



ID 08

## Analize vplivov seizmičnih valov na podzemno objekte

### Analysis of the seismic waves effects on underground structures

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#### POVZETEK

Z napredkom tehnologij izkopa in podpiranja podzemnih prostorov, pogostnostjo pojavljanja katastrofalnih naravnih pojavov med katere spadajo ekstremne temperaturne spremembe v ozračju in z njimi povezani padavinski dogodki in ne nazadnje pogosta potresna aktivnost v zemeljski skorji so v mnogo-čem pripomogli k povečani uporabi podzemnega prostora. Po svetu je v današnjem času močno prisotna gradnja podzemnih objektov za različne namene ob dejstvu, da še vedno prednjačijo infrastrukturne povezave ter energetske objekti. Med slednjimi je prav tako zaznati povečane aktivnosti pri izdelavi konceptov gradnje manjših podzemnih nuklearnih objektov, ki bi bili opremljeni s tako imenovanimi majhnimi modularnimi reaktorji (Small Modular Reactors - SMRs). Primerne lokacije za gradnjo tovrstnih objektov v optimalnih globinah in trdnem hribinskem okolju imajo veliko prednosti pred nuklearnimi objekti na površini, saj zagotavljajo naravni sistem zadrževalnikov in neprimerno višjo vsestransko varnost zelo občutljivih objektov v najširšem smislu varovanja okolja in prebivalstva. Navedene prednosti so v času gradnje, obratovanja in zaprtja predvsem s poudarkom na varnem izvajanju del v različnih naravnih okoljih, ki so podvržena spremljajočim tveganjem ob pozitivnem vplivu na trajnostni razvoj širših območij. V pričujočem prispevku so podani rezultati geomehanskih analiz stabilnosti vitalnih nuklearnih objektov, ki so izpostavljeni seizmičnim obtežbam v določenem hribinskem okolju. Ugotovljeno je bilo, da so ti objekti bistveno manj ogroženi kot podobni objekti na površini terena ali v manjših globinah pod njo.

**Ključne besede:** podzemni objekt, nuklearnika, naravni zadrževalnik, seizmična obtežba, pomiki hribine.

#### ABSTRACT

With the advancements of technologies excavation and support of underground structures, incidences of catastrophic natural phenomena which include extreme temperature changes in the atmosphere and associated precipitation events, and last but not least frequent seismic activity in the earth's crust in many ways contributed to the increased use of underground space possibilities. Nowadays in the world is strong presence construction of underground

structures for different purposes usually are still relating to infrastructure connections and different power plants. Among them is also observed increased activity in the manufacture of the concepts of small underground nuclear facilities constructions, which would be equipped with so-called Small Modular Reactors - SMR. Suitable locations for the construction of such facilities in optimal depths and in solid rock environments have many advantages in comparison with nuclear facilities in the ground surface. Underground environment provide a natural containment system of nuclear facilities and has an incomparably higher comprehensive security for highly sensitive objects to protect the natural environment and population. These advantages during the construction, operation and closure are mainly focusing on the safe implementation of works in different natural environments that are subject of the risks attendant with a positive impact on the sustainable development of the wider areas. This paper presents the results of geotechnical stability analysis of vital nuclear facilities, which are exposed to seismic loads in a given rock environment. It was found that these objects are significantly less risk exposed than similar objects on the ground surface or in smaller depths below.

**Key words:** underground structure, nuclear power plant, natural containment, seismic load, ground displacement.