J. Myanmar Acad. Arts Sci. 2018 **Vol. XVI. No.2**

INVESTIGATION ON ENVIRONMENTAL BENEFITS OF LOCAL RESOURCES FROM LOIKAW, KAYAH STATE

Naw htoo Lar Phaw*

Abstract

This research is preliminary proposing level to investigate how the addition of fly-ash affects the compressive strength of traditional bricks and the radon concentration of local resources. For this work dolomite, fly-ash and cement were used as raw materials to make brick samples. Before making bricks, they were analyzed by EDXRF and XRD techniques. Ten brick samples were prepared by dolomite and cement only without fly-ash as the ratio of 18:1(They have been currently used in Kayah State) and 6:1 in five of each. Other eight brick samples were prepared with different weight ratios of dolomite, fly-ash and cement. The compressive strengths of obtained bricks were determined by using Compressive Testing Machine (RBU-250). . From results the sample made by the mixture of dolomite, fly-ash and cement with the weight ratio of 2:1:1 shows the best compressive strength of 1325.59 PSI, which is significantly higher than that of traditional brick samples made by the mixture of dolomite and cement with the weight ratio of 18:1 (424.80 PSI). So that fly-ash (regional source) is an appropriate addition to make bricks with higher compressive strength. To study the radon concentration measurements in dolomite, fly-ash were examined by using LR 115 type II SSNTDs which were used as track recording materials.

Introduction

In the Kayah State , people are using traditional bricks which are made by the dolomite (Demawsore) and cement (KanBawZa) as the ratio of 18:1 in construction of buildings. If the concentration of them as the ratio of 6:1 are used instead of the ratio of 18:1 , the construction materials should be modified by using the higher compressive strength level. But cost will become high.

The addition of fly- ash (Tigyit) to cement, concrete and bricks can improve their mechanical properties such as compressive strength as well as reducing the cost of bricks.

*. Dr, Professor, Department of Physics, Pyay University

In this research, dolomite, fly-ash and cement were used as raw materials to make brick samples and they were examined by EDXRF and XRD methods. And then the compressive strength of the brick samples were determined by compressive strength testing machine (RBU-250) from the structural laboratory at department of civil engineering in Yangon Technology University.

In the present work, the raw materials were collected and analyzed the radon concentration to estimate the levels of radon in order to guaranty the safety of people and surrounding atmosphere. The aim of this work is to avoid the health risk in buildings.

Experimental Procedures

2.1 Determining the concentrations of elements

The raw materials which are dolomite (Demawsore, Loikaw), fly-ash (Tigyit, southern Shan State) and cement(Kan Baw Za) were collected and analyzed by EDXRF for determining the concentrations of elements. And then XRD analysis was carried out to probe the crystal structures of raw materials. For EDXRF and XRD analysis, the raw materials were ground by using agate motor and pestle to get the fine powder and pressed under uniaxial pressure of 5 tons per cm^3 to obtain pellets.

2.2 Measuring the compressive strength

At first, the five bricks which having the ratio as those currently used in local construction and other five bricks which are made with the dolomite (Demawsore) and cement (Kan Baw Za) as the ratio of 6:1 were investigated to determine their compressive strength by compressive strength testing machine.

Figure 1. Five bricks samples as 18:1 ratio

Figure 2. Five bricks samples as 6:1 ratio

The three elements such as dolomite, fly- ash and cement were weighted by using digital balance in the various ratio and listed in Table1. And then, the eight brick samples were made in such way that each pair of bricks, namely A_1 and A_2 , B_1 and B_2 ,C_1 and C_2 , D_1 and D_2 are the same in weight. When the eight bricks were got, they were dried by the sun for 28 days (25.6.2016 to 22.7.2016) and the temperatures were also recorded day by day. The average temperature is found to be 25.46℃.

