

CHEONGGYECHON RESTORATION AND URBAN DEVELOPMENT

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ABSTRACT: The design and construction aspects of the Cheonggyechon Restoration Project in Seoul, Korea are presented in this paper. The Cheonggye-chon('chon' means a stream) is a stream that flows from west to east across the northeastern quarter of Seoul. It had been covered by a concrete deck structure, served as a roadway that had been one of the capital's major arterials. An elevated expressway above the road was built to handle increased traffic loads. Due to several reasons, it was decided to remove the concrete roadway and the elevated expressway, and restore the environmental health of the stream. This renewal project not only brings environment-friendly eco-system to the area, but also promises a new economic life into the area.

It is the largest urban renewal project in Korean History. This work will include dismantling the elevated expressway, removing concrete structures covering the stream, constructing a total 21 bridges across the open stream, maintaining roadways of two to three lanes on both sides of the stream, providing new landscape and lighting system. The project started on July, 2003 and is to be completed on September this year. The Project is expected to achieve goals for restoring the stream, bringing old history and culture back, allowing more pleasant life to citizens and opening up a new and bright economic future to the area.

KEYWORDS: Urban Renewal, Restoration of Stream, Environment-friendly, Removal of Concrete Structure

1. INTRODUCTION

1.1. Overview

The largest urban renewal project in Korean history, the Cheonggyechon Restoration Project, began in July 2003 in Seoul and is to be completed by September this year. The Cheonggyechon, a stream flowing from west to east across the northeastern quarter of Seoul, had been covered by a concrete deck structure and used as a roadway that had been one of the city's major arterial roads. An elevated expressway above this road was built to handle an increased traffic load. The renewal project will seek to restore the environmental health of the stream by removing the concrete roadway structure and the elevated expressway and then restoring the stream and landscape. In the process it will also bring a new economic life into the area.

1.2. History of Cheonggye-chon

The Cheonggyechon has a total length of 10.92km and occupies an area of 50.96km². Since the late 14th century, when Seoul was designated as nation's capital, the stream has not only divided the capital geographically but also marked a boundary in the

realms of politics, society, and culture. Flooding, however, was a formidable problem, and efforts for flood control continued to the early 20th century. Unauthorized housing structures were built on the banks of the stream, and the sanitation left much to be desired. During torrential downpours, overflows used to dump raw sewage and debris into the stream and all over the area nearby. The solution adopted to handle these problems was to cover the stream with the concrete structure having enough cross sectional area for flood drain. The first plan was formulated in 1926, and the work began in 1937. The stream was fully covered in 1961 and partial repairing works continued intermittently till 1978. Since the covered concrete structure had been working as an arterial roadway, commercial buildings sprang up on both sides of what became Cheonggyechon-ro. The amount of traffic steadily increased over years and a detour road for motorists to bypass the congested downtown area was much needed. Eventually an elevated expressway was built over the Cheonggyechon-ro from 1967 to 1971 as shown in Figure1.



Figure1. Cheonggyecheon-ro and the elevated expressway (length 5.8km)

1.3. Background of the Project

Cheonggyecheon-ro is 50 to 80m wide and 5,400m long. The elevated expressway had a width of 16m and ran for 5,800m. In recent years, signs of deterioration in the expressway and the concrete structure covering the stream gave rise to concern over the safety and structural integrity. Following recommendations given by KSCE(Korean Society of Civil Engineers) in 1992, massive repair works were executed. In spite of these efforts, the long-term stability of the structure could not be ensured. The Cheonggyecheon Restoration Project was thus formulated not only to handle the stability and safety problems but also to revitalize the area economically and improve the living environment of the area.

2. NEW PARADIGM OF URBAN DEVELOPEMENT

2.1 Past Development of Cheonggye-chon

In the past, the urban development was mainly focused on the maximization of economic profit and hence the amenity of city life, the quality of urban environment and the cultural diversity were ignored in the process of the urban development. The urban development also brought the loss of humanity and social identity, destruction of natural eco-system and aggravating urban problems. The urban development in Seoul was accelerated with the covering of old stream (Cheonggyecheon) flowing from west to east and hence dividing Seoul into two parts. The covered concrete structure was used as one of the arterial roads in Seoul, resulting in the fast development of the area. The rapid growth of traffic in the city forced to have an elevated expressway constructed over this Cheonggyecheon-ro.

