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Editorial

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This issue of *Engineering History and Heritage* comprises four papers that are written by practising engineers with long experience in their respective domains. These papers focus on ten projects, namely, one building, three subterranean connections, and six bridges. For each project, the author(s) recalls its historical background, describes the design process, outlines the construction challenges, narrates the environmental degradation, and finally, suggests conservation and modernisation measures, where applicable. I hope that such information would be useful to civil engineers engaged in the design, construction and conservation of a broad range of infrastructure facilities beyond buildings, subterranean connections and bridges.

All ten projects are situated within greater Calcutta (renamed Kolkata in 2001), in West Bengal, India. Seven of these projects were inaugurated during the 20-year period between 1920 and 1940; the eighth project was conceptualised within the same period but abandoned due to lack of funds. Of the remaining two projects, one was inaugurated in 1966, and the other is a work-in-progress that is scheduled for inauguration in 2021.

Hence, I feel, a review of Kolkata city's founding and infrastructure development in the nineteenth century would provide a useful insight into the backdrop in which these projects were conceived, designed and constructed.

The city of Calcutta was founded in 1690 by Job Charnock, an administrator of the British East India Company (Wikipedia, 2019). Although Charnock was traditionally recognised as the founder of Calcutta, in 2003, in a public interest litigation, Calcutta High Court ruled that Charnock's role in the early days of the city was not adequate for him to be identified as the founder of the city because an older settlement long predated his arrival at the site (Encyclopaedia Britannica, 2020). Be that as it may, the selection of Calcutta as the capital city of British India was primarily the result of Charnock's persistence.

Charnock selected the site for Calcutta after careful consideration. The site was protected by the Hooghly or Ganges river to the west, a creek to the north, and marshy wetland to the east. Rival Dutch, French, and other European settlements were higher up the river on the west bank, so that access from the sea was not threatened at the port of river Hooghly. The river was more than 500m wide and 13 m deep and served as a formidable barrier against any intrusion (Singh, 2019). The mainland of India, which was mostly under the Mughal rule, was situated to the west of river Hooghly. Thus, Calcutta was strategically a more secure place for the British settlers. The only disadvantage was that the marshland to the east made the location somewhat insalubrious (Sinha, 2019).

In 1857, the British East India Company was dissolved, and all its assets in the Indian subcontinent were incorporated into the British Empire (Wikipedia, 2020a). As the capital of British India, Calcutta continued to grow. It remained the capital of British India until 1911, after which the capital was moved to Delhi (Wikipedia, 2020b).

By successive phases, as British authority extended over the subcontinent, the whole of northern India became a hinterland for the port of Calcutta. As the city expanded, two distinct towns – one British and one Indian – came to coexist in Calcutta. The British Town was built in a planned manner on a vast expanse of land that had been raised and drained. So many palaces came up in the British Town that the city earned the sobriquet of 'city of palaces'. In the Indian Town, rich Indians built many mansions, and simultaneously many tight clusters of huts sprang up for the poor Indians. The Indian Town grew in an unplanned manner mainly in low-lying areas that were traversed by canals and nullahs.

Rudyard Kipling, an English poet, novelist and Nobel Laureate (1887) wrote about Calcutta,

> Thus the midday halt of Charnock – more's the pity!
> Grew a City
> …
> So it spread –
> Chance-directed, chance-erected, laid and built
> On the silt.

Although Kipling had many detractors – one of whom, the influential British writer George Orwell scathingly wrote, in 1945, that Kipling was a 'jingo imperialist' (Dey, 2019) – in this instance,

Kipling was not wholly incorrect because indeed a large part of the city was unplanned, and the soil of Calcutta was comprised of the alluvial silt of the Gangetic delta. Such poor soil condition continues to adversely affect the design of the foundation of any significant structure in the city.

To manage the growth of the city, a municipal corporation was set up in 1726 by a royal charter. The corporation was responsible for lighting, conservancy services, laying of roads and drains, and supply of drinking water. The expansion of the British Town, the clearance of the Maidan, and construction of Fort William within the British Town were some of the significant developments between 1757 and 1800 (KMC, n.d.).

The second half of the nineteenth century witnessed significant urban infrastructure development in the city. The construction of railways began in 1854 and quickened the development of business and industry. Around the same time, the Grand Trunk Road from Calcutta to Peshawar (now in Pakistan) was completed. British mercantile, banking and insurance interests flourished. Calcutta became a busy hub of commerce, and people from other parts of India and many Asian countries migrated to the city (Sinha, 2019).

With the growth of Calcutta grew its twin city Howrah, across the river on the west bank of the Hooghly. It soon became an industrial hub. Howrah railway station was opened to the public in 1854. It became the gateway of Calcutta for accessing northern India. Today, it serves 1 million passengers every day and is one of the busiest railway stations in the world (Wikipedia, 2020c). In 1874, a pontoon bridge was constructed between Calcutta and Howrah (Wikipedia, 2020d); it provided a surface connection between Calcutta and Howrah station across the Hooghly, and from there to the mainland of India. In 1869, Sealdah railway station was opened in the heart of the Indian sector of Calcutta. Today, Sealdah railway station has a passenger footfall of over 1.8 million and is another of the busiest railway stations in the world (Wikipedia, 2020e).

Several other massive infrastructure projects were implemented during this period. Asia's first surface water supply system, the Pulta–Tallah system was inaugurated in Calcutta in 1868, with a capacity of 27.3 million litres per day (Dey and Patra, 2019). The sewer system of Calcutta was inaugurated in 1875. Its trunk sewers were 60 km long, large cross-section brick sewers. These were amongst the largest sewers in the world and was 'well ahead of the Bazalgette sewer system of London' (Downey, 2018).