Table 1. The weighted values of brick samples with various ratios

Sample	**Dolomite (g)**	**Fly-ash (g)**	**Cement (g)**
A_1, A_2	3840	3840	-
B_1 , B_2	3840	1920	1920
C_1 , C_2	3840	2304	1536
D_1 , D_2	3840	3072	768

Figure 3. Making Bricks

Figure 4. Eight samples as brick

Figure 5. Compressive testing machine (250)

2.3 For measuring radon concentration

In this measurement, can technique was to find out the radon concentration. LR-115 plastic film was used as track detector. Raw materials were air dried and ground in pulverized form. A known amount (100g) of each raw material was placed in plastic can of dimensions 7.5cm height and 7.5cm diameter. A piece of LR- 115 detector with area of (1.5cm by 1.5cm) was fixed on the bottom of the lid of each can. The cans were tightly closed from the top and sealed. The detectors were left inside the cans for 100 days of exposure time (13.8.2016 to 21.11.2016). During this time, alpha particles from the decay of radon and its daughter bombard the detectors in the air volume of the can. At the end of exposure time, the detectors were etched chemically in 6.25N solution of NaOH at 60℃ for 1hour. Then, the detectors were washed and dried.

After chemical treatment, the tracks were counted by using optical microscope with objective having the same magnification 40 was used for all detectors. Fifty different views scanned to reduce statistical errors.

Experimental Results

3.1 EDXRF Results

The raw materials were examined by EDXRF (EDX-720) analysis. They are depicted in Fig 6 and Fig 7 respectively. The concentrations of elements are shown in Table 2.

