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Cheong Gye Cheon Restoration Project

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Cheong Gye Cheon Restoration Project

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Abstract : Transforming a ten-lane road system into a stream in a downtown area of a metropolitan city, a grand civil engineering project named Cheong Gye Cheon Restoration came to realization in Seoul. In 2002 when 'Cheong Gye Cheon Restoration Project' was issued, nobody was quite sure of a successful finale to the project. Contrary to such a pessimistic prospect, however, three years were more than enough for the city's 6 km-long main road to be reborn as an eco-friendly stream, a sweet home to birds and fishes. Launched in July 2003, the Cheong Gye Cheon Restoration Project covering a length of 6 km, a width of 25~100m and an area of 276,650㎡ came to completion in October 1, 2005.

Key words : *river restoration, environment, urban regeneration*

Fig.1. Cheong Gye Cheon, before (top) and after restoration (bottom) in the downstream

1. OUTLINE OF THE CHEONG GYE CHEON RESTORATION PROJECT

Cheong Gye Cheon flows westward starting from the foot of a mountain located in the centre of Seoul (Fig.2). Up until 2002, the stream was left alone as an eyesore, dirty, unhygienic and dangerous place to citizens. Thus, it was favored to be as far away from it as possible.

Dating back 600 years ago when Seoul was chosen as the capital of the nation, Cheong Gye Cheon was literally a 'valley of clean water.' With the people across the nation flocking into Seoul and industrialization progressing, however, the stream soon became a huge sewer. In the 1960s following the Korean War, countless shanties came to occupy both sides of the stream, which led to irreversible deterioration of its surroundings. Pushed by various policies to accelerate industrialization, an idea to 'cover' the contaminated stream was adopted. For about a decade starting in 1967, the upper reach ranging for 6 km of Cheong Gye Cheon was covered with concrete slab to build the widest road of 10 lanes in Seoul. In order to meet ever-increasing transportation demand, an elevated four-lane road was constructed on the covered structure. Convenient transportation systems and accessibility helped surrounding areas of Cheong Gye Cheon to develop into a dynamic industrial and commercial zone, thus serving as an outpost of industrialization in the early stages of modernization of Korea.

In the 1980s when the economic scale of Seoul expanded, the industrial functions around the Cheong Gye Cheon area moved to the outskirts of the city, which led to the deterioration of its adjacent area and waning of the market zone. To make matters worse, a flurry of problems came to the fore: an unwholesome environment raising hygiene-related concerns inside the covered road, air pollution caused by increased traffic and endangered citizens' safety due to aging road structures. In 2002, these problematic conditions and the soaring demand of citizens for a better living environment and livelihood engendered the notion of turning the covered area into a lively stream, the Cheong Gye Cheon Restoration Project.

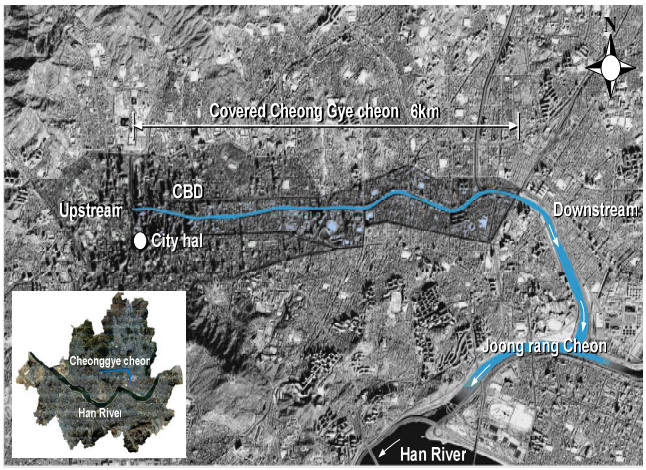

Fig.2. Location of Cheon Gye Cheon and its adjacent area

2. MASTER PLAN

The idea of Cheong Gye Cheon Restoration was initiated by a small group consisting of several scholars and environmental activists in late 1990s. The idea was not materialized until 2002. Seoul Metropolitan Government launched an organization to push the project forward in July 2002. The organization consisted of the 'Civil Committee,' charged with establishing principles for the restoration, 'Research Support Group,' which was in charge of research and survey of public opinion and 'Promotion Head Office,' responsible for the planning, design and execution of the project. First of all, Research Support Group took the initiative in putting all civilian-led research activities together to come up with a master plan encompassing the restoration of Cheong Gye Cheon including the development of adjacent areas.

