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A Study of Radon-222 Levels In Foamed Light Concrete

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Abstract: The purpose of this study is to measure and monitor the radon concentration in a fabricated foamed light concrete. Various proportions of Portland cement, mine sand, water and foamed were used in fabricating foamed light concrete. The concentration of radon released from the fabricated concrete was measured using Radon Monitor Model 05-420 from the Honeywell Inc. U.S.A. Results of this research showed that the mean radon concentration in foamed light concrete was 1.9pCi/L. The current radon concentration was proportional to temperature and inversely proportional to humidity. Gradual increased of radon concentrations were detected after three days of measurements, indicating a build up of airborne Rn due to Rn emanations from the fabricated foamed light concrete. However,with proper ventilations, the accumulation of the Rn emanated can be further reduced below the measured level. From this research finding, the fabricated foamed light concrete can beutilized as one of the alternatives to reduce radon concentration levels in human environment.

Key words: radon-222, foamed light concrete, mine sand, portland cement.

INTRODUCTION

Radon (Rn) is naturally occurring colourless, odourless radioactive inert gases, which come from the radioactive decay of uranium. It is radioactive with a short half-life of 3.8 days, decaying by the emission of alpha-radiation (α-radiation) to polonium, bismuth, and lead (radon progeny/daughters) in successive steps.

As an inert gas, radon simply goes in and out our lungs as we breathe without causing any harm, but the radon daughters (being basically solid and sometimes electrically charged) can stick to the surface of our bronchial tubes. The radon daughters also attach themselves to microscopic dust particles, which are then inhaled down into the deepest parts of the lung. This puts them right where they can do the most harm, for the cells lining our bronchial tubes are among the cell in our body most sensitive to radiation-induced cancer. The alpha radiation emitted in the decay of radon daughters, can reach those sensitive cells because they are deposited so close to them. Studies on the risk of lung cancer and the human exposure to radon have been studied in China(Sun *et al*.,2004); Poland (Malczewski *et al*.,2007); Germany (Kemski *et al*.,1996); Jordan (Kullab, 2005); Japan (Fujiyoshi *et al*., 2002) and Hong Kong (Tung, 2005)

The two isotopes of the element Radon that are important in health protection are Rn-222 and Rn-220 which are part of the decay series originating from U-238 and Th-232 respectively. Rn-222 is the first decay product of the naturally occurring element Ra-226. This paper however will be confined to discussions on Rn-222 emanations, from a fabricated foamed light concrete, which is generally referred to as Rn. The potential health hazard is primarily attributed to the α-emitting Rn progeny. According to BEIR VI report (US Environment Protection Agency, 2002) and a study (Center for Health Effects of Environmental Contamination, The University of Iowa, 2000) led by researchers at the University of Iowa College of Public Health, long term exposure to radon in the home is associated with lung cancer risk and present a significant environmental health hazard.

Measurements of radon levels in the home or outdoors are normally expressed as the concentration of radon in units of picocuries per liter of air (pCi/L). The United States EPA recommendations (EPA, 1986) are:

a. If results are about 200 pCi/L or higher:

It is recommended that action should be taken within several weeks. Residents should undertake action to reduce levels as far below 200 pCi/L as possible. If this is not possible, consultation with appropriate state or local health or radiation protection officials can determine if temporary relocation is appropriate until the levels can be reduced.

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b. If result are about 20 to 200 pCi/L:

Exposures in the range are considered greatly above average for residential structures. Action should be undertaken to reduce levels as far below 20 pCi/L as possible within several months.

c. If result are about 4 pCi/L to about 20 pCi/L:

Exposures in this range are considered above average for residential structures. Action should be undertaken to lower levels to about 4 pCi/L or below within a few years, sooner if levels are at the upper end of this range.

d. If result are about 4 pCi/L or lower:

Exposure in this range is considered average or slightly above average for residential structures. Although exposures in the range do present some risk of lung cancer, reduction of level this low may be difficult, and sometimes impossible, to achieve.

Source of Radon and How it Enters Homes:

The existing of radon gas normally is associated with rock with high concentration of uranium (U-238), however the concentration of U-238 in rock and soil varies significantly. The actual amount of radon that reaches the surface of Earth is related to the concentration of uranium in the rock and soil as well as the efficiency of the transfer processes from the rock or soil to soil-water and soil-gas. The soil composition under and around, and the material used for a house affect indoors radon levels and the ease which radon migrates toward a house.

