The Effect of Newspaper Powder on Structural Concrete Pressure Fc ’21, 7 Mpa

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Abstract. The development of the construction industry in the world will increase the need for concrete as a building material. It will continue to grow as well as the need for further concrete in the future. The Concrete is widely used in construction because it is easily formed according to the needs, especially the concrete-forming materials, namely sand, crushed stone, cement, and water. that materials are not difficult to obtain, maintenance does not require a lot of money, and has high compressive strength. The method used in this research is the experimental method at the Laboratory of the Faculty of Engineering, Universitas Islam Lamongan. In this study, the test object used was a cylindrical specimen with a diameter of 15 cm and a height of 30 cm. The concrete compressive strength test is carried out after the concrete has been immersed for a 7 days treatment period, then a conversion is carried out with a correction factor of 28 days. From the results of the normal concrete compressive strength test with 7 days of age converted to 28 days, the average value of 3 samples with a 3% percentage is 18.4 MPa, 5% percentage is 8.6 Mpa, and 10% percentage is 5.8 MPa. From the results of the compressive strength test of paper waste concrete with an age of 7 days converted to 28 days, the composition of 3% is suitable for use. So the 3% percentage of paper waste meets the requirements to be made into fine aggregate in concrete.

Keywords: newspaper, paper waste, structural, concrete pressure, concrete aggregate

1. Introduction
The current condition faced by the construction industry is the issue of natural damage caused by the use of materials in the construction industry, with concrete we can build buildings and infrastructure that make it easier for humans, and with concrete is also a contributor to global warming for the earth we live in (Błaszczyński and Król 2015). Therefore there is an effort to develop and present alternative materials that are environmentally friendly and can be used as a substitute for materials commonly used, especially in materials Concrete.

Experiments on finding alternative materials as concrete mixtures are also often carried out by researchers such as mixing glass waste in concrete mixtures as a substitute for fine or coarse aggregate can reduce compressive strength, this is because the critical percentage of glass replacement is associated with the water-to-cement ratio of concrete because the water-to-cement ratio affects the calcium hydroxide content that reacts with the glass. (Guo et al. 2020).

The experimental concrete mixture replacement also uses a coconut shell mixture (Sucayho, Agustapraja, and Damara 2020), conversion value of the compressive strength of the test object at the age o
Alternative materials that will be tested in this research are utilizing newspaper waste. This material is abundant and can be found in households, offices, schools, and so on. Newspaper paper material is used because it has elastic properties, has fiber, is easy to form, and can be mixed with cement so that the alternative material for newspaper waste in this study is used as an additional material to replace cement.

1.1 State of the art

This research has the following objectives to determine the processing of Newspaper waste which is used as additional material for making concrete? and to determine the effect of mixing Newspaper waste on the compressive strength of Fc 21.7 MPa concrete. So from this research, it can be concluded whether the newspaper material is suitable to be used as a sustainable alternative material as a substitute for cement. Whereas in this
research, using the test material of newspaper waste without combustion, only refined and as a substitute for a cement mixture, and tested with a compressive strength test with a cement substitute mixture of 3%, 5%, and 10%.

2. Methods
This research was conducted using an experimental method, namely by testing concrete samples in the laboratory according to the Indonesian National Standard (SNI) (Badan Standar Nasional Indonesia 2002), for concrete. The samples were tested between normal concrete and concrete with a mixed composition ratio using newspaper waste. The research items to be carried out consist of research on concrete composition materials and the compressive strength of concrete.

2.1. Concrete Materials Research
Composition of concrete constituent materials consisting of cement, sand, (coarse aggregate) gravel and water needs to be tested first, to know the quality of the stacking material whether it is by the provisions of the Indonesian National Standard (SNI) (Badan Standar Nasional Indonesia 2000), the test consists of testing cement, sand testing, gravel testing, and newspaper waste testing.

