ELIMINATION OF WATER EXCESS FROM BUILDINGS PERIMETER

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Abstract

For the purpose of ensuring the stability and normal exploitation of buildings, the land on which they are built and their foundation must comply with certain conditions. The growing demand for houses, office buildings, industrial halls, etc. especially in the big cities has also determined the expansion of buildings on less favourable lands, with excess humidity, landslides, etc. The high level of groundwater causes most problems, including significant damages to civil and industrial constructions, both during their execution as well as during their use and exploitation. This paper presents a method to eliminate the excess of water from groundwater and rainfall, in the case of buildings with lower ground floors. To remove the excess of water from the foundation, it is recommended to carry out a perimeter drainage at a level lower than the foundation base. In buildings with lower ground floors, filter columns spaced at 2.5-5.0 m facilitate the collection and evacuation of the excess of water. Moreover, in order to accelerate excess water removal, drainage can be doubled by placing a drainage tube at a depth of 1-1.5 m, distanced at 1.0-3.0 m from the face of the building, so as to take over the water from leaks from the surface of sidewalks, framings, parking lots, etc. Drainage lifetime can be increased by protecting the filter layer with geotextile material. By executing a drainage adequate to the constructions, an efficient elimination of excess water is ensured, the hydrostatic pressure exerted onto the walls is reduced, the formation of dampness and mould is avoided, allowing for a proper use of the spaces in basements and a longer lifetime of buildings.

Key words: groundwater, building drainage, drainage tube, prism filter, geotextile material

Water preservation is a prerequisite for a durable exploited environment. The effect of water flow reductions on the operation of the drainage systems of buildings must be understood and embedded in designing the sewer networks of the buildings (McDougall J. A. *et al*, 2003).

In the last years, the collection of rainwater became an integral part of the durable water management system. Although there are many studies showing the feasibility of using rainwater collection systems within a management system, they are not used and operated on a wider scale (Ward S. *et al*, 2012).

The local drainage systems consist of the sewer systems of the buildings and of drainage networks around the buildings and locally, on the streets, they are essential for everybody. The issues caused by the hydrostatic pressure of underground waters and surface waters on the foundations of the constructions, foundation walls, highways, supporting walls etc. are well-known (Chad M.K. and Rodney J.K., 1992; Ashley R. *et al*, 2007; Butler D. *et al*, 2018).

Water infiltration into the basement walls of buildings is a permanent issue to be solved by architects and designers. If the water is not removed from the base of foundations critical problems cam appear in the rooms placed at ground level, the infiltrations affecting also the resistance walls of the building (Radulescu *et al*, 2010). Moreover, water accumulation around the buildings makes the soil heavier to the detriment of walls that have sometimes to bear a double pressure compared to the normal situations (Alexandrescu I., 2010). Such kind of issues emerges due to a lack of measures of water elimination, to improper drains or due to wrong methods of sealing the walls to water infiltration.

In order to eliminate humidity from basement floors, Pratt J. M. proposes in 2003 the use of underground drainage pipes for underground water with rectangular section, impermeable to their lower part with slits (elongated openings) on the sides and the upper part. The pipes are placed below the floor near the foundation wall and have the role to takeover and transport the water infiltrated outside the building.

As the surfaces occupied by constructions extended, the surface of natural green areas decreased to the detriment of concrete platforms (Asakawa *et al*, 2004; Hickman C., 2013). The undersized sewage networks and sometimes their absence lead to the concentration of a large quantity of rainwater on the reduced green areas having an adverse effect on the neighboring constructions.

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MATERIALS AND METHOD

Real estate investments had a significant rise in the last 30 years in Romania. The economic crisis which affected Romania slowed down the rhythm of developments and the investors became more sensible to the need of sustainability, viable and durable constructions and high quality services contributing to the increase of the property value and its trading potential and the service providers of this field became more careful to the needs of the investors. Sustainability has implications on the entire construction process of a building, starting from designing and construction to the subsequent maintenance and operation.

In order to eliminate the rainwater excess and the phreatic input from the foundations of the constructions with basements, a method was adapted derived from the elimination of the water excess from agricultural lands made up from absorbing drains and filtering columns.

In case of the underground drainage associated with land modeling in ridge bands from the farm fields, the literature in the field recommends for improving the collecting conditions of absorbing drainages placed under ditches to erect columns of filtering materials from the drainage level to ditch level. The insertion of filtering columns, in the case of farm fields allows the increase of column size and reduction of collection-discharge network.

