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Experimental Study of Utilization Coconut Fiber as Additional Material and Slag as a Cement Substitution Against Compressive Strength and Split Tensile Strength of Concrete

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Abstract

Development developments have an impact on the building materials industry sector. To reduce CO2 emissions due to soaring productivity of cement, the industry can use Ground Granulated Blast Furnace Slag (GGBFS) as a substitute for cement. This study aims to determine the effect of using GGBFS as a substitute for cement and coconut fiber as an additive on the workability, density, water absorption, compressive strength and split tensile strength of concrete at 3, 7, and 28 days. In this study using the experimental method with a total of 84 samples of cylindrical specimens with a size of 10cm x 20cm. This research was conducted with variations of GGBFS substitution of cement (0%, 35.5%, 43.5%) and coconut fiber as an additive (0.23%, 0.63%).The results of this study indicate that the optimum compressive strength test value at the age of 28 days is at GGBFS (35.5%) and coconut fiber (0.63%) reaches an average compressive strength of 32.32 Mpa. The SU1 variation (24.63 Mpa), SU2 variation (30.20 Mpa), SU3 variation (30.77 Mpa), SU5 variation (28.16 Mpa), SU6 variation (28.31 Mpa). Optimal splitting strength at the age of 28 days, namely the SU4 variation with GGBFS 35.5% and coconut fibers (0.63%) reached an average split tensile strength of 2.23 Mpa.

Keywords :
Compressive Strength of Concrete, Ground Granulated Blast Furnace Slag, Split Tensile Strength of Concrete

1. Introduction

1.1. Backround

The development of infrastructure have an impact on the industrial sector of building materials, in the year 2021 the Indonesian government allocated a budget for the construction of the infrastructure of the country to reach Rp 417,4 trillion, which is budget the biggest for the last 6 years (Annur, 2021).

Concrete is a building material that is most widely used because of its performance is satisfactory in the power requirements and its ability to be molded into various shapes and sizes according to the needs (Oluborode & Olofintuyi, 2015).

The increasing needs of the concrete will directly have an impact on the demand for cement so as to make the productivity of the cement industry will be the soaring, based on data from the Intergovernmental Panel on Climate Change (IPCC) Industry manager cement in a year can produce CO2 gas (Carbon Dioxide) amounted to 930 million tonnes, ranked second after the power plant so that it can contribute about 7% of the total emission of CO2 gas ranges 13.470 million tons/year (M. Natsir Abduh, 2017). Concrete eco-friendly solution in an effort to reduce the emissions of carbon dioxide (CO2), began to do various kinds of research to find the raw materials that have elements compounds such as cement (Ratisno, 2021).

To reduce the emission of CO2 (Carbon Dioxide) due to the industrial manufacture of cement can utilize waste material such as waste material such as material waste, such as waste materials like Ground Granulated Blast Furnace Slag (GGBFS) as a substitution material on the cement. The GGBFS is a waste derived from the industrial processing of steel and can produce up to 940.000 tons of the GGBFS on 2019 is increased (Arief, 2019). The GGBFS is the waste that comes from the process of the manufacture of iron which is a compound consists primarily of SiO2, CaO, Al2O3, and MgO, similar to the main compound manufacture of cement (Turu'allo, 2013). Based on the research that has been done by Anand et al, (2017) found that occurs the increase of concrete compressive strength on concrete M40 with variations of a mixture of 40% on the concrete, so that the GGBFS useful for structural concrete and can reduce CO2 emissions and reduce pollution on the environment. The GGBFS is cementitious and has a content of compounds of similar chemical cement portland in general, so it could potentially be used as a material of the adhesive aggregates such as cement in general (Saranya, Nagarajan, & Shashikala, 2018). This research will use the GGBFS as a substitution material in cement and fibers coconut as an ingredient added to the mix of concrete against the weight of the concrete. Coconut fibers are very easily obtained, especially in the area of the coastal region of indonesia, the vast coconut plantations reached 3.76 million hectares and total production reached 14 billion grains coconut (Rachman, Banjarsanti, & Pranoto, 2020). With production reached 14 billion coconuts so that it has the potential to produce waste coconut fibers and the utilization of coconut fibers to absorb the waste into a material that is valuable and useful. Based on previous research, the use of coir fibers as a material added in the concrete, shows results that fibers of coconut increases the compressive strength of concrete with the variation of the addition of 0.6 % with the results of the compressive strength of 25,07 Mpa (Rachman et al., 2020). With the addition of coconut fibers as a material added to the concrete mix is expected to increase the economic value and the value of the order on the product fibers of the coconut to be able to manage the coconut fiber which is a waste material in the cities into the useful material.

