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PREVENCIA NEBLAHÉHO VPLYVU DAŽĎOVEJ VODY NA OPORNÉ MÚRY ESCARP NA HISTORICKOM HRADE SÁDEK

PREVENTING THE CALAMITOUS EFFECT OF STORM WATER ON THE RETAINING WALL ESCARP ON THE HISTORIC CASTLE SADEK

Abstract:
The aim of this paper is draw attention to the issue of the impact of rainwater on the historical monuments. As a specific example is Sádek castle built between 1270-1286. This paper deals with erosion influence to rainwater eskarp retaining wall and the surface of the moat. Part of this paper is a proposal addressing these problems. I present procedures for determining soil permeability in the ČSN 75 9010 and the application of these procedures in hard to reach places. The last thing is an example of infiltration drainage device and design eskarp.

Introducion

In this article I would like to share practical knowledge in solving problems with storm water during construction of historic monuments. To be specific, I was invited to the project construction work Sadek castle. My task was to solve the management of storm water. The current situation is totally unsatisfactory both in the present and for possible future use. The intention of the new owner is making this monument to the public, which includes access to the moat. The current status of this project does not ditch, driven to a large extent involved and the unresolved question of rainwater.

A brief history of the castle sádek

Castle Sadek initially called Ungersberg cone stands on a lonely hill near Kojetice, probably built between 1270-1286. Castle as the seat of robbery entourage was captured and destroyed in 1312 the army of John of Luxembourg. In the 2nd half of the 16th cent. was generous construction of a Renaissance palace. He was a 30-year war siege by the Swedes. Although the first siege in 1643 was unsuccessful, and two years later was Sadek Swedish army conquered and occupied half of the year. Damaged castle was only partially repaired after a 1694 lightning burned. After the fire took place in the 18th cent. Baroque modifications. After nationalization in 1945 met a grim fate castle, like many others in our area. This historic landmark has been the victim of yesteryear and some of its parts were in disrepair. From the late forties found refuge in the castle primary school, who ended scope in June 2007. The scope of school fortunately caused the state of the object is not worse. [1], [2]

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Fig. 1: Aerial view of the castle Sadek
(From: Mapy.cz, 2012)

Summary of issues

In times past and now are mostly drained rainwater from the roof with gargoyles in the castle moat, it covers the eastern part of the roof facing the ditch, and with a down pipes that carry rainwater from the roofs of most oriented to the courtyard. The draining pipe is brought to the surface eskarp where water flowed freely and seeping into the body eskarp. The western half of the roof facing the castle moat has mounted gutters and rainwater flow down freely to the surface eskarp. This solution works only in the short term and conditions prior to adjustments and clearing works in the ditch. In the long term are evident erosion and destructive effects of rainwater on retaining walls eskarp. This situation worsened after the removal of trees from the moat and surface eskarp. The root system of trees with their retention capacity contributed to the reduction effect of rainwater on the design eskarp. Another factor is deteriorating badly chosen method of repair of retaining walls in times past, where it was used impermeable mortar lining and so there infiltrated the accumulation of rainwater inside the body eskarp. The water pressure was the cause of many accidents. The destructive process of retaining walls eskarpy accelerated by the aforementioned removal of trees from the trench and surface eskarp. It was therefore necessary to resolve the question of rainwater as quickly as possible to avoid further problems.

Fig. 2: Eskarp collapse of a retaining wall on the north side of the ditch
(From: Ing. Michal Vondrák, 2012)

Opening balance sheet

After studying the available evidence and especially after a thorough tour of the building and its surroundings I suggested measures should in future avoid most of the problems mentioned above. The proposal can be summarized as follows at paragraphs:

- necessary to prevent the inflow of rainwater from the roof to the surface eskarp. This will be achieved by fitting rooftop gutters around the outer perimeter of the building, ie. add gutters on the west side. Following the Roof drains will be constructed drainage nerve-block anesthesia in the body eskarp to be drained into the ditch.

- Eliminate subsidies seduced rainwater from the court to the surface eskarp. Currently wastewater is led in the western passage of the object, resulting in distortion of the retaining wall and the erosion of the surface. It was designed to seduce the western part of the building, including newly created downpipes to seepage facility located on the south side of the ditch. I suggest underground infiltration devices coated with grasslands or sandy paths by finishing.

- It is also necessary to prevent the free discharge of the gargoyles on the northeast side and thereby prevent the erosion effects of free-falling water on the treated surface. I suggest to replace the gargoyle rain drain pipe and together with the newly established deception on the north side of it connected to the infiltration facility located on the north side of the ditch. Infiltration devices suggest an underground coated grasslands or sandy paths.

- The existing gargoyle on the southeast side will be given to maintain the architecture, it needs to extend only to avoid the impact of rainwater into the ditch, or for low flow.