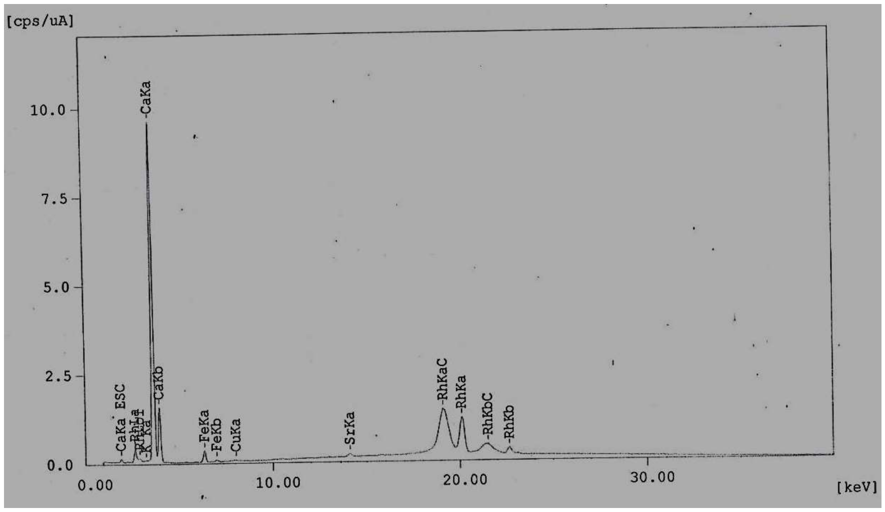

Figure 6. EDXRF analysis for dolomite

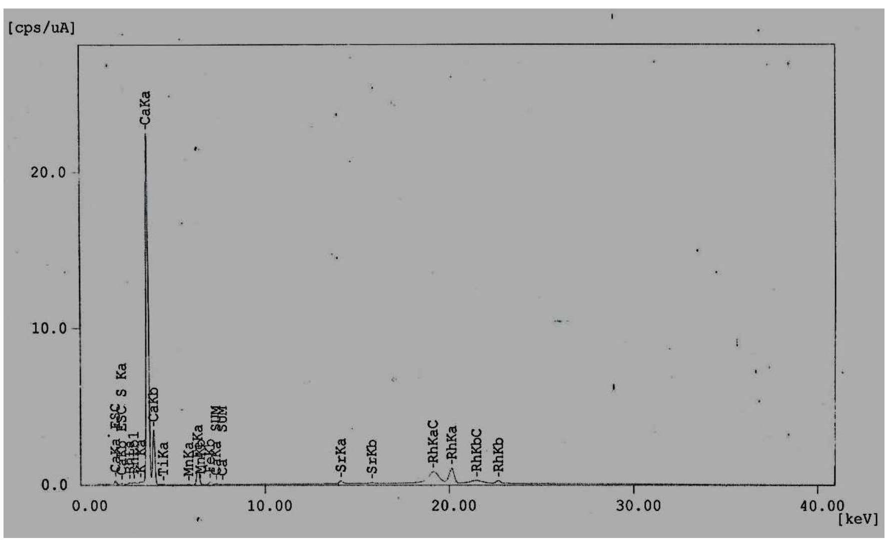

Figure 7. EDXRF analysis for fly- ash

Table 2. Concentrations of elements in dolomite and fly- ash

Elements	Dolomite	Fly - ash
Fe	1.838%	2.802%
Ti	ND	0.141 %
K	0.622 %	0.961 %
Ca	97.257 %	95.680 %
Mn	ND	0.068 %
Cu	0.165 %	ND
Sr	0.119 %	0.095 %
S	ND	0.259 %

3.2 XRD analysis

The results from XRD are shown in Fig 8, Fig 9 and Fig 10 and their properties are shown in Table 3 ,4 and 5 respectively.

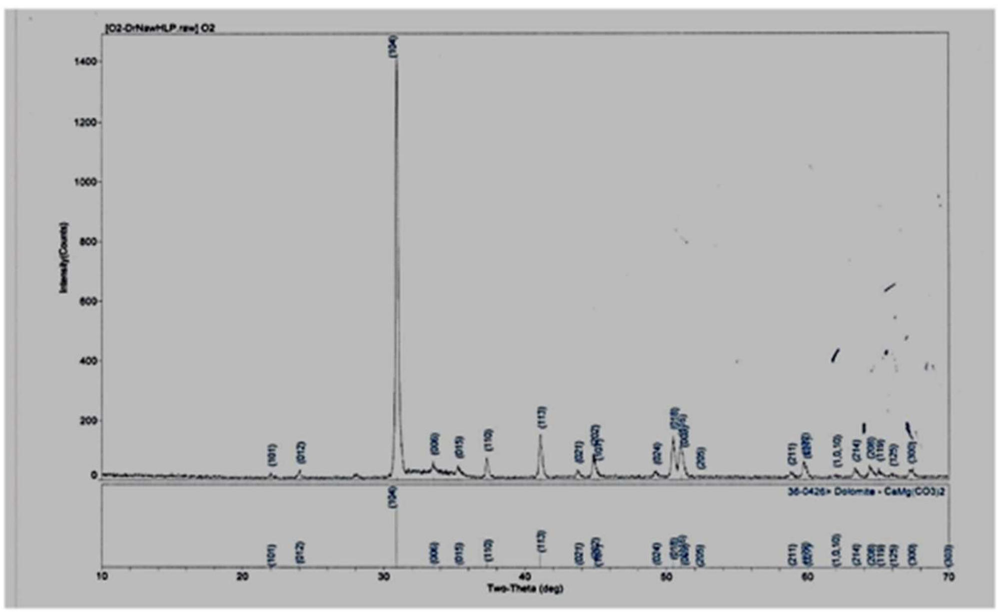

Figure 8. XRD pattern of dolomite

Table 3. XRD results of dolomite

Planes	**$(CaMg(CO_3)_2$**	**SiO_2**	**Al_2O_3**
(104)	(104)	-	-
(110)	(110)	-	-
(113)	(113)	-	-
(202)	(202)	-	-
(018)	(018)	-	-