The need for more research on the properties of concrete fiber with a combination of the composition of the GGBFS as cement substitution and coconut fibers as add to the weight of the concrete on the variation of the percentage of the different from research previous to get the results of percentage composition of the material mixture, the optimum has become a trigger for this study with the hope of making a satisfactory result in the material used for construction in the concrete mix. This study aims to utilize the GGBFS as a substitution material for cement and coconut fibers as material added to minimize the use of cement and increase the value of the order as well as the economic value of coconut fibers on the compressive strength and split Tensile strength of concrete.

1.2. Formulation of the Problem

Based on the description above background, the formulation of the problem, namely:

1. How the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against the workability of concrete?
2. How the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against the density of concrete?
3. How the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against water absorption of concrete?
4. How the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete on the compressive strength of concrete?
5. How the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against the split tensile strength of concrete?

1.3. Purpose and Objectives

The Purpose of this research is:

1. To determine the influence of variation of mixed waste the GGBFS and Coconut Fiber as the material mix on the concrete against the workability of concrete
2. To determine the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against the density of concrete?
3. To determine the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against water absorption of concrete?
4. To determine the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete on the compressive strength of concrete?
5. To determine the influence of variations in the mixture of waste the GGBFS and Coconut Fiber as the material mix on the concrete against the split tensile strength of concrete?

2. Literature Review

1. V. R. Anand, Pradeep Kumar, & Bhat, (2017) researched on the effects of concrete with the use of the GGBFS at high volume. (Subarkah, Sjah, & Maknun, 2020) examines the effects of the ggbfs and aggregate recycling of concrete compressive strength.
2. Cahit Bilim, Cengiz D. Atis, Harun Tanyildizi & Okam Karahan, (2008) examines the compressive strength of concrete the ggbfs using artificial neural network.
3. Vinayak Awasare & Prof. M. V. Nagendra, (2018) examines the analysis of the characteristics of strength in the concrete of the GGBFS.
4. Karim et al, (2020) researching about the Improvement of the Binding Properties of the Facades on White Portland Cement Using Ground Granulated Blast Furnace Slag (GBBFS).
5. Rizki Amalia Tri Cahyani, Ernawan Setyono, & Yunan Rusdianto (2020) researching on the Performance of Concrete With Ground Granulated Blast Furnace Slag Against Sulfate Attack.
6. Granulated Blast Furnace Slag Against Sulfate Attack.
7. Cahit Bilim, Cengiz D.Atis, Harun Tanyildizi & Okam Karahan, (2008) researching the compressive strength of GGBFS concrete using artificial neural networks.
8. Siti Fitriani, Wiki Muhammad Fathul M & Ida Farida, (2018) examines the Influence of Ground Granulated Blast Furnace Slag On the Properties of Physics Portland Cement Type-I.

9. Rachman et al, (2020) examines the Comparison of Abaca Fiber And fiber Coconut Fiber As a Material Added To the Concrete Mix.
10. Septian Maulana, (2017) researching about the Influence of the Substitution of Cement With Ash Seashell (Galolnia Expansa) And The Addition Of Fiber Coconut Fiber On The Concrete.
11. (Ir. H. Zainuddin & Wahyudi, 2019) research on the Influence of the Addition of fiber Coconut Fiber In Normal Concrete With the Test of Compressive strength And Flexural strength.

3. Research Methods

In this research use experimental methods with the use of waste the GGBFS or slag as a substitute against the cement and the addition of coir fibers against the weight of the concrete that will be testing the workability, density, water absorption, compressive strength and split tensile strength of concrete. All the process or procedure inconducting this research refers to the SNI (Standard Nasional Indonesia) and ASTM (American Society for Testing and Materials).

