Interlocked floor drainage, applied over concrete slab at Taguatinga shopping, Brasília/DF, Brazil

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ABSTRACT: For construction of parking uncovered of Taguatinga Shopping, at Distrito Federal, the project included the utilization of interlocked floor (*Bloquete*) over the concrete slab type "***Steel Deck***", waterproofed with asphalt mantle. It has been used a layer of drainage geocomposite for improvement of mechanical protection of the waterproofed mantle, but too as sliding layer and with main function, to drain the excess of water and liquids percolated through the cover structure made by blocks.
The project was composed by multidisciplinary concepts which brings together architectural aspects of the flooring coatings, chosen by architecture, looking the improvement of thermal and acoustic comfort of stores under the region with vehicle traffic; and structural, with control cracks, apart from geotechnical, in drainage of water in the layer of powder stone of settlement of blocks, over the slabs, avoiding thin pumping and effect of reduction of interaction between blocks caused by rising forces of water. For many years the shopping was the biggest, outside the Plano Piloto (Brasilia downtown region), in 2010 it increased its service area and too parking lots. The original proposal utilized in 3000m2 was replicated at extension, in an area of approximately 2000 m2.
After studies some alternatives which heeding the needs mentioned before, opted by utilization of the system composed by geocomposite drainage, with rigid drainage core. This system is composed by a drainage core formed by a extruded geogrid composed by polyethylene of high density and welded thermally to two non-woven geotextiles of polyester in all contact points. This drainage geocomposite was applied directly over the waterproofed slab, reducing the system drainage session for 7 mm meeting the needs of layers of mechanical protection and sliding separating, proposing an compact system, efficient, of low cost, efficient, and with production improvement. Keywords: Drainage, geosynthetics, draiange geocomposite, horizontal drainage.

1 INTRODUCTION

Inaugurated in November 2000, Taguatinga Shopping is now one of the business cards of Taguatinga - DF.

It was developed in steel, consisting of metal pillars and mixed steel-concrete beams, using slabs with Steel Deck. The steel used is highly resistant to corrosion and most of the parts are bolted, providing greater agility in the assembly process.

With 160 thousand m² of constructed area, Shopping is part of the Organizations Paulo Octavio in partnership with JC Gontijo Engenharia. After becoming a relevant shopping center for residents of the city and neighboring regions, there was a need to expand its facilities. The advantage was that the interventions had already been foreseen in the original project, which facilitated the expansion activities. To the existing construction, also executed with mixed structures, were added new stores, garages and two corporate towers (Figure 1).

The areas of shops and garages are constituted by metallic pillars and systems of mixed beams in steel-concrete, with the use of slabs in steel deck. According to Codeme Engenharia, the company responsible for the execution of the metal structures, the construction of the towers represented a challenge, since they were erected from frontal balances of 7.5 m, supported by metallic diagonals to the concrete core, with slab and truss metallic connection between towers with 40 m span. Among the advantages, the use of a mixed solution allowed the existence of a freer footing, not to mention that the system brought speed to the assembly and reduction in the number of workers in the construction site, not interfering in the operation of Shopping.

Figure 1. View of Taguatinga Shopping.

2 INTRODUCTION

In order to meet the architectural expansion needs of the taguatinga shopping mall, along with the steel deck structural design, the project envisaged the use of a top-floor interlocking carpet over the concrete slab (figure 2).

Figure 2. View of the floor with interlocking pavement on the slab of the upper parking lot of Taguatinga Shopping.

The main objective of Drainage geocomposite was to promote the horizontal drainage of waters vertically infiltrated by joints of the interlocked floor and transmitted to the settlement floor, eliminating the possibility of stagnation of water between the slab and the floor, besides making mechanical protection function and sliding layer of the waterproofing mat.

Another need presented was to promote the disconnection of the interlocking pavement layer with the concrete slab, thereby reducing disturbances caused by noise and vibrations propagated by steel and concrete structures.