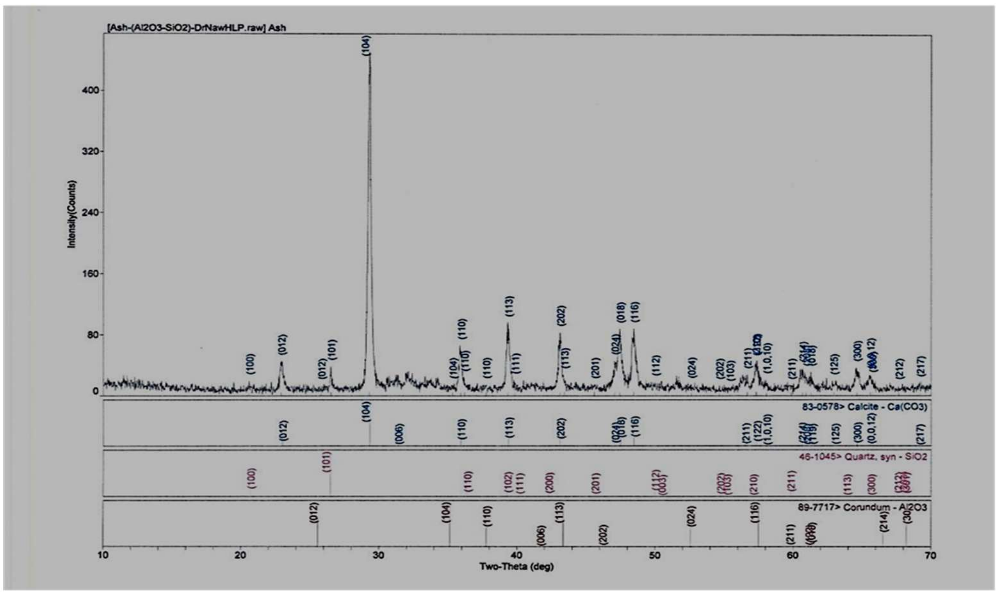

Figure 9. XRD pattern of fly-ash

Table 4. XRD results of fly - ash

Planes	Ca(CO_3)	SiO_2	Al_2O_3
(100)	-	(100)	-
(012)	(012)	-	(012)
(101)	-	(101)	-
(104)	(104)	-	(104)
(110)	(110)	(110)	(110)
(113)	(113)	(113)	(113)
(202)	(202)	(202)	(202)
(116)	(116)	-	(116)
(211)	(211)	(211)	(211)
(300)	(300)	(300)	(300)