These are three major pathways have been identified by which radon gas enters homes:

a. As a gas that migrates up from soil and rock
b. In groundwater pumped into wells
c. In construction materials

Among those three major pathways, the third factor is the main concern as most of the building materials used are direct or indirectly originated from granite rocks. When building materials with a high radium concentration are being used, the radon progeny in ordinary buildings may increase the radiation exposure of the public to unacceptable levels. Radon variations in buildings are caused by changes in temperature, relative humidity, building materials, barometric pressure, ventilation conditions, the wind speed and the design of the house (Zmazek, B. 2006)

Methods:

To evaluate the contributions from building materials to indoor Rn concentrations, the most important factor is the exhalation rate of Rn from the material. The building materials used in this study is a fabricated foamed light concrete whichrepresents the main materials used for some buildings in USM.The compositions of the foamed light concrete used were foamed (50%),Portland cement (20%), mine sand (20%), and water (10%). The building material sample together with the professional radon monitor model 05-240, thermometer and hygrometer were placed inside a closed, fabricated container. The small openings of the container were sealed by using modelling material.The build-up of Rn inside the container wasmeasured using the radon monitor. Radon concentration was recorded every hour for five consecutive days.Data acquired includes the average and current radon concentrations (pCi/L), temperature (°C), relative humidity (%) and the time of sampling.

Results:

Figure 1 shows the Rnemission rate measured from the fabricated foamed light concrete. The results from Table 1 and Figure 2 of this research showed that the mean radon concentration in foamed light concrete is 1.9pCi/L, well below the level of 4 pCi/L for residential structures as stipulated by EPA where action should be undertaken. The current radon concentration is proportional to temperature and inversely proportional to humidity. Gradual increased of radon concentrations were detected after three days of measurements, indicating a build up of airborne Rn due to Rn emanations from the fabricated foamed light concrete. However, with proper ventilations of dwellings, the accumulation of the Rn emanated can be further reduced below the initial level.

Conclusion:

Measurements of Rn-222 emanations from the fabricated foamed light concrete were found to be lower than the suggested EPA action level of 4 pCi/L for residential structures. There is a gradual increased of Rn-222 concentrations detected over time, however, the concentrations can be reduced remarkably with proper ventilations. From this research finding, the use of fabricated foamed light concrete can be one of the alternatives to reduce radon concentration levels in human environment.

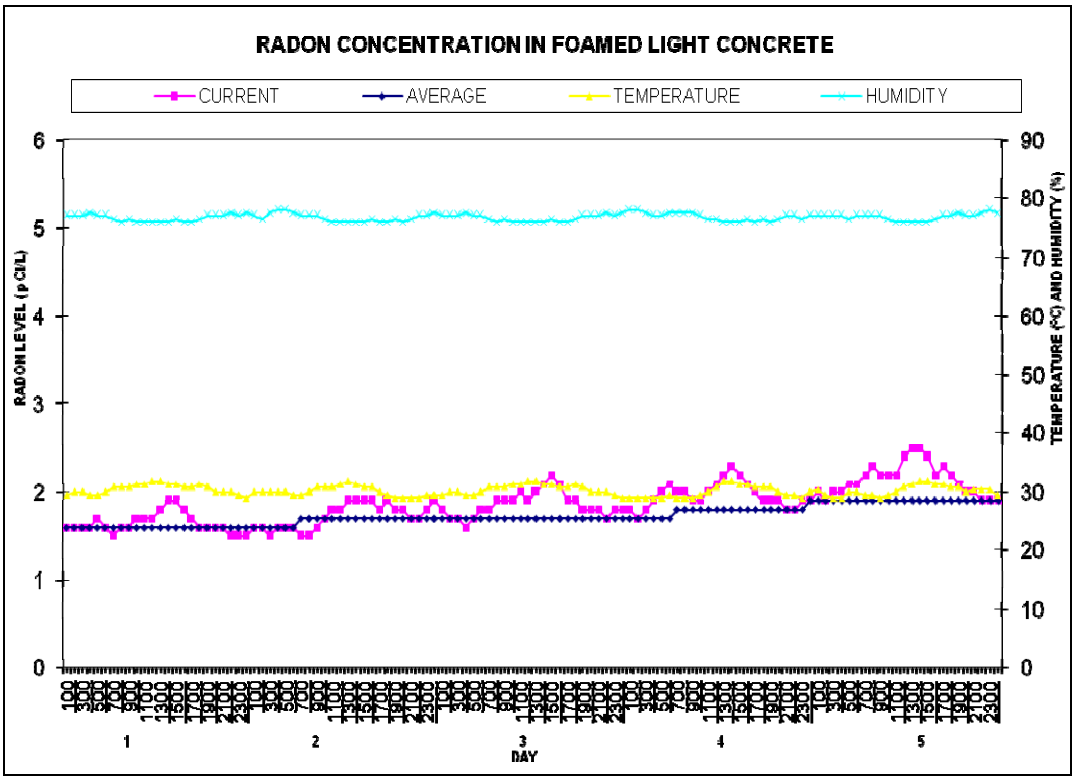
RADON CONCENTRATION IN FOAMED LIGHT CONCRETE
CURRENT
AVERAGE
TEMPERATURE
HUMIDITY
RADON LEVEL (pCi/L)
TEMPERATURE (°C) AND HUMIDITY (%)
DAY

