UNIVERSITI TEKNOLOGI MARA

CONFERENCE PROCEEDING

ICITSBE 2012

1ST INTERNATIONAL CONFERENCE ON INNOVATION AND TECHNOLOGY FOR SUSTAINABLE BUILT ENVIRONMENT

16 -17 April 2012

Organized by:
Office of Research and Industrial
Community And Alumni Networking
Universiti Teknologi MARA (Perak) Malaysia
www.perak.uitm.edu.my

PAPER CODE: CT 26

RELATIONSHIP BETWEEN THE STRENGTH AND THE ACOUSTICAL PROPERTIES OF CONCRETE BLOCKS MIXED WITH POFA TO REPLACE SEVERAL PERCENTAGES OF CEMENT CONTENT: AN INITIAL STUDY

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Abstract
This paper is basically an initial study. The objectives of this research are to evaluate the concrete compressive strength using POFA as cement replacement and to evaluate the performance of concrete blocks using POFA in term of sound insulation. Generally, there are four different percentages of POFA replacement in concrete which are 2.5%, 5%, 7.5% and 10% respectively. For compressive strength test, the concrete are tested on 7, 14 and 28 days. The concrete mixture was designed according to British standard with water cement ratio of 0.45. This research reveals the usage of POFA in concrete mixture can improve the compressive strength test and acoustical properties specifically for sound insulation. But the usage of POFA in concrete mixture strictly must not exceed 10% as it will decrease the performance of the concrete strength.

Keywords:POFA, Concrete, Sound Insulation.

1. Introduction

In recent years, there were studies carried out by different researchers all over the world in using agricultural waste such as coconut pitch and rice husk either as an additive or to replace cement or aggregates in concrete mixtures. There were also studies done on the usage of industrial wastes such as lime-sludge, slags, kiln dust, and pulverized fuel ash in the production of cement. Sludge generated from wastewater treatment plant was used as filler in concrete, or as lightweight aggregates for concrete, or as cementitious building materials. Previous researchers (Tay, H. and Show, K ,1995),(Saleh Bamaga, Mohamed A. Ismail, and M. W. Hussin, 2010) have conducted few experiments which involve agricultural waste such as Empty Fruit Bunch Ashes (EFB) and Fly Ashes as a cement replacement in concrete. Results show both negative and positive impacts from different aspects such as compression strength, chloride resistance and so forth.

2. Literature Review

POFA in mixing concrete can lead to optimize the utilisation of Oil Palm waste and looking forward to produce the new low cost mineral admixture sufficiently pozzolanic material that could be used in pozzolanic cement. The pozzolanic activity indices of palm oil fuel ash was obtained by (Abu, 1990) and (Sumadi and Hussin, 1993) are 78.6 and 87.6 % respectively. However, for all classes of ash; the pozzolanic activity is 75 % (ASTM C 618-94 a). The study of palm oil fuel ash was started by (Tay, H. and Show, K, 1995) who used it to replace Portland cement with 10–50%. (Chindaprasirt, S. Homwuttiwong ,C. Jaturapitakkul., 2007), found that in the range of 20–50% of cement replacement, the decrease in the compressive strength of concrete at various ages was almost proportional to amount of the ash in the concrete mixtures, except when only 10% ash was used.
(Chea Chandara, Etsuo Sakai, Khairun Azizi Mohd Azizli, Zainal Arifin Ahmad and Syed Fuad Saiyid Hashim, 2010) stated that Palm oil mills produce large amounts (equivalent to around 70% of the raw material) of solid waste by-products in the form of fibers, nutshells, and empty fruit bunches and this was clearly mentioned by (Saleh Bamaga, Mohamed A. Ismail, and M. W. Hussin, 2010) that nowadays, Malaysia strikes for 41% of world palm oil production and 47% of world exports.

