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THE IMPACT OF INFRASTRUCTURES ON SURFACE RUNOFF. ASE STUDY RESIDENTIAL AREA, PERIPHERY TIMISOARA

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Abstract: The case study represents an environmentally friendly solution for stormwater management from a residential periphery area. The accepted solution by the beneficiary provides for a classical water takeover, in which the volume of water taken over is collected through installation systems and transported towards the street sewage system. In this study we will bring to the discussion the change of this classic solution with a solution " environmentally friendly: that is, through BIORETENTION. The challenges faced by most cities today are daunting, and water management is one of the most serious concerns. Drinking water from pure sources is rare, other water sources need to be treated at high cost, and the volume of wastewater is increasing. Residents of cities in many areas of the world lack good quality water and get sick due to water-based diseases. The hydrological cycle and aquatic systems, including vital ecosystem services, are disrupted. That is the situation today; tomorrow will bring intensified effects of climate change and the continued development of cities. Extreme weather events, from prolonged droughts to violent tropical storms, are poised to overwhelm urban water infrastructure and cause extreme suffering and environmental degradation.

Keywords: runoff, bioretention systems, bioretention units, Minimum Impact Method

1. INTRODUCTION

The need to adapt the environment to today's technology and lifestyle involves the creation of new, more complex and interconnected civil and industrial constructions that meet European standards. The paving, concreting, and asphalting of increasingly extensive land surfaces, the creation of recreational areas (sports fields) with large impermeable surfaces (concrete, artificial turf, etc.) leads, from a hydrological point of view to the creation of impermeable surfaces and to a deficit cycle of water in nature. The existence of these large impermeable surfaces in urban areas manifests important changes in the hydrological system: decrease in infiltration, increase in surface runoff, acceleration of the evaporation process as a result of the greenhouse effect that is formed. Thus, we can say that cities are generators of a specific climate, characterized by significant deviations of all meteorological parameters from the characteristics of the extra-urban perimeter. Temperatures are higher during summer days and there are local wind intensifications.

Water deficit problems, exacerbated by poor water quality, can limit the amount of water available for specific uses. Usually degradation occurs from human activities - intensive agriculture, heavy industry, and rapid urbanization

- which distorts the natural water cycles and processes in the rural-urban spectrum. In cities, for example, the concentration of built-up impermeable areas means that less water seeps into groundwater. The basic flows of watercourses are affected and the volume of surface runoff increases. The resulting rainwater flows can carry larger amounts of pollutants, which reduce water quality.

2. CASE STUDY

The building is located on the outskirts of the city Timisoara. For analysis 2 scenarios are proposed. The Scenario 1 is the accepted solution by the beneficiary namely the organized parking at ground level.

The surfaces results for this scenario are S land = 848 sqm, S built = 248 sqm, S green area = 90 sqm, S landscaped area (parking and alleys) = 510 sqm

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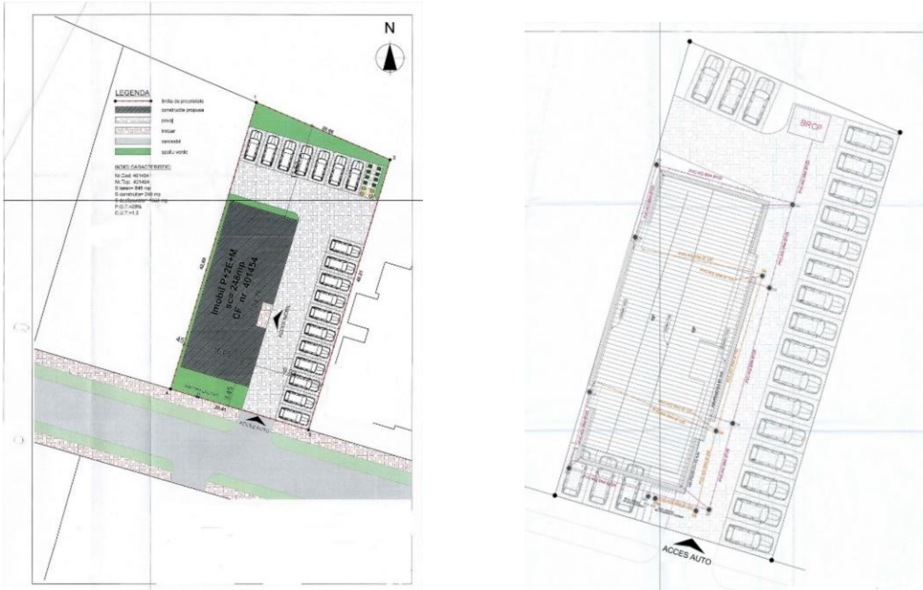

Figure 1. Scenario 1 - Urban development proposal and landscaping

Scenario 2 proposes a reorganization of the parking lots so that the soil is unsealed on a larger area.

