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## ENVIMIX BUILDING PRODUCTS BASED ON INDUSTRIAL WASTES AND THEIR POTENTIAL USE ALSO BEYOND THE AREA OF WATER ENGINEERING

### MATERIAŁY ENVIMIX NA BAZIE ODPADÓW PRZEMYSŁOWYCH I ICH POTENCJALNE WYKORZYSTANIE POZA OBSZAREM BUDOWNICTWA WODNEGO

#### Abstract

This contribution is focusing on a project which is offering new possibilities of water engineering constructions, mainly dams and ramparts from new EnviMIX products, with the use of selected coal combustion products during their production. The project assumption is elimination of negative influences of flowing water which are occurring in stabilizing components as well as of other undesirable riverscape impacts. One of soil surface stabilizing elements is vegetation cover and its root system, which is contributing to an increase in soil retention ability and also to its stabilization. The project comprises research activities of two research institutes; the building materials sphere is presented by Research Institute of Building Materials in Brno, and the pedology and vegetative cover sphere is presented by Research Institute of Fodder Plants in Troubsko.

*Keywords: stream-side blocks, industrial waste, dams, ramparts*

#### Streszczenie

W artykule przedstawiono projekt proponujący nowe możliwości konstrukcji w budownictwie wodnym, a także obwałowań powstałych na bazie produktu EnviMIX z wykorzystaniem wyselekcjonowanych produktów spalania węgla. Celem projektu jest stabilizacja brzegów rzek oraz ochrona walorów krajobrazowych. Jednym z elementów stabilizujących nadbrzeże jest pokrywa roślinna, która podnosi właściwości retencyjne gruntów. W projekcie porównano wyniki badań dwóch placówek naukowych: Instytutu Materiałów Budowlanych w Brnie (w zakresie materiałów budowlanych) oraz Instytut Hodowli Roślin Paszowych w Troubsku.

*Słowa kluczowe: umocnienia brzegowe, odpady przemysłowe, tamy, obwałowania*

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## 1. Introduction

The purpose of this project is the design and realization of new products that could enable us to introduce ecological building manufacture with industry waste content. The intended products usage is not only in water engineering, but also in ground shaping and surface stabilization. The cooperation with Research Institute of Fodder Plants in Troubsko consists in selecting and testing of chosen plants which were grown on new EnviMIX products in selected dams and ramparts applications. The cooperation also consists in evaluation of influence of new products on general expansion of selected plants, in many various tests in accordance with ecological conditions and plants needs. However, this article is focused on the technological part of new EnviMIX products development, realized by Research Institute of Building Materials, JSC. in Brno. During the last two years of development, we have focused mainly on products constitution and their optimization, ecological and technological suitability, pilot production, innovations and particular applications to selected localities and, consequently, on testing their influence.

## 2. New EnviMIX products, properties and their constitution

**EnviMIX I** is a granulate on fly-ash base, which has a positive influence on pH scale adjustment of acidic soil. The granulate has unlimited granulometry. Its production is supposed to start at a waste site, where the granulate is produced by compacting technology. The granulate is consequently transported and mixed with inert material at the usage location. Usage conditions are not only ecological restrictions according to valid legislation but also reinsurance of safe transport without dustiness as well as economic profitability for the producer and potential customers.

In the case of **EnviMIX II** product, we focus on a mixture for homogeneous dams which are made from soil with stabilizing agents from acceptable industry wastes. Our aim is to improve ramparts geotechnical properties and satisfy ecological restrictions according to valid legislation. For preliminary investigations, fly-ashes from classical and fluidised combustion as well as blast-furnace slag were chosen. Apart from preliminary ecological and chemical tests, we defined physical-mechanical characteristics of these specimens (grain size curve, loose and shakedown litre weight) and also determined soil compacting properties. For these assessments mixtures with 10 %, 30 % and 50 % content of selected industry wastes were chosen. On the basis of the soil compacting test results, we made testing specimens (cylinders with 36 mm diameter) with 10, 20 and 30 % waste content. On these specimens we performed some technological tests (bulk density, compressive strength, absorptive capacity) after 7 and 28 days of wet storage.

In the case of **EnviMIX III** product development we are considering design and realization of composite building components which will serve as a protection against stream-sides and ramparts erosion. The proposed formulas come out from basic composite formulas, which are made in our institute. The difference between these formulas is that in the case of stream-side blocks we utilize wastes from various forms of industrial production. To be specific, it is about waste addition from plaster grid production and crushed waste from fibre-glass concrete production from our institute. Therefore, it is possible to achieve the closed-cycle technology in this way. The cement 52,5 R is used as a binder. We considered a cement of lower strength classes at the beginning, but the financial saving proved to be insignificant.