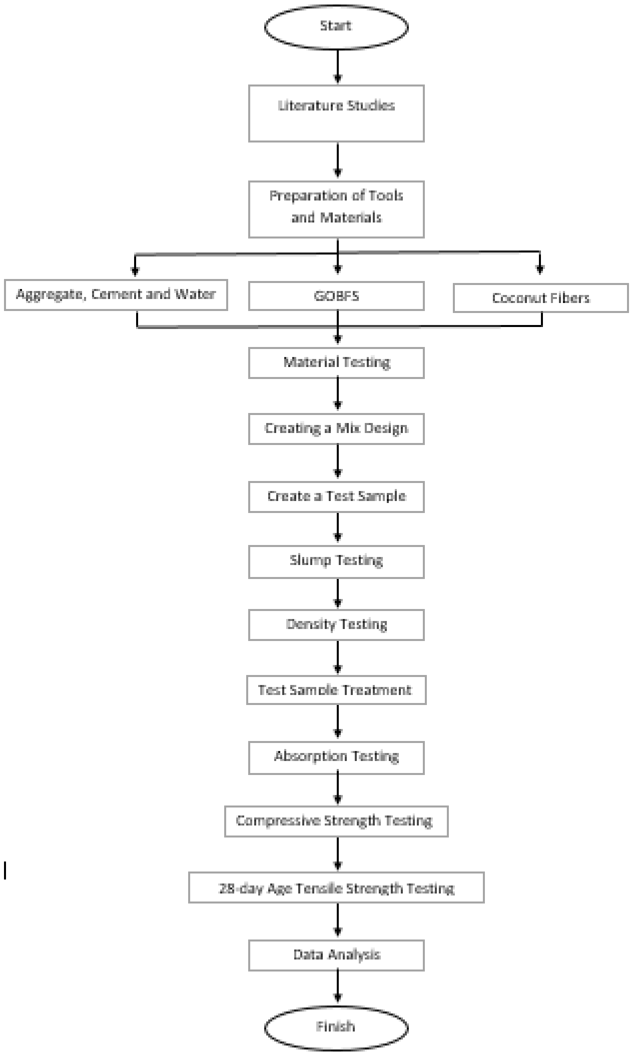

Figure 1. Flowchart Of Research Method

4. Results and Discussion

4.1. workability

Table 1. The Results of The Slump Test

Sample Code	Slump (cm)
BN	10
SU1	11
SU2	11
SU3	12
SU4	12
SU5	12
SU6	12

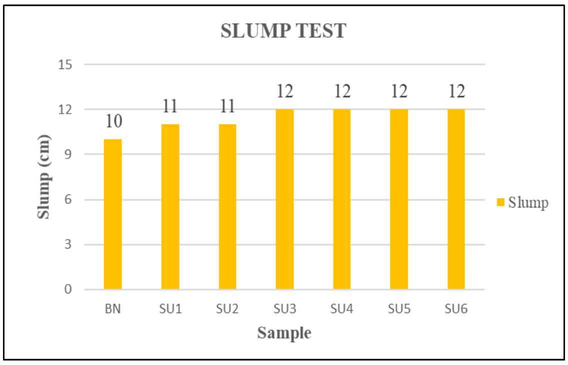

Figure 2. Diagram of Slump Test

From table 1 and figure 2 the results obtained from the slump on a mixture of normal concrete having a slump value of 10 cm which is lower than the test sample other, on the concrete with the addition of the GGBFS and coconut fibers to get the results of slump value by 11 cm - 12 cm. This shows that with the use of superplasticizer on the correct dose that can make the value of the slump in the concrete mixture of the GGBFS and coconut Fibers increased so as to make the concrete easier to work with.

