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## NEW TRENDS AND UTILISATION OF MATERIALS IN PROTECTION AGAINST FLOOD

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**Abstract:** *The climate change is causing changes in the environment. Drought periods are beginning to alternate with the period of major floods in recent times. The paper deals with principles of active flood control protection. Authors tried to give an information about new trends in flood protection by showing on new methods and new possibilities against flood and damage of men properties. The growing production and utilization of various materials, mainly plastics are enormous in the last period. Plastics have excellent mechanical properties, are light and in many cases replace metals. The volume of plastic waste is growing up, therefore it is necessary to determine how to solve the processing of plastic waste. In early studies were noted the methods of plastics recycling, whereas, the problem of utilisation of these plastics is much more complicated. From the plastic waste as the semi-products can be prepared the plastic plates, boards, foils. The contribution also deals with the testing of materials properties of recycled plastics produced by extruding and it shows the utilisation of produced plastics plates in engineering practice and environment. River floods are the most common natural disaster in Europe and world, too, and flood damage is expected to increase in the next decades. The purpose of current work was an experimental study of utilisation of plastic recycled materials, testing of their mechanical properties and their utilisation in specific conditions as flood barriers. The methods of experimental investigation and data processing have developed on a practical basis.*

**Keywords:** *Flood, protection, methods, materials, plastics*

### INTRODUCTION

Materials, however, with increased production bring also no small ecological problems. Plastic is one of the most adapted and water proof material. Higher plastic waste recycling rates, increased volumes and improved quality of re-granulates will boost the demand for secondary raw materials. In the context with this problem, there is a question of secondary use - recycling of waste material also in the flood protection area. Production, consumption and subsequent disposal of the waste are natural parts of the "life cycle" of all things. A circular plastics value chain is explained in the Figure 1.

### POSSIBILITIES OF PLASTICS WASTE IN FLOOD AS BARRIERS PROTECTION

The environmental questions, change of world climate, elevation of water surface forces the people to think about protection against water in the form as bags, flood barriers, gates and other accessories. The main goal of flood barriers is to accumulate water in high water levels outside inhabited areas (e.g. in water reservoirs, ditches or undeveloped areas, etc.) and to drain water from the area as quickly as possible in built-up areas. The construction of mobile flood barriers is an effective and at the same time very aesthetic protection against floods.

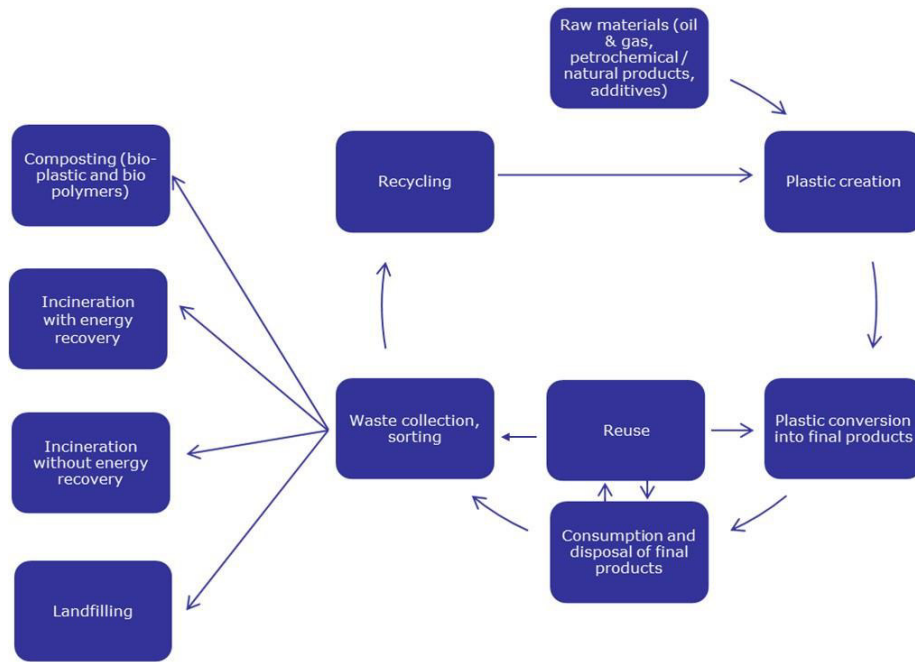


Figure 1. Circular plastics value chain [2]