- rainwater from the roof in the eastern part of the yard, I propose to bring into existing underground tanks, where they used to use for toilet flushing, irrigation, or for use according to the needs of the owner.

Withholding water will be concentrated seepage, and in two underground infiltration devices mounted in the moat. Now we come to the fact that it is necessary to determine the permeability of soil to design the infiltration device. When designing the applied procedure in the long-awaited ČSN 75 9010 - Infiltration devices rainwater.

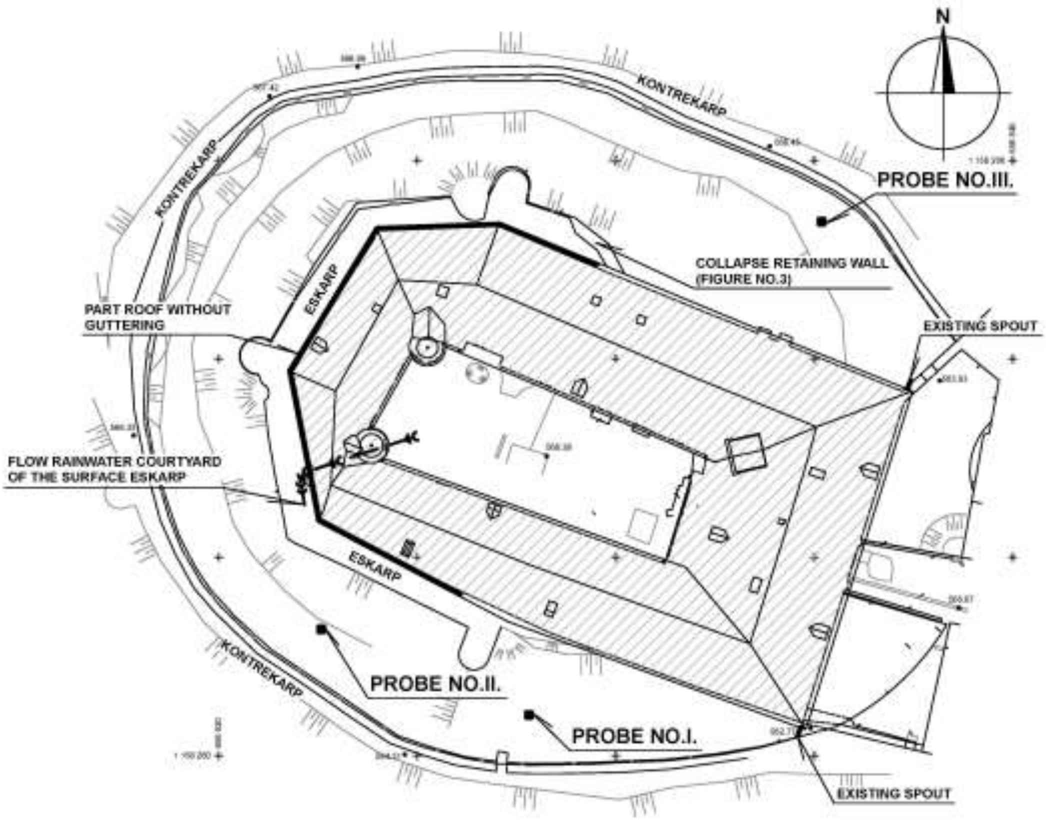

Fig. 3: Plan of the castle Sádek
(From: Ing. Michal Vondrák, 2013)

Test permeability

Basic values for the proper design of infiltration devices is to determine the permeability of the soil, which is in CSN 75 9010 defined the coefficient kv soak the unit m / s. Given that infiltration devices can be placed only in the moat becomes the biggest problem of access to the venue of the test. It can be said that the defensive ditch performs its function very well. [3]

Due to lack of access to the venue of the test was infiltration test (referred to in CSN 75 9010) adjusted in terms of the size of the probe and the amount of water infiltration. Total three probes were made in places where the ground was the most suitable location for seepage devices. The test procedure was then as follows:

a) The probes were excavated in size 50x50cm and depth of 90 cm, to the future day of seepage devices.

b) The bottom of the probe were compared to the level and irrigated for 30 minutes. To measure the level of motion was used mason meter mounted on a pole stuck into the bottom of the probe.

c) After emptying the probe was carried out first measurement. The probe was filled with water to a height of 30 cm and time was measured. After 30 minutes was deducted levels drop. In the case of water seepage before the specified time was recorded timestamp.

d) The test was repeated 3 times.