2.2. Compressive Strength Test
For the implementation of the compressive strength test carried out at the Civil Engineering Laboratory of the Islamic University of Lamongan, this compressive strength test functions to determine the results of the compressive strength of concrete with paper waste aggregates with an age of 7 days tested using a compression testing machine, machine as shown in Figure 1.

\[
\sigma = \frac{A}{P}
\]  
where:
\( \sigma = \) Compressive Strength of the test object (kg/cm\(^2\)),
\( P = \) Maximum load (kg),
\( A = \) Cross-sectional area (cm\(^2\)).

Figure 1. compression testing machine at at the Civil Engineering Laboratory

To obtain the compressive strength of concrete (\( \sigma \)), the formula is:

\[
\sigma = \frac{A}{P}
\]
2.3 Location and Time of Research
The research was carried out in the period between May-July 2020, at the Civil Engineering Laboratory, Faculty of Engineering, Lamongan Islamic University.

2.4 Data collection technique
Data collection in this research was carried out in several stages, namely as follows:
1. Testing the constituent materials of concrete
   a. Portland cement test (PC)
   b. Fine aggregate test (sand)
   c. Coarse aggregate test (gravel)
2. Testing Newspaper Waste as a substitute for cement, Newspaper Waste will later be turned into powder, then soaked and dried so that it can be dissolved and mixed with cement, as shown in Figure 2, the form of newspaper waste is smooth, soaked and dried.

![Figure 2. Drying Newspaper waste previously shredded into powder, soaked and dried](image)

3. Preparation of job mix design using standard with concrete quality (Badan Standar Nasional Indonesia 2000).
4. Testing the compressive strength of concrete based on SNI 03-1974-2011 (Badan Standar Nasional Indonesia 2011).

2.5 Data analysis
To analyse the experimental test results, the test method was carried out by the Indonesian National Standard (SNI) (Badan Standar Nasional Indonesia 2000), Concrete Material Practicum Guidelines, Civil Engineering, Universitas Islam Lamongan (UNISLA).
1. Testing of cement materials:
   - Normal consistency test of Portland cement.
   - Testing the density of cement.
   - Testing of cement binding and hardening time.
2. Testing of Fine Aggregate materials
   - Fine aggregate moisture test.
   - Sand density testing on SSD conditions.
   - Testing the moisture content of fine aggregate infiltration.
   - Testing of fine aggregate volume weight.
   - Fine Aggregate sieve analysis testing.
3. Testing of coarse aggregate materials
   - Coarse aggregate moisture test.
   - Coarse aggregate density testing on SSD conditions.
   - Testing the moisture content of coarse aggregate infiltration.
   - Coarse aggregate volume weight testing.
   - Coarse aggregate sieve analysis testing.
4. Testing of Newspaper paper waste materials
   - Waste newspaper humidity testing.
   - Testing the density of newsprint waste.
   - Testing the moisture content of newsprint waste infiltration.
   - Testing the volume weight of newsprint waste.
   - Testing of newsprint waste filter analysis.

5. Fresh Concrete Testing
   - Slump testing
   - Testing the weight of the concrete

6. Hard Concrete Testing
   - Compressive strength testing
   - Testing the weight of the hard concrete

3. Results and Discussion
The results of the research and trials carried out at the Integrated Laboratory, Civil Engineering, Universitas Islam Lamongan, the results of the concrete sample test were as follows:

3.1 Analysis of Cement Materials
In the trials carried out, using Portland cement material type I, namely cement with the brand Semen Gresik.

| No | Description of activities | Literature Review / Theory Basis | Research result | Information |
|----|---------------------------|----------------------------------|----------------|-------------|
| 1  | Normal consistency test of cement | According to ASTM C 187-86 cement consistency ranges from 26% -29% | Obtained the standard paste wetness conditions of 28% | suitable |
| 2  | Cement density test | (ASTM C 188-95) density of Portland cement which has a range of 3.0-3.2 | From the test, the density of cement obtained was 2.83 gr / liter | Not suitable |

Source: Research Results, 2020
In table 1, it explains that Normal cement consistency testing, cement density testing, and cement density testing, the results are standard by the Indonesian National Standard (Badan Standar Nasional Indonesia 2015).

