



Analysis of the micro-drainage infrastructure on an avenue in the city of Aracaju-SE

Análisis de la infraestructura de microdrenaje en una avenida de la ciudad de Aracaju-SE

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Abstract: The urban drainage system plays a vital role in the lives of people living in urban areas, protecting properties and citizens during heavy rainfall, preventing erosion on streets and public roads, and other benefits. To create an efficient drainage system, attention must be paid to the design, execution, and supervision of works by qualified professionals, as well as the maintenance of existing works. Because of the above, this article aims to analyze the micro-drainage infrastructure of Avenida Edélzio Vieira de Melo, in the city of Aracaju-SE. Initially, an *in loco* visit was made to assess the state of conservation and the presence of waste in the gutters and gutter inlet. It was observed that 51.2% of the gutter inlets are located in an undesirable way; 60.5% are partially or totally degraded and 81.4% have solid waste disposal. About the manholes, 90% are inadequately located, 80% are partially or totally degraded, and, finally, 70% are level with the sidewalk. The conclusion is that the devices need to be cleaned more frequently, and the population needs to be made more aware not to throw garbage in the street, since the presence of solid waste negatively affects the functioning of the drainage network. Finally, the location of the devices (manholes and gutter inlets) affects their efficiency, and durability and interferes with the comfort of those who use the road.

Keywords: *Gutter inlets; Manhole; Conservation.*

Resumen: El sistema de drenaje urbano desempeña un papel vital en la vida de las personas que viven en las zonas urbanas, protegiendo las propiedades y a los ciudadanos durante las fuertes lluvias, evitando la erosión en las calles y vías públicas, entre otros beneficios. Para desarrollar un sistema de drenaje eficiente, se debe prestar atención a la elaboración de proyectos, ejecución y supervisión de obras por profesionales calificados, así como al mantenimiento de las obras existentes. Teniendo en cuenta lo anterior, este artículo tiene como objetivo realizar un análisis de la infraestructura de microdrenaje de la Avenida Edélzio Vieira de Melo en la ciudad de Aracaju/SE. Inicialmente, se realizó una visita in situ y se evaluó el estado de conservación y la presencia de residuos en las cunetas y pozos de registro. Se observó que 51,2% de las bocas de lobo están localizadas de forma no recomendada; 60,5% están parcial o totalmente degradadas y 81,4% tienen disposición de residuos sólidos. En cuanto a los pozos de registro, el 90% están situados de forma inadecuada, el 80% están parcial o totalmente degradados y, por último, el 70% están a nivel del pavimento. Se concluye que la limpieza de los dispositivos debe realizarse con mayor frecuencia, es necesario concienciar a la población para que no arroje basura a la calle, la presencia de residuos sólidos afecta negativamente al funcionamiento de la red de drenaje y, por último, la ubicación de los dispositivos (bocas de lobo y pozos de registro) afecta a su eficacia durabilidad y también interfiere en la comodidad de quienes utilizan la carretera.

Palabras clave: *Bocas de lobo; Alcantarilla; Conservación.*

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INTRODUCTION

The growth of cities has increasingly required the development of efficient techniques to prevent the accumulation of rainwater, avoiding potential problems arising from this accumulated excess (Martins, 2021). Thus, the existence of a drainage network is important, as it promotes the well-being and safety of the population (Girão et al., 2017). However, in our country, several urban problems can be observed caused by the inefficiency of the drainage system, especially when it comes to the rainiest months (Fragoso et al., 2016).

The lack or inefficiency of urban drainage can cause damage such as flooding, which can harm the physical integrity of the population and result in the mixing of water discharged with solid waste, as well as sanitary sewer, enabling the emergence of various diseases correlated with inadequate sanitation (Macêdo et al, 2022).

Drainage and urban rainwater management are defined by Philippi Jr (2005) as the set of activities, infrastructure, and operational facilities for urban rainwater drainage, transportation, detention or retention to dampen flood flows, treatment, and final disposal of rainwater drained in urban areas; it should be included in Master Plans with reliable hydrological and meteorological information for the execution of urban drainage projects.