2.2 Needs for New Paradigm

The strategy of the urban development has been

changed at the end of 20th century from the growth-oriented model to the management-oriented model. Several good examples adopted in this strategy can be found in the San Antonio River Walk and the Boston Big Dig in USA , and Sanjicheon Project, Cheju, in Korea. Apart from the strategic point, Seoul city wanted to satisfy the following needs or problems of the city:

- 1) Deterioration of city environment
 - Traffic congestion in the area of Cheonggyecheon
 - Air and noise pollution
 - Lack of regional identity due to conglomeration of different kinds of business.
- 2) Decline of regional economy
 - About 63% of head offices of big companies located in the southern part of Seoul('Gangnam').
 - Decrease in the number of residents and workers in the region over the past decade
 - Continuous decline of competitiveness.
- 3) Safety of the elevated expressway
 - Deterioration of the structure due to long service and sub-standard structure from today' point of view.
 - Safety of traffic passengers
- 4) Creation of environment-friendly space
 - Transforming Seoul into environment-friendly city by restoring urban ecology
 - Human and nature co-existence principle
- 5) Recovery of historic significance
 - Restoration of cultural relics

- surrounding Cheonggyecheon area
- Enhancement of the cultural image of the city.

2.3 Concept and Philosophy

The basic concept for the Restoration Project is to recover the ecologically-sound environment which has been deteriorated seriously in the process of the industrialization and urbanization, and to restore the intrinsic functions of the river, such as water utilization, flood control, environmental preservation and others. The Restoration Project will bring back a clean, green and open space in the middle of the city, which will make co-existence of human and nature possible. With creating environment-friendly space in the city, Seoul city also wants to restore the culture and history of Seoul and plans to accommodate an international business and financial center in the same space, aiming for the 21st century's cultural and environmental city, Seoul.

3. PLAN AND DESIGN

3.1 Project Plan

The restoration of the Cheonggyecheon is a milestone project, heralding a new era in which the history, the culture and the environment become new core value over developmental and economic priorities. The

project, essentially restoring an environment-friendly ecosystem, is reflecting the wishes of citizens for the quality of life over the economic development. The city of Seoul wants to restore the legacy of 600 years' old history of the capital city and also tackle the long-standing unbalance between Gangnam and Gangbuk districts.

The restoration work will revive 5.9km long stream flowing west to east. As many as 21 various types of bridges will be built over the restored stream. Along both sides of the stream, sidewalks and two- or three-lane roads will be constructed. About 274,000m² of grass and recreation space will make the area more pleasant and enjoyable. Various streetlamps and underwater illuminators will be set up to enlighten the cityscape at night.

As shown in Figure 2, the project is divided into three sections and the major work items are dismantling the elevated expressway, removing the concrete structure covering the stream, constructing a total of 21 bridges across the open stream, and maintaining roadways of two or three lanes on either side of the waterway and landscaping of river banks (Table 1).

