Evolution of the Underground Drainage System of Historical Fortified City, Galle, Sri Lanka

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Abstract

The Galle Fort, located in Southern Sri Lanka is one of the few living forts in the world. It was built by Portuguese in 1588, rehabilitated by Dutch in 1640 and by British in 1796. As a result, it inherits different architectural features. This Fort has a unique drainage and sewer system. The purpose of this research was to study the evolution of the drainage system over three colonial eras. The results revealed that at one stage sewer system was mingled with drainage system. This required a flushing mechanism. Both Dutch and British had used sea water to flush the system. They employed a windmill to pump sea water which was then transported using bullock carts to flushing inlets. Later British improved the system by installing a storage facility and a pipe line. It was concluded that drainage system is still structurally and hydraulically stable considering its age.

Keywords: British, Drainage system, Dutch, Galle Fort, Portuguese,

1. Introduction

Galle is an ancient city of historical importance, located in the Southern Province of Sri Lanka. Its history dates back to 125AD. Galle port has been included even in the world map prepared by Ptolemy in 125AD-150AD (Galle Fort, n.d.). Galle was a busy port full of foreign traders during this period.

Arabian explorer, Iban Batuta landed on Galle in 1344. Even during that time, Galle port was used for foreign trade. Because of its strategic importance, Western nations realized that they could control trade of the Indian subcontinent, if they can capture Galle port (Rohanadeera 1997)

Galle Fort was built adjacent to Galle port. Historically, Galle Fort was owned and operated by three different western nations. Initially built by Portuguese in 1588 and subsequently captured by Dutch in 1649. Later British wrestled out the Fort in 1796 (Abeysinghe 1969).

The dawn of the golden era of Galle Fort, took place during Dutch rule. In addition Portuguese and British had done substantial construction work within the Fort.

2. Portuguese era – Initiation of the drainage system of Galle Fort

Prior to the construction of the Fort, this area was an uninhabited rocky peninsula. The topography of the land slopes in the North South direction (Welmer 1986). Portuguese decided to construct a rampart with three bastions in the Northern part of the land (Fig 1). They foresaw a major drainage problem with this design. During heavy rains a large pool of water could be accumulated near the southern side of the rampart. To mitigate this problem, they constructed drains underneath the rampart to convey water out of the area. This marks the initiation of the underground drainage system of the Galle Fort (Fig 1).

Some of the drains were constructed to transport water under the rampart towards the sea. Some were sloped South making use of the natural topography. The outlet number 4, shown in Fig 2 was used as a natural outlet during Portuguese era. This belongs to the latter category. This had been constructed in 1700 (Welmer 1984) and subsequently undergone major rehabilitation work. Even today, this outlet and related structures are in good condition.

The drains had been constructed using coral, granite and bricks. This indicates that Portuguese were cost conscious in construction works.

3. Dutch era - Expansion of the drainage system

Dutch extended the rampart to cover the entire peninsula which included 14 bastions (Nelson & De Silva 2004). What can be seen today is the Fort expanded by Dutch, with minor modifications. The Dutch drainage system consisted of 180 manholes, 8 outlets, 6 flushing inlets and 3 km of drains (Fig 2). They continued the Portuguese tradition of constructing drains using coral, granite and bricks with the additional difference of an internal metal lining (Fig 3) (Welmer 1986).

Dutch were concerned not only about the drainage system but also about the domestic water supply. In other forts in Sri Lanka, Dutch had constructed a system of water wells (Pieris 2012). However there’s no significant evidence that, this feature prevailed in Galle Fort.

There is a wide spread belief, that the drains were flushed using tidal movements of the sea. However study of the tidal movements indicates that this is not feasible. During tidal movements, the water level moves up and down gradually. But in order to flush a drain, water needs to flow rapidly. Further the tidal movement of water occurs near the outlet end of the drains. However, flushing is required further up where sewer water which contains solid particles is discharged to the system. On the contrary, the tidal movements seem to have a negative impact on flushing of drains. Observations made at the site indicate that outlets get blocked with dead coral and sand (Fig 4). It's apparent that this material got transported as a result of tidal movements. There is no reason to believe that this phenomenon did not occur in the past. The above facts conclude that tidal waves were never used to flush drains. Instead, Dutch had used a very sophisticated mechanism to flush the drains using sea water (Liyanage, 2009).