4.2. Densitas Beton

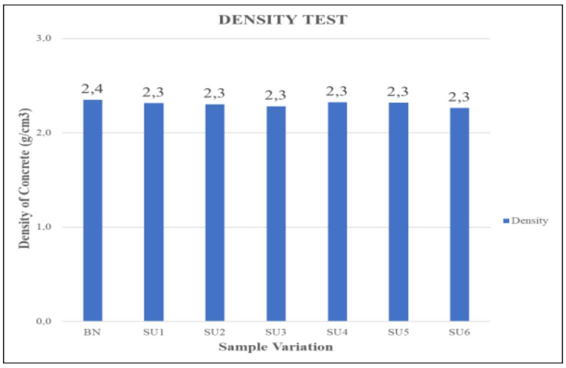

Figure 3. Diagram of Density Test

In figure 3 above explains that the value of the density is highest at the age of 3 days of 2.4 g/cm3 and a low of 2.3 g/cm3. The value of the density is highest at the age of 7 days of 2.4 Kg/m3 and a low of 2.2 g/cm3. The value of the density is highest at the age of 28 days of 2.4 g/cm3 and a low of 2.2 g/cm3. For the density values ranged between 2.3 to 2.4 g/cm3, with the presence of the GGBFS and coir fibers resulted in a density increase compared to the density of the normal concrete.

4.3. Water Absorption

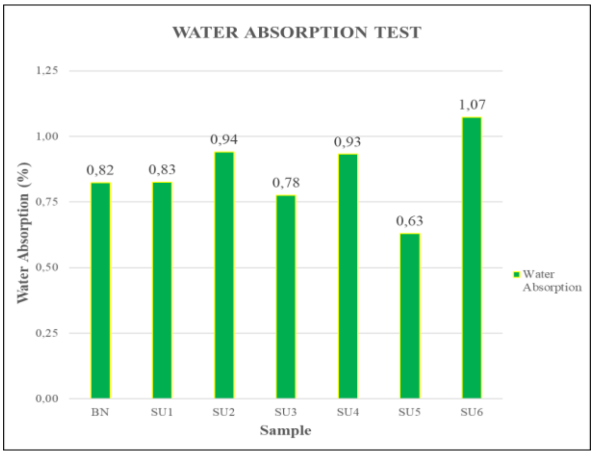

Figure 4 Diagram of Water Absorption

In figure 4 above explains that the value of the absorption of the optimum water contained in the test sample 6 of 1.07 % and minimum water absorption contained in the test sample 5 of 0.63 %. More and more use of coconut fibers resulted in the increasing value of water absorption in concrete.

4.4. Compressive Strength of Concrete on 3 Days

Table 2. Compressive Strength Result on 3 Days

No	Sample Kode	Percentage Coconut Fiber + GGBFS (%)	Compressive Strength F'c (Mpa) 3 Days
1	BN	0%S+0%G	14,35
2	SU1	0,23%S+0%G	13,59
3	SU2	0,63%S+0%G	15,12
4	SU3	0,23%S+35,5%G	15,77
5	SU4	0,63%S+35,5%G	16,79
6	SU5	0,23%S+43,5%G	16,64
7	SU6	0,63%S+43,5%G	16,97

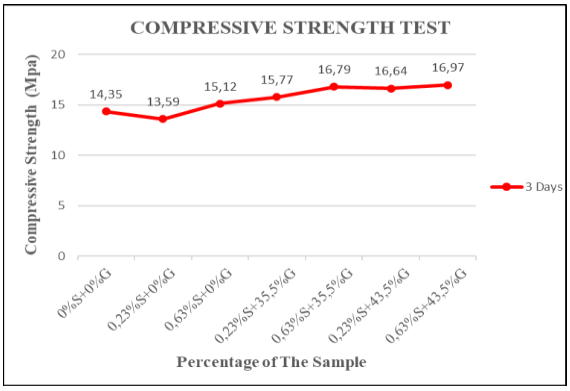

Figure 5. Graph of Compressive Strength on 3 Days

From table 2 and figure 5 the results obtained from the compressive strength at the age of 3 days with the optimum compressive strength on the SU6 by 16,97 Mpa and compressive strength minimum are on the SU1 by 13,59 Mpa. So with the addition of the GGBFS make the compressive strength increased at the time of fastening the beginning or 3 days compared to only wear the coconut fibers in the concrete.