The Calcutta Electricity Supply Corporation Limited (now CESC Ltd) was registered in 1899. In the same year, CESC inaugurated the first thermal power plant in the city. Calcutta was the first Indian city to be wholly electrified. Today, CESC is the sole distributor of electricity to 2.9 million consumers in Kolkata and Howrah (CESC, 2017). In 1873, horse-drawn trams rolled out in Calcutta; in 1882, it switched to steam engine-drawn trams; and finally, in 1900, electric-motor driven trams were introduced. Today, 270 tramcars ply over 57 km-long double tracks across Kolkata (WBTC, 2014).

Thus, during the second half of the nineteenth century, Calcutta witnessed enormous development in its urban infrastructure. This period coincided with the best part of Queen Victoria's just-short-of 64-year-long reign as the queen regnant of Great Britain and Ireland, and almost her entire reign of 25 years as the Empress of India from 1876 until she died in 1901. After the death of the queen, Lord Nathaniel Curzon, the governor-general and viceroy of India, proclaimed in 1905 that a grand monument be constructed in Calcutta in the memory of the deceased queen. It took 16 years to raise funds, design and construct the monument. Victoria Memorial Hall, as the monument was named, was thrown open to the public in 1921.

Victoria Memorial Hall is the subject of one of the four papers in this issue – the paper is written by me (Sen, 2020). The memorial sits at a prime location, at the eastern edge of what used to be the British Town, at the southeastern corner of the Maidan, and directly to the east of Fort William. In the 'city of palaces', the memorial building is by far the grandest edifice. It is the most famous monument of British India. The building has a massive planform and an imposing height. Today, with 3.7 million visitors annually, it is the most visited museum in India and the most iconic symbol of Kolkata.

The next paper gives an account of three different subterranean connections below the bed of the river Hooghly. The paper is co-authored by Parashuram Singh, Biswanath Dewanjee, Kaushik Gangopadhyay and Dr Ayanangshu Dey (Singh *et al.*, 2019). First, the paper narrates the conceptual design of an east–west 'tube rail' from Kolkata to Howrah, which was prepared in 1921. It was a 10.6 km-long rapid transit system, of which 9.6 km was below ground; it passed below the bed of river Hooghly. However, the government of Bengal felt that it could not afford the cost of the project, and for that reason, it abandoned the project. In 1933, CESC inaugurated the first utility tunnel in India below a river. The tunnel was used to route electric cables from its existing thermal power plant in Calcutta to Howrah across the river. The tunnel is 500 m long under the bed of river Hooghly, located 400 m downstream of Howrah pontoon bridge; it is still in service. Finally, this paper reports on an ongoing east-west metro project, connecting Kolkata with Howrah. It is 16.5 km long and currently in an advanced stage of construction. Its twin tunnels below the bed of Hooghly were completed in 2017. The project is scheduled to be inaugurated in 2021.

Going back nine decades, Willingdon Bridge (later renamed Vivekananda Bridge), a major rail-cum-road bridge across river Hooghly, located at Bally, was opened to the public in 1931. The next paper is on this bridge; it is authored by Utpal K Ghosh (Ghosh, 2020). The bridge has seven main spans, each 107 m long. The spans are bridged by fully rivetted, modified Petit type hog-backed steel trusses, and are supported on brick piers founded on steel caissons. This bridge provided the much-needed passage of cargo and passenger trains between Sealdah railway station and

the mainland of India across the river Hooghly. The bridge also connected Barrackpore Trunk Road in Calcutta with Grand Trunk Road in Howrah and thereby provided passage for vehicular traffic between Calcutta and the mainland of India. The bridge was repaired in three installments in the period between 1983 and 2004, and remains in service.

As the traffic density grew in Calcutta, many bridges were constructed for surface traffic (including tram tracks) and utilities like water mains to cross over the nullahs, canals and railway tracks that crisscrossed the city. The next paper reports on five such bridges within Calcutta; it is co-authored by Anirudha Das and Partha Roy (Das and Roy, 2020). These five bridges were constructed after 1920 and replaced older bridges at the same locations that had become unsuitable for the increased traffic. Out of these, four were reinforced concrete bridges, namely, Beliaghata Bridge with a 39 m span (1923), Alipore Bridge with a 45.7 m span (1932), Tollygunge Bridge with a 33.5 m span (1936), and Chitpore Bridge with a 23.8 m span (1940). They carried pedestrian and vehicular traffic, and in some cases tram tracks and utilities like water mains, across suburban railway tracks, Tolly Nullah, and the Circular Canal. Kidderpore Bridge, the fifth bridge reported in this paper, was inaugurated in 1966. A steel bascule bridge, with a span of 47.9 m, it is located at Kidderpore docks of Calcutta port and replaces the older swing bridge.

The authors of these four papers are duly appreciative of the acumen of the professionals who conceived and implemented the diverse array of heritage civil engineering projects they cover and go on to describe the conservation process of those projects. One of the key lessons from these papers is that maintenance is a critical factor in augmenting the life of a heritage structure.

The lesson is especially relevant to Kolkata today because, unfortunately, Kolkata has recently witnessed the collapse of Majherhat Bridge, which was a prestressed concrete road bridge, on a major arterial road, connecting New Alipore and the area further south with the city. Majherhat bridge was constructed approximately 60 years ago. It collapsed in 2018, causing loss of human lives and property (Web Desk, 2018). At present, the bridge is being replaced.

These four papers bring to the forefront the need to follow a strict regimen of maintenance of critical structures. The publication of these papers in *Engineering History and Heritage* will ensure that they will be available to serve as a useful reference for civil engineers for many years to come.

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