In the process of formulating the master plan, the consensus on preconditions has been reached upon through public involvement programs. The preconditions are as follows:

- to complete the project as soon as possible to minimize economic loss to nearby businesses
- to maintain a two-lane road on both sides of the stream

The first condition puts restraints on the period of the construction while the second one limits the width of the stream to be restored. Taking the second constraints into account means reducing the 14-lane road into the four-lane, two-lane for each side of the stream. The main works included in the project were as follows:

- demolition of the covering and elevated structures: 5.4km
- formation of watercourse and stream bed: 5.7km
- water supply: 120,000 tones per day through a 10.9km long water supply pipe
- construction of bridges: 22 places
- landscaping: 5.8km

2.1 Basic Design and Tendering

A detailed design guideline for the stream cross section was established by setting the maximum intensity of rainfall for the return period of 200 years. The construction cost was set at 357 million US dollars. The total construction section was divided into three 2 km-long sectors as shown in Fig.3. The 'design-build' method was adopted.

Considering Cheong Gye Cheon's traditional values and its urban image as well as restoration of its ecosystem, the project design was made with the upstream representing 'history and tradition', the midstream 'culture and modernity' and the downstream 'nature and future'. The average project cost per sector was about 120 million dollars. Total six construction firms and four design consultants were involved in the project. In the phase of detail design, a joint design office participating all firms was put into operation so that continuity of stream and structures between sectors was maintained and harmonized.

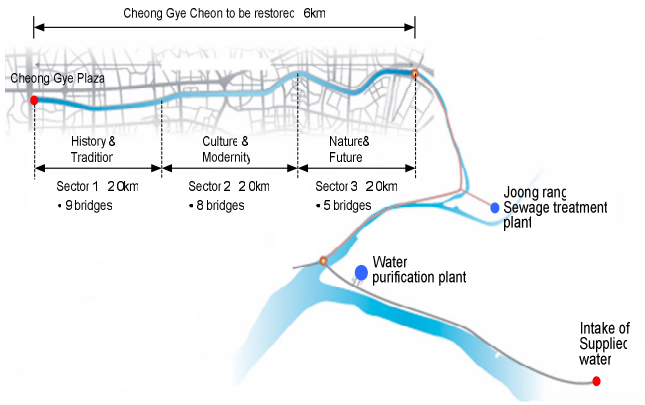

Fig.3. Sector division for the Cheong Gye Cheon Restoration Project

2.2 Demolition

Demolition of structure was the first step of the restoration work. The structures to be demolished were a 5.4 km long, ten-lane covered road, and a 5.7 km long, four-lane elevated road.

The demolition work was carried out in downtown areas where commercial and residential buildings were highly populated, and therefore, traffic (both passengers and freight) was also very heavy. Accordingly, the focus in the phase of planning was placed on reducing noise and dust generated during demolition and transporting them while minimizing inconvenience on the streets (Fig.4). The diamond wire saws resulting in a low level of noise and dust were used for cutting large structures like bridge piers, while slabs and other auxiliary structures were removed with wheel saws and/or crushers. Structures were severed to maximum sizes to reduce transportation. Large trailers were used to carry dismantled materials to the waste disposal facilities mostly at night.

The whole structures demolished weighed 907,000 ton; which contained 79,000 ton of concrete, 82,000 ton of asphalt concrete and 35,000 ton of steel. Materials transported were crushed in the twelve waste disposal facilities. About 96% (839,000 ton) of concrete and asphalt concrete were recycled as mostly sub-base for road construction. All reinforced steel bars were sent to mills for recycling. In order to preserve the traces of Korean modern history, three elevated bridge piers were remained in the down stream (see Fig.10).

Fig.4. Dismantling the elevated roads (top) and the covered structures (bottom)

2.3 Cross Section of the Stream

Urbanization and road pavement has reduced the possibility for rain to be absorbed into the ground and increase the chances of flood. The hydrological analysis and small scale model tests (Fig.5) for Cheong Gye Cheon basin indicated that the existing flow section could not be reduced for the design flood. Therefore, the original width of the stream was kept and deeper stream bed was formed. Consequently, some of covering structures were maintained so that spaces below them could be used for flow and surfaces on them for roads as shown in Fig.6.