According to Botelho (2017), experience shows that it is difficult to properly maintain a rainwater system; but by adopting preventive measures (good design and construction) and corrective measures (good operation and maintenance) it is possible to mitigate the problem. In other words, correct sizing and constant maintenance will prevent the system from collapsing with each rainfall, causing long-lasting and recurring overflows. Because of the above, this research aims to carry out an analysis of the state of the urban micro drainage infrastructure on Avenida Dr. Edélzio Vieira de Melo, in the city of Aracaju-SE.

THEORETICAL BACKGROUND

In 2022, an *in loco* visit was made to Avenida Francisco Porto, in the city of Aracaju-SE, where it was found that 58% of the gutter inlets are located in an undesirable way; 50% are degraded and 51.6% have their inlets partially or totally obstructed; concerning the gutters, 55% are well maintained, 79.2% are partially or totally obstructed (Ferreira et al, 2022). The authors emphasized the need for more frequent maintenance of the drainage system and devices, more intense inspection by the competent authorities, and greater awareness among the population.

Santos et al (2019) carried out an *in loco* visit and analyzed the state of conservation and the presence of solid waste in gutters, gutter inlets, and manholes. They found that 50% of gutter inlets are located in an undesirable way (on corners); 41.7% are partially or totally degraded and 54.5% have an

obstructed entrance. About gutters, 50% of the sections are partially or totally degraded, and 50% of the sections are partially or totally obstructed.

In studies carried out on drainage channels in the city of Aracaju-SE, it was found that the devices that border the channels, i.e. the manholes, present the same problems as those reported above. In the drainage channel of Avenida José Conrado de Araújo, most of the manholes are depreciated, many in an advanced state of disrepair (no cover, broken cover, walls, eroded sides, etc.), and many of them are obstructed by solid waste (Vieira, et al; 2022). During an *in loco* visit to the drainage channel on Avenida Anísio Azevedo, Vieira, et al, (2021) found that many manholes were depreciated, and some were even destroyed. According to these same authors, this state of conservation of the manholes can lead to clogging, making it difficult for the local micro-drainage system to function; in addition, the broken parts can be carried into the channel gutter, posing a risk to people passing through the area and causing an unpleasant aesthetic appearance.

METHODOLOGY

Initially, an *in loco* visit was made to analyze the state of conservation of the micro drainage devices on the avenue studied, as well as quantify these devices, accompanied by photographic records of the situations found along the route. The data collected was then used to draw up graphs, which will serve as a basis for further discussion.

Study Area

For this research, Avenida Edélzio Vieira de Melo in the city of Aracaju-SE was chosen, and the stretch from the intersection with Avenida Hermes Fontes in Bairro Suissa to the meeting point with the current Avenida Augusto Franco in the Pereira Lobo neighborhood was analyzed (Figure 01). This stretch is approximately 1.5 kilometers long, corresponding to 88.24% of its total length. This avenue was chosen because it is one of the city's main flooding points (G1 Sergipe, 2017).

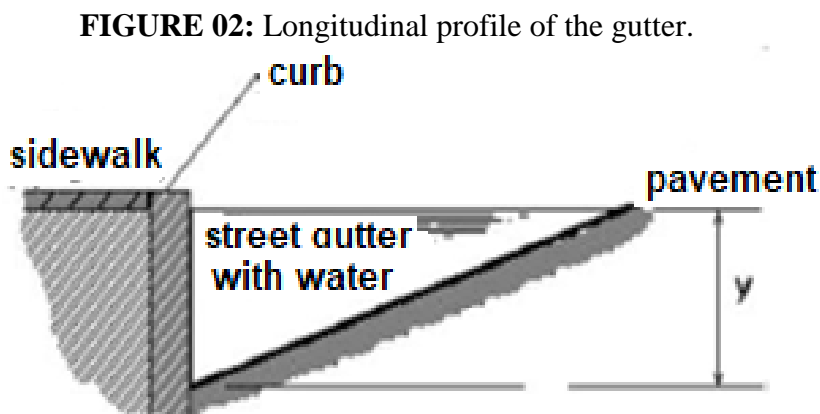
FIGURE 01: Analyzed stretch of Avenida Edélzio Vieira de Melo located in the city of Aracaju-SE.