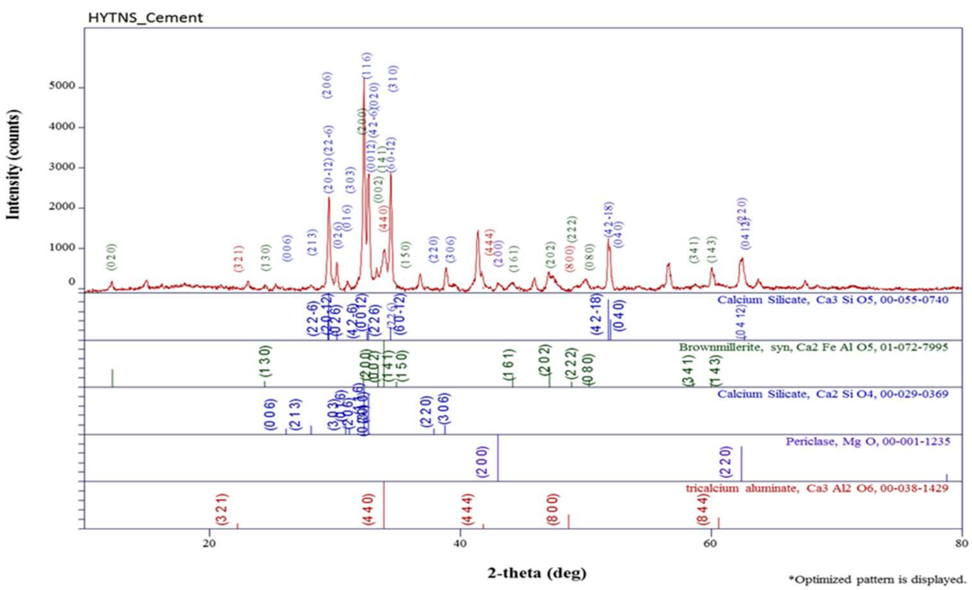

Figure 10. XRD pattern of cement

Table 5. XRD results of cement

Planes	Ca_3SiO_5	Ca_2SiO_4	Ca_2FeAlO_5	$Ca_3Al_2O_6$	MgO
$(20\overline{12})$	$(20\overline{12})$	-	-	-	-
(026)	(026)	-	-	-	-
(116)	-	(116)	-	-	-
(200)	-	-	(200)	-	-
$(00\overline{12})$	$(00\overline{12})$	-	-	-	-
(440)	-	-	-	(440)	-
(141)	-	-	(141)	-	-
$(60\overline{12})$	$(60\overline{12})$	-	-	-	-
(306)	-	(306)	-	-	-
(444)	-	-	-	(444)	-
(202)	-	-	(202)	-	-
$(42\overline{18})$	$(42\overline{18})$	-	-	-	-
(040)	(040)	-	-	-	-
(143)	-	-	(143)	-	-
$(04\overline{12})$	$(04\overline{12})$	-	-	-	-
(220)	-	-	-	-	(220)

3.3 Results for Compressive Strength

The compressive strengths were determined by compressive strength testing machine (RBU-250) of the structural laboratory at department of civil engineering in Yangon Technology University. The results are shown in Table 6(a) and 6(b) as the various ratio of dolomite, fly- ash and cement.

Table 6(a) Compressive strength for ten bricks as the various ratio

Items / Samples		Dolomite and cements as raw materials									
		18 : 1					6:1				
Weight (g)		6910	6760	6690	6890	6300	6860	6860	6760	6830	6660
Length (cm)		28.91	28.91	28.91	28.91	28.91	26.17	26.17	26.17	26.17	26.17
Width (cm)		13.17	13.17	13.17	13.17	13.17	12.15	12.15	12.15	12.15	12.15
Height (cm)		10.33	10.33	10.33	10.33	10.33	10.47	10.47	10.47	10.47	10.47
Unit Weight (lb/ft^3)		129.4	126.6	125.3	129.0	118.0	157.4	157.4	155.1	156.1	152.8
Maximum load (p) (N)		9443	10934	10437	8449	8946	44233	46221	42742	43736	40257
Compressive Strength	lb/in^2	416	482	460	372	394	2421	2530	2339	2394	2230

Table 6(b) Compressive strength for eight bricks as the various ratio

Items / Samples		Dolomite , fly- ash and cement as raw materials							
		A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2
Weight (g)		6120	6120	6880	7060	6820	6740	6800	6700
Length (cm)		26.0	25.5	26.0	26.0	26.0	26.0	26.0	26.0
Width (cm)		9.5	10.0	10.0	10.0	10.0	13.0	10.0	10.0
Height (cm)		12.0	12.5	13.0	13.5	13.0	13.5	13.0	13.5
Unit Weight (lb/ft^3)		130.97	121.79	129.11	127.58	127.99	93.69	127.61	121.08
Maximum load (p) (N)		71550	65770	16460	110620	158700	215120	216090	159930
Compressive Strength	lb/in^2	420.18	374.12	918.28	1732.90	885.36	923.17	1205.53	892.22

3.4 Microscope Results

Photomicrographs of alpha tracts in LR- 115 for raw materials such as dolomite and fly- ash are shown in Fig 11 and Fig 12 respectively.