It is proposed a semi-buried parking lot to solve the need for parking spaces for residents. The semi-buried parking lots will have 2 levels, at -1.5/1.5 m from the ground and will provide double the number of parking spaces on the same surface compared to the ground parking lots.


Source https://urban-tech.ro/modular-parking/

Figure 2. Type of semi-buried parking lots

The surfaces results for this scenario are S land = 848 sqm, S built = 248 sqm, S green area = 320 sqm, S landscaped area (parking and alleys) = 280 sqm

For the realization of the parking lot, it can opt for **precast reinforced concrete structure or monolithic reinforced concrete structure with slab-type floors**.

The structure of prefabricated concrete elements consists of a spatial system composed of vertical bars (poles) and horizontal bars (beams) returned in centralized workshops and assembled on site. The Advantages of the Structures with prefabricated elements are recommended for buildings that require increased load-bearing capacity at large loads or flexible parts / large openings (larger than those that are made in good technical conditions for monolithic concrete structures); this is made possible by using quality materials that can only be put into operation under controlled conditions (not on construction sites where only their assembly is performed). Execution of structures with prefabricated elements are realizes with great speed and precision, due to the special quality that the elements made in centralized conditions have, the assembly of these elements on site being mechanized, in a time and with minimal efforts.

The Disadvantages are Increasing the dimensions of the bays or openings in order to improve the flexibility of the space poses problems when making the floors and requires beams with large heights; the positioning of these beams reduces the maximum useful height of the levels, being necessary to place false ceiling systems or to increase the levels' height. The costs of achieving structures with prefabricated elements are relatively higher than in the case of other types of structures due to the need to use centralized workshops with formwork / special patterns and materials with clearly superior qualities (high strength concretes, strands, etc.)

The monolithic reinforced concrete structure with slab-type floors are composed of an assembly of vertical elements (poles) and a horizontal floor made in the form of a thick slab. Specific to buildings with concrete elements, the realization of these structures requires the formwork, reinforcement and pouring of concrete on site in successive technological stages: first the pillars and then the slab floor. The main feature of these floors is that support directly on the pillars without the means of beams.

The advantages of using structures with pillars and slab floors allow the realization of flexible structures from an architectural point of view; the lack of beams and the realization of a smooth ceiling at the bottom allows the free compartmentalization of the space without the existence of beams restricting the location of the interior walls; it is also allowed to reduce the level height and, implicitly, to reduce the height of the building but also favorable solutions of the installations.

Also, the technological problems of execution are simplified.

The costs involved in the realization of these structures are slightly higher (as well as the consumption of reinforcement and concrete of good quality) than in the case of structures in concrete frames, but slightly lower (5-15%) than in the case of prefabricated elements.

Calculation of rainwater flow for both scenario

The rainwater flow to be collected from the entire land area has been calculated after the Romanian standard 1846/2-2006, and is:

$$\mathbf{Q = m \times S \times Ø \times I}$$

where:

m = adimensional coefficient of reduction of the calculation flow, which takes into account the capacity of storage in time of the channels and the duration of the calculation rain t;

S = the area of the sewerage basin, afferent to the calculation section, in hectares;

Ø = average leakage coefficient;

i = the average intensity of rain l/s ha

In the calculations were used the following coefficients:

Leakage coefficient on the mineral surface	**0,9**
Coefficient of leakage of green space	**0,05**
Rain frequency	**1/2**
Storage coefficient	**0,8**
The intensity of the rain calculation	**160 l/s*ha**
Rain time calculation	**15 min**

Table 1. Leakage coefficients depending on the type of soil cover

Tipul de acoperire a solului	Coeficientul de scurgere
Pavaj dens, asfalt sau beton	0,70 - 0,95
Pavaj sau cărămidă	0,70 - 0,95
Acoperişuri de clădiri	0,75 - 0,95
Peluze de iarbă pe teren nisipos cu pante mici sub 2%	0,05 - 0,10

In the table 2 runoff flow increases in scenario 1 compared to scenario -2. The solution proposed in scenario 2 for the development of the territory leads to a lower surface runoff by 216.203104 mc/day, i.e., 30% lower compared to scenario 1.

