MEASUREMENT OF INDOOR RADON ACTIVITY LEVELS IN JOWAI REGION, MEGHALAYA, INDIA

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Abstract: In the present work, the activity levels of radon in dwellings and schools are reported for Jowai region. We have used LR-115 type 2 films which belong to the class of Solid State Nuclear Track Detectors (SSNTDs); the 'Bare-mode' methodology was adopted. Higher concentration levels were observed in concrete structures as compared to Assam type structures. Higher geometrical mean value was recorded for the first floor of multi-storeyed school buildings as compared to the ground floor.

Keywords: radon; LR-115 film

1. Introduction:

Radon is an inert gas that arises from the radioactive decay of radium; a naturally occurring trace constituent of the earth's crust. It is a known fact that radon contributes to more than 50 % of the natural background radiation received by the general population [1]. Exposure to high concentration of radon in indoor environment has proved to be a health concern due to the fact that on inhalation, radon gas reaches the lungs and further decays by means of alpha emission, this leads to impairment of lung tissues. Over time it can cause lung cancer [2, 3].

The indoor radon build-up depends upon many factors such as building materials, climate, ventilation, and occupant's behaviour [4]. The North Eastern region of India is expected to have higher concentration of radon due to its geological and seismic characteristics [5]. Jowai is the Headquarter of West Jaintia Hill district. The general geological formation of the region is characterized by the presence of rocks belonging to the age group of Achaean and tertiary. The plateau is composed of granites, phyllite, genesis, sandstone and limestone. This is more or less identical with the other parts of Meghalaya plateau. This region enjoys a remarkably pleasant climate, yet rainfall profile is very high during the South -West monsoon season which usually starts from the middle of May and declines towards the last part of September. The average annual temperature in Jowai is 17.7 °C. The percentage of relative humidity in Jowai is quite high in the month of October and comparatively low in the month of February [6].

In this study, measurements of radon activity concentrations were carried out in fourteen houses and nine schools of Jowai region. The types of house encountered in our study are reinforced cement concrete (R.C.C) and Assam type. Reinforced cement concrete type of house is the combination of ordinary concrete with reinforcement usually steel, to increase its compressive and tensile strength to a great extent. Assam type house are generally single-storey houses, but sometimes two storey varieties can also be found. The houses are made from different materials, ranging from wood and bamboo usually with a concrete plaster. For schools survey, the ground and first floors were chosen for deployment of detectors.

2. Experimental technique:

Solid State Nuclear Track Detectors, namely LR-115 Type 2 films were used for our study. These films are cut into small pieces of size 2.5 x 2.5 cm^2. They are then pasted onto a cardboard of dimension 6 x 9 cm^2. These detectors are placed at about 10 cm away from the nearest wall and 2 metres above the ground. After a period of exposure of about two months; these exposed films are retrieved and then they are chemically etched in 2.5N NaOH solution at 60 ºC for 90 minutes. The perforated holes or tracks that appear as bright spot in reddish

background are counted manually using an optical microscope at 150X magnification. The track density obtained are then converted into radon activity concentration using the equation below [7].

$$C_{Rn} = \frac{\rho}{kT} \quad (1)$$

Where ρ is the density of tracks (number of tracks counted per area of the film), k is the calibration factor used, and a value of 0.02 tracks.cm^{-2} d^{-1} (Bq.m^{-3})$^{-1}$ taken for current work [8] and T is the duration in days for which the detectors were exposed.

3. Result and discussion:

Table 1 lists the school that were surveyed in the current study. Table 2 depicts the value of radon concentration in selected dwellings and in schools of Jowai region, West Jaintia Hill district, Meghalaya India. In dwellings the concentration of radon varies from 53.8 ± 6.2 Bq.m^{-3} to 293.9 ± 15.6 Bq.m^{-3}, however in schools its value ranges from 11.9 ± 1.3 Bq.m^{-3} to 376.4 ± 26.3 Bq.m^{-3}**.** The higher concentration of radon in some dwelling and school may be due to room pattern or construction material used. Another reason could be poor ventilation system [9, 4]. For R.C.C type of structures the minimum and maximum values of radon concentration are 90.5 ± 10.0 and 293.9 ± 15.6 Bq.m^{-3} respectively with arithmetic mean and standard deviation of values 173.1 and 65.8 Bq.m^{-3} respectively. For Assam type house, the minimum and maximum values of radon concentration are 53.8 ± 6.2 and 137.5 ± 11.1 Bq.m^{-3} respectively, with arithmetic mean and standard deviation of values 99.11 and 32.85 Bq.m^{-3} respectively. In the ground floor of schools, the minimum and maximum values of radon concentration are found to be 11.9 ± 1.3 and 376.4 ± 26.3 Bq.m^{-3} respectively with arithmetic mean and standard deviation of values 182.3 and 112.6 Bq.m^{-3} respectively, whereas in the first floor the minimum and maximum values of radon concentration are 64.7 ± 7.7 and 307.9 ± 24.6 Bq.m^{-3} respectively with arithmetic mean and standard deviation of values 196.1 and 104.9 Bq.m^{-3} respectively.

