J. Myanmar Acad. Arts Sci. 2019 **Vol. XVII. No.2A**

A STUDY ON ELEMENTAL AND RADON CONCENTRATION IN RAW MATERIALS OF LIGHTWEIGHT CONCRETE BRICK AND ORDINARY BRICK

Myat Thanda Mon[1] and Shwe Nan Htet[2]

Abstract

In the present work, raw materials samples (lime, gypsum, aluminum powder, cement, river sand, terracotta and a mixture of terracotta and black clay) of lightweight concrete brick and ordinary brick were collected from concrete and brick factories in Yangon. The elemental contents and radon concentration of raw materials from lightweight concrete brick and ordinary brick were determined by EDXRF method and passive cup method respectively. Toxic elements such as Hg, Pb, Cd and As concentration in weight percent level were not observed in raw materials of lightweight concrete brick and ordinary brick in EDXRF measurement. From the radon measurement of seven samples, a mixture of terracotta and black clay showed the maximum value of average alpha track_67.82 ± 1.68, alpha track density_93.98 ± 2.54 tracks $cm^{-2}day^{-1}$ and radon concentration_4699 ± 127.08 Bqm^{-3} respectively, whereas the value of radon concentration of aluminum powder was comparable with background value. The values of radon concentration from lime, gypsum, aluminum powder and cement for building materials were below ICRP recommended permissible level of 200-600 Bqm^{-3} but river sand, terracotta and a mixture of terracotta and black clay samples were above permissible level. The annual effective dose of lime, gypsum, aluminum powder, cement and river sand samples were less than recommended level 50m Sv/y. The results showed that cement, gypsum (plaster of paris), lime and aluminum powder could be used as raw material for manufacture of building materials. They were radiological safe as compared to limit ICRP and did not pose any radiological risk

Keywords: elemental analysis, EDXRF method, toxic elements, LR-115 Type II plastic track detectors, passive cup technique

Introduction

The raw materials which are used in production of lightweight concrete brick and ordinary brick are containing various amounts of natural

1. PhD Candidate, Department of Physics, University of Yangon
2. Lecturer, Department of Physics, University of Yangon

radioactive elements. Determination of population exposure to radiation from raw materials is great importance since people spend about 80% of their life inside the buildings. Natural radionuclides in building materials may cause both external exposure caused by their direct gamma radiation and internal exposure from radon gas. Radon is present outdoors and is normally found at very low levels in outdoor air and in surface water, such as rivers and lakes. It can be found at higher levels in the air in houses and other buildings, as well as in water from underground sources, such as private well water. Radon gas that moves from under the ground can migrate into indoor spaces, such as basements and crawl spaces. Once inside an enclosed space, such as a home, radon can accumulate. The main source of indoor radon is its immediate parent radium-226 in the ground of the site and in the building materials. Radon concentrations in soil gas within a few meters of the surface of the ground are clearly important in determining radon rates of entry into pore spaces and subsequently into the atmosphere and it depends on the radium concentration in the bedrock and on the permeability of the soil.

Experimental Procedure

The raw material samples were dried in a temperature controlled furnace (oven) at a temperature 80 ± 0.1°C for 6 hours to ensure that moisture was completely removed. Then the samples were crushed to a fine powder and sieved through a small mesh size 250µm to remove the larger grains size and render them more homogenous. After sample preparation, all the samples were analyzed using an EDXRF, model Shimadzu EDX-720 at Universities' Research Center. The method of the fundamental parameter (FP) was used for the spectrum analysis. About 100 g of each sample was placed in a plastic can of dimensions of 11 cm in height and 8 cm in diameter. A piece of LR-115 detector of size 1.5 cm × 1.5 cm was fixed on the top of inner surface of the can, in such a way, that it was sensitive surface always facing the sample. The can was sealed air tight with adhesive tape and kept for exposure of 90 days as shown in Figure 1. After that, the detectors were removed from the sample cup, collected and chemically etched in a 2.5N NaOH solution at (60 ± 0.1) °C for a period of 90 min. The resulting alpha tracks were counted under an optical microscope of magnification 10X. The track density of each sample was calculated by using the track density equation:

$$\text{Average Track Density} = \frac{Net\ Tracks}{Microscopic\ Area \times Exposure\ Time}$$

To get the values of radon concentration, calibration factor must be used. The resulting track density was then converted into Bqm^{-3} by appropriate calibration factor of 0.02 tracks cm^{-2} day^{-1}. The annual effective doses from raw materials samples were calculated following International Commission on Radiological protection Publication where $1Bqm^{3}$= 0.0172 $mSvyr^{-1}$.

