

BRIEF OUTLINE OF A RESEARCH PROJECT DEALING WITH RADON RISK CLASSIFICATION OF FOUNDATION SOILS

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Introduction

The purpose of radon survey is to classify the building site area from the point of view of the risk of radon penetrating from the soil into the buildings. The uniform method, that is used for radon risk classification in Czech Republic since 1994 (1), is based on the assessment of the soil-gas radon (^{222}Rn) concentration and of the permeability of soil and rock for gasses. Both parameters are evaluated in the vertical profile up to the level of assumed building foundations or to the level of assumed contact building - soil.

Goals of the research project

Results of detailed radon surveys as well as results obtained from research studies, carried out in the Czech Republic in the period 1994 - 2000, indicated that the uniform method should be improved.

In 2000, RADON v.o.s. corp. in cooperation with other authors of the original uniform method, Milan Matolín (Charles University Prague, Faculty of Science) and Ivan Barnet (Czech Geological Survey), prepared a project dealing with this topic.

The research was divided into 10 sections:

A - Soil gas radon concentration measurements

- * choice of the basic grid used for soil gas sampling,
- * minimal statistical set of soil gas radon concentration values required for the evaluation
- * statistical evaluation of measurement results, when a building site of one family house is evaluated, and when a large area is evaluated

B - Soil gas sampling

- * relationship between the soil gas radon concentration and the changing sampling geometry
- * sampling in low permeable soils, possibility of enlargement of the active area for sampling
- * sealing during the soil gas sampling

C - Permeability determination

- * permeability of soils and rocks for gasses
- * new methods and equipment for direct measurements
- * spatial and seasonal variability and their impact on radon risk classification
- * minimal statistical set of permeability values required for the evaluation
- * advantages and disadvantages of various methods used for permeability determination

D - Radon exhalation rate from the ground

- * possibility of using this method for classification of radon risk when soil gas sampling in chosen depth is impossible (bedrock without cover, extremely low permeability, high saturation - extremely high soil moisture)
- * methods of measurements
- * statistical evaluation of measurement results

E - Integral and continual measurements of soil gas radon concentration

- * analysis of a possibility to use integral and/or continual measurements of soil gas radon concentration for classification of radon risk
- * intercomparison measurements of various equipments
- * testing of high and low temperatures influence on the results of measurements performed by various equipments

F - Geological parameters and their impact on the final assessment of radon potential of soils

- * choice of another geological parameter (other than permeability), more suitable for the assessment
- * soil moisture, saturation, effective porosity, porosity, density, bulk density
- * new methods and equipment for direct measurements
- * vertical and horizontal changes, seasonal variability and their impact on radon risk classification
- * advantages and disadvantages of various parameters for radon risk classification

G - Radon availability

- * practical use of radon survey results for the choice of an optimal building technology
- * definition of radon availability model
- * comparison of various models of „radon availability“
- * definition of geological index, that includes various geological factors influencing the radon behaviour
- * influence of changes in vertical profiles
- * influence of changing foundation depth used for the construction
- * possibility of substituting geological index for permeability determination

H - Uniform method for radon risk classification

- * final version of the improved version of the uniform method

I - Radon Risk mapping

- * practical use of the new method for radon risk mapping
- * quantity of measurements required for radon risk mapping in various scales
- * comparison of detailed measurements and radon risk maps in the scale 1:50000
- * how many measurements do we need if we want to perform a map with given reliability?

J - Radon reference sites in the Czech Republic

- * choice of new reference sites
- * detailed measurements at three reference sites, established in southern Bohemia
- * first intercomparison measurements at reference sites
- * statistical evaluation of soil gas radon concentration test measurements

Preliminary results

The research project started in June, 2000, and it is supported by the State Office for Nuclear Safety. Until now, the research has been almost finished in 6 sections (A, B, C, D, F and J). Selected preliminary results were presented at the Seventh International Symposium Natural Radiation Environment (NRE-VII), May 2002, Rhodes, Greece (section B - soil gas sampling). The results of section D - radon exhalation from the ground - and of section J - reference areas, will be presented on this workshop.

As for the soil gas radon concentration measurements, section A, it seems that there are no reasons to change the nowadays practice. It will be recommended to perform the detailed survey in a 10 x 10 m grid in the area of the assumed constructions. When a building site of one family house is evaluated, it will be necessary to realise at least 15 soil-gas sample measurements. The radon risk classification will be based on the assessment of values of soil-gas radon concentration and their distribution. When categorising areas of individual buildings or groups of buildings (small statistical sets), particularly significant statistical parameter for the evaluation of measurement results will be the third quartile (i.e. the 75th percentile). The values lower than 1 kBq.m⁻³ are not included in the data set evaluated by this method. It is still necessary to define the statistical evaluation of measurement results, when a large area is evaluated.

The research dealing with soil gas sampling, section B, confirmed the hypothesis, that measured soil-gas radon concentration do not depend on changing sampling geometry if the soil layer is homogeneous and low permeable, and that it is possible in those cases to enlarge the active area. A decrease of soil-gas radon concentration with increasing of the active area (by retracting the probe back to the surface) indicates that the vertical profile is not homogeneous and that the soil permeability is higher in shallow depths. A perfect sealing of all parts of the equipment is required when soil-gas samples are collected in low permeable soils.

Due to the permeability determination, section C, and to other geological parameters, section F, it is recommended to use the detailed description of all parameters and their changes in vertical profile from surface up to the level of assumed building foundations or to the level of assumed contact building - soil. It is necessary to describe as well as possible following parameters: permeability, grain size, soil moisture, saturation, effective porosity, porosity, density, bulk density, compactness, thickness of Quarternary cover, weathering character of the bedrock, modification of layers by various antropogeneous activities. This description should be completed by in situ permeability measurements, by the description of a resistance during the soil gas sampling, or by grain size analysis.

The research dealing with the radon exhalation rate measurement, section D, resulted in the conclusion that measurement of this parameter cannot be recommended to be used as a standard supplementary method for radon risk classification of foundation soils. Measured values of radon exhalation rate are substantially affected by conditions on the soil surface. Significantly lower values were observed when the soil surface was frozen or covered by water. If a water saturation of upper soil layers is connected with a low soil permeability, the radon exhalation rate from the surface is very low, even in case when the values of soil-gas radon concentration indicate a high radon potential.

As for the reference areas, section J, new three reference areas for intercomparison measurements were established in southern Bohemia, and a complete statistical evaluation of soil gas radon concentration test measurements was prepared. Just before the workshop, international intercomparison measurements of soil gas radon concentration and radon exhalation rate from the ground took place at one of these reference areas.

The research and all the measurements will be finished in the end of this year. We expect we will prepare both the results and the definitive version of the uniform method for presentation at any of scientific conferences during the next year.

References

(1) Barnet I. (1994) Radon Risk Classification for Building Purposes in the Czech Republic. In: Barnet I. and Neznal M., eds. Radon Investigations in CR. Vol. 5., Geological Survey Praha, p.18 - 24.