3.2 Fine Aggregate Analysis
Fine Grain Modulus (MHB), Table 2 explains that the results of the fine aggregate test used for concrete experiments are by Indonesian National standards (Badan Standar Nasional Indonesia 2008) the requirement for grain thirst modulus for concrete according to ASTM is 2.20% - 3.10% MHB 2.5 to 3.0%.

| No | Description of activities | Literature Review / Theory Basis | Research result | Information |
|----|----------------------------|----------------------------------|----------------|-------------|
| 1  | Testing of grain size distribution filter | According to ASTM C 33-78, the implied value | The test results obtained an average of 3.18%; | Not suitable |
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analysis/sand grading; is between 2.2 - 2.3; According to ASTM C 566-89, the permissible humidity for sand is <0.1; The results of the fine aggregate moisture test obtained an average value of 2.56%; Not suitable

Testing the moisture content of fine aggregates; According to ASTM 128-78 the indicated density of sand is 1-4%; The results of the sand density test on SSD conditions obtained an average of 2.70%; suitable

Sand density experiment; According to ASTM 29 M- 91, the implied values are in the range between 1.25-1.59; Obtained the average weight of the test results above is 1.432 gr suitable

The results of the fine aggregate volume weight test

Source: Research Results, 2020

3.3 Coarse Aggregate Analysis
The aggregate used in this research is black aggregate, the material testing process is carried out in 5 stages, namely: gravel moisture testing, gravel density testing, gravel infiltration water testing, gravel volume weight testing, gravel sieve analysis testing, in this test the following results were obtained. This:

Table 3 Suitability of Research Results and Literature Review

| No | Description of activities | Literature Review / Theory Basis | Research result | Information |
|----|---------------------------|----------------------------------|-----------------|-------------|
| 1  | Moisture Gravel Black;   | ASTM C 566-89 Required value between 0 - 3%; | The average gravel humidity is 0.861%; | suitable |
| 2  | Moisture Gravel           | ASTM 566-89 a grade required between 1 - 4%; | Average gravel moisture 4.18% | Not suitable |
| 3  | Density of Black gravel   | ASTM C 128-78 specific gravity of the Gravel required between 2.2 - 2.7 gr / dm³; | Gravel density the average of the test results 2.36gr / dm³. | suitable |
| 4  | Gravel Density Testing    | ASTM C 128-78 specific gravity of the Gravel required between 2.4 – 2.7gr / dm³; | The average density of gravel from the test results is 4.37 gr / dm³; | Not suitable |
| 5  | Absorption moisture testing Black Pebbles; | ASTM C 127-88-93 the obtained limit is between 1 - 4%. | The average water content of the gravel absorption test results was 11.79% | Not suitable |
| 6  | The water content of the gravel infiltration is steady; | ASTM C 127-88-93 the obtained limit is between 1% and 4%. | The average water content of gravel absorption was 5.25%; | Not suitable |
Black Gravel Volume Weight:

- **ASTM C 29-91**
  - Required Value: 1.4 - 1.7 kg / lt.
  - The average volume weight of gravel is 1.069 kg / lt.
  - Suitable

Gravel Mantup Volume Weight:

- **ASTM C 29-91**
  - The value is Required: 1.4 - 1.7 kg / lt.
  - The average volume weight of gravel is 1.37 kg / lt.
  - Suitable

Gravel Sieve Analysis:

- **ASTM C 33-93**
  - The allowable limit is 6 - 7%
  - Filter analysis: 4.29
  - Not suitable

Source: Research Results, 2020

Table 3 explains that analysis of coarse aggregate aggregate sieve. The sieve analysis using SNI 03 1968 1990 (Badan Standar Nasional Indonesia 1990a) obtained a modulus of fineness of 7.36. Provisions according to SII.0052 the fine modulus values of items 6 to 7.