Fig. 1:

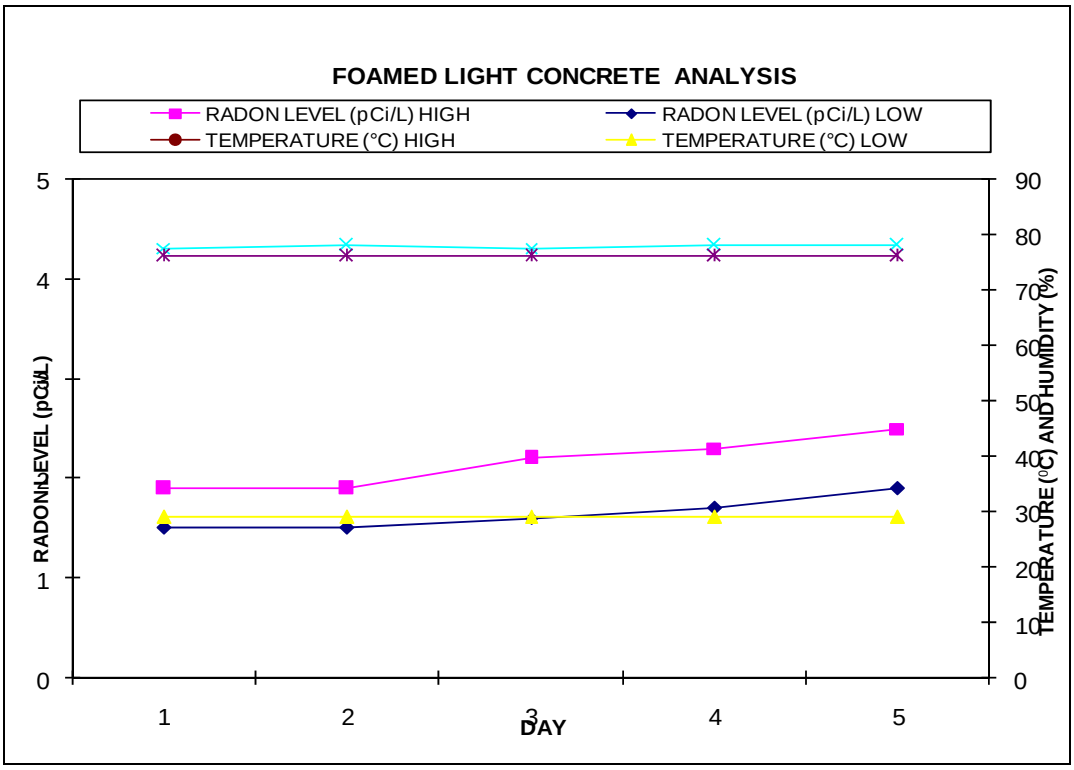
FOAMED LIGHT CONCRETE ANALYSIS
RADON LEVEL (pCi/L) HIGH
RADON LEVEL (pCi/L) LOW
TEMPERATURE (°C) HIGH
TEMPERATURE (°C) LOW
RADON LEVEL (pCi/L)
TEMPERATURE (°C) AND HUMIDITY (%)
DAY

Fig. 2:

Table 1:

DAY	RADON LEVEL (pCi/L)		TEMPERATURE (°C)		HUMIDITY(%)	
	HIGH	LOW	HIGH	LOW	HIGH	LOW
1	1.9	1.5	32.0	29.0	77.5	76.0
2	1.9	1.5	32.0	29.0	78.0	76.0
3	2.2	1.6	32.0	29.0	77.5	76.0
4	2.3	1.7	32.0	29.0	78.0	76.0
5	2.5	1.9	32.0	29.0	78.0	76.0

Future Work:

Future work will embark on other building materials, manipulating and covering exposed building materials of significant radon emanation, and study on the ventilation system in which natural or forced ventilation can be increased to diminish indoors levels of radon gas.

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