According to (MPOC, 2009) there are aapproximately 52 tonnes of nut shells, fibres and empty bunches discharged from the mills for every 100 tonnes of fresh fruit bunches processed. Discharged materials

are used as fuel for the production of steam in the palm oil mills and 5 % of ash is produced due to burning the discharged materials at temperature of about 800–1000 °C in the palm oil mill boilers based on (Tay, H. and Show, K, 1995). Also, according to (Tay, H. and Show, K, 1995) this light and small particles size ash is disposed of in landfills resulting in traffic hazard such as transportation of the ashes to the dumping landfill besides a potential health hazard leading to bronchi and lung diseases.

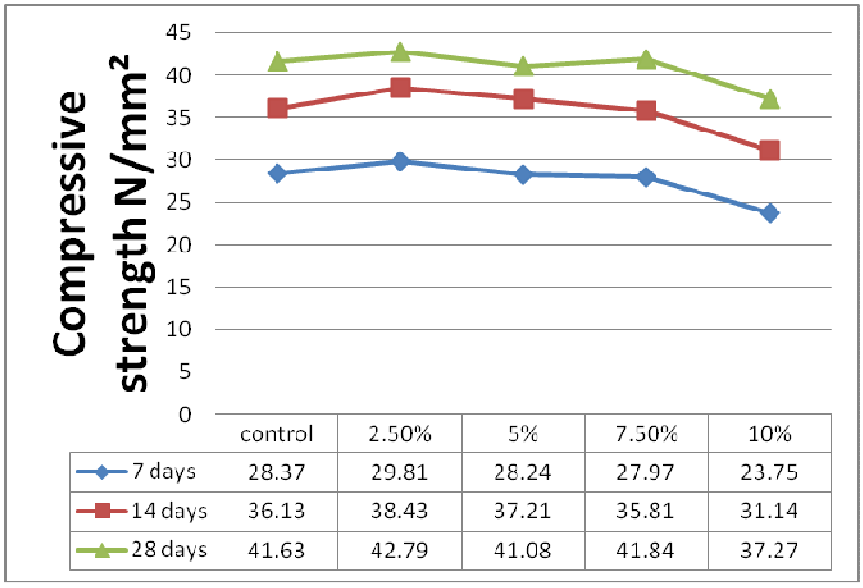
In Malaysia alone, the potential oil palm ash production is designated at 4 million tonnes/year based on (A.R. Mohamed, K.T. Lee, N.M. Noor, N.F. Zainudi, 2005), which striving towards huge criticisms and complaints, mainly attributed to its persistent, carcinogenic and bio-accumulative effects said by (V. Subramaniam, A.N. Ma, Y.M. Choo, M.N.S. Nik, 2008). According to data from (Rice Husk Ash Market Study, Bronzeoak Ltd., 2003) increasingly, with the price of the ash disposal cost (either in landfills or ash ponds) hitting as high as $5/tonnes in developing countries and $50/tonnes developed countries, the urgency of transforming the residue into a more valuable end product has been promulgated.

3. Methodology

Methodology is one of the crucial parts in doing a research. It emphasises the way how to conduct the research. For this research, there will be a few lab experiments that will be taken into consideration. Basically this research consists of two main parameter which are concrete properties and acoustical properties where the cement will be replaced by POFA partially. For the concrete properties, there will be two tests that will be carried out which are compression strength test and water absorption test. Compression strength test is where the strength of the concrete will be examined. There will be 5 different samples of concrete mixing consist of control sample and 4 different percentage of cement replacement with POFA and each sample will produce 9 concrete cubes 100mm x 100mm that will be tested on 7, 14 and 28 days. Water absorption test is where the amount of water absorbed by the surface of the concrete blocks. For the acoustical properties, a concrete block sizing 240mm x 190mm x 100mm will be casted in concrete lab. Then, the concrete block will be placed in a impact chamber room to examine the acoustical properties consist of sound insulation and sound absorption. And lastly all data collected from the above experiments will be analysed.