It is evident from Fig 1 that radon levels do vary even amongst same type of houses, this may be attributed to size and ventilation of the house and lifestyle of the inhabitant. However, in schools although the ground floor is found to have highest values of radon levels as compared to first floor, but contrary to expectations [9, 10], the first floor has higher geometrical mean value; ventilation and higher role of the building structure in radon emanation could be the reason but this conjecture needs to be investigated further.

In dwellings, it is observed that R.C.C type of house has much higher radon concentration as compared to Assam type of house, this is because in case of R.C.C type, construction material play a crucial role in enhancing radon level in indoor environment, but in case of Assam type, due to its design requiring lesser building materials and higher ventilation rates, the construction material has lesser contribution to radon build up, thus lowering radon concentration [11].

Table 1: G.P.S Coordinates of the schools under study.

Detector Code	Name of the site (Schools)	Latitude	Longitude	Elevation (in metre)
JP-S_1	Presbyterian L.P	N-25°27’07.4”	E-92°11’49.2”	1444
JM-S_1	Marian Hill	N-25°26’40.9”	E-92°11’482”	1371
JH-S_1	H.K Singh	N-25°26’20.1”	E-92°11’38.7”	1358
JC-S_1	Chestar	N-25°26’13.8”	E-92°11’46.0”	1378
JK-S_1	K.J.P	N-25°26’13.5”	E-92°11’52.7”	1332
JU-S_1	Jowai Presbyterian U.P	N-25°26’19.6”	E-92°11’53.6”	1333
JS-S_1	Jowai Presbyterian Sec.	N-25°26’15.6”	E-92°11’54.1”	1353
JT-S_1	Tpep-pale	N-25°26’24.7”	E-921158.3”	1353
JG-S_1	Government girls	N-25°26’11.94”	E-92°11’37.4”	1341
JU-S_2	Jowai Presbyterian U.P	N-25°26’19.6”	E-92°11’53.6”	1333
JS-S_2	Jowai Presbyterian Sec.	N-25°26’15.6”	E-921154.1”	1353

JK-S_2	K.J.P	N-25°26'13.5"	E-92°11'52.7"	1332
JT-S_2	Tpep-pale	N-25°26'24.7"	E-921158.3"	1353
JC-S_2	Chestar	N-25°26'13.8"	E-92°11'46.0"	1378
S_1= Ground floor ; S_2= First floor				

Table 2: Radon concentration in dwellings and schools of Jowai region.

Sl.no	In dwelling			In school		
	House type (R.C.C = J-h_1, Assam type = J-h_2)	Track density, ρ_d (track.cm^{-2})	Radon concentration (Bq.m^{-3})	School floor (Ground = J-s_1, First = J-s_2)	Track density, ρ_s (track.cm^{-2})	Radon concentration (Bq.m^{-3})
1	J-h_1	320.9	293.9 ± 15.6	J-s_1	72.6	62.8 ± 0.6
2	J-h_1	140.2	126.6 ± 12.6	J-s_1	215.1	192.4 ± 3.8
3	J-h_1	232.3	211.9 ± 13.9	J-s_1	243.3	218.0 ± 6.5
4	J-h_1	182.7	165.9 ± 11.7	J-s_1	330.0	296.8 ± 11.8
5	J-h_1	184.4	167.5 ± 1.0	J-s_1	21.0	190.4 ± 9.5
6	J-h_1	101.2	90.5 ± 10.0	J-s_1	119.5	105.5 ± 13.7
7	J-h_1	267.7	244.7 ± 15.7	J-s_1	417.5	376.4 ± 26.3
8	J-h_1	126.6	114.0 ± 10.6	J-s_1	208.7	186.6 ± 16.7
9	J-h_1	157.5	142.6 ± 11.4	J-s_1	16.5	11.9 ± 1.3
10	J-h_2	61.6	53.8 ± 6.2	J-s_2	248.0	222.3 ± 13.3
11	J-h_2	125.0	112.5 ± 9.1	J-s_2	74.7	64.7 ± 7.7
12	J-h_2	125.5	113.0 ±10.6	J-s_2	306.2	275.2 ± 27.5
13	J-h_2	152.0	137.5 ± 11.1	J-s_2	342.2	307.9 ± 24.6
14	J-h_2	88.3	78.5 ± 7.6	J-s_2	125.0	110.4 ± 15.4

