# CHEMICAL RESISTANCE OF CEMENT-BENTONITE SUSPENSION FOR SLURRY CUT-OFF WALL

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In Europe, bentonite occurrence in large quantities and high quality in Greece, Italy, Spain, Great Britain, Cyprus, Bulgaria, Hungary, Romania, Czech Republic and Slovakia is known. Most of deposits belong to open-cast mining and contain Ca-montmorillonite as the main component. The Ca-bentonite can be transferred to Na-type for utilisation in finished products for a very broad range of industrial applications. Until recently, exclusively sodium bentonite has been used in practice. The most important properties of sodium bentonite are high specific surface area (the very small particles compared to e.g. cement), high swelling capacity, the cation exchange capacity and low permeability. Bentonite is therefore a unique clay mineral with very high swelling potential and water adsorption capacity.

Cement is a system composed of clinker minerals and gypsum that react with water at different rates giving hydration products of various composition and crystallinity. Type and volume of the formed hydration products influence porosity, strength and other engineering properties of hardened final product. The use of only Portland cement generates some undesirable problems with shrinkage-expansion behaviour, chemical resistance and durability of cement composites. To this end, much attention in recent years is devoted to the development of new generation cements with the aim to improve physical-mechanical properties, chemical and environmental resistance, non-permeability and durability of final products. However, these cements are mainly suitable for concrete making technologies. The next idea (appeared approximately 50 years ago) was to get a synergetic effect by a combination of swelling (sodium bentonite) and non-swelling minerals (cement) for specific construction techniques (vertical barriers known as slurry cut-off walls). It is known that the first cut-off walls were built in the USA in 1945 having 12 m depth and 1.20 m thickness. In the present days slurry cut-off walls reach depth 20–30 m up to 60 m and vary in thickness between 0.6 and 1.2 m. Generally, two main production techniques are known for slurry cut-off walls: two-phase and one-phase method. The two-phase method is based in the first step on the bentonite suspension only that fills and stabilises the excavated trench. It is replaced in the second step by the concrete. This method is rather time-consuming, laborious and expensive. Therefore it was tried to replace two steps by the only one based on filling up the trenches by one sealing material. For this aim the bentonite suspension was mixed with cement during excavation for stabilisation of the trench. After excavation, the cement-bentonite suspension stayed in the trench creating after hardening permanent casting and sealing element.

The technological requirements on the cement-bentonite suspension for slurry cut-off walls are: stability and homogeneity after mixing with water having suitable viscosity (flow ability measured by the Marsh cone) and low water decantation. The claim to be achieved is to manufacture a cement-bentonite suspension that stays workable and flow able during the excavation period of several hours without any separation effects having in the final effect sufficient mechanical properties and chemical resistance. It is of great importance because compressive strength of cement-bentonite suspensions varies between 0.1 and 1 MPa up to 2 MPa. This is due to high water to cement ratios (1 to 3 and more). Sufficient chemical resistance is an essential requirement for slurry cut-off walls. This is caused by the fact that statistical reviews have found that more than one half of subsurface waters have aggressive effect on the hardened cement-bentonite suspension. Moreover, in the case of slurry cut-off wall deterioration, the protected surrounding will suffer by the hazardous chemical substances.

This paper shows the results of the chemical resistance of the cement-bentonite suspension with adjusted flow ability (Marsh test varies between 42 s and 45 s), water decantation less than 2vol% per 24 hours of suspension sedimentation in 1 litre cylinder and having 28-day compressive strength of 0.5 MPa. The suspension consisted of blast furnace slag Portland cement CEM II / A–S 32.5 (cement plant Povazska cementaren, a.s. Ladce) and sodium bentonite from Jelšový Potok deposit delivered as the final product Bentovet K (Gemerská nerudna spoločnosť, a.s. Hnusta), both from Slovakia. The suspension mixture composition on 1 $m^3$ is: 323 kg of cement, 27 kg of Bentovet K and 885 l of water (water to cement ratio = 2.74). The suspension was prepared by activated mixing to comply as much as possible with ready-mixed suspensions on the construction sites. The basis for the use of testing of aggressive solution is given in STN 73 1215 Concrete Structures—Classification of Aggressive Environments. It is worthy to mention that the published criteria in the above Standard are valid for concrete only and not for cement-bentonite suspensions having compressive strength ten to hundred times lower compared to concrete. No Standard related to cement-bentonite suspensions has been issued until now in the world. The chosen aggressiveness modified with regard to these facts represents the combined chemical attack of magnesium, chloride, ammonium and sulphate ions contemporarily. Long-term resistance of the suspension is described and assessed as well as cement-bentonite interaction and microstructure development of the specimens kept in reference water or exposed to aggressive medium are discussed too.