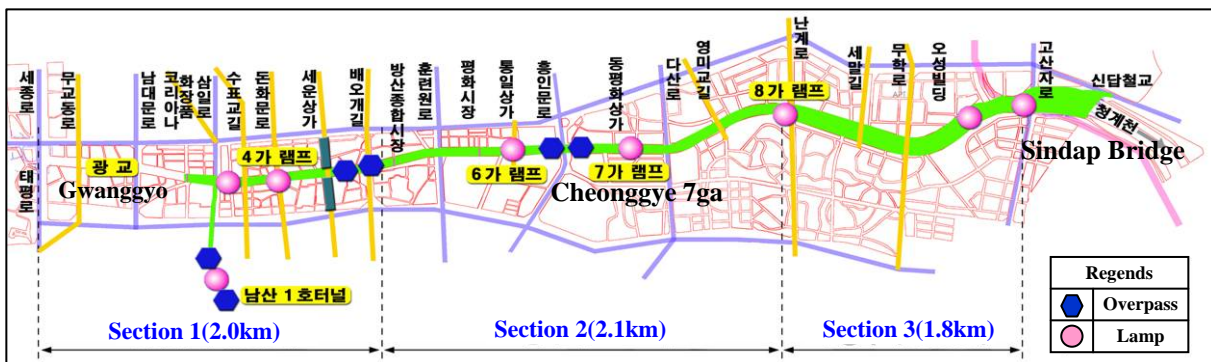


Figure 2. Three sections of Cheonggye Restoration Project

Table 1. Summary of work items in three construction sections

Section 1	Section 2	Section 3
Taepyung-ro~Gwangjang Market	Gwangjang Market~Nangye-ro	Nangye-ro~Shindap Bridge
1. Demolition - Covering Structure : 1.5km - Overpass Structure : 2.2km - Sewer : 2.6km 2. Stream Restoration : 1.8km 3. Improvement of Sewer: 4.6km 4. Bridges : 8 5. Landscape : 2.0km	1. Demolition - Covering Structure : 2.1km - Overpass Structure : 2.1km - Sewer : 2.3km 2. Stream Restoration : 2.1km 3. Improvement of Sewer : 6.5km 4. Bridges : 8 5. Landscape : 2.1km	1. Demolition - Covering Structure : 1.7km - Overpass Structure : 1.6km - Sewer : 0.1km 2. Stream Restoration : 1.7km 3. Improvement of Sewer : 3.6km 4. Bridges : 5 5. Landscape : 1.7km

3.2 Demolition Plan of the Existing Structure

In dismantling the elevated expressway and concrete deck structure, particular attention has been given to minimizing such side effects as noise, vibration, and the creation of dust. To dismantle the concrete structure, the following dismantling methods were applied for different type of structures:

- Concrete deck slab - crusher
- PSC beams of elevated roadway - diamond wire
- Piers of elevated roadway - diamond wire and

drilling device of the breaker type

The dismantling work started with the removal of ramps first, the sections away from the intersection next, followed by the sections over the intersection and then the pedestrian overpass. After removing the elevated roadway, the covering concrete deck structure of Cheonggyecheon-ro was then removed, together with its foundation. The demolition work generally followed the orders shown in Figure 3.

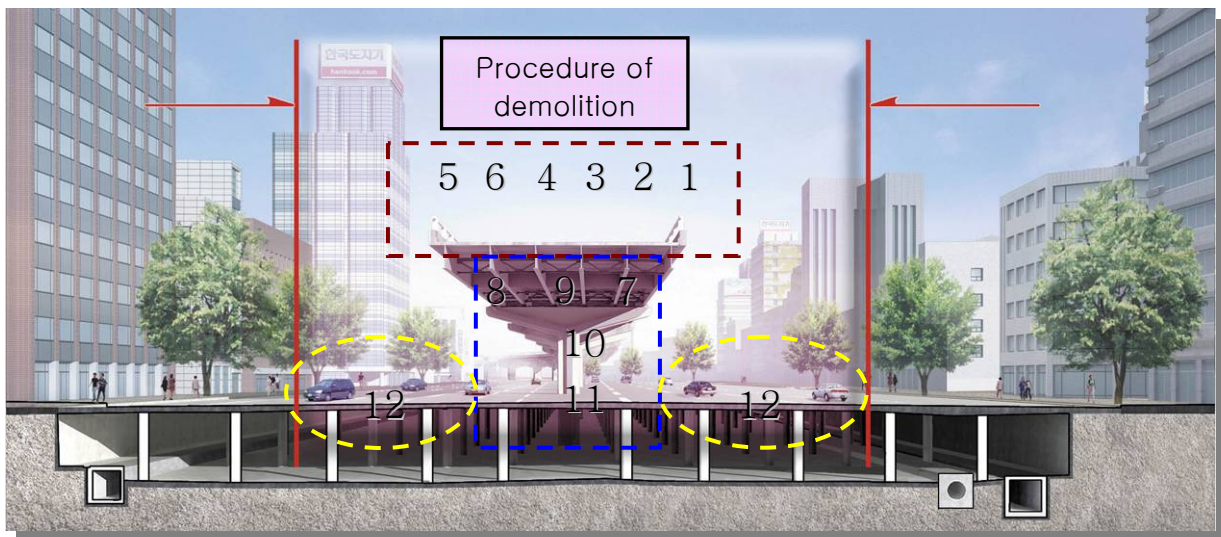


Figure 3. Procedure of demolition work

It is estimated that about 1.14 million tons of garbage and waste were generated by removing the structures along the stream. Most of them were recycled as a variety of landfill materials and hence the actual amount of garbage and waste transported to the Gimpo Reclamation Area was within the legal limit of 25% of total waste. Approximately 76,000 tons of steel reinforcement and steel materials were recycled.