SOURCE: Google Maps (2023).

Devices analyzed

Gutters: According to the Department of Highways of the State of São Paulo - DER/SP (2006), gutters are longitudinal triangular channels designed to collect and convey surface water from the paved road and the sidewalk to the drainage system.



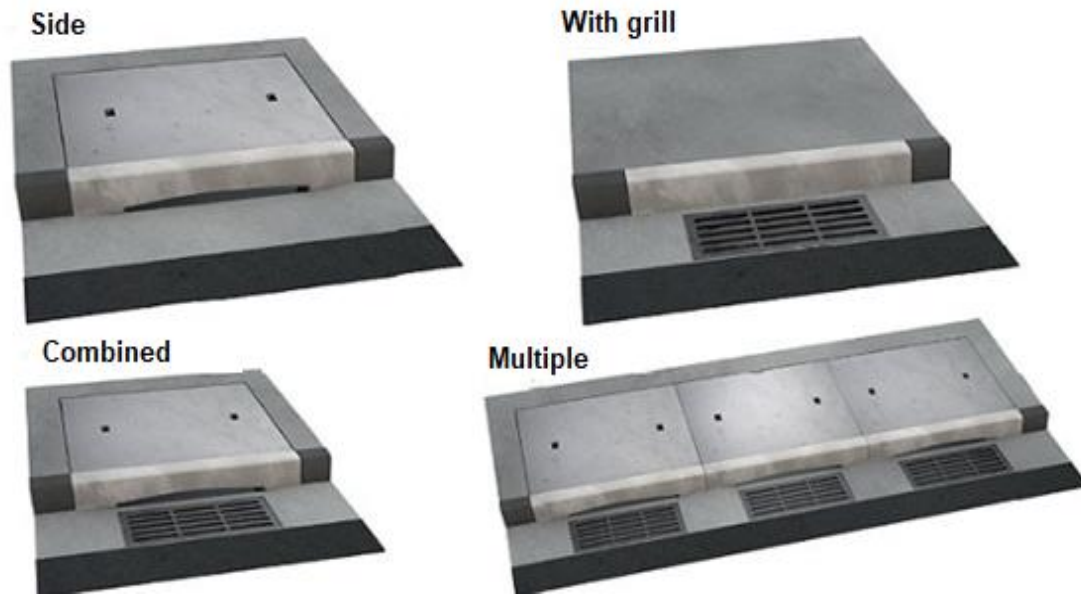
Source: Fernandes (2002) *apud* Inouye (2009).

Gutter inlets: These are devices in the form of collection boxes built from masonry. Their function is to receive the rainwater that flows through the gutters and direct it to the collection network. Depending on drainage needs, they can be single or multiple and equipped with precast concrete or ductile iron grates (Nakamura, 2011).

According to Nakamura (2011), there are generally four types of Gutter inlets:

- **Lateral:** indicated for installation at intermediate points in gutters with a small longitudinal slope (1% to 5%); when there are obstructive materials in the gutters; on roads with heavy and fast traffic; and upstream of intersections;
- **With grid:** indicated for gutters with limited depression; when there are no obstructive materials; for installation at intermediate points in streets with a high longitudinal slope (1% to 10%).
- Combined:** suitable for low points of streets and intermediate points of the gutter with an average slope of between 5% and 10%;
- **Multiple:** also recommended for low points and gutters with high flow rates.

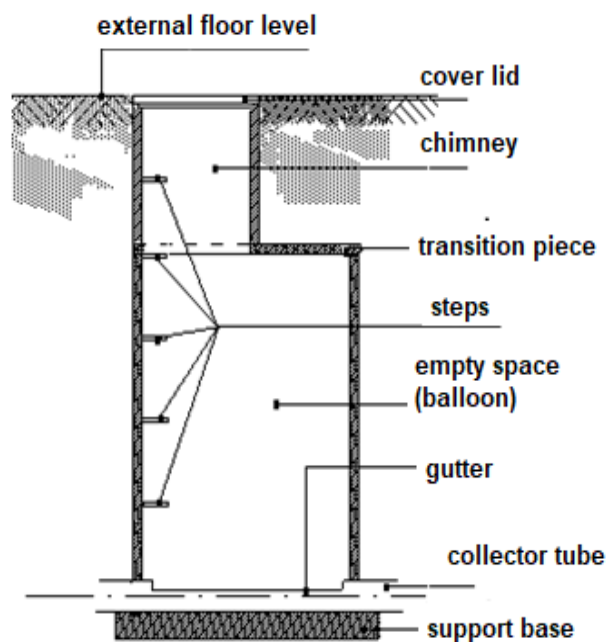
FIGURE 03: Types of Gutter inlets.