4.5. Compressive Strength of Concrete on 7 Days

Table 3. Compressive Strength Result on 7 Days

No	Sample Code	Percentage Coconut Fiber + GGBFS (%)	Compressive Strength F'c (Mpa) 7 Days
1	BN	0%S+0%G	24,51
2	SU1	0,23%S+0%G	19,99
3	SU2	0,63%S+0%G	21,77
4	SU3	0,23%S+35,5%G	21,93
5	SU4	0,63%S+35,5%G	22,84
6	SU5	0,23%S+43,5%G	17,28
7	SU6	0,63%S+43,5%G	20,40

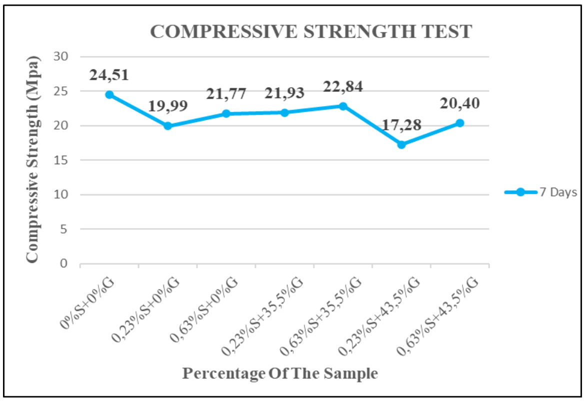

Figure 6. Graph of Compressive Strength on 7 Days

From table 3 and figure 6 the results obtained from the compressive strength at age of 7 days with the optimum compressive strength on the SU4 by 22,84 Mpa and compressive strength minimum are on the SU5 by 17,28 Mpa. So with the existence of the GGBFS and coconut Fibers create a strong press experience decrease compared to normal concrete as the control of a compressive strength, a strong decline press occurs due to the presence of the GGBFS and fibers of coconut create a drop time of pavement concrete that affect the strength of concrete at the age of 7 days.

4.6. Compressive Strength of Concrete on 28 Days

Table 4. Compressive Strength Result on 28 Days

No	Sample Code	Percentage Coconut Fiber + GGBFS (%)	Compressive Strength F'c (Mpa) 28 Days
1	BN	0%S+0%G	30,03
2	SU1	0,23%S+0%G	24,63
3	SU2	0,63%S+0%G	30,20
4	SU3	0,23%S+35,5%G	30,77
5	SU4	0,63%S+35,5%G	32,32
6	SU5	0,23%S+43,5%G	28,16
7	SU6	0,63%S+43,5%G	28,31

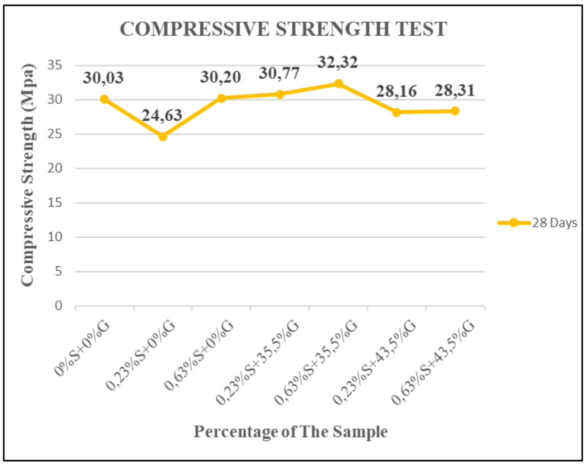

Figure 7. Graph of Compressive Strength on 28 Days

From table 4 and figure 7 the results obtained from the compressive strength at age of 7 days with the optimum compressive strength on the SU4 by 32,32 Mpa and compressive strength minimum are on the SU1 about 24,63 Mpa. So with the existence of the GGBFS and coconut fibers on concrete create a strong press to have an increase in the percentage of substitution of the GGBFS 35.5% and coconut fibers0.63 percent, at the age of 28 days the concrete increased the compressive strength on the percentage of the GGBFS 35,5%, this indicates that in the percentage of the cement can still receive substitution resulting in increased compressive strength while on the percentage of the GGBFS 43,5% occurs decrease in compressive strength, which prove that at the percentage of the cement is not able to work for a maximum due to receive a substitution of 43.5% so that the decline in the compressive strength at the age of treatment 28 days.