3.3 Water Supply Plan

The major task in the stream water management is to maintain the stream depth of at least 30 cm. The possibility of using the groundwater from the surrounding area was eliminated due to a web-based system acoustic stage gauges, and data loggers. With this system, it is expected to monitor the water stage and supply, the ecological state of the stream, and the amount of seepage loss.

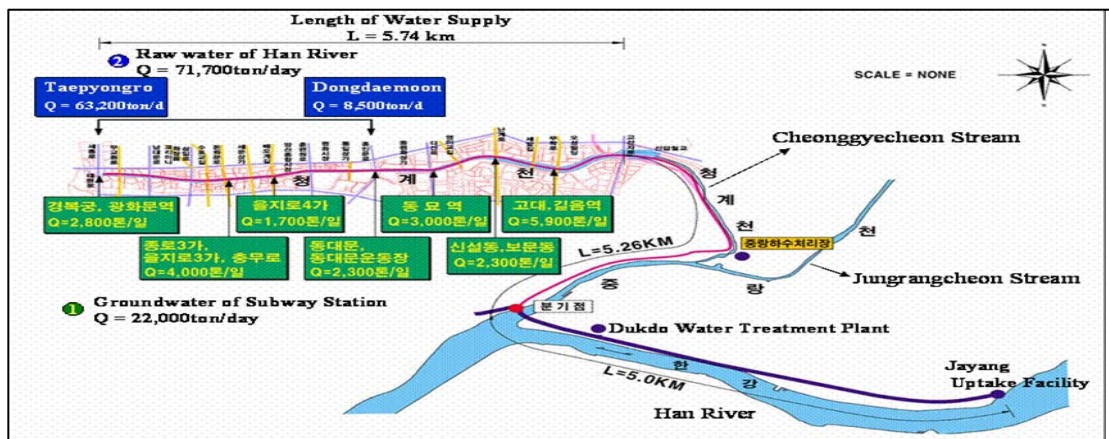


Figure 4. Water supply plan for stream maintenance

3.4 Sewage System Improvement

A part of Restoration Project is to improve the wastewater treatment system of the area vicinity. The intercepting sewers in the existing system are of the box or U type, and the odor is a problem. When the inflow per hour exceeds to a certain limit, the overflow occurs and causes water pollution. The plan for combined sewer is to be in the form of covered box type. After removing the existing system, a new

line would be built for the purpose of capturing and handling the overflow.

To accommodate the overflow during the storm, the capacity of the new line is designed to be 300 percent of the maximum wastewater flow. Polyethylene separating wall would be used in delivering the overflow to the subsidiary treatment(C.S.O box in Figure 5).