SOURCE: Nakamura (2011).

Manholes: According to the Belo Horizonte City Hall (2019), manholes are auxiliary devices installed in rainwater pipe networks to enable connections to manholes, changes of direction, slope, and diameter from one section to another and to allow inspection and cleaning of the pipe, and should therefore be installed at convenient points in the network.

FIGURE 04: Profile of the manhole.



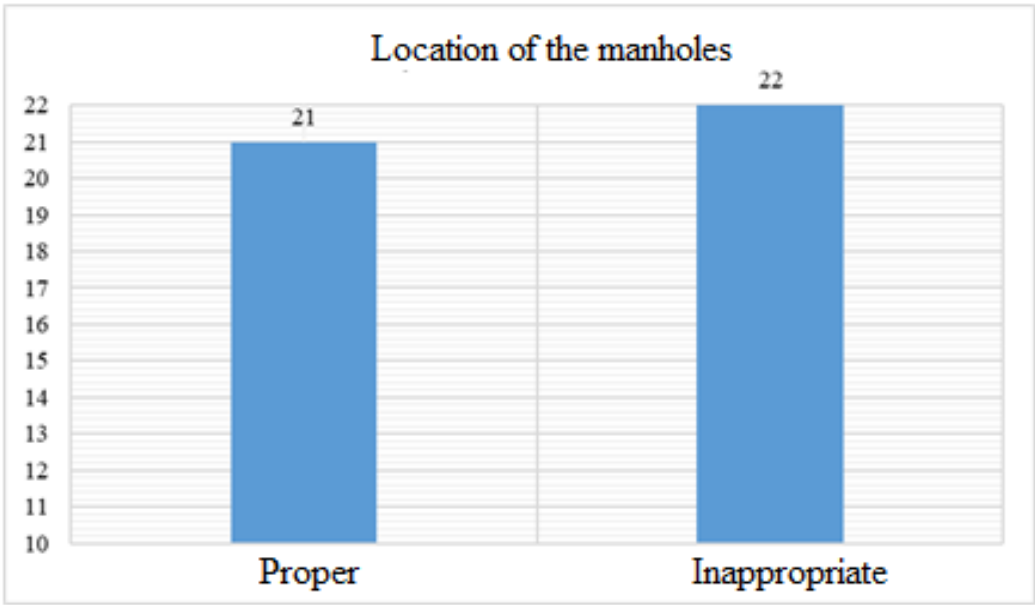
SOURCE: Botelho (2007) *apud* Acesso Alfa (2017).

RESULTS AND DISCUSSION

Analysis of the location, state of repair, and presence of debris in the gutter inlets