Evaluation of infiltration tests then held according to ČSN 75 9010 according to the equation

$$k_v = Q_{zk} / A_{zk} \quad (1)$$

where

k_v coefficient soak in m/s
Q_{zk} runoff in the probe in m^3/s
A_{zk} percolation test area during the test in m^2

To calculate the infiltration area was used equation

$$A_{zk} = L\,(h_{vz}/2 + \mathrm{b}) \quad (2)$$

where

L probe width in m
b probe length in m
h_{vz} water level in the probe in m

The result is then calculated from three coefficients different for each probe average, which was included in the calculation. [3]

Results of measurement

Probe number I.

number of measurement	time (min)	loss of water (m^3)	water outlet (m^3/s)	inf. area (m^2)	coefficient soak (m/s)
1	30	0,075	$4{,}167 \times 10^{-5}$	0,325	$1{,}28 \times 10^{-4}$
2	30	0,045	$2{,}5 \times 10^{-5}$	0,325	$7{,}69 \times 10^{-5}$

3	30	0,045	2,5 x 10^{-5}	0,325	7,69 x 10^{-5}
average					**9,39 x 10^{-5}**

Probe number II.

number of measurement	time (min)	loss of water (m^3)	water outlet (m^3/s)	inf. area (m^2)	coefficient soak (m/s)
1	30	0,060	3,333 x 10^{-5}	0,325	1,03 x 10^{-4}
2	30	0,058	3,222 x 10^{-5}	0,325	9,91 x 10^{-5}
3	30	0,058	3,222 x 10^{-5}	0,325	9,91 x 10^{-5}
average					**1,00 x 10^{-4}**

Probe number III.

number of measurement	time (min)	loss of water (m^3)	water outlet (m^3/s)	inf. area (m^2)	coefficient soak (m/s)
1	26	0,075	4,808 x 10^{-5}	0,325	1,48 x 10^{-4}
2	30	0,070	3,889 x 10^{-5}	0,325	1,20 x 10^{-4}
3	30	0,068	3,750 x 10^{-5}	0,325	1,15 x 10^{-4}
average					**1,28 x 10^{-4}**

Tab. 1: measured values
(From: Ing. Michal Vondrák, 2013)

Proposal for a solution

Coefficient were used in the design of infiltration devices. Storage space infiltration device consists infiltration plastic tunnels that will be stored on compacted gravel sub-base fraction 8-16 mm with a thickness of 10cm. The gravel layer will be laid before laying tunnels geotextiles weighing 220 g/m2. The tunnels will be backfilled with gravel, then the same faction as the subbase. The whole body is wrapped gravel geotextile. Above infiltration object must be a minimum cover layer of soil of thickness. 25 cm. To avoid drying up of vegetation over the device, it is necessary above the gravel backfill wrapped in geotextile layer of clay deposit of min. ply 5 cm. Rainwater objects must always be vented through vent chimney located on the opposite part of the device which is a tributary.

The biggest problem that plagues the owner and also the most dangerous, infiltrated accumulation of water behind a retaining wall eskarp. The vast majority of subsidies rainwater from the roof and the concentrated discharge pipe from the yard to the surface eskarp, could be repaired by fitting roof gutters and by diverting rainwater from seepage device. However, it is still necessary to solve the problem of water falling directly on the grassed surface eskarp. Even though it is not the amount of water as the roof, it must be included in the complex solution. The proposal was made carefully with regard to the fact that the building is a historical monument.

The surface eskarp was mined about 40 cm of soil and catchment made of clay layer of thickness. 6 cm. Gradient is selected in the center, which is located perforated drainage pipes of the upper 2/3 of the circuit. The pipe is placed on the geotextile and backfilled with gravel fraction 8-16 mm, then the gravel backfill this geotextile wrapped.