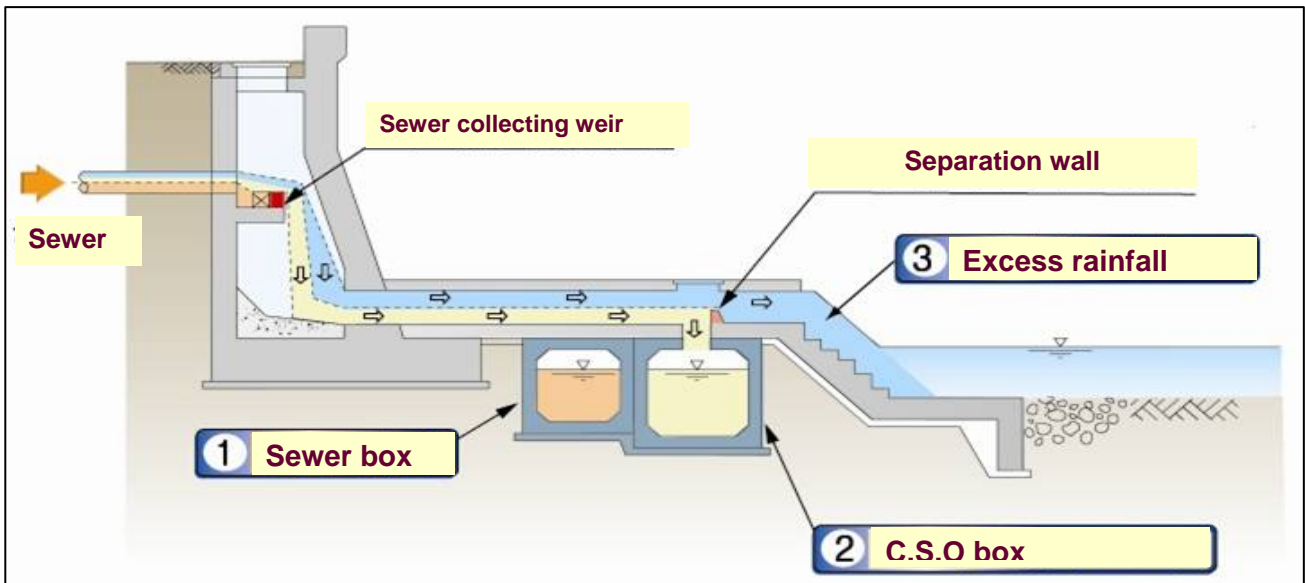


Figure 5. Schematic diagram of combined sewer system

3.5 Bridge Plan

As shown in Figure 6, the concept of bridge design gradually changes from the connection with historic bridges in the upstream, harmony of the old and the new in the middle-stream to an image of future in the downstream. The bridges that span over the restored

waterway have been designed to reflect the characteristics of their neighborhoods. The bridges across the restored stream have span of 25 to 30m and their structural types vary from the cable-stayed arch, PSC Rahmen structure, steel plate, preflex beam, to girder bridges.



Figure 6. Location and concept of bridge

The design of bridge has been guided not only by Korean design standards but also by those of the American Association of State Highway and Transportation Officials, the Post-Tensioning Institute, and ACI International Standard. The British Standard

also has been used, together with Japan's Manual of Durable Design for Concrete Structures. The strength design method was used in assessing the likelihood of deflections, fractures, and fatigue in the reinforced-concrete structures. The PSC structures were analyzed to ensure that they could handle both

normal service loads and ultimate loads. The allowable stress design method was used for the steel structures.

A monitoring system consisted of tension sensors, accelerometers, and deformation gauges, will be put in place for the purpose of bridge performance monitoring and maintenance. The system will detect

any abnormal movement and trigger an alarm if a threshold value is exceeded.

3.6 Landscape Plan

The fundamental concept of landscape design is a gradual transformation from urban landscape to one incorporating nature as shown in Figure 7.

Section 1 – urban landscape, bridge treading, Supyoseok(water gage)

Section 2 – combination of urban and natural landscape, ecological area, rest area, deck, stepping stones.

Section 3 – natural landscape, deck, large ecological parkland, direct interaction with nature

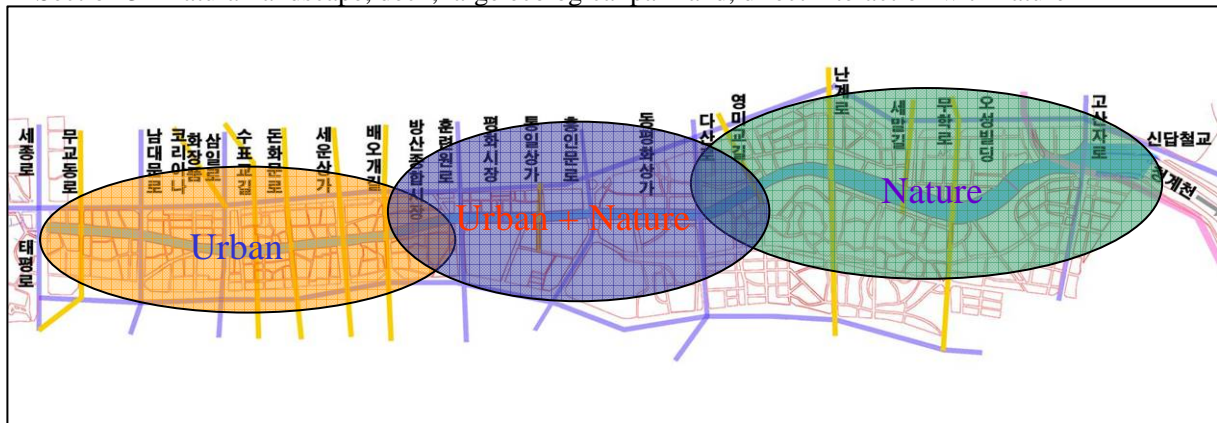


Figure 7. Segmentation diagram of landscape

Landscape design has been made to give the stream some curves and irregularities on the streambed, aiming for a better fish habitat. Swamps along the lower reaches of downstream side will be a good habitat to wildlife.