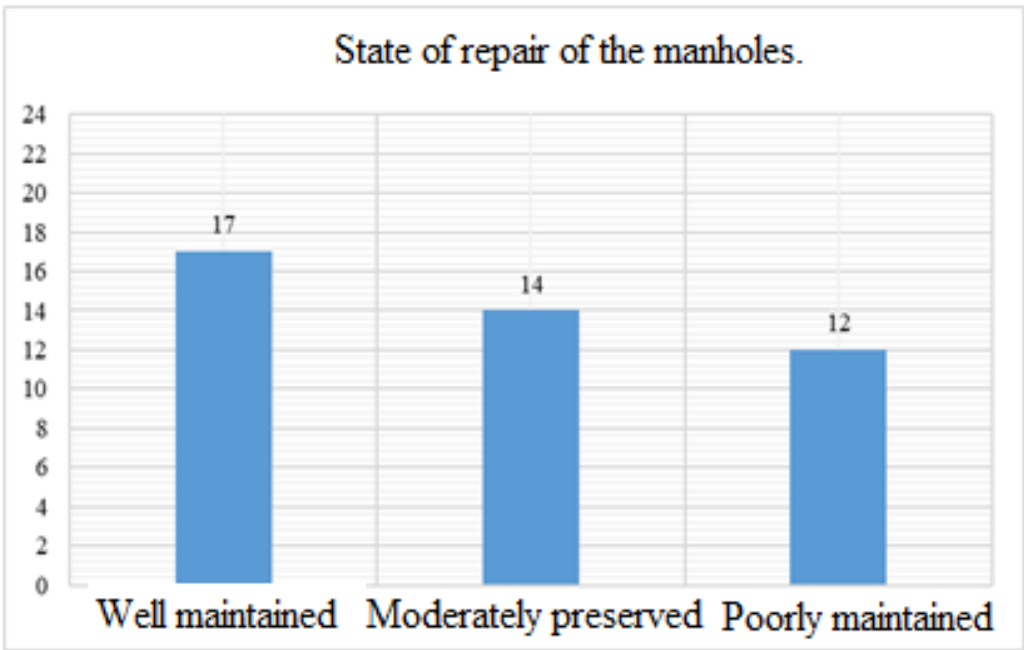
Along Avenida Dr. Edélzio Vieira de Melo, 43 gutter inlets were found. The results of the inspection are shown in Figures 5 and 6 below:

FIGURE 05 (a): Location of the gutter inlets.



SOURCE: Authors' data (2023).

FIGURE 05 (b): State of repair of the gutter inlets



SOURCE: Authors' data (2023)

According to Figure 05 (a), more than half (51.2%) of the gutter inlets are in an inappropriate location (corners). According to Nakamura (2011), gutter inlets should not be installed on corners (the section with the highest flow rate through the gutter) so that the flow of water does not interfere with the passage of pedestrians, nor does it reduce the efficiency of the device, as the converging torrents through the different gutters would flow at the opposite speed to the inflow into the gutter inlets. For this reason, it is recommended that gutter inlets be installed at points just upstream of each crosswalk used by pedestrians.

FIGURE 06: Example of poorly located and badly maintained gutter inlets.

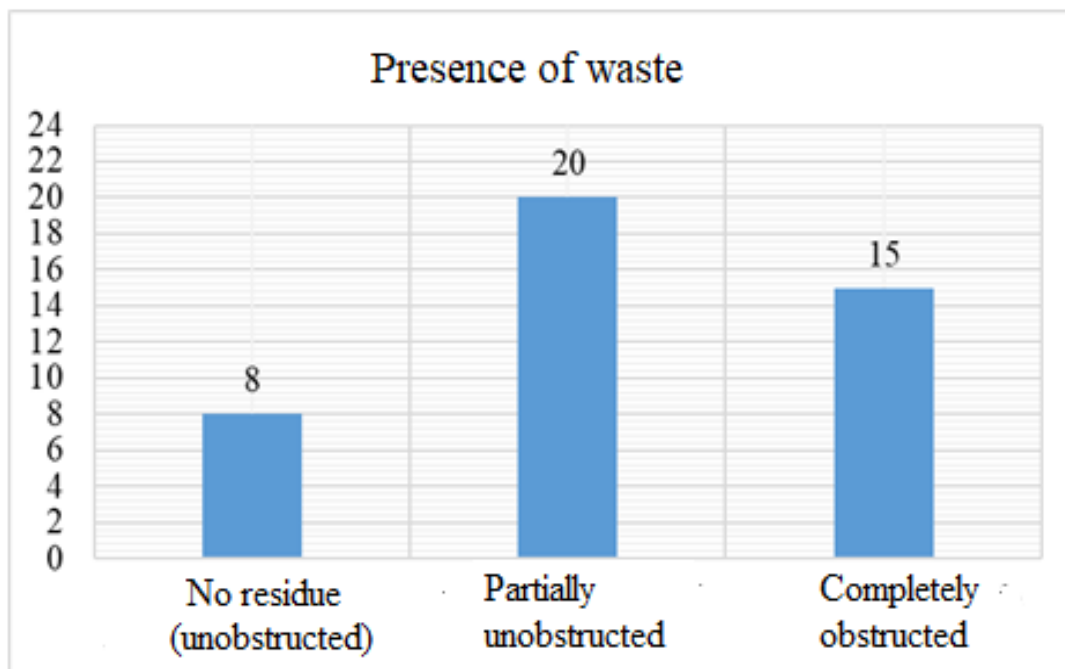


SOURCE: Authors' data (2023).

