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Preliminary Results of Radiological Impact Studies on the Usage of Granites in Hyderabad, Telangana State, India

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Abstract Natural background gamma radiation levels were measured using a NaI crystal based survey meter in different type's granite slab environs. These levels are found to vary between 2015 μGy y^{-1} and 2716 μGy y^{-1} with an average of 2270 μGy y^{-1}. This study establishes that usage of the granites as a flooring material in the building construction industry in the city like Hyderabad may not pose any additional radiation burden on the population.

Keywords Natural Background Gamma Radiation Levels, Granites, Hyderabad

1. Introduction

Radiation has always been present on the earth and is a part of our natural environment. Humans have been exposed to radiation from natural sources since the dawn of time. About 82% of total human exposure to radiation is from natural sources, man-made sources such as medical exposures, phosphate fertilizers and consumer products etc. add about 18% to the total exposure, which is known as technologically enhanced natural radioactivity [1 and 2]. Exposures from natural sources are due to (a) external sources of extra-terrestrial origin (cosmic rays), (b) sources of terrestrial origin (radioactive nuclides present in earth's crust, in atmosphere and in building materials), (c) internal exposure from radio nuclides taken into the body through ingestion of food materials, etc., and (d) indoor inhalation exposures due to radon (^{222}Rn), thoron (^{220}Rn) and their daughter products. These exposures vary depending on the location and elevated levels of naturally occurring radioactive substances like uranium (^{238}U), thorium (^{232}Th) and potassium (^{40}K) in specific localized areas. All exposures except those from the direct cosmic radiation are produced by the radioactivity of the radionuclides present in the environment [3 and 4]. Table 1 gives the radiation exposures to Indian population from different natural sources and its comparison with the reported global values.

The external exposures in indoors is largely due to the presence of radionuclides in the building materials used for the construction of dwellings. Surveys show that the exposure values are lower in wood-frame houses, in the countries such as New Zealand, Iceland and United States whereas higher values are in stone/masonry buildings of Portugal, Australia, Italy, Sweden, Iran and China [6].

Table 1. Radiation exposures to Indian population from different natural sources and its comparison with the reported global value [5]

Radiation Sources	India		World	
	Annual Effective dose ($mSvy^{-1}$)	Percent contribution	Annual Effective dose ($mSvy^{-1}$)	Percent contribution
External:				
Cosmic radiation	0.355	15.44	0.380	16.14
Terrestrial	0.379	16.48	0.480	19.55
Internal:				
Cosmogenic nuclide	0.015	0.65	0.010	0.41
^{222}Rn and ^{220}Rn	1.235	53.72	1.275	51.94
Terrestrial	0.315	13.70	0.310	12.63
Total (Rounded off)	2.30	100.0	2.5	100.0

In larger structures, the building materials may contribute a greater share to the indoor concentration, but the absolute contribution is usually small. However, certain materials have been found to constitute unusually large sources of radon, and in such cases, the building materials may be the source of unacceptably high indoor radon concentrations. Concretes made from aggregates of granite, pumice and shale have among the highest reported radon emanation rates while wood has a particularly low ^{226}Ra concentration and is a negligible source of indoor radon. The use in building and construction materials of industrial solid wastes that contain technologically enhanced concentrations of ^{226}Ra is a contributing source to high radon concentrations indoors. Fly ash from coal-fired power plants is used as an additive in cement and by-product gypsum from the phosphate industry is utilized in plasterboards and in concrete. These wastes contain a higher than average concentration of radium, and in some cases, such building materials are a significant source of indoor radon. The natural radioactivity content in some building materials and by-products frequently used in the building industry in India are shown in Table 2.

Table 2. Natural radioactivity content in some building materials and by-products frequently used in the building industry in India [7].

Materials used	^{40}K (Bq kg^{-1})	^{226}Ra (Bq kg^{-1})	^{232}Th (Bq kg^{-1})
Cuddapah tile	253	10	22
Mosaic tile	72	11	6
Grey-black granite	820	93	103
Black granite	76	6	9
Sandstone	439	11	12
Marble	<0.67	6	<0.40
Large stone chips	136	6	5
Small stone chips	120	7	9
Sand	464	18	46
Bricks	186	21	28
Cement	133	39	27
PoP	398	22	42
Concrete	180	15	17
Soil	170	9	14

In India, the terrestrial radiation profile has been prepared from the geological data by Sankaran et al., [8]. According to this, the granitic rocks and gneisses occupy major portions in the state of Telangana. A countrywide sample survey of outdoor natural background radiation levels has been carried out by earlier researchers [9]. It was reported that the average natural background radiation levels per caput is higher in this region. A national level coordinated research project to study the radioactivity levels has been initiated by the Board of Research in Nuclear Sciences of Department of Atomic Energy (BRNS-DAE). As a part of this project, the radioactivity levels in dwellings of Hyderabad, Ranga Reddy and Khammam district has been carried out. Part of the Nalgonda district is also covered for the estimation of natural background radiation levels by our group [10]. The results of these studies reveal that the natural background radiation levels are elevated in this region of Telangana state, India.

Hyderabad is one of the fast growing metropolitan cities in India. Due to the rapid urbanization a variety building materials have been using for the construction of buildings both for residential and commercial. Our research group has planned to study the radiation levels from different building materials used in the construction industry in Hyderabad city. As a part of it, it is learnt that a large amount of granites stones are using for the construction of buildings. Most of these granites are derived from the quarries of Southern India and on brand names like Pokarna, Suguna etc. Present paper deals with the preliminary investigation for the natural background radiation levels from different kinds of granite slabs used in Hyderabad city.