3.7 Lighting Plan

The lighting scheme has been designed to give the stream and its neighborhood a distinctive character at night. The lighting plan is concentrated on some selected target areas, such as the starting point, Gwang-gyo, Su pyo-gyo and Dongdaemun. An appropriate degree of illumination to fish and insect life will be adopted. For safety purpose, the landscape lighting will be shut down automatically during the flood and torrential downpour. The heat emitted by the light fixtures has been designed to promote plant growth.

4. CONSTRUCTION

4.1 Project Management

The construction of the Project started July 1, 2003

and is expected to be completed by September 30, 2005. The Project has been divided into three sections for the timely completion and awarded to three main contractors, as shown in Table 2. Hyundai Engineering and Construction Co., Ltd.(HDEC) in which the author is currently employed is in charge of the construction of Section 3 of the Project. The Project was tendered in the form of Turnkey Bidding in which the Contractor was preparing the design and construction in one package and submitting for the evaluation. The Project was awarded to the Contractor based on the technical (design) excellence and the project cost. Since the design for three sections were made by three different Engineering Companies, as shown in Table 2, some harmonization work was carried out to ensure unified themes or concepts in the design of bridge, landscape, lighting and other items. Designs of several bridges have been altered later and replaced with the old ones to bring the unified theme to the Project.

Table 2. Contractors and designers for Three Project Sites

Section	Main Contractor	Main Designer	Independent Check Engineer
1	Daelim	Cheongsuk Eng.	Suhyoung Eng.
2	LG Construction	Saman Eng.	Cheil Eng.
3	Hyundai Construction	Dongmyung Eng.	Cheongsuk Eng.

During the construction, the progress management, project coordination and project inspection were carried out by Independent Site Check Engineer(ISCE), as shown in Table 2. The role of ISCE is to inspect the quality of work, monitor the progress, and coordination of the project with the Client. A unified Project Management Information System(PMIS) was introduced in the beginning but it turned out to be not very useful, mainly because of different Contractors in turnkey project.

4.2 Traffic Management

The Cheonggyecheon-ro had served as a principal arterial road before the project started. Since the traffic flow of the area and the city as a whole, after removing the major portion of lanes in Cheonggyecheon-ro, was a main concern to the city government, Seoul city introduced a new transportation scheme mainly for mass transit bus system. The main ingredient in the new scheme is bus-only lanes connecting the outskirts of the city and downtown by a straight line, thus forming radial bus lanes meeting in downtown area. With the new scheme introduced, Seoul city delayed the removal of the elevated expressway and Cheonggyecheon-ro one week to monitor the traffic condition of the area. After finding that the traffic condition at the site turned out to be manageable, the removal of the structures started July 8, 2003. The traffic flow during construction has been managed using just two or three lanes on both sides of the stream and temporary bridges.

4.3 Construction Work

Major work items of the Project in three sites can be summarized as follows;

- the removal of the existing roadways,
- maintaining of two or three lanes on both sides of the stream,
- rearranging water supply and sewer lines
- bridge construction

- landscape work
- lighting work.

The construction of Section 3 started with the removal of concrete structures which was completed using diamond wire saw, buster, wheel saw and CCR(Concrete Cracking Reagent). More than 75% of 1.14 million tons of construction wastes was recycled in the form of recycling aggregates and steel scraps. Two or three lanes roads were reinforced to take more load from DB18 to DB24 and strengthen the weak and deteriorated parts. For the strengthening of the road deck foundation, micro pile and compaction grouting were adopted and MFRI(Mortar Fiber Rod reinforced Insert) and MDF(Macro Defect Free) wet spray methods were used for the reinforcing of slab and wall of the concrete structure. To maintain water level of the stream steady, a cut-off sheet pile wall was installed on both sides of the stream bank. The water supply line, steel pipe 1,100 mm in diameter, was placed to maintain the stream water level.