Fine aggregate The sieve analysis using SNI 03 1968 1990 (Badan Standar Nasional Indonesia 1990a), obtained the modulus of fineness of 2.08. The provisions according to SII.0052 the fine modulus value of grains is 1.5 to 3.8.

Specific gravity and aggregate absorption Testing for aggregate density and absorption used SNI 03 1969 1990 (Badan Standar Nasional Indonesia 1990b).

Wear testing using SNI 03-2417-1991 (Badan Standar Nasional Indonesia 1991). Water content of coarse and fine aggregates. Water content testing uses SNI 03- 1971-1990 (Badan Standar Nasional Indonesia 1990b). Inspection of the sludge content of the material passes through sieve no. 200. This examination uses SNI 03-4142-1996 (Badan Standar Nasional Indonesia 1996).

### 3.4 Slump Testing in Normal Concrete (ASTM C 144-78)

The sample test material that has been stirred and mixed will be carried out a slump test; this slump test is useful for determining the weariness of the concrete mix. For the slump test on concrete, it has a value of 60 mm-180 mm.

**Table 4 Concrete Mixing Comparison**

| No | Concrete Mixing Comparison | Date of manufacture | Slump Value |
|----|-----------------------------|---------------------|-------------|
| 1  | Normal                      | July 15th, 2020     | 9 cm        |
| 2  | C 3%                        | July 15th, 2020     | 8 cm        |
| 3  | C 5%                        | July 15th, 2020     | 8.5 cm      |
| 4  | C 10%                       | July 15th, 2020     | 8 cm        |

Source: Research Results, 2020
Slump is the height of the mortar in the truncated cone against the height of the mortar after the mold is taken. Slump is a guideline used to determine the fatigue level of a concrete mix, the higher the elasticity, the easier it is to work (high workability value). Table 4 explains that normal concrete slump has a height value of 9 cm, while mixing Newspaper paper powder as a substitute for cement with a replacement composition of 3% decreases and a height value of 8 cm is obtained, while in the mixture of 5% composition, a height value of 8.5 cm is obtained, whereas in the 10% composition mixture, a height value of 8 cm is obtained, thus it can be seen that there is an increase in the value of the slump height in the mixture of 5% which is close to the height value of normal concrete, the results of the up and down test can be seen in Figure 3.

3.5 Compressive Strength
The results of the concrete compressive strength test on test objects that is 7 days old, namely on normal concrete test objects and Newspaper waste concrete test objects, This compressive strength test was carried out at the Civil Engineering Laboratory of the Universitas Islam Lamongan (UNISLA), and the results were as follows: From the results of the compressive strength test of 3 normal concrete test objects with an age of 7 days which were converted to 28 days, the average value was 21.7 MPa. From the results of the compressive strength test of 3 Newspaper waste concrete test objects with an age of 7 days which were converted to 28 days, the average value was 10.9 MPa. From the comparison of the research results above, it can be concluded that the compressive strength of the concrete on the Newspaper waste concrete test object decreased by 10.8 Mpa compared to the normal concrete test specimen. This can be seen in table 5, so paper waste does not meet the requirements to be used as a cement mixture in concrete.
4. Conclusion

Based on the explanation in the previous chapters regarding the addition of newspaper waste as a mixture of concrete, it can be concluded as follows:

1. The process of making concrete using newspaper waste added material starts with the provision of newspaper waste powder, cement material testing, sand material testing, crushed stone material testing, concrete manufacturing process, fresh concrete weighing, concrete mold dismantling process, and finally curing process.