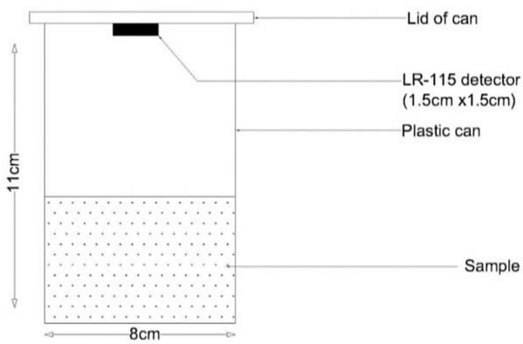

Figure 1: The schematic diagram of can technique

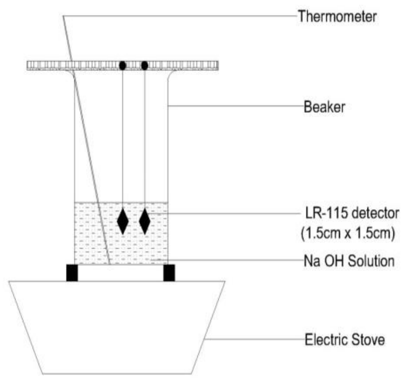

Figure 2: Schematic diagram of etching system

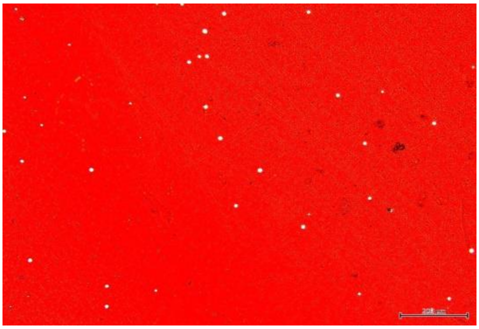

Figure 3: (a) Photomicrograph of Alpha Tracks in LR115 for River Sand sample at total magnification of 10X

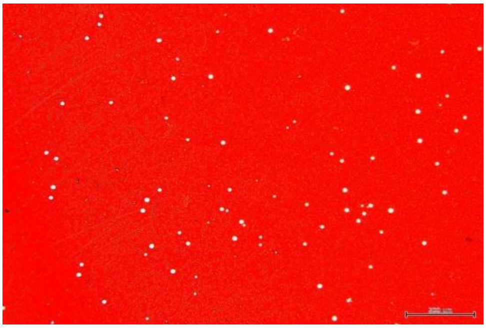

Figure 3: (b) Photomicrograph of Alpha Tracks in LR115 for Terracotta sample at total magnification of 10X

Table 1: Concentrations of elements in raw material samples of lightweight concrete brick and ordinary brick

Element	Sample1 (lime)	Sample 2 (Gypsum)	Sample 3 (Aluminum powder)	Sample 4 (cement)	Sample 5 (River sand)	Sample 6 (Terracotta)	Sample 7 (terracotta + black clay)
Si	ND	ND	ND	61.846	6.454	51.768	43.43
Fe	0.21	0.306	3.856	19.228	5.978	37.257	35.562
Ca	99.336	68.9	1.163	7.186	83.331	ND	9.103
K	ND	0.494	ND	9.272	1.986	6.642	7.077
Ti	ND	ND	ND	1.357	0.368	3.234	3.413
Zr	ND	ND	ND	ND	ND	0.401	0.381
Cr	ND	ND	0.146	0.414	ND	0.169	0.237
Mn	ND	ND	ND	0.32	0.05	0.204	0.225
Sr	0.21	0.19	ND	0.237	0.178	0.067	0.13
Zn	ND	ND	0.082	ND	0.025	0.087	0.116
Ni	ND	ND	ND	ND	ND	0.119	0.11
V	ND	ND	ND	ND	ND	ND	0.099
Y	ND	ND	ND	ND	ND	0.053	0.071
Rb	ND	ND	ND	0.139	ND	ND	0.047
S	ND	30.078	1.798	ND	1.595	ND	ND
Cu	0.031	0.032	0.057	ND	0.036	ND	ND
Al	ND	ND	92.651	ND	ND	ND	ND
W	ND	ND	0.176	ND	ND	ND	ND
Ga	ND	ND	0.071	ND	ND	ND	ND