An economic solution of the modeling system of the land in ridge bands consists of performing water caption from ditches with collecting drains, located perpendicular on the bands, at long intervals (about 75 m) and the discharging process of each ditch in the collecting drain being made by means of a prism in granular filter material. The prism raised from drain level to the land surface realizes the ditch-drain hydraulic connection, this one being protected against plugging by a layer of geotextile (Barbu Floru, 1986).

Determining the level differences in order to create a slope for water flowing within the drain lines was made by topographic measurements with the help of accurate geometric leveling instruments.

RESULTS AND DISCUSSIONS

The increasing demand in the last years, especially after 2013, of residential buildings and offices but also the higher standards of the potential buyers determined the real estate developers to carry out sustainable and durable constructions as well as high quality services. The demand of residences in the big cities including in Iasi Municipality, as close as possible to the cultural and commercial centers and industrial parks determined the erection of constructions also on less favorable lands with a high level of the phreatic water, a higher inclination degree of the lands etc. (*Figure 1*).

Figure 1 **Constructions near Iasi Municipality**

Water stagnation within the foundations of the constructions must not be neglected. If the water level rises then a hydrostatic pressure is put on the walls and the floor inside the building while the water inside the foundation rises to the same level from outside. If the water fails to pass the floor and the walls, the latter have to withstand a high pressure than the one taken into account on designing. Moreover, the water seeps into walls and foundation by fissures, joints or construction defects and, if the hydrostatic pressure persists, in the end the water will also seep inside the building. Designing the walls and floors for residential foundations and sub-basements which are strongly enough to withstand such hydrostatic pressure is not usually practiced due to the costs. Consequently, methods were developed to prevent the accumulation of hydrostatic pressure due to underground and surface waters.

In order to use the spaces of the sub-basements of constructions in a correct way, besides the protection of the sub-basement walls on the outside with a waterproof layer, mechanical protection layer etc., it is necessary to take measurements also for the removal of the water excess inside the foundation. The elimination of the water excess due to abundant rainfall and especially from the groundwater can be done by carrying out a marginal drainage at foundation level (*figure 2*).

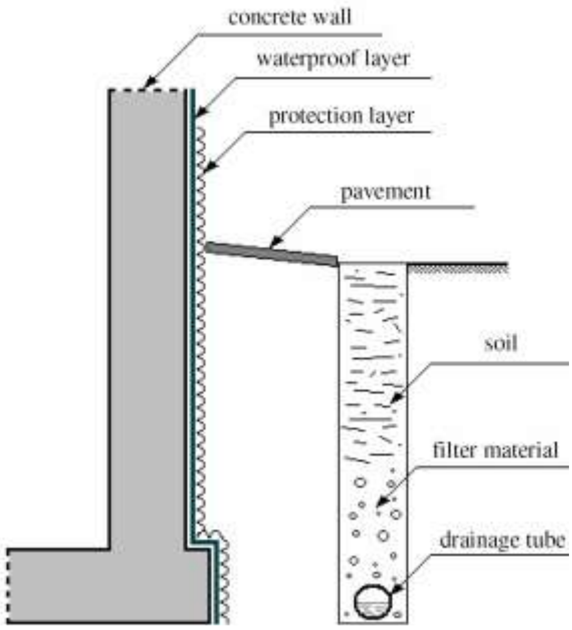

Figure 2 **Construction drainage scheme**

The marginal drainage consists from the execution of several drainage trenches at a distance of 1-3 m from the sub-basement walls so that the drainage tubing will be laid down upright on the sidewalk's edge. The drainage trenches consist in the execution of a ditch of 0.40 m width upstream at foundation level and downstream at a greater depth, thereby providing a longitudinal slope of about 2% for the water collected from the drainage tubing to flow.

From a technical and economical point of view, the most affordable drainage tubing is the one manufactured from corrugated plastic with transversal slits of 2 mm width available on the market in different sizes. The corrugated PVC tubes have high flexibility which allows their mechanized layout, providing the continuity of the drainage lines. Such tubes are fastened via sleeves and are connected via a series of fittings.

In order to avoid the silting of the drainage tubes, it is recommended to use filtering material manufactured from ballast with layers of 40-120 cm thickness depending on the depth of the foundation and the intensity of the humidity excess.

