Abram Teplitskiy, PhD, Scientific Consultant
Dallas, Texas, USA
tepl@sbcglobal.net

How Solution Finds a Problem to Solve

(Case Study)

After graduating from university, I was concentrated on my PhD research, which was connected with practical applications of nuclear methods for technological control in construction, one of which were density and moisture content monitoring of soil structures. At that time, after Geneva Conferences of peaceful applications of nuclear energy, these methods were declassified and open for general research. I investigated propagation of gamma radiation through materials and one of the unforeseen results was establishing dependences between fluxes on two sensors, one of which was located immediately on the outside surface of the soil strata, another – over gap from this surface. Scheme of these experiments is shown below in Fig.1. Inside capacity, filled with soil, was installed a source of gamma-radiation 3, and outside this capacity were installed two sensors of gamma radiation 1 and 2. Distance between source 3 and sensor S_1 was equal R_1, and distance between sensors S_1 and S_2 was equal R_2.

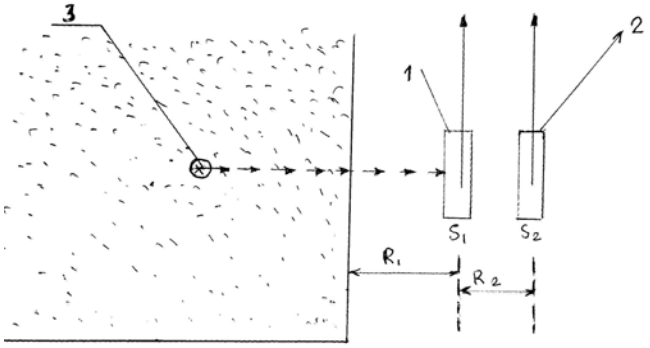

Fig.1. Scheme of experiments for investigation dependences Between fluxes of radiation on sensors and geometry of Sensors system.

After analyzing results of above investigations, we concluded a following formula:

$$N_1/N_2 = (R_1 + R_2) / (N1 / N_2 - 1)^{1/2} \quad \ldots\ldots\ldots \quad (1)$$

Where N_1 and N_2 are readings of the radiation sensors S_1 and S_2 respectively.

After getting above formula, we have no ideas about it possible practical applications. Later we started to use method of radioactive

markers in investigations of layer-by-layer deformations of soil structures on big depth, we found that besides traditional applications of this method for monitoring vertical deformation of soil strata, it would be very informative getting data about its horizontal movements. Author thinks that now everybody would remind above written formula, and exclaim "Eureka!" because this formula allows determining horizontal movements of radioactive marker. Now another problem was granted to problem-solvers – how to build a special measuring tools to determine what we could call "horizontal settlements" of soil strata! By considering above formula as a solution to a problem of measuring "horizontal settlements" of soil strata we will explain the title of this article.

As next step another, regular inventing question rose – how, in practice, measure horizontal movements of radioactive marker? Some versions readers can get in authors patents, two of which would be illustrated below. The first one is following the initial idea – place in a boring a sensor with two detectors of gamma radiation, separated by a known distance, and provide this system with ability to rotate. When the horizontal axle, which goes throw two separated detectors, also will pass through center of radioactive marker, one detector would register maximum of radiation, another – minimum. Finding the ratio of these radiation fluxes, using calibration formula based on equation (1), operator by calibration curve would find horizontal distance to marker. Schematically such device is shown in the Fig.2.

