KOCED PROGRAM: VISION, IMPLEMENTATION AND LESSONS LEARNED

Jae Kwan Kim\(^1\) and Peggy C. Cho\(^2\)

ABSTRACT

The Korea Ministry of Construction and Transportation (MOCT) launched the Korea Construction Engineering Development Collaboratory Program (KOCED Program) in 2004 to establish a comprehensive base for construction-related testing, research and education. With the ultimate goal of strengthening Korea's international competitiveness in construction technologies, the KOCED Program aims to promote research and development and to set up a nationwide education program to produce highly qualified researchers and practitioners in the various fields of construction engineering. During the next decade 12 large scale experimental facilities will be built and operated at the major regional universities. These facilities are going to be linked with the users along with a digital data repository and supercomputers using a grid architecture high performance information network. This paper outlines the KOCED Collaboratory Program and reports the current progress and future plans. In addition, it discusses the obstacles and difficulties encountered since the inception of the program. This experience is expected to be helpful for those who intend to launch similar programs.

Keywords: cyber infrastructure, grid, collaboratory, networking, IT

INTRODUCTION

Korea has made significant progress in the civil engineering field during the past three decades. Many leading Korean construction companies have participated in several landmark construction projects worldwide. In 1980, the Korean construction companies shared 7.6% of world construction market. But by 2000 it dwindled to a meager 3.1% and was decreasing rapidly. More importantly, in the design, consulting, and engineering service areas, the market share of Korean companies was almost zero. It meant that the design and engineering technology level was not recognized to be high by the world community.

Domestically, the Korean government has invested a large amount of budget in the construction of social infrastructure. New highways, airports, high speed railroads and long span bridges have recently been built. Modern high rise buildings and numerous apartment complexes were also constructed. But the massive construction work failed to be linked to the progress being made in the design and construction technologies. One of the causes is the lack of large scale testing facilities, especially in the structural engineering field. The advancement and development of state-of-the-arts

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technologies and original design methods requires good experimental facilities. The research community felt very strongly that large scale experimental research facilities should be built with urgency in order to be competitive globally, and to enhance the design and construction quality domestically. The civil engineering profession in Korea was in need of renovation and overhaul.

In order to achieve this objective efficiently and economically, a new ambitious project, named as the Korea Construction Engineering Development Collaboratory Program (KOCED Program) was launched by the Korea Ministry of Construction and Transportation. Its objective is to build 12 large scale testing facilities at the major universities evenly distributed around the country and interconnect them using a high performance information network. It will become a collaboratory, operating on a shared-use basis. A digital data repository and a high performance computing facility will be integrated into this grid system. It was inspired by the NEES Program of the United States. While NEES is concerned with earthquake engineering only, KOCED Program encompasses the entire civil engineering field.

In 2004 this program was officially started. As the first step, the Korea Ministry of Construction and Transportation (MOCT) created the KOCED Program Management Center (KOCED PMC) for the purpose of managing the whole program. The mission of the KOCED PMC is to develop a consortium that will operate the collaboratory, to develop and implement grid system that will interlink all the facilities, and to manage the construction process of the testing facilities. This paper describes the outline of the KOCED Collaboratory Program and reports the current progress, future plans, and lessons learned.

VISION

Because Korea was starting from scratch, the KOCED program proceeded in a top-down format. The plan was written by a group of dedicated investigators in 2003 with the following objectives in mind:

1. At least one experimental facility for each discipline of construction engineering is going to be built.
2. All the facilities should be brand new and up-to-date. Their capacity and performance should meet international standards.
3. The whole collaboratory should be shared by the entire construction engineering community of Korea.
4. The facilities should be utilized for both research and educational purposes.
5. The locations of the facilities should be evenly distributed around the country in order to contribute to the balanced development of the country.
6. The Program should accommodate and promote synergy with leading edge technologies in order to renovate the outdated construction engineering standards.

It became evident that the above objectives could be satisfied only if the experimental facilities are tied together using a high performance information network and the collaboratory is operated by a consortium as demonstrated by the NEES Program. Therefore the NEES model was adopted for the KOCED Program. This concept is described in Figure 1. In the KOCED Collaboratory, however, the experimental facilities are not limited to earthquake engineering applications, but extend over the whole civil and construction engineering applications.

The 12 chosen experimental facilities are shown in Fig. 2. These are considered to be prerequisites for the development of new design and construction technologies. The capacity and performance of the facilities are listed in Table 1.
For the balanced development of the country, an even nationwide distribution of the facilities was required. First, the country was divided into 4 regions. Then, based on the predetermined rules, the number and types of the facilities were assigned to each region as shown in Fig. 3. The dimensions and capacities of the facilities are listed in Table 1. The hosting university of a particular facility would be determined through open competition within each region.