Fig.5. Small scale hydrological experiments were carried out to ensure flow capacity for design flood (longitudinal model scale 1:50)

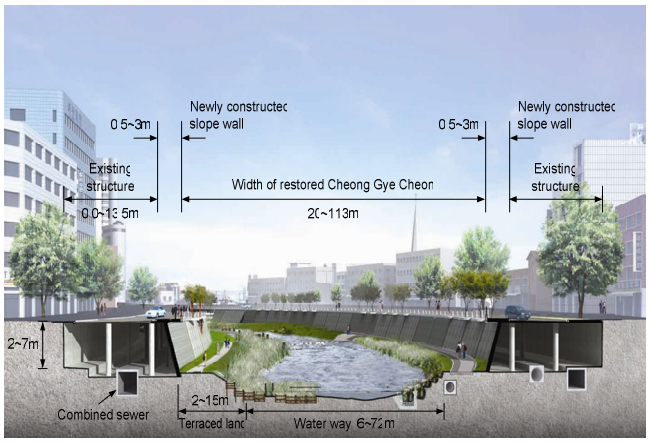

Fig.6. A typical cross section of restored Cheong Gye Cheon in the downstream

Remaining of the existing covering structures accompanied two important construction works.

- reinforcement work for the existing structures and foundations
- building embankment wall structures forming the slope walls between the road and the stream .

Total surface area of existing structure requiring reinforcement was 21,858m^2 in both sides of the stream. To increase the bearing capacity of foundation, micro piles (D=200mm) were added to the existing foundation. Upper parts of the slab requiring smooth surface were reinforced using carbon fibre strips, while lower parts using carbon rods.

The final stream cross section is 20 m wide in the upstream and 100 m in the downstream. At the stream level terraced land was formed so that people could gain easy access to the stream.

Sewer system around Cheong Gye Cheon is combined type of waste and rain water. Thus during flood, rain water would

overflow and flood into Cheong Gye Cheon directly. The direct inflow of highly contaminated initial rain water would destroy ecological system of restored Cheong Gye Cheon. To collect the initial rain water and send it to the waste water treatment plant, larger sewer boxes which can cover initial rain water up to 5 mm/hour of intensity of rain. In the upstream, sewer boxes were installed under the terraced land. The box section was generally divided into two parts to keep appropriate current speed preventing sedimentation in dry seasons as shown in Fig.7.

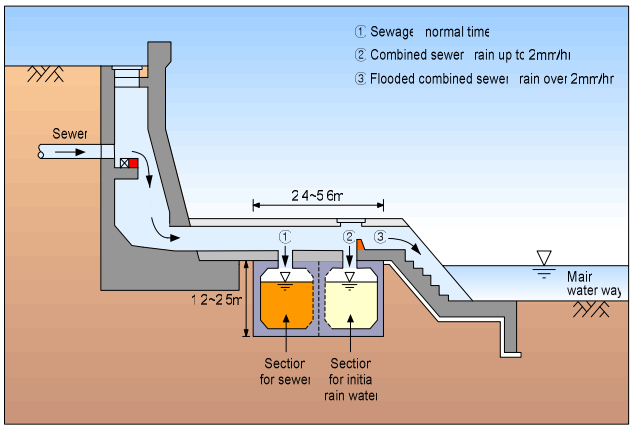

Fig.7. Combined sewer system to collect sewer and highly contaminated initial rain water (upstream section)

2.4 Water supply

Supplying water to the restored stream bed was one of the most controversial issues, especially over how to secure sufficient amount of water and to keep its quality sufficiently good. It was finally decided to supply daily 120,000 tons of water which was required to maintain a depth of 40 cm and 0.25 m/sec current speed in average. 100,000 tons of Han River water which is about 15 km away from the down stream of Cheong Gye Cheon (Fig.3) and 20,000 tons of groundwater from taking from subway tunnels were supplied daily.

Among the total supply, some 57% of water (68,180 tones) was discharged at Cheong Gye Plaza and the rest from four locations in the forms of fountains and waterfalls. Existing four continuous sewer boxes (culverts) of which total dimension 12m×4.3m were exposed at the starting point of restoration. Without rain water, a small amount of waste water runs in the boxes. In the case of flood, however, floodwater would flow the whole boxes.

In the upper reaches, there are more coarse sands on the bed of the stream. This topographical condition is vulnerable to water permeation which causes loss of the supplied water. Therefore, design guidelines which will allow up to 3 % of water loss were established. To meet the requirement, clay mats were installed in the stream bed. Also, cut-off walls which are about 10 meter deep and 50 cm thick on average were installed using high pressure square-shaped jet grouting on both sides of the water way.

2.5 Bridges

Turning roads into a stream is bound to block the free traffic between both sides of stream. Therefore, in order to keep the same traffic flow after restoration, the total number of 22 bridges were constructed, including both vehicle and pedestrian bridges (Fig.8), at all the existing intersections and crossings respectively. One of them was restored from the old bridge that was buried under the covering structure for several decades (Fig.9). The bridges across the restored stream span 20 to 100 m and range in width from 26 to 59 m. It is worth noting that the width of the vehicle bridges is greater than their length. Such geometrical features made it difficult to emphasize the structural aesthetics of bridges.