### 3. Technological properties of EnviMIX III stream-side blocks

EnviMIX III stream-side blocks create a “modular system“, which makes use of interlocking components. The shape design is not only subject to this criterion. Designed blocks must meet requirement for unlimited vegetation growth. On this account, stream-side blocks have big cyclic openings. We are limited by much more technical requirements during blocks development. We had to take into account proportions of designed blocks (max. 1 m in length) and their adequate weight (max. 30 kg) for maximal possible manipulability by two persons. Anchorage of the developed blocks is also innovative. An earlier anchorage was performed by a system of crooked hooks. These hooks affected the appearance of the entirely grounded area. The new anchorage with modified heads grounding through 1.5 cm holes does not affect the appearance of the grounded area.

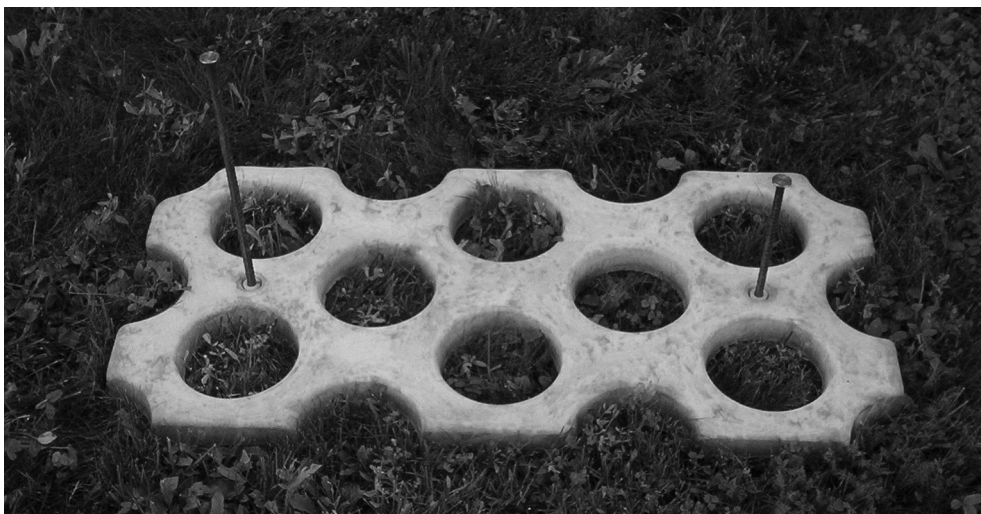


Fig. 1. EnviMIX III stream-side block including innovated anchorage

Rys. 1. Bloki EnvimMIX III wraz z innowacyjnym kotwieniem

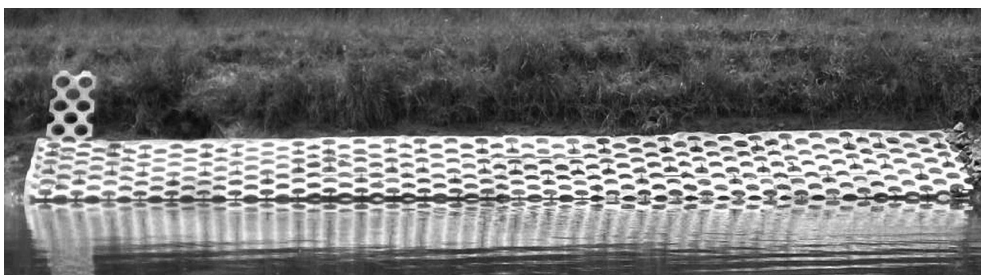


Fig. 2. EnviMIX III stream-side blocks applied in one of testing localities

Rys. 2. Zastosowanie bloków EnviMIX III w jednej z lokalizacji testowych

The next paragraph summarizes the most substantial achieved properties of EnviMIX III stream-side blocks:

bend tension strength	9.85 MPa
bend tension carrying-capacity	2.3 kN
compressive strength	88.0 MPa
frost resistance (100 cycles)	96% of bend tension strength
bulk density	1820 kg·m <sup>-3</sup>
weight	20.5 kg
dimensions	40 × 960 × 480 mm
	40 × 960 × 240 mm
	40 × 320 × 480 mm

#### 4. Conclusions

The Eureka Project was successfully completed in the year 2010. In the final phase we had EnviMIX products applied in more than four testing localities. We mainly tested physical-mechanical changes of the applied products owing to climatic conditions and mechanical influence of flowing water during the long-term storage. We also considered a suitable methodological development of technological build-up procedure of water engineering with the use of new EnviMIX products. EnviMIX products were also presented in several main Czech fairs and in 2010 we made the first commercial application of these products.

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