Once completed, the KOCED Collaboratory will have widely diversified functions as shown in Fig. 4. The major universities that will host the experimental facilities have responsibilities beyond education and research. Each university will be asked to become a kernel for the regional cluster, consisting of universities and colleges, research institutes, design firms and construction companies in the region. They will collaborate for the development of the regional construction industry and the economy in general (Fig. 5).
Real time hybrid structural testing facility

Geo-centrifuge

Multi-platform seismic simulation facility

Advanced construction materials testing facility

Large boundary layer wind tunnel

Ocean environment simulation wave tanks

Extreme load testing facility

Test facility for long-term environmental effects

Multi-purpose field test facility

Mobile geotechnical laboratory

Reconfigurable large-scale structural testing facility

Large-scale hydro-model test basin

Figure 2. Facilities of the KOCED Collaboratory
<table>
<thead>
<tr>
<th>Stage</th>
<th>Facility</th>
<th>Dimension and Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Real time hybrid structural testing facility</td>
<td>Dynamic Actuators: 250 kN, 1000 kN, 2000 kN Reaction Walls: 21m×12m×3m, 12m×12m×3m</td>
</tr>
<tr>
<td></td>
<td>Geo-centrifuge</td>
<td>Geotechnical Centrifuge: 5m(Radius), 240g·ton 2D Shaking Table, In-flight Robot</td>
</tr>
<tr>
<td></td>
<td>Multi-platform seismic simulation facility</td>
<td>One Fixed Shaking Table (2 DOF): Size: 5m×5m; Two Movable Shaking Table (2 DOF): Size: 3m×3m</td>
</tr>
<tr>
<td></td>
<td>Advanced construction materials testing facility</td>
<td>5MN Concrete Compression Testing machine 600 kN UTM (Steel), 100 kN UTM (Composite Materials)</td>
</tr>
<tr>
<td></td>
<td>Large boundary layer wind tunnel</td>
<td>Two Story Wind tunnel: 10m×2m×10m, 0.5-10m/sec</td>
</tr>
<tr>
<td></td>
<td>Ocean environment simulation wave tanks</td>
<td>3D Irregular Type Wave Generator: 50m×50m×1.5m 2D Irregular Type Wave Generator: 90m×2m×1.5m</td>
</tr>
<tr>
<td>2</td>
<td>Extreme load testing facility</td>
<td>Impact &amp; Collision Test Equipment Explosion Chamber</td>
</tr>
<tr>
<td></td>
<td>Test facility for long-term environmental effects</td>
<td>Durability Test Equipment: EPMA, SEM, XRF, XRD Creep, Shrinkage Test Equipment</td>
</tr>
<tr>
<td></td>
<td>Multi-purpose field test facility</td>
<td>Static Actuators: 300 ton, Shaker: 0.2Hz~15.0Hz Soil Box: 10m×10m×3m</td>
</tr>
<tr>
<td></td>
<td>Mobile geotechnical laboratory</td>
<td>Mobile Test Equipment for Site Investigation High Speed Wireless Network</td>
</tr>
<tr>
<td></td>
<td>Reconfigurable large-scale structural testing facility</td>
<td>Dynamic Actuators: 500kN, 1000kN Fixed Reaction Walls: 16m×5m×12.25m</td>
</tr>
<tr>
<td></td>
<td>Large-scale hydro-model test basin</td>
<td>Open Channel: 50m×1.2m×2m Circulation Channel: 18m×12m</td>
</tr>
</tbody>
</table>
Real time hybrid structural testing facility
- Multi-purpose field test facility
- Testing facility for long-term environmental effects
- Extreme load testing facility

Geo-centrifuge
- Reconfigurable large-scale structural testing facility
- Mobile geotechnical laboratory

Large boundary layer wind tunnel
- Ocean environment simulation wave tanks

Advanced construction materials testing facility
- Multi-platform seismic simulation facility

Metropolitan

Chungcheng-Gangwon

Honam

Yeongnam

Figure 3. Regional distribution of test facilities

Figure 4. Functions of the KOCED Collaboratory
THE ROLES OF KOCED PROGRAM MANAGEMENT CENTER

The KOCED PMC will play the key role in the execution of the KOCED Program. The mission of the KOCED PMC can be classified into three categories. First, the KOCED PMC will monitor and coordinate the construction of the experimental facilities. Second, it will develop the operating rules for the KOCED Collaboratory and technologies for the education and research applications. And third, the KOCED PMC should develop and implement the grid system that will link the experimental facilities seamlessly with users, the data repository and the supercomputer. These roles of KOCED PMC are described schematically in Fig. 6.