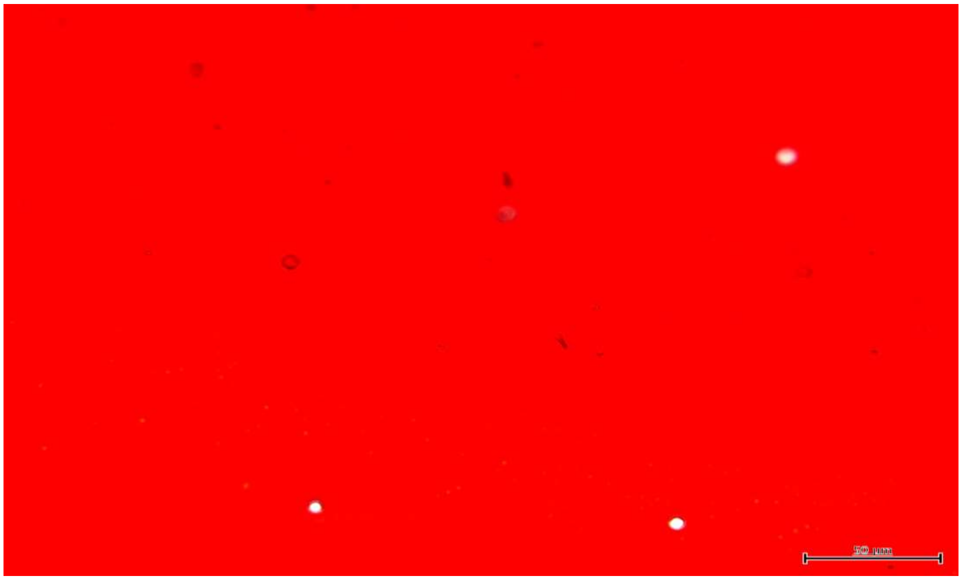

Figure 11. Photomicrographs of alpha tracks for dolomite

Figure 12. Photomicrographs of alpha tracks for fly- ash

The calculated values of radon concentration in dolomite and fly- ash are listed in Table 7.

Table 7. Results from radon concentration

Sample	Average net Tracks	Track Density (trackcm^{-2} day^{-1})	Radon concentration (Bqm^{-3})	Annual Effective Dose (mSv yr^{-1})	Activity (Bq m^{-3}h^{-1})	Mass Exhalation Rate (mBq kg^{-1}h^{-1})	Surface Exhalation Rate (mBq m^{-2} h^{-1})
Dolomite	1.28 ± 0.226	0.146 ± 0.026	6.952 ± 1.238	0.1196 ± 0.0213	(1.668 ± 0.297) 10^4	0.138 ± 0.025	3.114 ± 0.554
Fly - ash	2.88 ± 0.718	0.329 ± 0.082	15.667 ± 3.905	0.2695 ± 0.067	3.760 ± 0.937	0.310 ± 0.077	7.019 ± 1.750

Discussion and Conclusion

4.1 Discussion

The EDXRF results show that Ca contains the highest concentration of 97.257% in dolomite and 95.680% in fly- ash.

The XRD results show that in dolomite, the planes (104), (110), (113), (202) and (018) identify with the planes of dolomite. All of the planes can be attributed to dolomite ($CaMg(CO_3)_2$ phase, which is matched well with the library file no 36-0426 .

In fly-ash, the planes (110), (113), (202), (211) and (300) identify with the planes in calcite; silicate and aluminum oxide respectively. The planes (012), (104) and (116) identify with that of in calcite and aluminum oxide. Also the planes (100) and (101) identify with the planes in silicate from library file in XRD.

In cement, the presence of calcium silicate (Ca_3SiO_5), calcium silicate (Ca_2SiO_4), brownmillerite (Ca_2FeAlO_5), tricalcium aluminate ($Ca_3Al_2O_6$) and periclase(MgO) are observed. The planes $(20\overline{12})$, (026), $(00\overline{12})$, $(60\overline{12})$, $(42\overline{18})$, (040) and $(04\overline{12})$ are corresponding to the major phase of monoclinic structure Ca_3SiO_5. Other planes are represented by the minor phases such as Ca_2SiO_4, Ca_2FeAlO_5, $Ca_3Al_2O_6$ and MgO, respectively.

The measurement of compressive strengths of brick samples are summarized in Table 6(a) and (b). As listed in Table 6(a), dolomite and cement were used as raw materials. The average compressive strength of five bricks prepared by the mixture of dolomite and cement with the weight ratio of 18:1(according to the conventional brick that currently used in Loikaw township, Kayah State in Myanmar) is 424.8 $lbin^{-2}$. The average compressive strength of five bricks prepared by the mixture of dolomite and cement with the ratio of 6:1 is 2382.8 lb in^{-2}. In Table 6(b), dolomite, fly- ash and cement were used as raw materials as the various ratios. The average compressive strength of A_1 and A_2 made by the mixture of dolomite and fly- ash as the ratio of 1:1 is 397.15 lb in^{-2}.

The average compressive strength of B_1 and B_2 made by the mixture of dolomite, fly- ash and cement as the ratio of 2: 1:1 is 1325.59 lb in^{-2}. When dolomite, fly- ash and cement were mixed with 5:3:2 ratio, the average compressive strength of obtained bricks C_1 and C_2 is 904.27 lb in^{-2}. For samples D_1 and D_2, dolomite, fly-ash and cement were mixed with 5:4:1 and the average compressive strength of D_1 and D_2 is 1048.88 lb in^{-2}.