5. Windmill

Dutch had constructed a windmill near the Triton bastion (Fig 2). This windmill pumped water from the sea whenever there was sufficient wind energy. This water was then taken away using bullock carts to flush the drainage system and to wet the dirt roads (Wellmer 1986). The carts were filled directly from the outlet pipe of the pump. There was no facility to store excess water. Considering the historical time of the construction and the technology used, it can be concluded that this was a four blade, Dutch style windmill.

According to reports, the windmill has been functioning over a very short period of 20 years. Even thought there is no evidence, this short life span might have been due to high cost of maintenance and frequent break downs during high winds.

6. British era- Extension of the drainage system

During the British era, the administrative importance of Galle dwindled as they selected Colombo as their capital (Kuruppu 1992). Due to negligence, the drainage system experienced deterioration during early years of British era. This negligence was a result of confusion that existed with the arrival of British and retreat of Dutch. After settling down, British made a formidable effort to rehabilitate the system.

British made a major improvement to the flushing mechanism of the system. They built a windmill identical to the one which was used by Dutch and improvised a storage facility on the rampart to store water (Fig 5). An old battery used by the army was converted to a storage facility. Capacity of the storage facility was 110,000 liters sufficient to meet 10 days water requirement (Welmer 1986).

The daily water requirement for flushing and cleaning streets was about 11,000 liters. The windmill pumped water to a height of about 10 meters. According to reports, the minimum wind speed required to operate the mill was 10 km per hour. During minimum wind speed, the windmill was rotating at 1000 revolution per hour and pumped 1800 liters of water. There had been a mechanism to shut down the mill, during high winds to protect it from collapsing (Welmer 1986).

When British took over the Fort, some of the underground drains were caved in and were blocked at several locations. British took necessary steps to repair these drains. The outlet portals were constructed using dressed bricks for aesthetic reasons. The central part of the invert of the drains was replaced with dressed granite bricks of semi circular shape (Fig. 6). This design made low discharges with solid particles to flow in this semi circular section with a higher velocity to facilitate flushing. In addition, they extended the underground drainage system and constructed new open drains.

7. Current situation of the drainage system

Currently only storm and grey water are allowed into the drainage system. Sewer water from residences is expected to go into individual septic tanks. However, few residents illegally divert their sewer water into the drains.

Majority of the outlets are blocked by dead coral and sand (Fig 4). Primary reason for this is that the sand and dead coral get transported into the drains with the tidal movement. Once inside, there's no natural phenomenon to flush out this sand and dead coral. This fact and field investigations done reiterates that tidal movements cannot be used to flush drains.

Some of the outlets are blocked by constructing coffer dams (Fig 7). Enquires made revealed that this had been done to prevent sea bathing spots getting polluted. However effectiveness of these coffer dams is questionable. Observation made at the field indicated that the polluted water get escaped into the bathing area. These coffer dams creates pool of contaminated water between the dam and outlet, which itself is a cause of health hazard.

Granite manholes, including covers, made by Dutch are still in use. Only few manholes were constructed recently. They, including covers are made of concrete. Outlets belonging to two different eras, British and Dutch exist today. There is a significant difference in the cross sections of these outlets. Sample outlets constructed by Dutch and British are shown in figures 3 and 6 respectively. It can be concluded that the current drainage system is a consolidation of the system built by Dutch.

8. Conclusion

The Galle Fort was constructed by Portuguese in 1588 and subsequently modified by Dutch and British. This is one of the few living forts in the world. Galle Fort has a drainage system constructed over 400 years ago which is still functioning. Portuguese used this drainage system to dispose sewer water. But there was no mechanism to flush the drains which caused health hazards. To alleviate this problem, Dutch introduced a mechanism to flush the drains using sea water. Unique feature of this mechanism was the four blades, Dutch style windmill that was used to pump up sea water.

The drainage system is still functioning. However it is old and needs rehabilitation. Any effort to rehabilitate should be made using state of the art technology while preserving the archeological value of the Fort.

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