# 9th INDES 2020

## LIMITLESS MIND:

EMPOWERING INNOVATION THROUGH VISUALIZATION

UNIVERSITI TEKNOLOGI MARA

Cawangan Perak

PROGRAM
PROCEEDINGS
ABSTRACTS BOOK

The 9th International Innovation, Invention & Design Competition
INDES2020

17th May – 10th October 2020

# SUSTAINABLE CONCRETE WITH ADDITIONS OF NANO-MATERIALS AND NANO-BAMBOO CHARCOAL

Norizzati Ibrahim[1], Che Maznah Mat Isa[2]

[1]*Faculty of Civil Engineering, Universiti Teknologi MARA Cawangan Pasir Gudang, MALAYSIA*

*E-mail: izzati6752@uitm.edu.my*

[2]*Faculty of Civil Engineering, Universiti Teknologi MARA, MALAYSIA*

**ABSTRACT**

Nanomaterial concrete is new generation of concrete formed of materials in nanoscale. This research aims to investigate the strength of concrete with addition of nanomaterials. The material used in this research were Nano-Bamboo Charcoal (NBC) of size 10-140 nm, Ordinary Portland Cement (OPC), fine sand size of 50-650 um, and coarse aggregate in 5-10 mm. The portion of NBC are 3% and 10% based on the portion of cement weight. The addition of natural NBC could be a way to improve concrete durability and also sustainable construction. The focus of this research is utilizing the NBC in concrete. Furthermore, it is encourage using the renewable resources as building materials for continuing availability of building materials. This research aims to investigate the compressive strength of concrete by various portion addition of NBC based on cement weight. The results shows that concrete blocks with 3% NBC content showed better strength than those 10% NBC content. However, results of the control concrete of Grade 20 (0% replacement of NBC) show that lowest compressive strength compares to concrete which used NBC. Furthermore, a maximum strength of 38 N/mm$^2$ was achieved when the NBC content was 3% together with 0.40 moisture content as compare with normal concrete which is only 20 N/mm$^2$ only.

**Keywords:** sustainable concrete, concrete, bamboo charcoal, nano-technology, renewable resources

## 1. INTRODUCTION

Currently, the use of nanomaterials in construction is reduced, mainly for the following reasons: the lack of knowledge concerning the suitable nanomaterials for construction and their behaviour; the lack of specific standards for design and execution of the construction elements using nanomaterials; lack of detailed information regarding the nanoproducts content; high costs and also the unknown of health risks associated with nanomaterials [4]. Nanotechnology requires advanced imaging techniques for studying and improving the material behaviour and for designing and producing very fine powders, liquids or solids of materials with particle size between 1 and 100 nm, known as nanoparticles [2]. Nanotechnology can generate products with many unique characteristics that can increase the current construction materials as it lighter and stronger structural composites, low maintenance for coatings, better cementitious materials, lower thermal transfer rate of fire retardant and insulation, better sound absorption of acoustic absorbers and better reflectivity of glass [4]. The addition of small amounts (1%) of nanomaterials can improve the mechanical properties of mixture samples of portland cement and water [2,4]. Also, [10] studied different mineral admixtures are often added in concrete to improve the durability and mechanical properties of hardened concrete. For this research, bamboo charcoal is made from bamboo by pyrolysis (carbonizing) under high temperatures, typically being processed in a high-performance clay furnace oven heated to about 1000ºC, which produces NBC of the highest quality. The addition of NBC has pozzolanic behaviour which influences the concrete strength. The nano-particles used with fly ash concrete provide more environment

friendly cleaner concrete with early high strength of concrete than normal fly ash concrete [2]. It is also encouraged to use the renewable resources as building materials for continuing availability of building resources. The focus of this research is utilizing the NBC in concrete. The research is about improving the concrete performance by using nano materials and renewable resources [1].

## 2. EXPERIMENTAL WORK

The purpose of this research is to investigate the compressive strength and resistance of nanomaterial concrete by partial replacement of cement with nano-bamboo charcoal (NBC). NBC used in this study has the size of 10-140 nm with a mixed composition of 50% of the cement weight.

### 2.1. Concrete mix design

The concrete mix consists of NBC as a cement partial substitution material. For the experiments, NBC was added into the concrete mix as cement partial substitution of amount 50% of the weight of cement. Recapitulation of the concrete mix is shown in Table 1.

Table 1. Concrete Mix Design

| **Description** | **Water-cement ratio** | | |
|---|---|---|---|
| | **0.25** | **0.45** | **0.75** |
| Portland Cement (kg)<br>Nano-Bamboo Charcoal (NBC) (50% replacement) kg | 34<br>34 | 18.9<br>18.9 | 11.35<br>11.35 |
| Water (kg) | 17 | 17 | 17 |
| Total Aggregate ($m^3$) | 0.0594 | 0.0690 | 0.0738 |
| 8–12 mm (kg)<br>Sand (kg) | 24<br>32.6 | 19.9<br>57.6 | 21.3<br>61.6 |
| Super plasticizer (kg) | 0.41 | 0.13 | 0 |

### 2.2. Compressive strength testing

The tool used for testing the compressive strength is UTM (Universal testing Machine) of 2000 kN capacity. Specimens used were cylinders with a diameter of 100 mm and a height of 200 mm, with testing ages of 3, 7, 14, 21 and 28 days.