According to the radon concentration results, the alpha track density is 0.146 ± 0.026 tracks cm^{-2} day^{-1}, radon concentration is 6.952 ± 1.238 Bqm^{-3}, annual effective dose is 0.120 ± 0.021 $mSvyr^{-1}$, activity is 1.668 ± 0.297 $Bqm^{-3}h^{-1}$, mass exhalation rate is 0.138 ± 0.025 $mBqkg^{-1}h^{-1}$ and surface exhalation rate is 3.114 ± 0.554 $mBqm^{-2}h^{-1}$are found in dolomite. In fly-ash , the alpha track density is 0.329 ± 0.082 tracks cm^{-2} day^{-1}, radon concentration is 15.667 ± 3.905 Bqm^{-3}, annual effective dose is $0.270\pm0.067$$mSvyr^{-1}$, activity is 3.760 ± 0.937 $Bqm^{-3}h^{-1}$,mass exhalation rate is 0.310 ± 0.077 $mBqkg^{-1}h^{-1}$and surface exhalation rate is 7.019 ± 1.750 $mBqm^{-2}h^{-1}$.

4.2 Conclusion

The XRD results show that the Portland from Demawsore township, Kayah State is the type of dolomite which has the properties of cement. The fly-ash from Tigyit in Southern Shan State also has the properties of cement.

The average value of compressive strength of brick samples which were made by the mixture of dolomite and cement as the ratio of 18:1 is 424.8 PSI. This value is very lower than the standard values (1000~2500PSI). So that kind of bricks, currently used in Loikaw township, is not safe in constructing high buildings.

When dolomite and cement were mixed with the weight ratio as 6:1, the average value of compressive strength of that brick samples is 2382.8 PSI. It is a very perfect value for construction materials. But their prices become high.

In addition to use the fly-ash to mixture of dolomite and cement with the various weight ratio, the average values of compressive strength of that brick samples are 1325.59PSI (2:1:1) and 1048.88PSI (5:4:1).

From the above mentioned results, it can be concluded that fly-ash is an appropriate additive to prepare bricks with higher compressive strengths as well as it can be used especially in reducing the use of cement.

From International Commission on Radiological Protection (2010), the radon concentration data, annual effective doses are much lower than the limited level 300 Bqm^{-3} and 17 $mSvyr^{-1}$ respectively. So in construction materials which were made by using regional sources (dolomite, fly-ash) the level of indoor radon are well within acceptable values for the people and free from exposure to radon and radon daughters.

And also it can be concluded that the present work has primarily been focused upon the radon concentration and annual effective dose that will be a significant support for further studies concerning the environmental safety and health protection.

Acknowledgements

I would like to thank Pro-rectors from Pyay University Dr Nyunt Soe and Dr Nilar Myint, Professor Dr Pyone Pyone Shein, Head of Department of Physics, Pyay University, for their kind permission to do this work.

I also would like to thank Rector (YU) Dr Pho Kaung, Professor Dr Khin Khin Win (Head of Department of Physics, YU) and Professor Dr Soe Soe Nwe (YU) for their permission to present this research report.

I am also grateful to Dr Zeya Oo, Visiting Professor, Department of Engineering, Physics, Yangon Technological University for sharing the knowledge on Geopolymer which is a great motivation to initiate this paper.

References

Alton Wade.F., Richard Mattox.B., (1960) *Elements of Crystallography and Mineralogy* (Harper and Brothers, Publishers, New York)

Callister.W.D., (1997) *Materials Science and Engineering* (Toranto : Wiley)

Chris Pellant, (1992) *Rocks and Minerals* (Dorling Kindersley Limited, London)

Guy.A.G., (1972) *Introduction to Materials Science* (London : Mc Graw-Hill)

http://www.Introduction to Cement.com

http://www.Introduction to Polymers.com

http://www.Introduction to Geopolymer.com