ND= non- detected

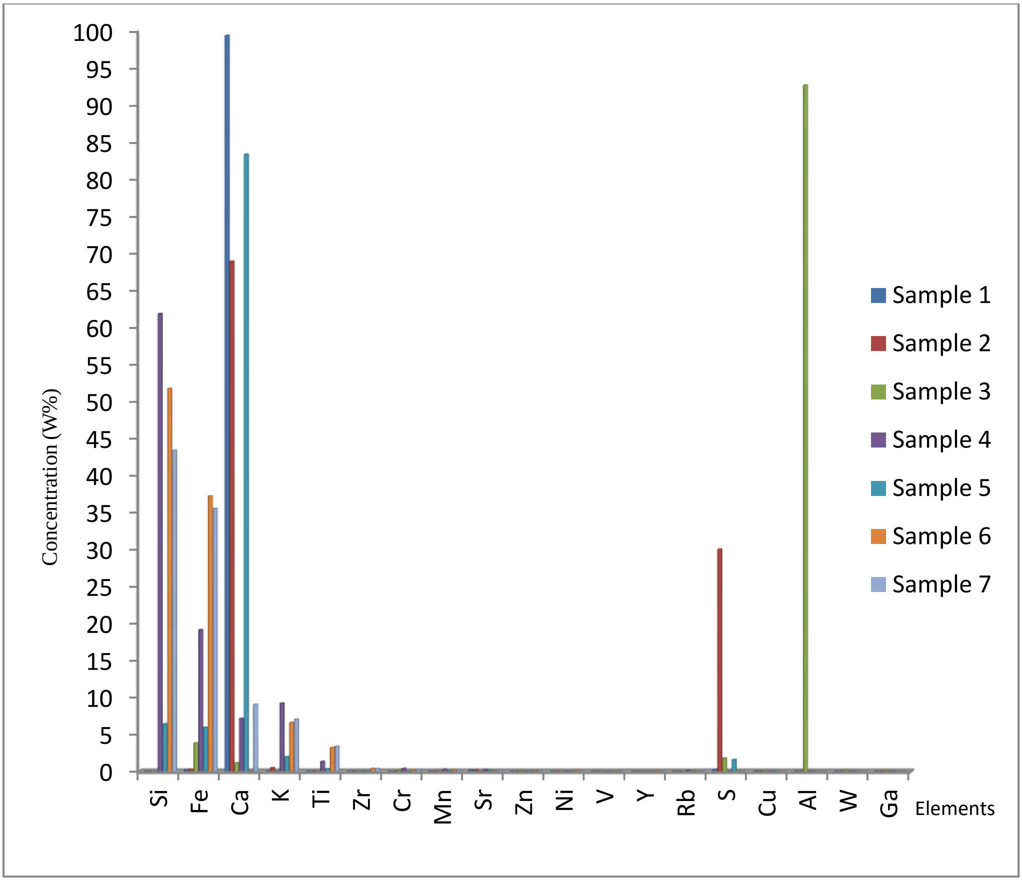

Figure 4: Concentration (W%) of elements contained in raw materials of lightweight concrete brick and ordinary brick

Table 2: Average alpha tracks, track density and radon concentration from raw materials samples of Lightweight concrete brick and ordinary brick

No	Samples	Alpha Track Density (tracks $cm^{-2}day^{-1}$)	Radon Concentration (Bqm^{-3})	Annual effective dose (mSv/y)
1	Lime (S1)	3.45 ± 0.51	73 ± 25.49	2.97 ± 0.44
2	Gypsum (S2)	1.50 ± 0.42	75 ± 20.72	1.29 ± 0.36
3	Aluminum Powder (S3)	0.54 ± 0.40	27 ± 19.79	0.46 ± 0.34
4	Cement (S4)	7.36 ± 0.59	368 ± 29.67	6.33 ± 0.51
5	River Sand (S5)	39.10 ± 1.29	1955 ± 64.45	33.62 ± 1.11
6	Terracotta (S6)	66.12 ± 1.75	3306 ± 87.64	56.86 ± 1.51
7	Terracotta + Black Clay (S7)	93.98 ± 2.54	4699 ± 127.09	80.82 ± 2.19