4. Result and Analysis

4.1 Compressive strength



	control	2.50%	5%	7.50%	10%
7 days	28.37	29.81	28.24	27.97	23.75
14 days	36.13	38.43	37.21	35.81	31.14
28 days	41.63	42.79	41.08	41.84	37.27

Figure 1

The compressive strength consists of POFA for several percentages and days are tabulated in figure 1. It was found that the concrete compressive strength increased over the days. But, the results were decreased over the percentages of replacement. For 2.5% replacement, the compressive strength was 29.81, 38.43 and 42.79. Concrete containing 5% POFA the compressive strength was 28.24, 37.21 and 41.08. and for the concrete that

contains 7.5% and 10%, the compressive strength results was 27.97, 35.81, 41.84 and 23.75, 31.14, 37.27 respectively.

4.2 Sound insulation

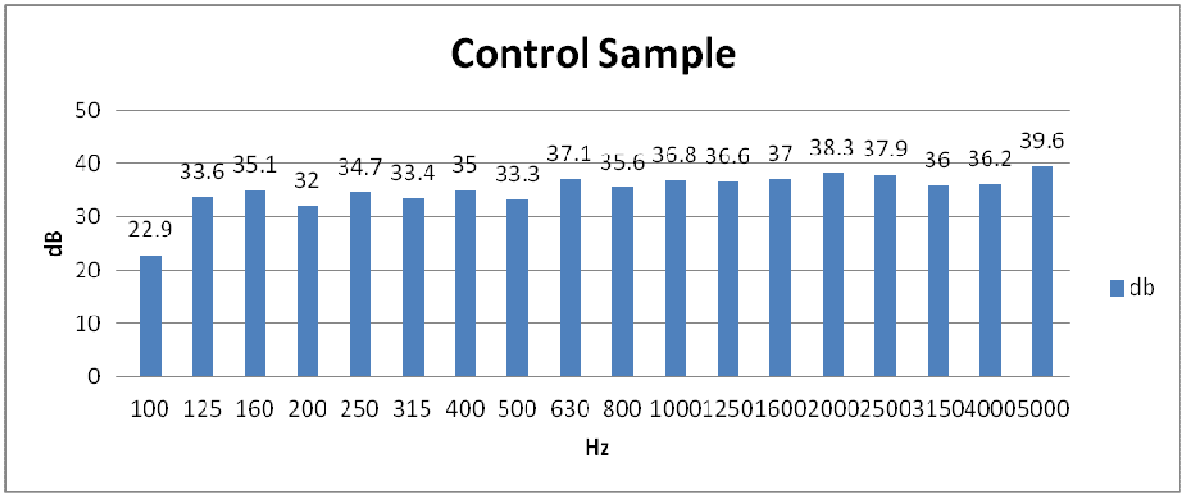


Figure 2

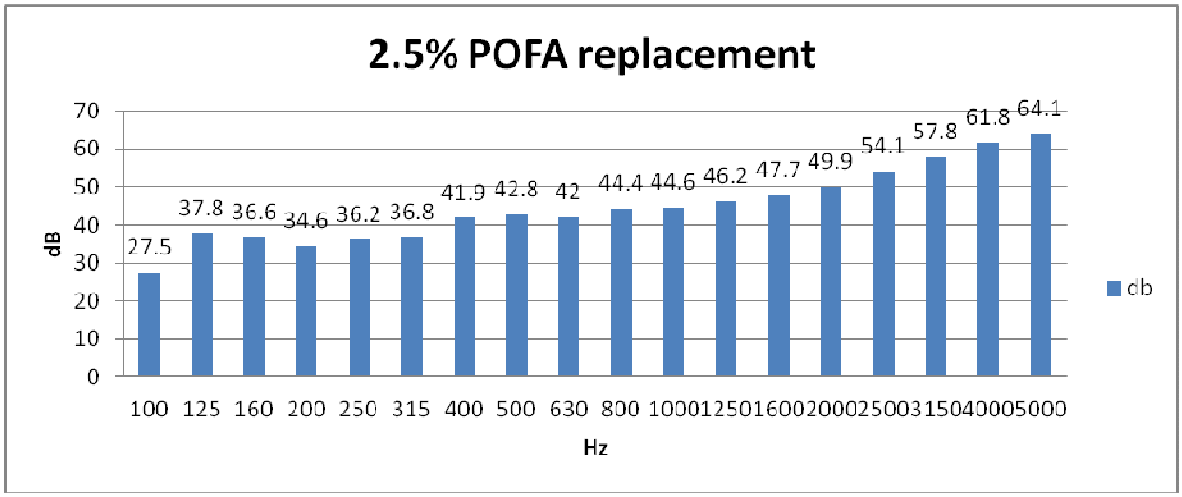


Figure 3

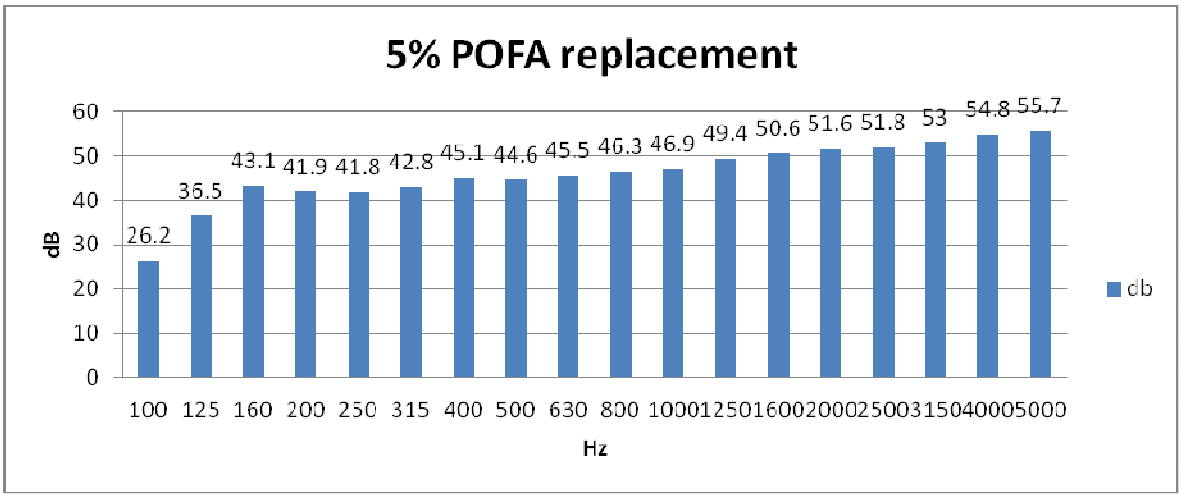


Figure 4

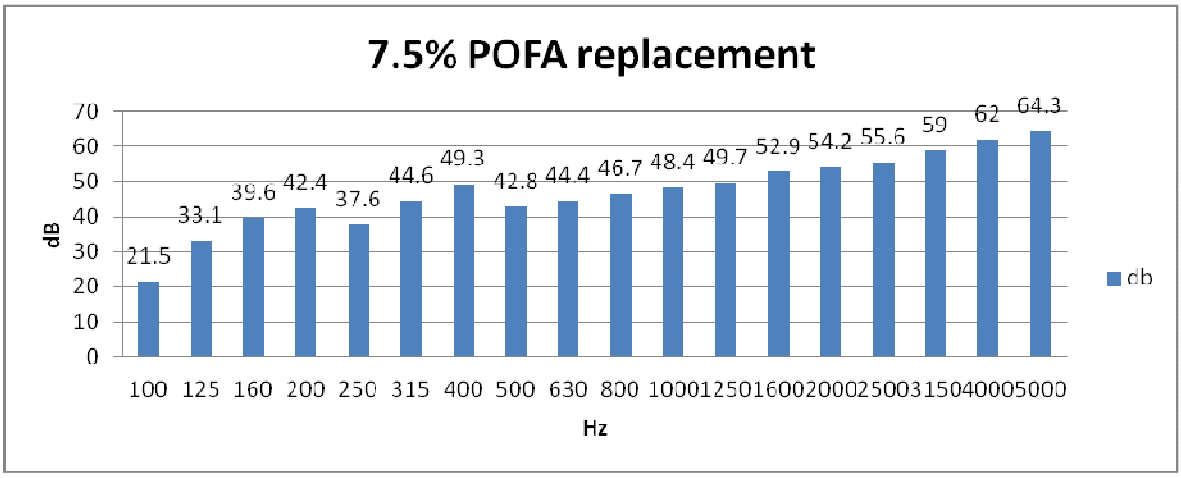


Figure 5

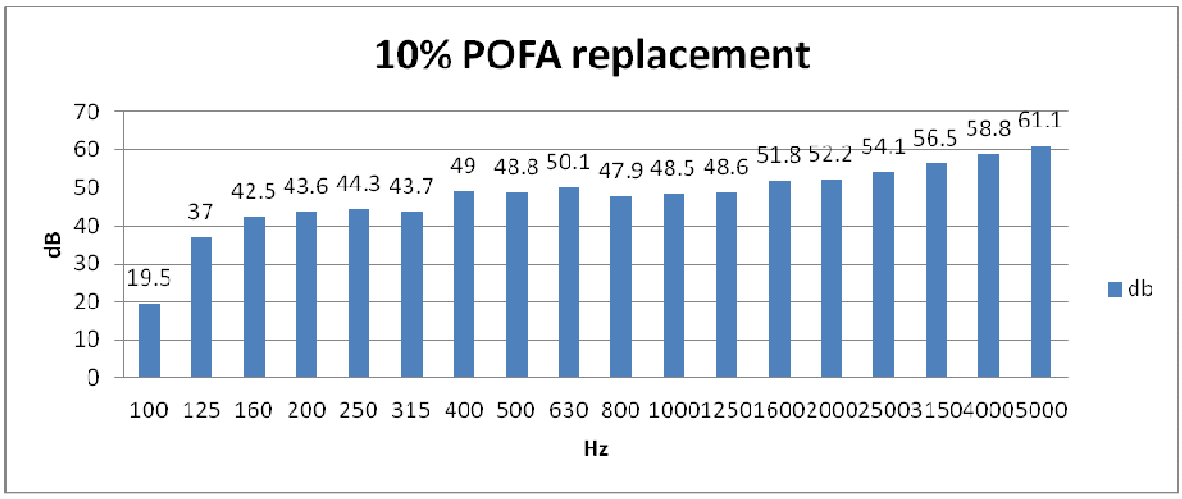