4.7. Compressive Strength of Concrete on 3, 7 and 28 Days

Table 5. Compressive Strength For All Age

No	Sample Code	Compressive Strength F'c (Mpa)		
		3 Days	7 Days	28 Days
1	BN	14,35	24,51	30,03
2	SU1	13,59	19,99	24,63
3	SU2	15,12	21,77	30,20
4	SU3	15,77	21,93	30,77
5	SU4	16,79	22,84	32,32
6	SU5	16,64	17,28	28,16
7	SU6	16,97	20,40	28,31

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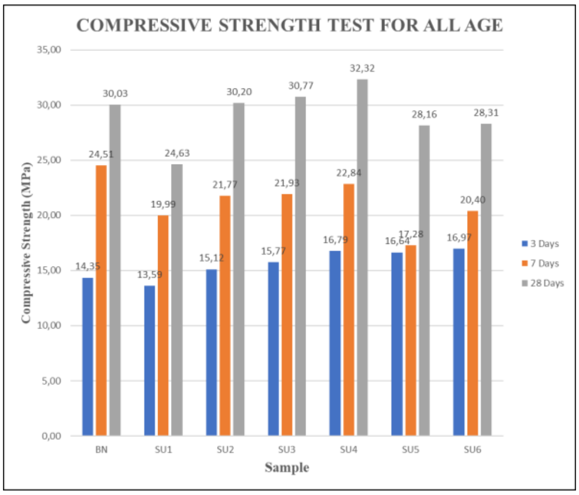

Figure 8. Compressive Strength For All Age

In table 5 and figure 8 above shows that the variation that produces compressive most high is in the test sample 4 at the age of 28 days is equal 32,32 MPa with the percentage of the GGBFS by 35,5% and coconut fibers of 0.63%, while the yield compressive most small variations of the test sample 5 at the age of 28 days is equal 24,63 MPa with the percentage of the GGBFS 43.5% and coconut fibers of 0.23%. Based on the above data, it can be concluded that the substitution of waste The ggbfs to cement has a tendency to increase the compressive strength of concrete on the percentage of substitution of the 35.5% compared with the percentage of substitution of 43.5% with coconut fiber as a natural admixture.

4.8. Kuat Tarik Belah Beton

Table 6. Kuat Tarik Belah Beton

No	Sample Code	Percentage Coconut Fiber + GGBFS (%)	Compressive Strength F'c (Mpa) 28 Hari
1	BN	0%S+0%G	2,08
2	SU1	0,23%S+0%G	2,19
3	SU2	0,63%S+0%G	2,16
4	SU3	0,23%S+35,5%G	2,14
5	SU4	0,63%S+35,5%G	2,23
6	SU5	0,23%S+43,5%G	2,08
7	SU6	0,63%S+43,5%G	2,00

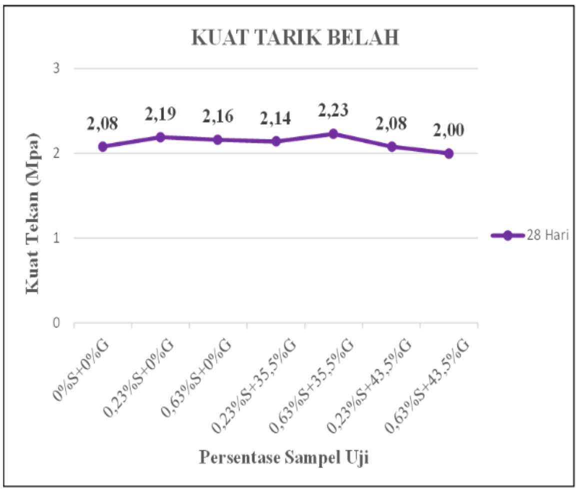

Figure 9. Split Tensile Strength

From table 6 and figure 9 above is known that the split tensile strength optimum contained in the sample test 4 by 2,23 Mpa and split Tensile strength minimum of contained in the sample test 6 amounted to 2.00 Mpa. With the addition of coconut fibers on the concrete resulted in an increase for split tensile strength of concrete while with the substitution The GGBFS by 35,5% and the addition of coconut fibers of 0.63% making the optimum increase in split tensile strength of concrete by 2,23 Mpa. The substitution of the GGBFS on the percentage of 43.5% make split tensile strength the decline compared to the substitution on the percentage of the GGBFS 35,5% against the cement.

