SUSTAINABLE SOLUTIONS FOR RAINWATER MANAGEMENT

Marcel-Răzvan PLOAE[1], Mariana POP [1#], Mihaela-Teodora TOADERE[1], Renate Alexandra LOBONȚIU [1], Remus Alexandru PLOAE[1]

[1] University of Oradea, Faculty of Constructions, Cadastre and Architecture, 4 Barbu Stefanescu Delavrancea St., 410058 Oradea, Romania

RESEARCH ARTICLE

Abstract

In the context of increasingly heavy rains due to climate change, this paper analyzes sustainable solutions for rainwater management, by presenting several systems designed to provide flexibility, resistance, easy installation, easy cleaning possibility and obviously a sustainable management of these waters through the possibility of their recovery and reuse.

Keywords: (max. 5) management, rain drainage, retention, infiltration, sustainable.
#Corresponding author: mrnpop@yahoo.com

INTRODUCTION

Recent climate changes have produced more and more abundant rainfall, thus requiring innovative solutions regarding rainwater collection, cleaning systems and natural release of rainwater taking into account the new environmental conditions. In crowded urban centers, rainwater rarely reaches the water cycle in nature, being transported through the sewage system to treatment plants, which reduces the regeneration of groundwater and water resources (TeraPlast).

Taking large amounts of water, resulting from heavy rains, requires the installation of a large network of pipes, but also additional investment in treatment plants for the construction of retention basins and overflows. Thus, the collection of rainwater through the sewage system leads to considerable investment and operating expenses. In addition, it is recommended that the sewage system has be used to drain rainwater only if it is highly polluted or if its infiltration is not technically possible (TeraPlast).

In order to achieve an efficient management of rainwater, it is necessary to implement some concepts to reduce the amounts of rainwater collected in the centralized system. Collecting rainwater in the centralized system involves the construction and operation of expensive and irrational sewage systems. At the same time, the possibilities of outflow of flows from exceptional rains would be superficial, which could cause floods (NP 133, 2022).

This paper deals with one of the sustainable concepts of integrated resource management and development of low-impact solutions, provided by Normative NP133/2022, Sewage systems, namely: the concept of water retention from rainfall, at the place of fall with alternative methods of sequential control of ecological type and execution of infiltration basins – accumulation (retention) with/without reuse of these waters (NP 133, 2022).

MATERIAL AND METHOD

The rainwater sewage system must provide:

- collection of surface water through drains, drains, access covers;
- separation of impurities and substances entrained by hydrocarbon separators and sludge hatches;
- mitigation of peak flows and temporary storage through retention (accumulation)/infiltration basins;
- controlled discharge of stored water through pumping stations and flow regulators (NP 133, 2022).

The retention (accumulation) and/or infiltration systems can be made in the following constructive variants:

A. Honeycomb infiltration blocks, modular, composable, made of plastic, polypropylene, PP-B, located underground.

In the case of this system, polypropylene that is used as a base material also contains recycled materials. The system has a load capacity of up to D400, due to the resistance of each post to high loads in combination with the assembly method. Inspection cameras and cleaning devices have access to any part of the system due to its open structure (ACO Stormbrixx).

Location conditions:

- Minimum burial depth at least 80 cm, observing the depth of freezing, without the influence of groundwater;
- Landscaped areas, without vehicles;
- Green landscaped areas;
- Pedestrian zones, protected by speed limiters; - Access roads to parking lots, transit by emergency vehicles is possible;
- Access roads for residential properties, with scheduled crossings of special vehicles (garbage trucks, tankers, as well as repair vehicles);
- Storage spaces and secondary infrastructure, which do not have constant heavy traffic (mainly stationary traffic or connections between storage spaces) (ACO Stormbrixx).

Since the system has a large number of practical applications that exceed a volume of over one million cubic meters, it presents a high reliability. The drain pipes by their ingenious design ensure that impurities are not brought into the pipe network and subsequently into the blocks restraint to avoid their clogging. Pipes have a self-cleaning capability that helps remove dirt deposits from the base of the pipe. All these features ensure the long-term life of the entire system, as well as reduced construction and subsequent operating costs (ASIO NIDAFLOW).

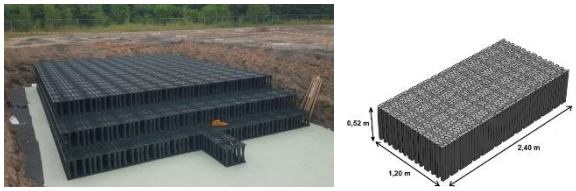

Figure 1 **Infiltration blocks (ACO, ASIO NIDAFLOW)**

This system, due to the ingenious design of the accumulation/infiltration blocks (figure 1), allows the creation of a system of water distribution channels inside the basin, thus ensuring long-term operational stability and protection of the individual blocks against clogging/clogging with dirt (ASIO NIDAFLOW).

By this type of water distribution system that allows horizontal and vertical flows within the system, excavation and material costs are reduced (ASIO NIDAFLOW).

B. Tunnel-shaped, semicircular, plastic, PE-HD polyethylene, closed at both ends with plastic caps. It is an underground system with a large capacity, which is suitable for the accumulation and gradual infiltration into the soil of the collected rainwater (TeraPlast).

The semicircular tunnels (figure 2) have a storage capacity of 100% and are much more efficient compared to the classic infiltration system with a layer of gravel and drain tubes. At the same time, they are more economical from the point of view of excavation works (up to 2/3 less of the excavation volume).