## 3. RESULT AND DISCUSSION

The results show in Figure 1 that the maximum compressive strength obtained in this series was 38 $N/mm^2$ and 34 $N/mm^2$ for the NBC composition were 3% and 10% of sand by applying vibration respectively compare to normal concrete only 30 $N/mm^2$

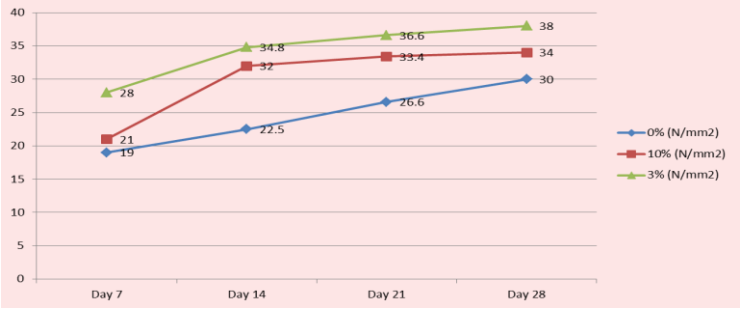


**Figure 1.** Compression Strength Result

## 4. CONCLUSION

Nanotechnology requires advanced imaging techniques for studying and improving the material behaviour and for designing and producing very fine powders, liquids or solids of materials with particle size between 1 and 100 nm, known as nanoparticles [2]. The addition of small amounts (1%) of carbon nanotubes can improve the mechanical properties of mixture samples of portland cement and water [2]. Also, different mineral admixtures are often added in concrete to improve the durability and mechanical properties of hardened concrete [7]. The addition of nano-bamboo charcoal (NBC) has pozzolanic behaviour which influences the concrete strength. The nano-particles used with fly ash concrete provides more environment friendly cleaner concrete with early high strength of concrete than normal fly ash concrete, which is also economical [2]. This research encouraged to use the renewable resources as building materials for continuing availability of building resources. The focus of this research is utilizing the nano materials and nano-bamboo charcoal in lightweight concrete. This research aims to investigate the durability of light weight concrete by various portion addition of NBC based on cement weight.

## REFERENCES

1. A.S.Wahyuni, F.Supriani, Elhusna, and A.Gunawan “The performance of concrete with rice husk ash, sea shell ash and bamboo fibre addition” in Journal of Procedia Engineering. [Online].95. pp. 473-478.Available:http://www.elsevier.com/locate/procedia
2. Rattan, P. Sachdeva and A. Chaudhary “ Use of nanomaterials in concrete” International Journal of Latest Research in Engineering and Technology (IJLRET) Volume 2, Issue 5, Pages 81-84, May 2016
3. J.Shenxue, “Traning manual of bamboo charcoal for producers and consumers” May 2004
4. R. Olar “Nanomaterials and nanotechnologies for civil engineering” Construction Architectural, Issue 4, Pages 109-117, August 2011
5. S. Kittinaovarat and W. Suthamnoi “Physical properties of polyolefin/bamboo charcoal composites” Metal, materials and Minerals, Volume 19, Pages 9-15, April 2009
6. S.P. Zhang and L.Zong “ Evaluation of relationship between water absorbtion and durability of concrete materials” Advances in Materials Science and Engineering, Volume 2014, Pages 1-8, April 2014
7. S. Ismanti and N. Yasufuku “ Effect of bamboo chips in cemented sand soil on permeability and mechanical properties in triaxial compression” World Academy of Science, Engineering and Technology, Volume 10, Pages 917-923, 2016
8. S.P.Zhang and L.Zong “Evaluation of relationship between water absorption and durability of concrete materials” Advances in Materials Science and Engineering, Volume 14, Pages 1-8,2014

9. Saloma, A. Nasition, I. Imran and M. Abdullah “Improvement of concrete durability by nanomaterials” Procedia Engineering, Volume 125, Pages 608-612, 2015.
10. T.Tehmina, N.Shafiq, and S.U.Khan. “Durability of concrete with different mineral admixtures: A review” International Journal of Civil and Environmental Engineering Volume 7, Issue 8, Pages 601-612, 2013.
11. W.L. Foo, M. Abdullah, B.S. Bashar and K.M. Anwar “Rapid chloride permeability test on lightweight concrete made with oil palm clinker” Journal of Engineering Research and Applications (IJERA), Volume 1, Pages 1863-1870, 2017.
12. W. Aperador, A.Delgado and J.Baustita-Ruiz “Effect of durability and chloride ion permeability in ternary cementitious concrete with additions of fly ash and blast furnace slag” International Journal of Electrochemical Science, Volume 11, Pages 2297-2305, 2016

Pejabat Perpustakaan
*Librarian Office*

Universiti Teknologi MARA
Cawangan Perak
Kampus Seri Iskandar
32610 Bandar Baru Seri Iskandar,
Perak Darul Ridzuan, MALAYSIA
Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299

UNIVERSITI TEKNOLOGI MARA

Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 30 Ogos 2022


YBhg. Profesor Ts Sr Dr Md Yusof Hamid, PMP, AMP
Rektor
Universiti Teknologi MARA
Cawangan Perak

YBhg. Profesor

**PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)**

Perkara di atas adalah dirujuk.

2. Pihak Perpustakaan ingin memohon kelulusan YBhg. Profesor untuk membuat imbasan (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna Perpustakaan terhadap semua bahan penerbitan UiTM melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak YBhg. Profesor dalam perkara ini amat dihargai.

Sekian, terima kasih.

**"WAWASAN KEMAKMURAN BERSAMA 2030"**

**"BERKHIDMAT UNTUK NEGARA"**

Yang benar