As shown below, Figure 3 illustrates a diagram of the application of the Drainage geocomposite on floor interlocked on the floor.

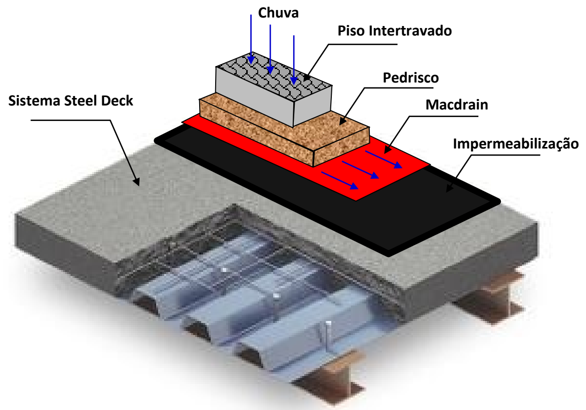

Figure 3. Application diagram of Drainage geocomposite on the concrete floor.

Figures 4 to 8 show the interlocking floor applied in the upper parking lot of the Taguatinga Shopping.

Figure 4. View of the upper parking lot of Taguatinga Shopping.

Figure 5. View of the outer parking lot from the top floor.

Figure 6. View of the interlocking floor in the outer parking lot of the upper floor.

Figure 7. Detail of the surface drainage, by means of box with grid, interconnected to the drainage system with drainage geocomposite .

Figure 8. View of interlocking floor joints.

The idea worked on this project was also influenced by the concept used in green roofing projects, with the aim of reusing the rainwater through the system shown in figure 3, contributing to the work a good thermal comfort to the environment covered by the solution. The processes of thermal exchange between the internal and external parts of the coated construction suffer a significant delay by the insulating action of the system on the cover, bringing a sensation of lower thermal variation.

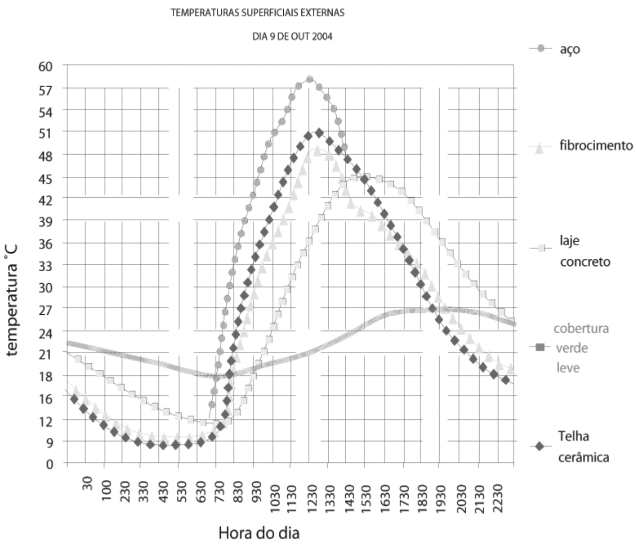

Figure 9. Performance of the various types of coverage, especially the lower thermal amplitude of the light green roofs. (Fonte:www.shs.eesc.usp.br/pessoal/docentes/pesquisas/14/tetoverde/resultados.html).

In the conventional roofs most precipitated water would be destined to public networks by means of surface runoff.

3 HYDRAULIC DIMENSIONING.

For the hydraulic design, tests of infiltration capacity were performed on floors according to the design structure (Figure 10). For this, prototypes were set up in laboratory with the layers and inclinations provided.

The data collected showed a relationship between the amount of water drained and that infiltrated from the or-dem of 0.90. Thus, to calculate the infiltrated flow, only 10% of the precipitated volume was considered.

Figure 10. View of the interlocking floor in the outer parking lot of the top floor.

Figure 11. Permeability test on interlocking floors.

Figure 12. Permeability test on interlocking floors.