5. Conclusion

There are some of the conclusions obtained in this study regarding the influence of waste the GGBFS as a substitute in cement and fiber coconut fiber as the material of the concrete mix, namely :

1. The value of the slump in the range of 10 cm – 12 cm, so it can be concluded that the use of superplasticizer in the concrete mixture of the ggbfs and coir fibers can affect the workability of the concrete. With the presence of superplasticizer make the slump value increases so that the obtained concrete in accordance with the slump plan.
2. Use the GGBFS and coconut fibers in the concrete mix to produce the density at the age of 28 days, which is relatively stable in the range of 2.3 to 2.4 g/cm3. Based on the use of the GGBFS is not so affect the density of the concrete.
3. Water Absorption value by using the The GGBFS gets the value of the water absorption of the highest on the test sample 6 of 1.07 % and the lowest in the test sample 5 of 0.63 %, so it can be drawn the conclusion that the use of the GGBFS and fiber coconut fiber affects absorption of water on the concrete. The higher the variation of the GGBFS (43,5%) the higher for absorption of water on the concrete.
4. The research proves that the waste of the GGBFS
5. and coconut fibers can affect the compressive strength of concrete. Concrete with the mixture of waste the GGBFS as much as 35.5% and coconut fibers as much as 0.63% on the sample test 4 get the compressive strength of the most high at the age of 28 days 32,32 MPa which increased 7,62 % from the variation of the normal concrete. The variation of the sample test 1 got the compressive strength at the age of 28 days by 24,63 Mpa which fell Variations of the test sample 2 gets the compressive strength at 28 days of 30,20 MPa, which increased by 0.56 percent. Variations of the test sample 3 got the compressive strength at 28 days of 30,77 MPa which rose at 2.46 %. Variations of the test sample 5 gets the compressive strength at 28 days of 28,16 MPa which fell to 2.66 %. Variations of the test sample 6 got a strong hit at the age of 28 days by 28,31 MPa which is where the down 5,72 %.
6. It can be concluded that the substitution of the GGBFS against the cement above
7. The research proves that the waste of the GGBFS
8. And fiber coconut fibers can affect the split tensile strength of concrete. Powerful Drag the sides of the highest on the test sample 4 by 2,23 Mpa, which increased by 7,21 % and split tensile strength low on the test sample 6 amounted to 2.00 Mpa with a decrease of 3,84 %. The use of waste slag as a material substitution to cement and fiber coconut fiber as the added material can increase the strong pull the sides of the concrete on the percentage of 35.5% of the slag and of 0.63 % coconut fibers at the age of 28 days. It can be concluded that the use of waste slag or the GGBFS more than 35.5% as a substitution material for cement that will lower the split tensile strength of concrete.

6. Suggestions

The suggestions that can be taken from this research , namely:

1. The use of the ggbfs in concrete mixture Fc 30 MPa will be better in the range of use of the 35.5% with a compressive strength 32,32 MPa and Fibers coconut fibers will be better used in the range of 0.63%.
2. Need to research more on the use of waste coconut fibers so obtained the percentage of usage is optimum on the quality of concrete that can be utilized for the construction of the construction and can reduce the waste coconut fibers. In doing research, should be more thoroughly to the selection, storage and handling of the material or of the material and samples of the concrete so that the quality of the concrete maintained.
3. At the time the special care is needed of the testing materials that can be used, the mix design, curring control, and compressive test to get the results as expected .

7. Thank You

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References

Anand, A., Patience, A. A., Sharma, N., & Khurana, N. (2017). the present and future of pharmacotherapy of Alzheimer's disease: A comprehensive review. National Center for Biotechnology Information.