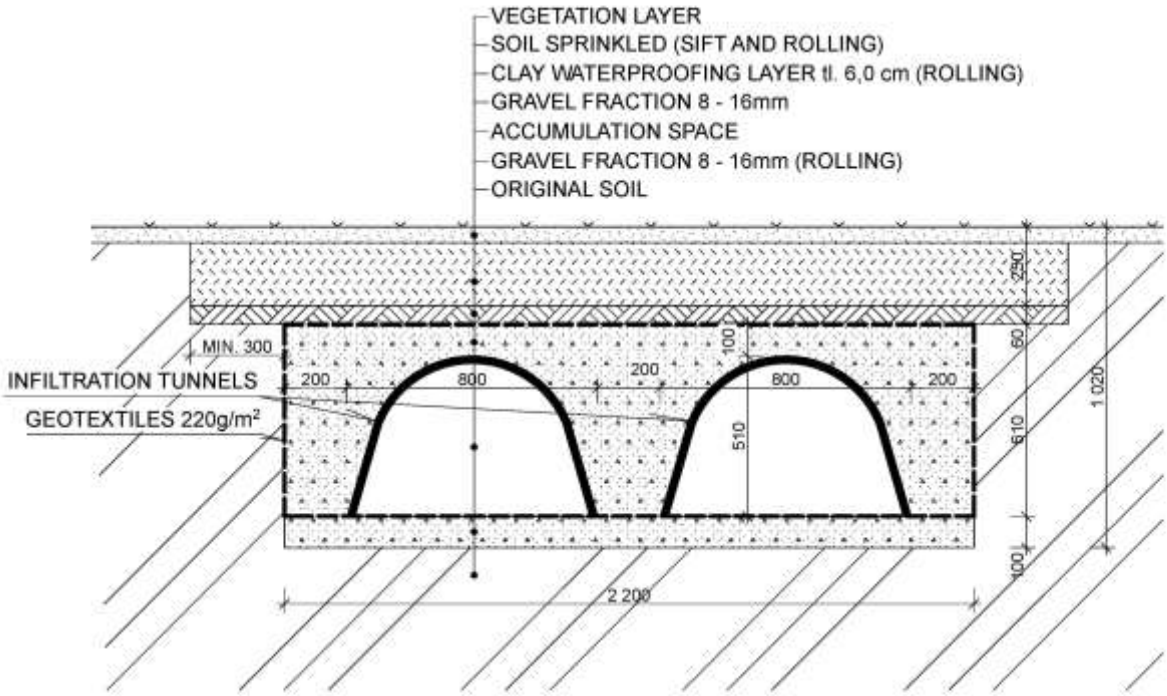

Fig. 4: Type cut infiltration device
(From: Ing. Michal Vondrák, 2013)

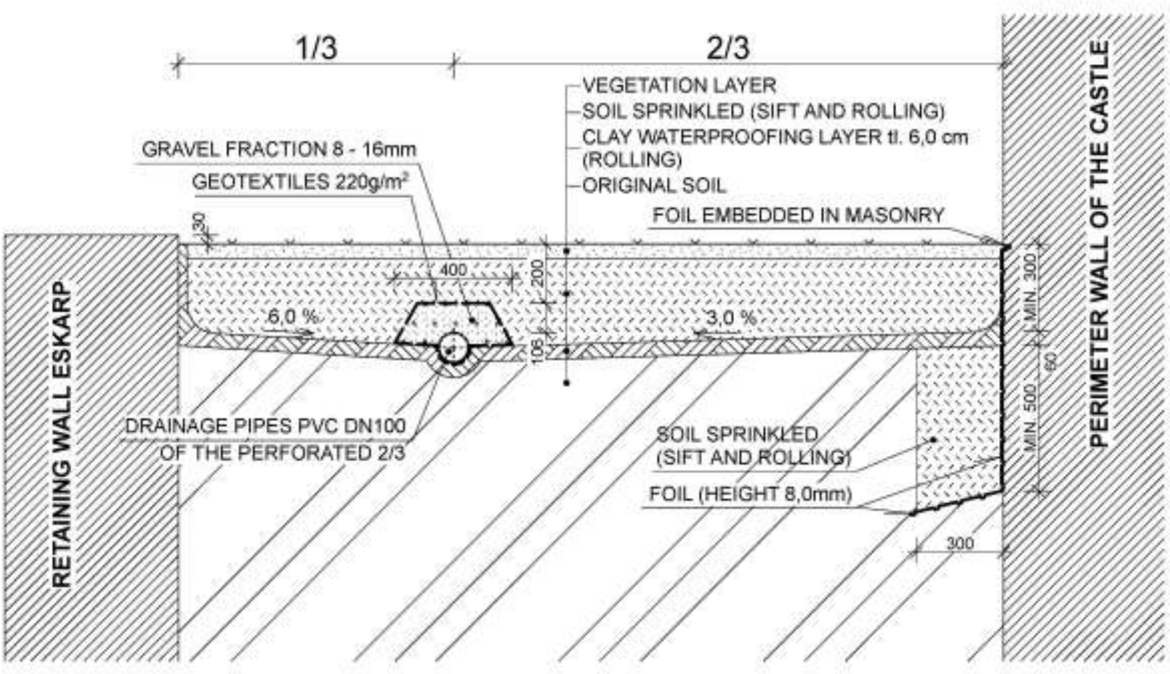

Fig. 5: Type cut body eskarp
(From: Ing. Michal Vondrák, 2013)

Conclusion

In this paper we describe only part of a comprehensive solution to the entire building. I would just like to point out the application of the above mentioned ČSN 75 9010 [3] in the rescue of historical monuments and adapt certain procedures in hard to reach places like the castle moat defensive Sadek.

References

[1] http://hrady.hyperlink.cz/hrad_sadek.htm

[2] http://www.zamek-sadek.com/

[3] ČSN 75 9010 *Vsakovací zařízení srážkových vod*. Praha : Vydavatelství ÚNMZ. 2012. 44 s.