The increase of the operation period of the drainage within constructions can be made, besides wrapping the drainage tubing in geotextile material, by sealing the ballast filtering layer with geotextile material (*figure 3*).

When adapting the drainage alternative, the water coming from the drains of roofs and concrete platforms must not be neglected in conditions of climatic changes with large quantities of water fallen in short time periods and having a high intensity.

Figure 3 **Marginal drainage at the level of the foundation layer**

Chad M. K. and Rodney J. K., in 1992, recommended for the increase of the effectiveness of water excess elimination from foundations the association of the horizontal drainage with a system of perforated vertical drainage pipes spaced at maximum 2 m which collect the water coming from underground and transporting it to the horizontal drains.

The same effect can be achieved by collecting and discharging the water coming from underground and from sidewalks accumulated due to rainfall by the filtering columns of a diameter of 0.30-0.60 m spaced at 2.5 - 5.0 m consisting of ballast from the level of the filtering layer up to the surface of the land (*figure 4*).

Figure 4 **Drainage with filtering prism in constructions**

In the case of a greater depth of the foundation as well as in the case of large concrete surfaces on the premises of constructions (sidewalks, alleys, parking lots etc.), the drainage can be doubled by placing a drain tube at a depth of 1 - 1.5 m, spaced at 1.0 - 3.0 m from the construction in order to take the water coming from the leaks of sidewalks, frameworks, parking lots etc. (*figure 5*).

Figure 5 **Doubling the marginal drainage**

Considering the climate changes which involve periods with abundant rainfall alternating with long dry spells, we have to talk about the durable use of water. For the durable management of water coming from the drainage network of constructions, its collection is advised into a collecting basin and its use for irrigation of households (*figure 6*).

There are a series of materials for the drainage of water from the outside of the foundation such as: high density polyethylene membrane, membrane supported by fabric, insulated drainage panels etc. which are mounted on the external walls according to various techniques and methods. However, such materials are expensive and need qualified staff and expensive mounting labor and this is the reason why most of residential entrepreneurs, in order to maintain the price competitiveness of their houses, do not use such drainage systems. Moreover, most of the materials are not resistant to a series of oil based products which are used frequently as waterproofing materials on the outside of foundations before the application of the drainage systems.

Consequently, the drainage alternative consisting of a horizontal drainage combined with filtering columns and doubling the drainage line for buildings with foundations of greater depth represents an improved drainage solution. This alternative does not need qualified staff for mounting, can be executed at low costs so that it can be used both for residential structures and for other more expensive structures without significantly increasing the construction costs.

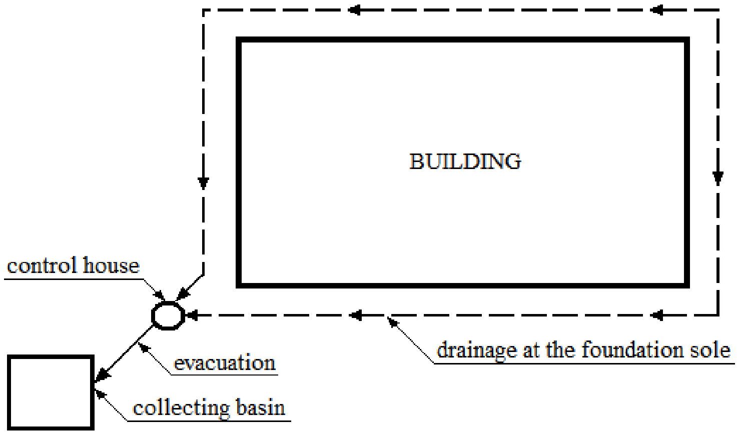

Figure 6 **Marginal drainage and collection basin**

CONCLUSIONS

The elimination of the water excess from the foundations of the constructions determines the reduction of the hydrostatic pressure on the basement walls, providing an increased stability and normal operation of the construction.

An adequate drainage system for the constructions with basement provides a quick elimination of the humidity excess, maintains the dryness of the basement walls, thereby avoiding the formation of dampness and mold in the basement rooms and their consequences.

The drainage system consisting of horizontal drainage combined with filtering columns and doubling the drainage line, in the case of buildings with foundations of great depth, manufactured from corrugated PVC tubing and with ballast filtering material, can be executed by unqualified staff and low costs. Therefore, it can be used both for residential structures and for other more expensive structures without a significant increase in the costs of the construction.

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