As for landscaping work, reeds and grasses along the stream were planted and stone decoration of the wall has been started. The most well-known stones from different parts of Korea are to be used for wall decoration. The remaining works to be completed till May this year are the placement of new road pavement for pedestrians on the flood plain, planting of the grass and trees and miscellaneous works. Starting from June, the test operation of the water supply and other systems will be performed.

4.4 Project Progress

As of January, 2005, the overall progress of the total Project is about 90%. The work progress of Section 3 of the Project is summarized in Table 3. At present, the Project is almost completed except the landscape on the stream banks and some minor works.

4.5 Project Evaluation

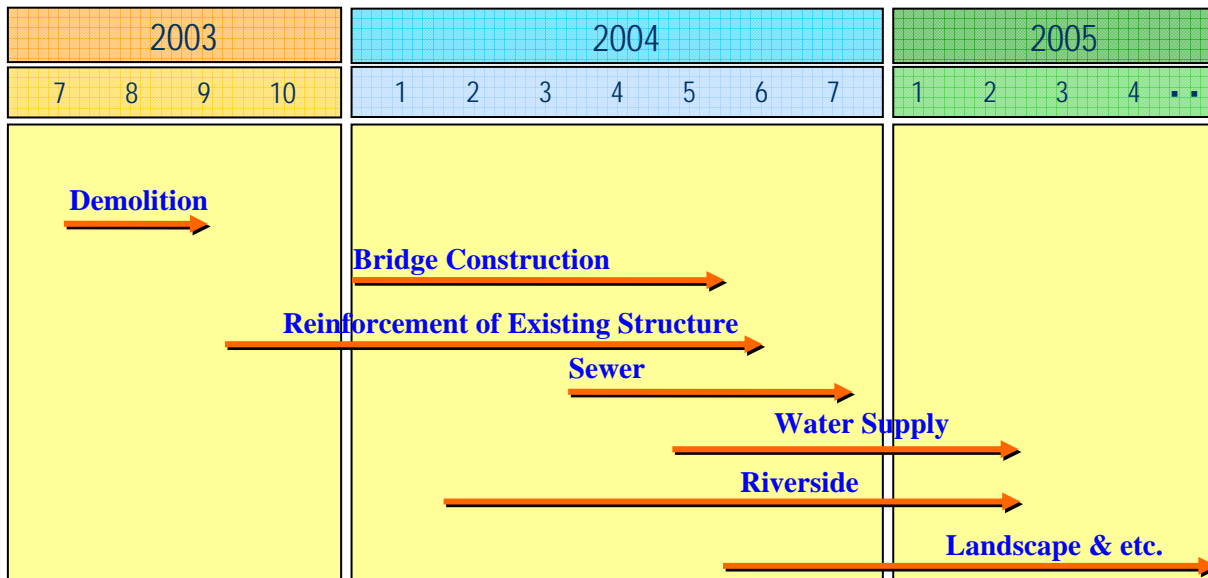
In the beginning, there were some objections against the Project. However, majority of Seoul citizens were in favor of the restoration of Cheonggyecheon and the

percentage has increased as the Project progresses. More than 70% of citizens expected the bright future of Seoul for 3 years to come from the start of the Project.

From the financial point of view, the total construction

cost is to be approximately 350mil. US dollars. The total social cost is in the range of 1,900mil. US dollars, while the total social benefit is expected to be 3,500mil. US dollars.

Table3. Construction schedule of Cheonggyecheon Restoration Project, Section 3



The effectiveness and usefulness of the Restoration Project will be evaluated by monitoring changes in the ecological system of the stream, the groundwater and flow regime of the area and hydrological and water circulation condition at the area. The initial phase of these works has been already started to monitor the initial condition during the construction period and the monitoring and analysis will be completed by year 2007.

After the completion of the Project, the surrounding area will be redeveloped block by block to be a new business district of the city. The development of the first block is in progress for the design and expected to start construction next year.

5. CONCLUSIONS

As an excellent case history for the application of new paradigm in urban development, the Cheonggyecheon Restoration Project is to be expected to achieve the following goals:

- Restoration of old and friendly urban environment
- Recovering the historic and cultural relics
- Balanced development of the city
- Provision of pleasant living environment
- Initiation of extensive redevelopment of the area

Though there were some objections against the Project in the beginning, majority of Seoul citizens have been sending their favorable responses to the Project.

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