Fig.8. A pedestrian bridge under construction

2.6 Landscaping

Restored Cheong Gye Cheon provides an uninterrupted tract of green space covering 276, 650 m^2 along 5.8 km of the stream. The basic concept of the landscape design is to implement the image of 'Urban Stream with Nature.' The downstream is more nature-like than the upstream. Landscaping focused on the optimal balance between exploitation and ecology. To comply with the concept, natural elements were stressed while respecting opinions of the citizens who would visit and exploit the area. To this end, the northern side of the stream was mainly considered as a promenade for citizens and the southern terrace highlighted ecology. Scouring force during flood was one of the main concerns in the landscape planning. Soils for roads were hardened with cement and some areas where vortexes were expected, were paved with mostly stone.

Along the stream, small squares, art works, waterfront decks were built for citizens and biotopes were introduced for plants, fishes and birds. The streambed of upper reach is mostly built with stone to resist scouring. Slope walls of 41,889 m^2 separating roads from the stream with a height of 2 to 6.5 m were newly built, and the surface of the wall was covered with granite plate to recreate the past image of

masonry wall.

As there are several traditional night markets adjacent to Cheong Gye Cheon, the importance of night activities in cities was considered in the phase of planning. In addition, it is also considered that night view is one of the most significant elements adding to city's attraction. Lighting of some area including Cheong Gye Plaza accented, while others are minimal lighting for protecting ecological system. Lighting plan was completed with help of the British born lighting expert, Mr. Andre Thames, who suggested water tight and indirect lighting. Fig.9 and 10 show two places with accented lighting.

Fig.9. Night view of the restored historical Gwangtong Bridge

Fig.10. Night view of the tunnel-waterfall with the existed bridge piers of elevated road structures

2.7 Project Management

2.7.1 Civil complains and public participation

It was not easy to control a construction site that was exposed to hundreds of thousands of people at the centre of the city. There were initially two big public involvement problems: resolving inconvenience and encouraging participation. The inconvenience involves two issues: traffic congestion caused by the reduced lanes of roads and economic loss to businesses adjacent to the stream due to construction work. The traffic problem was eased by introducing new transportation policy focusing on public transportation. For compensating business losses, measures to provide business stability fund and to relocate the places of business to other areas where tenants and/or owners want were introduced.

Intensive public involvement programs were operated; project teams had about 4000 meetings with residents and citizens individually or in groups. To motivate citizens' participation, the Wall of Hope Program was developed. More than 20,000 citizens participated and wrote down their wishes on a 10cm×10cm ceramic tile and put them on the slope wall as shown in Fig.11.

Fig. 11. Citizens' participation: the Wall of Hope

2.7.2 Schedule and Cost Management

The Cheong Gye Cheon restoration work took 27 months. The demolition was completed 3 months earlier than planned by introducing more work sites than planned. During the rainy season, the water floods within 30 minutes after rain begins. This caused many constraints to working in the stream bed. Construction progress were managed tightly.

The construction cost at the initial stage was estimated at 357 million dollars. The cost rose to 386 when the project was completed, up 29 million dollars. The reasons behind the hike of the cost are as follows: introducing measures to improve the water quality, setting up broadcasting devices and CCTV for maintenance and adjusting costs for inflation.

3. CONCLUSIONS

Since Seoul became the capital of Korea, Cheong Gye Cheon has played diverse roles, such as a natural rivulet in the beginning, a huge sewer, a main urban road in the industrial age and finally a stream again.

The Cheong Gye Cheon restoration project was initiated based on citizens' demand to improve the quality of urban life. Initially, it was influenced by other restoration projects

like Bievre Restoration Project in Paris, France, Potsdam Canal Restoration in Germany and Waterfront Restoration of Providence in New York and San Antonio in Texas, United States. However, the Cheong Gye Cheon Restoration Project now returns a positive stimulus to many cities which consider a similar one.

Fig.12. View of restored Cheong Gye Cheon in the upstream (top) and downstream (bottom)

After restoration, the number of species in Cheong Gye Cheon including migratory birds, bugs, and fishes are on the rise. In only 2 months following the restoration, a quarter of Koreans (around 10 million) visited the restored Cheong Gye Cheon. In areas adjacent to Cheong Gye Cheon, a great change in urban business and planning around the stream is taking place. Buildings with picturesque views of the stream are turning into restaurants or cafés. In addition, large scale reconstruction and redevelopment projects are now being undertaking along with the stream.

To fully complete the eventual goal, restoration should be continued even after completion of construction by channeling citizens' interests and efforts to help the adaptation process of naturalization.

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