As for the state of repair, only 39.5% of gutter inlets are well maintained, while 32.6% are moderately maintained and 27.9% are poorly maintained. This situation is detrimental to the functioning of these devices because, according to Descovi (2022), the state of repair of gutter inlets can indicate a serious maintenance failure, limiting the capacity to swallow rainwater and increasing flooding. Figure 06 below shows a poorly located gutter inlets (corner) in a very poor state of repair.

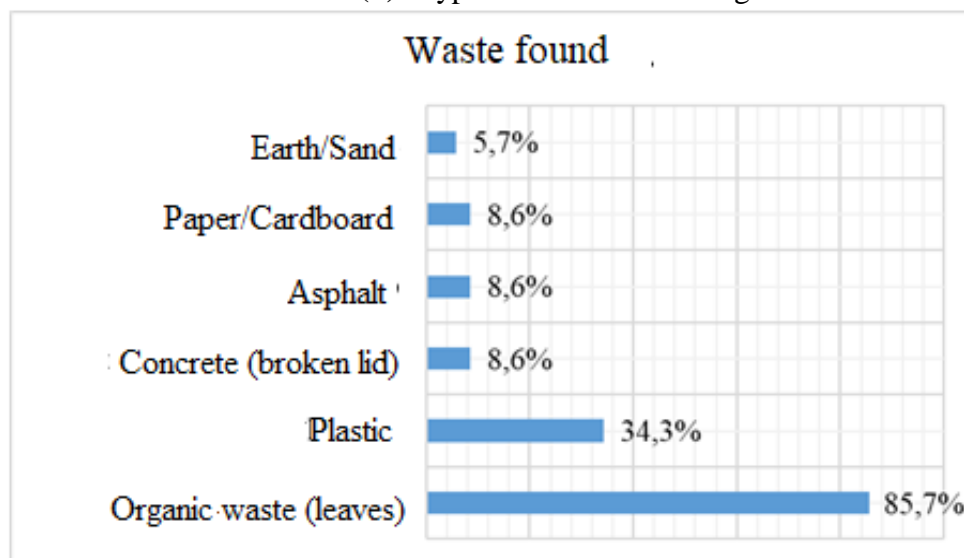
With regard to the presence of solid waste in the devices and the types of waste found, the result is shown in Figure 07.

FIGURE 7 (a): Presence of waste in gutter inlets.



SOURCE: Authors' data (2023).

FIGURE 7 (b): Types of waste found in gutter inlets.



SOURCE: Authors' data (2023).

With regard to the presence of waste in gutter inlets (Figure 7 a), it can be seen that only 18.6% of the devices evaluated did not have any waste at the time of the inspection, 46.6% were partially blocked and 34.8% were completely blocked. This situation is worrying because, according to Tucci (2005), when solid waste reaches the urban drainage network, most of it accumulates due to inefficient garbage

collection coverage, lack of urban cleaning, poor waste disposal by the population and rainfall. Figure 08 shows an example of a completely blocked gutter inlet found during the visit.

FIGURE 08: Gutter inlet completely blocked.