2. Materials and Methods

Natural background gamma radiation levels were measured using a NaI(Tl) crystal based μR-survey meter, M/s. Nucleonix Systems Private Limited, Hyderabad make for about 75 granite samples obtained from various suppliers with different trade names like Pokarna, Suguna, etc. Natural background gamma radiation levels were measured by bringing the granite slab very close in contact with the survey meter in a room on a wooden table of height about 1meter. Care has taken while using survey meter for one sample by keeping other granite samples far away from the table to minimize their influence. Our previous studies established that the natural background radiation levels estimated using survey meter and the thermoluminescence dosimeters (TLDs) in indoors are at good agreement (shown in Fig.1), with the correlation coefficient of about 0.9 [11].

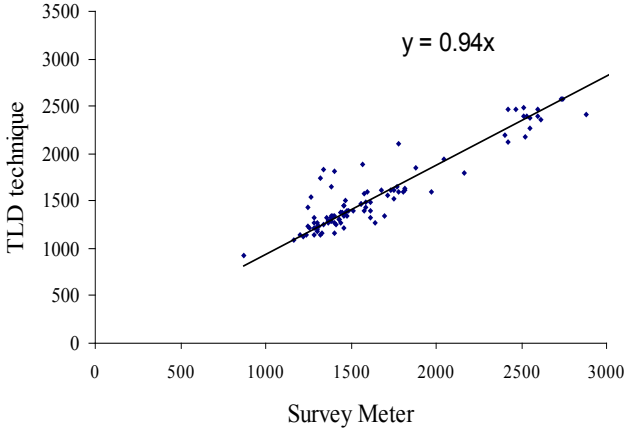

Figure 1. Correlation between the measurements of Survey meter and TLD technique (values in μGy y^{-1})

3. Results and Discussion

Natural background gamma radiation levels measured in

the vicinity of different granite slabs is shown in Table.3. The natural background radiation levels are found to vary between 2015 μGy y^{-1} and 2716 μGy y^{-1} with an average of 2270 μGy y^{-1}. The Natural background radiation levels measured using the same survey meter on the same table without any granite slabs in the vicinity is found to be 2102 μGy y-1, which is considered as a control.

The average value of Natural background radiation levels measured by keeping the granite slabs in contact with the survey meter is not varying significantly from the control except in one case. This establishes that the usage of these granites as a flooring material in the building construction industry in the city like Hyderabad may not pose any additional radiation burden on the population. However, the conclusion can be more effective when one studies the samples for the evaluation of U, Th and K-40 concentrations and exhalation rates; such an attempt is under progress.

Table 3. Natural background radiation levels (μGy y^{-1}) with different granite slabs.

S.No.	Trade Name	Natural background gamma radiation levels	S.No.	Trade Name	Natural background gamma radiation levels
1	Blue Antique	2102	39	Pokarna Tan Brown	2234
2	Blue Pearl	2059	40	Siberian White	2365
3	Brown Antique (ND Van)	2234	41	Silver Pearl-1	2234
4	Brown Antique (Van)	2146	42	Silver Pearl-2	2190
5	Dragon Red	2146	43	Silver Pearl Carres	2409
6	Dragon Red Leather	2365	44	Silver Pearl Flamed	2190
7	Emerald Pearl	2409	45	Silver Pearl Leather	2321
8	Faizal	2190	46	Silver Waves Brushed	2190
9	Flash Blue Cares	2190	47	Silver Waves Carres	2146
10	Flash Blue Flamed	2278	48	Silver Waves Honed	2321
11	Flash Blue Honed	2409	49	Silver Waves Leather	2278
12	Flash Blue Leather	2321	50	Silver Waves Polished	2453
13	Flash Blue Polished	2278	51	Stonex India Atlantic Beige	2190
14	Gold Dots Dark	2190	52	Stonex India Bronz	2059
15	Golden Dream	2190	53	Stonex Omani Beige	2102
16	Golden Dream Polished	2278	54	Suguna Armani Brown	2102
17	Hail Storm Flamed	2321	55	Suguna Bofichino Classicio	2146
18	Hail Storm Leather	2540	56	Suguna Bracia Dyna	2234
19	Hail Storm Polished	2497	57	Suguna Crema Fantasy	2102
20	Ikon white	2365	58	Suguna Crema Beige	2059
21	Mini Green Leather	2321	59	Suguna Marvo World RL	2190
22	Mini Green	2321	60	Suguna Perlato Sicilia	2102
23	Mini Green Polished	2365	61	Sun Surf Green Brushed	2190
24	Mint Green Brushed	2409	62	Sun Surf Green Polished	2321
25	Mint Green Carres	2453	63	Sun Surf Green Honed	2059
26	Mint Green Honed	2409	64	Sun Surf Green Leather	2102
27	Moon White 1	2453	65	Tan Brown-1	2278
28	Moon White 2	2321	66	Tan Brown-2	2321
29	Moon white Flamed	2409	67	Tropical Green Brushed	2321
30	Moon White Leather	2278	68	Tropical Green Flamed	2278
31	XX Pink	2716	69	Tropical Green Honed	2102
32	XX Purple dots	2015	70	Tropical Green Leather	2278
33	Pokarna Green Brushed	2540	71	Viscont White	2321
34	Pokarna Green Carres	2234	72	Viscont White Flamed-1	2409
35	Pokarna Green Flamed	2190	73	Viscont White Flamed-2	2234
36	Pokarna Green Honed	2321		**Minimum**	**2015**
37	Pokarna Green Leather	2365		**Maximum**	**2716**
38	Pokarna Green Polished	2234		**Average**	**2270**

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