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REDUCING THE CONCRETE RADIOACTIVITY LEVEL

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Abstract

The necessity of introducing additives into the composition of concrete is considered, the ways of reducing the radioactivity of concrete are given..

Keywords: concrete; radioactivity; building materials; radiation pollution.

The radioactivity of building materials creates both external and internal radiation for humans. External exposure directly depends on the magnitude of the activity of the building material and is created by the radiation of radionuclides of radium-226, thorium-232, potassium-40 contained in this material.

Exterior irradiation in rooms is created by the gamma - emitting natural radionuclides contained in building materials. According to the current standards (NRBU-97) in existing buildings and structures with permanent residence of people, the absorbed dose of gamma radiation in the air of the premises should not exceed 0.44 μG / h or 50 μR / h.

Internal irradiation is caused by the ingress of radon-222 into the human body through the respiratory system and the products of its decay.

The main sources of human exposure are natural radionuclides in the environment. The dose of gamma radiation in a room is determined by the effective specific activity of natural radionuclides in building materials, which depends on the type of building material used, the raw materials for its production, the type of deposit and other reasons [1].

By monitoring the radioactivity and content of fillers in concrete, it is possible to obtain building materials with low values of effective specific activity, which reduces the radiation exposure of people.

To protect against radiation, legislators have set maximum exposure limits. Radiation protection concrete (also called shielding concrete) is used to reduce the effects of hazardous radiation.

Confirmation of radiation attenuation is not the job of a concrete engineer; The radiation protection specialist must provide the necessary parameters for the design of concrete, taking into account the structural characteristics (for example, the thickness of the building element):

- density of solid concrete,
- content of chemically bound water.

According to DIN 1045, heavy concrete (dry density> 2.8 kg/m or oven-dried concrete density> 2.6 kg / dm^3) is used for:

- radiation protection (medicine, flaw detection, customs, research, nuclear power plants),
- ballasting (construction machines, ships, protection of the base against the lifting force, pipelines),
- safes,
- sound insulation.

Heavy duty aggregates may be used that satisfy the following basic requirements:

- the required particle size distribution, grain density, crystallization water content and chemical composition must be provided,
- the properties of fillers (granular aggregates) should not have a negative effect on the strength and density of concrete,
- the wear caused by the storage of the aggregates (granular aggregates), as well as the mixing and laying of the concrete mixture, should be negligible,
- the surface structure of the components of the aggregate (granular aggregate) should not reduce the adhesion in the mortar and, accordingly, the concrete,
- the aggregate (granular aggregate) must not contain components that affect the concrete and destroy the steel reinforcement,
- the minimum compressive strength shall be 80 N / mm^2.

Continuous care of the concrete to protect against radiation should be taken with particular care to avoid cracks. To prevent thermal stresses, the massive building elements must be covered by a heat-insulating coating.

Due to the absorption of concrete, the temperature of the concrete can be greatly increased, while along with the dehydration of the concrete at a temperature of 100 -250°C there is a loss of concrete strength by 20-25%. According to the current level of knowledge, neutron radiation with fluence above 1019 neutrons / cm2 or gamma radiation at a dose of 2x1014 J/g can lead to a deterioration of mechanical properties (strength, modulus of elasticity, coefficient of thermal expansion). Such radiation doses occur, for example, in a nuclear reactor vessel. Along with these factors, the types of aggregates (granular aggregate) that are most resistant to radiation should be selected when measuring or constructing structures.

Radiation-exposed building blocks are preferably those containing solvent or water-based emulsion epoxy resins and polyurethanes, which have particular requirements for radiation resistance and decontamination capacity. Requirements and test methods are presented in DIN 55 991 [2].

The influence of neutron radiation on the properties of aggregates must be taken into account. First, the absorption of neutrons by the nuclei of atoms may result in secondary y-radiation. This is especially true of iron. Therefore, iron scrap and ore cannot always be used. In this regard, the preferred barite does not give secondary y-radiation. Secondly, when colliding with nuclei of atoms, neutrons can disrupt their equilibrium position in the crystal lattice. It is possible to change the volume and properties of aggregates. For example, when quartz irradiated with neutrons, its amorphization occurs, accompanied by a significant anisotropic expansion, which can lead to the destruction of concrete. This phenomenon should be taken into account not only in the design of structures of protective concretes, but also the usual structural, heat-resistant and heat-insulating concretes used in the construction of nuclear installations.

The grain composition of the aggregates is selected in such a way that as much as possible to saturate the concrete with a heavy aggregate. Concrete mixtures on particularly heavy aggregates are largely prone to segregation, delamination. Therefore, the density and viscosity of the soluble part of concrete is of great importance. In the case of intermittent grain composition of the aggregate is sometimes used separate concreting by the method of ascending solution [3].

Conclusion

The concentration of natural radionuclides in building materials used for different structures of buildings is largely determined by the total value of the external and internal components of the human radiation dose. Therefore, NRBU-97 establishes permissible levels of effective specific activity of natural radionuclides in construction materials, materials, products that are controlled both at the stages of production of construction materials (materials) and in the production of construction materials and products.

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