According to the observations contained in the paving manuals with interlocking floors, such floors have satisfactory permeability by the joints. The layer of sand or hail captures the water from these joints and transmits them to the base. In the case of the work in question, where the block was applied in a layer of sand or pebbles on the slab, there will be a need to promote the drainage of the slab, avoiding the accumulation of water in it. Figure 13 shows details of water flow in this type of structure.

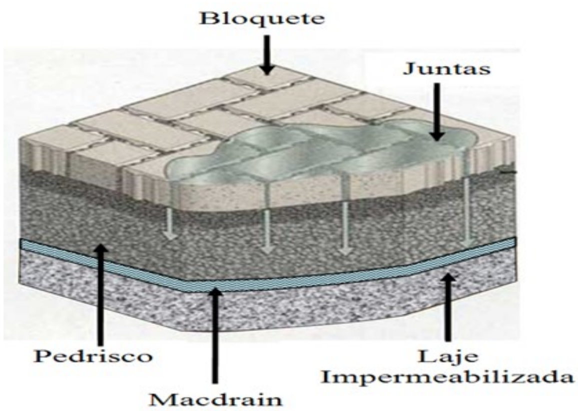

Figure 13 - Detail of the water flow in the block.

3.1 *Drainability of Drainage geocomposite R.*

For the calculation of flow capacity of Drainage geocomposite , only the hydraulic gradient i in the flow direction is required, and the vertical stress applied on the geocomposite due to the loads acting on the same.

Table 1 summarizes the flow data taken from the Drainage geocomposite R datasheet.

Table 1 - Drainage geocomposite flow capacity for i = 0.50.

Gradiente hidráulico / Presión	i = 0.50	
	(l /h) / m	(l / s) / m
10 kPa	160,8	0,45
50 kPa	140,4	0,39
100 kPa	131,5	0,37
200 kPa	121,5	0,34

In the design, a slope value of 0.5% was adopted for the drainage mattress, so the value of the hydraulic gradient adopted was also 0.5%. Considering that the sum of the self-weight of the block and the traffic overload generate a vertical voltage of 20KPa, it is necessary to interpolate Table 1, and a flow rate of Q = 0.43 l / s x m is obtained for this voltage.

According to normative guidelines and pertinent technical recommendations, the following reduction factors apply to the geocomposite:

FRin = 1,10 (soil intrusion);
FRcr = 1.20 (creep - Creep);
FRcq = 1.20 (Chemical Filling);
FRcb = 1.15 (Biological Filling).

Com isso obtém-se a vazão admissível para o sistema, conforme equação (1) a seguir:

$$\text{Qadm} = \frac{Q}{(\text{FRin . Frcr .FRcq .FRcb})} = 0{,}24\ \left(\frac{l}{s}\right).m \tag{1}$$

3.2 *Calculation of the contribution rate.*

For the contribution flow calculation, the rational method was used, being the most usual in small areas due to its simplicity in empirically relating several variables that can influence the system. The study in this case has a contribution area of 30 m², an estimated precipitation of 150 mm / h, and an infiltration coefficient of 0.1, which was found according to the aforementioned test.
According to equation (2) below, the contribution flow Q = 0.13 l / s is calculated.

$$\text{Qadm} = \text{C . i . A} = 0{,}13\ \left(\frac{l}{s}\right) \tag{2}$$

4 CONCLUSION AND RESULTS.

In order to verify the efficiency of the drainage system using the Drainage geocomposite system, in order to perform the previously proposed solution on an interlocked floor, some tests and calculations were performed. These actions made it possible to obtain satisfactory results, since the analyzed drainage system presented an efficiency of 85% higher than the contribution flow that the system should drain.
In addition to this factor, the use of this geocomposite provides the creation of a compact system, increasing efficiency and productivity, and reducing operation costs. Also considering the visual aspects, an efficient drainage like the proposal avoids diverse pathologies, like unwanted infiltrations, the appearance of spots caused by excess humidity and also the proliferation of fungi.

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