Figure 6

Sound insulation results for concrete blocks contain several percentages of POFA are tabulated in figure 2,3,4,5 and 6. Each figure shows different results because of the differences in POFA replacement. The figure shows only the initial results which is not calculated yet using ISO standard (140-8). **Figure 2** shows the performance of control sample concrete block in term of insulation. After had been calculated, the final result was 37dB. The final results for 2.5% POFA replacement was 45dB and the initial results is showed in figure 3. It shows that, the results are getting better compare to the previous one.

Figure 4, 5, and 6 show the initial results of sound insulation for 5%, 7.5% and 10% POFA replacement in concrete block. The final results or average for 5%, 7.5% and 10% was 48dB, 48dB and 49dB respectively. From the results collected, it can be interprate that the sound insulation for concrete block using POFA as cement replacement give a positive impact compared to control sample.

5. Conclusion

From the test conducted, POFA can be used as pozzolans to replace Portland cement in making concrete mixture which can improve the compressive strength and sound insulation performance of concrete block. But, the usage of POFA in concrete mixture has its own limitation. It was strictly recommended that the usage of POFA must not exceed 10% cement replacement as the concrete strength slightly decreased. Results for sound insulation extremely increase over the percentage replacement. It shows that POFA is a good material for sound insulation improvement in building but it has constrained on the usage because it will affect the compressive strength of the concrete. So, there are a few recommendations for future research for this pozzolan class F, POFA. What can be done is by creating a sound insulation panel for building elements especially wall by using POFA. Apart from that, POFA can be used for aerated concrete block which is considered as lightweight concrete blocks.

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