The system of mobile flood barriers most often consists metals as of aluminium palisades, which are stacked on top of each other. The testing and utilisation of plastics as flood barriers are also famous and useful. Flood barriers can be assessed from various perspectives:

- according to material composition, e.g. metallic and non-metallic ones,
- according to construction, movable and firmly anchored, with structure embedded in the ground,
- according to shape, thickness and hardness of the material, e.g. foils or plates,
- according to suitability of use,
- according to methods of fastening and handling.
- according to magnitude of the system.

The height of the barriers usually ranges from 20 cm to 1.8 m. In practice, it is possible up to a height of 3 - 4 m, or even in atypical dimensions. Main advantages of the flood mobile system are:

1. high stability,
2. water resistance
3. low weight of individual parts,
4. simple and fast assembly – disassembly,
5. affordability.

The great advantages have mobile flood barriers, which can be placed as:

- directly into the desired hole,
- for retaining wall / fence wall,
- between the walls,
- on the steel structure of the entrance gate,
- anchor the brackets to the wall,
- on support columns with support,
- for foundation steel piles / earth bolts, and others.

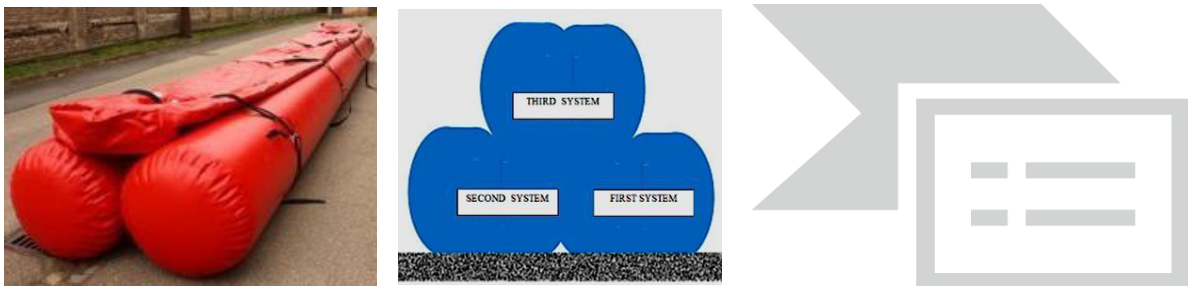
The principles and examples of plastics flood foil are shown in the Figure 2, Figure 3 and Figure4, where the plastics cylinder foils can be put in various systems. [4 - 8] The structure of the development anti-flood barriers from recycled plastics is composed from metal and plastic sources.



Figure 2. Quick dam water curb Realitycheckextreme.com [7, 8]



Figure 3. system with one or two cylinder plastic foils barriers [4, 6]



Figures 4. System with three-cylinder plastic foils barriers [5, 6]

Some plastic flood barriers are made by plastic mould injection technology. The examples are shown in the Figure 5 and Figure 6.



Figure 5. Flood fighting system from NOAQ [10]



Figure 6. Example of plastic concave flood barriers [9]

Examples of systems with water flood metal barriers, mainly from aluminium or steels and their details are shown in the Figure, 7, Figure 8 and Figure 9. Their depths are based on bedrock and subsequent expected height of the barrier. They can be designed as a small ones for protection of doors or have a large construction for protection of houses, streets or gardens.