Figure 2 **Semicircular tunnels (TeraPlast)**

Collected rainwater can freely enter the soil through the bottom and side openings of the plastic tunnel. Both fronts of the tunnel are provided with an inlet connection and are adapted to connect a pipe up to DN300 diameter (TeraPlast).

C. Rectangular or cylindrical tank (figure 3 and figure 4) for storing and reusing water both outside and inside the dwelling. They are designed to be installed underground and can be arranged according to the size of the available space. Due to their shape they require less excavation than cylindrical tanks. Several different rainwater tanks can be combined, adapting the system to satisfy personal requirements (ACO Rain4me, 2018).

Figure 3 **Rectangular storage system (ACO Rain4me, 2018)**

Figure 4 **Cylindrical storage system (LIVPLAST)**

A home's water consumption can be reduced by up to 50% by reusing collected rainwater, as follows (figure 5):
- 2% of clothes cleaning water,
- 5% of the water used for watering the garden,
- 13% of the water used for cleaning,
- 30% of the water used for the sink and toilet bowl (ACO Rain4me, 2018).

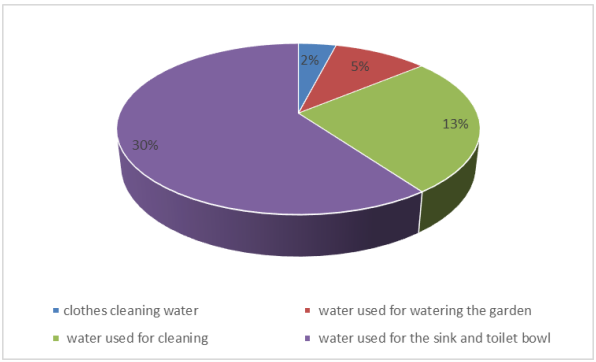

Figure 5 **Reducing the water consumption of a house by reusing rainwater**

The structure of the retention basin, Stormbox type, is made entirely of block copolymerized polypropylene, mainly used for buried sewage pipe systems, due to its very good impact resistance, even at extreme temperatures (PIPE LIFE).

RESULTS AND DISCUSSIONS

The advantages of these rainwater retention and infiltration systems, compared to the classic rainwater management options, are presented in table 1.

Table 1

Advantages of systems

System	Advantages
Honeycomb infiltration blocks, modular	• Easy and quick installation, without coupling elements; • Self-cleaning effect to prevent clogging of retention blocks; • Cost savings for excavation work; • Very large storage space (95%); • Easy infiltration blocks; • Sufficient strength of the entire system and resistance to vehicle traffic;
Tunnel-shaped, semicircular system, plastic, PE-HD polyethylene, closed at both ends with plastic caps	• Efficient construction, an excellent economic advantage; • Minimum installation costs; • Minimal transport costs; • Good strength and strength for road areas; • Use 100% of the storage space; • Simple and fast assembly by connecting tunnels together; • Long service life, due to recyclable polyethylene material; • Light and portable;
Rectangular or cylindrical tank for storing and reusing water both outside and inside the dwelling	• Installation can be easily done in the available space • Cost savings for excavation work • Reducing water consumption by reusing rainwater • Good impact resistance

It is thus noted that these systems have advantages both economically and in terms of their strength. The first two systems offer the possibility of water infiltration into the ground, and the third one the possibility to store and reuse water.

CONCLUSIONS

These systems are much more advantageous rainwater management solutions than classical ones due to the following characteristics:

Flexibility: Both the size of the system and its resistance to loads can be individually adapted to meet requirements in areas with or without traffic.

E600 load resistance: It supports loads of 60 tons and can be covered with a layer of earth 800 mm thick.

Burial depth up to 5 m: The module system can be installed up to 5 m deep even in heavy traffic conditions.

Connections up to diameters of 500 mm: In the case of large water capacities, connection pipes with large diameters are required.

Designed for decades of use: These systems are durable, being designed for a lifespan of over 50 years.

Universal use: They can be used to infiltrate and collect rainwater.

Simple to install: They are simple to transport, handle and install (figure 6). The modular structure that makes up the system requires a small number of accessories.

Figure 6 **Honeycomb infiltration blocks installation (ACO Stormbrixx)**

Easy to inspect: Standard module inspection channels allow effective monitoring of the entire system. The system made with blocks allows access to video cameras.

Press-jet cleaning: The module system easily resists the use of pressure jet hoses for cleaning as it can be seen in figure 7.

Figure 7 **Head of pressure jet hose for cleaning (ACO Stormbrixx)**

Sustainability: These systems are sustainable solutions for rainwater management in terms of its storage, infiltration and reuse, a very important aspect in the context of current climate changes, sustainable development and environmental protection (figure 8).

Figure 8 **Storage, infiltration and reuse of rainwater (ACO Stormbrixx)**

Rainwater management is an issue of wide European and global interest, given that water is the natural resource indispensable to the life that we must value and sustainable development is closely linked to the reuse of these natural sources.

REFERENCES

ACO S.R.L Technical catalog, ACO Stormbrixx - Modular system for mitigation.and infiltration of rainwater.

ACO S.R.L, 2018. Technical catalog, ACO Rain4me Modular storage system.

ASIO ROMANIA Technical catalog, NIDAFLOW, Rainwater accumulation and infiltration system.

PIPE LIFE ROMANIA S.R.L Data sheet: Retention-infiltration system STORMBOX II, RAINEO,.

TeraPlast rainwater management Technical catalog.

Normative on the design, execution and operation of water supply and sewerage systems of cities, indicative NP 133-2022, volume II — Sewerage systems.

https://livplast.ro /rainwater-recovery/underground-tanks, October 10, 14 pm, 2023.