2. From the compressive strength data of normal concrete with an age of 7 days, it is converted to 28 days with $F_c$ 21.7 Mpa. Conclusion the final results of the study get the value of 3 samples with a percentage of 3% compressive strength of 18.4 MPa, 5% percentage of 8.6 MPa, 10% percentage of 5.8 MPa. From the results of the compressive strength test of paper waste concrete with an age of 7 days, it is converted to 28 days so that all percentages cannot be used. It can also be said that the higher the percentage, the lower the quality of the results obtained from the concrete mixture.
5. Recommendation
From the research on adding paper powder from newspaper waste as an additive to the concrete mixture, suggestions that can be given for further research are:

1. In subsequent research, be more careful in the process of weighing and mixing the concrete mixture so that there are no errors and loss of the concrete mixture material.
2. With this research, it is expected that paper waste material can be an alternative for added materials to concrete mixtures in the future.
3. This research is also expected to be used as a contribution to further research for the added material for paper powder or other additives that can be used for concrete mixtures.
4. In further research, a comparison of the addition of added material that has been studied can be carried out with other comparisons so that we can determine the certainty of the value of the change in the compressive strength of concrete with this added material of paper powder.
5. It is necessary to do further research by testing the compressive strength of concrete which has not been carried out in this study.

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References
[1] Badan Standar Nasional Indonesia. 1990a. “SNI 03-1968-1990, Metode Pengujian Tentang Analisis Saringan Agregat Halus Dan Kasar.” 1–5.
[2] Badan Standar Nasional Indonesia. 1990b. “SNI 03-1969-1990, Metode Pengujian Berat Jenis Dan Penyerapan Air Agregat Kasar.” 2–5.
[3] Badan Standar Nasional Indonesia. 1991. “SNI 03-2417-1991, Metode Pengujian Keausan Agregat Dengan Mesin Abrasi Los Angeles.” 12(12):1–5.
[4] Badan Standar Nasional Indonesia. 1996. “SNI 03-4142-1996, METODE PENGUJIAN JUMLAH BAHAN DALAM AGREGAT.” 200(200):1–6.
[5] Badan Standar Nasional Indonesia. 2000. “SNI 03-2834-2000, Tata Cara Pembuatan Rencana Campuran Beton Normal.”
[6] Badan Standar Nasional Indonesia. 2002. “SNI 03-2847-2002, Tata Cara Perhitungan Struktur Beton Untuk Bangunan Gedung. SNI 03-2847-2002.” Bandung: Badan Standardisasi Nasional 251.
[7] Badan Standar Nasional Indonesia. 2008. “SNI 1970-2008, Cara Uji Berat Jenis Dan Penyerapan Air Agregat Halus.” Badan Standar Nasional Indonesia 7–18.
[8] Badan Standar Nasional Indonesia. 2011. “SNI 1974-2011, Cara Uji Kuat Tekan Beton Dengan Benda Uji Silinder.” Badan Standardisasi Nasional Indonesia 20.
[9] Badan Standar Nasional Indonesia. 2015. “SNI 2531:2015, Metode Uji Densitas Semen Hidraulis (ASTM C 188-95 (2003), MOD).” Bandung 95(2003):14.
[10] Błaszczyński, Tomasz, and Maciej Król. 2015. “Usage of Green Concrete Technology in Civil Engineering.” Procedia Engineering 122(Orsdce):296–301. doi: 10.1016/j.proeng.2015.10.039.
[11] Guo, Pengwei, Weina Meng, Hani Nassif, Hongye Gou, and Yi Bao. 2020. “New Perspectives on Recycling Waste Glass in Manufacturing Concrete for Sustainable Civil Infrastructure.” Construction and Building Materials 257:119579. doi: 10.1016/j.conbuildmat.2020.119579.
[12] Meko Kejela, Bikila. 2020. “Waste Paper Ash as Partial Replacement of Cement in Concrete.” American Journal of Construction and Building Materials 4(1):8. doi: 10.11648/ajcm.20200401.12.
[13] Sucahyo, Ilham Adjii, Hammam Roﬁqi Agustapraja, and Bobby Damara. 2020. “PEMANFAATAN LIMBAH TEMPURUNG KELAPA SEBAGAI CAMPURAN PAVING BLOCK (Ditinjau Dari Kuat Tekan Dan Resapan Air).” UKaRsT 4(1):1. doi: 10.30737/ukarst.v4i1.708.