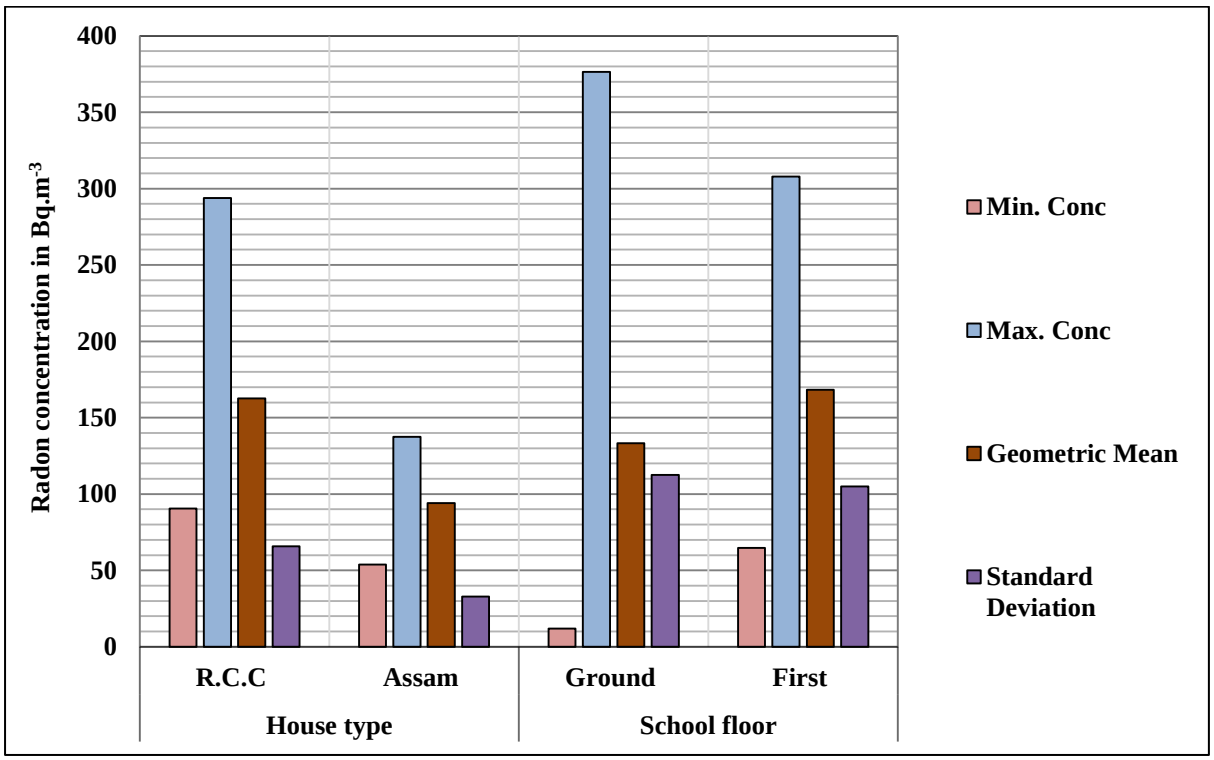

Figure 1: Bar-graph representation of the basic statistics radon concentration in dwellings and schools of Jowai region grouped according to house type and building floor number respectively.

4. Conclusion:

R.C.C type of building material showed higher radon levels compared to Assam type of houses, lending more evidence to the hypothesis that building materials and building design are crucial components in the accumulation of radon in indoors. In line with the above conclusions are the results for multi-storeyed schools, wherein the ground floors were found to have higher radon levels than the first floor. In terms of radiological protection, the radon activity levels of almost all houses and school rooms reported in the present study have concentration lower than the International Commission on Radiological Protection-recommended value of 300 $Bq.m^{-3}$[12].

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