Anand, V. R., Pradeep Kumar, A. V., & Bhat, A. V. (2017). An experimental investigation on the performance of high volume ground granulated blast furnace slag concrete. International Journal of Civil Engineering and Technology, 8(2), 328–337.

Annur, C. M. (2021). Terbesar dalam Enam Tahun, Anggaran Infrastruktur Capai Rp 417,4 Triliun pada 2021. Https://Databoks.Katadata.Co.Id/, 2022.

Arief, A. M. (2019). Produksi Bertambah, Serapan Terhadap GGBFS Tahun Ini Diproyeksi Meningkat. Retrieved November 3, 2022, from https://ekonomi.bisnis.com/read/20190519/257/924505/produksi-bertambah-serapan-terhadap-ggbfs-tahun-ini-diproyeksi-meningkat

Ir. H. Zainuddin, M., & Wahyudi, A. E. (2019). Pengaruh Penambahan Serat Sabut Kelapa Pada Beton Normal Dengan Uji Kuat Tekan Dan Kuat Lentur, (2), 36–47.

Karim, G. A., Devinta, I., Dedi, D., Balai, B., Bahan, B., & Teknik, B. (2020). Perbaikan Sifat Pengikatan Semu pada Semen Portland Putih Menggunakan Ground Granulated Blast Furnace Slag (GBBFS). Seminar Nasional Teknik Kimia Kejuangan, 0(0), 10. Retrieved from http://jurnal.upnyk.ac.id/index.php/kejuangan/article/view/3588

M. Natsir Abduh. (2017). Teknologi Green Pada Bangunan Berkelanjutan Abstrak. Seminar Ilmiah Nasional Teknik Sipil Universitas Bosowa, 1–17. Retrieved from https://docplayer.info/86195341-Teknologi-green-pada-bangunan-berkelanjutan-abstrak.html

Oluborode, K. ., & Olofintuyi, I. . (2015). American Publication. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), 13(1), 123–131. Retrieved from http://asrjetsjournal.org/

Rachman, L. H., Banjarsanti, S., & Pranoto, Y. (2020). A Perbandingan Serat Abaka (Musa Textillis Nee) Dan Serat Sabut Kelapa Sebagai Bahan Tambah Terhadap Campuran Beton. Jurnal Teknik Sipil, 115–119. Retrieved from https://scholar.google.co.id/citations?view_op=view_citation&hl=id&user=zLaB11EAAAAJ&citation_for_view=zLaB11EAAAAJ:_Re3VWB3Y0AC

Ratisno, A. (2021). Pengaruh Penambahan Abu Bonggol Jagung Sebagai Subtitusi Sebagian Dari Semen Terhadap Kuat Tekan K-225/fc′ 18MPa.

Rizki Amalia Tri Cahyani, Ernawan Setyono, & Yunan Rusdianto. (2020). Performa Beton Dengan Ground Granulated Blast Furnace Slag Terhadap Sulfate Attack. Jurnal Rekayasa Sipil, 3(16), 185–193. Retrieved from https://scholar.google.co.id/citations?view_op=view_citation&hl=id&user=HCd0F7IAAAAJ&citation_for_view=HCd0F7IAAAAJ:2osOgNQ5qMEC

Saranya, P., Nagarajan, P., & Shashikala, A. P. (2018). Eco-friendly GGBS Concrete: A State-of-The-Art Review. IOP Conference Series: Materials Science and Engineering, 330(1). https://doi.org/10.1088/1757-899X/330/1/012057

Septian Maulana, L. (2017). Sistem Informasi Pengelolaan Karyawan CV. Kabita Informatika. Retrieved from https://onesearch.id/Record/IOS4207.52065

Subarkah, M. G., Sjah, J., & Maknun, I. J. (2020). Effects of Ground Granulated Blast Furnace Slag and Recycled Coarse Aggregates in Compressive Strength of Concrete. IOP Conference Series: Earth and Environmental Science, 498(1), 012045. https://doi.org/10.1088/1755-1315/498/1/012045