CURRENT PROGRESS FUTURE PLANS

The original time table of this project is shown in Fig. 7. According to this plan, 12 experimental facilities will be built, the grid system called “KOCED grid” will be constructed, and the consortium will be developed for 6 years from 2004 through 2009. The budget for the construction of 12 facilities and development of the KOCED grid and KOCED Consortium is expected to exceed 100 million USD.
Develop operating rules and regulations of consortium

Manage construction of test facilities

Develop application technologies

Develop and construct KOCED grid system

Figure 6. Roles of the KOCED PMC

<table>
<thead>
<tr>
<th>2004~2009</th>
<th>2010~2024</th>
<th>2025~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Test facilities</td>
<td>Collaboratory Operation by consortium</td>
<td>Turnover to the hosts</td>
</tr>
<tr>
<td>Development of KOCED Grid</td>
<td>KOCED Consortium</td>
<td>Host Universities</td>
</tr>
<tr>
<td>Development of KOCED Consortium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6 years 15 years

Figure 7. Strategic plan of the KOCED Program

During the 15 year period starting from 2009, the KOCED Collaboratory will be operated on a shared-use basis and managed by the KOCED Consortium. In the year 2025, all the facilities will be turned over to the hosting universities.
In 2004 the KOCED PMC completed the basic design for the 12 facilities. Hosting universities for the first 6 facilities were determined through open competition in December 2004 as shown in Fig. 8. A research center was established at each hosting universities to manage its testing facility. Detail designs of these facilities have been completed followed by the actual design starting from August this year. Each Center will hold the ground breaking ceremony this fall including commemorative lecture.

The KOCED grid will be built using the existing high performance information network called KREONET (Fig. 9). This network is operated by the Korea Institute or Science and Technology Information (KISTI) with which the KOCED PMC is negotiating on the terms of usage. The KISTI is very positive in providing the networking service and is willing to extend the network to Centers which have not been linked yet.

For various reasons, however, the construction of the second six testing facilities has been postponed. The revision of the 2nd phase is being under review. It has been suggested that the KOCED Program be extended to incorporate such fields as transportation, environmental and architectural engineering. It has also been proposed that all the existing testing facilities in Korea be connected to the KOCED grid.

One of the long term goals of the KOCED Program is to create one single virtual campus for the whole nation. It is envisioned that as IT progresses eventually the boundaries of universities will disappear. The students will be able to attend lectures remotely through the KOCED grid system. These lectures can be carried interactively; with students getting advises remotely from the professors. They can do their experiment and research at any place through KOCED Collaboratory. It will open an exciting new era to the college education. The KOCED PMC will pursue the task of implementing this very idea.
LESSONS LEARNED

The KOCED Program is very unique in the R&D history of Korea construction engineering field. It was planned and made into a major government funding research program by the devoted researchers in rather rapid phase. Consequently there was not enough time for the consensus buildup in the construction engineering community, which caused many difficulties. Since the program officially started in 2004, some people have expressed their doubts as to whether it is worthwhile and feasible. The institutes that own large testing facilities were not supportive of the program, and the universities that failed to win the competition turned critical about it. The majority of construction engineering community was skeptical about the GRID system. The government officials were not enthusiastic over the program with the funding agency reluctant to provide adequate funding. The development of KOCED grid requires close cooperation between engineers and computer scientists at the KOCED PMC. It takes time for them to understand and communicate with each other.

For the success of the program like KOCED, it is of utmost importance to convince and persuade the government. In addition a strong support from the construction engineering community is necessity. During the past two years, the KOCED PMC has paid a particular attention to improving the relation with the construction engineering community and the government. The KOCED PMC produced brochures and video CDs about its program. At major conferences the KOCED PMC installed and operated the information booth to demonstrate the Grid system and telepresence technologies.

Now the atmosphere in the construction engineering community is changing into a positive and friendly one. The government, if slowly, has begun to recognize and appreciate the value of this program. Young engineers and researchers seem to believe that the future of Korea construction technology depends on the success of the KOCED Collaboratory. The KOCED PMC will do its best to serve the whole community.
CONCLUSIONS

The main objective of the KOCED program is to lift the technology standards of the civil and construction engineering fields to a higher level. The outcome of this program will be welcoming, efficient and safe infra-systems. The benefactors will the public. Moreover, the benefits should not be limited to within the borders of Korea, but should be shared by the world community. We believe that civil and construction engineers should continue to reinvent and renovate ourselves, our profession and our world. In this regards, the international collaboration with substance is a prerequisite. The KOCED PMC will cooperate with the international community to achieve this goal.

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