties. According to (wikipedia.com), Fly ash production produced from power plants in Indonesia is increasing.based on a report by PT PLN (Persero), in 1997, the production of flying ash waste is estimated at 2 million tons and will increase to 3.3 million tons until 2009. Until

2016, according to (dunia-energy.com, 2016) it is predicted that the resulting fly ash waste can reach a value of 8.31 million tons in 2019.. For fly ash itself, there is quite a lot of waste which if not reprocessed, the waste will accumulate and can cause negative impacts on the environment. by utilizing fly ash as an added ingredient for concrete mixtures, it will be very useful and reused in the future.

Fly Ash is a material that comes from the rest of the combustion of coal ash. According to ASTM C.618 (ASTM, 1995:304), Fly Ash is a fine grain derived from coal combustion residue or can be called coal powder. According to ACI Committee 226, Fly Ash has fine grains that pass the NO sieve. 325 (45 milli microns) 5-27% with a specific gravity between 2.15-2.7 and has a gray-black color. The pozzolanic processing properties of Fly Ash are similar to those of other pozzolanic materials. In addition to meeting the criteria for being a material that has pozzolanic properties, Fly Ash also has good characteristics, namely an average pore radius of 0.16 milli microns, a median size of 14.83 milli-microns, and a specific surface area. 78.8 m2/grams. The shape of the fly ash particles is spherical with a smooth surface which is very good for workability. used as a cementitious and pozzolanic ingredient in hydraulic cement concrete. Fly ash particles have glassy, solid or hollow spherical shape. Nowadays, fly ash has been concerned to replace partial of cement in order to improve the properties of concrete. Previous research, showed influence of fly ash particles (see Fig. 37.1) on the properties of freshly mixed, unhardened concrete, the strength development and other properties of hardened concrete. Using fly ash as partial replacement of concrete decreases the demand of cement so that reduces the CO2 emission from the cement industry.

In Indonesia itself, Fly Ash Waste can be categorized as B3 Waste. Environmental damage in Indonesia caused by Fly Ash pollution can have a negative impact. One of the efforts is the utilization of Fly Ash waste. The general use of Fly Ash is :

1. Production of building materials such as paving, brick, ceramics, cement.
2. Building material works such as the production of concrete, mortar, and so on.
3. Paving and pavement paving.
4. Backfill structure, backfill construction, filling vacant land, mine land, dam area.

Table of Fly As Chemical Requirements

DESCRIPTION	CLASS		
	N	F	C
SiO2 + AI2O3 + Fe2O3, min, %	70	70	50
SO3, max, %	4	5	5
Moisture content, max, %	3	3	3
Incandescent, max, %	10	6A	6

Table Chemical composition and physical properties of the cement, fly ash, and silica fume.

Chemical composition (% by mass)	Cement	Fly Ash	Silica Fume
Silica (SiO2)	21.14	54.46	85.32
Alumina (Al2O3)	5.38	21.70	0.84
Iron oxide (Fe2O3)	3.22	8.85	0.91
Calcium oxide (CaO)	63.24	4.45	0.56
Magnesium Oxide (MgO)	1.19	1.48	0.45
Sodium Oxide (Na2O)	0.28	1,03	1,04
Potassium Oxide (K2O)	0.54	3.85	1,01
Sulfur Trioxide (SO3)	2.34	0.59	0.66
Specific gravity	3.24	2.21	2.19
Blaine fineness (cm2 / g)	3429	3850	165

According to (Trimurtiningrum Google Schoolar), fly ash can increase the compressive strength. it is because the pozzolanic reaction with the calcium hydroside is derived from the hydration of portland cement to from calcium silicate hydrate (CSH) and the small size of fly ash particles causes denser concrete. Moreover, the spherical shape of fly ash increases the workability of fresh concrete, so that a water can be reduced. Therefore, mixture with higher percentage of fly ash has lower water-cementitious ratio that influences the concrete strength. The highest compressive strength is 46.26 MPa at 28 days obtained by the FA-50 mixture. The trends of the strength development of the fly ash concretes show the same result with previous research conducted by P. Nath that fly ash in concrete decreased strength at the earlier age as compared to the control concrete, however they gather more strength or very close to control concrete strength on later age.

According to (Adibroto Google Schoolar), For the value of the compressive strength of concrete, it increased at the age of 28 days where the highest strength value was 30.77 MPa with a 10% variance, followed by 12.5%, 15%, 20%, and 25% variants. For cement substitution using fly ash with a 10% variance, the value exceeds that of normal concrete with a value of 28 MPa. So based on the results of this compressive strength test, the use of 10% Fly Ash variation can be used for rigid pavement planning.

According to (Apriwelni Google Schoolar), The compressive strength of concrete using fly ash and glass powder produces concrete that is better than conventional concrete. Concrete with 0% fly ash and 10% glass powder has the highest compressive strength of concrete compared to the others, which is 46.77%. As the glass powder increases, the compressive strength of the concrete increases. The addition of fly ash to the concrete mixture can affect the compressive strength of the concrete. The 15% fly ash variation is the optimum condition for the concrete

mixture which produces a concrete compressive strength of 43.31 MPa. Both of these wastes can be combined with fly ash as a substitute for cement and the addition of glass powder and used in high-strength concrete.

Aaccording to (Roshani Google Schoolar), The mechanical characteristics of eco-friendly concrete made with Fly ash, which is a waste material in the power generation industry, were correlated with six input parameters including cement, water, Fly ash, and coarse and fine aggregates, along with the SiO2 content of Fly ash, through the development of artificial neural networks The network resulted in accurate prediction of concrete's compressive and tensile strengths, in addition to the modulus of elasticity, in the presence of Fly ash with MSEs of 0.0016, 0.0036, and 0.0004, respectively. The novelty of the paper is to consider the characteristics of Fly ash in predicting the mechanical properties of concrete. With this in mind, any type of Fly ash with any characteristics can be used to produce sustainable and ecofriendly concrete. Almost 83% of the reported results based on the simulation were between ±20% of the experimental compressive strength for the ANN model, which indicated that the proposed ANN was successfully trained to generalize the provided data. The ANN prediction for tensile strength, along with the modulus of elasticity, show more than 83% and 98% within ±20% of the experimental values, respectively. Moreover, the ANN's simulation results were dispersed around the bisector, which indicates neither over-estimation nor under-estimation.

Bibliography

Adibroto, F., Suhelmidawati, E., & Zade, A. A. M. (2018). Eksperimen Beton Mutu Tinggi Berbahan Fly Ash Sebagai Pengganti Sebagian Semen. *Jurnal Ilmiah Rekayasa Sipil*, *15*(1), 11–16. https://doi.org/10.30630/jirs.15.1.85

Apriwelni, S., & Bintang Wirawan, N. (2020). Kuat Tekan Beton Mutu Tinggi dengan Memanfaatkan Fly Ash dan Bubuk Kaca Sebagai Bahan Pengisi. *JURNAL SAINTIS*, *20*(01). https://doi.org/10.25299/saintis.2020.vol20(01).4846

Roshani, M. M., Kargar, S. H., & Farhangi, V. (2021). *Predicting the Effect of Fly Ash on Concrete ' s Mechanical Properties by ANN*. 1–16. https://doi.org/10.3390/su13031469

Trimurtiningrum, R., & Subakti, A. (n.d.). *Compressive Strength and Shrinkage Test of Flowing Concrete Using Fly Ash and Naphtalene-Based Superplasticizer*. 445–454. https://doi.org/10.1007/978-3-319-56062-5