Figure 7. Examples of large metal systems of flood barriers



Figure 8. Examples of small metal systems of flood barriers – door protection [11]



Figure 9. Examples of medium metal systems of flood barriers – garage or terrace [11]

The new possibility is to combine and design of anti-flood barriers from recycled plastics and from metal and other plastic sources. When designing the geometry and constructing the barrier, the first stage is to design a structure based on the shape of unified blocks made from PP and PE. [7, 8, 9]. The newest generation of the flood barriers system, from tested materials, was subject to burdening tests on the TOP 2016 conference (“Engineering for Environment Protection – TOP”) where was used with

basin with dimensions 5x10m and demonstration wall, 12 m. In the Figure 10 and Figure 11 are shown the tested model of basin and the construction detail of demonstration wall [7, 8].



Figure 10. Modular flood barrier structure – test basin at TOP 2016 [7]

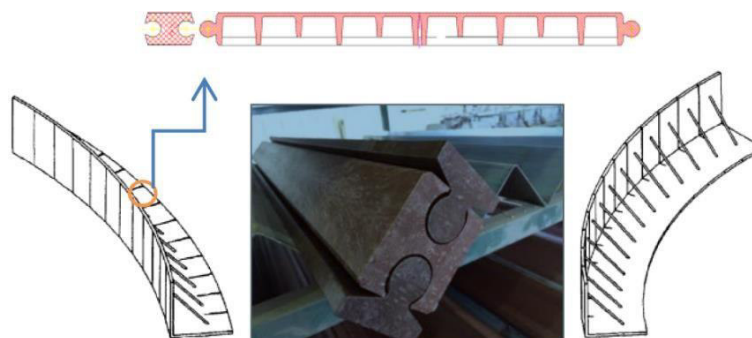


Figure 11. Convex and concave engineering solution of barrier joining [8]

## EXPERIMENTAL VERIFICATION OF TESTED MATERIALS

The experiments were made in the Department of Engineering of Environment, Faculty of Mechanical Engineering, TU in Kosice. By mutual agreement and the requirements of TOPlast, Inc. Kosice, who is plastics recycled plates producer, was tested chosen types materials: the shape of the test specimens: rectangular prism, dimensions of test specimen: length  $l = 80$  mm, width  $b = 35$  mm, thickness  $h = 15$  mm. The tested material was made from separated, shredded, mixed and coloured recycled plastics from polypropylene, polyethylene and additives, under material name as TOeco, produced by extruding [8] and were supplied as a boards, Figure 12. After conditioning of the test specimens, there were performed the bending tests according to Standard EN ISO 178.



Figure 12. Supplied plastic sorted semi- product and final plastics boards from recycled material

Bending tests, according to Standard ISO 178, were made on the testing machine TIRA Test 2300, the bending machine recommended parameters were:

- 1 the roller was fitted on the load tip with a radius of 5 mm,
- 2 2 rollers were put on supports with a radius 5 mm,
- 3 setting longitude of support,  $L = 64$  mm according to Standard EN ISO 178,
- 4 tested speed was set on 50 mm / min by using of program.

The testing samples were prepared and chosen from direction plastic material is shown in the Figure 13.

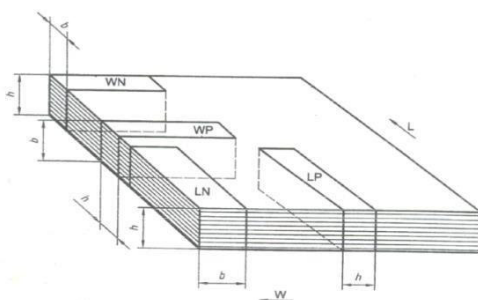


Figure 13. Position of test piece in relation to the direction of orientation of product

After loading of the test sample by a force, in most cases there were no ruptures in all the cross-section, but only on the outside of the bend specimens, while in the resulting crack of materials were visible fibres (Figure 14). The inner sides of the bend test specimen remained intact.

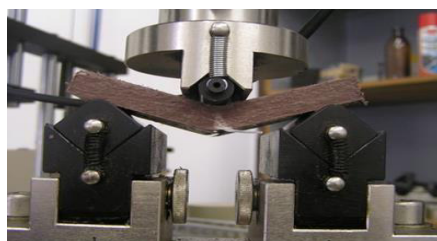


Figure 14. The detail of the bending test

The course of tensile test of recycled plastics board and its mechanical properties is shown in Figure 15.