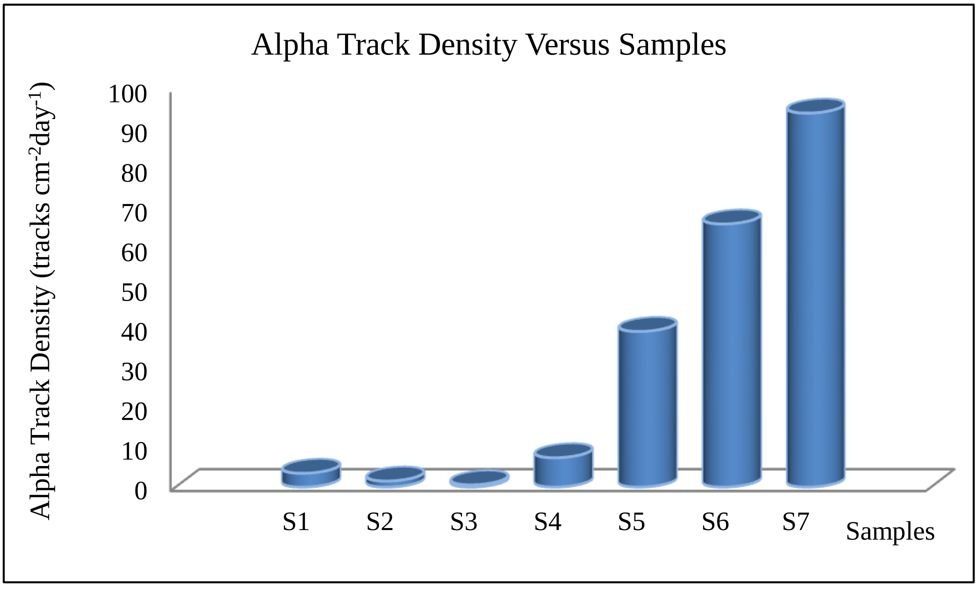

Figure 5: The average alpha track density of raw materials samples of lightweight concrete brick and ordinary brick

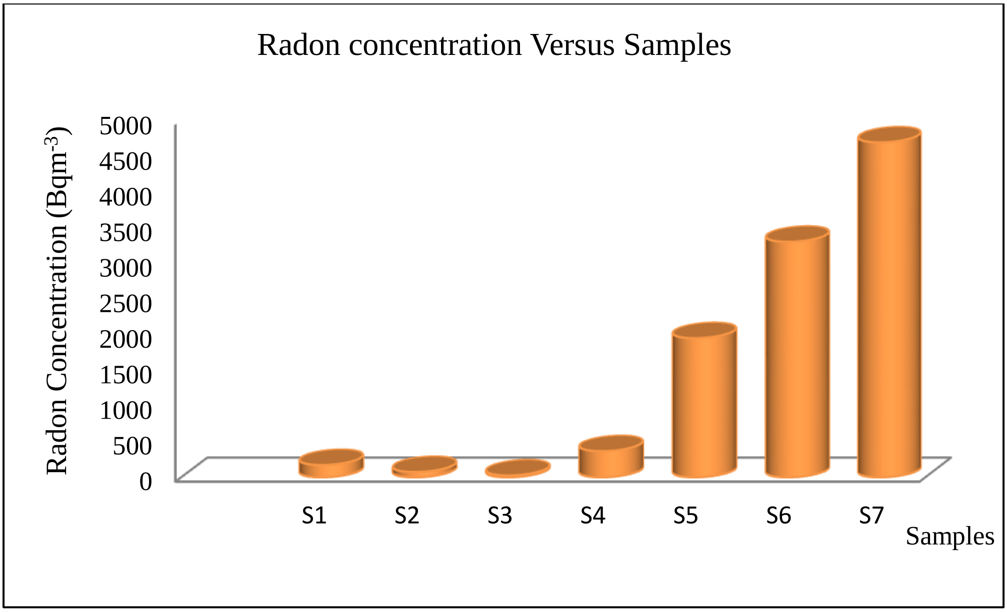

Figure 6: The radon concentration of raw materials samples of lightweight concrete brick and ordinary brick