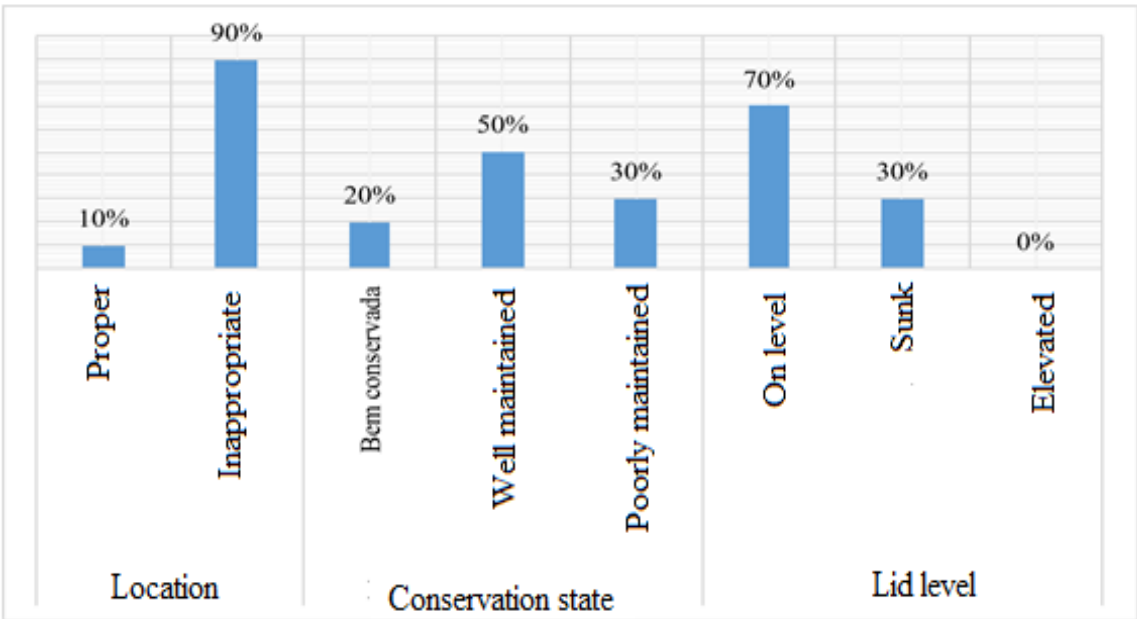


SOURCE: Authors' data (2023).

Analysis of the location, state of repair and leveling of manhole covers.

Regarding the manholes, the results obtained are shown in Figure 09.

FIGURE 09: Analysis of manholes.



SOURCE: Authors' data (2023).

As shown in Figure 09, only 10% of the manholes are properly positioned, i.e. they are located in central areas of the lanes, reducing the passage of car tires over the device. Improperly located manholes are found in the lane of the avenue where car tires pass over them, resulting in damage to these devices and reducing their useful life. There were also manholes covered with paving, as shown in Figure 10 below.

FIGURE 10: Covered manhole with paving.



SOURCE: Authors' data (2023).

Regarding the state of repair of the manholes, it can be seen that only 20% are well maintained; the other 80% are partially or totally degraded (broken cover, cracks and fissures in the surrounding sidewalk, sinking, among others). As for the leveling of the cover, 70% of the covers are level with the sidewalk, while 30% are sunk, which can cause discomfort for drivers on the avenue. In addition, degraded manholes pose a risk to the population traveling on urban roads.

Impact of solid waste on the swallowing capacity of gutter inlets

The capacity of gutter inlets to retain rainwater does not exceed 60 l/s (Botelho, 1985) when they are well built and clean. Therefore, in order to simulate the impact of solid waste on the efficiency of the drainage network, it will be assumed that gutter inlets are partially obstructed and have their retention capacity reduced by 50% (30 l/s), and those that are totally obstructed have their capacity reduced by 75% (15 l/s). In the ideal situation, i.e. all the gutters are unblocked, we have a total flow of 2,580 l/s, and in the situation verified on site, the total retention capacity drops to 1,305 l/s, i.e. a reduction of 49.4%.

CONCLUSIONS

Based on the analysis of the data obtained, it can be concluded that:

- a) it is extremely necessary to clean the devices more frequently, in order to avoid such high rates of blockage of the gutter inlets.
- b) Raising awareness among the population is essential to maintaining the efficient functioning of the drainage system, because if garbage is thrown onto the streets, it will end up in the urban drainage system if it rains before the variation;
- c) when building drainage networks, care must always be taken to carefully analyze the location of the devices, as this has an impact on their efficiency and durability, as well as interfering with traffic flow.

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