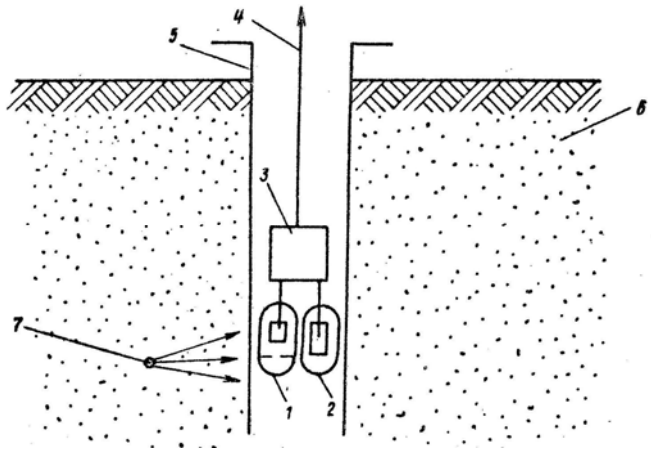

Fig.2.
Scheme of determining distance between axles of the boring and radioactive marker.
Public Domain – SU Patent #748,321

1,2 - sensors of gamma-radiation; 3-registration block; 4 - electrical cable; 5 – casing of a boring; 6 – soil; 7 – radioactive marker.

In the Fig.3 another version of device to monitor 3-dimentional movements of radioactive markers is shown.

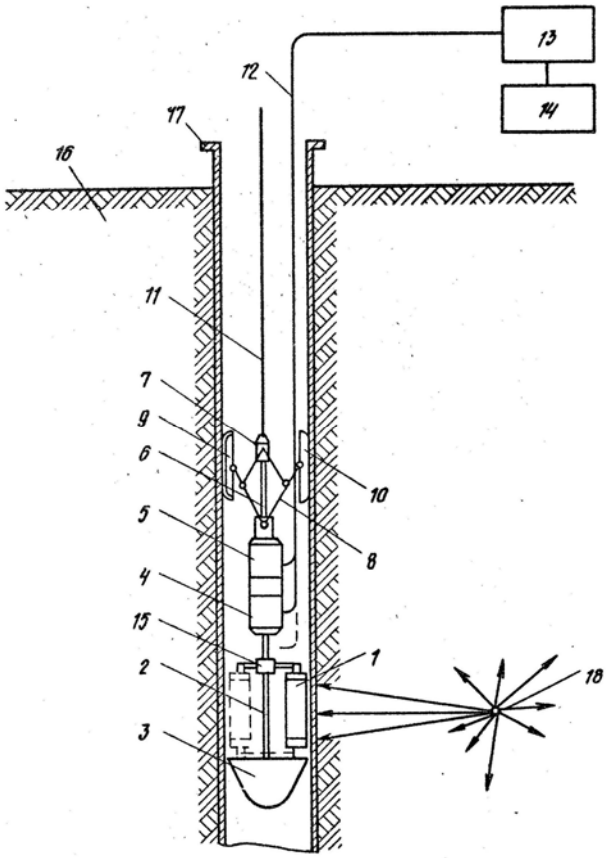

Fig.3.
Scheme of determining distance between axles of the boring and radioactive marker.
Public Domain – SU Patent #1,000,982

1,2 - sensors of gamma-radiation; 3-connic weighting block;
4 – rotating drive; 5 reversible drive; 6 – screw; 7 – nut;
8- pantograph; 9, 10 – clamping elements; 11 – driving element;
12 – cable; 13 – control panel; 14 – registration device;
15 – sliding contact; 16– soil strata; 17 – casing;
18 – radioactive marker

Experiments and investigations using radioactive markers have to comply with all safety rules required by acting official regulations.

Usually radioactive markers are placed in soil strata by inserting them through casing in wall of a boring on the project distance. For this purpose could be used special mechanical devices, some principles of which are described in one of previous author's publications in TRIZ Journal, special "guns" developed for this purpose, for example by Schlumberger Company, etc. (1).

Periodically, using standard technology, vertical position of radioactive markers around every boring could be located by vertical logging the radiation emitted by each marker. Using technology described in this article it could be also possible to monitor the horizontal movements of radioactive markers.

Some technological problems in Geotechnique, which could be solved using Radioactive Marker Technique, interested readers could find in referenced articles.

Finalizing, we once more underlining than sometimes a solution has to find its way to a problem!

References:

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