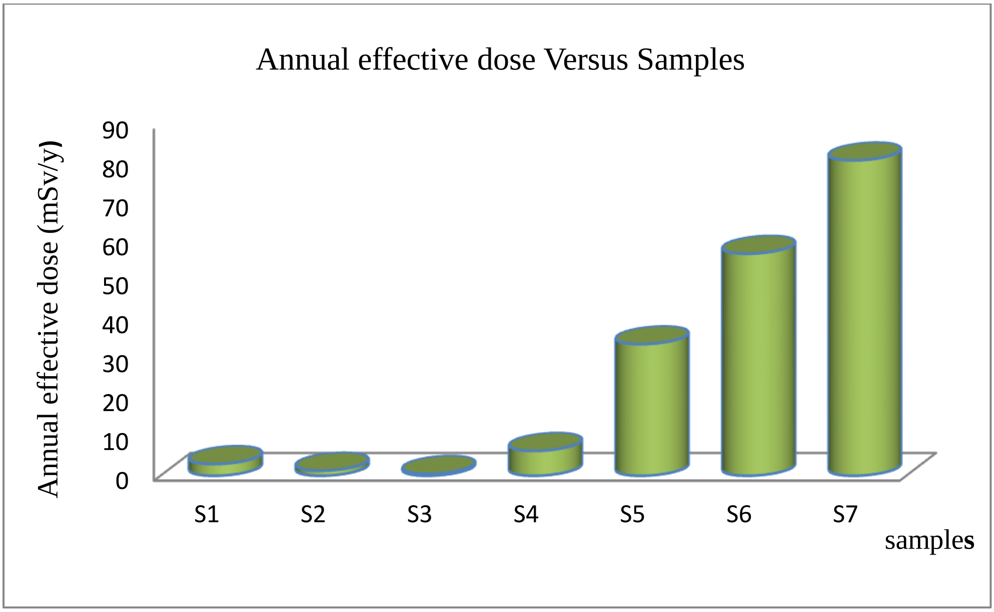

Figure 7: Annual effective dose for raw materials samples of lightweight concrete brick and ordinary brick

Results and Discussion

The elemental concentrations of raw materials of lightweight concrete brick and ordinary brick were measured by using Energy Dispersive X-ray Fluorescence method. The contents of elements in raw materials are shown in table 1 and the results are shown in figure 4. According to the measurement data of raw materials samples of lightweight concrete bricks using EDX-720, the results showed that Ca was found in sample 1 (lime), sample 2 (Gypsm, p-o-p) and sample 5 (river sand) as major elements. The result showed that Si was found higher amount and Fe is second large as major element and Zr, Cr, Mn, Zn and Ni were found in raw materials samples of ordinary brick as minor constituents. By using LR-115 detector, the calculated values of average alpha track from raw material samples varied from 1.76 ± 0.16 to 67.82 ± 1.68 and the values of alpha track density varied from 0.54 ± 0.40 to 93.98 ± 2.54 tracks cm^{-2} day^{-1}, based upon these values, radon concentration had been calculated. The values of radon concentration varied from 27 ± 19.79 Bqm^{-3} to 4699 ± 127.09 Bqm^{-3}. From the Table 2, it was observed that the values of radon concentration from lime, gypsum, aluminum powder and cement for building materials were below the recommended permissible level of 200-600 Bqm^{-3} by ICRP -103, 2007 but the radon concentration of river sand, terracotta and a mixture of terracotta and black clay samples were above permissible level. The highest value of annual effective dose of terracotta and a mixture of terracotta and black clay samples were above permissible level. Since the annual effective dose of lime, gypsum, aluminum, cement and river sand samples were less than recommended level 50m Sv/y, there was no health hazard for people.

Conclusion

Toxic elements such as Hg, Pb, and Cd and As concentration in weight percent level were not observed in raw materials of lightweight concrete and ordinary brick in EDXRF measurement but Sr concentration was found in poor weight percent level of raw materials of light weight concrete brick. Based on seven samples examined, a mixture of terracotta and black clay showed the maximum value of average alpha track, alpha track density and radon concentration 67.82 ± 1.68, 93.98 ± 2.54 tracks $cm^{-2}day^{-1}$ and 4699 ±

127.09 Bqm^{-3} respectively, whereas the value of radon concentration of aluminum powder was comparable with background value. The highest value of annual effective dose of terracotta and a mixture of terracotta and black clay samples were above permissible level. The annual effective dose of lime, gypsum, aluminum powder, cement and river sand samples were less than recommended level 50m Sv/y. It depends on the radioactive content of the materials, emanation factor and diffusion coefficient of radon in that material, porosity and density of the material. Although the radon concentration of river sand sample used in lightweight concrete brick was above permissible level, it was much less than raw materials samples of ordinary brick. So lightweight concrete brick could be used safety for building constructions.

Acknowledgements

I would like to thank Professor Dr Khin Khin Win, Head of Department of Physics, University of Yangon for her kind permission to carry out this research.

I am greatly indebted to Professor Dr Aye Aye Thant, Department of Physics, University of Yangon for her encouragement.

References

Anjos R.M.,Ayub JJ.Cid A.S., Cardoso R.and Laceuda T. (2011). External gamma ray dose rate and radon concentration in indoor radon environments covered with Brazillian granites. Journal of Environmental Radioactivity (102), 1055-1061

Amrani, D., Tahtat, M.,(2001). Natural radioactivity in Algerian building materials. Appl. Radiat. Isot. 54, 687-689.

ICRP, (1993),Protection against radon-222 at home and at work. ICRP Publication 65.Ann. ICRP 23

ICRP, (2007). The 2007 Recommendations of the international Commission on Radiological Protection. ICRP Publication 103.Ann. ICRP 37 (2-4)

J.K. Otton, L.C.S. Gundersen and R Schumann,(1993).The Geology of Radon.

WWW.elsevier.com/locate/radmeas