Tables 2 - Runoff for the study area in all the scenario

	Scenario 1			Scenario 2		
	S	Q		S	Q	
	mp	l/s	mc/day	mp	l/s	mc/day
Build surfaces	758	8,73216	754,4586	528	6,08256	525,5332
Green surfaces	90	0,0576	4,97664	320	0,2048	17,69472
TOTAL Runoff		8,78976	759,4353		6,28736	543,2279

It is known that rainfall water leaking from the urban surface has a serious impact on the emissary through degradation of water quality, erosion, and habitat destruction. Additionally, the increase of the impermeable surfaces leads to the increase of the temperature in the surface watercourses, to the increase of the surface leakages of the water from the precipitation, to the reduction of the basic flows due to the decrease of the water recharge of the aquifer and to the increase of the frequency of the local floods.

"The hydrological consequences of the expansion of urban areas have long been recorded for isolated precipitation events, but the long-term consequences have been very little studied." The replacement of agricultural crops, fields and forests with impermeable surfaces leads to the intensification of surface runoff, facilitates the erosion of the riverbed of the watercourses and there is a variation of the loading flows of the aquifers.

3. SUSTAINABLE RAINWATER DRAINAGE SYSTEM

If until now the drainage system of the city was designed for protection against floods by eliminating as soon as possible the rainwater fallen on the urban surface, through separative or unitary sewerage systems (until 1990) or through a separative sewerage system combined with retention basins (after 1990), now we are trying to create a sustainable drainage system that takes into account both the protection and ensuring a comfort of the population and the protection of the population environment and water resources .

MIM (Minimum Impact Method) [25] is a new concept in integrated urban water management, being one of the measures applied to maintain the hydrological conditions in the urban area close to those estimated in the hypothesis in which the urban area is a natural area. All green spaces have the functionality to maintain rainfall water inside the system (urban area), by involving natural processes in reducing surface leakages (interception and facilitation of infiltration).

Bioretention units

A bioretention unit consists of a layer of porous soil covered by a thin layer of "plant debris", with or without a drainage system. The water drainage system for bioretention systems is recommended if the existing soil does not allow water leaching, a situation that can be found inside urban areas. Known to us more as a "rain garden", a Bioretention unit consists of a layer of porous soil covered with a thin layer of "plant residues", with or without a drainage system. The water drainage system for bioretention systems is recommended if the existing soil does not allow water leaching, a situation that is especially common in urban areas. Normally, bioretention utilities are integrated into the local development plans and placed in such a way as to intercept the surface leakage near the source.

Figure 3. Bioretention systems

Over time, various underground water infiltration systems have been developed, such as underground infiltration basins, infiltration chambers, drainage pipe system – gravel filling, infiltration tunnel, infiltration blocks. The type of material from which they are made, as well as their shape, structure and dimensions differ from one manufacturer to another.

The sizing of the systems is made according to the structure of the land in which the water is to infiltrate, the precipitation in the area and the impermeable surface from which the water is taken, etc. If the existing soil has a low infiltration capacity, then these systems can be used more as storage tanks for the purpose of further water use (irrigation, street washing, fireproof, etc.).

The designer can develop a landscape architecture plan for bioretention systems in a similar way to conventional landscaping plans. The main difference is that the integration of rainwater management is essential, resulting in a functional and at the same time aesthetic landscape.

When integrating bioretention into an area, the designer must consider the following elements: site conditions and constraints, proposed land uses, types of plants, types of soil, types of pollutants contained in rainwater, humidity conditions soil, proper drainage, groundwater recharge, discharge. Even if these systems are designed to capture and treat rainwater, designers are cautioned not to treat bioretention systems such as wetlands, ponds, or other facilities that include water. In addition, the arrangement of bioretention systems requires the choice of plant species that can withstand high fluctuations in soil moisture.

4. CONCLUSIONS

With the increase of the population, the level of water taken over and transported from homes or buildings has become a challenge for the existing water transport system. Bioretention eliminates the overcrowding of the sewerage system and the reuse of water for other purposes, by the non-polluting method.

BIORETENTION is the perfect example that proves that a thing (water in this case) can be captured and reused for other useful purposes. Thus, we can create beautifully designed, environmentally friendly spaces to the detriment of sewerage systems that involve endless construction sites with high costs and flooded parking lots.

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