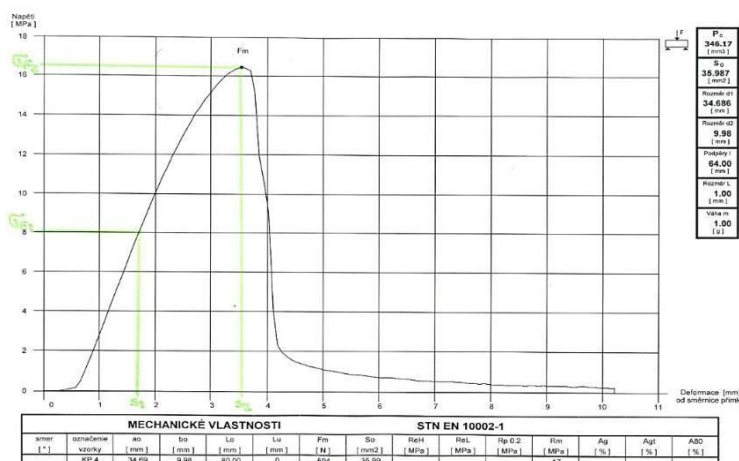


Figure 15. The course of tensile test of recycled plastics board and its mechanical properties

The graphs of Figure 16 and Figure 17 show the evaluation of values of flexural modulus, depending on the site of sampling, and according to the sampling direction (laterally or longitudinally in the filler).

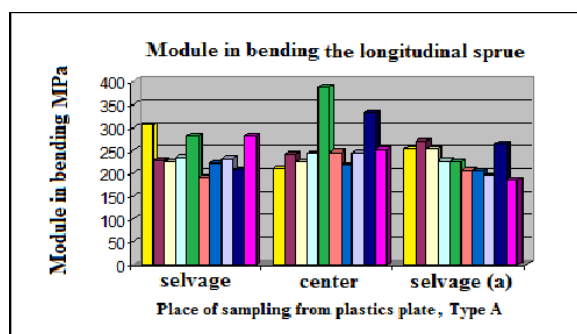


Figure 16. Bending in longitudinal sprue, Type A

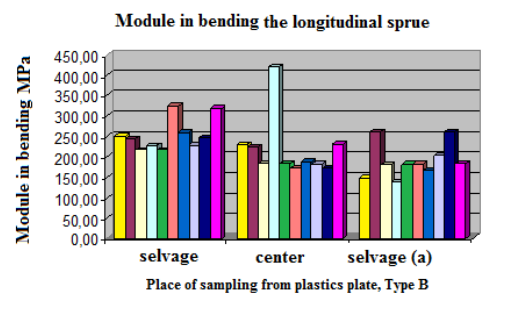


Figure 17. Bending in longitudinal sprue, Type B

## CONCLUSIONS

In the contribution dealt with the new trends in flood protection by using various types of materials. The protection of the people and the private properties, and the environment protection as whole one, are very important areas and the questions of protection have to be solved very quickly, because of rapid climate changing. After loading of the tested plastics samples, the samples were not cut in all the cross-section, but only in outside part of the bend specimen. The recycled plastics material as board or plate is possible to use as barriers, because there is loading on the whole area of board not exactly in one place. In the contribution, the authors tested the recycled plastics material – boards. A great number of producers utilize the plastics as a flood protection material for barriers, but only few of them utilize the recycled materials. This proposal solves two questions how to minimise the plastic waste and how to utilize the recycled plastics material in the practice and help to protect the environment. The production of recycled plastic materials has a great usage in the future, but it depends of their material structure and clearness, it means on mechanical properties. The importance of utilization of plastic waste from production and from collection points is very favourable and useful, because this is the way, how to reduce the plastic waste, to save the production costs and to protect the environment.

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